# SOS Save Our State

Bald and Golden Eagles, Grant and Codington Counties, 2017 & 2018

# Grant County Planning and Zoning on WES

April 17th, 2018

1. Questions from the public
2. General information and where to find more information, includes setback information from Vesta manuals, health, decommissioning and return on Tax Production Credit
3. Health information and where to find more, includes Cooper interview and personal testimony
4. Property value loses, includes report from PUC debunking the Next Era claim
5. Decommissioning issues
6. Language used in Wind Contracts

This book contains websites and where to find more information.
If you have questions, need additional reports you may contact
Vince Meyer 605-949-1916

Facts, Findings and Conclusions

We would like **FINDINGS** to the following issues to be addressed as answers in local newspapers for the public to review and discuss.

1. Has Next Era, APEX, or any wind energy developer, provided **scientific methods** to prove flicker, sound, infrasound or other nuisance, will trespass on to non-participants' land, for a certain allotment of time, please present the methods and studies to support the claim.

2. Have Planning and Zoning members and Commissioners read a Turbine manual for all the models being proposed to be used for safety setbacks? If so, where is a manual for the public to evaluate?

3. Has a MSDS for the county?

4. Wind farms are privately owned. They do not supply electricity to the public. Their electricity is for sale. Hence they are not a public utility. How will the county or township handle trespassing on private land be it rights-of-ways or other types of property?

5. How will the county deal with health or property complaints? Contracts say that the wind farm will work with landowners concerning flicker and noise.) The county must address recourse for non-participating land owners.

6. There is no Complaint Resolution System listed in the ordinance. What are your intentions for a Complaint Resolution System and the exact steps to be taken to mitigate any problem with WES?

7. What will the county do when the wind tower company sells the easement to another company that uses the easement for other purposes or the company is not as reliable as the original company? How will transfer of ownership affect the county, participating and non-participating property owners?

8. What will the county do when/if the wind energy company has no funds to dismantle the towers at the end of the contract period? (CAFO's are required to be built on at least 80 acres so money can be recouped if the facility leaves the country.)

9. Why is there no mention of Road Haul Agreements for the decommissioning phase of a wind energy project? How will the county protect its roads and township roads during that phase?

10. Have each of you read a lease from Apex, Next Era, Excel, or a Delaware LLC named on the first page of many leases?

11. How have you considered the ramifications to our county residents, lease holders, and non-lease holders?

12. Has a lease been reviewed by an independent attorney on behalf of the county residents?

13. Will every lease offered in our county be scrutinized by our county officials and an independent attorney to safeguard our residents?

14. Have you, your immediate and/or extended family, signed or considered signing a lease with a wind energy project?

15. Is there anything that would hinder you from making an impartial decision in regard to wind turbine setbacks, statues, ordinances, or anything that would impact the county residents as a whole?

16. What are your considerations regarding acceptance of wind energy projects in our county?

17. At the PUC hearing, APEX said North Dakota is getting newer, better turbines, which translates to the ones they are proposing in Codington and Grant counties are already obsolete. What is the county doing to protect its residents from obsolete, inferior, dangerous, or other flawed turbines in our county? What approval process is being proposed?

18. Turbines being proposed here are the largest ever installed in South Dakota. Where is the county's research concerning these?

19. What research has the county done on the impact of industrial turbines on our aquifers and water shed?

20. What has been done to protect our Indian artifacts and any other historical items in the area?

21. When these turbines leak oil out of them and it runs down to the ground, does the zoning board have anything in the guidelines as to who is responsible for

reporting the problem? Who does it get reported to? How much oil is needed to run a Vesta 4.2 mw turbine?

22. What is the county requiring in the form of maintenance of turbines? Who is required to look for leaks, failures, and how often?

23. Do the reports go to the zoning board, county commissioner, sheriff, EPA, Haz Mat or local fire department? Who is responsible for the cleanup?

24. On the matter of fire or medical situations, does the turbine corporation have a quick response team in place or are they relying on local fire departments for emergency response?

25. Does our fire department have the resources or training to perform fire or EMS on a 500-foot tower and have never been instructed as to where a safe working area would be around them. Has the county considered the isolated positions of the turbines and the emergency response?

26. Has the county considered the danger of grass fires in our rural areas, especially if a turbine would fail and disperse sparks and fire 500 feet in the air to dry grassland?

27. What resources do the members of Planning and Zoning, and the county Commissioners currently have at their disposal to help them understand wind turbine noise and infrasound and its potential impact on the county's residents? Will a consultant be hired?

28. If resources exist, who or what are they, and when will they be made available for the public to review?

29. Do the policy makers understand, that the noise from Turbines has a vibration that is intensified inside a house, and that it can be deceiving to listen to a turbine for a snapshot in time? Please read Vicki May, David Janes and Tim Hartke

30. If the commission is currently not engaged with any independent experts do you plan to work with anyone to ensure you have unbiased information on this topic?

31. If yes, who, when, and when will the information they provide be made public?

32. If no, why not?

33. If wind energy projects are considered AG land, why isn't it taxed on projected income at the county level like farmland

34. Who is liable for non-participating resident's health issues and WES violations regarding flicker, infrasound, property value loss, vibrations, loss of viewshed, audio, and radio frequency disruptions electromagnetic field issues, air turbulence, loss of quiet enjoyment of property?

35. What party carries the liability insurance to protect property and residents from ice throw, blade malfunction, fire, crop yield loss, grass fire, ect...

36. What dollar limits will the policy be required to be?

37. How would the addition of Industrial WES help build a better community?

38. Why isn't the PUC application fee sufficient to cover professional consulting fees? What are your plans to remedy the insufficient fees provided?

39. How will you inform the public of the physical dangers and health risks associated with wind energy systems if erected in our county?

42. What research has the county done to provide the residents of our county assurances of aquifer and land surface water protection?

43. If the turbines are safe, why does the contract contain an "effects easement"?

44. Are you aware the industry only works with contract holders to mitigate effects and does not work with non-participants? It is the county's job to mitigate the effects of infrasound, audio, visual, view, light, flicker, noise, shadow, vibration, air turbulence, wake, electromagnetic, electrical and radio frequency interference, and other effects attributable.

45. Do you know that infrasound from a turbine has its own unique signature and is not like the noise from riding in a car or light bulb as compared to from wind?

46. Where is the cradle to grave report show that Wind turbines are "Green" ?

47. Wind industry has an easement agreement and works with contract holders, they do not work with non-participators. How will Grant County protect nonparticipators from impacts like property value loss, property rights loss and health issues.

CONFLICT OF INTEREST

6-1-17. Official prohibited from discussing or voting on issue if conflict of interest exists--Legal remedy. No county, municipal, or school official may participate in discussing or vote on any issue in which the official has a conflict of interest. Each official shall decide if any potential conflict of interest requires such official to be disqualified from participating in discussion or voting. However, no such official may participate in discussing or vote on an issue if the following circumstances apply:

(1) The official has a direct pecuniary interest in the matter before the governing body; or

(2) At least two-thirds of the governing body votes that an official has an identifiable conflict of interest that should prohibit such official from voting on a specific matter.

If an official with a direct pecuniary interest participates in discussion or votes on a matter before the governing body, the legal sole remedy is to invalidate that official's vote.

**Source:** SL 2005, ch 40, § 1.

1-27-1.16. Material relating to open meeting agenda item to be available--Exceptions--Violation as misdemeanor. If a meeting is required to be open to the public pursuant to § 1-25-1 and if any printed material relating to an agenda item of the meeting is prepared or distributed by or at the direction of the governing body or any of its employees and the printed material is distributed before the meeting to all members of the governing body, the material shall either be posted on the governing body's website or made available at the official business office of the governing body at least twenty-four hours prior to the meeting or at the time the material is distributed to the governing body, whichever is later. If the material is not posted to the governing body's website, at least one copy of the printed material shall be available in the meeting room for inspection by any person while the governing body is considering the printed material. However, the provisions of this section do not apply to any printed material or record that is specifically exempt from disclosure under the provisions of this chapter or to any printed material or record regarding the agenda item of an executive or closed meeting held in accordance with § 1-25-2. A violation of this section is a Class 2 misdemeanor. However, the provisions of this section do not apply to printed material, records, or exhibits involving contested case proceedings held in accordance with the provisions of chapter 1-26.

- SD Constitution Article 6 Bill of Rights
  § 1. Inherent rights. All men are born equally free and independent, and have certain inherent rights, among which are those of enjoying and defending life and liberty, of acquiring and protecting property and the pursuit of happiness. To secure these rights governments are instituted among men, deriving their just powers from the consent of the governed.

1-27-1.18. Recommendations, findings, and reports of appointed working groups to be reported in open meeting--Action by governing body. Any final recommendations, findings, or reports that result from a meeting of a committee, subcommittee, task force, or other working group which does not meet the definition of a political subdivision or public body pursuant to § 1-25-1, but was appointed by the governing body, shall be reported in open meeting to the governing body which appointed the committee, subcommittee, task force, or other working group. The governing body shall delay taking any official action on the recommendations, findings, or reports until the next meeting of the governing body.

**Source:** SL 2010, ch 9, § 4.

Dan Kaaz

Health, Safety & Wellness

Pretty dynamic wording. The main job of the elected commissioner is to protect the Health, Safety & Wellness of their constituents. With the advent of the oncoming Wind towers, it would appear several issues have been outright ignored.

One issue is proper signage. Each tower should be identified at the lease road that identifies the tower number, address/GPS location, emergency contact, etc. I have heard that the wind companies are proposing a "Binder" located at the base of the tower containing this information. If said tower is on fire, leaking fluid, spinning out of control are you going to walk under it and thumb through a "binder" to find the information?

How is "trespass zoning" fair to non-participating land owners? The Fifth Amendment of the U.S. Constitution provides, "No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a grand jury, except in cases arising in the land or naval forces, or in the militia, when in actual service in time of war or public danger; nor shall any person be subject for the same offense to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation. Non-participating land owners have not been compensated, however we will be deprived of our lands. It will create land that I (the non-participating land owner) cannot utilize or develop. When a wind turbine is erected, there is a "safe zone" going around the footprint of the turbine, all the way from the tower to MY HOME. Even if the zoning board allows a permit, any construction in said "safe zone" would be prohibited, if not uninsurable. How is this fair & legal to me & other landowners who desire to develop their property?

In past years I had to secure a permit first for a mobile home to be moved to my property, years later a similar permit had to be secured to move a house from Waverly SD to my property. I also had to secure the approval of my neighbors to be allowed to move said living quarters to my property, to be sure they didn't find them intrusive to their homes. Why is it acceptable to inundate the lands around me without approval from non-participating land owners? The home I moved in was approximately 30 X 30 and is 2 stories tall. These wind tower are proposed to be 45 stories tall, how is that not more intrusive?

Our state & federal constitutions give us the right to quiet enjoyment of our property. The new requirements set forth by the planning commission are unfair & unconstitutional to non-participating land owners and do not in any way promote the health, safety or welfare of the people in Codington County, only benefits wind turbine companies. Why are the constitutional rights of non-participating land owners being ignored?

Teresa Kaaz

property values...
Never thought I would have to request Codington county commissioners to be mindful of the fact they are taking money away from all Codington county residences!!!!
You have been misled. you had been told thru studies that Brookings county showed no loss of property values and some have gained value.
THE WIND IS BLOWING MISINFORMATION into Codington county.
I have evidence proving at the PUC level that those reports provided by WES showing property loss or gains have been debunked. This information and testimony under oath, will be provided to all of you, my commissioners.
There is not a definitive formula to measure loss for all properties by wind energy projects statewide yet, including farm, ranch, residential and rural residential properties. For a study to be done to understand the true effects in Codington county, a third party South Dakota licensed appraiser should be requested by Codington county officials to establish those percentages of loss.
But here is what we do know,...
property values will decrease substantially by the placement of the turbines, transmission and feeder lines to non-participating land owners and residences property.
Example being if you place a turbine 1500 foot from the home, there is almost a guarantee that that home will become unlivable, due to noise, flicker and infrasound. The use of the property will be unusable as to the property falling into the safety zone of the turbine... which in turn means to the property owner he or she will suffer a complete of value and you the county will be held liable for that. versus placing turbine 2 miles away from the property line. There will still be a loss pf property value as the turbines will still be in the viewshed, but it will be far less.
That is why i said all Codington county residences will suffer property value loss but you as commissioners can determine how much of a loss will be burdened to each homeowner.
in conclusion... I am going to remind you all that ordinance 65 general provisions section 1.01.03 purpose, you as county officials job description is #6 is "to protect and enhance real estate values."
My question that i am asking all of you "how are you commissioners intending on making sure that this is upheld"? and what methods have been used in considering a 1500 foot setback from my home is in any way protecting Codington county real-estate values?
This is why we the people of Codington county are requesting to have the setback of 2 miles with a waiver be revised as the wind ordinance for Codington county.
that means that you the commissioners will not be held accountable for the huge property value loss we will suffer but that that loss will be placed in the hands of the landowners working with WES.
Thank you for your time.
If you have any questions i will volunteer my time to answer those questions.
Teresa Kaaz

Kathy Tyler

Summary of typical Wind Farm Lease and Easement Agreement

This is not a legal opinion unless specifically labeled as such.

In this document, 'operator' is the wind farm person; 'owner' is the landowner.

Quotes are from an actual contract.

The owner can contract only with one operator: "If Operator only exercises the Option for a portion of the Owner's Property, then the Option granted herein shall remain in full force and effect for any other portion of the Owner's Property that was not included in the Option Notice."

The Operator has TOTAL control over the property via "Construction Rights" and "Access Rights."

The Owner is forbidden to interfere with wind speed or wind direction: "Owner shall not engage in any activity on Owner's Property that might interfere with wind speed or wind direction over any portion of any Turbine or Met Tower Easement Properties, whether located on or off the Owner's Property..."

The Operators recognize issues, and the Owner cannot do anything about the following: "Owner grants to Operator a non-exclusive easement for audio, visual, view, light, flicker, noise, shadow, vibration, air turbulence, wake, electromagnetic, electrical and radio frequency interference, and other effects attributable to the Wind Farm or activity located on the Owner's Property or on adjacent properties over and across the Owner's Property."

Easement term is 50 years. There is no way for the Owner to get out of the lease. "Operator, at its option, shall have the right to terminate this Agreement....." "Owner hereby waives all other right it may have, in law or in equity, to terminate this Agreement prior to the expiration of the Term."

The Operator is obligated to remove all physical material within 12 months after termination of the lease. If the Owner removes the material, he/she will be reimbursed by the Operator. (What happens in a bankruptcy of the Operator?)

The Owner has the right to use the property as it should be used: "Owner expressly reserves the right to use the Owner's Property for all other purposes.....provided that no such other use interferes in any way with Operator's use...."

The Owner gives up any setback or other government regulations: "....Owner hereby waives enforcement of any applicable setback and side yard requirements and restrictions and any other zoning restrictions pertaining to the amount of land required surrounding Improvements, whether imposed by a government authority or otherwise, applicable to the Wind Farm on the Owner' Property or any such facilities to be placed upon property **adjacent** to Owner's Property."

The Operator can actually mortgage his easement: "Operator may, upon notice to Owner, but without requiring consent or approval, mortgage, or collaterally assign, or otherwise encumber and grant security interests in all or any part if its interest in the Operator Property."

The easement can be subleased or sold to any other Operator: "Operator shall have the right, without Owner's consent, to sell, convey, lease, grant an easement, or assign all or any portion of the Operator Property, .... Or to grant subleases, co-leases, sub-easements....to one or more persons or entities."

Wind Turbine Noise and its Potential Impact on the Welfare of Codington County Residents.

My name is Patrick Lynch and I live in North East Codington County. I want to speak to you today about Wind Turbine noise and the impact it may have on the health and welfare of people in Codington County. I will summarize a recent study that you may want to take into consideration when implementing new zoning rules that you are putting in place to protect the health, welfare, and prosperity of the counties residents.

Hydro Pacific is an energy producer in Australia that has Wind Energy in their portfolio. In 2014 after receiving complaints from residents living 1,900 feet, 2,800 feet, and 5,000 feet, from their 2 megawatt turbines they decided to fund a study on acoustic noise, vibration and the impact it may have on those residents. The acoustic team placed noise detection equipment at the homes of the affected individuals and at intervals around the wind turbines. This equipment could measure both audible and low frequency (Infrasound) spectrum. Hydro Pacific kept track of wind speed, turbine speed, and turbine output. The residence were ask to keep notes on when they were experiencing sensations such as sleeplessness, restlessness, pressure, elevated heart rates, vibrations, or headaches and the severity of those sensations. With the most severe sensation resulting in the person having to leave there home. At the end of the data collection period the information was gathered and compared. What they found is that changes in turbine output corresponded with changes in audible and inaudible noise levels at the residences. Those noise level changes matched the unique audio and vibration signature that all turbines create with the turbulence from their blades and those changes also aligned with the times and dates the residence recorded experiencing their sensations.

- Turbines create low frequency (infrasound) noise and vibration that can be sensed by people and should be regulated in addition to the audible spectrum to minimize its impact on nearby residence.
- Spikes in turbine power output corresponded with times of severe negative sensations reported by residence.
- Even when turbines were shut down (not moving) they still created a noise signature during windy conditions that corresponded with residences recorded sensations.

The sensation symptoms reported by these individuals in the Hydro Pacific study match up with the symptoms from individuals at the Shirley Wind farm in Brown County Wisconsin where the county board of health declared the turbines a Public Health Hazard. They also match the symptoms listed in a summary of research done by the Minnesota Department of Health on the impact of wind turbines on health.

This is a complicated topic. Turbine projects quickly cover a large area, and standing at 485 feet they will change our landscape and impact many residents for a minimum of 25 years. Because of this I would expect the commissioners to have a deep understanding of these topics and their potential impacts. If needed I hope they would bring in independent experts on these topics to review both the data provided by any Wind Energy Systems and residents, as well as to do their own research so as to provide an unbiased opinion on appropriate setbacks and noise levels.

Questions for the commissioners.

What resources do the commissioners currently have at their disposal to help them understand wind turbine noise and its potential impact on the counties residence?

If resources exist who or what are they and when will the feedback they provide be made public?

If the commission is currently not engaged with any independent experts do you plan to work with anyone to ensure you have unbiased information on this topic?

If yes, who, when, and when will the information they provide be made public?

If no, why not?

References:

*Cape Bridgewater Acoustic Report (2014),* The Acoustic Group

*Duke Energy's Shirley Wind Turbines Declared a "Human Health Hazard" (2014),* Brown County Citizens for Responsible Wind Energy

*Public Health Impacts of Wind Turbines (2009),* Minnesota Department of Health

My name is Melissa Lynch and I live in Codington County.

I live in a beautiful area and I purchased my farm for this very reason. I take walks on my land to relax. I find happiness in experiencing the sounds of nature and exhilaration at the sight of migratory birds. I find peace in watching the sun rise and set.

Relaxation, happiness and peace are all aspects of human welfare. Therefore, the natural environment and view I am able to experience from my property is directly tied to my welfare. This is solidified through countless studies. To illustrate, I will reference a paper published in Health Promotion International, a peer-reviewed public health journal. The paper titled, "Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations" outlines the following supporting evidence:

-The majority of places that people consider favourite or restorative are natural places, and being in these places is recuperative.

-Exposure to natural environments enhances the ability to cope with and recover from stress, cope with subsequent stress and recover from illness and injury.

-Natural environments foster recovery from mental fatigue and are restorative.

