Zoning and Public Safety

At a minimum, any zoning effort in any county should be directed at the *common health, safety, and welfare of its citizens.*

Zoning may address many issues such as waste management, adult entertainment industry, restaurant codes, sewers and drainage, etc.

While the development of wind power in general is a good thing, it must be done within the confines of existing communities in a manner that does not compromise the *health, safety, or welfare of that community.*

Issues to address via zoning regarding turbines:

- Doppler radar
- Property line setbacks
- Noise
- Shadow flicker
- Medical effects
- Property value guarantees
- Proximity to schools
- Decommissioning
Doppler Radar and Turbines
Doppler Radar
• Radar transmitter sends out microwave radiation in all directions
• Those microwave signals are reflected back by weather systems
• The frequency of the reflected wave detected at the radar tell us it’s position and velocity at that location, at that time
There is a two-fold effect that turbines have on Doppler systems:

- In the line of sight of the doppler station, each turbine reflects back the microwaves, thereby eliminating any opportunity to detect weather patterns in the same direction—including tornadoes.
- Turbines move a great deal of air, so that air poses as its own weather pattern, creating a great deal of clutter in the Doppler radar imaging—including false positives.
Zones of Compromised Doppler:

- No Build Zone
- Mitigation Zone
- Consultation Zone
- Notification Zone

The foremost experts on the effects of wind turbines on Doppler radar systems are in the Radar Operations Center of the NWS. Their work has led them to designate 4 zones that characterize the levels of compromise in data from Doppler radars due to the presence of wind turbines.
Zones of Compromised Doppler Radar

• The **No Build Zone** is a 4 km (2.5 mi) radius red circle around the radar. The ROC is requesting that developers do not build turbines in the RLOS within 4 km of the radar due to the potential for serious impacts, including turbine nacelles blocking the radar beam and potential receiver damage if sited in the radar’s near field.

• The **Mitigation Zone**, orange areas on the map, is the area between 4 km (2.5 mi) and 36 km (22 mi) where a 160-meter turbine would penetrate more than one elevation angle. Wind farms sited within the mitigation zone have the potential for moderate to high impacts. Therefore, the ROC will work with the developer to get detailed project information, do a thorough impact analysis, and discuss potential mitigation solutions.

• The **Consultation Zone**, yellow areas on the map, is the area between 4 km (2.5 mi) and 36 km (22 mi) where a 160-meter turbine only penetrates the 1st elevation angle or when a 160-meter tall turbine will penetrate more than one elevation angle between 36 km (22 mi) and 60 km (37 mi). Due to the increased potential for impact to operations the ROC is requesting consultation with the developer to track the project and acquire additional information for a thorough impact analysis. (The 4.2 MW Vesta V150 turbine measures 241 m, or 791 ft tall)

• The **Notification Zone**, green areas on the map, is the area between 36 km (22 mi) and 60 km (37 mi) where a 160-meter tall turbine will only penetrate one elevation angle, or any area beyond 60 km that a 160-meter tall turbine is in the RLOS. Since impacts are typically minimal beyond 60 km and workarounds are available for penetration of only one elevation angle, the ROC is making consultation optional; however, NOAA would still like to know about the project.
NTIA Analysis (National Telecommunications and Information Administration)

• Prior to the installation of turbines, an NTIA analysis is conducted to determine the wind farm’s effects on air traffic, telecommunications, radar systems, etc. (NTIA, FAA, NWS, etc)

• The result of which is the designation of the aforementioned zones surrounding a doppler installation.

• The National Weather Service can make recommendations to the wind farm developer, but those recommendations are not legally binding and, in effect, the turbines could be built where the developer pleases relative to the Doppler installation.

• Hence, the need for an ordinance...
Worst Case Scenario: Taylorville, IL on 12/1/2018--Tornado sighted by Doppler radar disappears when passing through wind farm reappears miles later after emerging from wind farm. FYI, this time lapse was 20 minutes!
Recommended Ordinance Language regarding Turbine installation and our Doppler radar:

A) Prior to project approval, an NTIA analysis of the proposed project must be conducted by the National Telecommunications and Information Administration and made available to the public via submission to the County Commissioners.

