



Michigan State University Extension
Land Use Series

Sample Zoning for Wind Energy Systems

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This flyer presents a zoning ordinance sample amendment for utility scale wind energy systems and smaller wind electric generation systems for an individual business or home. There are earlier versions of this document. They should not be used. There are significant and important updates and changes to this version. Do not use a version dated prior to August, 2017.

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Introduction and History of this Sample Zoning

In April 2008 the Energy Office, Michigan Dept. of Labor and Economic Growth (DLEG) (now the MI Energy, Michigan Agency for Energy, http://www.michigan.gov/energy/) introduced a set of guidelines to assist local governments to develop siting requirements for wind energy systems.

“Thirty seven million acres is all the Michigan we will ever have”
William G. Milliken

This is a fact sheet developed by experts on the topic(s) covered within MSU Extension. Its intent and use is to assist Michigan communities making public policy decisions on these issues. This work refers to university-based peer reviewed research, when available and conclusive, and based on the parameters of the law as it relates to the topic(s) in Michigan. This document is written for use in Michigan and is based only on Michigan law and statute. One should not assume the concepts and rules for zoning or other regulation by Michigan municipalities and counties apply in other states. In most cases they do not. This is not original research or a study proposing new findings or conclusions.

The 2008 sample was the only sample zoning for this topic developed for Michigan communities by State Government or a university. It was written by John Sarver, Michigan Energy Office, retired and now a member of the Great Lakes Renewable Energy Association. It was written with review and input from members of the Michigan Wind Working Group.

In Fall 2002, a group of organizations interested in wind energy in Michigan began meeting. Sarver chaired and facilitated the Michigan Wind Working Group. The Group included:

- wind developers,
- utilities,
- Michigan Energy Office,
- Michigan Public Service Commission,
- U.S. Department of Energy,
- Michigan State University,
- Great Lakes Renewable Energy Association,
- Michigan Environmental Council,
- and many other interested parties.

The Group worked closely with the Wind Powering America program of the U.S. Department of Energy and served as the wind committee for the Michigan Public Service Commission's Michigan Renewable Energy Program. The Group was open to any interested party. They provided a forum for the exchange of information.

In April 2003, the Group began discussing the development of wind siting guidelines. They usually met monthly to discuss the variety of issues related to zoning and siting wind turbines. The guidelines went thru eight drafts before they were finalized in March 2006. There was never a consensus on the variety of issues involved with the guidelines and the Group's participants did not endorse the guidelines. Professor Robert Fletcher, Ph.D. and Daniel Alberts, graduate student from Lawrence Technological University helped by providing briefings on technical issues related to siting. Kurt H. Schindler, AICP, Regional Land Use Educator with Michigan State University Extension reworked the guidelines to make them more useful to planners and put the guidelines in typical sample zoning ordinance language. The rewritten state guidelines, now sample zoning language, were posted on the Energy Office web site in April 2008.

The 2008 sample zoning along with other documents, research, and information was all posted on an MSU Extension web page. In 2015-2016 MSU started an effort to redesign its web pages to meet accessibility standards and for flexibility for viewing with mobile phones. The wind energy materials did not easily convert to the new web design, so much of the information is consolidated into this one document.

In fall 2016 and spring 2017 Schindler and Brad Neumann updated the sample zoning language to reflect additional scientific research and experience from counties and municipalities in Michigan.

(See discussion on sample versus model zoning on page 19.)

What is presented here is a variation on the DLEG's sample zoning and has also not been endorsed by them. The specific changes in this sample zoning that differ from the 2008 guidelines are pointed out in the commentary boxes.

In brief the changes from the 2008 version to this version include:

- A starting point (for discussion) of 45dB(A) noise threshold at the residence property line, edge of the curtilage, or other point.
- 60 versus 90 days for sound testing.
- Road modification plan as a required part of a zoning permit application.
- Greater distances for which flicker mitigation may be required or modeled to determine mitigation practices if needed.
- Introducing the possibility of a lease unit boundary and distances the tower needs to be from that boundary.

The material presented here is not intended to apply in urban areas. It has been developed with the intention of striking an appropriate balance between the need for clean, renewable energy and the necessity to protect the public health, safety, and welfare. The guidelines represent sample zoning language for local governments to consider for rural areas if they amend their zoning ordinance to address wind energy systems.

The Michigan Agency for Energy has no authority to issue regulations related to siting wind energy systems.

Different requirements are presented 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 single 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 typically have towers up to 30 meters and Utility Grid wind energy systems can have towers up to 100 meters or more in height.

Court and case law

Utility scale wind energy have been very controversial in some communities. Even so, there has been relatively few court rulings from a court of record (Michigan Appeals Courts, Michigan Supreme Court).

Cautions and Commentary

All of the principals and rules for zoning apply to zoning regulations relating to wind energy systems. Just because a wind energy system is strongly opposed, or strongly supported does not mean that basic due process and other rules do not apply. These issues are covered here because we have seen communities try to circumvent these basic principles because of strong feelings for or against wind energy systems development in their jurisdiction.

They do. These include the following:

Procedural Due Process

Requirements for procedural due process,¹ meaning going through all the notifications, rendering decisions based on standards in the zoning ordinance and competent and material evidence, and more, still must be followed.

Substantive Due Process

When regulating people's property, one of the major concerns in the United States is that the regulation does not become too restrictive thereby infringing on a person's private property rights, or regulating in areas outside of what is appropriate for government.

Substantive due process has to do with the substance of the regulation, and that the regulation has a logical connection between the government's purpose and the regulation itself, and finally that the regulation is the least amount possible while still achieving the public purpose. Substantive due process is one of our constitutional rights found in the 5th and 14th Amendments, Bill of Rights, of the United States Constitution. The U.S. Supreme Court used substantive due process to give added force to the 4th, 5th and 6th Amendments of the U.S. Constitution.

Substance of the Regulation

Not everything is a legitimate subject for government to regulate. For example, local government regulation that infringes on constitutional liberties would be out-of-bounds for a local ordinance.

Commonly, with zoning ordinances, there are sign regulations. The regulation of signs is permissible provided it is about placement, size, lighting and so on. But if the regulation is based on what the sign says, that conflicts with free speech.² Thus, regulation of signs must be content-neutral; government cannot regulate what the sign says and cannot treat one sign differently than another based on what the sign says.

So the regulation has to have a rational government purpose, or further a legitimate governmental interest.

Regulation Related to Purpose

The second part of substantive due process is that the regulation relates to the government purpose. In simple terms, that means the local government should be able to explain how the regulation accomplishes its purpose or goal. With zoning, in Michigan, one looks to the master plan to contain the goals, objectives, strategies and actions upon which the zoning ordinance (regulation) is based. Within the master plan there are certain elements, comprising the "zoning plan," which more directly tie regulation in zoning to goals, and objectives in the master plan.

Zoning ordinances include a zoning map dividing the municipality into various zoning districts. The zoning plan elements of the master plan should clearly show how the master plan developed those particular geographic areas – such as text and existing land use maps and analysis, future land use map,

¹ U.S. Constitution, Amendment V; Michigan Constitution of 1963, Art. I, §17

² First amendment to the U. S. Constitution.

projections showing future housing, commercial and industrial needs, natural resource attributes for working lands and so on.

So there needs to be a rational connection between what is trying to be accomplished (legitimate governmental purpose) and the regulation.

Least Regulation

Finally, the rules should be the least amount of regulation possible to achieve the public purpose. If studies and science show a minor regulation will do the job, then that is all that should be required. It would not be appropriate to require additional regulation.

Master Plan and Research

The documentation of substance of the regulation and how the regulation relates to the public purpose should be reflected in the community's master plan, or supplement to its master plan. So the regulation of wind energy should be based on sound university-based research or expert's findings. It is important to use care when looking for such research. With wind energy there is a higher than normal amount of "studies" which are not quality university-based research, and in some instances there is outright fabrication of research.

Applies to Wind-Energy also

Substantive due process deals with the substance of the government regulation. Government may not overly regulate a wind-energy issue. It has to be a legitimate government purpose, not contrary to protected constitutional rights and other areas established through our history of court cases. If the regulation of a wind-energy land use is about a legitimate governmental purpose the regulation has to logically be related to that government purpose and not off the mark or indirect. The regulation cannot go too far and should be the least regulation possible while still accomplishing the public purpose.

Accommodate all Land Uses

The Michigan Zoning Enabling Act requires consideration of all legitimate land uses:

A zoning ordinance or zoning decision shall not have the effect of totally prohibiting the establishment of a land use within a local unit of government in the presence of a demonstrated need for that land use within either that local unit of government or the surrounding area within the state, unless a location within the local unit of government does not exist where the use may be appropriately located or the use is unlawful.³

Given the need for reliable, clean energy, as prescribed in the Michigan Clean, Reliable, and Efficient Energy Act of 2008,⁴ (and the omnibus legislation adopted in 2016) it is unlikely that a local unit of government could successfully argue in a court of law that there is not a demonstrated need for utility scale or home-use wind energy systems, and therefore such systems may be effectively banned through overly restrictive and unreasonable zoning regulations.