-There are some known beneficial physiological effects that occur when humans encounter, observe or otherwise positively interact with animals, plants, landscapes or wilderness.

I believe that we can conclude from this paper and the studies it references that promoting a natural environment within our county is important for the wellbeing of its citizens. The introduction of industrial wind turbines will disturb the view of the sun rising and setting, will detour birds and other wildlife in the area, will create a noise that disrupts the peaceful noises of nature, and introduces an unnatural structure to the open sky we see today. Therefore, the introduction of industrial wind turbines to our county will ruin the surrounding natural environment that fosters the effects referenced in the paper I just discussed, and will therefore negatively impact our welfare.

I feel as though I have covered this topic as concisely and clearly as I can. Before I conclude, I'd like to understand from the Commissioners if this was heard and understood as clearly as I have intended it.
-Do you understand either now or previously through your own research that there is a link between natural landscapes and human wellbeing?
-(If no) Do you plan to conduct more research on this topic before finalizing the wind turbine ordinance?

In conclusion, I support banning wind towers in our county. If this can not be agreed to, I support a 2-mile setback from property lines, aircraft detection lighting systems and a limit to wind tower height, all in an effort to mitigate disruption to the natural environment and therefore my welfare.

Thank you.

**Reference:**

Maller, C., Townsend, M., Pryor, A., Brown, P., and St Leger, L. (2005) "Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations" *Health Promotion International, Vol 21 No.1*. Melbourne, Australia: Oxford University Press

Greg Wall

My questions are as follows: When these turbines leak oil out of them and it runs down to the ground, does the zoning board have anything in the guidelines as to who is responsible for reporting the problem? Whom does it get reported to? Do the reports go to the zoning board, county commissioner, sheriff, EPA, Haz Mat or local fire department? Who is responsible for the cleanup?

On the matter of fire or medical situations, does the turbine corporation have a quick response team in place or are they relying on local fire departments for emergency response? As the chief for a local volunteer fire department that has turbines proposed for a large part of our jurisdiction, we do not have the resources or training to perform fire or EMS on a 500-foot tower and have never been instructed as to where a safe working area would be around them.

My name is Linda Lindgren and I live with my husband on our farm at 16050 464th Ave, South Shore. He has lived on this farm all of his life. I on the other hand am new to the area as I moved here in 2013.

I am daily amazed by the natural beauty all around us. The wild turkeys, deer, and pheasants. The geese flying overhead. Rolling hills and open skies and pastures and fields going on seemingly forever.

Yesterday I saw a bald eagle between South Shore and our home. The wild turkeys seem at times to come around daily in our area. We soon might need a Turkey Crossing sign on the road in front of our house.

Wildlife is so beautiful and essential to our fragile ecosystem. So important in fact that there is a law against killing Bald Eagles. Do any of you know what the penalty for killing a bald eagle is? I will tell you. If a non-developer kills a bald eagle the fine is up to $250,000 and the person can face up to two years' imprisonment.

*A story in the Washington Times reports that Bald and golden eagles may be legally killed or injured in the thousands by high-speed turbines . The rules, which affect individual wind-energy companies that plan to operate the technology for up to 30 years, allows up to 4,200 of the birds to perish. The U.S. population of bald eagles stands at roughly 143,000, while the Fish and Wildlife Service puts the number of golden eagles at 40,000. 4,200 endangered bird-deaths per company is bigger than it sounds. There is nearly a dozen such "companies" which means (for 10) a whopping 42,000 bald and golden eagles are permitted to be killed by wind developers. The 4,200 limit is fake. Wind developers can break up their corporations into smaller ones.

Five-hundred-foot high wind towers will greatly affect the draw that our beautiful state has to offer. Less animals to hunt because of the damage to the ecosystem and less beauty with the wind towers higher than the statue of liberty marring the beautiful and natural landscape.

More information can be found at and many other sites. Please do the research and contact your County Commissioner with your concerns.

Linda Lindgren
South Shore, SD

*Pages 94 and 95 of Paradise Destroyed by Gregg Huber

Amber Christenson.

I live 20 miles NE of Watertown in Codington County. I have lived there 24 years, and in the city of Watertown before that. I am a Watertown business owner and have been since 1997.

December of 2016, I lost my home to a fire. I love my property in the country, I love the geese migration, the deer, the turkeys, the sounds of cattle and tractors, so I rebuilt...a brand new home, which I moved into in this last September.

I built a home with a LOT of windows...a LOT. For the past 24 years, I've enjoyed the views and the peace and quiet, and had no idea that could change. I had no idea, when the planning and zoning board gave me a building permit that I would be investing in a new home in the middle of an industrial wind energy plant. Maybe someone, one of you, should have mentioned that before letting me invest heavily in this county again, because had I known, I would have made a different choice. At the very least, I would have liked to have been given a choice.

I have improved my property since the day I bought it, and have paid the tax increases, sent my son to the local school, and thought I was part of a real community. Imagine my surprise, when I find out my county isn't a community any more. No longer are the residents allowed to enjoy the peace of their country home unencumbered by the choices of their neighbor. The neighbor's choice now interferes with MY property. I can't trespass on my neighbor's property 24/7, but because my 'neighbor' decides he wants a check in the mail, he can trespass on MY property for the next 50 years.

Well, I reject that. My county officials need to protect me and my property, just like it says in Ordinance 65 that you passed. You will 'protect and promote the public health, safety, peace, comfort, convenience, prosperity and general welfare of your residents. Not just residents who want a paycheck, all of us.

You have accepted my property taxes for 24 years. You have accepted my sales tax collections since 1997. You have been grateful that I have created 20 jobs and the payroll tax and wages those provide. You have been grateful I have leased buildings for my businesses from local builders. You have been grateful for ALL I have done for the community, until a guy from Florida, with Wyoming plates drives up selling a field of dreams. Now, the rest of us, who have been here all along, helping build this county, are thrown under the bus for promises from someone who has no history here, and the history they have in other communities, is not a good one.

I don't want ANY wind development. I believe it to be a huge scam. But if you are going to let those people invade us, you need to protect those of us who are not participants. We need a 2 mile setback from our property line, and nothing less. 1500 turbines are proposed to come into our area. We expect protection.

**Resolution Creating Safe Setbacks from Industrial Wind Turbines (IWT)**

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 Section 103 are "... adopted for the promotion of the public health, safety, morals, or general welfare..."

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 Section 1211.01 WES "... protect(s) the health, safety and welfare of the County's citizens." [Ord. 2004-1, Rev. 2004-1G]

*Whereas* Industrial Turbines near where people live, work, and enjoy recreation is a human health hazard. October 14, 2014, the Brown County WI, Board of Health declared the Shirley Wind [Farm] a Human Health Hazard. Pierpoint MD PHD 2010 - *Wind Turbine Syndrome;* Chapman - *Facts About Industrial Turbine Noise*

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 does not address Flicker (strobe light sensation) vibroacoustic issues, infrasound, stray voltage, and the effects on human and livestock health.

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 Section 1101.01 defines the purpose of an Agriculture District: This district is established to maintain and promote farming and related activities within an environment which is generally free of other land use activities

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 Section 1300 CAFO. Intent. A supply of healthy livestock, poultry and other animals is essential to the well-being of county citizens and the State of South Dakota.

*Whereas* Grant County Compiled Zoning Ordinance dated 1-25-2018 Section 1211.03 WES states: "...precautions to protect livestock during all phases of the project's life..." but wind towers cause issues with livestock--, Knuth 2010 - testimony to Public Service Commission; Holler 1978 - *White Paper Engineering and Service Center US Airforce Fish and Wildlife and Us Department of Interior;* Yunk 2010 Testimony Wind Siting Rules Public Service Commission

*Whereas* Industrial Wind Turbines create local climate that decreases crop and vegetation yield, and soil moisture. Industrial Wind Turbines increase water stress and soil temperature. Tang, B., Wu, D., Zhao, X., Zhou, T., Zhao, W. and Wei, H. 2017 - *The observed impacts of wind farms on local vegetation growth*; Droz 2018 compiled report *Industrial Wind Projects Clash with Real Farming*

*Whereas* the fact that Industrial Wind Turbines currently proposed in Grant County can be .25 kilometer or 820.21 feet tip height, 4.2 MW, are larger than a Jumbo 747 jet; and the industry recommended acceptable risk safety zone of 500 meters (1,640 feet) in each direction. This makes a 193.4-acre industrial zone that has limited and decreased agricultural use. Jonathan Rogers, Nathan Slegers and Mark Costello 2011- *A method for defining wind turbine setback standards* Johan Meyers and Charles Meneveau 2011- *Optimal turbine spacing in fully developed wind-farm boundary layers*

*Whereas* the county zoning ordinances does not address the non-participating landowner's safety, liability, property rights, limited uses and devaluation of home and farmland because of the larger required safety zones.

*Whereas* landowner's property value, use and enjoyment is diminished. The study Martin Heintzelman and Carrie Tuttle 2011 - *Values in the Wind* showed properties within 1-3 miles of an industrial turbine had a negative impact from 15% to 31%, if the property had an industrial wind turbine the value decreased by 65%, Kurt C Kielisch 2009 – *Wind Turbine Impact Study*.

*Whereas* the Industrial Wind Turbine landowner contracts are confidential and maybe in direct conflict with Grant County Compiled Zoning Ordinance; and the assignment and sublease clause in Industrial Wind Turbine contracts could put the greater community at risk.

*Whereas* Citizens of Grant County promote a legacy of family, productive farmland, wildlife and outdoor recreation, clean air, water, and ecology to leave for future generations.

*Be it therefore Resolved*: To uphold Grant County Compiled Zoning Ordinance dated 1-25-2018 Grant County establishes a requirement for best practice aircraft lighting detection system and an Industrial Wind Turbine 2-mile setback from a nonparticipating owner property line, allowing for a waiver.

# Wind Energy Fact Sheet

Minnesota has a enacted a renewable energy policy that focuses on wind energy. Unfortunately, building wind turbines and transmission lines to satisfy the state's mandate has been enormously expensive. Moreover, Minnesota's enormous investment in wind energy has failed to make a dent in reducing the state's carbon dioxide emissions—its stated purpose. What it has done, is to drive up the cost of electricity for all Minnesotans.

Here are some basic facts, from the report by Steven F. Hayward and Peter J. Nelson titled "Energy Policy In Minnesota: The High Cost of Failure." The report is illustrated with numerous charts and graphs.

* Minnesota has adopted a renewable energy standard that requires utilities to obtain 25% to 30% of their electricity from renewable sources. In Minnesota, that essentially means wind.

* Minnesota has also adopted a goal of reducing the state's CO2 emissions by 80% by 2050. That goal cannot possibly be met.

* To date, approximately **$10.6 billion** has been spent on wind farms to supply energy to the state's utilities, and another **$4 billion** on transmission lines.

* Historically, electricity in Minnesota was consistently cheaper than the national average, by 18%-20%. As these enormous investments have been made in wind energy, that advantage has been lost. 2017 was the first year ever in which electricity in Minnesota was **more expensive than the national average**.

* Minnesotans are now paying over **$1 billion a year** more for electricity per year than if the state had maintained its historic price advantage.

* Minnesota has not developed wind farms in order to meet increased demand for electricity. Consumption of electricity has been flat, and the state already had enough power capacity through its coal, natural gas and nuclear plants. Wind power has been an added-on cost above and beyond those existing facilities.

* $15 billion spent on wind energy has done little to reduce Minnesota's CO2 emissions, which for the state as a whole are virtually the same as they were 20 years ago.

* Even emissions from the power generation sector are down only slightly compared with their 2005 peak.

* Wind power will never replace conventional sources of electricity (coal, natural gas and nuclear) because it is **intermittent** and **unreliable**. Wind turbines only generate electricity when the wind blows, so Minnesota needs enough reliable electricity sources to meet peak demand, no matter how many wind farms are constructed.

* Electricity cannot be stored at scale, and must be consumed as it is produced. Wind energy is particularly low-value since it provides the most electricity when it is least needed: in the spring and fall, and at night. At times, wind farms actually pay utilities to take their electricity because there is no demand for it. Wind farms can make money doing this on account of federal subsidies.

* While the supposed environmental benefit of wind energy—reduction in CO2 emissions—turns out to be illusory, its environmental costs are very real: it needs vastly greater land area than conventional power plants; wind turbines are unsightly and noisy; being located far from where most electricity is consumed, they require many miles of transmission lines; and they kill large numbers of birds and bats.

Jeremy Kitson

# Let's look at some science:

Terry Matilsky Study: Rutgers Physics Professor

- Math that proves a 300' hub height turbine can throw debris over 1700'
- All the math is proven with equations and functions that can all be correlated
- Extrapolate that data out for the model of turbine
- Ex) 660' turbine at 15 RPM (based on the 3 sec rotation in the study)
- 660'/300 = 2.2 (1700') = 3740' danger zone
- For comparison a ½ mile is only 2640' and our setback is 1125' from the property line now (could be 1225' from the house)

all studies available upon request

# Equitable Zoning and Safety page 1

- Wind developers cannot prove where their setback distances originate from. Ask them a simple question: "Can you provide a scientific, independent, peer-reviewed study that proves the setback distance your industry deems as the STANDARD?"
- Matilsky Study plus a University of Illinois Physics Professor Scott Willenbrock recently suggested 1.5 mile setbacks from turbines may be appropriate
- The reality: Developers throw the shortest possible setback out there and hope it sticks
- On March 6, 2017, Michigan State published recommendations on what constitutes a safe setback and it varies. The minimum is 1,640' in communities that are "homogeneous and in support of the project". This 1,640' setback is also recommended by turbine manufacturers Vestas and Nordex in case of tower failure or fire.

# Equitable Zoning and Safety page 2

- MSU recommends that a 3,280' setback is appropriate where the "community is diverse in interests, beliefs, and reasons for living in a rural area."
- MSU points out that governments in Europe who have a longer experiences with wind energy have setbacks of 1 KM (3,281').
- MSU points out that 2,500' minimum is recommended to mitigate observed shadow flicker.
- Link: http://iiccusa.org/uncategorized/msu-extension-office-wind-documents/
- Link for Vestas/Nordex recommendation: https://northeastwindmills.com/wp-content/uploads/2013/07/vestas-nordex.pdf
- https://patch.com/massachusetts/falmouth/vestas-confidential-health-safety-instruction-manual-falmouth-ma-wind-farm-0

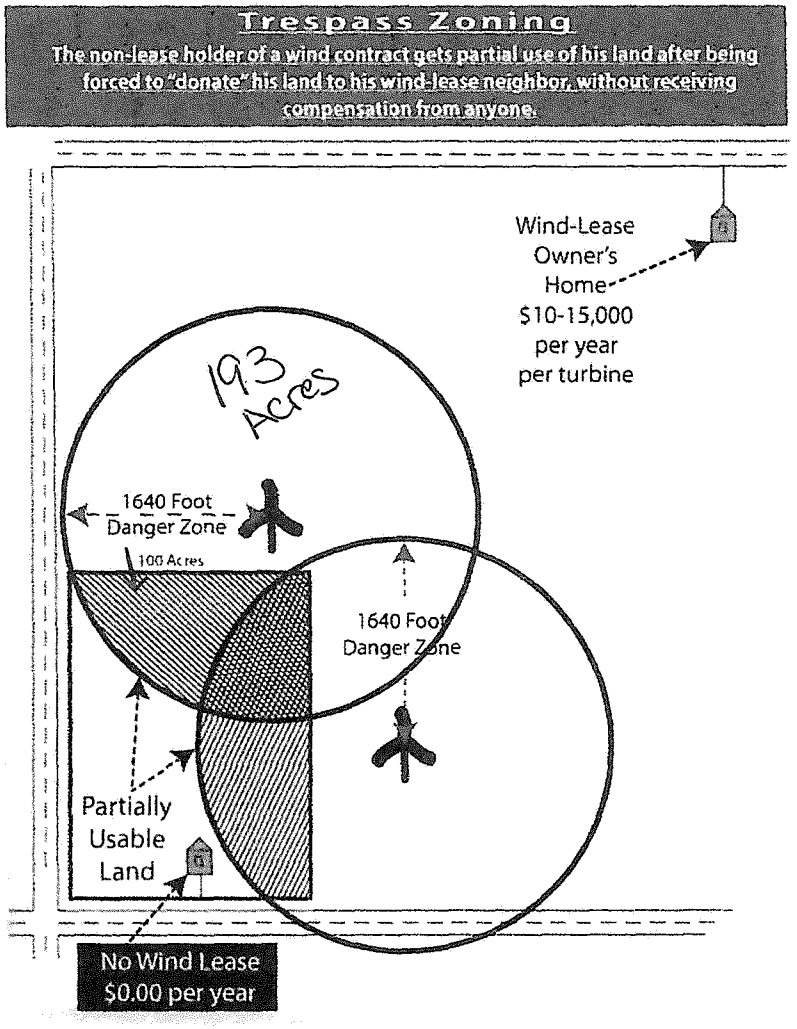
# Equitable Zoning and Safety page 3

- Ironically, you will not find a direct link online to the MSU study. It has been modified.
- Insiders in Michigan believe that the wind industry and wind lobby were not happy and put pressure on MSU to make it more wind friendly.
- Conclusion: If we have experts in the wind industry suggesting setbacks for safety, we should start there as a minimum. This setback should be measured to the PROPERTY LINE to ensure EQUITABLE zoning that is in place to protect ALL landowners, not just those with wind leases. This forces RES to negotiate with more landowners which they do not want to do, they expect to steal as much uncompensated easements as they can.

# Trespass Zoning

- Setbacks should be to a property line
- Contracts have restrictive language regarding future development
- Many contracts have "gag orders" where you waive the right to complain
- Setbacks to a home is not equitable

***The wind industry claims the health, safety, and noise issues are non-existent, but why do their contracts admit they exist and you can't complain????***



# Noise Limits

- Developers say that turbines are no more noisy than a refrigerator and recommend 50-60dB, some even up to 90dB!!
- Human conversation is said to be 40-45dB.
- We need to be proactive with the General Assembly
- There are rumblings out there that turbines could be approaching 800'!
- Dr. Robert Rand: states "vigorous objections" to turbine noise occur when 20 dB occur, unless you want a refrigerator running or conversation happening while you sleep in your bed, the only thing that mitigates noise is distance!
- http://randacoustics.com/wind-turbine-sound/wind-turbines-published-articles/wind-turbine-noise-an-independent-assessment/

30dBA
20dBC
need both

# Infrasound

- Infrasound is inaudible and below what we can hear
- Scientific studies show it has numerous negative consequences on human health
- Dr. Alec Salt: http://www.epaw.org/documents.php?article=n14
  https://www.wind-watch.org/documents/author/?a=Salt,+Alec
  https://stopthesethings.com/tag/alec-salt/
- It is believed the sonic attacks on our embassy in Cuba were infrasound: https://www.nytimes.com/2017/09/29/us/politics/us-embassy-cuba-attacks.html (The NY Times of all sources, a pretty left leaning outfit!)

