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SOUTH DAKOTA PUBLIC
UTILITIES COMMISSION

Public Utilities Commission
Capitol Building, 1st floor
500 E. Capitol Ave.
Pierre, SD 57501-5070

My name is Lucas Nelsen, and I am a Policy Associate at the Center for Rural Affairs. The Center is a private, independent non-profit organization committed to strengthening rural communities. We are based in Lyons, Nebraska and Nevada, Iowa.

We know that economic development opportunities are essential to helping our communities grow and thrive. Renewable energy provides one such opportunity. These projects have the potential to bring in new tax revenue, provide additional income for landowners, and bring temporary and long-term jobs to rural areas.

As new projects are being developed across the state and region, it is important that developers and local officials work together with community members to identify and address concerns. In order for a community to fully capture the benefits of new development, projects must be built in a way that is supported by local residents. This is best achieved by soliciting community input, gathering unbiased information, and developing balanced ordinances.

Included with this letter are several fact sheet that provide additional information on studies that have reviewed the potential health effects related to wind turbine noise, the effects of icing on wind turbines, shadows produced by wind energy systems, and lighting requirements for turbines. These issues are frequently brought up by community members in questions about new wind energy development, or mentioned as concerns during hearings on proposed projects.

You may already have similar information on hand or have additional resources available to residents of South Dakota. If so, please feel free to share those resources with our organization.

Sincerely,

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FACT SHEET:
WIND ENERGY AND LIGHTING

Every day, rural communities benefit from wind energy. Wind development provides new income for landowners, new tax revenue to fund schools and services, and creates local career and job opportunities. County officials are responsible for enacting siting or zoning standards that help ensure wind development is supported by local residents. Many seek to address the issue of lighting.

Requirements for lighting

- The Federal Aviation Administration (FAA) provides wind turbine lighting standards to increase the visibility of systems for pilots. See Figure 1 on reverse side.[1]
- Systems must consist of aviation red (FAA L-864) obstruction lights that are either flashing, strobe, or pulsed. This lighting must be synchronized to flash with nearby systems.
- In some cases, the FAA will not require that every turbine in a wind farm feature this lighting.
    - Lighting may be placed on turbines at the perimeter of the wind farm, although unlit sections of the perimeter cannot exceed 804 meters or .5 statute mile.
    - Within the perimeter of a cluster of wind turbines, there can be no unlit section larger than 1.6 kilometers or 1 statute mile.[2]
- Turbines with a rotor tip height above 499 feet must be lit no matter the configuration of a wind farm or nearby turbines.
    - Wind energy systems above 699 feet must feature lighting on the nacelle—the housing for the generator at the top of a turbine that is connected to the rotor—as well as at a midpoint on the turbine's mast, placed between the nacelle at the top of the turbine and the ground.

Recommendations

- While zoning standards must comply with FAA regulations, local officials may include provisions that limit the amount of obstruction lighting used if possible, or require alternative approved lighting systems.[3]
    - Alternative lighting systems that have been approved by the FAA are Aircraft Detection Lighting Systems for wind turbines. These reduce persistent lighting for wind turbines by using obstruction lights that only activate when radar systems detect an approaching aircraft.
- Developers should meet with stakeholders to determine ways to minimize this visual impact from ground level while considering site configuration for a project or a lighting plan.
    - Mitigating the visual impact of turbine obstruction lighting can be difficult due to lighting requirements and the unique nature of these lights in areas where wind projects are built. Minimizing impacts from homes may be possible by avoiding direct viewsheds from residences, or using existing tree cover or other vegetation to block lighting.

Turn over for Figure 1.

