Michigan State University Extension
Land Use Series

Sample Zoning for Wind Energy Systems

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This document presents zoning ordinance sample amendments for utility scale wind energy systems (WES) and smaller wind electric generation systems for an individual business or home.

Contents

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

[1] There are earlier versions of this document dating back to 2008. **They should not be used.** There are significant and important updates and changes to this version.

Purpose and Use of Sample Zoning

Background

Michigan's entry into wind energy production started in 1996 with a single commercial wind turbine installed in Traverse City. In 2019, approximately 2000 megawatts (MW) are generated by wind energy in Michigan accounting for about 5% of the total energy produced.[2] This document is designed for local units of governments in Michigan that are amending a zoning ordinance to include wind energy systems (WES) for the first time or amending an existing regulation. As of December 2019, less than half of all Michigan communities had adopted wind energy zoning ordinances (753 out of 1773 total units of government).[3]

This sample zoning resource was originally developed in 2008 and is periodically revised with the intent of striking a balance between the need for clean, renewable energy and the necessity to protect the public health, safety, and welfare. New research and technological advances around wind energy invite periodic revision. While some communities will choose to model zoning on similarly situated communities in Michigan, it is beneficial to consider recent research, experiences, standards, and regulations in the broadest context. This document refers to wind energy system regulations and research from Michigan, other states, Canada, and Europe.

Policy and Process

This sample zoning resource begins with a discussion of due process, related case law, public acceptance factors related to wind energy development, and steps towards a better process. Wind energy proposals can bring controversy and the size of a project can be at a scale the community has not yet experienced. Despite the large scale or changes to normal procedure, the basics of due process and reasonable regulation based on a plan still apply. The guidelines, court cases, and cautions in this document offer supplemental policy and process considerations for wind energy regulation.

Sample Zoning

Sample zoning language is included as a resource for local governments to consider when amending the zoning ordinance to include WES. This document offers sample regulation for temporary anemometers, on-site, and utility-scale WES. Temporary anemometers are often installed as a precursor to a utility-scale WES to assess the wind resource. On-site WES, generally, are sized to primarily serve the needs of a single home, farm, or small business. Utility-scale WES 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.

The sample zoning language offers a range of options and does not prescribe a specific set of zoning requirements. Michigan's land use patterns, average parcel sizes, and dwelling densities vary among communities, making a one-size-fits-all recommendation impractical. Additionally, grid-like road networks, major transmission lines, and natural features, can have the effect of creating a relatively more

[2] U.S. Energy Information Administration (EIA), Michigan State Profile Estimates (2020). https://www.eia.gov/state/analysis.php?sid=MI

[3] Michigan Department of Environment, Great Lakes, and Energy (EGLE), Office of Climate and Energy, Zoning for Renewable Energy Database (2019). https://www.michigan.gov/climateandenergy/0,4580,7-364--519951--,00.html

confined canvas for wind energy development in Michigan than in other areas of the country with significantly larger parcels or limited road networks.

Appendix

This updated version also includes detailed information on wind turbine noise (Appendix A: Wind Turbine Noise) as certain aspects sound and noise regulation introduce complex regulatory language that may be unfamiliar. This is followed by a comparison of WES zoning regulation in Michigan communities and Midwestern states (Appendix B: Comparison of Regulation) and a more detailed look at shadow flicker and Federal Aviation Administration (FAA) lighting (Appendix C: Shadow Flicker, FAA Lighting). An annotated bibliography of Michigan wind energy research (Appendix D: Summary of Michigan-Specific Wind Energy Research and Information) and revision history (Appendix E: List of Revisions to this Document) are also provided.

This is a fact sheet developed by educators within MSU Extension and was reviewed by outside agencies and experts. 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. This is not original research or a study proposing new findings or conclusions.

Due Process

All the principles and rules for zoning apply to zoning regulations relating to WES. Strong opposition or support of a WES does not mean that basic due process and other rules do not apply. These issues are covered here because communities have been observed trying to circumvent these basic principles because of strong feelings for or against WES development in their jurisdiction.

Procedural Due Process

Requirements for procedural due process,[4] meaning going through all the notifications, rendering decisions based on standards in the zoning ordinance and competent and material evidence, and more, must be followed. Although wind energy developments can be controversial and potentially overwhelming to a rural community, there are no shortcuts or exceptions to following zoning procedures outlined by the Michigan Zoning Enabling Act.[5]

A failure to follow procedural due process,[6] such as improper noticing or an incomplete record of proceedings, is one of the fastest ways to land in court. Procedural due process errors might also include assigning alternates to serve on a planning commission (when there is no legal authority to do so) or missing addresses in the required noticing area for a public hearing. Communities reviewing a wind

[4] U.S. Const., amend. V.; Michigan Const. of 1963, Art. I, §17.

[5] Schindler, K. (2013, July 22). *"Due Process" is often a source of lost court cases in local government*. MSU Extension. 2013. https://www.canr.msu.edu/news/due_process_is_often_a_source_of_lost_court_cases_in_local_government

[6] Cornell Law School. (n.d.). Procedural due process. In *Legal Information Institute's Wex*. Retrieved September 3, 2020, from https://www.law.cornell.edu/wex/procedural_due_process

energy system application should work closely with an experienced municipal attorney to satisfy all procedural due process requirements.

Substantive Due Process

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

Substantive due process has three key components: the substance of the regulation, that the regulation has a logical connection between the government's purpose and the regulation itself and that the regulation is the least amount possible while still achieving the public purpose of the regulation. Substantive due process is one of the constitutional rights found in the Fifth and Fourteenth Amendments of the United States Constitution.

Substance of the Regulation

An initial consideration for determining if substantive due process is met is whether the issue is a legitimate one for the government to regulate. Not every issue is a legitimate subject for local government regulation. For example, local government regulation that infringes on constitutional rights, such as freedom of speech or freedom of the press, would be out-of-bounds for a local ordinance. The regulation has to have a rational government purpose, or further a legitimate governmental interest in preserving public health, safety, and welfare.

A common example of this within zoning is sign regulation. The regulation of signs is permissible provided it is about placement, size, lighting and so on. If the regulation is based on the content of the sign, or what the sign says, that regulation conflicts with constitutionally protected free speech.[7] 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. Again, government must have the constitutional or statutory authority to regulate the subject in the first place.

Regulation Related to Purpose

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

Zoning ordinances include a zoning map dividing the municipality or county into various zoning districts. The zoning plan elements of the master plan should clearly show how the master plan supports the configuration of those particular geographic areas. Supporting elements of the master plan include text and existing land use maps and analyses, the future land use map, projections showing future housing, commercial and industrial needs, natural resource attributes for working lands and so on.

[7] US Const. amend. I.

Least Regulation

Local ordinance standards should be the least amount of regulation possible to achieve the public purpose. If research shows a minimal regulation will do the job, then that is all that should be required. It would not be appropriate to require additional regulation beyond that minimum threshold.

With respect to WES regulation, this concept is easily explained with standards related to wind turbine noise. If research concludes that noise beyond a specified level can be harmful to human health, then that noise level is the least regulation to accomplish the public purpose of protecting health, safety, and welfare. Adopting a more stringent regulation that requires a lower noise level may go too far – beyond what is appropriate for government to regulate and defend if challenged in court.

Master Plan and Research

As zoning must be based on a plan, the master plan process is the starting point for understanding local support for different types of renewable energy such as wind. The legitimacy of government regulation of WES is strengthened by a clear relationship between the master plan and the zoning ordinance.

Some communities specifically address renewable energy (such as solar and wind) in their master plans.[8] Other communities do not, but still regulate WES through zoning. Communities that identify policy directions for renewable energy in their master plans are more clearly able to show the rational relationship between their zoning regulations and the government's purpose.

When planning for renewable energy, a community would be wise to seek public input on multiple forms of renewable energy such as solar, wind, geo-thermal, and biomass. This planning process may start with educating the public about different types of renewable energy, how renewable energy relates to climate change and related community goals, and possibly followed by a visual preference survey with photos of small, medium, and large-scale development (on-site vs. utility-scale, for example).

The 2020 Draft Huron County Master Plan includes survey results for resident preferences of various forms of renewable energy (solar, geothermal, wind, etc.).[9] Community preferences for type, location, and scale of renewable energy can help to assign various uses (or not) to specific zoning districts or an overlay zone. The plan also includes policies on decommissioning or repowering existing WES once they reach the end of their useful life.

The regulation of wind energy should also be informed by the most recent published, peer-reviewed research findings. This documentation ties to the substance of the regulation and how the regulation relates to the public purpose. As such, the master plan process sets the stage that frames and legitimizes particular zoning approaches.

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[8] Gratiot County. (2017). *County-Wide Master Plan.* https://www.gogrowgratiot.org/uploads/9/5/3/0/9530559/final_gratiot_master_plan_1.14.19.pdf

Objective 4.3, Strategy 4.3.2 "Continue to pursue alternative energy companies, market the County as an alternative energy industry hub." Objective 1.3, Strategy 1.3.7 "Pursue existing funding opportunities and create incentives for large farms to utilize, maintain, and create green energy."

[9] Huron County. (2020). *Master Plan Draft, 2020.* https://590e4aa5-9f61-478f-8f4c-d72a53f03ffb.filesusr.com/ugd/f69a3e_ab4ea34605a1455e992278a4cd90ab7e.pdf

Figures 20 and 21 "Alternative Energy Options" present the results of a survey question that asked "Through the zoning ordinance, Huron County should provide avenues to pursue the following alternative energy development:" with wind ranking higher than biomass and anaerobic digesters, but lower than solar, geothermal, and methane gas capture. The "Vision for Huron County-Goals and Action Items" contains a section on Renewable Energy Goals, including those for utility-scale Wind Energy.

Accommodate All Land Uses

A separate concept is that of accommodating all legitimate land uses in zoning. The Michigan Zoning Enabling Act requires a zoning ordinance to accommodate all legitimate land uses in the presence of a demonstrated need:

> 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.[10]

There is a need for reliable, clean energy, as prescribed in Michigan's Clean and Renewable Energy and Energy Waste Reduction Act of 2008 (amended in 2016 with the new target of producing 35% of the state's electric needs through energy waste reduction and renewable energy sources by 2025[11]). Local units of government must consider whether overly restrictive zoning regulations for utility-scale wind energy systems (or solar energy systems) amount to an unlawful exclusion of a land use where there is a demonstrated need (referred to as exclusionary zoning).

Isabella County used a Geographic Information System (GIS) to determine how different setbacks would change the potential number of turbines that could be built within a square mile section (if any at all). Planners applied different setback distances using GIS datasets for roads, wetlands, water bodies, parcel lines, and primary dwellings. This mapping exercise illustrated how setbacks, between 1,000 feet and 2,000 feet, would substantially change the number and placement of utility-scale wind towers within a study area.[12] A larger setback may have the effect of severely limiting or even excluding wind energy from a jurisdiction.

It is likely that some land uses cannot be reasonably accommodated in every local unit of government in Michigan. A local unit of government with concerns about excluding a specific land use in the presence of a demonstrated need, or severely limiting the extent or scale of a land use, should consult an experienced municipal attorney to better understand potential consequences.

Takings

Local zoning cannot amount to 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.[13] Property owners or wind energy developers might challenge a zoning ordinance in court by alleging that regulations are overly restrictive (i.e. unreasonable) and deprive them of economical use of

[10] Michigan Zoning Enabling Act. Mich. Comp. Laws. 125.3207 (2006). http://legislature.mi.gov/doc.aspx?mcl-125-3207

[11] Michigan Clean, Reliable, and Efficient Energy Act. Mich. Compl. Laws (PA 342 of 2016). Amends Act 295 of 2008. http://legislature.mi.gov/doc.aspx?mcl-460-1001

[12] Tim Nieporte, Director of Isabella County Community Development. Interview (2019). Planners used a set of assumptions including each parcel under 10 acres being considered non-participating (did not sign a lease) and about 80% of parcels over 40 acres considered participating (did sign a lease).

[13] 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:" https://www.canr.msu.edu/resources/property_taking_types_and_analysis

their property. Case law establishes that a regulatory taking only occurs if the regulation in question results in total (i.e. 100%) economic deprivation.[14]

Equal Protection

Zoning must provide equal protection of all persons affected by the laws.[15] Equal protection means similarly situated individuals are treated in a similar manner and bear no greater burdens than are imposed on others under like circumstances. Therefore, local zoning regulations must be applied uniformly across all the properties within a zoning district. It is common for wind energy regulations in the Midwest to include differential standards based on the presence of a wind energy lease or not (i.e. participating parcel vs. non-participating parcel). Such an approach does not violate equal protection because the property owner in this instance is electing to live under a different regulatory regime in exchange for monetary compensation from the wind energy developer or energy utility. However, it is not appropriate for local regulations to in any way require or otherwise coerce such payments as a condition of approval.

Cannot Delegate Legislative Decisions

A local elected body cannot delegate away its legislative authority. In practice, this may occur if a zoning standard includes a requirement for neighbors to sign off as a condition of approval. A zoning ordinance provision may be invalidated if it effectively delegates the legislative power, originally given by the people to a legislative body, to a narrow segment of the community.[16]

Police Power Versus Zoning

For purposes of this discussion there are two different types of ordinances: (1) police power ordinances (sometimes referred to as regulatory ordinances) and (2) zoning ordinances. The two types of ordinances deal 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 the Michigan Zoning Enabling Act, and vice versa.[17]

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[14] *Palazzolo v. Rhode Island*, 533 U.S. 606 (2001)

[15] U.S. Const, amend. IV.

[16] There is more to consider about delegating away legislative authority as pointed out in *Howard Twp. Bd. of Trs. v. Waldo*, 168 Mich. App. 565, 573-74, 425 N.W.2d 180, 184 (1988):

"Zoning ordinances have been invalidated when a consent provision, in effect, delegates the legislative power, originally given by the people to a legislative body, to a narrow segment of the community. *City of Eastlake v Forest City Enterprises, Inc*, 426 U.S. 668, 677; 96 S Ct 2358; 49 L Ed 2d 132 (1976). However, not all consent provisions are invalid. As stated in *Cady v Detroit*, 289 Mich 499, 515; 286 NW 805 (1939):

"A distinction is made between ordinances or regulations which leave the enactment of the law to individuals and ordinances or regulations prohibitory in character but which permit the prohibition to be modified with the consent of the persons who are to be most affected by such modification." 43 CJ, p 246.

If such consent is used for no greater purpose than to waive a restriction which the legislative authority itself has created and in which creation it has made provision for waiver, such consent is generally regarded as being within constitutional limitations. *City of East Lansing v Smith*, 277 Mich 495 [269 NW 573 (1936)].

Here, the consent provision does not delegate legislative power to a narrow segment of the community. Rather, it merely requires a waiver as the first step in an administrative procedure authorized by the zoning ordinance."