# Infrasound: Con't

- Another infrasound study by Electrical/Acoustical Engineer Dr. Paul Schomer reveals infrasound is real and it does affect people.
- "For at least four decades there have been reports in scientific literature of people being made ill by low-frequency sound and infrasound. In the last several years there have been an increasing number of such reports with respect to wind turbines". This is right from the study's summary.
- The paper says, "Nobody understands why only a fraction of the population is affected" and how infrasound affects people. Dr. Alec Salt explains this in his medical opinion based on the types of hair follicles in our inner ear as does this study in Section 4: "Excitation of the otolith".
- http://www.windturbinesyndrome.com/wp-content/uploads/2013/08/WindTurbineNoise-Schomer-et-al.pdf

# Conclusion: Audible and Inaudible Noise

- Wind developers say there is no scientific evidence that noise and infrasound affect people, that to me is an outright fabrication.
- https://stopthesethings.com/2014/12/17/21-peer-reviewed-articles-on-the-adverse-health-effects-of-wind-turbine-noise/
- Dr. Schomer believes 3,330' is the minimum safe distance for noise and Infrasound
- Schomer Opinion

Property Value

# Home Value 3

- Appraisal One Group in Wisconsin did an extensive study on wind turbine effects on property value
- Homes depreciated anywhere from 11-60%
- https://www.wind-watch.org/docviewer.php?doc=AGO-WIND-TURBINE-IMPACT-STUDY.pdf
- RES will attempt to refute this, so you have to make up your own mind.
- Mr. Lila also said he's never seen a safety manual (go to the 50 min mark of the youtube link on the previous slide)
- If RES is so sure that property values will not fall, then they should have no problem offering a PROPERTY VALUE GUARANTEE. It's not much to ask to ask them to put their good faith and own money on the line for residents.

# Wind Developers tell us they are saving the Earth

- A look at the truth
- Humans produce 40 billion tons of $CO_2$ annually http://www.slate.com/blogs/bad_astronomy/2014/08/20/atmospheric_co2_humans_put_40_billion_tons_into_the_air_annually.html
- Natural processes on Earth produce 645 million tons of $CO_2$ annually https://www.forbes.com/sites/startswithabang/2017/06/06/how-much-co2-does-a-single-volcano-emit/#7d36f61c5cbf
- Turbines mitigate about 400 million tons annually (from a pro wind site) http://gwec.net/wp-content/uploads/2012/06/Wind-climate-fact-sheet-low-res.pdf
- What about $CO_2$ produced to mine, fabricate, transport, and construct a turbine? https://stopthesethings.com/2014/08/16/how-much-co2-gets-emitted-to-build-a-wind-turbine/

# Does wind help save the Earth?

- Here is the math:
  40 billion + 645 million / 400 million is 0.0098
- So globally, wind turbines mitigate just under 1% of $CO_2$ worldwide
- RTO (regional transmission organization) MISO who manages wind rich states like Iowa and Minnesota concluded that it costs $237/per ton of $CO_2$ mitigated by wind turbines
  https://www.misoenergy.org/Library/Repository/Communication%20Material/EPA%20Regulations/MISOEPACO2EmissionReductionAnalysis.pdf
- Wind is not the way to help climate change, a great breakdown here:
  https://www.brookings.edu/blog/planetpolicy/2014/05/20/why-the-best-path-to-a-low-carbon-future-is-not-wind-or-solar-power/

# Economics of Wind

- The economics of wind is a complicated subject with many variables
- We need to get as familiar as we can of the many structures that the common person (not even a lot of wind project managers) does not understand
- I'll break down some of these common structures into as simple a terms as I can
- Some of the main structures are the PTC (ITC for solar), REC's, the UCP construct, imposed cost on other generation, and PILOT
- If you can get a basic understanding of these structures, you will see that wind is high cost, low value, and does nothing more than rip off tax and utility ratepayers while achieving little of the stated goals a developer uses to persuade the community

# The PTC (Production Tax Credit)

- The PTC is a subsidy that wind loves and claims they can live without
- It is based on the energy produced and supplied to the electricity market
- Currently the taxpayer subsidizes wind at 2.4 cents/kWh on wholesale prices that on average are 9 cents/kWh nationally
- We subsidize wind at about $4.2 billion a year due to the PTC https://www.masterresource.org/production-tax-credit-ptc/wind-ptc-excessive-benefit-demands-repeal/
- https://www.masterresource.org/production-tax-credit-ptc/ptc-just-facts/
- Wind will argue all generation gets subsidies, yes, but wind and solar get 60% of that pie. Who gets the largest ROI (return on investment) on the tax subsidies for consumers? By the way, most developers are subsidiaries of fossil fuel companies, a wind subsidy is largely a fossil fuel subsidy also!

# PTC Facts:

- Check your utility bill for 2 rates, one at 7.5 cents/kWh for conventional generation, and 9.5 cents/kWH for renewables
- The PTC was created in 1992 to allow renewables access to the electricity markets, it's been phased out and extended multiple times by politicians
- Wind is still one of the most expensive generation next to solar even with the PTC
- The intermittent nature of wind allows it to produce during times of low demand. Rarely is wind available when peak demand occurs (usually warmer afternoon times of summer)
- PTC is currently phasing out 20% a year, wind is desperate to get projects approved so they can't keep bilking the taxpayer (hence all the whining to congress the past few weeks on the passing of the budget bill)

# REC's (Renewable Energy Credits/Certificates)

- When you hear wind developers tout all these big companies (Amazon, Google, Whirlpool, Facebook and the likes) wanting to "power their facilities on 100% renewables" it's because of REC's in their PPA's (power purchase agreements)
- An REC is awarded based on 1 MWH of renewable generation purchased
- This lowers the tax liability of these companies and hurts the US Treasury
- When electricity is generated it is not traced exactly where it is used
- For wind to say 1 MWH replaces 1 MWH of fossil fuels is disingenuous, there is no current system to track, let alone prove it
- It's a tax credit businesses and developers get that the US taxpayer makes up
- https://www.masterresource.org/renewable-energy-credits-recs/recs-prime/

# Uniform Clearing Price (UCP) Construct

- When peak demand occurs, the RTO opens up an "auction" to the electricity markets that generators bid into
- Due to subsidies like the PTC, wind can actually bid NEGATIVE (up to $-23/MWh) compared to other generation and the amount of MW that can be supplied, the UCP was created well before intermittent generation
- Once the peak demand is met, the last bid in (usually in the neighborhood of $30/MWh) is paid on ALL BIDS that met that on time demand
- Essentially wind guarantees its way into the auction by bidding low, sometimes negative, then gets paid top dollar bid by another generation source
- This hurts all consumer utility bills by forcing expensive wind into the electricity market on unsuspecting consumers

# Imposed Cost

- Conventional generation is not meant to fluctuate output to the grid, it is designed to supply a consistent amount of dispatchable baseload power
- Renewables, including wind energy, are intermittent sources of generation and are not always available
- When the wind is blowing, market rules and legislation FORCE conventional generation to "ramp down" which these plants are not designed to do
- This adds "imposed costs" onto the most reliable dispatchable generation
- Who do you think these imposed costs are passed on to?
- Imposed Cost plus the UCP construct hurts all utility consumers on their power bills and creates grid instability
- https://instituteforenergyresearch.org/analysis/news-flash-wind-power-not-cheaper-coal/

# Big wind always refers to the Lazard Study on LCOE

- LCOE: Levelized Cost of Energy comparing cost of different generation
- Lazard claims wind is cheaper than many other technologies, that is a distortion.
- "The lower contract prices were the result of subsidies."
- "Equating LCOE's of wind and solar with those of coal and natural gas power plants in fallacious". It's impossible to replace coal and natural gas with wind and solar on a one to one basis like they are interchangable types of generation.
- Author: Donn Dears, former GE executive and policy advisor to the Heartland Institute
- http://www.powerforusa.com/2017/09/26/misleading-costs-for-wind-and-solar/

# LCOE: Con't

- The EIA (the U.S. Energy Information Administration) states, "The duty cycle for intermittent renewable resources, wind and solar, is not operator controlled, but dependent on the weather and solar cycle. As a result, their LCOE values are not directly comparable to dispatchable technologies."
- https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf
- New wind is far more expensive than already existing generation.
- http://instituteforenergyresearch.org/wp-content/uploads/2015/06/ier_lcoe_2015.pdf

# LCOE Final Conclusion

- Kevon Martis, Director of the Interstate Informed Citizens Coalition
- "Even Lazard goes to great lengths to explain that there are significant regional cost variations with wind energy as the wind resource varies."
- "Wind turbines are nothing more than an expensive yet short lived fuel saving attachment for fossil fuel generators, mainly gas-fired. No fossil, no wind."
- "All wind energy does is save some fuel (primarily gas) and some variable O&M, I am aware of no place in the US that unsubsidized wind would be cheaper than the value of those two combined."
- www.iiccusa.org
- Great resource on wind experienced Michigan

# PILOT (Payment in lieu of taxes)

- Apex will ask your commissioners for PILOT
- They ask for a special tax exemption on the backs of you, the local people
- They will agree to a specific amount to put into the public coffer and landowner payments based on their megawatt generation or nameplate capacity of the project
- Ask Apex to prove how much money the community gets versus how much they pocket on the backs of all of us
- If we improve the capital of our property do we get a tax abatement like PILOT?
- The audacity to ask for PILOT is an insult to all local landowners and their property taxes

# Pay attention to Legislation

- Wind was largely saved by politicians in DC
- Many tax structures are still firmly in place
- Even the BEAT provision that remained in the budget bill was only considered a "flesh wound" for wind developers
- https://www.wind-watch.org/news/2017/12/17/tax-bill-largely-preserves-incentives-for-wind-and-solar-power/
- Wind and Solar get almost 60% of the annual subsidies given to generators and still are not competitive after decades of subsides.
- What is our ROI on all that tax money and credits plus incentives that wind garners annually? Nothing more than overly expensive, unreliable, unpredictable generation that is only there 30% of the time or so (capacity factor) even in the most windy regions

# Other things your officials hold the cards to:

- RUMA (road management use agreement), make sure the dollar figure negotiated is double what is offered. Most first time communities forget to include the DECOMMISSIONING value, if turbines go in, they will eventually have to come out, include general maintenance of the turbines as well
- Fair Decommissioning Plan: the cost to take down one turbine is anywhere between 500-700K. (Our officials currently have a bond for 5K a turbine!!!)
- Many cases the developer of a project sells that project off, make sure all agreements transfer to the new company
- Complaint Resolution System: what will be the rules of the ordinance if the public files a complaint against the developer? There needs to be specific defined procedures to ensure public trust, safety, and quality of life impacts

# Final Thoughts:

- Wind does not care about wind resource, they care about states that have a firm RPS (Renewable Portfolio Standard) like we have in Ohio
  https://www.nrel.gov/gis/images/80m_wind/USwind300dpe4-11.jpg
- They find communities desperate for money that have the weakest possible setback language and they start signing leases before many people are even aware
- They make false promises that this is a great economic opportunity, they refuse to see that the overall NET effect is negative when all the social fabric and moral factors are factored in
- The money is puny compared to the irreparable community damage

# Facts about Industrial Wind Turbine Noise

- Wind farm proponents; (wind developers, participating landowners, and government officials); often rely on an industry-backed study to deny health problems. One often cited is the Massachusetts Department of Environmental Planning (DEP) "Wind Turbine Health Impact Study, which has been under a great deal of criticism, with one scientist (Raymond S. Hartman, PhD) saying it "fails to rise to the level of reliable scientific research, is incomplete, biased, distorted, without scientific merit, and not to be used as the basis for public policy." Meanwhile, there are peer-reviewed papers and studies that find links between turbine noise and ill health. Because this is currently not settled, proven science, no one, including governments can claim certainty. Because it is uncertain and involves public health and safety, government must maximize safety measures such as noise limits and setbacks to protect its citizens.

- **The FACTS are:**

    - The closer people are to wind turbines, the greater the negative impacts to them. Close proximity increases exposure to noise pollution, and other risks and annoyances.

    - Not all, but some more sensitive people suffer adverse health effects as a result of living near large wind turbines. This is a result of exposure to the audible and inaudible sound industrial wind turbines produce.

    - Scientific studies show wind turbines disturb sleep, and sleep disturbance is proven to cause impaired health.

    - Peer-reviewed scientific studies have proven the existence of infrasound (McPherson), and how it physically affects people (Salt and Kaltenbach), (Salt and Lichtenhan). "Large wind turbines generate very low frequency sounds and infrasound (below 20 Hz) when the wind driving them is turbulent. The amount of infrasound depends on many factors, including the turbine manufacturer, wind speed, power output, local topography, and the presence of nearby turbines (increasing when the wake from one turbine enters the blades of another). Infrasound cannot be heard and is unrelated to the loudness of the sound that you hear. Infrasound can only be measured with a sound level meter capable of detecting it (and not using the A-weighted scale)." - Alec N. Salt, PhD.

    - It is known that infrasound causes health problems. And it is now being established through sound studies in Brown County, Wisconsin and the Cape Bridgewater Wind Farm in Australia that large wind turbines create infrasound that can be measured in nearby homes. <u>These are facts.</u> The only debate is what safety measures must be taken for mitigating this. LFN and infrasound must be included in zoning regulations.

- **What a Few of the <u>Peer Reviewed</u> Studies are Saying:**

    - **Ambrose - <u>Wind turbine acoustic investigation - Infrasound and low-frequency noise - A case study</u> 2012** An acoustical study was conducted to investigate the presence of infrasonic and low-frequency noise emissions from wind turbines located in Falmouth, Massachusetts, USA. During the study, the investigating acousticians experienced adverse health effects consistent with those reported by some Falmouth residents. The authors conclude that the rapid onset of adverse health effects during the study confirms that wind turbines can harm humans if placed too close to residents.

    - **Hanning - <u>Turbine Noise Seems to Affect Health Adversely 2012</u>** In a survey of people residing in the vicinity of two US wind farms, those living within 375-1400 meters (1,230 – 4,593 feet) reported worse sleep and more daytime sleepiness, in addition to having lower summary scores on the mental component of a health survey than those who lived 3-6.6 km (1.9 – 4.1 miles) from a turbine, with a sharp increase in effects between 1 km and 2 km. A New Zealand

studies available upon request

survey showed lower health related quality of life, especially sleep disturbance, in people who lived less than 2 km from turbines. A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and external noise levels that are permitted in most jurisdictions.

- **Jeffery - Adverse health effects of industrial wind turbines - 2013** Industrial wind turbines can harm human health if sited too close to residents. Harm can be avoided if IWTs are situated at an appropriate distance from humans. Owing to the lack of adequately protective siting guidelines, people exposed to IWTs can be expected to present to their family physicians in increasing numbers. The documented symptoms are usually stress disorder–type diseases acting via indirect pathways and can represent serious harm to human health.

- **Nissenbaum - Effects of industrial wind turbine noise on sleep and health - 2012** We conclude that the noise emissions of IWTs disturbed the sleep and caused daytime sleepiness and impaired mental health in residents living within 1.4 km of the two IWT installations studied. Industrial wind turbine noise is a further source of environmental noise, with the potential to harm human health.

- **Phillips - Properly interpreting the epidemiologic evidence about health effects of industrial wind turbines on nearby residents 2011** There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder-type diseases, It is always possible that further research will reveal that, under certain circumstances, turbines can be sited near people's homes with minimal health risk. Such is always possible for any exposure, given the nature of science (open to additional information) and changing technology. But our current knowledge indicates that there are substantial health risks from the existing exposure, and we do not know how to reduce those risks other than by keeping turbines several kilometers away from homes. Dismissal of health effects cannot be seen as honest disagreements about the weight of the evidence.

- **Salt - Infrasound from wind turbines could affect humans 2011** Based on our current knowledge of how the ear works, it is quite possible that low-frequency sounds at the levels generated by wind turbines could affect those living nearby. We can conclude that based on well-documented knowledge of the physiology of the ear and its connections to the brain, it is scientifically possible that infrasound from wind turbines could affect people living nearby.

## Don't Ignore New Information

- Knowledge about this is changing fast. A groundbreaking study by sound engineer Stephen Cooper completed at the Cape Bridgewater Wind Farm in Australia proves the connection between large wind turbines and its effects on people. It found a link between an operating wind farm and the sensations of 6 residents in 3 of the nearest homes. The results of this study have prompted a senate inquiry in Australia.

- Cooper's is the first study of effects on people that included a cooperating wind farm operator, in conjunction with a researcher that does not work exclusively for wind farms. Six subjects, 3 couples from different homes, were participants in this study. They were self-selected as being particularly sensitive and susceptible to wind farm acoustic emissions, so much so that one couple has abandoned their house. Cooper found that these six subjects are able to sense attributes of the wind turbine emissions without there being an audible or visual stimulus present, and that these responses correlate with the wind turbine power being generated but not with either the sound or vibration.

- It finds that something is coming from the wind turbines to affect these people and that something increases or decreases as the power output of the turbine increases or decreases. See http://www.pacifichydro.com.au/pacific-hydro-releases-cape-bridgewater-wind-farm-acoustic-study/

- Events in Brown County, Wisconsin support the Cape Bridgewater study. A study was done at the Shirley Wind farm involving four acoustical consulting firms and included Hessler Associates, who derives significant income from wind development projects. The study found "sufficient evidence to classify LFN and infrasound emanating from the turbines as a serious issue, possibly affecting the future of the wind industry". It "showed unequivocally that low level infrasonic sound emissions from the wind turbines were detectable..." The long-term response for inhabitants at one residence studied was severe for the wife and child, causing the family to move, while the husband has experienced no ill effects. This illustrates the complexity of the issue.

- After this independent sound study was done and with careful consideration, the Brown County Board of Health declared industrial wind turbines a human health hazard. See http://bccrwe.com/index.php/8-news/16-duke-energy-s-shirley-wind-declared-human-health-hazard

**These studies mean that: (1) wind farm operators cannot say there are no known effects and no known people affected. (2) Local governments charged with protecting the health and welfare of citizens cannot say any longer that they know of no adverse effects.**

## The Only Proven Safety Measure is a Safe Setback

- Setbacks must be measured from a non-participant's property line. A setback measured from a dwelling limits the non-participating landowner's use of their property, and greatly reduces protections for non-participants from noise pollution and its proven ill effects, shadow flicker, property devaluation, and potential property damage from blade failure or fire.

- All landowners should have the right to do with their land what they choose as long as it doesn't harm or impede a neighboring land owner. A setback for safety reasons, regardless of its distance, must be maintained. Any zoning that allows a wind turbine to be built next to a non-participant's property line eliminates that property owner from safely using that land. It creates an easement over the neighboring, non-participating property that eliminates the owner from any further developments. This amounts to an uncompensated taking of private property rights.

