E N V I R O N M E N T A L   L A W   I N S T I T U T E

Siting Wind Energy Facilities – What Do Local Elected Officials Need to Know?

An Environmental Law Institute Guide

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Environmental Law Institute
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Introduction

Energy security is one of the foremost priorities of the United States today, and a diversified power portfolio is a key to energy independence. The last decade in the U.S. has seen a surge in research and deployment of advanced commercial-scale utility wind energy generation facilities – now the fastest-growing source of renewable energy. Commercial-scale wind is likely to come to thousands of communities across the U.S. in the coming decades.

This Guide focuses on the role of local governments in making informed decisions about the siting of these facilities. It provides information for local elected officials serving communities that may be affected by commercial-scale wind facilities (defined as generating 5 megawatts or more of power for sale to utilities), as distinguished from "small wind" (facilities serving individual homes or businesses or small community-based systems).

Wind Energy Potential in the United States

The United States boasts tremendous wind energy potential. The Department of Energy estimates that the total land-based energy potential available from wind in the contiguous United States is 10,500 gigawatts (GW), which is about ten times the electric generating capacity we currently derive from *all* existing sources. A gigawatt is one thousand megawatts (MW). Our potential offshore wind energy capacity is over 4,150 GW. Given the size of these resources, the Department of Energy has identified a goal of meeting 20 percent of our electric power needs by 2030 through wind power (300 GW), and we are well on our way toward achieving that goal.

The United States continues to be one of the global leaders in wind energy development. By the start of 2012 U.S. electrical energy providers had installed 47 GW of large-scale land-based wind energy generation capacity, a number that rose dramatically to 60 GW by the end of 2012 (Wiser & Bolinger/National Renewable Energy Laboratory 2012; American Wind Energy Association 2012). This repre*sents about 45,000 wind turbines, with capacity to power 14.7 million American homes.

What is US wind energy potential and installed capacity?

	Potential	Installed
Onshore	10,500 GW	60 GW
Offshore	4,150 GW	0 GW

Scale of Wind Facilities

Modern commercial or utility-scale wind power facilities (also called "wind farms") typically consist of 25-150 turbines (Denholm/NREL 2009). Typically outfitted with 3 long, curved blades, each turbine is mounted on a separate tower, approximately 250-300 feet high measured from the ground to the turbine hub (American Planning Association 2011). Each wind turbine has a rated output of 1.5 to 3 MW (Wiser & Bollinger/NREL 2012; APA 2011). Although the area of land physically occupied by each turbine along with associated service roads and transmission facilities is not large, a typical commercial scale wind power facility is likely to involve siting on a land area of several square miles – making wind power a fairly large land use in comparison with other uses with which local governments may be more familiar (Denholm/NREL 2009).

Local Government Role in Wind Facility Siting

Local governments play a significant role in the siting of commercial-scale wind facilities in 48 of the 50 states (Environmental Law Institute 2011), excluding Ohio and Vermont, where state boards have exclusive authority over facility siting. In more than half the states, local governments exercise primary authority over wind facility siting. In the others, some combination of state and local regulation occurs, often with the state setting baseline standards or with a state board exercising jurisdiction over facilities over a certain minimum size. However, even in states that give primary siting approval authority to state utility boards and public utility commissions, most local governments can affect the design, siting, and characteristics of large wind facilities through adopting and applying local ordinances (ELI 2011; APA 2011).

Unlike traditional power plants, where other land uses are excluded from the site, wind power facilities are often intermingled with rural, residential, commercial, or industrial lands that continue to be used for other purposes. Local land use controls will play a role in affecting these compatible uses.

Local governments need to know what issues have been addressed by state laws and industry standards, what issues have been solved technically in connection with previous wind facilities, and what issues may need to be addressed in a specific way in each community. These factual issues will continue to become more important to local governments across the U.S. as wind power makes the transition from mostly a rural land use to one that is increasingly located in more densely populated areas where the electric power is used.