[17] In *Forest Hill Energy-Fowler Farms, L.L.C. v. Township of Bengal* Michigan Court of Appeals (Unpublished, No. 319134, December 4, 2014), the court expressed a jurisdictional hierarchy as follows:

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.[18]

The Michigan Zoning Enabling 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.[19]

Conflict of Interest

Conflict of interest is common among members of the legislative body and/or the planning commission when rural wind energy projects are being considered. This may be the case because wind energy developments span large geographic areas and often involve many separate landowners, some of which may be elected or appointed local officials. The legislative body or planning commission may have existing rules or bylaws on what constitutes a conflict of interest for one of its members and how a conflict of interest is handled. Planning commissions are required to have bylaws with rules on handling a conflict of interest.[20] If no such rules or bylaws are in place, they should be established and would apply to all matters before the board or commission.

A conflict of interest for the board or commission member could, among other things, result from:

1. Relationship:

A. The member is the applicant

B. A member's relative is the applicant (how distant a relative should be defined in the board rules or 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 board rules or bylaws.

3. Financial:

- County police power ordinances. (Counties have very limited police power ordinance adoption authority. See "County government powers are very limited:" https://www.canr.msu.edu/news/county_government_powers_are_very_limited)
- Municipal (Township, city, and village) police power ordinances will supersede the above ordinances.
- County zoning ordinance will supersede each of the above ordinances.
- Township zoning ordinance will supersede each of the above ordinances (except townships and counties do not have general jurisdiction within the boundaries of a village or city).

[18] Michigan Zoning Enabling Act. Mich. Comp. Laws. 125.3210 (2006). http://legislature.mi.gov/doc.aspx?mcl-125-3210

[19] Michigan Zoning Enabling Act. Mich. Comp. Laws. 125.3209 (2006). http://legislature.mi.gov/doc.aspx?mcl-125-3209

[20] Michigan Planning Enabling Act. Mich. Comp. Laws. 125.3815 (2008). http://legislature.mi.gov/doc.aspx?mcl-125-3815

Also see the MSU Extension Sample Bylaws for a Planning Commission: https://www.canr.msu.edu/resources/sample_1e_bylaws_for_a_planning_commission

A. The member (or relative) stands to gain or lose financially by the decision of the decision-making body.

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 for one or more board members (such as they have signed a lease or easement with a wind energy company).

Neutrality

As with any zoning issue, members of the planning commission and zoning board of appeals should not announce or conclude publicly they are for or against a WES or wind energy 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 applicant's due process rights are upheld. 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.

Special land use standards can invite and encourage differing viewpoints coming into the meeting (as compared to appeals board variance standards). Outside of the public hearing, however, members of the planning commission or appeals board should remain neutral for all pending administrative decisions.

It is not appropriate for a planning commission member or an appeals board member to say "I'm going to vote against *X* no matter what because I dislike *X*." Following the hearing and discussion of facts relating to 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 describing no risk to the community is convincing or meets this standard in the ordinance."

A healthy outcome of deliberation and debate during a public meeting is being able to consider a change of approach or opinion. It is okay (and normal) for opinions to change through a public hearing process. The job of the planning commission and zoning board of appeals is to thoroughly review the request according to the ordinance standards and make a decision. Dialogue and debate help to shape that decision.

When tensions are high, a planning commission or legislative body may be less inclined to deliberate or share opinions. The chairperson will have to provide strong leadership here to make sure that the public, the applicant, and the board feel safe and supported when offering opinions and questions.

Must approve if all standards are met

Like any land use application, whether a permitted use or a special use under the local zoning ordinance, a WES application must be granted if the applicant 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.[21]

Leases and Easements

Developers may not own the property on which wind turbines sit, but instead sign private leases or easements with landowners that convey certain rights from the landowner to the developer. Zoning has

[21] Michigan Zoning Enabling Act. Mich. Comp. Laws. 125.3504 (2006). http://legislature.mi.gov/doc.aspx?mcl-125-3504

no authority to require specific content or performance within a lease or easement or enforce the provisions of a lease or easement among private parties. Leases and easements are binding legal agreements that define what is required of each party, such as tax payments, revenue payments to the landowner, access to the property, expiration of the agreement, and options for renewal. There may be agreements with landowners who will not have a wind turbine on their property but who made an agreement with the wind developer, for example, to not construct another structure such as a cellular tower that might alter access to the wind resource. Furthermore, these agreements can be secured by one party/developer and then sold to another.

Related Case Law

Utility-scale WES have been very controversial in some communities. Even so, there has been relatively few published court opinions that have precedential value.[22] In *Tuscola Wind III, LLC v. Almer Charter Township et al.*[23] the court upheld the township's regulation of wind energy development. This 2017 opinion emphasizes the importance of defining a noise descriptor (such as Leq, L90) to determine zoning compliance rather than specifying only a maximum sound level (such as 45 dBA) without a noise descriptor. The Township prevailed in representing that they interpreted their ordinance sound level of 45 dBA as an Lmax, (the maximum sound level during a measurement period or a noise event) although it was not written in the ordinance. See Appendix A: Wind Turbine Noise for definitions of various sound descriptors.

In a second case, *Tuscola Wind III, LLC v. Ellington Township et al.*,[24] the court found the Township's wind energy moratorium enacted by resolution, not by ordinance was in violation of the Michigan Zoning Enabling Act. The court concluded that a 2015 ordinance in effect prior to the "invalid" moratorium was the standard of review, but recognized there was no timeline in the ordinance for the township to act, so it could wait to consider the application until after adoption of a subsequent, more restrictive amendment to the zoning ordinance was enacted. Additional arguments around due process, injunctive relief, and the Open Meetings Act were dismissed or found to be moot.

These cases were heard by the United States District Court Eastern District of Michigan, Northern Division.[25] Typically, a federal district court's interpretation of state law (as opposed to federal law) is not binding on state courts, although state courts may adopt their reasoning as persuasive. Thus, for example, if a case is construing the Michigan Zoning Enabling Act, it will not have any precedential effect on Michigan courts.

[22] The March/April 2020 issue of *Planning & Zoning News* reviews several Michigan court cases involving wind energy. Copies can be ordered at: http://pznews.net/.

[23] *Tuscola Wind III, LLC v. Almer Charter Twp.*, 327 F. Supp. 3d 1028 (E.D. Mich. 2018) U.S. District Court, Eastern District of MI, Northern Division

[24] *Tuscola Wind III, LLC v. Ellington Twp.*, Case No. 17-cv-11025 (E.D. Mich. Jul. 27, 2018) U.S. District Court, Eastern District of MI, Northern Division

[25] The 6th Circuit Court of Appeals takes the position that the doctrine of stare decisis makes a federal district court decision binding precedent in future cases in the same court (until reversed, vacated, or disapproved by a superior court, overruled by the court that made it, or rendered irrelevant by changes in the positive law). Copy of opinion: https://www.gpo.gov/fdsys/pkg/USCOURTS-mied-1_17-cv-10497/pdf/USCOURTS-mied-1_17-cv-10497-1.pdf.

In a published Michigan Court of Appeals opinion, *Ansel v. Delta County Planning Commission*,[26] appellants expressed concern over noise and shadow flicker that turbines "would be expected to produce"[27] and the plaintiff asserted that they were not aggrieved parties and lacked standing to appeal the decision to Circuit Court (the ZBA is not authorized to hear appeals of special land use permits in Delta County, so the party appealed the matter directly to Circuit Court). The Court affirmed the trial court's ruling that the appellants lacked standing to appeal because they failed to show they suffered special damages or unique harm not common to other property owners. To be an aggrieved party, one must "show damages of a special character distinct and different from the injury suffered by the public generally."[28] Although maps were available that specified the anticipated noise and flicker on particular properties, the "…appellants happen to be residents scattered about the community whose objections…are more apparently driven by concerns of a general nature than by expected consequences of operation of the turbines peculiar to themselves."[29]

An unpublished opinion from the Michigan Court of Appeals regarding an attempt to regulate wind energy by police power (i.e. regulatory) ordinance is worth mentioning too, *Forest Hill Energy-Fowler Farms, LLC v Bengal Twp., Dallas Twp., and Essex Twp.*[30] After Forest Hill applied for a special land use permit under the Clinton County Zoning Ordinance, Bengal, Dallas and Essex Townships, who were subject to the county zoning ordinance, each adopted a wind energy ordinance under the Township Ordinances Act.[31] These regulatory ordinances had the effect of prohibiting Forest Hill's proposal due to height, setback, noise, and shadow flicker standards. Forest Hill filed a lawsuit and the Court of Appeals ultimately agreed with the trial court's finding that the townships' ordinances actually constituted zoning ordinances, and that because the townships' ordinances were not enacted under the Michigan Zoning Enabling Act, the county ordinance was controlling.

Public Acceptance Factors Related to Wind Energy Development

Development and siting of a large wind energy project can be one of the more controversial issues that a rural community faces. However, not all wind energy projects are controversial. Community acceptance factors are complex and varied.[32] One analysis of North American wind energy research over the past 30 years identified six factors that help explain wind energy acceptance by individuals living near proposed or existing wind energy developments: (1) socioeconomic aspects; (2) sound annoyance and health risk perceptions; (3) visual/landscape aspects, annoyance, and place attachment; (4) environmental concerns

[26] *Ansell v. Delta County Planning Comm'n*, 2020 Mich. App. LEXIS 3688, 2020 WL 3005856 (Court of Appeals of Michigan June 4, 2020, Decided)

[27] *Ansell v. Delta Cnty. Planning Comm'n*, p. 5

[28] *Olsen v. Jude & Reed, LLC*, 325 Mich. App. 170, 924 N.W.2d 889 (Mich. Ct. App. 2018)

[29] *Ansell v. Delta Cnty. Planning Comm'n*, p. 5

[30] *Forest Hill Energy-Fowler Farms, LLC, LLC v. Twp. of Bengal*, 2014 Mich. App. LEXIS 2380 (Court of Appeals of Michigan December 4, 2014, Decided)

[31] Township Ordinances Act. Mich. Compl. Laws (PA 246 of 1945). http://legislature.mi.gov/doc.aspx?mcl-Act-246-of-1945

[32] Fournis, Y. & Fortin, M.J. (2017). From social 'acceptance' to social 'acceptability' of wind energy projects: Towards a territorial perspective. *Journal of Environmental Planning and Management*, 60(1), 1-21. https://doi.org/10.1080/09640568.2015.1133406.

and attitudes; (5) distance from turbines; and (6) perceptions of planning process, fairness, and trust.[33] The relationships between each of these factors and public acceptance of wind energy developments are briefly summarized in the following sections.

Socioeconomic Aspects

Research points to both potential positive and negative economic impacts from wind energy development. Studies on this theme explore impacts on local job creation, local tax revenue, landowner compensation, impacts on tourism, electricity bills, and property value impacts.

Economic benefits and negative economic impacts of wind energy developments – and the extent to which community members put weight into each – vary from place to place. One consistent theme in how individuals respond to wind development proposals relates to the concept of distributional justice, referring to the distribution of the costs and benefits of wind energy developments.[34] Some of these concerns are on the distribution of benefits and costs between the host community and the greater region or society at large. This can include concern that rural communities are bearing the burden of reaching renewable energy goals with projects owned my multinational (i.e., non-local) corporations and producing much more power than the rural community itself needs, thus having that power exported to an urban area.[35]

There is also often concern about distributional justice between those residents who would receive direct compensation from the wind developers and those who would not. A nationwide study by Firestone *et al.*[36] and a study of Michigan windfarms by Mills *et al.*[37] find this direct compensation important in influencing attitudes toward wind energy projects. As a result, developers have broadened the geographic extent of royalty payments to include residents within the entire area of a project. While this does tend to influence attitudes positively, it also has the effect of increasing the number of township board or planning commission members who may have a conflict of interest.

Sound Annoyance and Health Risk Perception

There are two key strands of research connecting how noise from wind turbines impacts an individual's attitude about wind turbines: those related to annoyance and direct impacts to human health.

There is evidence that the sound generated by wind turbines causes more annoyance than a similar sound produced from some other source. Research of U.S. wind turbines by Haac *et al.*[38] showed that while an individual's annoyance with wind turbine sound is linked to measured turbine noise levels, annoyance is

[33] Rand, J. & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned? *Energy Research & Social Science*, 29, 135-148. https://doi.org/10.1016/j.erss.2017.05.019

[34] Rand, J. & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned? *Energy Research & Social Science*, 29, 135-148. https://doi.org/10.1016/j.erss.2017.05.019

[35] Groth, T.M. & Vogt, C. (2014). Residents' perceptions of wind turbines: an analysis of two townships in Michigan. *Energy Policy*, 65, 251-260. https://doi.org/10.1016/j.enpol.2013.10.055

[36] Firestone, J., Hoen, B., Rand, J., Elliott, D., Hübner, G., & Pohl, J. (2017). Reconsidering barriers to wind power projects: community engagement, developer transparency and place. *Journal of Environmental Policy & Planning*, 20(3), 370-386. https://doi.org/10.1080/1523908X.2017.1418656

[37] Mills, S., Bessette, D., & Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. *Land Use Policy*, 82, 754-762 https://doi.org/10.1016/j.landusepol.2019.01.010

[38] Haac, T.R., Kaliski, K., Landis, M., Hoen, B., Rand, J., Firestone, J., Elliott, D., Hübner, G., Pohl, J. (2019). Wind turbine audibility and noise annoyance in a national U.S. survey: Individual perception and influencing factors, *The Journal of the Acoustical Society of America*, 146, 1124-1141. https://doi.org/10.1121/1.5121309

better explained by how the individual felt about the visual appearance of the wind turbine (i.e., those who reported disapproving of the looks of wind turbines were also more likely to report being annoyed by their sound) and whether or not the individual was receiving direct compensation.

As to direct health risk, although an individual's perception of health risk increases their opposition to wind turbines, Rand and Hoen (2017) write "Recent epidemiological research concludes that wind turbine sound and infrasound are not directly related to adverse human health effects or sleep quality." Even so, since the perception of health risk plays a role in acceptance of wind energy facilities, project developers may see value in addressing these concerns through appropriate changes to project design beyond what local regulations might minimally regulate.

Visual/Landscape, Annoyance, and Place Attachment

The idea that beauty is in the eye of the beholder is true for wind turbines. Many studies of public opinion in host communities of utility-scale WES have found negative perceptions of turbine impact on scenic beauty. Research found that this opposition to wind energy development is most common when individuals feel that the turbines threaten what makes a particular landscape special, and is particularly evident in places where people have strong attachment to the landscape.[39] Recent research, for example, found more opposition to wind energy in landscapes that are national parks or other protected areas.[40]

However, the negative reaction to turbines within a landscape is not universal. Many agricultural communities have shown moderate to high support for wind energy, as residents see wind turbines as *protecting* the rural farming character of the landscape by preventing suburban expansion, or see them as another productive use of the land.[41] Related research suggests that wind turbines in operation are perceived more positively as compared to when not operating and idle.[42] Other research finds that some perceive the visual impact of wind energy facilities to be symbolic and positive, a way of showing progress or a commitment to the environment.[43]

How well wind turbines might be perceived to fit within the landscape may vary from community to community, and even within communities. As a result, it is not uncommon to see modern-day discussions about wind energy resembling those that gave rise to Right to Farm laws 40 years ago: trying to balance the rights of those who see the land for productive uses and those who value it for other reasons, including but not limited to aesthetics. With this in mind, local officials should consider how their local master plans and zoning ordinance provisions balance these competing landscape views and apply that logic to WES, as appropriate and legally defensible.