³ Section 207 of P.A. 110 of 2006, as amended, (being the Michigan Zoning Enabling Act, M.C.L. 125.3207).

⁴ MCL 460.1051 et seq.

Nonconformities

Local zoning must allow the continuation of a nonconforming use⁵ and expansion of a nonconforming use⁶ (an existing building or use of land that lawfully existed prior to zoning or prior to a zoning amendment). However, the ordinance can provide for reasonable terms for restoration, reconstruction, extension, substitution, and acquiring of nonconforming uses that may limit their life span.

Takings

Local zoning cannot constitute a taking, which occurs if a regulation requires or permits physical invasion by others onto private property or is so sweeping that it, in effect, takes away all economically viable use of land.⁷

Equal Protection

Zoning must provide equal protection of all persons affected by the laws.⁸

It is not appropriate to write regulations which depend on a neighboring landowner to approve something – such as setbacks, noise limits, or shadow flicker. This can run afoul of the equal protection clauses of both the state and federal constitutions. It can also be argued that the result is arbitrary and capricious. The neighbor might say “yes” to one because they are good friends, and “no” to another because of past rancor. That is not a decision based on standards or treating people equally.

Requirements for “good neighbor payments” cannot be done.⁹

Specific List of Special Uses

The zoning ordinance must list possible special uses in specific terms.¹⁰ It cannot be general or broad categories of land uses.

Most ordinances are written in a permissive way. “A permissive format states the permissive uses under the classification [zoning district], and necessarily implies the exclusion of any other non-listed use.”¹¹ So, a zoning ordinance that is silent on wind energy conversion systems actually makes such uses illegal

⁵ Section 208 of P.A. 110 of 2006, as amended, (being the Michigan Zoning Enabling Act, M.C.L. 125.3208).

⁶ *Century Cellunet of Southern Michigan v. Summit Township et al.*, 250 Mich. App. 543 (2002), Jackson Circuit Court LC No. 99-096108-AA.

⁷ Both state and federal constitutions prohibit taking of private property for public use without just compensation – U.S. Constitution, Amendment V, and Michigan Constitution 1963, Article 10 §2. The U.S. Supreme Court has recognized that the government effectively “takes” a person’s property by overburdening that property with regulations. *Pennsylvania Coal Co. v. Mahon*, 260 US 393, 415; 43 S Ct 158; 67 L Ed 2d 322 (1922). As has the Michigan Supreme Court *K & K Construction, Inc. v. Department of Natural Resources*, 456 Mich 570, 576; 575 NW2d 531 (1998). See also *Land Use Series* “Property Taking, Types and Analysis:” http://msue.anr.msu.edu/resources/property_taking_types_and_analysis

⁸ U.S. Constitution, Amendment IV.

⁹ This does not preclude voluntary payments by developers. But such payments must be voluntary, and not in any way initiated, required, or otherwise coerced by the zoning authority.

¹⁰ *Whitman v. Galien Twp.*, Michigan Court of Appeals (288 Mich. App. 672; 2010 Mich. App. LEXIS 1042, June 10, 2010).

¹¹ *Independence Twp. v. Skibowski*, 136 Mich App 178 (1984).

and they are not allowed unless the ordinance is amended to add them to the lists of permitted or special uses, or the zoning board of appeals grants a use variance for the use (and is permitted to do so).

Can't delegate legislative decisions

One cannot use community dispute resolution in the process of adopting zoning amendments. The local elected body¹² cannot delegate away its legislative authority in this way. (However a community dispute resolution process may be a very good idea, and legal, to deal with complaints about issues revolving around the operation of a wind energy system.)

Police Power versus Zoning

The hierarchy for ordinances relative to zoning within a single jurisdiction is established by statute. (Case law dealing with priorities between local zoning ordinance and state statutes is much more complex than outlined here. See *Land Use Series* "Restrictions on Zoning Authority."¹³) The Michigan Zoning Enabling Act reads:

Except as otherwise provided under this act, an ordinance adopted under this act [a zoning ordinance] shall be controlling in the case of any inconsistencies between the [zoning] ordinance and an ordinance adopted under any other law.

—MCL 125.3210, brackets added

The zoning act also preserves the historical priority of township zoning over county zoning. It reads:

Except as otherwise provided under this act, a township that has enacted a zoning ordinance under this act is not subject to an [zoning] ordinance, rule or regulation adopted by a county under this act.

— MCL 125.3209, brackets added

For purposes of this discussion there are two different types of ordinances: (1) police power ordinance and (2) a zoning ordinance. The two types of ordinances are dealing with entirely different subjects and have different procedures for adoption. If a police power ordinance purports to regulate use of land, then it is a zoning ordinance and will be struck down if not adopted according to the procedures in Michigan Zoning Enabling Act. And vice versa. If a zoning ordinance tries to regulate the speed of automobiles on public highways, for example, it's not a zoning ordinance and is *ultra vires*¹⁴ in municipalities that tried to adopt it, even if they do have police power authority.

In a wind energy regulatory jurisdiction dispute an unpublished Michigan Court of Appeals case put forth one simplistic rundown of jurisdiction hierarchy.¹⁵

¹² Township Board of Trustees, City Council, Village Council, and County Board of Commissioners.

¹³ Counties have very limited police power ordinance adoption authority. See http://msue.anr.msu.edu/resources/restrictions_on_zoning_authority

¹⁴ Beyond one's legal power or authority.

¹⁵ Forest Hill Energy-Fowler Farms, L.L.C. v. Township of Bengal Michigan Court of Appeals (Unpublished, No. 319134, December 4, 2014). The hierarchy expressed in this court case was:

- County police power ordinances. (Counties have very limited police power ordinance adoption authority. See "County government powers are very limited:" http://msue.anr.msu.edu/news/county_government_powers_are_very_limited)
- Municipal (Township, city, and village.) police power ordinances will supersede each of the above ordinances.
- County zoning ordinance will supersede each of the above ordinances.

Townships and counties do not have general jurisdiction within the boundaries of a village or city. Thus, cities and villages are independent and usually only their ordinances apply in the city or village.

Conflict of Interest

Members of the planning commission still have a duty to remove themselves from the deliberations, meetings, and voting on an item if they have a conflict of interest. A conflict of interest could, among other things include:

1. Relationship:
 - A. The member is the applicant
 - B. A member's relative is the applicant (how distant a relative could be defined in the planning commission's bylaws.)
2. Proximity:
 - A. The member is the property owner
 - B. The member's property is adjacent, or within a certain proximity to the land under consideration. Proximity could be established in the planning commission's bylaws.
3. Financial:
 - A. The member (or relative) stands to gain financially by the decision of the planning commission (or zoning board of appeals).

With any of these situations if there is question whether a conflict of interest exists, the Michigan Planning Enabling Act (and Michigan Zoning Enabling Act in regards to appeals boards) require the issue be disclosed and the planning commission (or appeals board) vote to determine whether a conflict of interest exists or not. Full recusal of the conflicted member is the general rule in the event of a conflict of interest.

Involvement of the community's attorney that is experienced in municipal (planning and zoning law) is advised when a conflict of interest issue presents itself.

Neutrality

As with any zoning issue, members of the zoning board of appeals and planning commission should not announce or conclude publicly they are for or against a wind energy system or project before the public hearing and all the information has been presented and deliberated, findings of fact have been adopted and reasons in support of the decision formulated, and a motion containing a decision has been made and seconded. Just like any issue, members have the task of remaining neutral so that an application receives its "fair day in court." When this has not been done disgruntled applicants have applied to circuit court asking the judge to remove the member of the planning commission or appeals board who is displaying bias by announcing his or her favor or opposition to a wind energy project.

Many attorneys advise the same duty to be neutral prior to the hearing for members of the planning commission. There are attorneys who advise the duty is not as rigorous for members of a planning commission. This is because special use standards invite and encourage differing viewpoints (compared to appeals board variance standards). Thus, it may be a good thing for planning commission members to

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- Township zoning ordinance will supersede each of the above ordinances.

have differing views on the facts and the evidence, and expressing those views in a hearing or meeting. One should error on the side of remaining neutral for all administrative decisions (planning commission and appeals board).

It is not appropriate for an appeals board member or planning commission member to say “I’m going to vote against X no matter what because I dislike Xs.” But following the hearing and discussion of facts as they relate to the standards in the ordinance, it is fine for a planning commissioner or zoning board of appeals member to express an opinion that is factually based, such as: “I don’t think that your evidence that there is no risk to the community is convincing or meets the standards of the ordinance” even if at that moment such a statement clearly implies or is tantamount to saying that the member will vote against X. The opinion may change as the dialogue on the request continues and other facts and perspectives are brought to the table. That is the job of the planning commission and zoning board of appeals to thoroughly review the request against the ordinance standards and the dialogue helps to shape a group decision.