B) To ensure the safety of Gibson County residents and to ensure accurate and timely early warning of inclement weather provided by the Doppler Radar system located in Owensville, IN, no wind turbine structures may be located within the designated No-Build, Mitigation, or Consultation Zones, as determined by the NTIA analysis submitted to the County Commissioners.

This language renders the safe placement of wind turbines at a distance from the Doppler installation that is determined by an objective, outside agency, rather than by developers or industry standards that are motivated only by profit.
Setback Distances and Wind Turbines

- **Setback** is the required distance from the turbine base to any defined location (property lines, homes, roads, schools, etc.). The purpose of having a setback is related to safety risk, noise problems, light flicker, electromagnetic interference, ice throw, etc.

- E.ON proposed a setback of 1250 ft. from occupied dwellings, and 550 ft. from non-occupied buildings or property lines including roadways

- There are MANY reasons this proposed setback is **unacceptable**, as outlined in upcoming slides.

- In Indiana alone, many counties have outright banned Industrial Wind Turbines for some of the same concerns – these counties include Allen, Boone, Fulton, Marshall, Wayne, and Wells. Pulaski and Tippecanoe counties are currently working on bans.

- Other counties in Indiana have put ordinances in place that require specific setback distances – Wabash and Noble counties have 3960 ft. setbacks.

Sources: E.ON handouts at Gibson Southern High School meeting in 2018 (Q&A handouts)
The Rensselaer Republican – September 2018
Examples of issues related to insufficient Setback Distances:

- Safety – The risk of projectiles flying off high speed turbine blades is not as low as you might think
  - The Wildcat Wind Project Northeast of Indianapolis suffered 4 structural failures between 2012 and 2016, with two blade failures within 2 months.

- Windpower Monthly published data indicating 3800 blade failures will occur annually as of 2015

- The Vestas turbine manual in 2007 defined the safe setback distance as 500m, or 1640 ft based on safety risk alone, based on a much smaller turbine than proposed for Gibson County:

  DANGER FALLING TURBINE PARTS In case of a fire in the nacelle or on the rotor, parts may fall off the wind turbine. In case of a fire, nobody is permitted within a radius of 500 m from the turbine. (See Exhibit 3)

- If a runaway operation should occur, the plant must be evacuated immediately by running upwind, and access to the surrounding area in a radius of at least 500 metres must be restricted.

Sources:
- https://www.windpowermonthly.com/article/1347145/annual-blade-failures-estimated-around-3800
What should determine Setback Distance?

• Science of projectile motion and possible blade throw
  • Based on data and evidence, not arbitrary wishes of developer
• Amount of noise as a function of distance
• Shadow Flicker as a function of distance

• Not developer recommendations
  • Based on profit potential
• Not “industry standards”
Proposed Turbine size, and design, and installation

• Specific turbine model have not been selected, but E.ON has stated the power range to be between 2.2 and 4.2MW, and has also mentioned Vestas as the possible manufacturer.

• MW (megawatt, or million watts) is the measure of max power generated by the turbine during ideal conditions. Regardless of power output in the 2.2-4.2MW range, the height can be anywhere from 590-790 feet from base to top of blade at highest point, with no contractual height limit.

• The Max Turbine RPM (revolutions per minute) are generally 12-16 RPM making the speed at the tips of the blades over 200 MPH on most options for our area – an important factor when we discuss safety considerations, as this speed increases with blade length.

• Each blade assembly weighs 36 tons on a GE 1.5MW turbine, a rotational weight of nearly 20 cars!

• Installation of a turbine is highly damaging to roadways, field tiles, and surrounding areas due to the heavy equipment required (cranes, semi trucks, etc.)

Sources: E.ON handouts at Gibson Southern High School meeting in 2018 (Q&A handouts)
https://www.windpowermonthly.com/article/1437274/vestas-scales-42mw
Determining Setback Distances

- Safety – In 2011, Wind Energy partnered with the Georgia Institute of Technology’s aerospace engineering department, and University of Alabama’s Mechanical and Aerospace Engineering departments to publish a research article titled “A Method for Defining Wind Turbine Setback Standards.” [Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/we.468]

- The following graphics from this study shows the range/spread of turbine blade fragment throws:

Using the research from this paper, a Vestas V150 turbine with a rotational speed of 12 rpm and a blade radius of 75 m would have a 100% safe throw distance of 2600 m!