- Because of widespread concerns about health and safety, many jurisdictions scattered around the United States and Canada have adopted larger setbacks in recent years.

| *Government Entities* | |
|---|---|
| Catarunk, Maine | 7,920 ft. |
| Moscow, Maine | 7,920 ft. |
| Haut-Saint-Laurent, Montérégie, Québéc | 6,562 ft. |
| Fayette County, Pennsylvania | 6,000 ft. |
| Carteret County, North Carolina | 5,280 ft. from all abutting property lines |
| Frankfort, Maine | 5,280 ft. from property line |
| Umatilla County, Oregon | 5,280 ft. from "unincorporated community" |
| Mason County, Kentucky | 5,280 ft. from property line |
| Trempealeau County, Wisconsin | 5,280 ft. from inhabited structures |
| Hillsdale County, Michigan | 5,280 ft. from residences |
| Sumner, Maine | 5,280 ft. from property line |
| Newport, North Carolina | 5,000 ft. from neighboring property lines |
| Ellis County, Kansas | 4,921 ft. from rural residences |
| Rumford, Maine | 4,000 ft. from property line |
| Clifton, Maine | 4,000 ft. from occupied structures |
| San Diego, California | 3,937 ft. from residences |
| Halifax, Nova Scotia | 3,281 ft. from habitable building |

| | |
|---|---|
| Claybanks Township, Michigan | 3,000 ft. from property line |
| Cape Vincent, New York | 2,953 ft. |
| Potter County, Pennsylvania | 2,900 ft. |
| Wareham, Massachusetts | 2,800 ft. from residences |
| Goodhue County, Minnesota | 2,700 ft. from non-participants |
| Roanoke County, Virginia | 2,640 ft. from residences |
| Tipton County, Indiana | 2,640 ft. from residences |
| Union Township, Wisconsin | 2,640 ft. from residences |
| Perry, New York | 2,640 ft. from residences |
| Rock County, Wisconsin | 2,640 ft. |
| Buckland, Massachusetts | 2,640 ft. from residences |
| Granville, Pennsylvania | 2,500 ft. from property line |
| Charlton, Massachusetts | 2,500 ft. |
| Allegany, New York | 2,500 ft. |
| | |
| *Advisory Boards* | |
| UK Noise Association | 5,280 ft. |
| French Academy of Medicine | 4,921 ft. from residences |
| National Research Council | 2,640 ft. |
| | |
| *Turbine Manufacturers* | |
| Volkswind | 1,640 ft. (US) 3,280 (Germany) |
| Vestas Safety Manual | 1,300 ft. |

One Mile = 5,280 feet ½ Mile = 2,640 feet ¼ Mile = 1,320 feet
1,000 ft = 305 meters 1,000 meters = 1 km = 3,281 ft = 0.62 mi

# RECOMMENDATIONS

Any zoning change that reduces the protections provided under the current Lancaster County limit of 35dBA at night significantly impacts the health of non-participating land owners.

The appropriate setback distance must be measured from the non-participant's property line, not their residence. To ensure citizen health, safety, and property rights, the setback should correspond to a distance of ten rotor heights, or not less than one mile from the non-participant's nearest property line, (unless agreed to).

LFN and infrasound must be included in zoning regulations, and the zoning specify that all post construction sound measurements can be requested by a nonparticipant, and be measured with C-weighted sound measurements to ensure that it is not excessive. The costs of all such testing should be paid by the wind developer, not the county.

The Lancaster County Health Department was provided information from Brown County, Wisconsin regarding wind turbines causing health risks. Based on responses from the Health Department, it appears this information was ignored. Ignoring this information is dangerous for our citizens.

**If there is no clear scientific consensus about safety, the county must err to the side of caution and have strict sound limits and significant setbacks.**

BCCRWE
Brown County Citizens for Responsible Wind Energy

**FOR IMMEDIATE RELEASE** **October 16,2014**

# Duke Energy's Shirley Wind Turbines Declared a "Human Health Hazard"

DENMARK, WI - At the October 14, 2014 Brown County Board of Health meeting, a motion was unanimously approved declaring the Shirley Wind turbines a "Human Health Hazard". The text of the unanimously approved motion reads:

*"To declare the Industrial Wind Turbines at Shirley Wind Project in the Town of Glenmore, Brown County, WI. A Human Health Hazard for all people (residents, workers, visitors, and sensitive passersby) who are exposed to Infrasound/Low Frequency Noise and other emissions potentially harmful to human health."*

We applaud the integrity of the Brown County Board of Health in the work they have done to carry out their mission to 'promote individual and community health'. They have been deeply involved in trying to resolve the public health crisis that has existed in the Town of Glenmore since Emerging Energies of Wisconsin built the industrial wind project there in 2010. The project has been sold twice since its construction and is now owned by the renewables arm of Duke Energy, with Wisconsin Public Service purchasing the electricity.

Since the erection of the 8 turbines in Glenmore, among the largest in the United States at just under 500 feet tall, three families have vacated the homes they still own and complaints involving over 75 people in the project area have been filed with the Brown County Board of Health (including affidavits representing over 50 people that have been submitted to the Public Service Commission of Wisconsin). The root of the complaints and the home abandonments are the conditions created by Shirley Wind, allege the residents.

The declaration of Duke's Shirley Wind turbines as a "Human Health Hazard" follow a year long study linking the signature of inaudible low frequency noise (created by the passing of the massive turbine blades past their supporting towers) to the homes that have been abandoned and to the homes where people continue to suffer. The Board of Health was asked to look at the study's raw data, the evidence linking the sound data to the wind turbines, peer-reviewed medical research and the complaints of the people living in the conditions around Duke's Shirley Wind project. They looked at the facts, they listened to the residents, they studied the medical literature, and then made the connection between Shirley Wind's operations and the suffering in Glenmore - declaring the wind turbines a "Human Health Hazard".

The Brown County Board of Health, the Brown County Human Services Committee, and the Brown County Board of Supervisors have all taken action on the wind turbine issue over the past four years. When resolutions have been sent to the State of Wisconsin to conduct the studies that their own PSC-funded testing called for, nothing was done. When emergency relocation aide was requested for those families forced from or suffering in their homes, the request was ignored. When they endorsed the 'Wisconsin Citizens Safe Wind Siting Guidelines' which includes science-based protections from low frequency noise, they were summarily dismissed. Brown County has now recognized this as a public health issue caused by the operation of Duke's Shirley Wind.

The State of Wisconsin has stripped the right of towns and counties to responsibly site wind turbines in their own communities and have created state-wide siting rules with little protection for families forced to live in wind projects. The State refuses to recognize the health impacts around its existing wind turbine installations and draft better protections for future projects. By ignoring these impacts, they are dooming more communities to the same fate as the Town of Glenmore.

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#2

# Public Health Impacts of Wind Turbines

Prepared by:
Minnesota Department of Health
Environmental Health Division

In response to a request from:
Minnesota Department of Commerce
Office of Energy Security

May 22, 2009

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## I. Introduction

In late February 2009 the Minnesota Department of Health (MDH) received a request from the Office of Energy Security (OES) in the Minnesota Department of Commerce, for a "white paper" evaluating possible health effects associated with low frequency vibrations and sound arising from large wind energy conversion systems (LWECS). The OES noted that there was a request for a Contested Case Hearing before the Minnesota Public Utilities Commission (PUC) on the proposed Bent Tree Wind Project in Freeborn County Minnesota; further, the OES had received a long comment letter from a citizen regarding a second project proposal, the Lakeswind Wind Power Plant in Clay, Becker and Ottertail Counties, Minnesota. This same commenter also wrote to the Commissioner of MDH to ask for an evaluation of health issues related to exposure to low frequency sound energy generated by wind turbines. The OES informed MDH that a white paper would have more general application and usefulness in guiding decision-making for future wind projects than a Contested Case Hearing on a particular project. (Note: A Contested Case Hearing is an evidentiary hearing before an Administrative Law Judge, and may be ordered by regulatory authorities, in this case the PUC, in order to make a determination on disputed issues of material fact. The OES advises the PUC on need and permitting issues related to large energy facilities.)

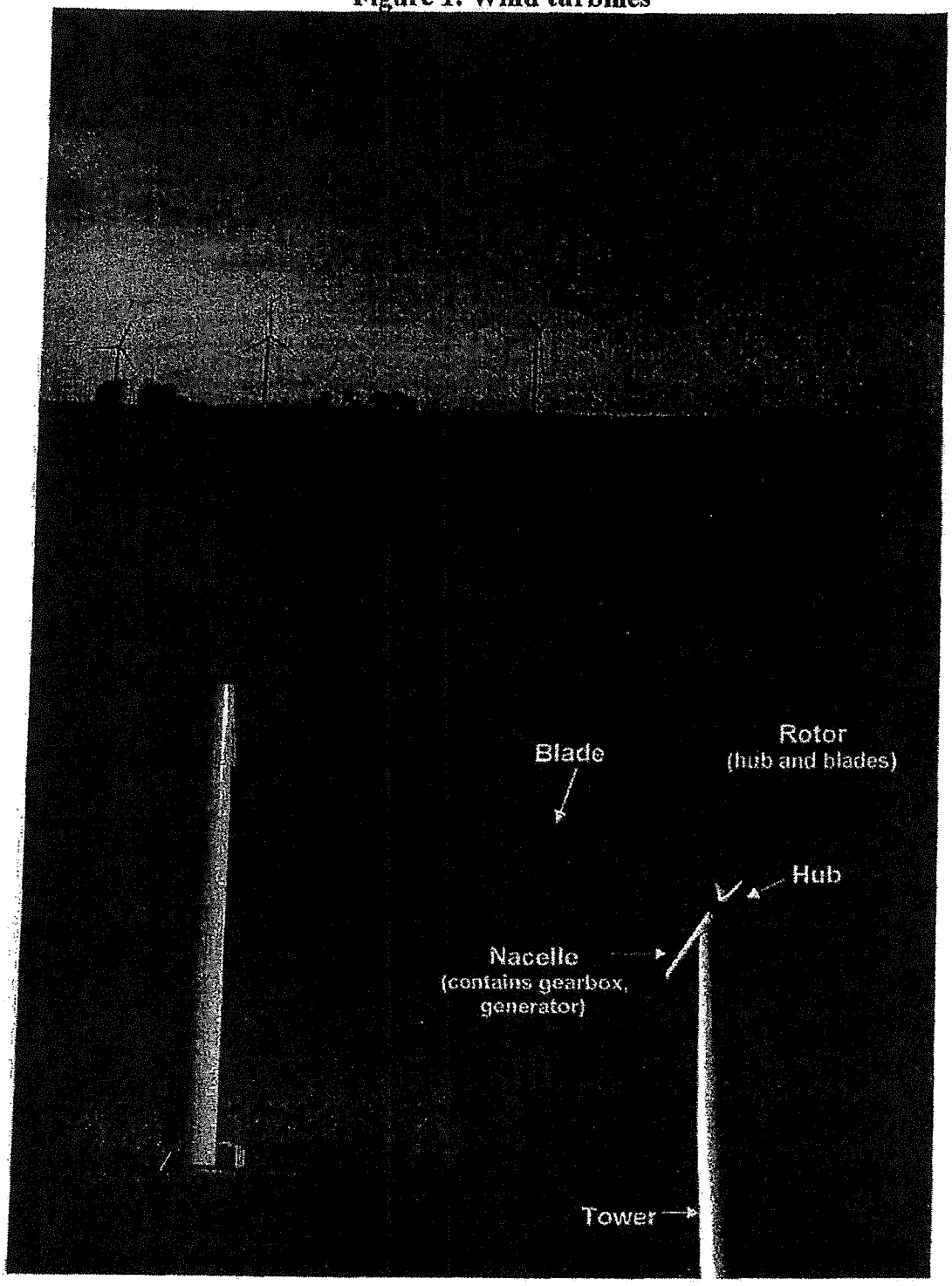
In early March 2009, MDH agreed to evaluate health impacts from wind turbine noise and low frequency vibrations. In discussion with OES, MDH also proposed to examine experiences and policies of other states and countries. MDH staff appeared at a hearing before the PUC on March 19, 2009, and explained the purpose and use of the health evaluation. The Commissioner replied to the citizen letter, affirming that MDH would perform the requested review.

A brief description of the two proposed wind power projects, and a brief discussion of health issues to be addressed in this report appear below.

### A. Site Proposals

Wind turbines are huge and expensive machines requiring large capitol investment. Figure 1 shows some existing wind turbines in Minnesota. Large projects require control of extensive land area in order to optimize spacing of turbines to minimize turbulence at downwind turbines. Towers range up to 80 to 100 meters (260 to 325 feet), and blades can be up to 50 meters long (160 feet) (see Tetra Tech, 2008; WPL, 2008). Turbines are expected to be in place for 25-30 years.

**Figure 1: Wind turbines**



**1. Bent Tree Wind Project in Freeborn County**

This is a proposal by the Wisconsin Power and Light Company (WPL) for a 400 megawatt (MW) project in two phases of 200 MW each (requiring between 80 and 130 wind turbines). The cost of the first phase is estimated at $497 million. The project site area would occupy approximately 40 square miles located 4 miles north and west of the city of Albert Lea, approximately 95 miles south of Minneapolis (Figure 2) (WPL, 2008). The Project is a LWECS and a Certificate of Need (CON) from the PUC is required (*Minnesota Statutes 216B.243)*. The PUC uses the CON process to determine the basic type of facility (if any) to be constructed, the size of the facility, and when the project will be in service. The CON process involves a public hearing and preparation of an Environmental Report by the OES. The CON process generally takes a year, and is required before a facility can be permitted.

WPL is required to develop a site layout that optimizes wind resources. Accordingly, project developers are required to control areas at least 5 rotor diameters in the prevailing (north-south) wind directions (between about 1300 and 1700 feet for the 1.5 to 2.5 MW turbines under consideration for the project) and 3 rotor diameters in the crosswind (east-west) directions (between about 800 and 1000 feet). Thus, these are minimum setback distances from properties in the area for which easements have not been obtained. Further, noise rules promulgated by the Minnesota Pollution Control Agency (MPCA; *Minnesota Rules* Section 7030), specify a maximum nighttime noise in residential areas of 50 A-weighted decibels (dB(A). WPL has proposed a minimum setback of 1,000 feet from occupied structures in order to comply with the noise rule.

**2. Noble Flat Hill Wind Park in Clay, Becker and Ottertail Counties**

This is a LWECS proposed by Noble Flat Hill Windpark I (Noble), a subsidiary of Noble Environmental Power, based in Connecticut. The proposal is for a 201 MW project located 12 miles east of the City of Moorhead, about 230 miles northwest of Minneapolis (Figure 3) (Tetra Tech, 2008). The cost of the project is estimated to be between $382 million and $442 million. One hundred thirty-four GE 1.5 MW wind turbines are planned for an area of 11,000 acres (about 17 square miles); the site boundary encompasses approximately 20,000 acres. Setback distances of a minimum of 700 feet are planned to comply with the 50 dB(A) noise limit. However, rotor diameters will be 77 meters (250 feet). Therefore, setback distances in the prevailing wind direction of 1,300 feet are planned for properties where owners have not granted easements. Setbacks of 800 feet are planned in the crosswind direction.

**Figure 2: Bent Tree Wind Project, Freeborn County**

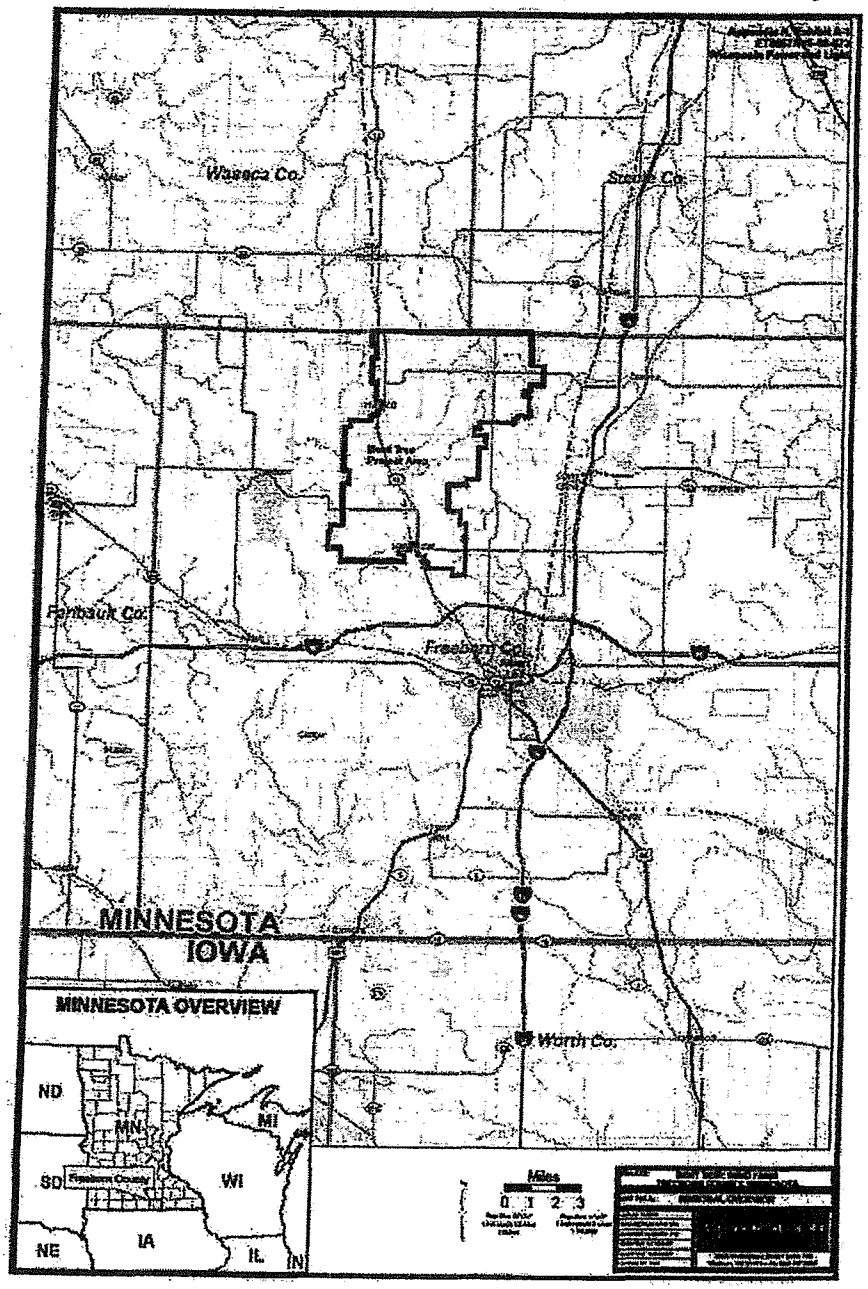
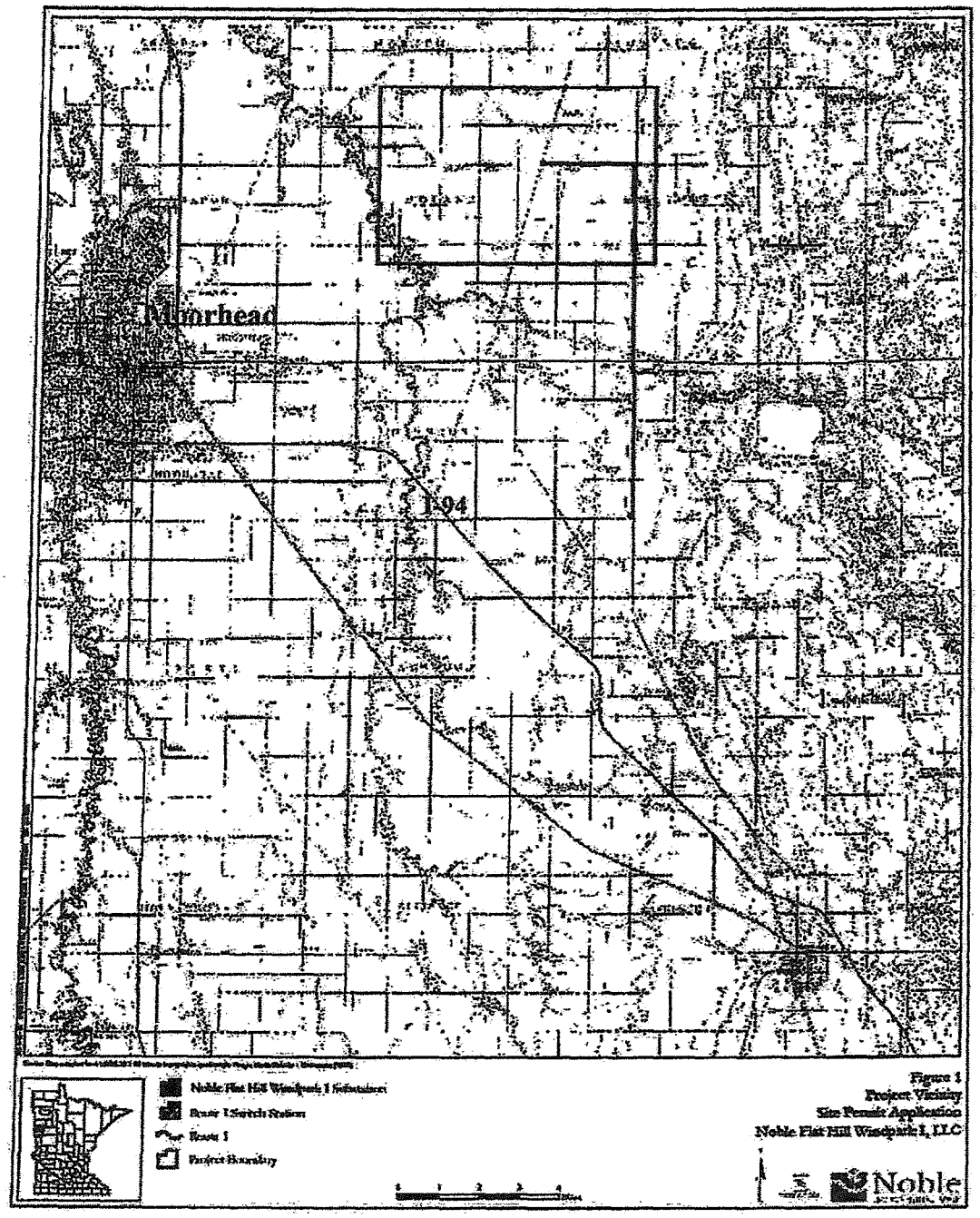


**Figure 3: Noble Flat Hill Wind Park, Clay, Becker, Ottertail Counties**



### B. Health Issues

The National Research Council of the National Academies (NRC, 2007) has reviewed impacts of wind energy projects on human health and well-being. The NRC begins by observing that wind projects, just as other projects, create benefits and burdens, and that concern about impacts is natural when the source is near one's home. Further, the NRC notes that different people have different values and levels of sensitivity. Impacts noted by the NRC that may have the most effect on health include noise and low frequency vibration, and shadow flicker. While noise and vibration are the main focus of this paper, shadow flicker (casting of moving shadows on the ground as wind turbine blades rotate) will also be briefly discussed.