Must approve if all standards are met

Finally, like any land use, whether a permitted or a special use under the local zoning ordinance, a wind energy system application must be granted if the applicant reasonably satisfies the standards and conditions set forth in the zoning ordinance. To protect the public interest and to assure compliance with the ordinance, reasonable conditions may be imposed as a requirement for approval.¹⁶

Noise

Sample Noise Standards Table in an Ordinance

Zoning District	Night: constant source of noise: ___ hours [e.g., more than eight hour duration]	Night: intermittent source of noise: ___ hours [e.g., less than eight hour duration].	Day: constant source of noise: ___ hours [e.g., more than eight hour duration].	Day: intermittent source of noise: ___ hours [e.g., less than eight hour duration].
Residential and special and unique (environmental) zoning districts	S dB(A) Leq (one hour)	T dB(A) Leq (one hour)	U dB(A) Leq (one hour)	V dB(A) Leq (one hour)
Commercial and office zoning districts.	U dB(A) Leq (one hour)	V dB(A) Leq (one hour)	W dB(A) Leq (one hour)	X dB(A) Leq (one hour)
Agricultural, industrial, and rural residential zoning districts	W dB(A) Leq (one hour)	X dB(A) Leq (one hour)	Y dB(A) Leq (one hour)	Z dB(A) Leq (one hour)

Notes: Need to define “day” and “night.” Where S is the least noisy, and Z is the most noisy: S < T < U < V < W < X < Y < Z.

¹⁶ MCL 125.3504.

Caution and commentary

Regulation of noise can be handled as part of the zoning ordinance, or it might be done as part of a separate police power ordinance. If noise regulations are in a police power ordinance, then the zoning ordinance would include a standard which requires compliance with the noise ordinance.

Such a noise ordinance would be written to address all noise, not just wind generators. This may help insure equal treatment, and avoids accusation of singling out one industry or land use for different treatment.

If done with a police power ordinance the following points should be considered:

- Noise regulation applies to all sources of noise
- Can differentiate based on day or night; residential, commercial, industrial, and agricultural neighborhoods/districts; and intermittent, or a constant noise source (see sample noise standards table on this page).
- Content neutral (free speech)
- Difficulty measuring and thus enforcing.
- More from Huron and Mason Counties experience.

This can also be done with noise regulations within the zoning ordinance. The largest difference between the two, is that zoning has to allow continuation of nonconformities (sources of noise that existed prior to the noise regulation being added to the zoning ordinance). See page 5.

Wind turbine noise has characteristics that differ from other types of noise. Wind turbines produce both aerodynamic noise of the blades moving through the air and mechanical noise from components within the nacelle. Wind turbine noise is characterized as low-intensity, broadband sound, or considered to be more continuous in nature (although it may be amplitude modulated or have tonal components). Wind turbine noise therefore differs from short-term intruding sources of noise, such as traffic, aircraft, etc.

There are unpublished court cases (from other states) which found regulation in zoning that applied only to wind energy generation were not arbitrary or unreasonable.¹⁷ The argument

. . . that the ordinance violates equal protection guarantees by arbitrarily singling out windmills for noise control, and due process because it unreasonably limits windmill noise to 50 dBA while other ambient sounds often rise above that level. The ordinance, however, is a zoning regulation Since it is "social" legislation it need be justified only by a showing that, in any state of facts, it reasonably advances a legitimate state purpose. . . . [and] legitimately protects public health and welfare by proscribing excessive noise. Limiting noise from windmills indisputably advances that legitimate purpose and does so in a reasonable way. The claim that "other ambient sounds" may exist above 50 dBA ignores the distinction between noise (unwanted sound) and natural ambient sounds. It is not unreasonable for Brigantine to classify a windmill's sound "noise" and thus limit it. Nor is it unreasonable for the city to attack the noise problem "one step at a time," beginning with windmills, "addressing itself to the phase of the problem which seems most acute to the legislative mind."

The equal protection standard is the same in Michigan where:

However, unless the dissimilar treatment alleged impinges on the exercise of a fundamental right or targets such protected classifications as those based on race or

¹⁷ *Rose v. Chaikin*, 187 N.J. Super. 210, 223; 453 A.2d 1378 (1982)

gender, the challenged regulatory scheme will survive equal protection analysis if it is rationally related to a legitimate governmental interest.¹⁸

and

[T]he party raising the equal protection challenge has the burden of proving that the challenged law is arbitrary and thus irrational." *Id.*, citing *Neal*, 226 Mich.App. at 719, 575 N.W.2d 68.

The sample zoning provided here is written with both the police power or zoning approach with the option of which approach to take that of the local government. The municipal attorney should be directly involved in the discussion which route is used in any given municipality.

This document is written for use in Michigan and is based only on Michigan law and statute. One should not assume the concepts and rules for ordinance or other regulation by Michigan municipalities applies in other states. In most cases they do not. If adopting a police power ordinance to regulate noise then:

If the ordinance is for a township: The ordinance needs to be adopted according to statute requirement for ordinance adoption by a township (MCL 41.181 *et seq.*).

If the ordinance is for a general law village: The ordinance needs to be adopted according to statute requirement for ordinance adoption by a general law village (MCL 67.1 *et seq.*).

If the ordinance is for a home rule village: The ordinance needs to be adopted according to both statute requirement for ordinance adoption by a home rule village (MCL 78.1 *et seq.*) and any further requirements found in the village charter.

If the ordinance is for a home rule city: The ordinance needs to be adopted according to statute requirement for ordinance adoption by a home rule city (MCL 117.3 *et seq.*) and any further requirements found in the city charter.

If the ordinance is for a county: Chances are the county does not have authority to adopt a police power ordinance. Enabling legislation for general ordinance powers by a county are very limited. See: http://msue.anr.msu.edu/news/county_government_powers_are_very_limited. For a county to be able to adopt an ordinance specific enabling legislation to do so must exist. A county planning commission can prepare sample or model ordinance language to present and/or recommend for adoption by each municipality in the county.

If the ordinance is for a Joint Planning Commission: A Joint Planning Commission does not have any police power ordinance adoption authority. Such ordinances must be adopted by each municipality participating in the joint planning commission. The joint planning commission can prepare sample or model ordinance language to present and/or recommend for adoption to each participating municipality.

There are many different ways for an ordinance to deal with the issues outlined here. The sample provided here is just one. It is written with the assumption municipality's attorney whom is experienced in municipal law will review any proposed ordinance or amendments before they are adopted.

Noise standards

Noise issues are complex aspects of wind energy systems which warrant attention. Many communities do not have any detailed noise standards, or they have standards which are not detailed or specific enough.

¹⁸ *Dowerk v. Oxford Charter Twp.*, 233 Mich. App. 62, 73, 592 N.W.2d 724 (1998).

Regulation of noise tends to focus on volume or sound pressure, expressed as decibels (dB) with various ways of measuring it. But volume is not the only characteristic of noise. It is also characterized by pitch, tone, pulsation, and other features.

There are documented health issues with excessive volume of noise (see the next paragraphs). Thus, the zoning emphasis has tended to be on limiting how loud a land use can be. But that will not satisfy everyone. The other characteristics of noise can be annoying and result in complaints. For example, one can comply with a regulation, not making a noise above the required volume, while running fingernails down a chalk board.

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 – often parallel to the United States Department of Labor Occupational Safety and Health Administration (OSHA) work place safety regulations. The United States Environmental Protection Agency (EPA) and World Health Organization documents indicate that 55 dB(A) is too low to produce hearing loss or long-term health effects.¹⁹ 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 (13.1 feet) before there would be any interference.

dB means decibels.

dB(A) means A-weighted decibels, relative loudness of sounds reducing low frequency sounds because the human ear is less sensitive to low audio frequencies.

L means sound level. **L10** would express the noise level is exceeded 10 percent of the time, **L90** would be 90 percent of the time, using a statistical analysis. For example **L90** might be used to eliminate wind-caused spikes and other short-term sound events that are not caused by wind turbines.

Lmax means the maximum noise measured (not a viable measure for wind energy noise regulation).

Leq means equivalent sound level over a given period of time (e.g., one hour) – average of all sound. For example **Leq 1 hour** for an average noise level over one hour time.

See: <http://www.acoustic-glossary.co.uk/>

Concerning 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.”²⁰ 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.²¹

This document introduces a noise standard range for communities to consider of 45dB(A) to 55dB(A) with the recommendation to select a very specific measurement methodology. See commentary box on page 25-26. A community will need to select a sound pressure level to regulate that is publicly supported and legally defensible. It will also want to adopt measurement methodology for testing conformance with

¹⁹ EPA, 1974. Protective Noise Levels: Condensed Version of EPA Levels Document; and World Health Organization, 1999. Guidelines for Community Noise. (EPA and World Health measure sound differently for the 55 dB(A) sound pressure level.)