There are documented blade fragment throw distances of over 1 mile during extreme cases of turbine blade failure. [Caithness]

Sources:  
http://camm.gatech.edu/images/7/7a/Wind_Turbine.pdf  
http://www.caithnesswindfarms.co.uk/AccidentStatistics.htm
Examples of issues related to insufficient Setback Distances

• **The same study concluded:**

  “Wind turbine setback standards designed to protect people, property and infrastructure from impact by thrown blade fragments play an important role in wind farm planning and can often be a determining factor in the number of turbines that can be placed within a given parcel of land. Given the critical importance of these regulations, there is a desire to develop setback standards based on a physical model of blade throw rather than arbitrary rules of thumb. First, a physical model for full or partial blade throw based on rigid body dynamics was described. This model, coupled with Monte Carlo simulation techniques, was used to **simulate tens of thousands of blade throws** for three example wind turbines of varying size. **It was shown that typical current setback standards do not provide adequate protection in most cases.** Then, the importance of fragment release velocity in determining maximum throw distance was analytically demonstrated, and its effect verified through analysis of Monte Carlo results. Normalizing throw distance by fragment release velocity yielded a near-linear relationship between this normalized distance and the percentage of impacts that lie within this distance from the turbine. A final example used this relationship to determine a proper setback distance for an example turbine based on an acceptable level of risk. **Setback development using this methodology allows regulators to mitigate risk using valid engineering analysis rather than arbitrary rules that provide inconsistent and inadequate protection.**”

Sources: [http://camg.gatech.edu/images/7/7a/Wind_Turbine.pdf](http://camg.gatech.edu/images/7/7a/Wind_Turbine.pdf)
What is Trespass Zoning?

- Trespass zoning is a situation where “non-participant” land owners have Property Rights effectively violated by the safety evacuation range being projected onto their property. This limits future uses, and in many cases puts people at a safety risk when present in these areas on their own property.

- This situation is avoided with safety setbacks measured from PROPERTY LINES. Keep in mind, the 1640 ft. setback suggested by RWE is the MINIMUM requirement from Vestas for turbines much smaller than those proposed for Gibson County, with engineering studies suggesting increased setbacks as a safety requirement.

- Setback distances for turbines should be from property lines, not residences.
Recommended Ordinance Language regarding Turbine installation and Setbacks

To protect property, structures, and landowners from turbine throw, no turbine may be located less than 4.5 times the height of the turbine, including the blade at its highest point to any Non-Participating landowner property line.

Additionally for all turbine installations, requirements include:
- 2 mile setback from incorporated town limits.
- 2 mile setback from clearly defined unincorporated town
- 2 mile setback from all schools
- 2 mile Property Value Guarantee for residents who decide to sell their home and leave

Note: The 4.5x value was reached by calculation from the aforementioned paper using a blade radius of 75 m and a nominal rotational speed of 12 rpm.

Sources: [http://camm.gatech.edu/images/7/7a/Wind_Turbine.pdf](http://camm.gatech.edu/images/7/7a/Wind_Turbine.pdf)
Noise and Wind Turbines

• Wind turbine noise concerns are likely the most difficult to explain and discuss due to hundreds of reports on both sides of the argument. There are reports suggesting noise is simply an annoyance, and reports suggesting significant health risks related to cardiovascular issues, insomnia, etc.

• In the legal agreement with the Wind company, there is the following statement: “Owner acknowledges that there may be risks associated with windpower energy generation, including but not limited to electromagnetic fields, shadow, stray voltage, ice throw and health effects potentially associated with flicker, noise and air turbulence, and owner knowingly waives all claims related to such risks.”

• Two key facts for Posey and Gibson Counties, according to a University of Notre Dame “Wind Turbine Acoustics” course [AME 40530], “Wind turbine noise is more commonly a concern at lower wind speeds.” And, “In general, sound pressure levels [increase] with the rotor diameter.”