Noise originates from mechanical equipment inside the nacelles of the turbines (gears, generators, etc.) and from interaction of turbine blades with wind. Newer wind turbines generate minimal noise from mechanical equipment. The most problematic wind turbine noise is a broadband "whooshing" sound produced by interaction of turbine blades with the wind. Newer turbines have upwind rotor blades, minimizing low frequency "infrasound" (i.e., air pressure changes at frequencies below 20-100 Hz that are inaudible). However, the NRC notes that during quiet conditions at night, low frequency modulation of higher frequency sounds, such as are produced by turbine blades, is possible. The NRC also notes that effects of low frequency (infrasound) vibration (less than 20 Hz) on humans are not well understood, but have been asserted to disturb some people.

Finally, the NRC concludes that noise produced by wind turbines is generally not a major concern beyond a half mile. Issues raised by the NRC report and factors that may affect distances within which wind turbine noise may be problematic are discussed more extensively below.

## II. Elementary Characteristics of Sensory Systems and Sound

### A. Sensory Systems

#### 1. Hearing

Sensory systems respond to a huge dynamic range of physical stimuli within a relatively narrow dynamic range of mechanical, chemical and/or neuronal (electrophysiological) output. Compression of the dynamic range is accomplished by systems that respond to logarithmic increases in intensity of physical stimuli with arithmetically increasing sensory responses. This general property is true for hearing, and has been recognized since at least the mid-19$^{th}$ century (see e.g., Woodworth and Schlosberg, 1964). "Loudness" is the sensory/perceptual correlate of the physical intensity of air pressure changes to which the electro-mechanical transducers in the ear and associated neuronal pathways are sensitive. Loudness increases as the logarithm of air pressure, and it is convenient to relate loudness to a reference air pressure (in dyne/cm$^2$ or pascals) in tenths of logarithmic units (decibels; dB). Further, the ear is sensitive to only a relatively narrow frequency range of air pressure changes: those between approximately 20 and 20,000 cycles per second or Herz (Hz). In fact, sensitivity varies within this range, so that the sound pressure level relative to a reference value that is audible in the middle of the range

(near 1,000 Hz) is about 4 orders of magnitude smaller than it is at 20 Hz and about 2 orders of magnitude smaller than at 20,000 Hz (Fig. 3). Accordingly, measurements of loudness in dB generally employ filters to equalize the loudness of sounds at different frequencies or "pitch." To approximate the sensitivity of the ear, A-weighted filters weigh sound pressure changes at frequencies in the mid-range more than those at higher or lower frequencies. When an A-weighted filter is used, loudness is measured in dB(A). This is explained in greater detail in Section B below.

The ear accomplishes transduction of sound through a series of complex mechanisms (Guyton, 1991). Briefly, sound waves move the eardrum (tympanic membrane), which is in turn connected to 2 small bones (ossicles) in the middle ear (the malleus and incus). A muscle connected to the malleus keeps the tympanic membrane tensed, allowing efficient transmission to the malleus of vibrations on the membrane. Ossicle muscles can also relax tension and attenuate transmission. Relaxation of muscle tension on the tympanic membrane protects the ear from very loud sounds and also masks low frequency sounds, or much background noise. The malleus and incus move a third bone (stapes). The stapes in turn applies pressure to the fluid of the cochlea, a snail-shaped structure imbedded in temporal bone. The cochlea is a complex structure, but for present purposes it is sufficient to note that pressure changes or waves of different frequencies in cochlear fluid result in bending of specialized hair cells in regions of the cochlea most sensitive to different frequencies or pitch. Hair cells are directly connected to nerve fibers in the vestibulocochlear nerve (VIII cranial nerve).

Transmission of sound can also occur directly through bone to the cochlea. This is a very inefficient means of sound transmission, unless a device (e.g. a tuning fork or hearing aid) is directly applied to bone (Guyton, 1991).

**2. Vestibular System**

The vestibular system reacts to changes in head and body orientation in space, and is necessary for maintenance of equilibrium and postural reflexes, for performance of rapid and intricate body movements, and for stabilizing visual images (via the vestibulo-ocular reflex) as the direction of movement changes (Guyton, 1991).

The vestibular apparatus, like the cochlea, is imbedded in temporal bone, and also like the cochlea, hair cells, bathed in vestibular gels, react to pressure changes and transmit signals to nerve fibers in the vestibulocochlear nerve. Two organs, the utricle and saccule, called otolith organs, integrate information about the orientation of the head with respect to gravity. Otoliths are tiny stone-like crystals, embedded in the gels of the utricle and saccule, that float as the head changes position within the gravitational field. This movement is translated to hair cells. Three semi-circular canals, oriented at right angles to each other, detect head rotation. Stimulation of the vestibular apparatus is not directly detected, but results in activation of motor reflexes as noted above (Guyton, 1991).

Like the cochlea, the vestibular apparatus reacts to pressure changes at a range of frequencies; optimal frequencies are lower than for hearing. These pressure changes can be caused by body movements, or by direct bone conduction (as for hearing, above) when vibration is applied directly to the temporal bone (Todd et al., 2008). These investigators

found maximal sensitivity at 100 Hz, with some sensitivity down to 12.5 Hz. The saccule, located in temporal bone just under the footplate of the stapes, is the most sound-sensitive of the vestibular organs (Halmagyi et al., 2004). It is known that brief loud clicks (90-95 dB) are detected by the vestibular system, even in deaf people. However, we do not know what the sensitivity of this system is through the entire range of sound stimuli.

While vestibular system activation is not directly felt, activation may give rise to a variety of sensations: vertigo, as the eye muscles make compensatory adjustments to rapid angular motion, and a variety of unpleasant sensations related to internal organs. In fact, the vestibular system interacts extensively with the "autonomic" nervous system, which regulates internal body organs (Balaban and Yates, 2004). Sensations and effects correlated with intense vestibular activation include nausea and vomiting and cardiac arrhythmia, blood pressure changes and breathing changes.

While these effects are induced by relatively intense stimulation, it is also true that A-weighted sound measurements attuned to auditory sensitivity, will underweight low frequencies for which the vestibular system is much more sensitive (Todd et al., 2008). Nevertheless, activation of the vestibular system *per se* obviously need not give rise to unpleasant sensations. It is not known what stimulus intensities are generally required for for autonomic activation at relatively low frequencies, and it is likely that there is considerable human variability and capacity to adapt to vestibular challenges.

## *B.* Sound

### 1. Introduction

Sound is carried through air in compression waves of measurable frequency and amplitude. Sound can be tonal, predominating at a few frequencies, or it can contain a random mix of a broad range of frequencies and lack any tonal quality (white noise). Sound that is unwanted is called noise.

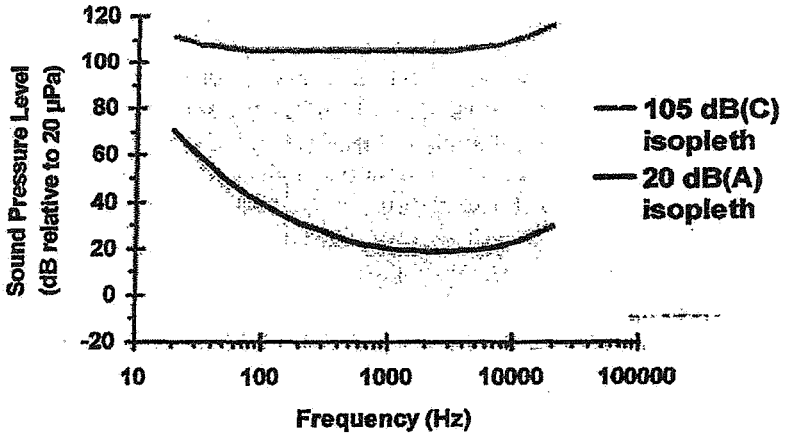
*Audible Frequency Sound*

Besides frequency sensitivity (between 20 and 20,000 Hz), humans are also sensitive to changes in the amplitude of the signal (compression waves) within this audible range of frequencies. Increasing amplitude, or increasing sound pressure, is perceived as increasing volume or loudness. The sound pressure level in air (SPL) is measured in micro Pascals (μPa). SPLs are typically converted in measuring instruments and reported as decibels (dB) which is a log scale, relative unit (see above). When used as the unit for sound, dBs are reported relative to a SPL of 20 μPa. Twenty μPa is used because it is the approximate threshold of human hearing sensitivity at about 1000 Hz. Decibels relative to 20 μPa are calculated from the following equation:

$$\text{Loudness (dB)} = \text{Log}\left((\text{SPL} / 20\ \mu\text{Pa})^2\right) * 10$$

Figure 4 shows the audible range of normal human hearing. Note that while the threshold sensitivity varies over the frequency range, at high SPLs sensitivity is relatively consistent over audible frequencies.

## Figure 4: Audible Range of Human Hearing




Equivalence curves for different frequencies, when sound meter readings in dB are taken with A or C-weighting filters. (Adapted from EPD Hong Kong SAR, 2009)

*Sub-Audible Frequency Sound*

Sub-audible frequency sound is often called infrasound. It may be sensed by people, similar to audible sound, in the cochlear apparatus in the ear; it may be sensed by the vestibular system which is responsible for balance and physical equilibrium; or it may be sensed as vibration.

*Resonance and modulation*

Sound can be attenuated as it passes through a physical structure. However, because the wavelength of low frequency sound is very long (the wavelength of 40 Hz in air at sea level and room temperature is 8.6 meters or 28 ft), low frequencies are not effectively attenuated by walls and windows of most homes or vehicles. (For example, one can typically hear the bass, low frequency music from a neighboring car at a stoplight, but not the higher frequencies.) In fact, it is possible that there are rooms within buildings exposed to low frequency sound or noise where some frequencies may be amplified by resonance (e.g. ½ wavelength, ¼ wavelength) within the structure. In addition, low frequency sound can cause vibrations within a building at higher, more audible frequencies as well as throbbing or rumbling.

Sounds that we hear generally are a mixture of different frequencies. In most instances these frequencies are added together. However, if the source of the sound is not constant, but changes over time, the effect can be re-occurring pulses of sound or low frequency modulation of sound. This is the type of sound that occurs from a steam engine, a jack hammer, music and motor vehicle traffic. Rhythmic, low frequency pulsing of higher frequency noise (like the sound of an amplified heart beat) is one type of sound that can be caused by wind turbine blades under some conditions.

## 2. Human Response to Low Frequency Stimulation

There is no consensus whether sensitivity below 20 Hz is by a similar or different mechanism than sensitivity and hearing above 20 Hz (Reviewed by Møller and Pedersen, 2004). Possible mechanisms of sensation caused by low frequencies include bone conduction at the applied frequencies, as well as amplification of the base frequency and/or harmonics by the auditory apparatus (eardrum and ossicles) in the ear. Sensory thresholds are relatively continuous, suggesting (but not proving) a similar mechanism above and below 20 Hz. However, it is clear that cochlear sensitivity to infrasound (< 20 Hz) is considerably less than cochlear sensitivity to audible frequencies.

Møller and Pedersen (2004) reviewed human sensitivity at low and infrasonic frequencies. The following findings are of interest:

- When whole-body pressure-field sensitivity is compared with ear-only (earphone) sensitivity, the results are very similar. These data suggest that the threshold sensitivity for low frequency is through the ear and not vestibular.
- Some individuals have extraordinary sensitivity at low frequencies, up to 25 dB more sensitive than the presumed thresholds at some low frequencies.
- While population average sensitivity over the low frequency range is smooth, sound pressure thresholds of response for individuals do not vary smoothly but are inconsistent, with peaks and valleys or "microstructures". Therefore the sensitivity response of individuals to different low frequency stimulation may be difficult to predict.
- Studies of equal-loudness-levels demonstrate that as stimulus frequency decreases through the low frequencies, equal-loudness lines compress in the dB scale. (See Figure 4 as an example of the relatively small difference in auditory SPL range between soft and loud sound at low frequencies).
- The hearing threshold for pure tones is different than the hearing threshold for white noise at the same total sound pressure.

## 3. Sound Measurements

Sound measurements are taken by instruments that record sound pressure or the pressure of the compression wave in the air. Because the loudness of a sound to people is usually the primary interest in measuring sound, normalization schemes or filters have been applied to absolute measurements. dB(A) scaling of sound pressure measurements was intended to normalize readings to equal loudness over the audible range of frequencies at low loudness. For example, a 5,000 Hz (5 kHz) and 20 dB(A) tone is expected to have the same intensity or loudness as a 100 Hz, 20 dB(A) tone. However, note that the absolute sound pressures would be about 200 μPa and 2000 μPa, respectively, or about a difference of 20 dB (relative to 20 μPa), or as it is sometimes written 20 dB(linear).

Most sound is not a single tone, but is a mixture of frequencies within the audible range. A sound meter can add the total SPLs for all frequencies; in other words, the dB readings over the entire spectrum of audible sound can be added to give a single loudness metric. If sound is reported as A-weighted, or dB(A), it is a summation of the dB(A) scaled sound pressure from 20 Hz to 20 kHz.

In conjunction with the dB(A) scale, the dB(B) scale was developed to approximate equal loudness to people across audible frequencies at medium loudness, and dB(C) was developed to approximate equal-loudness for loud environments. Figure 4 shows isopleths for 20 dB(A) and 105 dB(C). While dB(A), dB(B), dB(C) were developed from empirical data at the middle frequencies, at the ends of the curves these scales were extrapolated, or sketched in, and are not based on experimental or observational data (Berglund et al., 1996). As a result, data in the low frequency range (and probably the highest audible frequencies as well) cannot be reliably interpreted using these scales. The World Health Organization (WHO, 1999) suggests that A-weighting noise that has a large low frequency component is not reliable assessment of loudness.

The source of the noise, or the noise signature, may be important in developing equal-loudness schemes at low frequencies. C-weighting has been recommended for artillery noise, but a linear, unweighted scale may be even better at predicting a reaction (Berglund et al., 1996). A linear or equal energy rating also appears to be the most effective predictor of reaction to low frequency noise in other situations, including blast noise from mining. The implication of the analysis presented by Berglund et al. (1996) is that annoyance from non-tonal noise should not be estimated from a dB(A) scale, but may be better evaluated using dB(C), or a linear non-transformed scale.

However, as will be discussed below, a number of schemes use a modified dB(A) scale to evaluate low frequency noise. These schemes differ from a typical use of the dB(A) scale by addressing a limited frequency range below 250 Hz, where auditory sensitivity is rapidly changing as a function of frequency (see Figure 4).

## III. Exposures of Interest

### *A.* Noise From Wind Turbines

#### 1. Mechanical noise

Mechanical noise from a wind turbine is sound that originates in the generator, gearbox, yaw motors (that intermittently turn the nacelle and blades to face the wind), tower ventilation system and transformer. Generally, these sounds are controlled in newer wind turbines so that they are a fraction of the aerodynamic noise. Mechanical noise from the turbine or gearbox should only be heard above aerodynamic noise when they are not functioning properly.

#### 2. Aerodynamic noise

Aerodynamic noise is caused by wind passing over the blade of the wind turbine. The tip of a 40-50 meter blade travels at speeds of over 140 miles per hour under normal operating conditions. As the wind passes over the moving blade, the blade interrupts the laminar flow of air, causing turbulence and noise. Current blade designs minimize the amount of turbulence and noise caused by wind, but it is not possible to eliminate turbulence or noise.

Aerodynamic noise from a wind turbine may be underestimated during planning. One source of error is that most meteorological wind speed measurements noted in wind farm literature are taken at 10 meters above the ground. Wind speed above this elevation, in

the area of the wind turbine rotor, is then calculated using established modeling relationships. In one study (van den Berg, 2004) it was determined that the wind speeds at the hub at night were up to 2.6 times higher than modeled. Subsequently, it was found that noise levels were 15 dB higher than anticipated.

Unexpectedly high aerodynamic noise can also be caused by improper blade angle or improper alignment of the rotor to the wind. These are correctable and are usually adjusted during the turbine break-in period.