²⁰ World Health Organization, 1999. Guidelines for Community Noise: 40 dB(A) Lnight average night sound level over a year of time.

²¹EPA, 1974. Protective Noise Levels: Condensed Version of EPA Levels Document

the regulated sound pressure level. Huron County is one example approach with a detailed measurement methodology.²² Mason County is another example approach.²³

A sound pressure level of 40 dBA measured at a residence may be the lowest standard that is defensible, based on WHO research, if the goal of the regulation is to limit night-time noise disturbance. But the 40 dBA WHO standard is an average reading over a relatively long period of time, a year – requiring ability to have constant measurement of sound over that period of time.²⁴ That is often not practical for local government and thus not easy to implement. This regulatory approach may be more appropriate in a suburban environment, as opposed to rural or agrarian environment.²⁵

One approach that may cover both concerns is to measure noise at the edge of the curtilage or yard.

Besides the selection of a sound pressure level and measurement methodology, a community will also need to select a measurement location for compliance testing and complaint resolution. The thought to measure sound at a property boundary has to do with a person's desire to preserve relative tranquility when outside in their yard versus the residence. The idea is that one lives in the country on a small parcel and part of the value is to not have constant noise from machines. This thought may have merit in residential locations. A counterpoint is that an area with active production agriculture is not “residential,” but rather is a food production industry area. Farmers have activities that generate noise at any time of the day from running machines, noise makers to discourage birds, deer, and other animals from eating crops, and more. It is important to remember the concept that any regulation be applied equally regardless of the source of the noise.

One approach that may cover both concerns is to measure noise at the edge of the curtilage²⁶ or edge of the yard, or 50-100 feet toward the wind tower from the dwelling. This avoids excessive regulation of noise on large parcels where no one resides, but still covers a dwelling and area around the house.

Whatever noise standard or measure is used it is important that the regulation has the following attributes:²⁷

- **Relevance.** Based on adopted ordinance or other law that is within requirements of substantive due process and reflects the way humans hear and react to sound.
- **Repeatability.** It is important for the method for making sound measurements made by more than one party produced similar results.
- **Predictability.** This is so that, during the design, the developer and community have a reasonable expectation of the noise standard requirement and resulting noise which can be modeled with a high degree of confidence.
- **Ease of implementation.** Measures that require a level of sophistication to accomplish the above, but are not beyond the means of the local government to do. For example it is able to be measured by an enforcement officer (or individual with appropriate training in acoustic measuring and

²² <http://co.huron.mi.us/documents/ArticleXWindEnergyOverlayZoningOrdinanceNovember2015.pdf>

²³ <http://www.masoncounty.net/departments/zoning/zoning-ordinance.html>

²⁴ EPA 55 DNL metric is an annual average with 10 dB added to the nighttime sound levels. For wind turbine noise, the annual average is typically about 5 dB below the one-hour maximum (Kaliski, K., Duncan D., "Calculating annualized sound levels for a wind farm" Proc. of meetings on acoustics Vol 9, 2010)

²⁵ Chief Medical Officer of Health of Ontario, Canada, Report The Potential Health Impact of Wind Turbines (May 2010)).

²⁶ An area of land attached to a house and forming one enclosure with it. The term originates from Middle English: from Anglo-Norman French, variant of Old French courtilage, from courtil 'small court', from cort 'court'.

²⁷ RSG *et al*, “Massachusetts Study on Wind Turbine Acoustics,” Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection, 2016.

gathering court-admissible evidence) with readily available sound monitoring equipment (although, some metrics can only be measured by an experienced noise control engineer with specialized equipment).

The state of Oregon standard is 10 dB above the background level, with the lowest assumed background level of 26 dBA.²⁸ (However a standard for noise that is impossible to comply with could be challenged as so sweeping that it, in effect, takes away all economically viable use of land –a taking.) Germany bases its regulation on three different zones, ranging from 35 to 45 dBA.²⁹ Ontario also bases sound and setback on the size of the system (how many turbines).³⁰ New Hampshire went through a lengthy, very extensive, review of wind turbine siting to come up with general standards. They have 45 dBA day, 40 dBA night (8 PM to 8 AM).³¹ A *Frontiers in Public Health* article includes a table of noise standards from various countries.³²

The wind energy system has to be initially designed and built to meet a given noise standard measured over a consistent unit of time. After built, control on noise can occur though after construction noise reduction is limited. One regulatory approach might be required operation in a “night mode,” or set back the turbines farther so they can run at full power all the time.

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.

Mason and Huron Counties, may be a good examples for a sample ordinance on sound (e.g., Mason’s 45 Db(A))± of a utility grid zoning ordinance relating to noise issues.³³ Huron and Mason Counties are examples of working with an Institute of Noise Control Engineering (INCE) Board Certified engineer to develop wind turbine noise regulations with a specific, enforceable measurement methodology.³⁴

See page 34.

Shadow Flicker

Shadow flicker is a shadow that is cast by the spinning wind turbine blades which causes a strobe effect to be cast on a dwelling window or similar structure.

²⁸ Haugen, Kathryn M. B.; “Summary of Wind Policies and Recommendations by Country: Companion Summary Chart to “International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences;” Minnesota Department of Commerce: Energy Facility Permitting.

²⁹ Haugen, Summary chart and

Haugen, Kathryn M. B.; “International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and other Concerns;” Minnesota Department of Commerce: Energy Facility Permitting; October 19, 2011.

³⁰ Haugen, Summary chart and International Review.

³¹ Haugen, Summary chart and International Review and New Hampshire Site Evaluation Committee administrative rules site 301.14(f) in http://www.gencourt.state.nh.us/rules/state_agencies/site100-300.html at <http://www.nhsec.nh.gov/rules/>

³² Berger RG, P Ashtiani, CA Ollson, M Whitfield Aslund, LC McCallum, G Leventhall, LD Knopper. "Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines." *Frontiers in Public Health* (2015) 3:31.

³³ <http://www.masoncounty.net/departments/zoning/zoning-ordinance.html>

³⁴ <http://co.huron.mi.us/documents/ArticleXWindEnergyOverlayZoningOrdinanceNovember2015.pdf>

The distance flicker travels is not well documented. In general the farther away the turbine is from a particular observation point the less the duration of the flicker, the intensity of the flicker decreases (is more diffuse and so bothers a smaller percentage of people) and the lower the likelihood it is observed because of various obstructions, such as trees, structures, topography, that block it. Atmospheric conditions play a role in the distance flicker travels. Clear, dry weather (sunny day in winter) is when flicker will be most noticeable for longer distances. Haze, humidity, a few wispy clouds diminishes flicker intensity and length of travel.

Frequently quoted industry standards are that there should not be a shadow flicker for more than 30 minutes a day or 30 hours per year. This is based on a German standard.³⁵ The German standard is an astronomical maximum of 30 hours but an actual eight hours maximum of shadow flicker. The astronomical maximum refers to a formula where the sun is always shining, the wind turbines are operating all of the time, the blades are oriented in the correct direction to make shadow flicker, and there are no obstacles (buildings, vegetation, etc.) between the turbine and the structure on which the shadow is cast. After an astronomical maximum is determined, a factor is applied (depending on the location, available sunny days, etc.) to get to an estimated amount of time for shadow flicker.³⁶

Technology has advanced since then. Some would argue now the wind industry has the technology to control shadow flicker that it should be held to a much lower number. In Mason County's experience the technology works very well to minimize or eliminate shadow flicker which is limited by ordinance to 10 hours per year. The State of New Hampshire has adopted eight hours.³⁷

Residents in the vicinity of utility scale wind energy systems indicate flicker can be observed at great distances (one testimonial mentions it as far as 10,000 feet for example in Mason County) but it is faint and brief. Based on a couple anecdotal statements flicker a mile (5,280 feet) away is visible and more noticeable. Flicker more than one mile is not as likely because a direct line of sight is blocked (by trees, structures, and topography). It becomes a public policy decision as to what duration of flicker warrants regulation to control it.

Theoretically, the shadow of a 22 meters (72 feet) long turbine blade may be visible up to a distance of 4.8 kilometers (15,748 feet or about three miles). This may occur just a little after the sunrise and just a little before the sunset. Practically, for a 3 MW wind turbine, with a blade of 45 meters (148 feet) length and 2 meters (6.6 feet) width, the shadow of the spinning blade may be visible up to a distance of 1.4 kilometers (4,593 feet), although some weak shadow casting may be observed at a distance of 2 kilometers (6,562 feet).³⁸

Mason County decided to require modeling for flicker for a distance of 20 times the rotor diameter: 2,000 meters (6,561 feet) for a 50 meter (164 foot) blade. Just because a house is modeled to receive flicker does not mean it will be a nuisance. The flicker may occur on a garage or a part of the house that is rarely occupied. Also a house may be modeled to receive flicker, but may not actually receive it due to obstructions.