• There are literally hundreds of reports of complaints from citizens who live around Industrial Wind Projects, often resulting in lawsuits and people moving from their homes to avoid the exposure to noise issues.

Source: https://www3.nd.edu/~tcorke/w.WindTurbineCourse/Acoustics_Presentation.pdf
Turbine Noise Overview

• At E.ON’s informational meeting at North Posey High School on June 26th, 2019, one of their paid experts covered noise at great length. During this presentation, an attempt to discredit the ‘Low Wind Speed/Higher Noise Concern’ topic mentioned in the Notre Dame course

• After further research, we found additional credible supporting information around this concern

• Sandia Labs, one of the country’s largest research and engineering laboratories, issued a Study documenting this topic among others, including wind turbine noise reduction technologies

• In this study, the following statement was made regarding turbine blade noise:

“...overall sound pressure levels were decreased by an average of 3.2 dB over a range of wind speeds from 6 m/s to 10 m/s on a 2.3MW test turbine......However, the noise reduction was dependent on wind speed, and the lowest reduction was near the lower part of the wind speed range. This is problematic, since wind turbine noise is often most perceptible at low wind speeds when the background noise from the wind is relatively low and ineffectively masks the turbine noise.”

Source: https://www3.nd.edu/~tcorke/w.WindTurbineCourse/Acoustics_Presentation.pdf
Turbine Noise Overview, continued...

- See the Indiana Wind Speed map to right:
- This map shows the wind speeds in Posey and Gibson counties to be far lower than in all areas currently occupied by Industrial Wind Turbines
- The correlation between greater noise concern and lower wind speeds is an obvious problem in terms of the proposed project in our specific area of Indiana.
- The same goes for Illinois – there are no Industrial Wind Projects in operation where wind speeds (and more noise concern) are consistently this low.

Sources:  https://windexchange.energy.gov/maps-data/40
https://windexchange.energy.gov/maps-data/37
Turbine Noise Overview, continued...

- Keeping in mind the proposed turbines sizes (MW output) are possibly the largest in the state, this factor needs consideration related to noise output and risk.

- The “type” of noise is also a critical factor. The low frequency component of the turbine noise has been well documented to be the main problem in terms of health/sleep/annoyance issues in previous Wind Project installations.

- In particular, the low frequency noise has a much greater ability to travel through houses, schools, etc. (think about bass in car stereos), making this type of noise much more intrusive than road traffic noise or other ambient noise.

According to a Danish study in 2010:

“The results confirm the hypothesis that the spectrum of wind-turbine noise moves down in frequency with increasing turbine size. The relative amount of emitted low frequency noise is higher for large turbines (2.3-3.6 MW) than for small turbines (≤ 2 MW). The difference is statistically significant for one-third-octave bands in the frequency range 63-250 Hz. The difference can also be expressed as a downward shift of the spectrum of approximately one third of an octave.”

From the same study:

When discussing "future" installations of increasing turbine size, they calculated “a turbine of double size emits more than the double sound power....." "It must be anticipated that the problems with low-frequency noise will increase with even larger turbines."

- In late 2018, the World Health Organization (WHO) acknowledged wind turbine noise as a possible health hazard.

Sources:

Turbine Noise Overview, continued...

Wind turbine noise concerns from school superintendent:

- See the letter to the right written by an Illinois school superintendent after an industrial wind project went online in his school district. This should be a serious concern for everyone in our community regarding the validity of the noise/health relationship with these turbines. During the approval process the superintendent was neutral. After the installation, he realized the negative impact and voices this in the following letter:

Source: http://www.windaction.org/posts/38759-illinois-school-superintendent-letter-turbine-noise-creating-health-problems-for-students#zXb2hWwX1M
Audible vs. Inaudible Sound

• Audible sound ranges from low pitch to high pitch 20-20,000 Hz
  • This is the range of sound the human ear can hear

• Inaudible sound ranges from 0-20 Hz
  • While the human ear cannot hear this range, the energy from the sound source is still present and can be perceived by the human body
  • Research has shown that inaudible sound can induce neural activity in the brain increasing the risk for seizure for those prone to it.
Recommended Ordinance Language regarding Turbine installation and Noise Levels