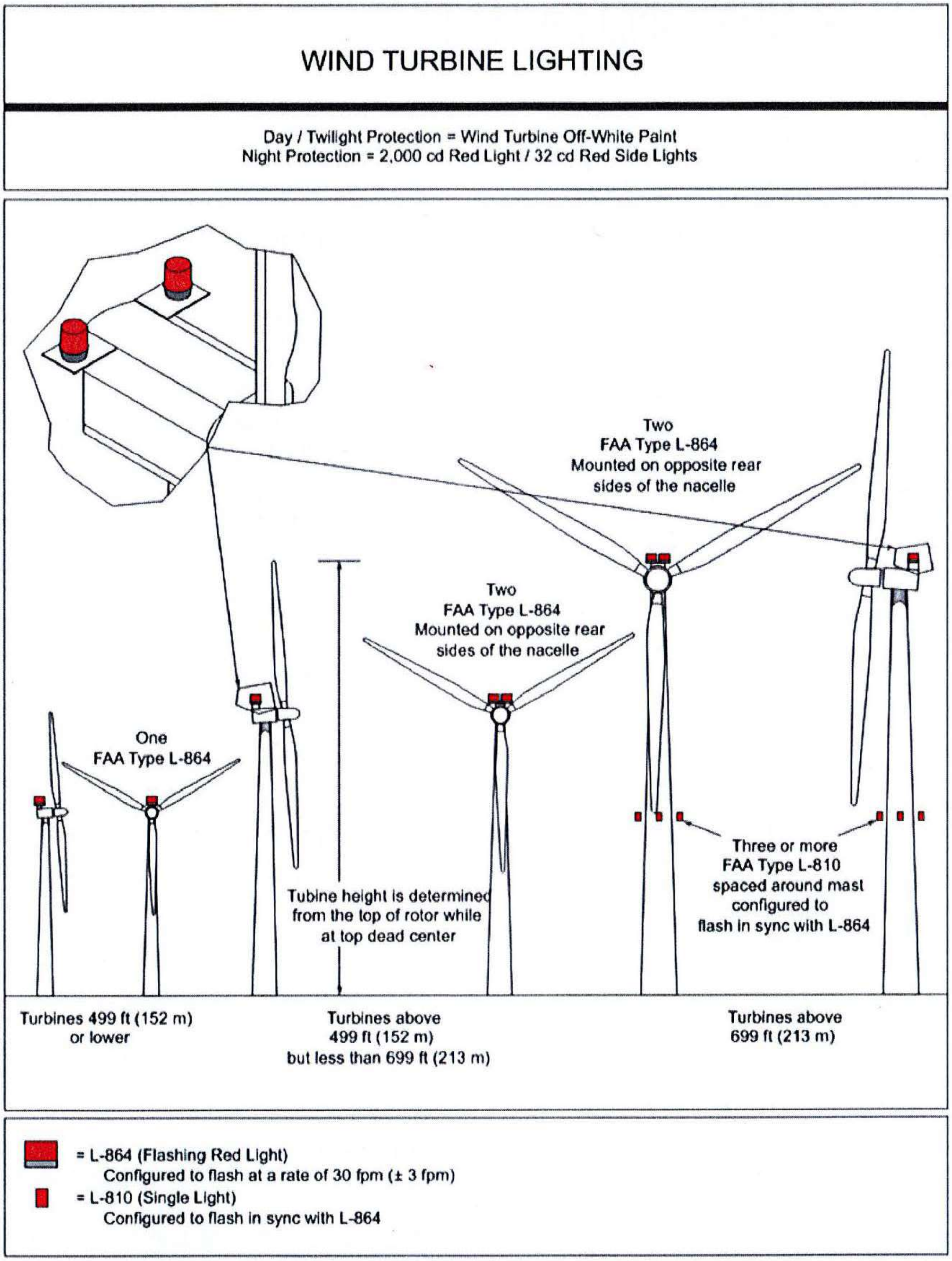
Sources

1 "Advisory Circular 70/7460-1 L." Federal Aviation Administration, U.S. Department of Transportation, Aug. 17, 2018, faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_-_Obstuction_Marking_and_Lighting_-_Change_2.pdf. Accessed June 2019.

2 Ibid.

3 Rynne, Suzanne, et al. "Planning for Wind Energy." American Planning Association, 2011, planning-org-uploaded-media.s3.amazonaws.com/publication/online/PAS-Report-566.pdf. Accessed June 2019.