³⁵ Haugen, International Review; p. 5

³⁶ Haugen, International Review; p. 6.

³⁷

<http://legislature.vermont.gov/assets/Documents/2016/WorkGroups/House%20Natural%20Resources/Bills/S.230/Written%20Comments/S.230-Penny%20Dube-New%20Hampshire%20Wind%20Siting%20Rules-5-6-2016.pdf>

³⁸ Katsaprakakis, Dimitris Al. "A review of the environmental and human impacts from wind parks. A case study for the Prefecture of Lasithi, Crete." *Renewable and Sustainable Energy Reviews*, Vol. 16, Issue 5, pages 2850-2863. June 2012. <https://doi.org/10.1016/j.rser.2012.02.041>.

Mason County adopted a zero flicker policy because (1) it is easier to enforce “is it happening or not” rather than standards based on minutes per day, (2) less burden on landowner, and (3) the wind industry technology to mitigate flicker (turn off turbines when flicker is likely to occur) works really well. This is not advocated or recommended, just one example.

This updated sample zoning requires shadow flicker modeling to a distance of 5,400 feet (or 20 times rotor diameter [which is 6,561 feet with 164 foot blades], whichever is less) from each turbine based on actual experience with Mason County. The 5,400 feet was the farthest distance Mason County documented flicker was observed. This provision was not in the 2008 Guidelines – it simply had a requirement to minimize shadow flicker impacts. A standard of a not more than 30 total hours of shadow flicker per year at any given location is the approach used in Huron County and is also found in some German municipalities.

Any regulation of shadow flicker may be problematic. There is no scientific evidence that shadow flicker presents any health hazard. This can call into question the legitimate public policy purpose for such regulation. The counterpoint is the shadow flicker is a nuisance that may affect quality of life.

Not all wind farms are controversial

Development and siting of large wind energy projects, or wind farms, can sometimes be some of the most controversial issues in a community. In other cases, they do not generate much concern at all.³⁹

Research suggests a community’s and developer’s ability to provide meaningful education, collaborative discussions, with a strong public participatory process very early in the process lessens friction among parties. “Very early” means prior to wind studies or installation of anemometer towers, etc. The research⁴⁰ was done by Peggy Kirk Hall, J.D., and Assistant Professor and field specialist in agricultural and resource law at The Ohio State University.

The focus of Professor Hall’s research was the reasons why a project may be controversial and the factors behind opposition. Then it focuses on things a community can do to further understanding and develop a possible consensus – pro or con – on the wind energy issue.

Hall said it is not accurate and too simplistic to characterize opposition to utility scale wind generation projects as just “NIMBYism” (Not In My Back Yard). There are legitimate concerns which need to be understood and acknowledged, along with an active effort that is needed to mitigate those concerns. In some cases, those concerns cannot be successfully mitigated, and in other cases it may be possible – which may lead to a community issuing local permit approval for a wind farm, or not.

Concern or opposition to a wind farm might be categorized into three areas: (1) anticipated effects, (2) fairness of the development, and (3) values and beliefs, according to research done by David Bidwell (2013).⁴¹

³⁹ An observation by Sarah Banas Mills, UofM Center for Local, State, and Urban Policy, is that wind farms developed where there is not any local regulation (no zoning at all) are locations where there was no controversy. This might not be to say local regulation is the source of controversy, but may have more to do with the lack of any forum (approval process) through which concerns are expressed.

⁴⁰ http://ncrcrd.msu.edu/ncrcrd/chronological_archive

⁴¹ Bidwell, David; “The role of values in public beliefs and attitudes towards commercial wind energy.” *Energy Policy*; 58 (2013) 189-199, <http://www.sciencedirect.com/science/article/pii/S030142151300164X>

Anticipated effects

The anticipated effects of a wind farm can be listed as concerns within these categories: impacts on wildlife & habitat, health and safety, traffic, road use, noise, property values, economic impact on the community and landscape. The last one, landscape, should not be passed over as just aesthetic views. Research includes a “place identity theory” where a person’s personal identity is tied to valued landscapes or place. In other words landscape has a symbolic value – so those with a strong bond to their community may view wind farms as a form of “alien invasion” according to Cass and Walker (2009).⁴²

Fairness of the development

Fairness of the development, or process, includes such beliefs and results as: (1) outside interests are profiting or benefitting more than the local community, (2) opposition directed toward the developer and (3) whether procedural fairness, such as unbiased decision making, stakeholders are being treated fairly and other due process issues is being observed by the governing bodies charged with the decision. These concerns come down to the process used and the distribution of the effects. For process, there are two extremes. A community, or local government, may operate in an open and participatory manner, or at the other extreme would be a closed and institutional community, along with everything in-between. Distributional fairness has to do with how residents feel the benefits and burdens are being shared. One may perceive outside interests are getting all the benefits and profits, with little for the local community. This can translate into one’s feeling that locals are being treated unfairly. Often, research shows, this leads to opposition directed toward the developer.

Values and beliefs

Values and beliefs include environmental values where wind energy is seen as a clean, renewable, carbon-free way to generate electricity and yet environmental opposition to wind energy develops locally, known as “green on green” conflicts. One might also characterize it as a local versus global perspective. Bidwell’s research suggests:

- Anticipated effects of a wind farm on the local economy have the single greatest effect on people’s support or opposition.
- The more a person is attached to their place, or neighborhood, the more a person is likely to express caution toward wind energy farm.
- Fairness of the development, or process used is not a significant predictor of support or opposition toward a wind farm. Fairness of development did have a contributing relationship with the two previous points.
- The more a person is considered to have altruistic values toward other humans and community (place identity), the more likely one might express caution toward a wind energy farm.
- General environmental beliefs (altruistic values toward ecosystems) by a person tend to result in enthusiasm for wind energy.
- Higher education attainment slightly raises the measure that one will be cautious toward a wind energy farm development.

⁴²

[http://www.academia.edu/5085553/Emotion and rationality The characterisation and evaluation of opposition to renewable energy projects](http://www.academia.edu/5085553/Emotion_and_rationality_The_characterisation_and_evaluation_of_opposition_to_renewable_energy_projects)

- Persons holding traditional values (family, safety for loved ones, honoring elders, showing respect, self-discipline, and resistance to temptation) have a strong link to a person with a strong self-identity to place and which is likely to include skepticism of wind farm economic benefits.

Hall's research suggests a significant part of the difference between a very controversial wind development and one that is not controversial is a community's and developer's ability to provide meaningful education and collaborative discussions, with strong public participation very early in the process.

So what can a community do to further understanding and develop a possible consensus – pro or con – on the wind energy issue?

Hall presents the following points for a community which may be addressing a proposed wind energy project. First and foremost, the legally required process is not enough. The public hearing on a submitted application, which is held only after the plan has been largely developed, may be the worst way to engage the public. In Michigan, the public hearing required for a special use permit takes place too late in the process. Likewise the format of the public hearing does not accommodate effective addressing of the factors behind any opposition.⁴³

Hall recommends communities start an education process early –before an application is even submitted. Education should be about:

1. wind energy generally,
2. the specific wind project including things such as siting issues and
3. the identity and history of the project developer.

This education should be done by a trusted third party, not the developer, not the local government, not the local chamber or economic development office, all which may be perceived as on one side of the issue. This may be a role for Michigan State University Extension, a community college, other universities, League of Women Voters or similar organizations.

Education

Before the project application or land easement acquisition starts is the time to increase awareness and to educate and inform people.⁴⁴ Reproducing academic research and studies can be an effective educational tool. Education should not have a goal to convert or persuade members of the community to oppose or support a wind energy project. It needs to be neutral and by a trusted third party. Such efforts can include open houses with experts or a storefront where representatives of the project are accessible. Tours of existing wind farms may also be an effective technique.

⁴³ Other Michigan State University Extension articles on public participation:

- The Public Hearing is the worst way to involve the public:
http://msue.anr.msu.edu/news/the_public_hearing_is_the_worst_way_to_involve_the_public
- Before settling for a public hearing, consider the continuum of public involvement:
http://msue.anr.msu.edu/news/before_settling_for_a_public_hearing_consider_the_continuum_of_public_involvement
- Increasing public participation in the planning process:
http://msue.anr.msu.edu/news/increasing_public_participation_in_the_planning_process

⁴⁴ There may be push-back to this approach. Developers want to get easements as quietly and as quickly as possible. The belief is publicity just raises the price of leases for a developer. However there are examples where education before the project application or land easement acquisition starts has worked, e.g., John Deere in Huron County and other developers in Gratiot County, Michigan.