At any Non-Participating Landowner's residential lot, public school, public library, or recreational area within one-half mile of the project boundaries, the audible (20-20,000 Hz) and inaudible (0-20 Hz) sound pressure levels as a result of the sound emitted by the project shall not exceed either, the lesser of 40 dB(A) for audible sound and 85 dB(G) for inaudible sound or the Ambient Baseline Sound Pressure Level of the project at Critical Wind Speeds. Audible sounds will be measured in A-weighted units and inaudible sounds in G-weighted units. The Ambient Baseline Sound Pressure Level, if used, shall be determined by a baseline acoustic emissions study conducted by the County Commission and funded by the Applicant. Measurement of sound and vibration levels shall be conducted by certified acoustic professionals using equipment calibrated to NIST standards for sound measurement and in compliance with all other applicable county, state and federal regulations.
Summary

• Ordinance to protect our Doppler Radar accuracy and integrity

• Ordinance to protect our homes with adequate setbacks determined by science and data, not developer recommendations or industry standards

• Ordinance to protect our way of life by maintaining our rural areas with respect to noise pollution and its negative health effects
Turbine “Shadow Flicker” Risks

- In the legal agreement with the Wind Project company, there is the following statement: “Owner acknowledges that there may be risks associated with windpower energy generation, including but not limited to electromagnetic fields, shadow, stray voltage, ice throw and health effects potentially associated with flicker, noise and air turbulence, and owner knowingly waives all claims related to such risks....”

- Wind companies will argue they perform “flicker studies” to minimize the impact to the community, but there are many documented cases even at great distances where this issue goes on without resolution.

- Based on the possible layout of turbine locations in Posey and Gibson county, many homes and properties would be within the “flicker zone” of turbines installed on properties already signed into contracts.

- According to a flicker study performed for a proposed wind project in Alabama:
  “At distances less than 1000 meters, shadow flicker may be more noticeable.”

That’s 3280 feet - To make matters worse, the proposed turbines in the study were significantly shorter than those proposed in Posey and Gibson county. Taller turbines = greater risk and distance of projected shadow flicker.

Recommended Ordinance Language regarding Turbine installation and Noise Levels

The maximum turbine shadow flicker experienced at a Non-Participating landowner dwelling shall be zero. Measurements to assess shadow flicker shall be for all Non-Participating landowner dwellings located within 0.6 miles or 3,168 feet of a turbine. If shadow flicker will exceed this level, then a shadow flicker mitigation plan must be submitted by the Applicant for each affected Non-Participating dwelling which shall provide for zero shadow flicker for the affected Non-Participating dwelling.
Property Value Issues

• Similar to the Noise issue, Wind Project companies will argue that Property Values are not affected negatively by Industrial Turbine installations, siting a study performed by the Lawrence Berkeley National Laboratory and supported by Office of Energy Efficiency and Renewable Energy (Wind and Water Power Technologies Office) of the U.S. Department of Energy under Contract No. DE-AC02-05CH1123

• While the study deserves review, there are clear conflicts of interest in who drove the study relative to their support of Wind Energy

• Upon further research, many property value concerns are found:

McCann Appraisal performed a study in Tipton County, IN showing evidence of a negative value impact, saying:

“A wind farm creates an easement over neighboring non-participating properties that impairs the value, or a regulatory taking of private property rights, or uncompensated taking.” ".. The average value loss started dropping within 2 miles of the wind farm, starting at 25 percent and going up."

http://www.journalreview.com/opinion/article_7bf96384-4d7a-11e8-9b99-97a87f0c4ab.html
https://www.osti.gov/servlets/purl/1165267
Weather Radar Performance issues

• Meteorologist’s comments prove Wind Turbines block weather radar:

Just a little over 2 years ago, a dangerous tornado ripped through portions of Posey and Gibson County...many buildings were lost but lives were spared thanks in part to recent advances in weather radar technology that allow forecasters to pinpoint tornado locations and possible paths, giving warning to those who may be in danger. This was the second tornado to pass through this area in the past 17 years, with many other possible tornados tracked during this time period. The paths these two tornados took passed over land that has recently been leased to E.ON or extremely close to it.