FIGURE 1. WIND TURBINE LIGHTING



FACT SHEET:

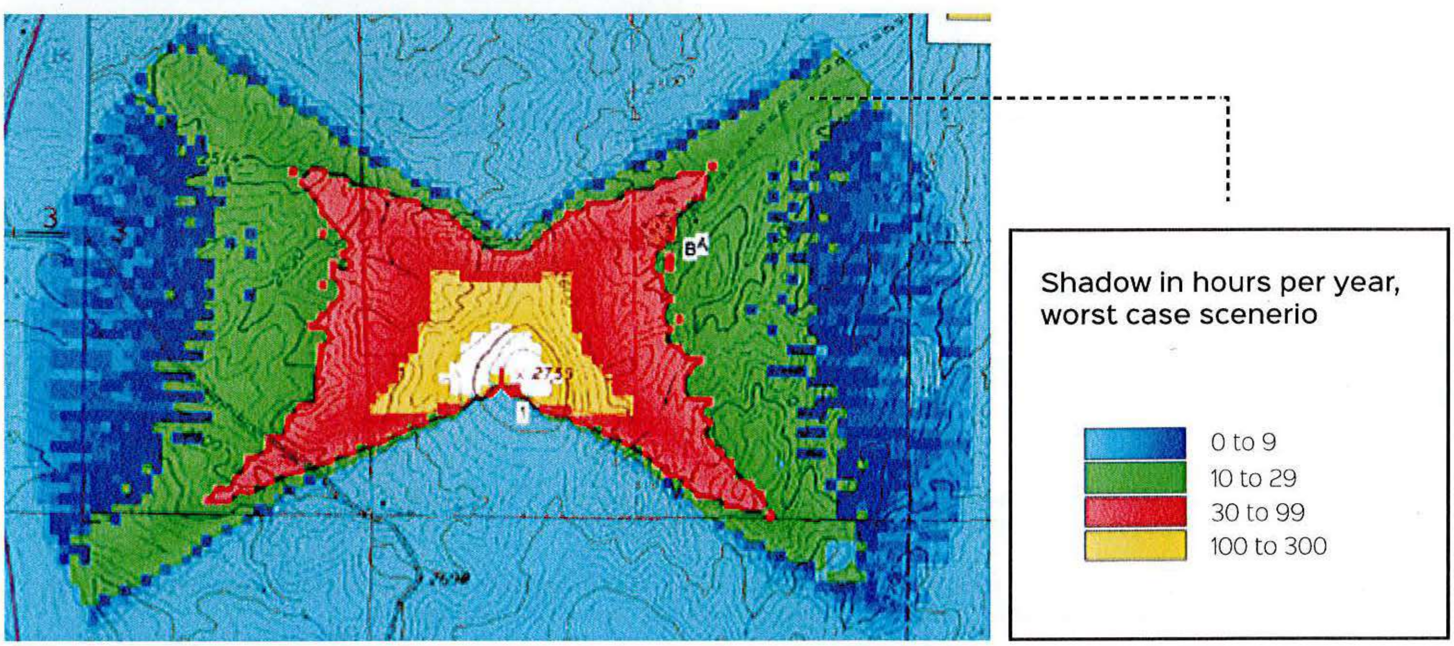
WIND ENERGY AND SHADOW FLICKER

Every day, rural communities benefit from wind energy. Wind development provides new income for landowners, new tax revenue to fund schools and services, and creates local career and job opportunities. County officials are responsible for enacting siting or zoning standards that help ensure wind development is supported by local residents. Many seek to address the incidence of shadow flicker.

What is shadow flicker?