Participatory process

There needs to a participatory process for addressing issues with all stakeholders. This also means interaction, and conducting one-on-one meetings. Ideally the developer visits a person's farm or home and talks with the resident. Care should be taken to go to all property residents on large and small parcels in the area expected to be affected by the project in some way. The discussion, project planning and problem solving needs to be a collaboration. But the developer must be willing to address individual and stakeholder concerns and be willing to negotiate. The more a developer engages, the less distrust is likely to exist. One does not want the first, or only contact to be with those approaching property owners to get leases signed.

Local government, or a third party, can assemble a team whose job it is to identify the various issues for a specific wind energy project. The team should include stakeholders representing the various viewpoints that surface in the community. Activity may include conducting additional studies. That team effort can then lead to development of solutions. This should also happen early in the process. Part of the function of such a team is to engage in "collaborative problem-solving": people involved sharing perspectives, defining issues and interests, exploring different options and evaluating and modifying options to reach an agreement. This team might be a community advisory panel that has direct involvement in the design and siting of the wind energy project. This can be reflected in project revisions (shown in the project application for local government approval). It may also result in recommendations for revisions to the local regulations about wind energy. These teams, when created by any unit of government, are committees subject to the open meeting act and freedom of information act, and are subservient to the board or commission that formed the committee.

Even with these practices in place, the conflict and disagreement in a community may be too intense. In those cases one might consider court sanctioned mediation.

Sample Zoning Amendments for Wind Energy Systems

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

This is a sample, meaning that it is not a definitive recommendation by the authors or MSU Extension. A sample is a starting point for discussion and development of a ordinance, ordinance amendment, or zoning ordinance amendment that is appropriate for a particular community. Conversely a model ordinance, or amendment, would be presented as the ideal or utopia intended as a recommended approach. This is not a model ordinance, or ordinance amendment. That means any numerical standard (dimensional standard) offered in the sample zoning amendment is just a starting point for discussion. Often there is already discussion about the standard in the commentary which is intended to provide a community with information to decide what the numerical standard should be for a particular community.

This document is written for use in Michigan and is based only on Michigan law and statute. One should not assume the concepts and rules for an ordinance or zoning by Michigan municipalities and counties apply in other states. In most cases they do not.

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. A step-by-step

checklist of procedures to amend a 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.lu.msue.msu.edu.

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. Checklist #4 is also applicable here.

Zoning done by a Joint Planning Commission: If this is being done in a municipality that relies on joint zoning, then the municipality must work with the joint planning commission so these provisions are placed in the joint zoning ordinance pursuant to the Michigan Zoning Enabling Act, Municipal Joint Planning Act, and the Joint Planning Ordinance and Agreement. Checklist #4 is also applicable here.

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 apart from the adoption of a complete zoning ordinance establishing rules and creating the public offices and bodies necessary pursuant to the Michigan Zoning Enabling Act.

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 a site plan review process 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 lu.msue.msu.edu.
3. The municipality's attorney whom is experienced in municipal law (planning and zoning) will review any proposed amendments before they are adopted.

Following are the sample zoning ordinance [amendments] with commentary.

Definitions

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

A-WEIGHTED SOUND LEVEL means the sound pressure level in decibels as measured on a sound level meter using the A-weighting network, expressed as dB(A) or dBA.

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. Also includes the same equipment for evaluating wind characteristics in preparation of or evaluation of construction of on Site Wind Energy System and Utility Grid Wind Energy System.

ANSI means the American National Standards Institute.

BACKGROUND SOUND means sound from all sources except the source of interest. It is the total of all sources of interference in a system used for the production, detection, measurement, or recording of a signal, independent of the presence of the signal. "Ambient sound" means the all-encompassing sound associated with a given environment, being usually a composite of sound from many sources near and far, as defined by ANSI S12.9 Part 3, current revision.

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 intensity.

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

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

Commentary. The IEC is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. [End of commentary]

ISO means the International Organization for Standardization.

Commentary. ISO is a network of the national standards institutes of 156 countries. [End of commentary]

LEASE UNIT BOUNDARY means one or more parcels for which there is a lease or easement for development of a Utility Grid Wind Energy System and a parcel(s) for which there is a non-development lease or easement for a Utility Grid Wind Energy System located in proximity to a wind energy tower and rotor.

Commentary: The definition for Lease Unit Boundary or “pooling” or “good neighbor agreement” was added. This topic was not covered in the 2008 sample. [End of commentary]

LEQ means the equivalent average sound level for the measurement period of time.

PERCENTILE-EXCEEDED SOUND LEVEL means the A-weighted sound pressure level which is exceeded by a specified percent of the time period during which a measurement is made, denoted as LXX and expressed as dB(A). (For example a 10-Percentile-Exceeded Sound Level shall mean the A-weighted sound pressure level which is exceeded 10 percent of the time period during which a measurement is made, denoted as L10 and expressed as dB(A).)

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.

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.

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 the difference at a given point between the pressure produced by sound energy and the atmospheric pressure, expressed as pascals (Pa).

SOUND PRESSURE LEVEL means twenty times the logarithm to the base 10, of the ratio of the root-mean-square sound pressure to the reference pressure of twenty micropascals, expressed as decibels (dB). Unless expressed with reference to a specific weighing network (such as dB(A)), the unit dB shall refer to an un-weighted measurement.

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 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, agriculture, or small business.

Commentary: Another way to differentiate between On-Site Use and Utility Grid wind energy systems is size of the generators. Early drafts of the 2008 guidelines 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. [End of commentary]

- B. Shall have a tower height of ____ [for example: 20 meters (65.6 feet)] or less.

- C. Property Setback: The distance between an On-site Use wind energy system and the owner's property lines shall be equal to ____ [for example: specific number of feet or 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 ____ [for example: specific number of feet or equal to the height of the tower]. No part of the wind energy system structure, including guy wire anchors, may extend closer than ____ [for example: 10] 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.

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. Greater setbacks are more likely to result in substantive due process challenges. [End of commentary]

- D. Sound Pressure Level: Shall comply with the ____ [municipality] _ noise ordinance of ____ [date] _.

Or alternatively (see discussion on page 8):

- E. Sound Pressure Level: On-site Use wind energy systems shall not exceed ____ [for example: 45 to 55] dB(A) L ____ [for example Leq or L50] (_ [unit of time]) at the ____ [for example property line, curtilage, edge of the yard, or 50-100 feet toward the wind tower from the dwelling] 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 sound pressure level exceeds ____ [for example: 45 to 55] dB(A)) L ____ [for example Leq or L50] (_ [unit of time]) at the ____ [for example property line], the standard shall be background sound dB(A) plus ____ [for example: 5] Db(A).

Commentary: See the section on noise on page 9. [End of commentary]

- F. 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.

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. [End of commentary]

- G. 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 grade shall be ____ [for example: 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 ____ [for example: 20] meters high, and Anemometer Towers over ____ [for example: 20] meters high.

An Utility Grid Wind Energy System, On-site Use Wind Energy System over ____ [for example: 20 meters (65.6 feet) high], and Anemometer Towers over ____ [for example: 20 meters (65.6 feet)] high shall meet the following standards in addition to the general special use standards (section ? of this Ordinance):

A. Property Setback:

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 ____ [for example: a specific number of feet or the height of the tower] from property lines or from the lease unit boundary, whichever is less.

Commentary: (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.

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: https://www.co.huron.mi.us/building_zoning.asp. [End of commentary]

2. Utility Grid Wind Energy System 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 ____ [for example: a specific distance (see commentary), menu approach (see commentary) or the height of the tower including the top of the blade in its vertical position from property lines or from the lease unit boundary], whichever is less.

Commentary: The property setback requirement is designed to protect neighbors in the unlikely event of a tower failure, and ice-throw. General Electric Company, a manufacturer of wind turbine generator systems, recommends in its technical documentation that for the purpose of tower collapse, a setback of 1.1 times the tip height be used, and for purposes of blade failure or ice throw, a setback of 1.5 times the hub height plus the rotor diameter be used. Greater setbacks based on tower height are more likely to result in substantive due process challenges.

One should also consider setbacks from major natural gas transmission lines and similar transmission lines (oil, untreated gas, etc.), for which 1.1 times the tip height should be sufficient. For example see New Hampshire Site Evaluation Committee administrative rules site 301.14(f) in http://www.gencourt.state.nh.us/rules/state_agencies/site100-300.html at <http://www.nhsec.nh.gov/rules/>.