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[39] Devine-Wright, P. (2009). Rethinking NIMBYism: The Role of Place Attachment and Place Identity in Explaining Place-protective Action. *Journal of Community & Applied Social Psychology*, 19, 426–441. https://doi.org/10.1002/casp.1004

[40] Giordono, L.S., Boudet, H.S., Karmazina, A., Taylor, C.L., & Steel, B.S. (2018). Opposition "overblown"? Community response to wind energy siting in the Western United States. *Energy Research & Social Science*, 43, 119-131. https://doi.org/10.1016/j.erss.2018.05.016

[41] Banas Mills, S., Borick, C., Gore, C., & Rabe, B.G. (2014, April). "Wind Energy Development in the Great Lakes Region: Current Issues and Public Opinion." Issues in Energy and Environmental Policy No. 8. *Center for Local, State, and Urban Policy, Ford School of Public Policy, University of Michigan*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2652865

[42] Fergen, J. & Jacquet, J. (2016). Beauty in motion: Expectations, attitudes, and values of wind energy development in the rural U.S. *Energy Research & Social Science*, 11, 133–141. http://dx.doi.org/10.1016/j.erss.2015.09.003

[43] Mulvaney, K.K., Woodson, P., & Stalker Prokopy, L. (2013). A tale of three counties: Understanding wind development in the rural Midwestern United States. *Energy Policy*, 56, 322-330. https://doi.org/10.1016/j.enpol.2012.12.064

Environmental Concerns and Attitudes

It is common for environmental concerns to be brought up both by proponents and opponents of wind energy. Wind energy development—like any other development—will have impacts on wildlife, particularly during construction. While many wildlife will return following construction, that may not be the case if the project impacts niche habitat. There are also often concerns over the long-term impact on birds and bats, and there is no shortage of research estimating bird and bat fatalities.[44] There is also research putting these fatalities in perspective of other human activities.[45] Further, many environmental organizations, including the National Audubon Society, support properly sited wind energy, as it helps mitigate climate change, which poses an even graver threat to species.[46] The American Wind Wildlife Institute, a collaboration that includes equal representation of environmental organizations and wind energy developers, includes numerous research studies and recommendations on best practices to avoid conflict with wildlife.

Distance from Turbines

As Rand and Hoen (2017) write in their review of research articles on wind energy perceptions, "researchers have consistently examined the hypothesis that those living closest to turbines will have the most negative attitudes about the local wind facility. These studies, however, have produced no clear consensus" (p. 142).[47] In some cases, those nearest the turbines had more positive views; in other cases, these nearest neighbors had more negative views. As suggested in a paper based on a study of Michigan windfarms, this is likely because many previous studies do not take into account that the most intense impacts—both positive and negative—often accrue to those nearest the turbines.[48] While those closest to the turbines may be the most likely to hear the turbines, they are also the most likely to be financially compensated. As a result, the distribution of those nearest neighbors who receive compensation versus those that do not across the projects that have been studied may lead these conflicting research findings. Again, this is likely among the reasons wind developers have broadened the geographic extent of royalty payments to include residents within the entire area of a project.

Perceptions of Planning Process, Fairness, and Trust

Countless studies point to community trust in the wind energy development siting process as being extremely important to public acceptance or acceptability. Indeed, research from Michigan finds that attitudes about the siting process to be even more important to perceptions about wind energy than whether or not the respondent is financially compensated by a wind developer.[49] Further, this research

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[44] American Wind Wildlife Institute. (2017, June). Wind Turbine Interactions with Wildlife and Their Habitats: A Summary of Research Results and Priority Questions. Washington, D.C. https://awwi.org/wp-content/uploads/2017/07/AWWI-Wind-Wildlife-Interactions-Summary-June-2017.pdf

[45] Zimmerling, J., Pomeroy, A., d'Entremont, M., & Francis, C. (2013). Canadian estimate of bird mortality due to collisions and direct habitat loss associated with wind turbine developments. *Avian Conservation and Ecology*, 8(2) 10. http://dx.doi.org/10.5751/ACE-00609-080210

[46] Sovacool, B. K. (2013). The avian benefits of wind energy: A 2009 update. *Renewable Energy*, 49, 19-24. https://doi.org/10.1016/j.renene.2012.01.074

[47] Rand, J. & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned? *Energy Research & Social Science*, 29, 135-148. https://doi.org/10.1016/j.erss.2017.05.019

[48] Mills, S., Bessette, D., and Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. *Land Use Policy*, 82, 754-762. https://doi.org/10.1016/j.landusepol.2019.01.010

[49] Mills, S., Bessette, D., and Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. *Land Use Policy*, 82, 754-762. https://doi.org/10.1016/j.landusepol.2019.01.010

found that attitudes about process fairness have impacts not just in the short-term (i.e., about how contentious the process is or whether or not a wind project gets built), but can shape how residents feel about a wind energy project long after the project has been built.

A study from 2017 provides a useful summary on procedural fairness in the wind energy development process and its relationship to the overall community attitudes associated with wind projects.[50] Researchers find that 1) a developer being open and transparent, 2) a community having a say in the planning process, and 3) a community being able to influence the outcome are all statistically significant predictors of a process perceived as being fair.

Trust and sense of fairness are directly tied to meaningful public engagement in the siting and decision-making process. This includes both actions taken by wind developers as well as those taken by local officials (i.e., planning commissioners and township/county board members).[51] If kept out of the siting, review, and decision-making process, community members may perceive that concerns related to anticipated effects are not being addressed and costs and benefits are not being fairly distributed across the community and with the developer. This can lead to community members feeling that local officials are not listening to them and the community as a whole is being treated unfairly, which can result in opposition directed both at the developer and the policymakers who reviewed the project.[52]

As a result, it is imperative that local governments follow a process that is open and allows for meaningful participation by members of the community (discussed in further detail below). Additionally, wind energy developers "…have to negotiate expectations with host communities and articulate a shared vision for a project. This requires interacting with a wider segment of the public than NGOs or municipal decision makers and making concerted efforts to learn the history and culture of a place" (p. 29).[53]

Towards a Better Process

Research recommends wind developers and local governments provide meaningful education, collaborative discussions, and robust public participation opportunities very early in the process in order to lessen friction among parties. Very early in this context means prior to wind studies or installation of anemometer towers, etc.[54] When communities plan and zone for wind energy facilities prior to a project being proposed, they have the benefit of time to more thoughtfully consider whether, how, and where it fits within their community. Proactive planning can also send a message to wind developers that your community would welcome a renewable energy development or not. If a developer has already submitted

[50] Firestone, J., Hoen, B., Rand, J., Elliott, D., Hübner, G., & Pohl, J. (2017). Reconsidering barriers to wind power projects: community engagement, developer transparency and place. *Journal of Environmental Policy & Planning*, 20(3), 370-386. https://doi.org/10.1080/1523908X.2017.1418656

[51] Bidwell, D. (2013). The role of values in public beliefs and attitudes towards commercial wind energy. *Energy Policy*, 58, 189-199. https://doi.org/10.1016/j.enpol.2013.03.010

[52] Ellis, G., Barry, J. & Robinson, C. (2007). Many ways to say 'no', different ways to say 'yes': Applying Q-methodology to understand public acceptance of wind farm proposals. *Journal of Environmental Planning and Management*, 50(4), 517-551. https://doi.org/10.1080/09640560701402075

[53] Fast, S. & Mabee, W. (2015). Place-making and trust-building: The influence of policy on host community responses to windfarms. *Energy Policy*, 81, 27–37. http://dx.doi.org/10.1016/j.enpol.2015.02.008

[54] Romich, E., Hall, P. & Beyea, W. (2013 December 18). Utility Scale Renewable Energy Development - Project Siting & Conflict Resolution. Recorded webinar. *North Central Regional Center for Rural Development*. https://www.canr.msu.edu/ncrcrd/webinars/chronological_archive/index

an application in a community, there are still steps that can be taken to help increase public involvement in the siting process.

Community-Wide Education

The time to increase awareness and to educate and inform people about wind energy development is ideally before a project application is submitted or land easement acquisition starts.[55] Education should not have a goal to convert or persuade members of the community to oppose or support a wind energy project, but rather to provide fact-based information about the benefits and negative impacts of wind energy. Educational efforts can include open houses with experts or a storefront where representatives of the project are accessible. Education should be about:

1. Wind energy generally,
2. Siting issues,
3. Findings from published academic research and peer-reviewed studies, and
4. Possibly include tours of existing wind energy developments.

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.

Process for Drafting the Zoning Ordinance

While planning commissions typically operate via public hearings, as required by the Michigan Zoning Enabling Act, this format has certain shortcomings, particularly while drafting zoning ordinance amendments related to WES. For example, public hearings invite for or against comments and do not allow or encourage the planning commission to engage in a conversation with community members or other interested stakeholders.

As with other types of development, there are a variety of public engagement techniques for collecting public opinion on potential land uses and appropriate standards. These, however, should be conducted *before* an application for that type of development is submitted.[56]

For a complex issue such as wind energy development, focus or working groups, made up of community members, including local planning commissioner(s) and developers, could be formed by the local unit of government to dig deeper into key issues and concerns. A list of potential discussion topics is included in

[55] 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., early John Deere wind energy projects in Huron County and other developers in Gratiot County, Michigan.

[56] Further Reading from Michigan State University Extension on public participation:

The Public Hearing is the worst way to involve the public:
https://www.canr.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:
https://www.canr.msu.edu/news/before_settling_for_a_public_hearing_consider_the_continuum_of_public_invol

Increasing public participation in the planning process:
https://www.canr.msu.edu/news/increasing_public_participation_in_the_planning_process

a "Lessons Learned" document from the first decade of wind development in Michigan.[57] These groups would provide a better opportunity for dialogue than the more rigid public hearing format, particularly with regard to a proposed zoning amendment. Focus groups or other intentional facilitated sessions, when organized by a unit of government, would be subject to the Open Meetings Act and Freedom of Information Act.

To reiterate, focus groups would be appropriate for a zoning amendment process in instances where a zoning application has yet to be submitted. *Ex parte* communication (discussing the business of the public body outside of a public meeting) would become an issue if planning commissioners were meeting in a focus group after a developer had submitted an application for a wind energy system.

Process for Evaluating Zoning Applications

Once a zoning application for a wind development is submitted, local officials still have a role to play in helping ensure that the community understands the planning process. One important role of the planning commission is articulating to the public what amount of discretion they have once a zoning application is submitted.

In many cases, the public hearing format can lead to a perception of lack of fairness, especially when a clear majority of the comments are opposed or in support of a certain proposal and the planning commission makes a decision contrary to the opinion of the majority of the public in the room during the formal hearing. This is not an outcome unique to wind energy development. This is all too often the outcome of new development proposals because the planning commission is an administrative body that has the primary responsibility to uphold and apply the ordinance as written. Community members, however, rarely know that this is the case. In these situations, the planning commission should be clear to remind the public that the planning commission has very little discretion in applying the ordinance standards. Instead, they are obliged to review the application against the current ordinance standards and render a decision as to whether the development proposal satisfies all applicable ordinance standards. If the proposal satisfies those standards, it must be approved; if it does not satisfy one or more standard, it must be denied. Further, while planning commissioners may be tempted to ignore points made in public comments that do not pertain to the ordinance standards before them, it may be helpful to acknowledge those points and to, again, educate the public on why the commission cannot consider them in evaluating the proposal.

Sample Zoning Amendments for Wind Energy Systems

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

This sample ordinance is not a definitive recommendation by the authors or MSU Extension. A sample is a starting point for discussion and development of an ordinance or ordinance amendment that is

[57] Wind Energy Stakeholder Committee. (2018 January). Lessons Learned: Community Engagement for Wind Energy Development in Michigan, Wind Energy Stakeholder Committee (WESC). https://static1.squarespace.com/static/564236bce4b00b392cc6131d/t/5a848c6771c10b7697cb6c50/1518636136391/Lessons+Learned_WESC+Report_Final.pdf

appropriate for a particular community. That means any numerical standard (dimensional standard) offered in the sample zoning amendment is just a starting point for discussion.

The commentary shown in highlighted boxes in the sample ordinance is intended to provide more detailed information to aid local policy decisions around numeric standards or other regulation.

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 by Michigan municipalities and counties apply in other states. In most cases they do not. First, consider the following:

- **If zoning exists in a city, village, township, or county**, then a zoning ordinance amendment 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[58]: For Adoption of a Zoning Ordinance Amendment (including some PUDs) in Michigan".[59]
- **In a township with county zoning** the township, or residents of the township, must work with the county planning commission to consider a zoning amendment to the county's zoning ordinance pursuant to the Michigan Zoning Enabling Act. Checklist #4 is also applicable here.
- **Where there is a Joint Planning Commission** the municipality must work with the joint planning commission to amend a zoning ordinance pursuant to the Michigan Zoning Enabling Act, Joint Municipal Planning Act, and the local Joint Planning Ordinance and Agreement. Checklist #4 is also applicable here.
- **If 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.

Options for Ordinance Structure

There are different ways for a WES to be classified in a zoning ordinance. The zoning classification for a WES is influenced by the height and scale (on-site v. utility-scale) of the systems, and the potential for impact to neighboring properties. Communities typically use two or more of the following regulatory approaches for different types of WES:

- **Permitted use:** Often used for on-site systems under a certain height, often approved administratively with basic site plan or plot plan.
- **Special land use (system):** Used for utility-scale systems as one application for the entire system. Although dozens or hundreds of turbines may be included under one application, community members can object to the placement of specific turbines or request turbine specific mitigations.
- **Special land use (individual turbine):** Applications are submitted and reviewed for each wind turbine generator (this is not a common approach). Some communities designate larger on-site systems (such as those over 90 feet) as a special land use.

[58] Schindler, K. (2016 May 31). Check List #4 For Adoption of a Zoning Ordinance Amendment (including some PUDs) in Michigan. *Michigan State University Extension*.
https://www.canr.msu.edu/resources/check_list_4_for_adoption_of_a_zoning_ordinance_amendment_including_some_pu

[59] Also see MSU Extension article "Amending a zoning ordinance requires adopting an ordinance" at: https://www.canr.msu.edu/news/amending_a_zoning_ordinance_requires_adopting_an_ordinance

- **Overlay district:** A specific zoning district that applies over underlying zoning districts that specifies areas for wind development and uses the site plan review process rather than a special land use approval process (Huron and Gratiot County are examples of this approach and it is discussed in more detail below).
- **Planned unit development (PUD):** This option has not been utilized in Michigan to date, but it offers yet another approach to design a wind energy system that meets performance standards designed for overall community benefit.