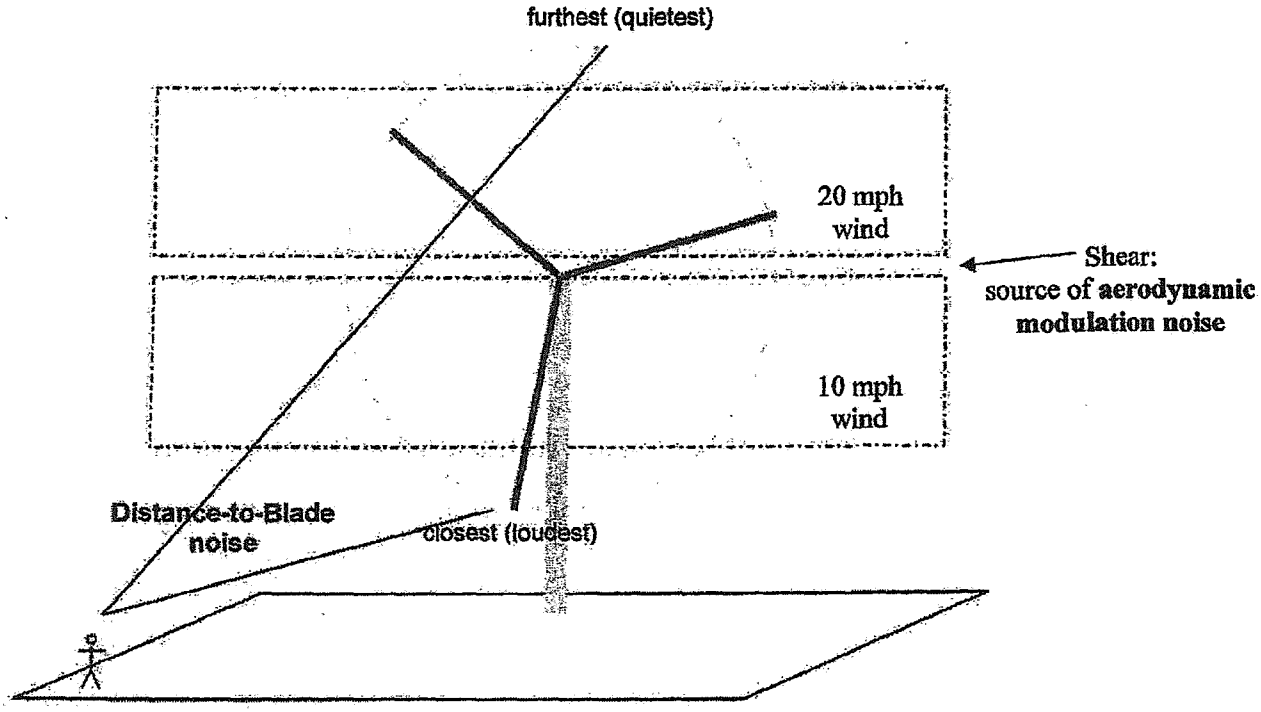
**3. Modulation of aerodynamic noise**

Rhythmic modulation of noise, especially low frequency noise, has been found to be more annoying than steady noise (Bradley, 1994; Holmberg et al., 1997). One form of rhythmic modulation of aerodynamic noise that can be noticeable very near to a wind turbine is a distance-to-blade effect. To a receptor on the ground in front of the wind turbine, the detected blade noise is loudest as the blade passes, and quietest when the blade is at the top of its rotation. For a modern 3-blade turbine, this distance-to-blade effect can cause a pulsing of the blade noise at about once per second (1 Hz). On the ground, about 500 feet directly downwind from the turbine, the distance-to-blade can cause a difference in sound pressure of about 2 dB between the *tip* of the blade at its farthest point and the *tip* of the blade at its nearest point (48 meter blades, 70 meter tower). Figure 5 demonstrates why the loudness of blade noise (aerodynamic noise) pulses as the distance-to-blade varies for individuals close to a turbine.

If the receptor is 500 feet from the turbine base, in line with the blade rotation or up to 60° off line, the difference in sound pressure from the *tip* of the blade at its farthest and nearest point can be about 4-5 dB, an audible difference. The tip travels faster than the rest of the blade and is closer to (and then farther away from) the receptor than other parts of the blade. As a result, noise from other parts of the blade will be modulated less than noise from the tip. Further, blade design can also affect the noise signature of a blade. The distance-to-blade effect diminishes as receptor distance increases because the relative difference in distance from the receptor to the top or to the bottom of the blade becomes smaller. Thus, moving away from the tower, distance-to-blade noise gradually appears to be more steady.

Another source of rhythmic modulation may occur if the wind through the rotor is not uniform. Blade angle, or pitch, is adjusted for different wind speeds to maximize power and to minimize noise. A blade angle that is not properly tuned to the wind speed (or wind direction) will make more noise than a properly tuned blade. Horizontal layers with different wind speeds or directions can form in the atmosphere. This wind condition is called shear. If the winds at the top and bottom of the blade rotation are different, blade noise will vary between the top and bottom of blade rotation, causing modulation of aerodynamic noise. This noise, associated with the blades passing through areas of different air-wind speeds, has been called aerodynamic modulation and is demonstrated in Figure 5.

**Figure 5: Sources of noise modulation or pulsing**




In some terrains and under some atmospheric conditions wind aloft, near the top of the wind turbine, can be moving faster than wind near the ground. Wind turbulence or even wakes from adjacent turbines can create non-uniform wind conditions as well. As a result of aerodynamic modulation a rhythmic noise pattern or pulsing will occur as each blade passes through areas with different wind speed. Furthermore, additional noise, or thumping, may occur as each blade passes through the transition between different wind speed (or wind direction) areas.

Wind shear caused by terrain or structures on the ground (e.g. trees, buildings) can be modeled relatively easily. Wind shear in areas of flat terrain is not as easily understood. During the daytime wind in the lower atmosphere is strongly affected by thermal convection which causes mixing of layers. Distinct layers do not easily form. However, in the nighttime the atmosphere can stabilize (vertically), and layers form. A paper by G.P. van den Berg (2008) included data from a study on wind shear at Cabauw, The Netherlands (flat terrain). Annual average wind speeds at different elevations above ground was reported. The annual average wind speed at noon was about 5.75 meters per second (m/s; approximately 12.9 miles per hour(mph)) at 20 m above ground, and about 7.6 m/s (17 mph) at 140 m. At midnight, the annual averages were about 4.3 m/s (9.6 mph) and 8.8 m/s (19.7 mph) for 20m and 140 m, respectively, above ground. The data show that while the average windspeed (between 20m and 140m) is very similar at noon and midnight at Cabauw, the windspeed difference between elevations during the day is

much less than the difference at night (1.85 m/s (4.1 mph) and 4.5 m/s (10 mph), respectively). As a result one would expect that the blade angle can be better tuned to the wind speed during the daytime. Consequently, blade noise would be greater at night.

A number of reports have included discussion of aerodynamic modulation (van den Berg, 2005; UK Department of Transport and Industry, 2006; UK Department for Business Enterprise and Regulatory Reform, 2007; van den Berg, 2008). They suggest that aerodynamic modulation is typically underestimated when noise estimates are calculated. In addition, they suggest that detailed modeling of wind, terrain, land use and structures may be used to predict whether modulation of aerodynamic noise will be a problem at a proposed wind turbine site.

**4. Wind farm noise**

The noise from multiple turbines similarly distant from a residence can be noticeably louder than a lone turbine simply through the addition of multiple noise sources. Under steady wind conditions noise from a wind turbine farm may be greater than noise from the nearest turbine due to synchrony between noise from more than one turbine (van den Berg, 2005). Furthermore, if the dominant frequencies (including aerodynamic modulation) of different turbines vary by small amounts, an audible beat or dissonance may be heard when wind conditions are stable.

## *B.* Shadow Flicker

Rhythmic light flicker from the blades of a wind turbine casting intermittent shadows has been reported to be annoying in many locations (NRC, 2007; Large Wind Turbine Citizens Committee, 2008). (Note: Flashing light at frequencies around 1 Hz is too slow to trigger an epileptic response.)

Modeling conducted by the Minnesota Department of Health suggests that a receptor 300 meters perpendicular to, and in the shadow of the blades of a wind turbine, can be in the flicker shadow of the rotating blade for almost 1½ hour a day. At this distance a blade may completely obscure the sun each time it passes between the receptor and the sun. With current wind turbine designs, flicker should not be an issue at distances over 10 rotational diameters (~1000 meters or 1 km (0.6 mi) for most current wind turbines). This distance has been recommended by the Wind Energy Handbook (Burton et al., 2001) as a minimum setback distance in directions that flicker may occur, and has been noted in the Bent Tree Permit Application (WPL, 2008).

Shadow flicker is a potential issue in the mornings and evenings, when turbine noise may be masked by ambient sounds. While low frequency noise is typically an issue indoors, shadow flicker can be an issue both indoors and outdoors when the sun is low in the sky. Therefore, shadow flicker may be an issue in locations other than the home.

Ireland recommends wind turbines setbacks of at least 300 meters from a road to decrease driver distraction (Michigan State University, 2004). The NRC (2007) recommends that shadow flicker is addressed during the preliminary planning stages of a wind turbine project.

## IV. Impacts of Wind Turbine Noise

### A. Potential Adverse Reaction to Sound

Human sensitivity to sound, especially to low frequency sound, is variable. Individuals have different ranges of frequency sensitivity to audible sound; different thresholds for each frequency of audible sound; different vestibular sensitivities and reactions to vestibular activation; and different sensitivity to vibration.

Further, sounds, such as repetitive but low intensity noise, can evoke different responses from individuals. People will exhibit variable levels of annoyance and tolerance for different frequencies. Some people can dismiss and ignore the signal, while for others, the signal will grow and become more apparent and unpleasant over time (Moreira and Bryan, 1972; Bryan and Tempest, 1973). These reactions may have little relationship to will or intent, and more to do with previous exposure history and personality.

Stress and annoyance from noise often do not correlate with loudness. This may suggest, in some circumstances, other factors impact an individual's reaction to noise. A number of reports, cited in Staples (1997), suggest that individuals with an interest in a project and individuals who have some control over an environmental noise are less likely to find a noise annoying or stressful.

Berglund et al. (1996) reviewed reported health effects from low frequency noise. Loud noise from any source can interfere with verbal communication and possibly with the development of language skills. Noise may also impact mental health. However, there are no studies that have looked specifically at the impact of low frequency noise on communication, development of language skills and mental health. Cardiovascular and endocrine effects have been demonstrated in studies that have looked at exposures to airplane and highway noise. In addition, possible effects of noise on performance and cognition have also been investigated, but these health studies have not generally looked at impacts specifically from low frequency noise. Noise has also been shown to impact sleep and sleep patterns, and one study demonstrated impacts from low frequency noise in the range of 72 to 85 dB(A) on chronic insomnia (Nagai et al., 1989 as reported in Berglund et al., 1996).

Case studies have suggested that health can be impacted by relatively low levels of low frequency noise. But it is difficult to draw general conclusions from case studies. Feldmann and Pitten (2004)) describe a family exposed during the winter to low frequency noise from a nearby heating plant. Reported health impacts were: "indisposition, decrease in performance, sleep disturbance, headache, ear pressure, crawl parästhesy [crawling, tingling or numbness sensation on the skin] or shortness of breath."

*Annoyance, unpleasant sounds, and complaints*

Reported health effects from low frequency stimulation are closely associated with annoyance from audible noise. "There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects" (WHO, 1999). It has not been shown whether annoyance is a symptom or an accessory in the causation of

health impacts from low frequency noise. Studies have been conducted on some aspects of low frequency noise that can cause annoyance.

Noise complaints are usually a reasonable measure of annoyance with low frequency environmental noise. Leventhall (2004) has reviewed noise complaints and offers the following conclusions:

> " The problems arose in quiet rural or suburban environments
> The noise was often close to inaudibility and heard by a minority of people
> The noise was typically audible indoors and not outdoors
> The noise was more audible at night than day
> The noise had a throb or rumble characteristic
> The main complaints came from the 55-70 years age group
> The complainants had normal hearing.
> Medical examination excluded tinnitus.
>
> " These are now recognised as classic descriptors of low frequency noise problems."

These observations are consistent with what we know about the propagation of low intensity, low frequency noise. Some people are more sensitive to low frequency noise. The difference, in dB, between soft (acceptable) and loud (annoying) noise is much less at low frequency (see Figure 4 audible range compression). Furthermore, during the daytime, and especially outdoors, annoying low frequency noise can be masked by high frequency noise.

The observation that "the noise was typically audible indoors and not outdoors" is not particularly intuitive. However, as noted in a previous section, low frequencies are not well attenuated when they pass through walls and windows. Higher frequencies (especially above 1000 Hz) can be efficiently attenuated by walls and windows. In addition, low frequency sounds may be amplified by resonance within rooms and halls of a building. Resonance is often characterized by a throbbing or a rumbling, which has also been associated with many low frequency noise complaints.

Low frequency noise, unlike higher frequency noise, can also be accompanied by shaking, vibration and rattling. In addition, throbbing and rumbling may be apparent in some low frequency noise. While these noise features may not be easily characterized, numerous studies have shown that their presence dramatically lowers tolerance for low frequency noise (Berglund et al., 1996).

As reviewed in Leventhall (2003), a study of industrial exposure to low frequency noise found that fluctuations in total noise averaged over 0.5, 1.0 and 2.0 seconds correlated with annoyance (Holmberg et al., 1997). This association was noted elsewhere and led (Broner and Leventhall, 1983) to propose a 3dB "penalty" be added to evaluations of annoyance in cases where low frequency noise fluctuated.

In another laboratory study with test subjects controlling loudness, 0.5 – 4 Hz modulation of low frequency noise was found to be more annoying than non-modulated low

frequency noise. On average test subjects found modulated noise to be similarly annoying as a constant tone 12.9 dB louder (Bradley, 1994).

## *B.* Studies of Wind Turbine Noise Impacts on People

### 1. Swedish Studies

Two studies in Sweden collected information by questionnaires from 341 and 754 individuals (representing response rates of 68% and 58%, respectively), and correlated responses to calculated exposure to noise from wind farms (Pedersen and Waye, 2004; Pedersen, 2007; Pedersen and Persson, 2007). Both studies showed that the number of respondents perceiving the noise from the wind turbines increased as the calculated noise levels at their homes increased from less than 32.5 dB(A) to greater than 40 dB(A). Annoyance appeared to correlate or trend with calculated noise levels. Combining the data from the two studies, when noise measurements were greater than 40 dB(A), about 50% of the people surveyed (22 of 45 people) reported annoyance. When noise measurements were between 35 and 40 dB(A) about 24% reported annoyance (67 of 276 people). Noise annoyance was more likely in areas that were rated as quiet and in areas where turbines were visible. In one of the studies, 64% respondents who reported noise annoyance also reported sleep disturbance; 15% of respondents reported sleep disturbance without annoyance.

### 2. United Kingdom Study

Moorhouse et al. (UK Department for Business Enterprise and Regulatory Reform, 2007) evaluated complaints about wind farms. They found that 27 of 133 operating wind farms in the UK received formal complaints between 1991 and 2007. There were a total of 53 complainants for 16 of the sites for which good records were available. The authors of the report considered that many complaints in the early years were for generator and gearbox noise. However, subjective analyses of reports about noise ("like a train that never gets there", "distant helicopter", "thumping", "thudding", "pulsating", "thumping", "rhythmical beating", and "beating") suggested that aerodynamic modulation was the likely cause of complaints at 4 wind farms. The complaints from 8 other wind farms may have had "marginal" association with aerodynamic modulation noise.

Four wind farms that generated complaints possibly associated with aerodynamic modulation were evaluated further. These wind farms were commissioned between 1999 and 2002. Wind direction, speed and times of complaints were associated for 2 of the sites and suggested that aerodynamic modulation noise may be a problem between 7% and 25% of the time. Complaints at 2 of the farms have stopped and at one farm steps to mitigate aerodynamic modulation (operational shutdown under certain meteorological conditions) have been instituted.

### 3. Netherlands Study

F. van den Berg et al. (2008) conducted a postal survey of a group selected from all residents in the Netherlands within 2.5 kilometers (km) of a wind turbine. In all, 725 residents responded (37%). Respondents were exposed to sound between 24 and 54 dB(A). The percentage of respondents annoyed by sound increased from 2% at levels of 30 dB(A) or less, up to 25% at between 40 and 45 dB. Annoyance decreased above 45 dB. Most residents exposed above 45 dB(A) reported economic benefits from the

turbines. However, at greater than 45 dB(A) more respondents reported sleep interruption. Respondents tended to report more annoyance when they also noted a negative effect on landscape, and ability to see the turbines was strongly related to the probability of annoyance.

**4. Case Reports**

A number of un-reviewed reports have catalogued complaints of annoyance and some more severe health impacts associated with wind farms. These reports do not contain measurements of noise levels, and do not represent random samples of people living near wind turbines, so they cannot assess prevalence of complaints. They do generally show that in the people surveyed, complaints are more likely the closer people are to the turbines. The most common complaint is decreased quality of life, followed by sleep loss and headache. Complaints seem to be either from individuals with homes quite close to turbines, or individuals who live in areas subject to aerodynamic modulation and, possibly, enhanced sound propagation which can occur in hilly or mountainous terrain. In some of the cases described, people with noise complaints also mention aesthetic issues, concern for ecological effects, and shadow flicker concerns. Not all complaints are primarily about health.

Harry (2007) describes a meeting with a couple in Cornwall, U.K. who live 400 meters from a wind turbine, and complained of poor sleep, headaches, stress and anxiety. Harry subsequently investigated 42 people in various locations in the U.K. living between 300 meters and 2 kilometers (1000 feet to 1.2 miles) from the nearest wind turbine. The most frequent complaint (39 of 42 people) was that their quality of life was affected. Headaches were reported by 27 people and sleep disturbance by 28 people. Some people complained of palpitations, migraines, tinnitus, anxiety and depression. She also mentions correspondence and complaints from people in New Zealand, Australia, France, Germany, Netherlands and the U.S.

Phipps (2007) discusses a survey of 619 households living up to 10 kilometers (km; 6 miles) from wind farms in mountainous areas of New Zealand. Most respondents lived between 2 and 2.5 km from the turbines (over 350 households). Most respondents (519) said they could see the turbines from their homes, and 80% of these considered the turbines intrusive, and 73% considered them unattractive. Nine percent said they were affected by flicker. Over 50% of households located between 2 and 2.5 km and between 5 and 9.5 km reported being able to hear the turbines. In contrast, fewer people living between 3 and 4.5 km away could hear the turbines. Ninety-two households said that their quality of life was affected by turbine noise. Sixty-eight households reported sleep disturbances: 42 of the households reported occasional sleep disturbances, 21 reported frequent sleep disturbances and 5 reported sleep disturbances most of the time.

The Large Wind Turbine Citizens Committee for the Town of Union (2008) documents complaints from people living near wind turbines in Wisconsin communities and other places in the U.S. and U.K. Contained in this report is an older report prepared by the Wisconsin Public Service Corporation in 2001 in response to complaints in Lincoln County, Wisconsin. The report found essentially no exceedances of the 50 dB(A) requirement in the conditional use permit. The report did measure spectral data

accumulated over very short intervals (1 minute) in 1/3 octave bands at several sites while the wind turbines were functioning, and it is of interest that at these sites the sound pressure level at the lower frequencies (below 125 Hz) were at or near 50 dB(A).

Pierpont (2009) postulates wind turbine syndrome, consisting of a constellation of symptoms including headache, tinnitus, ear pressure, vertigo, nausea, visual blurring, tachycardia, irritability, cognitive problems and panic episodes associated with sensations of internal pulsation. She studied 38 people in 10 families living between 1000 feet and slightly under 1 mile from newer wind turbines. She proposes that the mechanism for these effects is disturbance of balance due to "discordant" stimulation of the vestibular system, along with visceral sensations, sensations of vibration in the chest and other locations in the body, and stimulation of the visual system by moving shadows. Pierpont does report that her study subjects maintain that their problems are caused by noise and vibration, and the most common symptoms reported are sleep disturbances and headache. However, 16 of the people she studied report symptoms consistent with (but not necessarily caused by) disturbance of equilibrium.