An option to consider for setbacks is to have a menu approach with a range of options. In Michigan that would mean different setbacks for different zoning districts, but the same setback within any given zoning district. A community may be homogenous and in support of the project (such as all farmers and large acreage land holders) and the developers have worked well with landowners (compensation, inclusiveness, page 17 and 19). In that case, a relatively smaller setback may be fine. In other areas where the community is diverse in interests, beliefs, reasons for living in a rural area (resources vs. aesthetics) then a relatively larger setback may be more appropriate. Depending on the land use patterns and parcel sizes in the area could also make a difference in local policy. In many parts of Europe 500 meters to 1,000 meters is common. Ontario and other states fall within that range as well. It is important the setback does not prevent construction of wind energy towers – a form of illegal exclusionary zoning. [End of commentary]

3. Utility Grid Wind Energy System shall be located within a lease unit boundary located so that it is at least ____ [for example: 1,000+] feet from the property line of any parcel which is not receiving compensation for the Utility Grid Wind Energy System (not within the lease unit boundary). The required distance from a lease unit boundary is designed to insure a distance back from property owners that are not receiving some form of royalty payment because of proximity.

Commentary: The concept of a lease unit boundary is an attempt to codify the public policy desire to pool royalties, or “friendly neighbor payments,” so that some form of compensation is made to landowners near a wind tower in addition to the landowner where the wind generator is located. Its purpose may also be to include parcels to receive some compensation because those parcels are impacted more by the wind energy development. The public purpose is to use the findings reflected in the “Fairness of the Development” on page 17 to reduce local opposition to the project that might exist and increase local support for the project. This concept was not presented in the 2008 Guidelines. It is an option for communities to consider or disregard. The approach should be reviewed by a jurisdiction's attorney. The challenge, if this is to be done at all, is to determine the distance or acreages involved –best done through a participatory process, page 19.

When establishing the distance or size of a lease unit boundary the following may assist. Distance between wind generators is determined by a number of factors including making sure turbines don't “steal” wind from each other, minimize impact on area available for farming, use of existing roads, etc. A 1,000 foot distance is an observed shortest distance from one wind generator to another wind generator from a sampling of 28 built wind generator pairs near Pigeon, Ludington, and Ithica, Michigan. The average distance between the 28 pairs was about 1,600, or about 2.1 to 2.8 wind generators per public land survey section square mile. This may, or may not, be an adequate rationale for 1,000 feet, but it reflects spacing “as built” in the three locations surveyed.

Rather than a distance the unit boundary could be expressed as a minimum number of acres per wind generator: e.g., about three per square mile (range of about one to seven per square mile).

This provision was not in the 2008 Guidelines.

A community may be homogenous and in support of the project (such as all farmers and large acreage land holders) and the developers have worked well with landowners (compensation, inclusiveness, page 17 and 19). In that case a relatively smaller lease unit area or distance may be fine. In other areas where the community is diverse in interests, beliefs, reasons for living in a

rural area (resources vs. aesthetics) then a relatively larger lease unit area or distance may be more appropriate. In Michigan that would mean different lease unit area, or distance, requirements for different zoning districts. But it would need to be the same within zoning district. [End of commentary]

4. 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.
5. 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.

B. Sound Pressure Level: Shall comply with the _____ [municipality] _ noise ordinance of _____ [date] _.

Commentary: See the section on noise on page 11. [End of commentary]

Or alternatively (see discussion on page 9):

C. Sound Pressure Level: The sound pressure level shall not exceed ____ [for example: 45 to 55] dB(A)) L _ [for example Leq] (_ [unit of time]) measured at the _____ [for example property line, curtilage, edge of the yard, or 50-100 feet toward the wind tower from the dwelling] or the lease unit boundary, whichever is farther from the source of the noise. If the sound pressure level exceeds ____ [for example: 45 to 55] dB(A) L _ [for example Leq] (_ [unit of time]), the standard shall be background sound dB(A) plus ____ [for example: 5] dB(A).

1. [Add, here, specific sound measuring methodology to be used.]
2. A post-construction Sound survey duplicating the site plan Sound Modeling Study to document levels of sound at various distances, weather conditions, designed to show compliance or lack of compliance with sound standards applicable to this ordinance.

Commentary: Sound measuring methodology to be used requires making several choices and should involve an acoustic specialist consultant. For example Leq or another measure, 10 minutes or one hour, measurement location, instrument requirements, environment factors, and many more choices.

The Leq is the most commonly used metric in environmental sound regulations for wind turbines. International Electrotechnical Commission (IEC) 61400-11 and -14 govern measurement and declaration of a wind turbine's sound power by manufacturers and result in a sound power level specified as a Leq. The ISO 9613-2 standard for taking that sound power and modeling the sound pressure level at a receiver also results in a Leq. The standardized use of a Leq for testing and modeling wind turbine noise suggests the use of a Leq for post construction sound surveys will enhance the predictability of satisfying the noise regulation and result in more consistency from planning through construction and enforcement.

See Mason County's and Huron County's ordinance. [End of commentary]

D. 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 ____ [for example: 20] feet for a wind energy system employing a horizontal axis rotor.

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. [End of commentary]

- E. Post-Construction Permits: Construction Codes, Towers, and Interconnection Standards: Shall comply with all applicable state construction and electrical codes and local building permit requirements.
- F. Pre-Application Permits:
 - 1. Utility Infrastructure: Shall comply with Federal Aviation Administration (FAA) requirements, the Michigan Airport Zoning Act (Public Act 23 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.

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. [End of commentary]

- 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.

- G. Performance Security: Performance Security, pursuant to section ? of this Ordinance, shall be provided for the applicant making repairs to public roads damaged by the construction of the wind energy system.
- H. 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.
- I. 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 approved by the Planning Commission. 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.

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. [End of commentary]

- 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.

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. [End of commentary]

- 3. Shadow Flicker: Shadow flicker does not exist or there are mitigation measures to minimize potential impacts from shadow flicker, as identified in the Shadow Flicker Impact Analysis for human-occupied structures. Mitigation shall include, but not limited to:
 - a. Change the proposed location of the wind energy tower; or

- b. The Utility Grid Wind Energy System or shall be turned off (so the rotor(s) are not moving) during the period of time the structure designed for human occupancy experiences shadow flicker; or
- c. There is screening (forest, other building(s), topography, provided window blinds) which shields the structure designed for human occupancy from a direct line of sight to the rotors causing shadow flicker.
- d. Consent granted by the parcel owner where the shadow flicker will exist which (1) acknowledges shadow flicker will occur beyond what is required by this Ordinance, (2) consents shadow flicker may occur beyond what is required by this Ordinance, and (3) such agreement is in recordable form and recorded in the Register of Deeds office in a form that is binding on future owners of the parcel.

Commentary: See Shadow Flicker on page 15. [End of commentary]

- 4. Decommissioning: A planning 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.

Commentary: There should also be an administrative system for periodic review of the decommissioning plan to make sure the amount of performance guarantee and other aspects of the plan are updated. Maybe do this every 3 to 5 years to make sure the decommissioning funds cover costs 20-30 years down the road when it is decommissioned. [End of commentary]

- 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.

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.

9408. Site Plans for Anemometer Tower, Utility Grid Wind Energy System, and On-site Use Wind Energy System.

Commentary: 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 and not more.

Some communities have an escrow deposit system to cover costs of more involved special use permit reviews, such as utility scale wind energy systems are likely to involve. [End of commentary]

In addition to the requirements for a site plan found in sections ?, ?, and ? [Sections on various site plan content requirements] 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 ____ [for example: 20 meters (65.6 feet)] high shall include 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. (This may include a map of sound level isoline and sound levels at parcel boundaries.)
- 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 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 showing levels of sound at various distances, weather conditions, designed to show compliance or lack of compliance with sound standards applicable to this ordinance 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, 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 ____ [for example: 60 to 90 with exceptions due to weather or other delays] days of the commercial operation of the project.

Commentary: This 90 day provision was not in the 2008 Guidelines. Those guidelines had 60 days. [End of commentary]

2. A detailed traffic, road modification plan to accommodate delivery of component of the wind energy system along existing and proposed roads and return of those roads and adjacent lands to their original condition after construction
3. 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. Include sample of construction materials painted or colored so it is finished in a single, non-reflective matte finished color.
4. 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.
5. 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.
 - a. (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.)
 - b. (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.)
 - c. (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.)

6. A copy of a shadow flicker analysis at structures within a maximum of ____ [for example: 5,400 (or omit this subsection)] feet or ____ [for example:20 (or omit this subsection)] times the rotor diameter, whichever is less, from a structure designed for human occupancy 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 sunrise to sunset over the course of a year. The site plan shall identify problem areas where shadow flicker may affect the occupants of the structures.

Commentary: See Shadow Flicker on page 15. [End of commentary]

7. A second site plan, which includes all the information found in sections ?, ?, and ? [Sections on various site plan content requirements] 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.
8. 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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Appendix A: Summary of Wind Energy Research and Information.

The Michigan Agency for Energy⁴⁵ has more resources on this topic as well as Michigan Wind Energy Resource Maps, U.S. Department of Energy wind maps on Michigan.⁴⁶

The 2008 Sample Zoning for Wind Energy Systems,⁴⁷ was prepared in zoning amendment format, following guidelines developed by a wind energy work group, Energy Office for the State of Michigan.