The sample provided here uses the special land use approach, but there are others to consider. The sample zoning for utility-scale WES is written with the following assumptions:

a) The municipality has a site plan review process in its zoning ordinance and follows it.

b) The municipality's attorney whom is experienced in municipal law (planning and zoning) will review any proposed amendments before they are adopted.

The Overlay Zoning Approach

An alternative option to the special land use provided in this sample zoning ordinance, is the overlay zoning district approach. The method uses zoning amendments (map and text) to identify and approve land areas suitable for wind energy development. Some overlay zoning districts are considered floating and are not mapped until the applicant requests a map amendment. Once land is approved in the wind energy overlay district classification, the wind turbine locations and other features of the development (like access roads) are subject only to site plan review procedures. A benefit of the overlay district is that it allows for more careful targeting of sections of the township or county that are appropriate for the use, rather than allowing for WES in the entirety of the Agriculture district (some of which may have an ag-residential character as compared to areas dominated by agricultural production).

The overlay zoning approach can be used to craft predictable and transparent WES regulation and it can be tailored in many ways. In Huron County, as one example, WES are classified as a permitted use and the overlay district regulation details required studies, setbacks, sound standards, and site plan requirements. This approach offers an option to remove the discretionary standards common to the special land use process, such as "will be harmonious with the essential character or the area" or "will not be hazardous or disturbing" When conditions on a permit are tied to these types of broad discretionary standards, rather than putting the standards into the ordinance language, it can create a less predictable and potentially more inefficient process.[60]

Definitions

Add the following definitions to Section 503[61] (or the section of the zoning ordinance that defines words used in the ordinance).

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.

[60] Huron County. (n.d.) *Wind Facility Overlay District Zoning.* Retrieved September 3, 2020 from https://www.dropbox.com/s/37850k50b328cct/Wind%20Energy%20Facility%20Overlay%20Zoning%20Revised%20Ordiance.pdf?dl=0

[61] This number system comes from the MSU Extension zoning ordinance codification system found here: https://www.canr.msu.edu/resources/organization_and_codification_of_a_zoning_ordinance. A community should stick to their own numbering system.

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.

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-scale 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-scale WES.

ANSI means the American National Standards Institute.

BACKGROUND SOUND means sound from all sources except the source of interest.

dBA means the sound pressure level in decibels using the "A" weighted scale defined by ANSI.

DECIBEL means a unit used to measure the intensity of a sound or the power level of an electric signal by comparing it with a given level on a logarithmic scale.

END OF USEFUL LIFE means the end of the manufacturer's recommended useful life of the product, when lease or easements expire, the WES or parts of the WES are abandoned for 12 months or more, or power purchase agreements expire.

> **Commentary.** The end of useful life provision provides direction to the next generation of planners as to what will happen in 20-30 years when a WES owner requests to re-tool (such as install new equipment to extend the life of the project), modify, or remove the project. [End of commentary]

HEIGHT means the distance between the base of the wind turbine tower at grade to the tip of the blade at its highest reach.

HORIZONTAL AXIS WIND TURBINE means a wind turbine that utilizes a main rotor shaft and electrical generator at the top of the tower and points into the wind for optimal operation.

IEC means the International Electrotechnical Commission.

> **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]

LAYDOWN AREA means a designated area where turbine components are temporarily stored prior to erection. A central laydown area may be used for the project or there may be several laydown areas. A laydown area may be used temporarily during construction or may be a permanent feature of the WES development.

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

Ln, 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 dBA. (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 dBA. L90 denotes the sound level exceeded 90 percent of the time period.)

PARTICIPATING PARCEL means one or more parcels under a lease or easement for development of a utility-scale WES[62].

NON-PARTICIPATING PARCEL means a parcel for which there is not a signed lease or easement for development of a utility-scale WES associated with the applicant project.

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

ON-SITE WIND ENERGY SYSTEM (WES) means a land use for generating electric power from wind and is often an accessory use that is intended to primarily serve the needs of the consumer on-site or an adjacent property.

SHADOW FLICKER means alternating changes in light intensity caused by the moving blade of a WES 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 dBA), the unit dB shall refer to an un-weighted measurement.

UTILITY-SCALE WIND ENERGY SYSTEM (WES) 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-scale WES is designed and built to provide electricity to the electric utility.

VERTICLE AXIS WIND TURBINE means a wind turbine utilizing a vertical rotor shaft, these are often mounted the ground or a building and do not need to point into the wind to be effective.

WES means wind energy system (see on-site WES and utility-scale WES).

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 WES.

WIND TURBINE means a group of component parts used to convert wind energy into electricity and includes the tower, base, rotor, nacelle, and blades.

[62] Note: earlier versions of this document, described this concept as a lease unit. A "pool" or "pooled parcels" may also describe a group of parcels under lease or easement.

General Provisions (On-Site WES/Temporary Towers)

Add to Article 10 subpart 107 (on-site WES) and 108 (Temporary towers)[63] the following provisions for small WES and temporary towers as a use by right. That means a special use permit is not required. Permanent anemometers included as part of utility-scale WES are included in sections on utility-scale WES.

107. An on-site WES is a permitted or accessory use which shall meet the following standards:

A. Designed to primarily serve the needs of a home, agriculture, or small business or to test wind or other environmental conditions in the area for a period not to exceed 3 years from the date the permit is issued.

> **Commentary**: A way to differentiate between on-site and utility-scale WES is height or electrical generation capacity of the generators. Due to changes in efficiency and technology, it is recommended to use height rather than rated capacity to classify on-site WES in a zoning ordinance. Height in this sample ordinance refers to the tower height plus the length of the blade at its highest reach. On-site WES tower heights generally range between 30 to 70 feet. Nearby trees may require an increase in the tower height to adequately capture the wind resource. Not all on-site WES are on towers, smaller systems are often mounted directly to the peak of a building or other structure, such as a pole. Larger on-site WES between 70 to 120 feet could be used to serve more energy intensive principal uses, such as agricultural operations. A community may choose to designate these taller systems as a special land use and may exempt smaller, mounted systems from requiring a zoning permit as shown below. [End of commentary]

B. **Height:** Total height for on-site WES shall not exceed ___ [for example: 66, 90, or 120] feet.

C. **On-Site System Exception**: On-site WES mounted to existing structures (such as a roof or pole) that extend ___ [for example: 8] feet or less above the highest point of the structure are exempt from this zoning ordinance.

D. **Property Setback:** The horizontal distance between the base of an on-site WES and the owner's property lines shall be no less than ___ [for example: 1.1] times height. No part of the WES structure, including guy wire anchors, may extend closer than ___ [for example: 25] feet to the owner's property lines, or the distance of the required setback in the respective zoning district, whichever results in a greater setback.

> **Commentary**: The property setback for on-site systems is intended to protect neighbors from potential noise and/or in the unlikely event of a tower failure. A setback relative to the height as opposed to the same setback distance for all property (such as 50 feet) helps to maintain an appropriate relationship between the height of the on-site system and the subject property. Due to the wind resource, trees, topography, lot size, and many other factors, some properties will be more well-suited to on-site WES. The turbine setback must have a rational basis and purpose, that protects health, safety, and welfare. Review the local zoning setbacks for on-site television antennas/Wi-Fi towers – a similar setback rule for on-site WES may be appropriate. [End of commentary]

E. **Sound Pressure Level:** The audible sound from an on-site WES shall not exceed ___ dBA L__ (_-minute) at the ___ [for example: property line or dwelling] closest to the WES.

[63] This number system shown here comes from the MSU Extension zoning ordinance codification system found here: https://www.canr.msu.edu/resources/organization_and_codification_of_a_zoning_ordinance. A community should stick to their own numbering system.

Commentary: For example (above) the audible sound from an on-site WES shall not exceed 45 dBA Leq (10 minute) at the property line closest to the WES. Manufacturers of on-site turbines provide a maximum predicted sound level as part of the documentation given to the owner or installer. A zoning administrator can ask for this information upon application to verify sound levels will meet the regulation. It is unlikely that the owner of the on-site WES will be able to afford a detailed sound study, like those required of a utility-scale WES. The manufacturer's predicted sound level is important documentation to keep in the file should a complaint arise. In the event that two or more on-site systems are requested for the same property, additional detail may be needed from the manufacturer to obtain the cumulative sound level contributed by more than one turbine. [End of commentary]

F. **Construction Codes, Towers, and Interconnection Standards:** On-site WES towers shall comply with all applicable state construction and electrical codes and local building permit requirements. An interconnected on-site WES shall comply with Michigan Public Service Commission and Federal Energy Regulatory Commission standards. Off-grid systems are exempt from this requirement.

G. **Aviation and Airports:** Where applicable, on-site WES 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.

Commentary: Structural and electrical safety issues are addressed by reference to these other codes. Depending on the height of the tower and distance to the airport, FAA, Michigan Tall Structures, and/or local airport zoning permits may not be required. [End of commentary]

H. **Safety:** An on-site WES 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.

I. **Ground Clearance:** The minimum vertical blade tip clearance from grade shall be ___ [for example: 20] feet for a horizontal axis wind turbine[64]. Vertical axis wind turbines are exempt from this ground clearance provision, but sufficient clearance should be maintained for the safety of people, animals, machinery, or others that may traverse under or near the vertical turbine.

108. Temporary Towers (temporary anemometers for wind testing, bat testing towers)

A **Height**: Temporary anemometers or other temporary testing towers (such as for bat studies) shall not exceed ____feet [for example: 200].

B **Setback:** The horizontal distance between the base of a temporary anemometer tower and the owner's property lines shall be no less than ___ [for example: 1.1] times height. No part of the tower structure, including guy wire anchors, may extend closer than ___ [for example: 25] feet to the owner's property lines, or the distance of the required setback in the respective zoning district, whichever results in a greater setback.

C **Construction Codes, Towers, and Interconnection Standards:** Temporary towers shall comply with all applicable state construction and electrical codes.

D **Aviation and Airports:** Where applicable, temporary anemometers shall comply with Federal Aviation Administration requirements, the Michigan Airport Zoning Act (Public Act 23 of 1950, MCL 259.431 *et seq*.), the

[64] Rynne, S., Flowers, L., Lantz, E., & Heller, E. (ed.) (2011). *Planning for Wind Energy*. American Planning Association, Planning Advisory Service Report Number, 566. https://www.planning.org/publications/report/9026890/

Michigan Tall Structures Act (Public Act 259 of 1959, MCL 259.481 *et seq*.), and local jurisdiction airport overlay zone regulations.

E **Performance Guarantee:** The Planning Commission shall obtain a performance guarantee for a temporary anemometer or other temporary tower in an amount sufficient to guarantee removal of the tower at the end of three years. The performance guarantee shall be obtained in compliance with Section _____ of this ordinance.

> **Commentary**: It is typical for a developer to test the wind resource for a year or more in an effort to determine if an area is well-suited for wind development. More than one tower may be necessary. Wind testing is done by using temporary towers to record wind speeds and directions at higher heights. In Mason County, a temporary bat tower was also erected to monitor bat activity prior to submittal of a WES application[65]. [End of commentary]

[65] Resolution Approving Utility Grid Wind Energy System, Special Land Use, Part B (12) Impacts on Bird and Bat Species; Study Required, https://www.masoncounty.net/departments/zoning/lake-winds-energy-park.html

Special Use Standards

Add a section to Article 16 (the part of the zoning ordinance for specific special use permit standards) to regulate utility-scale wind energy system (WES) which may include Anemometer Towers accessory to the proposed Utility-Scale WES.

1609 Utility-Scale WES (including permanent Anemometer Towers accessory to the project).

A. **Setbacks:**

1. An Anemometer Tower shall be setback a distance equal to ___ [for example: 1.1] times height from a property line or road right-of-way.
2. A wind turbine setback shall be measured from ___ [for example: the closest point of the base of the wind turbine to the [property line] or [inhabited structure]] and shall not exceed:
    i. Road right of way: A horizontal distance equal to ___ [for example: 1.1 or 1.5] times the height or ___ feet [for example 500] from the edge of the road right-of-way, whichever is greater;
    ii. Non-participating parcels: A horizontal distance equal to ___ [for example: 1,300 feet or 3 times height] from the ___ [property line] or [dwelling];
    iii. Participating parcels: A horizontal distance equal to ___ [for example: 1,100 feet or 2.5 times height (something less than 2. ii above) from the [property line] or [dwelling];

Commentary:

Setback to property line or dwelling: Deciding whether setbacks are measured to a property line or a dwelling is a common issue when crafting a zoning ordinance for WES. Some communities use setbacks to dwellings or inhabited structures, others use setbacks to property lines, and some use a combination of both (See Appendix A: Wind Turbine Noise for more information on setbacks). When using both, there may be a setback to a dwelling for a participating parcel and a setback to a property line for a non-participating parcel. In Michigan, wind development has generally occurred in areas with around 2 to 2.5 times height or 1,000 to 1,250 foot setbacks to a dwelling or property line.

Geographic Information Systems (GIS) can be a helpful tool to model various setbacks from roads, property lines, dwellings, and natural features (lakes, rivers, natural areas). Seeing how setback distances change the viability or the density of a WES can help a Planning Commission determine a point at which a combination of setbacks would allow for, or potentially exclude, wind energy development.

Participating and non-participating properties: Property owners that enter into a lease or easement agreement with a wind energy developer are referred to here as participating properties. Those that were asked but declined, or those that were never approached, are non-participating. It is important to remember that not all properties that are impacted by a WES will have been approached about signing a lease or easement. This is certainly the case for properties lying just outside the boundaries of the wind development. With this in mind, some communities adopt separate standards for each type of property, with more restrictive standards applied to non-participating properties and that approach is used here (Appendix A: Wind Turbine Noise, Table 1: Utility-Scale Wind Energy Zoning Regulation Comparison in Michigan). The purpose for doing so is to further minimize nuisance for those not receiving compensation from the wind energy development and create an incentive for developers to work with property owners in the vicinity of the project.

Setback distances vary: Setback distances vary among Michigan communities and other Midwestern states (Appendix A: Wind Turbine Noise, Table 2: Comparison of Midwestern State Standards Regulating Wind Energy Development). Land use patterns and parcel sizes in the area can impact local regulation. In many parts of Europe where land use controls and patterns restrict residential development in rural areas, 500 meters (1,640 feet) to 1,000 meters (3,280 feet) for a setback is common[66]. The Canadian province of Ontario starts at a 550 meters (1,804 feet) and the setback increases with wind turbine sound power and the number of turbines within 3 kilometers (1.86 miles)[67]. In Michigan and nearby Midwestern states where a system of roads bordering one mile sections are common, the constraints on development are different. This is where the use of GIS can be helpful in Michigan to illustrate local opportunities or constraints.