## V. Noise Assessment and Regulation

### 1. Minnesota noise regulation

The Minnesota Noise Pollution Control Rule is accessible online at: https://www.revisor.leg.state.mn.us/rules/?id=7030 . A summary of the Minnesota Pollution Control Agency (MPCA) noise guidance can be found online at: http://www.pca.state.mn.us/programs/noise.html . The MPCA standards require A-weighting measurements of noise; background noise must be at least 10 dB lower than the noise source being measured. Different standards are specified for day and night, as well as standards that may not be exceeded for more than 10 percent of the time during any hour (L10) and 50 percent of the time during any hour (L50). Household units, including farm houses, are Classification 1 land use. The following are the Class 1 noise limits:

**Table 1: Minnesota Class 1 Land Use Noise Limits**

| Daytime | | Nighttime | |
|---|---|---|---|
| L50 | L10 | L50 | L10 |
| 60 dB(A) | 65 dB(A) | 50 dB(A) | 55 dB(A) |

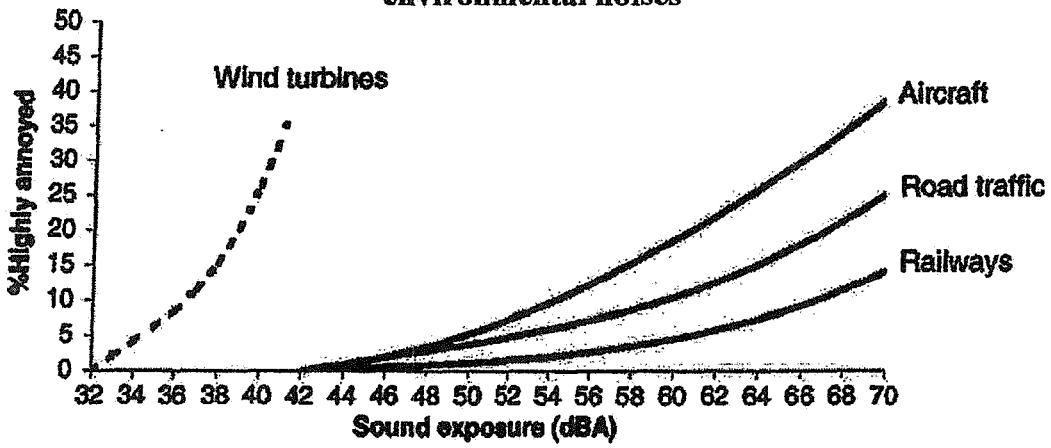
These noise limits are single number limits that rely on the measuring instrument to apply an A-weighting filter over the entire presumed audible spectrum of frequencies (20 Hz to 20 KHz) and then integrating that signal. The result is a single number that characterizes the audible spectrum noise intensity.

### 2. Low frequency noise assessment and regulation

Pedersen and Waye (2004) looked at the relationship between total dB(A) sound pressure and the annoyance of those who are environmentally exposed to noise from different sources. Figure 6 demonstrates the difficulty in using total dB(A) to evaluate annoyance. Note how lower noise levels (dB(A)) from wind turbines engenders annoyance similar to

much higher levels of noise exposure from aircraft, road traffic and railroads. Sound impulsiveness, low frequency noise and persistence of the noise, as well as demographic characteristics may explain some of the difference.

**Figure 6: Annoyance associated with exposure to different environmental noises**




Reprinted with permission from Pedersen, E. and K.P. Waye (2004). Perception and annoyance due to wind turbine noise–a dose-response relationship. The Journal of the Acoustical Society of America 116: 3460. Copyright 2004, Acoustical Society of America.

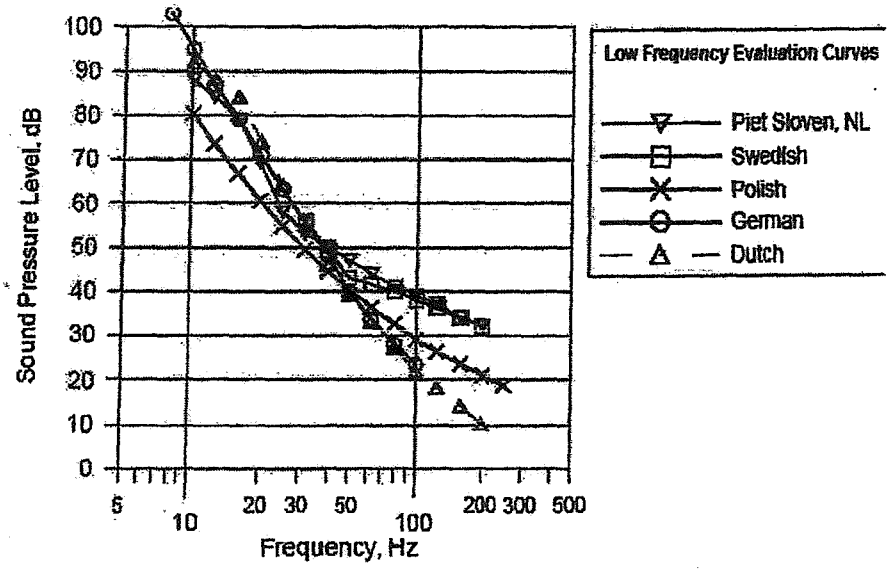
Kjellberg et al. (1997) looked at the ability of different full spectrum weighting schemes to predict annoyance caused by low frequency audio noise. They found that dB(A) is the worst predictor of annoyance of available scales. However, if 6 dB ("penalty") is added to dB(A) when dB(C) – dB(A) is greater than 15 dB, about 71% of the predictions of annoyance are correct. It is important to remember that integrated, transformed measurements of SPL (e.g. dB(A), dB(C)) do not measure frequencies below 20 Hz. While people detect stimuli below 20 Hz, as discussed in above sections, these frequencies are not measured using an A-weighted or C-weighted meter.

The World Health Organization (WHO) recommends that if dB(C) is greater than 10 dB more than dB(A), the low frequency components of the noise may be important and should be evaluated separately. In addition, WHO says "[i]t should be noted that a large proportion of low-frequency components in noise may increase considerably the adverse effects on health." (WHO, 1999)

Many governments that regulate low frequency noise look at noise within bands of frequencies instead of summing the entire spectrum. A study by Poulsen and Mortensen (Danish Environmental Protection Agency, 2002) included a summary of low frequency noise guidelines. German, Swedish, Polish, and Dutch low frequency evaluation curves were compared (see Figure 7). While there are distinctions in how the evaluation curves are described, generally, these curves are sound pressure criterion levels for 1/3 octaves from about 8 Hz to 250 Hz. Exceedance in any 1/3 octave measurement suggests that the noise may be annoying. However, note that regulations associated with low frequency

noise can be quite complex and the regulatory evaluations associated with individual curves can be somewhat different.

**Figure 7: 1/3 Octave Sound Pressure Level Low frequency Noise Evaluation Curves**




(Danish Environmental Protection Agency, 2002)

The Danish low frequency evaluation requires measuring noise indoors with windows closed; SPL measurements are obtained in 1/3 octave bands and transformed using the A-weighting algorithm for all frequencies between 10 and 160 Hz. These values are then summed into a single metric called $L_{pA,LF}$. A 5 dB "penalty" is added to any noise that is "impulsive". Danish regulations require that 20 dB $L_{pA,LF}$ is not exceeded during the evening and night, and that 25 dB $L_{pA,LF}$ is not exceeded during the day.

Swedish guidance recommends analyzing 1/3 octave bands between 31.5 and 200 Hz inside a home, and comparing the values to a Swedish assessment curve. The Swedish curve is equal to the United Kingdom (UK) Department of Environment, Food and Rural Affairs (DEFRA) low frequency noise criterion curve for overlapping frequencies (31.5 – 160 Hz).

The German "A-level" method sums the A-weighted equivalent levels of 1/3 octave bands that exceed the hearing threshold from 10 – 80 Hz. If the noise is not tonal, the measurements are added. The total cannot exceed 25 dB at night and 35 dB during the day. A frequency-dependent adjustment is applied if the noise is tonal.

In the Poulsen and Mortensen, Danish EPA study (2002), 18 individuals reported annoyance levels when they were exposed through earphones in a controlled environment to a wide range of low frequency environmental noises, all attenuated down to 35 dB, as depicted in Table 2. Noise was simulated as if being heard indoors, filtering out noise at

higher frequencies and effectively eliminating all frequencies above 1600 Hz. Noise levels in 1/3 octave SPLs from 8 Hz to 1600 Hz were measured and low frequencies (below 250 Hz) were used to predict annoyance using 7 different methods (Danish, German A-level, German tonal, Swedish, Polish, Sloven, and C-level). Predictions of annoyance were compared with the subjective annoyance evaluations. Correlation coefficients for these analyses ranged from 0.64 to 0.94, with the best correlation in comparison with the Danish low frequency noise evaluation methods.

As would be expected, at 35 dB nominal (full spectrum) loudness, every low frequency noise source tested exceeded all of the regulatory standards noted in the Danish EPA report. Table 2 shows the Danish and Swedish regulatory exceedances of the different 35 dB nominal (full spectrum) noise.

**Table 2: 35 dB(A) (nominal, 8 Hz-20KHz) Indoor Noise from Various Outdoor Environmental Sources**

| | Traffic Noise | Drop Forge | Gas Turbine | Fast Ferry | Steel Factory | Generator | Cooling Compressor | Discotheque |
|---|---|---|---|---|---|---|---|---|
| Noise | 67.6 dB(lin) | 71.1 dB(lin) | 78.4 dB(lin) | 64.5 dB(lin) | 72.7 dB(lin) | 60.2 dB(lin) | 60.3 dB(lin) | 67.0 dB(lin) |
| Noise ≥ 20 Hz | 35.2 dB(A) | 36.6 dB(A) | 35.0 dB(A) | 35.1 dB(A) | 33.6 dB(A) | 36.2 dB(A) | 36.6 dB(A) | 33.6 dB(A) |
| | 62.9 dB(C) | 67.3 dB(C) | 73.7 dB(C) | 61.7 dB(C) | 66.0 dB(C) | 58.6 dB(C) | 59.0 dB(C) | 57.8 dB(C) |
| Danish Environmental Protection Agency | 14.5 dB | 21.5 dB * | 14.8 dB | 15.0 dB | 13.1 dB | 16.1 dB | 14.0 dB | 18.0 dB * |
| Swedish National Board of Health and Welfare | 14.1 dB | 19.7 dB | 15.9 dB | 16.8 dB | 15.5 dB | 18.3 dB | 16.0 dB | 10.0 dB |

* Includes 5 dB "penalty"

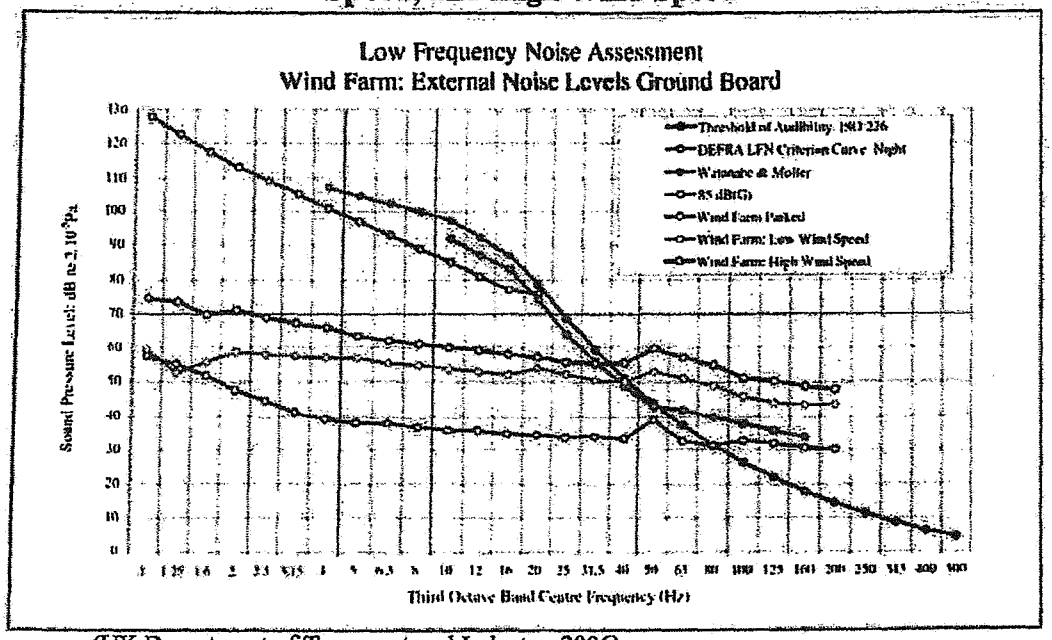
Noise adjusted to dB(lin), dB(A), dB(C) scales. Calculated exceedances of Danish and Swedish indoor criteria. (data from Danish Environmental Protection Agency, 2002)

In their noise guidance, the WHO (1999) recommends 30 dB(A) as a limit for "a good night's sleep". However, they also suggest that guidance for noise with predominating low frequencies be less than 30 dB(A).

### 3. Wind turbine sound measurements

Figure 8 shows examples of the SPLs at different frequencies from a representative wind turbine in the United Kingdom. Sound pressure level measurements are reported for a Nordex N-80 turbine at 200 meters (UK Department of Transport and Industry, 2006) when parked, at low wind speeds, and at high wind speeds. Figure 8 also includes, for reference, 3 sound threshold curves (ISO 226, Watanabe & Moller, 85 dB(G)) and the DEFRA Low Frequency Noise Criterion Curve (nighttime).

**Figure 8: Low Frequency Noise from Wind Farm: Parked, Low Wind Speed, and High Wind Speed**

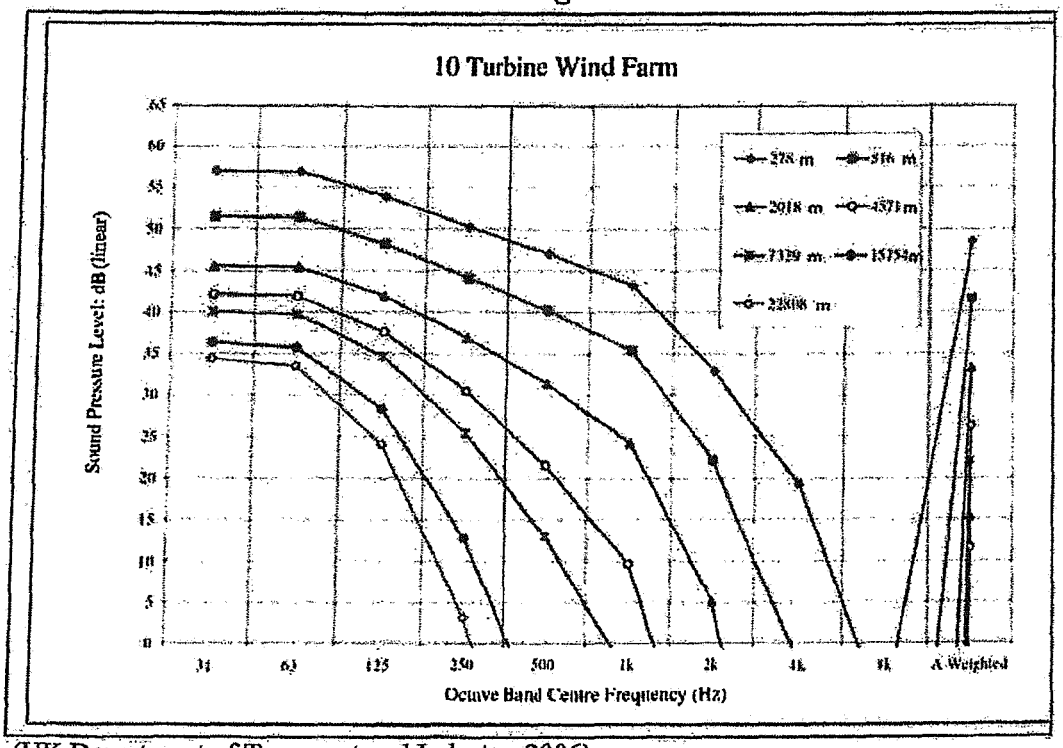



(UK Department of Transport and Industry, 2006)

In general, sound tends to propagate as if by spherical dispersion. This creates amplitude decay at a rate of about -6 dB per doubling of distance. However, low frequency noise from a wind turbine has been shown to follow more of a cylindrical decay at long distances, about -3 dB per doubling of distance in the downwind direction (Shepherd and Hubbard, 1991). This is thought to be the result of the lack of attenuation of low frequency sound waves by air and the atmospheric refraction of the low frequency sound waves over medium to long distances (Hawkins, 1987).

Figure 9 shows the calculated change in spectrum for a wind farm from 278 meters to 22,808 meters distant. As one moves away from the noise source, loudness at higher frequencies decreases more rapidly (and extinguishes faster) than at lower frequencies. Measurement of A-weighted decibels, shown at the right of the figure, obscures this finding.

**Figure 9: Change in Noise Spectrum as Distance from Wind Farm Changes**




(UK Department of Transport and Industry, 2006)

Thus, although noise from an upwind blade wind turbine is generally broad spectrum, without a tonal quality, high frequencies are efficiently attenuated by both the atmosphere, and by walls and windows of structures, as noted above. As a result, as one moves away from a wind turbine, the low frequency component of the noise becomes more pronounced.

Kamperman and James (2008) modeled indoor noise from outdoor wind turbine noise measurements, assuming a typical vinyl siding covered 2X4 wood frame construction. The wind turbine noise inside was calculated to be 5 dB less than the noise outside. Model data suggested that the sound of a single 2.5 MW wind turbine at 1000 feet will likely be heard in a house with the windows sealed. They note that models used for siting turbines often incorporate structure attenuation of 15dB. In addition, Kamperman and James demonstrate that sound from 10 2.5 MW turbines (acoustically) centered 2 km (1¼ mile) away and with the nearest turbine 1 mile away will only be 6.3 dB below the sound of a single turbine at 1000 feet (0.19 mile).

**4. Wind turbine regulatory noise limits**

Ramakrishnan (2007) has reported different noise criteria developed for wind farm planning. These criteria include common practices (if available) within each jurisdiction for estimating background SPLs, turbine SPLs, minimum setbacks and methods used to

assess impacts. Reported US wind turbine noise criteria range from: ambient + 10 dB(A) where ambient is assumed to be 26 dB(A) (Oregon); to 55 dB(A) or "background" + 5 dB(A) (Michigan). European criteria range from 35 dB(A) to 45 dB(A), at the property. US setbacks range from 1.1 times the full height of the turbine (consenting) and 5 times the hub height (non-consenting; Pennsylvania); to 350 m (consenting) and 1000 m (non-consenting; Oregon). European minimum setbacks are not noted.

## VI. Conclusions

Wind turbines generate a broad spectrum of low-intensity noise. At typical setback distances higher frequencies are attenuated. In addition, walls and windows of homes attenuate high frequencies, but their effect on low frequencies is limited. Low frequency noise is primarily a problem that may affect some people in their homes, especially at night. It is not generally a problem for businesses, public buildings, or for people outdoors.

The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on quality of life. Sleeplessness and headache are the most common health complaints and are highly correlated (but not perfectly correlated) with annoyance complaints. Complaints are more likely when turbines are visible or when shadow flicker occurs. Most available evidence suggests that reported health effects are related to audible low frequency noise. Complaints appear to rise with increasing outside noise levels above 35 dB(A). It has been hypothesized that direct activation of the vestibular and autonomic nervous system may be responsible for less common complaints, but evidence is scant.

The Minnesota nighttime standard of 50 dB(A) not to be exceeded more than 50% of the time in a given hour, appears to underweight penetration of low frequency noise into dwellings. Different schemes for evaluating low frequency noise, and/or lower noise standards, have been developed in a number of countries.