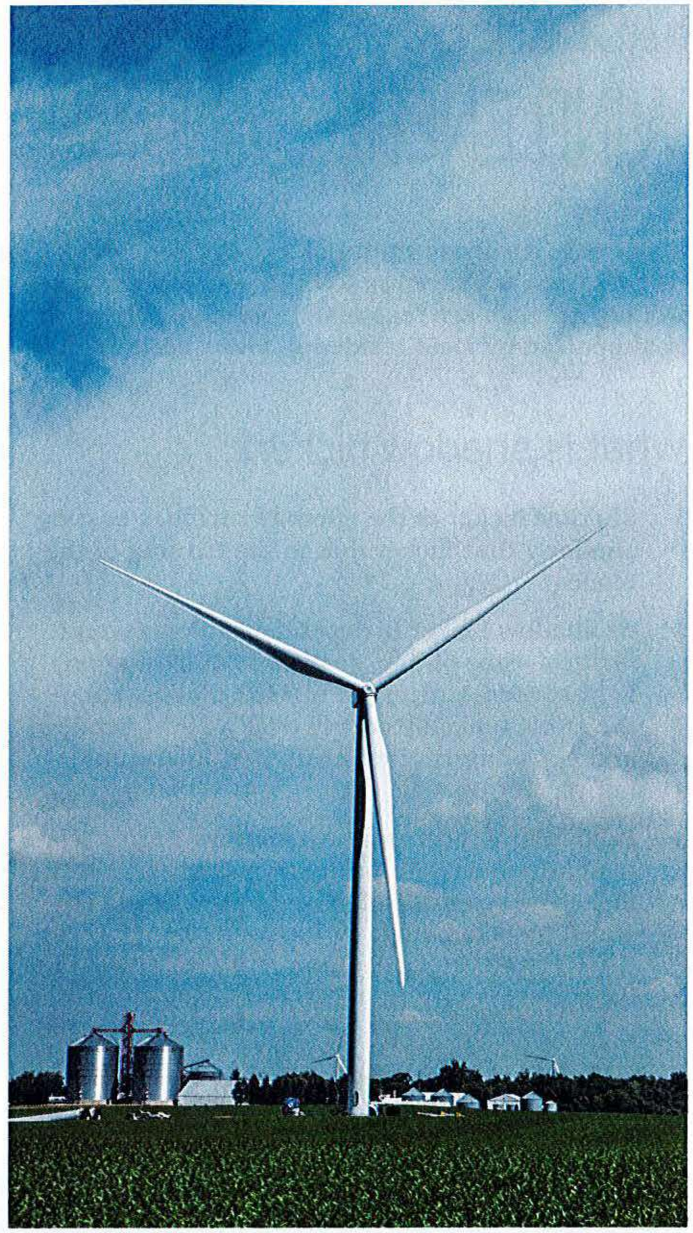
- Shadow flicker is the effect of turbines casting shadows that flicker due to the turning of the blades.
- As shadow flicker is dependent upon several factors—time of day, seasonal consideration, light source, turning of turbine blades, etc.—the effect typically occurs over a short window, and exposure is often measured in annual hours.
- Particular concerns about shadow flicker relate to shadows cast across nearby homes, and the flickering or strobe effect that may be experienced by occupants.
- While shadow flicker may be perceived as an annoyance, it is unlikely to contribute to or trigger health conditions like photosensitive epilepsy.
    - Flashing lights that typically contribute to epileptic seizures fall in the 5 to 30 Hertz range, while most modern turbines would cause a shadow flicker in the range of 0.6 to 1 Hertz.[1]
- Developers are able to calculate and map areas affected by shadow flicker from turbines prior to construction, creating the opportunity to reduce or avoid shadow flicker during the planning phase. See Figure 1.[2]

FIGURE 1. SHADOW FLICKER MAP



Recommendations

- County officials may choose to require data on the number of properties impacted by shadow flicker from turbines, as well as the total annual hours that shadow flicker will likely occur.
- While annual limits on hours of shadow flicker are found in wind energy ordinances, it is important that planning and zoning officials consider the impact limits may have on the ability of wind energy facilities to operate without curtailment.
  - For example, a county may implement a limit of 30 hours annually for a wind turbine, requiring developers to demonstrate the amount of shadow cast on homes from a turbine will not exceed that limit in a given year.
  - Additionally, officials may set similar limits for shadow flicker on other areas such as roads or recreation areas.
- Developers should use early public engagement as an opportunity to identify homes, businesses, and other properties that may fall within the area around a turbine where shadow flicker can occur. These locations and the configurations of these properties will assist developers in forming mitigation measures or reducing shadow flicker.
  - Mitigation may include siting a turbine in such a way so that shadows are blocked by existing vegetation or the placement of new vegetation. During certain times of year, it may be necessary for projects to be curtailed—a forced stop for the wind energy system—during times of day to reduce the annual total shadow flicker from systems.