Setback to roads and other infrastructure: In addition to setbacks to road right of way (ROW), some communities adopt setbacks to railroads, major gas lines, and electrical transmission lines, such as 1.1 times turbine/tower height. In the absence of these additional setbacks, the location of transmission lines and railroads should be shown on site plans and communication between the developer and major utilities/railways can be facilitated through the site plan review process. [End of commentary]

3. A Wind Turbine is not subject to property line setbacks for common property lines of two or more participating parcels, except road right-of-way setbacks shall apply.

B. **Height:** WES are not subject to height limitations found in Section ___ [this is the height standard applied to buildings and signs in the zoning district, such as a maximum of 30' or 40'].

Commentary: Modern utility scale wind turbines include a tower (90 to 110 meters) and blades (45 to 55 meters) for a total height of about 440 to 550 feet. Generally, wind turbines are getting taller and more powerful. Where a single turbine might have produced 1.4 megawatts (MW) in the early 2000s, a modern onshore wind turbine can produce 2.5 to 3 MW. Using this example, building a 100 MW wind farm two decades ago would require about 70 turbines. In 2020, 33 to 40 turbines would be needed to produce the same amount of energy. If a community limits turbine height to 200, 300, or even 400 feet, they may be excluding modern utility-scale wind development and/or creating an incentive to site more, smaller turbines. [End of commentary]

C. **Accessory Uses:** An Operations and Maintenance Office building, a sub-station, or ancillary equipment shall comply with property setback requirements of the respective zoning district. Overhead transmission lines and power poles shall comply with the setback and placement requirements applicable to public utilities.

D. **Laydown Area:** A centralized temporary laydown area for wind turbine component parts and other related equipment shall comply with property-setback requirements of the district and be detailed in the application.

E. **Sound Pressure Level:** The sound pressure level shall not exceed the following:

1. **Non-participating property:** Sound from a WES shall not exceed ___ dBA L_ (_-minute) measured at the ___ [dwelling] or [property line] of a non-participating property. If the average

[66] Summary of Wind Energy Policies by Country (2012) Minnesota Environmental Review of Energy Projects, Minnesota Department of Commerce, https://mn.gov/eera/

[67] Ontario Environmental and Energy. (n.d.). Chapter 3: Required setbacks for wind turbines. In *Technical Guide to Renewable Energy Approvals.* https://www.ontario.ca/document/technical-guide-renewable-energy-approvals/required-setback-wind-turbines#

background sound pressure level exceeds ___ dBA L_ (_-minute) the standard shall be background sound dBA plus ___ [for example: 5 or 10] dBA.

2. **Participating property:** Sound from a WES shall not exceed ___ dBA L_ (_-minute) measured at the ___ [dwelling] or [property line] of a participating property. If the average background sound pressure level exceeds ___ dBA L_ (_-minute) the standard shall be background sound dBA plus ___ [for example: 5 or 10] dBA.

3. **Sound measurement methodology:** Sound pressure level measurements shall be performed by a third party, qualified professional selected by the developer and approved by the Planning Commission. Testing shall be performed according to the procedures in the most current version of ANSI S12.18 and ANSI S12.9 Part 3. 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.

4. **Post-construction sound survey:** A post-construction sound survey shall commence within the first year of operation to document levels of sound emitted from wind turbines. The study will be designed to verify compliance with sound standards applicable to this ordinance. The WES owner shall provide SCADA data during the testing period to the sound consultant completing the study.

Commentary: Choosing a regulation and methodology for post-construction sound compliance testing should involve an acoustic consultant with a background in wind turbine noise compliance testing. The testing methodology should be related to the regulation and public purpose and be detailed enough that if two acousticians are tasked with compliance testing at the same location at the same time, they would end up with similar results. If the ordinance provides no detail on how the testing will be performed, the details will have to be negotiated at a later date. An acoustic consultant can provide details and recommendations on the most recent methodologies (such as using attended and unattended measurement), number of testing locations, times of day/night, and data needed to determine compliance. The detail required and necessary tailoring to the regulation precludes a full outline of compliance testing methodology here.

See Mason and Huron County's ordinances in the Michigan Zoning Database[68]. [End of commentary]

F. **Safety:** Utility-scale WES 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 WES. A sign shall be posted near the tower or Operations and Maintenance Office building that will contain emergency contact information. A sign shall be placed at the road access to a wind turbine 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 WES employing a horizontal axis rotor.

G. **Construction Codes, Towers, and Interconnection Standards:** Utility-scale WES shall comply with all applicable state construction and electrical codes and local building permit requirements.

H. **Pre-Application Permits:** Utility-scale WES shall comply with applicable utility, Michigan Public Service Commission, Federal Energy Regulatory Commission interconnection standards, FAA requirements, and tall structures requirements, including but not limited to:

1. Aviation and Airport

[68] Michigan Department of Energy, Great Lakes, and Environment. (2019). *Michigan Zoning Database* (April 1, 2019) [Data set]. https://www.michigan.gov/climateandenergy/0,4580,7-364--519951--,00.html

i. Federal Aviation Administration (FAA) requirements. The minimum FAA lighting standards shall not be exceeded. The lighting plan submitted to the FAA shall include an Aircraft Detection Lighting System (ADLS) for the utility-scale WES. The tower shaft shall not be illuminated unless required by the FAA.

ii. Michigan Airport Zoning Act (Public Act 23 of 1950 as amended, MCL 259.431 *et seq*.).

iii. Michigan Tall Structures Act (Public Act 259 of 1959 as amended, MCL 259.481 *et seq*.).

iv. Local jurisdiction airport overlay zone regulations.

Commentary: For additional commentary on FAA standards and Aircraft Detection Lighting Systems (ADLS) see "FAA lighting" in Appendix C: Shadow Flicker, FAA Lighting. [End of commentary.]

2. Environment: The application will demonstrate 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. The application shall demonstrate compliance with:

i. Michigan Natural Resources and Environmental Protection Act (Act 451 of 1994, MCL 324.101 *et seq*.) (including but not limited to: Part 31 Water Resources Protection (MCL 324.3101 *et seq*.),

ii. Part 91 Soil Erosion and Sedimentation Control (MCL 324.9101 *et seq*.)

iii. Part 301 Inland Lakes and Streams (MCL 324.30101 *et seq*.)

iv. Part 303 Wetlands (MCL 324.30301 *et seq*.)

v. Part 323 Shoreland Protection and Management (MCL 324.32301 *et seq*.)

vi. Part 325 Great Lakes Submerged Lands (MCL 324.32501 *et seq*.)

vii. Part 353 Sand Dunes Protection and Management (MCL 324.35301 *et seq*.)

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

3. Avian and Wildlife Impact: Site plan and other documents and drawings shall provide mitigation measures to minimize potential impacts on avians and wildlife, as identified in the Avian and Wildlife Impact analysis.

i. The application shall demonstrate consultation with the U.S. Fish and Wildlife Service's Land-Based Wind Energy Guidelines.

ii. Applicants must comply with applicable sections of the Federal Endangered Species Act and Michigan's endangered species protection laws (NREPA, Act 451 of 1994, Part 365).

iii. The applicant or the applicant's impact assessment must show consultation with the U.S. Fish and Wildlife Service regarding federally listed species and the Michigan Department of Natural Resources for state listed species. Early coordination with state and federal agencies is recommended.

Commentary: Wind turbines do kill birds in some areas, but they are not a major contributor to bird mortality[69]. According to research published in 2015, an estimated 234,000 birds were killed annually in the US from wind turbines. This is below other causes of direct bird mortality, including communication towers (6.6 million), building collisions (599 million) and cats (2.4 billion).[70] This sample zoning requires an Avian and Wildlife Impact Analysis but does not specify how the analysis should be conducted. Site specific issues should determine which issues are emphasized in the analysis. To assist applicants to minimize, eliminate, or mitigate potential adverse impacts, the U.S. Fish and Wildlife Service has developed the Land-Based Wind Energy Guidelines (2012).[71] 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. [End of commentary]

H. **Performance Security**: Performance security, pursuant to Section ___ of this Ordinance, shall be provided for the applicant to make repairs to public roads damaged by the construction of the WES. In lieu of a performance security agreement with ___ [County or Township], the applicant may enter into a road use agreement with the ___ County Road Commission to cover the costs of all road damage resulting from the construction of the WES.

Commentary: Many ordinances defer to the County Road Commission to enter into a separate road use agreement with the developer or project owner because public roadways in Michigan are under the jurisdiction of Michigan Department of Transportation or the County Road Commission. A road use agreement typically specifies a performance guarantee, detailed documentation/videos/photos of roadway condition before and after construction, road intersection modifications to accommodate the enlarged turning radius associated with turbine component transport, and more. The local Road Commission should provide feedback on this ordinance provision to help shape a regulation around performance guarantees for public road repairs. [End of commentary]

I. **Utilities:** Electric transmission lines extending from a wind turbine to a sub-station should be placed underground to a minimum depth of ___ feet to allow for continued farming and existing land use operations in the vicinity of the WES, and to prevent avian collisions and electrocutions. All other above-ground lines, transformers, or conductors should comply with the Avian Power Line Interaction Committee (APLIC) published guidelines[72] to reduce avian mortality.

J. **Visual Impact:** Utility-scale WES projects shall use tubular towers and all utility-scale WES in a project shall be finished in a single, non-reflective, matte finish, color approved by the Planning Commission. A project shall be constructed using WES components (tower, nacelle, blade) of similar design, size, operation, and appearance throughout the project. An area of ___ square feet or ___ [for example: 5] percent of the nacelle [on one or two sides] may be used for a sign, such as for turbine identification or other insignia. The applicant shall avoid state or federal scenic areas and significant visual resources listed in the local unit of government's Master Plan.

[69] Breining, Greg (2020) Power or Prairie? It doesn't have to be an either/or. *Living Bird*, Cornell Lab of Ornithology. 65.

[70] Loss, S., Will, T. & Marra, P. (2015). Direct Mortality of Birds from Anthropogenic Causes. *Annual Review of Ecology, Evolution and Systematics*, 46, 99-120.

[71] U.S. Fish and Wildlife Service. (2012). U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. https://www.fws.gov/ecological-services/es-library/pdfs/WEG_final.pdf

[72] Avian Power Line Interaction Committee & US Fish and Wildlife Service. (2005). Avian Protection Plan (APP) Guidelines. https://www.aplic.org/uploads/files/2634/APPguidelines_final-draft_Aprl2005.pdf

Commentary: These guidelines try to address visual impact issues by providing some design standards around color and finish and by limiting commercial advertising. Allowing for signage on a turbine is optional; the content of a small identification sign on a turbine (letters, numbers, logos, corporate insignia) cannot be dictated by the zoning ordinance and are protected by the 1st Amendment.[73] [End of commentary]

K. **Shadow Flicker:** Shadow flicker shall not exceed ___ [for example: 30] hours per year and/or ___ [for example: 30] minutes per day measured to the exterior wall of a dwelling or other occupied building on a non-participating parcel. Mitigation measures to minimize or eliminate potential impacts from shadow flicker, as identified in the Shadow Flicker Impact Analysis for human-occupied structures, shall include, but not be limited to:

1. Change the proposed location of the wind energy tower; or

2. The utility-scale WES shall be turned off by manufacturer approved automated system during the period of time an inhabited structure receives shadow flicker; or

3. The utility-scale WES shall be turned off during flicker events after ___ hours/year of shadow flicker on an inhabited structure; or

4. There is screening (forest, other building(s), topography, window treatments/blinds) which shields the inhabited structure from a direct line of sight to the rotors causing shadow flicker.

Commentary: See Appendix C: Shadow Flicker, FAA Lighting for more information on Shadow Flicker. [End of commentary]

L. **Signal Interference:** No utility-scale WES 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 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 WES. No utility-scale WES shall be installed in any location within the line of sight of an existing microwave communications link where operation of the WES is likely to produce electromagnetic interference in the link's operation.

M. **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, 4) the anticipated manner in which the project will be decommissioned and the site restored, and 5) the review of the amount of the performance guarantee based on inflation and current removal costs to be completed every ____ [for example 3 or 5] years, for the life of the project, and approved by the _____ [legislative body] board.

Commentary: A periodic review of the amount required to remove the system (such as every 3 to 5 years) will ensure adequate funds are available to cover decommissioning costs 20 to 30 years down the road. A review might also be triggered by a change of ownership, for example. The ordinance should specify which body is responsible for approving the amount of the performance guarantee; the planning commission could recommend an amount with the legislative body making the final decision. A community could review how performance guarantees are handled for other types of developments, such as landscaping guarantees, and discuss how this could be similar or require a higher level of review. [End of commentary]

73 *Reed, et al v. Town of Gilbert, AZ et al.*, 135 S. Ct. 2218, 576 U.S. __ (2015)

N. **Complaint Resolution:** A complaint resolution plan shall be presented to the planning commission and approved prior to approval of a special land use permit. The complaint resolution program will describe how the developer receives, responds, and resolves complaints that may arise from the operation of the WES. The complaint resolution plan shall include appropriate timelines for response and other detailed information (such as forms, and contact information). As a condition of filing a complaint, a landowner must allow the _____ staff or designated agents and WES owner or agents on the subject property for further investigation.

O. **Annual Maintenance Review:** The WES shall be maintained and kept in a safe working condition. The WES owner shall certify on an annual basis that all turbines are operating under normal conditions. Non-operational turbines at the time of the annual review, shall be identified and provided an expected date to resolve the maintenance issue. A wind turbine generator that has not been operational for over 12 months shall be considered abandoned and a violation of the special land use permit.

P. **End of Useful Life:** At the end of the useful life of the WES, the system owner:

1. Shall follow the decommissioning plan approved by the Planning Commission under Section _____ [from local government ordinance] and remove the system as indicated in the most recent approved plan; or,

2. Amend the decommissioning plan with Planning Commission approval and proceed with P.1 above; or,

3.The _____ [local unit of government] reserves the right to approve, deny, or modify an application to modify an existing WES at the end of useful life, in whole or in part, based on ordinance standards at the time of the request. Expenses for legal services and other studies resulting from an application to modify or repower a WES will be reimbursed to the _____ [local unit of government] by the WES owner in compliance with established escrow policy.

Commentary: There are many scenarios that could occur at the end of useful life of a WES, other than decommissioning and removal. In Minnesota, several projects[74] constructed in the late 1990s or early 2000s are being repowered with new wind turbines[75]. For the Jeffers Wind Energy Center Repower Project in Minnesota, 2.5 MW turbines are being replaced with a 2.2 MW turbines. There are no examples in Michigan, to date, of repowering or replacing an existing WES. During the initial special land use permit review, a municipal attorney could help to frame a process for a request to repower or modify the proposed WES at the end of useful life. [End of commentary]

[74] Minnesota Department of Commerce. (n.d.) *Wind Turbines, Open Projects*. Environmental Review of Energy Projects. Retrieved September 3, 2020 from https://mn.gov/commerce/energyfacilities/#turbine

[75] Minnesota Department of Commerce. (n.d.) *Jeffers Wind Repowering Project*. Environmental Review of Energy Projects. Retrieved September 3, 2020 from https://mn.gov/eera/web/project/13517/

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 utility-scale WES, which may also include permanent anemometer towers.