Energizing Michigan, MSU's web page on alternative energy⁴⁸ (and specifically on wind energy⁴⁹) is also available.

This does not list all research on the topics. To be listed here the research must be peer reviewed, published, university based research, or research using university protocols for research, and summary papers of the same, unless noted otherwise.

This document refers to Mason County's experience and handling of various issues. Mason County was chosen for several reasons. The county was facing very strong and vocal opposition to the proposed wind energy project and had a very reputable high profile wind project developer. The county planning commission, staff, and hired planning consultant did an excellent job taking appropriate steps to remain neutral during the application process. County staff took great care to make sure information presented to county policy makers was accurate, science based, and stayed within the realm of substantive due process (page 4) requirements as well as the other cautions contained in this document, starting on page 3. The community had another group which worked with West Shore Community College's science department to provide peer reviewed-science-based information at a public forum. Finally when the county (or developer) was challenged in court the county or developer prevailed.

Huron County is referenced in this document because the county has experienced more commercial wind development than any other community in Michigan. As of early 2017, Huron County had 472 wind turbines in operation or under construction. Huron County updated their wind energy overlay zoning ordinance in November 2015 after many years of experience administering zoning regulations with commercial wind energy development and an in-depth study of wind turbine noise in the county conducted by an Institute of Noise Control Engineering (INCE) Board Certified engineer. The years of experience and in-depth noise study informed the 2015 zoning ordinance amendment that includes a very comprehensive noise measurement methodology.

However, Huron County's November 2015 wind energy overlay zoning ordinance differs somewhat from their acoustic engineering consultant's final recommendation.⁵⁰ The ordinance uses a methodology for measuring average noise at a receptor site over time using the continuous sound level (Leq), as opposed

⁴⁵ <http://www.michigan.gov/energy>

⁴⁶ http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab-mi

⁴⁷ http://msue.anr.msu.edu/resources/sample_zoning_for_wind_energy_systems

⁴⁸ http://msue.anr.msu.edu/program/info/msue_wind_power

⁴⁹ http://msue.anr.msu.edu/program/msue_wind_power/community_wind

⁵⁰ Acoustic by Design (ABD) originally proposed L50 as the compliance metric. Huron County understood that the Leq metric can be more susceptible to short-term intruding sound events from non-turbines sources. It was decided by Huron County that ABD could revise the specific provisions of the noise ordinance methodology to correct for continuous and transient background noise sources. ABD provided Huron County with updated ordinance language to reflect the use of the Leq metric. ABD understood the motivation to use the same metric for post-construction sound compliance as used for pre-construction predictive sound modeling.

to the 50-percentile-exceeded sound level (L50) recommended by the county's acoustics consultant. The Leq measurement is highly influenced by short-term intruding events, such as road traffic, and therefore produces measurements that the consultant felt are less accurate representations of wind turbine noise at a typical site. The L50 measurement results in a similar, average noise level at a site, but uses a metric less susceptible to intruding short-term sound events.

There are two references to highlight:

First is Rand and Hoen's "Thirty years of North American wind energy acceptance research: What have we learned?" This review synthesizes the literature, revealing the following lessons learned. (1) North American support for wind has been consistently high. (2) The NIMBY explanation for resistance to wind development is invalid. (3) Socioeconomic impacts of wind development are strongly tied to acceptance. (4) Sound and visual impacts of wind facilities are strongly tied to annoyance and opposition, and ignoring these concerns can exacerbate conflict. (5) Environmental concerns matter, though less than other factors, and these concerns can both help and hinder wind development. (6) Issues of fairness, participation, and trust during the development process influence acceptance. (7) Distance from turbines affects other explanatory variables, but alone its influence is unclear. (8) Viewing opposition as something to be overcome prevents meaningful understandings and implementation of best practices. (9) Implementation of research findings into practice has been limited.

Second is Berger, et al.'s. "Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines." The purpose of this paper was to investigate whether audible noise-based guidelines for wind turbines account for the protection of human health, given the levels of infrasound and low frequency noise (IS and LFN) typically produced by wind turbines. Overall, the available data from this and other studies suggest that health-based audible noise wind turbine siting guidelines provide an effective means to evaluate, monitor, and protect people from audible noise as well as IS and LFN.

Selected references are:

- 2007 Wind Symposium Videos and Presentations⁵¹
- Adelaja, Soji and Yohannes Hailu; "Projected Impacts of Renewable Portfolio Standards on Wind Industry Development in Michigan" (December 2007)
- Adelaja Soji, Yohannes Hailu, John Warbach, Mike Klepinger, Chuck McKeown, Ben Calnin, and Max Fulkerson; "Meeting Michigan's 2015 Renewable Portfolio Standard (RPS): Wind Turbines Required and Projected Land Usage"⁵² (December 2007)
- Adelaja, Soji and Charles McKeown. "Michigan's Offshore Wind Potential"⁵³ (October 2008)
- Final Report of the Michigan Wind Energy Resource Zone Board, Oct. 15, 2009:
http://msue.anr.msu.edu/resources/final_report_of_the_michigan_wind_energy_resource_zone_board
- Haugen, Kathryn M.B.; "International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences: Setbacks, Noise, Shadow Flicker, and other Concerns;" and "Summary of Wind Policies and Recommendations by Country: Companion Summary Chart to "International Review of Policies and Recommendations for Wind Turbine Setbacks from Residences;" Minnesota

⁵¹ For a copy of this report contact the Land Policy Institute (LPI): charron@landpolicy.msu.edu. For other LPI energy related materials see http://landpolicy.msu.edu/program/info/renewable_energy_policy_program.

⁵² For a copy of this report contact the Land Policy Institute (LPI): charron@landpolicy.msu.edu. For other LPI energy related materials see http://landpolicy.msu.edu/program/info/renewable_energy_policy_program.

⁵³ For a copy of this report contact the Land Policy Institute (LPI): charron@landpolicy.msu.edu. For other LPI energy related materials see http://landpolicy.msu.edu/program/info/renewable_energy_policy_program.

Department of Commerce: Energy Facility Permitting; (October 19, 2011):
<http://mn.gov/commerce/energyfacilities/#tabs=3>

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- A series of fact sheets on **perceptions of the impact of wind energy generation in coastal communities** by MSU’s Land Policy Institute. The series is in response to the idea that windy, coastal communities will face pressure to develop wind farms now and for many years to come. The purpose of the fact sheets is to help understand the complex dynamics between communities, policy and the public.
- Community Views - This fact sheet examines how the respondents feel about their community, and potential changes to it, as related to wind energy development: http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communities
 - Energy Policy Priorities - This fact sheet summarizes what coastal residents say are their policy priorities, and identifies the types of energy infrastructure and associated policy incentives that policy makers should be examining: http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communities
 - Regulation Issues - This fact sheet explores what survey respondents say about who should regulate wind energy and how confident they feel in various aspects of the planning, zoning and regulatory process: http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communities

- Trust and Fairness Issues - This fact sheet reviews the opinions of the survey respondents in regards to trust, fairness and exploitation in relation to the development of commercial wind energy:
http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communi2
- Impact Perceptions - This fact sheet addresses the potential impacts of wind development on a community and examines the level of knowledge survey respondents say they have about renewable energy and wind energy development:
http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communi3
- Project Overview - This fact sheet provides an overview of the project and survey results, plus reviews methods used in the study:
http://msue.anr.msu.edu/resources/perceptions_of_the_impact_of_wind_energy_generation_in_coastal_communi4
- **Sample zoning regulation and administration.**
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 - Mason County website on its wind energy zoning and administration. An example of noise and flicker ordinance provisions and follow up administration:
<http://www.masoncounty.net/departments/zoning/lake-winds-energy-park.html>
 - Huron County, particularly for their approach to noise regulation:
<http://co.huron.mi.us/documents/ArticleXWindEnergyOverlayZoningOrdinanceNovember2015.pdf>
- **Opinion on windfarms from Michigan.**
 - “Michigan Wind Energy Landscape Symposium” Workshop Report 2011:
<https://www.macalester.edu/windenergy/symposia/MISymposiumWorkshopReport.pdf>
 - “Residents' perceptions of wind turbines: An analysis of two townships in Michigan” 2014 Groth & Vogt: <https://scholars.opb.msu.edu/en/publications/residents-perceptions-of-wind-turbines-an-analysis-of-two-townshi-4>
 - Michigan Public Policy Survey of local government officials, 2014:
<http://closup.umich.edu/michigan-public-policy-survey/34/wind-power-as-a-community-issue-in-michigan/>
 - Views of Wind Development from Michigan's Windfarm Communities. 2017:
<http://closup.umich.edu/files/wind-summary-20170216.pdf>