Sources

1 Priestly, Thomas. "An Introduction to Shadow Flicker and its Analysis." CH2M Hill, Feb. 10, 2011. windharvest.com/wp-content/uploads/2017/03/Shadow-Flicker.pdf. Accessed June 2019.

2 Ibid.

3 Rynne, Suzanne, et al. "Planning for Wind Energy." American Planning Association, 2011, planning-org-uploaded-media.s3.amazonaws.com/publication/online/PAS-Report-566.pdf. Accessed June 2019.

FACT SHEET:
WIND ENERGY AND NOISE

Every day, rural communities benefit from wind energy. Wind development provides new income for landowners, new tax revenue to fund schools and services, and creates local career and job opportunities. County officials are responsible for enacting siting or zoning standards that help ensure wind development is supported by local residents. Many seek to address the issue of **noise**.

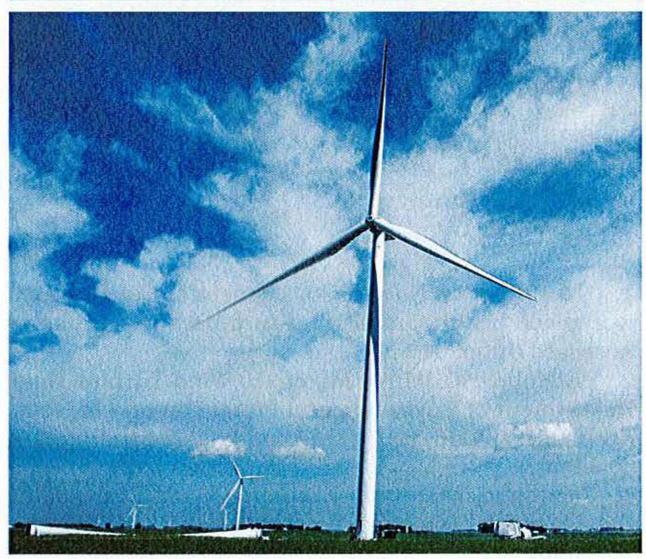
Noise produced by wind energy systems

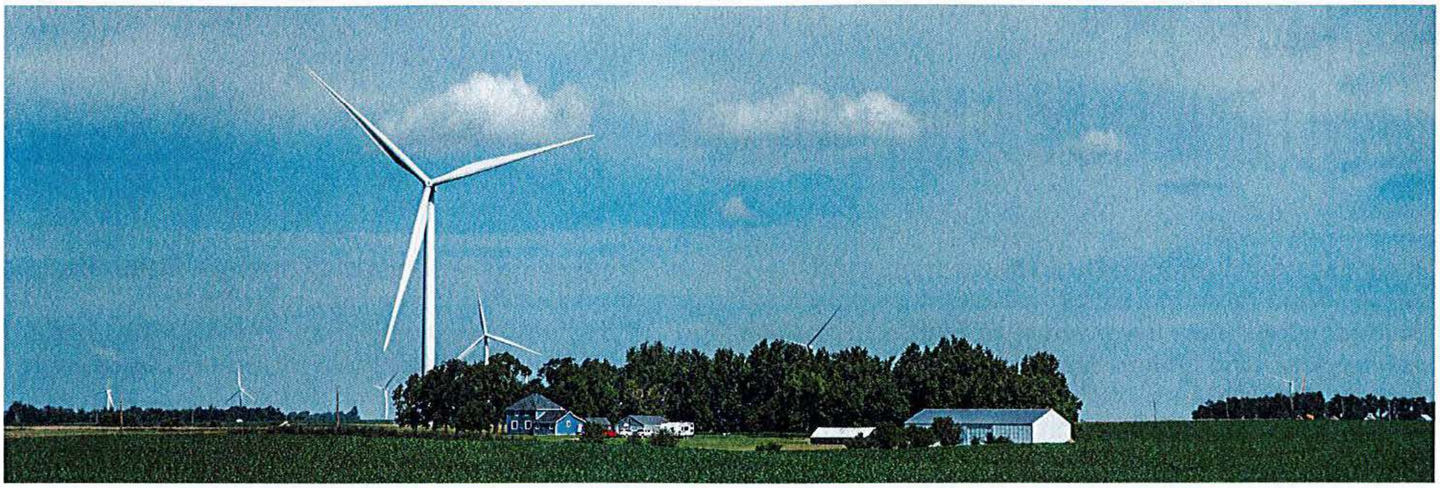
- An operating wind turbine can create noise—or unwanted sound—due to vibration and the rotating blades.
- The amount of noise generated by wind turbines is influenced by multiple factors: atmospheric conditions, whether the turbine is upwind or downwind from the person perceiving the sound, the model and design of the turbine, the local terrain, distance from the turbine, and ambient sound.
- Sound decreases as it travels from the source, meaning any noise produced by a turbine will be more intense next to the system.