9408. Site Plans for Utility-Scale WES.

Commentary:

Site Plan required (at the time of application): As indicated earlier, this sample is written with the assumption that site plans are already a requirement in the zoning ordinance. Further, that the site plan and/or permit application requires basic information such as parcel identification including property boundaries, scale, north point, natural features, water bodies, location of structures and access drives (existing and proposed), neighboring drives, buildings, etc., topography, existing and proposed utilities, landscaping, buffering features, soils data, and so on.

Scale/Format Modifications: The applicant is required to produce site plans and studies that are both readable and useable for the staff, Planning Commission, and the public. It is reasonable to request large-scale composite maps (such as on a 36-inch x 48-inch format) of the entire project and more detailed site plans (such as 1:100 or 1:200 scale) for each wind turbine or grouping of turbines. Participating and non-participating parcels should be identified on the composite maps (especially when an ordinance requires different standards for these two groups). Some communities have minimum site plan requirements (such as a 1:100 scale) that may need to be amended to accommodate these unique, large-area projects.

Obtain all other permits first: Most zoning ordinances require (and if they don't, it is a best practice) that all other applicable permits be obtained prior to submission of the site plan, or at least the site plan will include the same information that will be required by other agencies for review. This includes local airport zoning permits, Michigan Tall Structures, FAA, and U.S. Fish and Wildlife/MDNR consultation for avian and bat studies.

Fees/Escrow: Application fees and a site plan review fee may need to be modified to cover the cost of review for a Utility Scale WES. The work is substantially more time consuming than a typical application on which most fees are based. A revised fee schedule must be adopted by the legislative body of the local unit of government. In addition, many communities have an escrow deposit system to cover costs of more involved special use permit reviews. As with all fees, the amount must be set by the legislative body to cover anticipated actual cost of the application review and not more. [End of commentary]

Site plans and supporting documents for permanent Anemometer Tower or utility-scale WES shall include the following additional information:

A. Documentation that 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 as applicable:

   1. Proof of the applicant's public liability insurance for the project.

   2. 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-scale WES; legal description of the property(ies).

   3. The construction schedule including details of all phases.

4. Participating and non-participating parcels within the project area boundary and non-participating parcels extending a quarter-mile beyond the edge of the project boundary.

5. The location, height, and dimensions of all existing and proposed structures and fencing.

6. The location, grades, and dimensions of all temporary and permanent roads from the nearest county or state maintained road.

7. The location, grade, and dimension of all temporary or permanent laydown areas for turbine component parts (if in a central location).

8. All new infrastructure above ground related to the project.

9. 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.

B. **Sound Modeling Study:** A copy of a predictive noise modeling and analysis report showing sound levels at various distances. The modeling must show compliance with sound standards applicable to this ordinance. The modeling study shall use turbine locations identical to the site plans submitted with this application. The analysis will show that the WES will not exceed the permitted sound pressure levels under any conditions. The noise modeling and analysis should utilize the methods outlined in ISO 9613-2 (or most recent version), including sound power levels determined using IEC 61400-11.

> **Commentary**: Maps of sound modeling isolines are effective in showing anticipated sound levels and can be shared with the public early in the process. Predicted sound is usually expressed in 35, 40, 45, 50 dBA intervals. With the use of GIS both sound and flicker maps can be overlaid on a parcel layer map and shared with the public. [End of commentary]

C. **Transportation Plan**: A detailed road modification plan to accommodate delivery of components of the WES along existing and proposed roads and return of those roads and adjacent lands to their original condition after construction.

D. **Visual Impact Simulation and Materials:** A visual impact simulation showing the completed WES from multiple angles, locations and scales. The simulation should show the non-reflective, low-gloss finish of a finished turbine and be a neutral color such as white, off-white, or gray. The application shall include a sample of finished component materials to demonstrate finish and color of wind turbine components.

E. **Environment Analysis:** An analysis by a third party qualified professional shall be included in the application 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 analysis shall identify all appropriate measures to minimize, eliminate or mitigate adverse the impacts identified and show those measures on the site plan, where applicable. The applicant shall identify and evaluate the significance of any net effects or concerns that will remain after mitigation efforts.

F. **Avian and Wildlife Impact Analysis:** The application shall include 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 evaluate the significance of any net effects or concerns that will remain after mitigation efforts. The analysis must show consultation and evaluation based on applicable U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines (2012 or latest version).

1. At a minimum, the analysis shall include a thorough review of existing information regarding species, potential habitats, and sites requiring special scrutiny (such as endangered or threatened species habitat or other known special habitat) 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 laws (NREPA, Act 451 of 1994, Part 365).

2. 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.

G. **Shadow Flicker Study:** The application shall include a shadow flicker analysis extending ___ [for example: 5,280] feet or ___ [for example: 20] times the rotor diameter (whichever is less) from proposed wind turbine generator locations. The study shall indicate all modeling assumptions. The site plan and study shall describe the predicted annual amount of flicker on inhabited structures on non-participating properties impacted by shadow flicker. The study shall detail one, or more mitigation strategies to comply with the ____ hour per year regulation.

> **Commentary**: A community can require a shadow flicker analysis tailored to their regulation. Shadow flicker modeling can produce a very detailed, predictive analysis for each inhabited structure. Some communities find that having detailed shadow flicker modeling data is important when responding to flicker complaints or undertaking enforcement efforts. See Shadow Flicker in Appendix C: Shadow Flicker, FAA Lighting. [End of commentary]

H. **Decommissioning Plan:** A decommissioning plan shall be included in the site plan application.

I. **Complaint Resolution Plan:** The application shall include a description of a complaint resolution process including forms, phone numbers, and timelines for complaint referral, response, and resolution. The plan must be approved by the Planning Commission.

> **Commentary**: A complaint resolution plan or regulation is optional. The benefit of requiring a plan is that it provides a pro-active measure to anticipate issues from the WES, such as with shadow flicker or unexpected changes in television reception. A complaint resolution plan as part of the site plan documentation a) assists landowners/local unit of government/WES owner with the details and methods needed to submit a complaint b) allows the local unit of government and the system owner to work out a shared agreement on expected timelines for resolution and c) allows the community and system owner a way to track complaints from start to finish. Some may view this as unnecessary because if the complaint stems from a zoning violation, then it falls on the local unit of government to enforce the regulation. If the complaint is not a zoning violation, then it should not be regulated here. Another concern is that the complaint resolution requirement is arbitrary, particularly if wind energy is the only special land use with a complaint resolution requirement. [End of commentary]

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Appendix A: Wind Turbine Noise

Wind Turbine Noise

Noise issues can be a technically complex aspect of WES. Many planners, appointed officials, and elected leaders that have dealt with WES in Michigan find themselves trying to learn more about wind turbine noise, and quickly. What they may find is that the study of sound is highly technical and uses unfamiliar language. The purpose of this section is to provide background information on wind turbine noise and commonly used terminology that may be presented by citizens or sound experts.

Setting a maximum sound level in an ordinance speaks to volume or loudness measured in decibels, but this is not the only characteristic of sound. Pitch, tone, and rhythm also characterize sound. Quiet, rhythmic sounds can be highly annoying (mosquito, dripping sink) and louder sounds can be quite enjoyable (waterfalls, music).

Wind turbine noise can invite detailed regulation, often beyond a simple decibel level (such as 45 dBA). This is because the noise produced by wind turbines differs from other power generation facilities in how it is created, how it is propagated, and how it is perceived.[76] Measuring wind turbine sound is a unique and specialized field among acousticians and requires special attention when regulating WES.

Regulation of noise, defined as unwanted sound or sound determined to be unpleasant, tends to focus on volume or sound pressure, expressed as a maximum decibel (dB) limit. Sound maximums shown as dBA mean that the sound is measured based on the A-frequency weighted scale, a scale that most closely represents what humans typically hear (the A-weighting scale mimics the fact that humans are more sensitive to higher frequency sound than to low frequency sound). It is most common for wind turbine ordinances to use the A-weighted scale, expressed in dB(A) or dBA. This sample ordinance uses the dBA scale with the goal of regulating audible sound.

Infrasound (1 to 20 Hz) and low frequency (20 to 200 Hz) sound generated by WES may be a public concern. Questions may arise around using the dBC scale in regulation as the C-scale is better suited to measure low frequency sound. Communities that desire to regulate with the dBC scale (in addition to dBA) should only do so with the consultation of an acoustician experienced in measuring wind turbine noise.

Sound Studies and Standards

There are documented health issues with excessive noise exposure from a range of different noise sources. Noise standards may consider the potential for bodily injury, long term health effects, interference with speech, sleep, and other activities. Many noise standards parallel the United States Department of Labor Occupational Safety and Health Administration (OSHA) workplace safety regulations. The 1974 standards from the United States Environmental Protection Agency (EPA) indicate that 55 dBA L_{dn} is too low to produce hearing loss or long-term health effects.[77]

[76] Hessler, D. (2011). *Best Practice Guidelines for Assessing Sound Emissions from Proposed Wind Farms and Measuring Performance of Completed Projects*. Minnesota Public Utilities Commission. https://www.michigan.gov/documents/energy/MLUI9_NARUC_420200_7.pdf

[77] U.S. Environmental Protection Agency. 1978. *Protective Noise Levels: Condensed Version of EPA Levels Document*. https://nepis.epa.gov/Exe/ZyNET.exe/20012HG5.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1976+Thru+1980&Do

There have been no updated noise standards, such as for WES, published by any agency within the United States government since those 1974 standards (at a federal level). The World Health Organization (WHO), other nations, and states have published recommendations specific to WES or determined thresholds at which annoyance and/or health effects occur. Several studies have found statistical associations between high degrees of annoyance toward noise and self-reported health effects that include, but are not limited to, migraines, heart disease, diabetes, and hypertension.[78]

In a 2019 study, researchers found that outdoor audibility of turbine sound was "overwhelmingly dependent on turbine sound level, [but] noise annoyance was best explained by visual disapproval" (p. 1124).[79] Meaning that wind turbine sound levels are not necessarily the strongest predictor of what causes annoyance from wind turbines.

The Canadian government undertook a multi-year research study in 2012 carried out by Health Canada and Statistics Canada called the Wind Turbine Noise & Health Study "to explore the relationship between exposure to sound levels produced from wind turbines and the extent of health effects reported by, and objectively measured in, those living near wind turbines" (2014 para. 3).[80] The Health Canada study included survey results from 1,238 households in Ontario and Prince Edward Island living near wind turbines. Several peer-reviewed journal articles resulted from the study, one of which concluded at the highest wind turbine noise levels (40-46 dBA) 16.5% in the Ontario study and 6.3% in the Prince Edward Island study were very or extremely annoyed by the wind turbine noise.[81] Wind turbine noise is not the only factor that contributes to annoyance, other factors such as distance to turbines, changes to views, and monetary benefit have can increase or decrease in annoyance. [82]

The 2018 World Health Organization (WHO) Environmental Noise Guidelines for the European Region provide a conditional recommendation[83] of 45 dBA (L_{den}) for wind turbine noise. The 2018 WHO guideline is specific to wind turbine noise and further states "To reduce health effects, the Guidance Development Group conditionally recommends that policymakers implement suitable measures to

cs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C76thru80%5CTxt%5C00000008%5C20012HG5.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

[78] Michaud, D.S., Keith, S.E., Feder, K. & Voicescu, S.A. (2016). Personal and situational variables associated with wind turbine noise annoyance. *Journal of the Acoustical Society of America*, 139(3), 1455-1466. https://doi.org/10.1121/1.4942390

[79] Haac, R., Kaliski, K., Landis, M., Hoen, R., Rand, J., Firestone, J., Elliott, D. & Hubner, G. (2019). Wind turbine audibility and noise annoyance in a national U.S. Survey: Individual perception and influencing factors. *The Journal of the Acoustical Society of America*, 146, 1124-1141. https://doi.org/10.1121/1.5121309

[80] Health Canada. (2014 May 10). *Wind Turbine Noise*. https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise.html

[81] Michaud, D.S., Feder, K., Keith, S.E., & Voicescu, S.A. (2016). Exposure to wind turbine noise: Perceptual responses and reported health effects. *Journal of the Acoustical Society of America*, 139(3), 1443-1454. http://dx.doi.org/10.1121/1.4942391 .

[82] Michaud, D.S., Feder, K., Keith, S.E., & Voicescu, S.A. (2016). Personal and situational variables associated with wind turbine noise annoyance. *Journal of the Acoustical Society of America*, 139(3), 1455-1466. https://doi.org/10.1121/1.4942390

[83] World Health Organization. "Environmental Noise Guidelines for the European Region." 2018. Within the Guidelines, a "strong recommendation" can be adopted as policy in most situations. A conditional recommendation (as given for wind turbine noise) "requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of the efficacy owing to the lower quality of evidence of a net benefit… meaning there may be circumstances or settings in which it will not apply" (p. 23). http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018

reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure."

Sound Descriptors

It is important to consider the sound descriptor and sound level together when writing regulation. The regulation should be based on current studies, such as the WHO recommendation, peer reviewed research, and other studies specific to wind energy such as the Health Canada[84] study. Sound descriptors are the way in which sound is quantified, analyzed, and described. Leq and L50 are the descriptors most commonly used for wind energy (Figure 1, Common Sound Descriptors).

Some Michigan communities have adopted regulation using the Lmax descriptor, which is a different standard than L_{eq} or other sound descriptors that average sound pressure over a period of time (such as 10 minutes or one hour). Lmax measures the instantaneous, loudest sound coming from a WES, such as within 1 second. Communities adopting a lower sound level maximum (40 dB or lower) in combination with an Lmax descriptor are adopting a standard that is not supported by long-term studies. By design, long-term noise studies that describe the impact of WES on health (sleep, annoyance) are based on descriptors that average sound (L_{eq}, L_{den}, or Lnight,outside which is the L_{eq} over the entire night) and use measurements over the course of hours, days, and years—not seconds. Those seeking to regulate with Lmax descriptor should first consult with an acoustician and review *Tuscola Wind III, LLC, v. Almer Charter Township.*[85]

In addition, the commonly used ISO 9613-2 standard (Acoustics-Attenuation of sound during propagation outdoors) uses Leq to model predicted sound pressure level at a receiver in pre-construction sound studies, as does the IEC 61400-11 standard used to measure the noise output of a single turbine.

Figure 1. Common Sound Descriptors

dB means decibels.

dBA 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.

L_{10} is the sound level that is exceeded 10% of the time. For 10% of the time, the noise has a sound pressure level above L10

L_{50} means the sound level exceeded 50% of the time. It represents the median sound level and is the statistical mid-point of the noise readings.