For some projects, wind velocity for a wind turbine project is measured at 10 m and then modeled to the height of the rotor. These models may under-predict wind speed that will be encountered when the turbine is erected. Higher wind speed will result in noise exceeding model predictions.

Low frequency noise from a wind turbine is generally not easily perceived beyond ½ mile. However, if a turbine is subject to aerodynamic modulation because of shear caused by terrain (mountains, trees, buildings) or different wind conditions through the rotor plane, turbine noise may be heard at greater distances.

Unlike low frequency noise, shadow flicker can affect individuals outdoors as well as indoors, and may be noticeable inside any building. Flicker can be eliminated by placement of wind turbines outside of the path of the sun as viewed from areas of concern, or by appropriate setbacks.

Prediction of complaint likelihood during project planning depends on: 1) good noise modeling including characterization of potential sources of aerodynamic modulation noise and characterization of nighttime wind conditions and noise; 2) shadow flicker modeling; 3) visibility of the wind turbines; and 4) interests of nearby residents and community.

## VII. Recommendations

To assure informed decisions:

- Wind turbine noise estimates should include cumulative impacts (40-50 dB(A) isopleths) of all wind turbines.
- Isopleths for dB(C) - dB(A) greater than 10 dB should also be determined to evaluate the low frequency noise component.
- Potential impacts from shadow flicker and turbine visibility should be evaluated.

Any noise criteria beyond current state standards used for placement of wind turbines should reflect priorities and attitudes of the community.

## VIII. Preparers of the Report:

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## IX. References


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Wind Turbine Noise and its Potential Impact on the Welfare of Codington County Residents.

My name is Patrick Lynch and I live in North East Codington County. I want to speak to you today about Wind Turbine noise and the impact it may have on the health and welfare of people in Codington County. I will summarize a recent study that you may want to take into consideration when implementing new zoning rules that you are putting in place to protect the health, welfare, and prosperity of the counties residents.

Hydro Pacific is an energy producer in Australia that has Wind Energy in their portfolio. In 2014 after receiving complaints from residents living 1,900 feet, 2,800 feet, and 5,000 feet, from their 2 megawatt turbines they decided to fund a study on acoustic noise, vibration and the impact it may have on those residents. The acoustic team placed noise detection equipment at the homes of the affected individuals and at intervals around the wind turbines. This equipment could measure both audible and low frequency (Infrasound) spectrum. Hydro Pacific kept track of wind speed, turbine speed, and turbine output. The residence were ask to keep notes on when they were experiencing sensations such as sleeplessness, restlessness, pressure, elevated heart rates, vibrations, or headaches and the severity of those sensations. With the most severe sensation resulting in the person having to leave there home. At the end of the data collection period the information was gathered and compared. What they found is that changes in turbine output corresponded with changes in audible and inaudible noise levels at the residences. Those noise level changes matched the unique audio and vibration signature that all turbines create with the turbulence from their blades and those changes also aligned with the times and dates the residence recorded experiencing their sensations.

- Turbines create low frequency (infrasound) noise and vibration that can be sensed by people and should be regulated in addition to the audible spectrum to minimize its impact on nearby residence.
- Spikes in turbine power output corresponded with times of severe negative sensations reported by residence.
- Even when turbines were shut down (not moving) they still created a noise signature during windy conditions that corresponded with residences recorded sensations.

The sensation symptoms reported by these individuals in the Hydro Pacific study match up with the symptoms from individuals at the Shirley Wind farm in Brown County Wisconsin where the county board of health declared the turbines a Public Health Hazard. They also match the symptoms listed in a summary of research done by the Minnesota Department of Health on the impact of wind turbines on health.

This is a complicated topic. Turbine projects quickly cover a large area, and standing at 485 feet they will change our landscape and impact many residents for a minimum of 25 years. Because of this I would expect the commissioners to have a deep understanding of these topics and their potential impacts. If needed I hope they would bring in independent experts on these topics to review both the data provided by any Wind Energy Systems and residents, as well as to do their own research so as to provide an unbiased opinion on appropriate setbacks and noise levels.

Questions for the commissioners.

What resources do the commissioners currently have at their disposal to help them understand wind turbine noise and its potential impact on the counties residence?

If resources exist who or what are they and when will the feedback they provide be made public?

If the commission is currently not engaged with any independent experts do you plan to work with anyone to ensure you have unbiased information on this topic?

If yes, who, when, and when will the information they provide be made public?

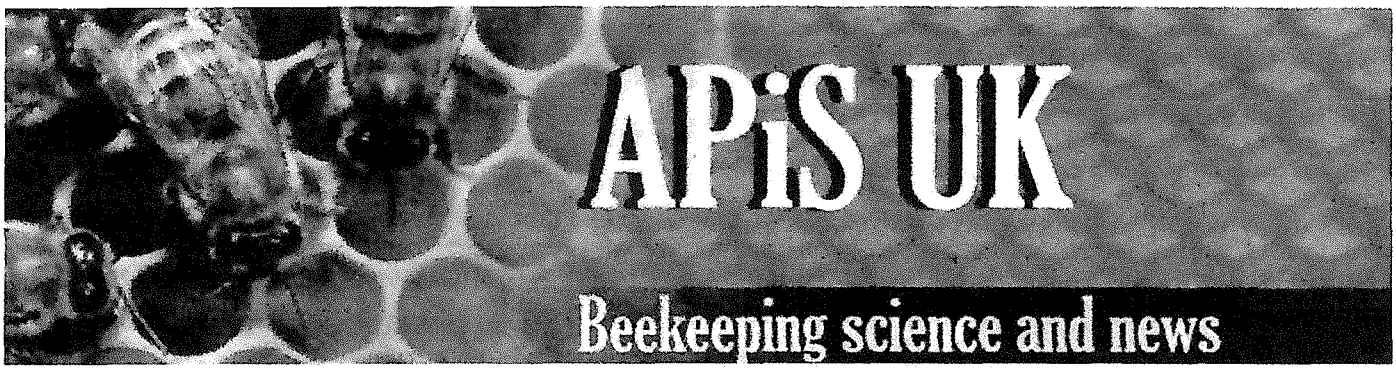
If no, why not?

References:

*Cape Bridgewater Acoustic Report (2014),* The Acoustic Group

*Duke Energy's Shirley Wind Turbines Declared a "Human Health Hazard" (2014),* Brown County Citizens for Responsible Wind Energy

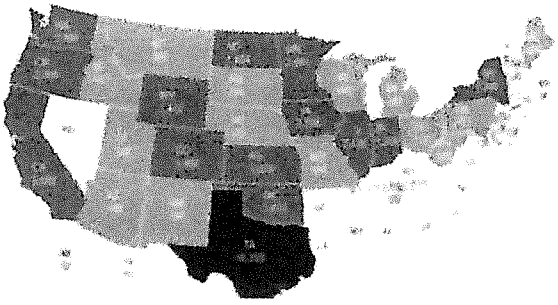
*Public Health Impacts of Wind Turbines (2009),* Minnesota Department of Health




September 24, 2013

# Research – Bees and wind turbines

It is a known to everyone that noise from wind turbines generates sound both heard and inaudible to humans. Sounds emitted that are not within the scope of being audible to humans, basically come in the form of vibrations. These vibrations can travel much further than audible sound and affect a vast area, several miles from the wind farm itself. Downwind, these low frequency vibrations can travel up to 50 KM from the source.

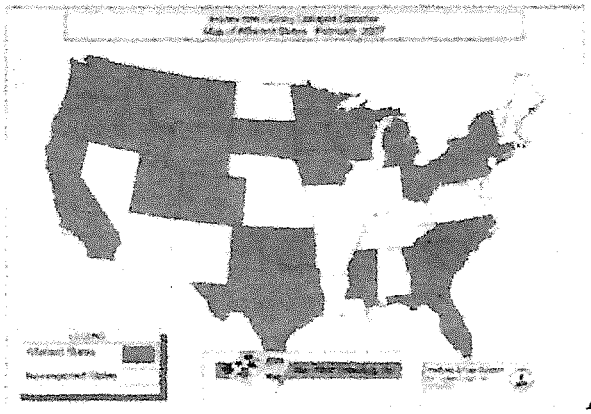


The drastic increase in the number of wind farms in the United States began between 2004 and 2005, and has blossomed to cover vast sections of the country today, as seen on the blue map below.

Interesting to note is the time frame of drastic increases of the number of wind farms from 2004 to 2005. This time frame becomes very important, because it is also the exact time when massive disappearances of honey bees began to be reported, beginning in 2005, with drastic increases in the years to follow.

The next map shows the states where the most losses of honeybees have occurred.

The orange amp below is also an interesting map, because if you didn't know better, you would believe it is another wind farm map. Although the southeast area of the United States, such as Florida does not have large numbers of operating wind farms, the honeybee disappearances in that area are attributed to weather events.



A series of hurricanes in 2004 and 2005, including hurricane Katrina virtually wiped out this area's honeybee population. With this in mind, the direct link to wind farms for the massive die off can be made.

While scientists scramble trying to find answers and offer theories ranging from a new form of virus, the earth's magnetic shift, to perhaps solar flares. It would be wise for them to look into the effects of sound vibrations emitted from wind turbines.

In a report by WH Kircher, titled Acoustical Communication in Honeybees on 02/05/1993, finds that airborne sounds and vibrations play an important role in honeybee communication. It is also coming to light that honeybees use sound vibrations to navigate, similar to sonar used by marine life and bats.

Since vast areas are within affective range of low frequency sound levels emitted by wind turbines, it becomes clear that there is a connection between low frequency sound produced by wind turbines and the disappearance of honeybees. The areas with the most disappearances of honeybees directly

correspond with that of operating wind farms.

California is second, behind North Dakota for honeybee losses and first in wind farm operations, within range of areas where honeybee colonies are located. As of 2007, most North Dakota wind farms were concentrated within a small area in the southeastern portion of the state. Since then,

wind farms have spread to many other sections of the state, and the resulting losses of honeybees will most likely increase as well.

On a world scale, areas of honeybee disappearances does correlate with operating wind farms in particular regions. It isn't enough that the wind industry continues to operate under the guise of being a renewable energy source that will help in getting us off fossil fuel, when in reality they use more fossil fuel than they will ever produce.

The sad fact is this industry is only responsible for degrading our countryside with useless spinning towers. While the building and operations of the wind farms are killing millions of endangered bird species, raping pristine land and turning it into nothing more than a cluttered mess of steel and fiberglass. Turbines are destroying the natural habitat of wildlife in such areas. It seems now, that it may be responsible for the near destruction of the world's honeybee population.

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The above has been taken directly from the www.ufodigest.com website and does give room for thought on the matter. To see what a research consultant says about this aspect of possible bee destruction, let's take a look at what Bio3 says about the matter.

Bio3 is a company recognized as a national leader in biodiversity consultancy, research and information systems. It has been awarded the title of SME Leader in Portugal in 2009, 2010, 2011 and 2012. In 2011 Bio3 was considered one of the 174 most innovative SME's operating in Portugal and was integrated in the COTEC SME Innovation Network.

Founded in 2005, Bio3 achieved a solid growth rate and is currently a national reference operating in its market. During the first 7 years of existence, Bio3 developed the biological section of over 400 projects, mostly related to environmental assessment, post-evaluation, environmental management and planning. Bio3 also executes applied research studies. They are experts on Ecological Baseline Studies and Biodiversity Monitoring Surveys, with an emphasis on renewable energy projects. Our clients include big Portuguese companies, such as EDIA, EDP Renewables, ENEOP2, ENERSIS, GALP Energia, GENERG, IBERWIND, REN and Ventinveste.

From day to day experience and knowledge of bee behaviour and ecology serious concerns are arising concerning to potential negative impacts of wind farms on bees derived from several effects,

such as the noise, stray voltage, air pressure changes and turbulence and electromagnetic field caused by the turbines.

Some American apiarists have shown concern by the shadowing, flashing, strobing effect from the blades, since it lasts 2 to 3 hours a day for 2 to 3 weeks in spring and fall when the sun comes up. They fear that the bees would either become disoriented or irritated by the effect. Other concerns of these apiarists were the "thumping noise" from the blades and the effect of "stray voltage" to the bees.

Wind Turbine Meeting Notes.....May 28, 2013 Boone County Zoning Meeting

My name is Ted Hartke. I am a professional engineer and professional land surveyor, and I own Hartke Engineering and Surveying, Inc. My dad, Phil, and my brother, Dave, are both farmers. As a land surveyor, I know how emotional and protective people are about their land and the rights they have to get the most out of their property. This wind farm issue is very difficult to deal with, and I have an important story to tell you.

I live in the center of the InvEnergy California Ridge wind farm located in Vermilion County, Illinois, consisting of 138 turbines rated at 1.6 megawatts each and being 495 feet tall.

Before our project started, and throughout its construction, I had no issues with my county's decision to create our existing wind industry ordinance including all of the details within it regarding setbacks or other matters. I did not know or worry about noise pollution. There had been some negativity about noise, so during the summer of 2011, I parked under a wind turbine near Bloomington Illinois on our way to Phillip's church camp. I turned off the car, and myself, my wife, and my kids all got out to walk around and look at things. I could hear light wispy air "whooshing" sounds. I could hear a tractor in a field a mile away and also birds chirping about as loud as the blades' air disturbance. I thought I had very little to worry about the noise from turbines about to be constructed near my home in Vermilion County.

We managed to get through the dust, traffic, construction noise while our road was reconstructed in front of our property. It was exciting to see the huge turbine components hauled past our house. For me, things were friendly between me, the construction crews, and the wind farm representatives. Everything was "just fine." We thought we had lived through the worst part of the project.

In January, our noise problem began. We had a couple bad nights of engine whining noise. We thought we might get used to it....sort of like people become accustomed to living near busy highways or train tracks. However, our noise was lasting all night long, kids were waking up numerous times every night. It was totally unexpected....a complete shock. We were unaware of how the noise was going to change our lives.

I have personal first-hand knowledge of and expert witness testimony as follows:

1.) Wind turbines will wake you up at various times. It is impossible to get healthy sleep.
2.) The engine "whining" or "humming" noise is very disturbing and stressful. This low frequency noise penetrates your house, and there is no place where you can go inside your house to escape it. (OUTSIDE your house, the noise doesn't seem so bad. INSIDE your house, the noise is unbelievable.)
3.) There were mornings when I put clothes on my kids and shoved them out the front door when they were sleep deprived and not ready for a full day of school. Wind turbines are hard on your children.
4.) Our son already had a pre-existing sleep problem and we have been seeing a specialist for ~ 2 years now. Up until the turbines went live, Phillip's symptoms had been improving dramatically and in early January at his last check up with the specialist we had discussed weaning him off his sleep meds. Since the turbines turned on in January, Phillip's symptoms have been gradually returning/becoming worse. Since the developer will not turn the turbines off at night anymore,

we had a very bad noise event at our home on May 11. This was the first time Phillip complained of dizziness from the noise. Later in the evening he started vomiting. It was a really miserable night for the entire family.

The Dr. made some suggestions to help cut down on the noise (special ear plugs) and to cut down on the vibrations caused by low-frequency sound (shock absorbers under the legs of his bed). He also increased the dosage of a medication our son was already taking due to his sleep disorder in the hopes that this would allow Phillip to have greater periods of uninterrupted sleep.

5.) I have argued with my wife at 2:30, 3:30, 4:30, and 5:30 in the morning. Wind turbines are hard on your marriage.

6.) Being exhausted severely impacts your work performance and stresses relationships with employees and co-workers. Wind turbines are hard on your careers.

7.) I have embarrassed myself and have cried in front of my peers while describing the insurmountable problem my family is experiencing with this noise. Wind turbines are hard on your public image.

8.) Standing up and requesting assistance to solve this problem required me to put pressure on my county board representatives. My ties with community leaders have been severed....hurting my small business. Just like any other person, I had to put my family first, and I put my business at great risk while going up against neighbors, public officials, fellow citizens, and construction companies who hire my firm to do engineering and survey work. I decided to come up to your community tonight because I feel a heavy burden and responsibility to other men, women, and children who will suffer from future wind turbine placement.

9.) Between January and May, I was able to convince InvEnergy to shut down turbines approximately 50 times during nighttime noise events. During that time, I contacted contractors and researched ways to soundproof my home. I was rejected by several contractors who did not believe they could fix my problem. Soundproofing against low frequency noise is extremely difficult. My home had too many large windows, a fireplace flue, 5 dormers, vaulted ceilings in the living room and upstairs bedrooms. On Saturday, May 11$^{th}$, my request to turn off one of these turbines was declined. We were awake all night with high levels of wind turbine noise. We cannot live this way. This wind turbine noise is torture.....torture is what you do to terrorists, not my children!

10.) I have researched and studied soundproofing improvements to my home. To get some relief from soundproofing, it will require new windows, doors, exterior sheeting, wall insulation, and roofing insulation. To get the insulation completed will require removal of existing windows, siding, sheeting, and a build-up of roofing materials. The approximate cost to soundproof my home in this manner is $150,000.

11.) My wife and I were very stressed and needed help....we decided that this horrible noise should be documented and reported because of the upcoming discussions for the county board and also to build records to justify our soundproofing repairs with InvEnergy. A Vermilion County Sheriff's Deputy was at my house, in my bedroom, to listen to the noise at 2 AM. Our Mother's Day holiday was ruined.

12.) I emailed the entire county board an open invitation to come to my home, spend time inside my bedroom where I sleep. They have declined to address my problem. Unfortunately, this noise problem will grow and affect more Vermilion County citizens as more turbines are constructed. For

as long as you allow wind turbines to be constructed within 2,500 feet of homes, you will have noise complaints from neighbors. You will become a target of controversy, complaints, political challenges, hatred, and lawsuits.

13.) It is not too late for your community to create an ordinance that protects you from the trouble I am living through.

In conclusion:

I am requesting that, before you vote on this, think about the resident like me who will invite you to stand in their bedroom to listen to the noise. While you are there, he or she will introduce you to their precious children. You will have the opportunity to sit down and discuss with the kids about how it makes them feel. While there are few things worse than a sick or injured child, I believe that hurting them by allowing wind turbines to be constructed too close to their homes is unforgivable.

If you still want to proceed with allowing wind farm development under this weak ordinance, then maybe you should think about how stressed you will be when your names are listed on the lawsuit for voting in support of the inadequate setbacks and no way to enforce noise violations. Now is your opportunity to stop and think about it. If a wind farm chooses not to enter your county based on noise restrictions, then you know that they do not have the capability to fulfill their "good neighbor" promise. Put your noise restriction in writing and include a corrective action to address it such as night-time turbine shutdown upon a legit noise complaint.

Don't be afraid to change your mind. When I have said "no" to my kids, my employees, my clients, and my family, they went through a short period of unhappiness, but I always wanted to do what was fair to everyone involved and still be able to provide for them. You will earn my respect and the respect of wind company representatives.....they may not like it, but they will respect it. It is OK to change your mind in the course of exploring all of the avenues and throughout the presentation of facts. Opening the door to the first wind farm development is like selling the business or the home farm.....you only get one chance at doing it right. Try to learn from other's mistakes and make adjustments accordingly. Learning from your own mistakes is a harder way to go about it.

When you became a board member, I hope it was to serve your community. If you are seated at this table, and your interests are about self-preservation for you and your friends, then you are in the wrong room.

Although my five minute time allowance is up, I would be pleased to give you more detailed feedback and information so that you may make the best possible decisions.

Thank you for allowing me to speak to you tonight. I hope that sharing my experience helps your community.