> Noise is measured in decibels, commonly using an A-weighted or C-weighted filter. A-weighted decibels (dBA) measure sound based on the loudness and the response to that sound, while C-weighted decibels (dBC) include measurement of lower or higher frequencies that people cannot hear.[1]

  - Modern turbines produce a sound pressure level of just over 100 dBA. At 400 meters from the turbine, this sound pressure level typically drops to 40 dBA or less—a level consistent with sound produced by household appliances, such as a refrigerator.[2]

- Wind energy systems also produce infrasound, or vibrations measuring under 20 Hertz. Infrasound measured from wind turbines has been below the threshold for human perception.[3]
- While some have raised concerns about health impacts related to noise from wind turbines, there have been no studies that show a direct connection between specific health conditions and exposure to wind turbine noise.[4]
- However, wind turbine noise may be a cause of annoyance for nearby residents. Studies have shown that self-reported annoyance from wind turbine noise increases as sound levels surpass 35 dBA.
  - Notably, other factors may contribute to self-reported annoyance—perceived sensitivity to noise, personal benefit or lack thereof, and aesthetic issues related to wind turbines.
- Annoyance itself has been shown to have an effect on health, although the link between a particular noise level and annoyance has not been identified.[5]





Recommendations

- Local officials may wish to enact noise limits on wind energy systems to reduce exposure to nearby residents. Before putting a noise limit into place, however, officials should develop an understanding between noise level and distance—more restrictive noise standards significantly limit viable turbine locations.
  - If a county wishes to enact a noise standard, it should also create requirements for measuring sound levels, typically pre- and post-construction. Officials can also request sound modeling information from developers, providing decision makers with more information on the potential sound impacts of a project.
  - Counties should seek out certified professionals if they wish to do their own independent sound modeling.
- Rather than putting into place noise limits, counties can use distance setbacks to limit potential impacts of noise produced by wind turbines.
  - In this case, the aforementioned sound modeling data can offer insight into the optimal distance to limit potential impacts.
- Developers can limit potential for high level noise exposure to residents by using the nearby landscape and their own setback distances to reduce noise levels when possible.
- Because annoyance may be derived from actual wind turbine noise as well as perceptions of a given project, developers must work to include stakeholders early in the development process. Addressing myriad concerns and integrating insight from nearby residents may assist in reducing annoyance and improve the final design of a project.

Sources

1 "A Primer on Noise." Government of Canada, Oct. 28, 2014, canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/primer-noise-environmental-workplace-health.html. Accessed July 2019.

2 Ellenbogen, Jeffrey M., et al. "Wind Turbine Health Impact Study: Report of Independent Expert Panel." Massachusetts Department of Environmental Protection and Massachusetts Department of Public Health, January 2012, mass.gov/files/documents/2016/08/th/turbine-impact-study.pdf. Accessed July 2019.

3 Ibid.

4 Michaud, DS, et al. "Exposure to wind turbine noise: Perceptual responses and reported health effects." Journal of the Acoustical Society of America, 139(3): 1467-1479, March 2016.