L_{90} means the sound level that is exceeded 90% of the time. For 90% of the time, the noise is above this level.

L_{dn} is an equivalent sound level, day-night average, over a 24-hour period where a 10 dB penalty is added to nighttime sounds (10 pm to 7 am)

L_{den} is an equivalent sound level, day-evening-night average, over a 24-hour period at the most exposed façade, outdoors; a 10 dB penalty is added to night time noise and 5 dB

[84] Health Canada. (2014). *Wind Turbine Noise and Health Study*. https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html

[85] *Tuscola Wind III, LLC, v. Almer Charter Township, et al*, US District Court, Eastern District of MI, Norther Division, Case No. 17-cv-11025 (2018)

penalty is added to evening noise (7pm to 10pm).

L_{max} means the maximum sound pressure level associated with an individual noise event.

$L_{night,outside}$ means the equivalent outdoor sound pressure level associated with a particular type of noise source during nighttime (at least 8 hours), calculated over a period of a year.

L_{eq} means equivalent sound level over a given period of time (e.g., one hour) – average of all sound. For example, $L_{eq\ 1\ hour}$ is the average noise level over one hour. See: https://www.fhwa.dot.gov/Environment/noise/resources/fhwahep17053.pdf

Sound Levels and Measurement

When selecting a maximum sound level, a community should ask if it is defensible, reasonable, and supported by evidence or research. After a sound level is determined, it should be accompanied by a testing methodology that can verify compliance with the regulation. Huron County is one example approach with a detailed measurement methodology. [86] Mason County is another example approach.[87]

Wind turbine noise measurement for compliance purposes is a highly sophisticated endeavor requiring specific sound measurement equipment, a knowledge of complex mathematical calculations, and experience applying ANSI and ISO standards to measure wind turbine noise. Measuring noise from WES poses unique challenges different from measuring other kinds of noise. Relatively few acousticians have this expertise.

A local enforcement official will not have the expertise or tools to measure wind turbine noise for making a determination of compliance or non-compliance. However, a local zoning enforcement officer may be an asset to help diagnose a complaint and inform the need for additional sound testing by an acoustic expert (often from out-of-state and at some expense). For example, some zoning administrators in Michigan have worked under the guidance of an acoustician to take short term measurements using a Type 1 sound level meter. These short-term measurements helped to provide more clarity and direction as to whether an acoustician was needed to perform additional testing. A local zoning administrator may also be helpful in scouting measurement locations for post-construction studies for access or other obvious issues that may interfere with sound testing, such as a barking dog.

Sound Measurement to the Dwelling or Property Line

Communities in Michigan typically measure sound from either the property line, near the exterior wall of a dwelling, or other distance defining a curtilage[88] around the perimeter of dwelling. The required setback to the wind turbine (being from the house or property line) is often mirrored for the noise regulation. For example, if a participating property setback from a wind turbine is measured to the dwelling, sound is also measured at the dwelling. Sound maximums measured to property lines would preserve the existing soundscape when outside in a yard or walking the property and may support future development options. Measuring sound levels at the dwelling protects the place where people spend the

[86] Huron County. (n.d.) *Wind Facility Overlay District Zoning.* Retrieved September 3, 2020 from https://www.dropbox.com/s/37850k50b328cct/Wind%20Energy%20Facility%20Overlay%20Zoning%20Revised%20Ordiance.pdf?dl=0

[87] Mason County. (n.d) *Zoning Oridinance Section 17.70, Utility Grid Wind Energy Systems Zoning Ordinance (Wind Turbines)*. Retrieved September 3, 2020, from http://www.masoncounty.net/userfiles/filemanager/1494/

[88] Curtilage means the land immediately surrounding a house including any closely associated buildings or structures.

most time and provides a greater level of flexibility in locating wind turbines. Some standards apply at the residence at the most exposed facade, such as the WHO's, which includes sleep disturbance as a measured health outcome[89].

Another approach is to measure noise at a distance of about 50 feet toward the wind tower from the dwelling. This 50-foot buffer would be considered the curtilage. This avoids excessive regulation of noise on large parcels where no one resides, but still covers a dwelling and a defined area around the house where people may spend time outside on their decks, in their gardens, etc. It also satisfies the typical requirement of acoustical measurement standards to stay away from large reflective surfaces, such as a building.

The number and location of sites used in compliance testing must be consistent with the regulation, such as measuring at the dwelling if the ordinance specifies the sound maximum is measured at the dwelling. Whatever noise standard or measurement is used, it is important that the regulation has the following attributes:[90]

- **Relevant**. The regulation is 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.
- **Repeatable**. It is important for the method for taking sound measurements produce similar results under similar conditions, including when measured by other parties.
- **Predictable**. 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.
- **Implementable**. An acoustician experienced in wind turbine sound will perform sound compliance testing and sound modeling. Consider the possibility of using both attended and unattended measurements in order to obtain enough data to determine compliance.[91] Opportunities for compliance testing are dictated by meteorological conditions and are relatively limited during the course of a year. Consultants look for periods with low ground wind combined with high hub height winds, so the turbines are operating at full power with limited extraneous noise at ground level. Sound testing is avoided on a typical windy day or stormy/gusty day where winds are high at ground level. Low-level ground wind is a prerequisite of acceptable testing methodology. Testing is also generally done at night to avoid other background noise, such as traffic and the activities of residents.

Relative Sound Standards

Rather than a maximum sound level (such as 45 dBA L_{eq}) some communities opt for a relative sound standard. This is typically expressed as something like 5 decibels above the background sound level. In Massachusetts, wind energy facilities are regulated by the Massachusetts Department of Environmental

[89] World Health Organization. "Environmental Noise Guidelines for the European Region." 2018. (p. 85) http://www.euro.who.int/en/publications/abstracts/environmental-noise-guidelines-for-the-european-region-2018

[90] Resource Systems Group. *(2016) Massachusetts Study on Wind Turbine Acoustics.* Massachusetts Clean Energy Center and Massachusetts Department of Environmental Protection. Retrieved September 3, 2020 from https://tethys.pnnl.gov/sites/default/files/publications/RSG-2016-Report.pdf

[91] Attended testing allows for a technician to tag extraneous noise in real time (such as a car passing) but requires that all meteorological conditions support meeting ANSI standards (low ground wind, high hub height wind), and consultants are on site; this can be difficult to predict. Unattended testing means leaving equipment on-site for several days to capture data without a person present. With unattended measurement, a tape recorder is used and the data is analyzed at a later date to remove extraneous sounds. A combination of attended and unattended measurement is a compliance testing option.

Protection air pollution regulations where noise sources are limited to 10 decibels over ambient sound levels.[92]

Relative noise standards create a variable sound maximum throughout the project as ambient noise levels can change from day to day and location to location. Atmospheric conditions, corn or tree leaves rustling, traffic, and insects can significantly change background sound levels day to day and season to season. Because of this, a relative sound standard is more difficult to determine compliance with.

For example, if a community opts for a 10 dB over background noise standard, the maximum noise regulation could range from 36 dBA in the quietest areas to 55+ dBA in the areas near a busier road. Pre-construction sound studies would be essential when using relative sound standards because setbacks to dwellings or property lines could vary significantly to achieve compliance. Some communities opt to lock-in the pre-construction background noise measurements for future compliance testing post-construction. A more common approach is to turn wind turbines on and off during post-construction compliance testing to obtain background sound during the testing. On-off testing can be difficult to execute, particularly when wind speed and/or direction changes over the course of a several hour testing period.

Sound Mitigation

It is best practice that a WES be initially designed and built to meet the noise regulation using conservative estimates and worst-case scenario conditions. This would include environmental conditions such as wind shear and ground cover. Standard departures of 1 to 2 dB from the manufacturer's sound power levels for a given WES model are also be taken into account.[93]

The purpose of wind turbine setbacks is, among other things, to support compliance with a sound standard. Multiple turbines, a downwind orientation to predominant wind direction, and other environmental factors can increase the audibility of wind turbines. Sound modeling can account for this variability.

After wind turbines are erected, noise mitigation options are limited. Turbine manufacturers offer some variation of Noise Reduced Operations (NRO) modes which can typically reduce sound emissions by 1 to 3 dB[94]. NRO modes decrease sound by changing the orientation of the turbine blades in relation to the wind and cause a slight decrease in turbine power production. In addition, serrated edges can be affixed to blades if not already present.

[92] Massachusetts Department of Environmental Protection, 310 CMR 7.10. https://www.sec.state.ma.us/reg_pub/pdf/300/310007a.pdf

[93] Keith, S.E., Feder, K. Voicescu, S.A., & Soukhovtsev, V. (2016). Wind turbine sound power measurements. *The Journal of the Acoustical Society of America*, Volume 139(3), 1431. https://doi.org/10.1121/1.4942405

[94] Ofelia J., Rosen, M.A., Naterer, G., (2011 November). Noise Pollution Prevention in Wind Turbines; Status and Recent Advances, presented at the 1st World Sustainability Forum, November 2011. Retrieved September 3, 2020 from https://sciforum.net/manuscripts/623/original.pdf

Appendix B: Comparison of Regulation

Regulations vary among communities

Depending on local conditions, setbacks can play a major role in allowing, limiting, or functionally prohibiting a WES. Michigan communities represent a variety of landscapes, population densities, lot sizes, agriculture types, topographies, and coastlines. Among Michigan local units of government, WES regulations for setbacks, sound, and other regulations are highly variable (See Table 1). Unlike other Midwestern states (See Table 2), Michigan does not have a state agency charged with wind energy siting or regulation of WES noise.

In addition to setbacks, the Tables 1 and 2 below include sound maximums and where the sound is measured from (property line or dwelling). Measuring to the property line is perhaps done for the public purpose of unspoiled use and enjoyment of one's property. Measuring to the dwelling is perhaps done to minimize nighttime noise disturbance. It is reasonable that the noise standards associated with these two measurement points and associated public purposes would be different.

TABLE 1: Utility Scale Wind Energy Zoning Regulation Comparison in Michigan[95]

Jurisdiction	Type	Setback to participating parcel	Setback to non-participating parcel	Setback to ROW	Sound maximum
Gratiot County*	Overlay District	2 X height or 1,000 feet (whichever is greater) to inhabited building	Minimum of 1.5 X height to the property line of non-participating	The greater of 400 feet or 1.5 X height	55 dBA at the habitable structure closest to the wind energy system
Huron County**	Overlay District	1,320 feet to inhabited structure	1,640 feet to inhabited structure	The greater of 500 feet or 1.5 X height	45 dBA non participating (day/night); 45 dBA day, 50 dBA night (10 pm to 7 am) for participating (Leq 10-minute)
Isabella County*	SLU	2 X height or 1,000 feet (whichever is greater) to inhabited building	Same setback as participating.	The greater of 400 feet or 1.5 X height	50 dBA "not calculated as an average" at non-participating property line
Mason County**	SLU	3 X height to inhabited structure	4 X height to property line	1.5 X height	45 dBA for non-participating property line; 55 dBA to participating inhabited structure (Leq 10-minute)
Schoolcraft County	SLU	3 X height to inhabited structure	6 X height to property line	6 X height to State ROW, 2 X height to other ROW	45 dBA participating / 35 dBA non-participating
Ellington Township	SLU	None	5 X height to property line of non-participating property (with waiver option)	3 X height	40 dBA (Leq 1-second) or (50 dB(C) Leq 1-second) on any non-participating property (with waiver option)
Long Lake Township	SLU	2 X height to property line and 1.25 X height to inhabited structure *(max height 199 feet)*	2 X height to property line *(max height 199 feet)*	2 X height	10 decibels over ambient baseline sound level at the property line
Riga Township	SLU	2.5 X height to inhabited structure, waiver option allowing up to 2 X height	4 X height to property line, can be waived up to 2.5 X height	1.5 X height	40 dBA (10 pm to 6 am), 45 dBA (6 am to 10 pm) at property line of non-participating parcel

*WES projects were approved under these listed ordinance requirements.
**Huron and Mason Counties approved WES under less restrictive setbacks than those in the current regulation listed here.

[95] These communities referenced in Table 1 were not selected for the purpose of directing the reader to model ordinances, but rather to illustrate variation in local zoning regulations in Michigan.

TABLE 2: Comparison of Selected Midwestern State Standards Regulating Wind Energy Development

State regulation	Approving body	Setback to participating property	Setback to non-participating property	Setback to ROW	Sound maximum
Ohio	Ohio Power Siting Board	1.1 X height from participating property line.	1125 feet plus the length of the turbine blade at 90-degrees (about 1300 feet) measured to the property line.	1.1 X height	Ambient plus 5 dBA and/or a 24 hour Leq of max of 50 dBA
Wisconsin	Wisconsin Public Service Commission	1.1 X height from participating residences.	The lesser of 1250 feet or 3.1 X tip height from occupied community buildings and non-participating residences.	1.1 X height	45 dBA (10 pm to 6 am applied as one-hour Leq), 50 dBA (6 am to 10 pm). A community may adopt a less restrictive standard.
Illinois (sound only)	Local unit of government.	Determined by local jurisdiction	Determined by local jurisdiction.	Determined by local jurisdiction.	Illinois Pollution Control Board limits sound by octave band sound pressure levels, one-hour Leq.
Minnesota	Minnesota Public Utilities Commission	500 feet plus the distance required to meet the state noise standard	3 rotor diameters (RD) (760 to 985 feet) for secondary wind axis (typically east-west) and 5 RD (1280 to 1640 ft) for primary wind axis (typically north-south) for turbines with 78 to 100 meter rotor diameter.	250 feet	50 dBA (night) L50 one-hour.

Appendix C: Shadow Flicker, FAA Lighting

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. There is no scientific evidence that shadow flicker causes seizures[96]. There may be some increased risk of seizure with smaller wind turbines that interrupt sunlight more than three times per second[97]. Despite the lack of health effects, shadow flicker is often cited as a public concern and can result in annoyance.

[96] Harding, G., Harding, P., & Wilkins, A. (2008). Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. *Epilepsia* 49(6), 1095–1098. https://doi.org/10.1111/j.1528-1167.2008.01563.x

[97] Smedley, A.R.D., Webb, A.R., Wilkins, A.J. (2010). Potential of wind turbines to elicit seizures under various meteorological conditions. *Epilepsia*, 51(7), 1146-1151. https://doi.org/10.1111/j.1528-1167.2009.02402.x

A 2016 article based on data from the *Health Canada Wind Turbine Noise & Health Study* sought to better understand how exposure to shadow flicker correlates with an annoyance response. The study found that exposure to wind turbine noise, blinking lights, and concerns for physical safety were better predictors of annoyance caused by shadow flicker than the level of shadow flicker exposure modeled to be present[98].

In general, the farther away the turbine is from a particular observation point the less the duration of the flicker, the less intense the flicker (i.e. it 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, etc. that block the shadow. Atmospheric conditions play a role in the distance flicker travels. Clear, dry weather (i.e., a sunny day in winter) is when flicker will be most noticeable at longer distances. Haze, humidity, fog, and partial clouds diminish flicker intensity and length of travel.