• In DeWitt County (Illinois) a local meteorologist on Channel 25 (WEEK channel) stated the following while tracking a tornado:

“This has been a little difficult to keep track of the last little bit here because there are a lot of wind farms in the area and those wind farms really interfere with the rotation...the velocity aspect of radar...[it] can kind of be problematic and that’s been the case lately....”

In another video clip, the meteorologist is heard saying “...those wind farms actually mess with our Doppler velocity returns that get shown on radar...those moving wind turbines...so likely the rotation could very well be more significant than we are seeing right now.”

Video clips including quotes on next slide
Weather Radar Performance issues, continued...

- Quotes from NOAA’s National Weather Service:

  “Rotating wind turbine blades can impact the radar in several ways. Wind turbines can impact the NEXRAD radar base data, algorithms, and derived products when the turbine blades are moving and in the radar’s line of sight (RLOS); and, if turbines are sited very near to the radar their large nacelles and blades can also physically block the radar beam or reflect enough energy back to the radar to damage the radar’s receiver hardware.”

  “Impacts increase greatly as wind turbines are sited closer to the radar, especially within 18km (assuming level terrain), as radar operator workarounds become more difficult.” [18km=11mi]

  “Wind turbine clutter has not had a major negative impact on forecast or warning operations, yet. However, with more and larger wind turbines coming on line, radars in some parts of the country will have multiple wind farms in their line of sight. Cumulative negative impacts should be anticipated – which, at some point, may become sufficient to compromise the ability of radar data users to perform their missions.”

Source: https://www.roc.noaa.gov/WSR88D/WindFarm/TurbinesImpactOn.aspx
Decommissioning Concerns

- E.ON is proposing to cover decommissioning costs only after 20 years of wind energy production.
- If the project fails for any reason within the first 20 years (bankruptcy, equipment failures, wind speeds not adequate...) E.ON would not cover the complicated decommissioning process of the turbines.
- This is a risk the county and its residents should not burden – some counties now require 100% UP FRONT bonding from the wind company to ensure complete decommissioning is covered before any project is started.
- Decommissioning includes turbines, concrete base, utility lines, substations, access roadways, etc.
- Recommendations are as high as $250,000 required per turbine system up front to cover all decommissioning costs.
- According to the law link below discussing decommissioning:
  - Source: https://digitalcommons.law.ou.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1079&context=onej

Another question that needs to be answered is who has the responsibility to bring the turbines down. Should this job be left to the landowner? Or is it a more practical approach to require the developer to decommission the turbines at the end of their useful life? Typically it is the developer/owner of the turbines with the responsibility to bring them down. For those states that have passed legislation on the matter, it is unanimous that the developer of the wind farm is in the best position to decommission the projects.
Other issues

- Electromagnetic field issues
- Uncontrolled field fires
- Ice throw from turbine blades in the Winter months
- Stray voltage
- Angry neighbors and the resulting loss of “community”
- Population decreases
- School enrollment decreases
- Road condition problems after they are initially repaired
Overview of Proposed Project Requirements

• Increase setback to a minimum of 4X height of turbine (base to tip) to any non-participating property line, BASED ON SAFETY ALONE. See slides 8-12 for supporting data/documentation.

• In combination with the other factors discussed in this presentation (noise issues, light flicker, etc.) it should be mandated to extend the minimum setbacks from any property lines to at least 8X height of turbine, in line with the 10 other Indiana counties who have standards at least this stringent. See slides 13-21 for supporting data/documentation supporting this recommendation.

• There is not a magic number or calculation to determine the exact appropriate setback – these recommendations are based on real concerns, supported by data and actual experiences from people who live in/near wind projects, or from people who have been involved in the approval processes. Our recommendation is based on this data, in combination with the other real concerns such as weather radar performance, division of the community, etc. as described in this presentation.

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• 2 mile setback from incorporated town limits.
• 2 mile setback from clearly defined unincorporated town 2 mile setback from all schools
• 2 mile Property Value Guarantee for residents who decide to sell their home and leave
• Mandate a decommissioning bond be set upfront before any approvals are made - $250k/turbine system
• If any company could not comply with the minimum responsible and safe setback standards, Posey and Gibson County would not be the right location for such a project to be given approval