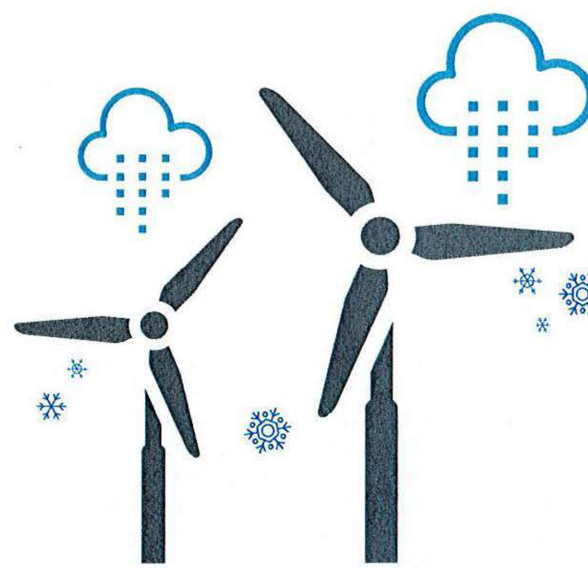
5 Ibid.

FACT SHEET:
ICING AND WIND ENERGY SYSTEMS

Every day, rural communities benefit from wind energy. Wind development provides new income for landowners, new tax revenue to fund schools and services, and creates local career and job opportunities. County officials are responsible for enacting siting or zoning standards that help ensure wind development is supported by local residents. Many seek to address the issue of **icing**.

Icing on wind energy systems

- Like most structures, the accumulation of ice on wind turbines occurs due to localized temperature and other weather conditions, such as humidity and precipitation.
- While accumulation itself may not pose a particular threat to a wind system or the surrounding area, the shedding of ice can be hazardous to the area directly underneath a system or to nearby locations due to ice throw.[1]
  - Ice throw is a term applied to the shedding of ice from a turbine blade while a turbine is in operation, with the motion of the blades potentially propelling ice over a greater distance.
  - The distance that ice can travel when thrown varies, depending on factors such as blade speed, weight and size of the ice, the position of the blade when the ice is dislodged, etc.
- When ice formation is detected—either by personnel or automated systems—wind farm operators may shut down turbines until the ice has been shed.



Recommendations

- If ice accumulation is likely in a project area, local officials may request developers to provide data on potential ice throw from the wind energy systems that will be used, as well as maps for the affected area around each turbine.
    - Officials should also request information about the procedures that a wind farm operator will use during periods of icing and methods that will be used to detect ice formation on systems.
- While the overall risk of ice throw may be small due to the amount of variables that affect the formation and shedding of ice, officials should consider the possibility when determining appropriate setback distances for wind energy systems.
    - One study suggests that a buffer zone of 1.5 (hub height + rotor diameter) may be sufficient to reduce risk to the nearby area in locations with a high probability for ice formation.[2]
    - Officials may also require signage placed near this buffer zone to alert people to the risk of ice throw under certain weather conditions.
- Wind farm operators can employ passive or active measures that reduce the potential for icing or address the accumulation of ice. Officials should consider the overall effectiveness of these measures as well as the associated costs before requiring their use.
    - An example of a passive mitigation measure is the application of a hydrophobic coating to the surface of a wind turbine which can limit icing. Although this may be a low-cost option for addressing ice build up, wind farm operators will likely have to reapply this coating to maintain its effectiveness.
    - Heating systems integrated into a turbine are an active measure for preventing ice formation. The effectiveness of these systems depends upon the ability of personnel to identify icing conditions and activate the systems to address icing.[3]

Sources

1 Wahl, David, and Philppe Giguere. "Ice Shedding and Ice Throw - Risk and Mitigation." GE Energy, 2006, ge.com/content/dam/gepower-pgdp/global/en_US/documents/technical/ger/ger-4262-ice-shedding-ice-throw-risk-mitigation.pdf. Accessed July 2019.

2 Tammelin, B., et al. "Wind energy production in cold climate (WECO)." Finnish Meteorological Institute, 2000, orbit.dtu.dk/files/167477321/26134.pdf. Accessed July 2019.

3 Froese, Michelle. "Cracking the icing problem on turbine blades." Windpower Engineering and Development, March 28, 2017, windpowerengineering.com/business-news-projects/cracking-icing-problem-turbine-blades/. Accessed July 2019.