Wind energy developments in the United States are commonly designed for a maximum shadow flicker of 30 minutes a day or 30 hours per year measured on a dwelling. Most Michigan communities and Midwestern states have adopted a standard of 30 hours per year of actual shadow flicker on a dwelling.

This 30 hours metric is based on a German standard.[99] The German standard, however, is an *astronomical maximum* of 30 hours per year and eight(8) hours per year maximum of *actual* shadow flicker[100]. The astronomical maximum refers to a theoretical condition where the sun is always shining, wind turbines are always operating, the blades are oriented to make maximum shadow flicker, and there are no obstacles (buildings, vegetation, etc.) between the turbine and the shadow receptor (e.g. an occupied dwelling). Computer models calculate an astronomical maximum and then apply a reality factor (depending on the location, dominant wind direction, available sunny days, etc.) to estimate *actual* shadow flicker.[101]

Flicker mitigation technology continues to advance and allows for turbines to be turned off when flicker may occur on a receptor. This involves the use of computer modeling and light sensors on a turbine to alert the turbine if the conditions exist to create a shadow or not. In Mason County's experience with Vestas systems[102], flicker mitigation technology was effective for minimizing or eliminating shadow flicker on inhabited structures. With available technology, it is possible to adopt a flicker standard lower than 30 hours per year.

Many communities require that flicker mitigation technology be installed on turbines predicted to cause shadow flicker above the maximum allowable amount. Other forms of flicker mitigation may include moving a wind turbine in the design phase or the installation of window treatments and/or large trees/shrubs after construction and at the expense of the WES owner. In Huron County, some owner/operators voluntarily turned off turbines for the duration of a predicted shadow flicker event when a complaint was received. Other owner/operators in nearby developments chose not to turn off the turbines when the flicker event(s) were within regulatory compliance.

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[98] Voicescu, S.A., Michauda, D.S., & Feder, K. (2016). Estimating annoyance to calculated wind turbine shadow flicker is improved when variables associated with wind turbine noise exposure are considered. *The Journal of the Acoustical Society of America*, 139(3), 1480. https://doi.org/10.1121/1.4942403

[99] *WEA-Schattenwurf-Hinweise* (German).

[100] Update of UK Shadow Flicker Evidence Base, Department of Energy and Climate Change (2010); p.14. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf

[101] Haugen, International Review; p. 6.

[102] Mason County adopted a 10 hour flicker maximum per year, then lowered the limit to zero hours/year based on the effectiveness of the Vestas shadow detection technology and time/resources needed to enforce a 10 hour/year maximum.

For ease of enforcement, modeling, and mitigation technology, this sample ordinance recommends regulating shadow flicker at the dwelling rather than the property line.

Shadow Flicker Travel

The distance that shadow flicker can travel is dependent on a number of conditions such as topography, obstructions (trees, structures), height of turbine, and blade length. Based on multiple field observations in Mason County, flicker from a 476-foot turbine located a mile (5,280 feet) away is visible and perceptible. Due to these observations, Mason County adopted regulations to require flicker modeling at 20 times the rotor diameter: 2,000 meters (6,561 feet) for a 50 meter (164 foot) blade, which is twice the industry standard of 10 times the rotor diameter.

In another study, a wind turbine with a blade 45 meters (148 feet) long and 2 meters (6.6 feet) wide, produced shadow flicker visible up to a distance of 1.4 kilometers (4,593 feet), with weak shadow casting observed at a distance of 2 kilometers (6,562 feet).[103]

This sample zoning presents a sample standard of requiring shadow flicker modeling to a distance or 20 times rotor diameter based on experience in Mason County. This is a conservative approach that will provide a community with a more accurate assessment of total shadow flicker impacts when enforcing an hours/year maximum. A 10-foot rotor diameter model can also be used, but it may result in an under prediction of total flicker and/or some individuals may experience flicker that were not modeled to receive it.

FAA Lighting and ADLS

The Federal Aviation Administration (FAA) requires obstruction lighting on wind turbines characterized by red, blinking lights located on top of the nacelle. Obstruction lighting is synchronized to go on and off at the same time. Lighting plans are submitted to the FAA for review and approval. FAA authority supersedes local zoning on obstruction lighting.

Not every wind turbine may be required to have obstruction lighting within a utility-scale WES. The FAA reviews the perimeter of the WES and clusters of turbines within the development to determine which turbines are required to have lighting. Turbines that are above 499 feet to the tip of the blade at the highest reach are required to have slightly different lighting configurations than those below 499 feet.

A newer technology known as Aircraft Detection Lighting Systems (ADLS) provides a potential alternative to night time lighting that operates all night, every night. ADLS is a sensor-based system designed to detect aircraft as they approach. When an aircraft approaches, it activates the obstruction lights until they are no longer needed.

The FAA reviews and approves ADLS applications on a case-by-case basis. A local unit of government cannot require the FAA to approve an ADLS application, but it may require the applicant to submit an ADLS application for FAA review. The FAA reviews the application for proximity to airports, low-altitude flight routes, military training areas, and other areas of frequent flight activity. The FAA can approve, modify, adjust, or deny an application. Some portions of a WES may be approved for an ADLS while other areas are required to maintain obstruction lighting during night time hours. [104]

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[103] Katsaprakakis, D.A. (2012). 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*, 16(5), 2850-2863. https://doi.org/10.1016/j.rser.2012.02.041.

[104] US Department of Transportation. (2015). Federal Aviation Administration, Advisory Circular No: 70/7460-1L, Obstruction Marking and Lighting. Retrieved September 3, 2020 from https://www.faa.gov/documentlibrary/media/advisory_circular/ac_70_7460-1l_.pdf

Appendix D: Summary of Michigan-Specific Wind Energy Research and Information

The Michigan Office of Climate and Energy[105] maintains resources on wind energy, as well as Michigan Wind Energy Resource Maps prepared by the U.S. Department of Energy.[106]

Other Michigan-specific academic research is listed here in an attempt to provide a comprehensive list of locally relevant information. Not all of the resources are published in peer-reviewed journals, however all research is from academic institutions. Michigan-specific academic resources include:

Adelaja, S. & Hailu, Y.G. (2008). Renewable energy development and implications to agricultural viability. Paper presented at the American Agricultural Economics Association annual meeting, Orlando, FL, July 2008. Retrieved September 3, 2020 from http://ageconsearch.umn.edu/bitstream/6132/2/470566.pdf

Adelaja, S., Hailu,Y.G., Warbach, J., Klepinger, M., McKeown, C., Calnin, B., & Fulkerson, M. (2007). Meeting Michigan's 2015 Renewable Portfolio Standard (RPS): Wind Turbines Required and Projected Land Usage. *Michigan State University Land Policy Institute*.[107]

Banas Mills, S., Borick, C., Gore, C., & Rabe, B.G. (2014, April). "Wind Energy Development in the Great Lakes Region: Current Issues and Public Opinion." Issues in Energy and Environmental Policy No. 8. *Center for Local, State, and Urban Policy, Ford School of Public Policy, University of Michigan*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2652865

Bidwell, D. (2016). The effects of information on public attitudes toward renewable energy. *Environment and Behavior*, 48(6), 743-768. https://doi.org/10.1177/0013916514554696

Bidwell, D. (2013). The role of values in public beliefs and attitudes towards commercial wind energy. *Energy Policy*, 58, 189-199. https://doi.org/10.1016/j.enpol.2013.03.010

Groth, T.M. & Vogt, C. (2014). Residents' perceptions of wind turbines: an analysis of two townships in Michigan. *Energy Policy*, 65, 251-260. https://doi.org/10.1016/j.enpol.2013.10.055

Michigan State University Land Policy Institute & Great Lakes Commission. (2011). Wind Farm Development in Coastal Communities Integrated Assessment Factsheet Series . Available at: https://www.canr.msu.edu/planning/zoning_ordinance_resources/wind-energy-alternative-energy#per1

Michigan State University Land Policy Institute. Renewable Energy Policy Program. 2007-2013 Archive. Accessed April 2020: https://www.canr.msu.edu/landpolicy/program-archive/renewable_energy_policy_program/

Mills, S. (2015 January). Farming the Wind: The impact of wind energy on Farming – Summary Survey Results. *Center for Local, State, and Urban Policy, Ford School of Public Policy, University of Michigan*. Retrieved April 2020: http://closup.umich.edu/wind/farming-the-wind-the-impact-of-wind-energy-on-farming.php

Mills, S. (February 2017). "Views of Wind Development from Michigan's Windfarm Communities – Landowner Survey Summary." *Center for Local, State, and Urban Policy, Ford School of Public Policy, University of Michigan*. Retrieved September 3, 2020 from

[105] Michigan Department of Environment, Great Lakes, and Energy (n.d.) Office of Climate and Energy: Overview. Retrieved September 3, 2020 from https://www.michigan.gov/climateandenergy

[106] Office of Energy Efficiency & Renewable Energy. (n.d.) Wind Energy in Michigan. Retrieved September 3, 2020 from https://windexchange.energy.gov/states/mi

[107] For a copy of this report contact: charron@msu.edu. For other MSU Land Policy Institute energy related materials see https://www.canr.msu.edu/landpolicy/program-archive/renewable_energy_policy_program

https://static1.squarespace.com/static/564236bce4b00b392cc6131d/t/575b315d9f7266050a4143aa/1465594217864/Sarah+Mills+Summary+Findings.pdf

Mills, S., Horner, D., & Ivacko, T. (2014 July). Wind power as a community issue in Michigan. Michigan Public Policy Survey. *Center for Local, State, and Urban Policy, Ford School of Public Policy, University of Michigan*. Retrieved September 3, 2020 from http://closup.umich.edu/michigan-public-policy-survey/34/wind-power-as-a-community-issue-in-michigan/

Nordman, E., VanderMolen, J., Gajewski, B., Isely, P., Fan, Y., Koches, J., Damm, S., Ferguson, A., & Schoolmaster, C. (2015). An integrated assessment for wind energy in Lake Michigan coastal counties. *Integrated Environmental Assessment and Management*, 11(2), 287-297. https://doi.org/10.1002/ieam.1602

Phadke, R., Manning, C., Buchanan, A., DeJong, E., & Camplair, N. (2011 August 6). Michigan Wind Energy Landscape Symposium – Workshop Report. Macalester College – Understanding Wind Initiative. Retrieved September 3, 2020 from https://www.macalester.edu/windenergy/symposia/MISymposiumWorkshopReport.pdf

Nordman, E. (n.d.) West Michigan Wind Assessment. *Grand Valley State University* Retrieved September 3, 2020 from https://www.gvsu.edu/wind/

Wind Energy Resource Zone Board. (2009). Final Report of the Michigan Wind Energy Resource Zone Board. Retrieved September 3 2020 from https://www.canr.msu.edu/resources/final_report_of_the_michigan_wind_energy_resource_zone_board

Appendix E: List of Revisions to this Document

August 24, 2017:

- Many non-substantive edits throughout.
- Additional reviewers of this material: Sarver, Ivan, Banas-Mills, Kaliski, and Wyckoff.
- Added disclaimers indicating this is not a new study, not recommendations by MSU or MSUE (it is a sample, not a model, zoning ordinance) and disclaimers and assumptions about use of sample ordinance language.
- Updated and more detail about the 2008 sample zoning and this document.
- Considerable additional information in the introductory material and sample ordinance on regulation of noise, with suggestion to move noise regulation to a police power ordinance, importance of specifying method of measuring noise, location of noise measurement (edge of the curtilage), differentiation of the decibel level depending on method and location of measurement, complexity of noise standards (consult/hire an acoustic specialist) and attributes for the same.[108]
- Changing the sample ordinance to present a range of possible standards (rather than a single numeric standard) for a community to consider and adopt what is appropriate for the respective zoning district, community, and so on.

[108] The March 6, 2018 version of the Sample Zoning had problems that resulted in confusion and misinterpretation. The March version of this document was a substantial update from a 2008 document issued by the State of Michigan on the same topic (Michigan Siting Guidelines for Wind Energy Systems).

Specifically, research and definitions related to noise measurement and regulation needed to be updated and expanded. The intent with any work by MSUE is to provide (1) the current university-based (peer reviewed, double blind, repeatable, published) research and (2) the legal parameters on a topic.

- In the sample ordinance a differentiation between a parcel setback for wind energy towers and a required distance from the edge of a unit boundary – now handling those as two separate distinct standards.[109]
- Added definitions to the sample ordinance.
- Additional options for addressing shadow flicker.
- Use of a sound modeling study and shadow flicker study as part of the application.
- Further explanation of the use of Mason and Huron Counties in the document.
- Further vetting of cited resources (adding some and removing some).

September 2020

- Added new state and federal cases to "Court and Case Law."
- Added caution to use a very specific measurement methodology tied to the public purpose of the regulation for sound measurements.
- Added summary of additional research on public engagement and education.
- Added detail on sound regulation, sound descriptors to a new Appendix A.
- Added FAA and ADLS information to an Appendix C.
- Added comparative regulatory table Appendix B.
- Added section on leases and easements (zoning has no authority).
- Added information on relative sound standards.
- Removed noise compliance tied to a police power ordinance (rather than regulating in the zoning ordinance).
- Moved history of the sample zoning document to a new Appendix E.
- Replaced language about a lease unit boundary with participating and nonparticipating standards
- Modified "commentary" on performance guarantees and many other sections.
- Added commentary (in footnote) cautioning against property owners or neighbors waiving or reducing zoning standards (page 7).
- Added new language about "End of Life" of a wind energy system
- Additional reviewers, Sarah Banas Mills, Jeff Smith, Brian Ross, Tyler Augst, Mike Hankard (Hankard Environmental, Inc.) (sound only).

[109] The March 6, 2018 version of the Sample Zoning had problems that resulted in confusion and misinterpretation. The March version of this document was a substantial update from a 2008 document issued by the State of Michigan on the same topic (Michigan Siting Guidelines for Wind Energy Systems).

Specifically, the use of the word 'setback' in connection with the lease unit boundary concept needed to be clarified. The zoning setbacks and distance from lease unit boundaries are two different things, The March 2017 version of the document did not make a clear distinction between a property line setback and a distance required from a lease unit boundary. (We should not have used the word "setback" for both, and do not in the August Version). The August version tries to clarify this, but does not change the original intent in any material way. For example, the March version introduced a minimum distance from a lease unit boundary of 1,640 feet. The August version introduced a distance from a lease unit boundary of 1,000 feet or more based on 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 Ithaca, Michigan. (Also, we did not want to give a single distance (prescriptive) but rather a range so the community makes an informed decision as to what is right for them.) A definition for a lease unit boundary, which includes compensated buffer properties, was also added to the August version of the document. The August version actually increases the suggested distance to consider as a possible lease unit boundary distance to anything 1,000 feet or greater and makes a clearer distinction between lease unit boundary distance and property line setback.