Interest Groups

Any local government dealing with wind energy facility issues will consider information provided by an array of interested parties. These will include the wind energy facility developers and utilities that may be proposing or supporting the project, participating landowners who have leased their land or are otherwise participating in the project with the expectation of financial return, non-participating adjacent landowners who may have concerns about potential impacts of the projects, other landowners and residents who may support or oppose the project for various reasons (including environmental, health, economic, aesthetic, and social issues), and organized interest groups who may either support or oppose wind facilities because of their interest in other forms of energy or in specific social values. Each of these interested parties is likely to provide information to local elected officials to support approving, modifying, expediting, delaying, or disapproving projects.

In approaching local decisions and engaging with the interested parties, it is important for elected officials to understand what information is known, and what issues have been addressed elsewhere, in order to start with a solid basis of information. Fortunately for busy elected officials, hundreds of wind energy facilities have been constructed across the U.S., and so there is a substantial track record and a body of research on these facilities. Many states have adopted or developed model local ordinances or published standards, and others have identified best practices (ELI 2011). Federal research laboratories, including the National Renewable Energy Laboratory (NREL), have conducted studies and assessed many of the issues of potential concern. Professional organizations such as the American Planning Association have compiled and evaluated information from local governments across the nation to make the information assessment task easier (APA 2011).

Use of this Guide

This Guide is intended to assist local elected officials in understanding issues that may arise in connection with proposed wind energy facilities in their communities. It draws on credible scientific and governmental studies intended to assist decisionmakers. For each issue, the Guide identifies the substantive concern and why it may be of interest. Then it summarizes what is currently known about the issue, providing citations to the information provided. Finally, for each issue, the Guide indicates how relevant impacts, if any, may be addressed. This Guide does not, of course, anticipate every geographical setting or land use pattern a local government may face. But it provides a way to distinguish among issues – identifying those where much is already known and concerns have been resolved, and those where more local scrutiny may produce a better outcome.

Because local elected officials need a credible place to start their inquiry, this Guide relies entirely upon authoritative research, government and academic sources, and previous actions by state and local regulatory bodies across the country. Wind energy is not mysterious, and local officials should be able to approach their decisions about it with confidence.

Key Issues for Local Governments

Wind Facility Location

Approving sites where wind energy facilities may be constructed is perhaps the most important decision made by local governments in the wind energy context. Where not preempted by state energy siting laws, local elected officials' actions in land use planning, zoning, and permitting will determine where commercial scale wind facilities may be constructed and operated.

Siting issues carry with them the kinds of questions that local governments routinely address in the land use context: is the location compatible with the local government's comprehensive plan or master plan, what are compatible and incompatible land uses for adjacent and underlying lands, and what effect will a wind facility have on neighboring property uses?

It is important to understand the scale of this land use. A comprehensive study by the National Renewable Energy Laboratory of all existing U.S. commercial-scale wind facilities found that the land occupied directly by the wind turbines and associated facilities was one acre (0.4 hectares) or less per megawatt (MW) of capacity. Thus, for example, for a 25-turbine wind farm rated at 2.5 MW/turbine, the directly disturbed and occupied land surface area typically covers less than 62 acres of land. But the wind farm itself is spread across a much larger area. Because of turbine spacing, the typical commercial-scale wind farm can be distributed over 4 square miles or more (Denholm/NREL 2009).

Several studies have sought to evaluate the possible effect of wind projects on nearby home values. The most thorough studies have found no evidence of any statistically significant impact on selling prices of homes within one mile of the turbines (Hoen et al. 2011; National Association of Regulatory Utility Commissioners 2012). Additional studies evaluated sales data on single family homes within 10 miles of 24 existing wind facilities in nine states. “Neither the view of the wind facilities nor the distance of the home to those facilities [was] found to have any consistent, measurable, and statistically significant effect on home sales prices” (NARUC 2012).

Many local governments have anticipated the siting of wind facilities – adopting an enabling ordinance, or sometimes creating an overlay zone. Some have listed wind energy as an authorized use by right, or as a conditional use, for certain zones. These typically allow wind energy facilities at least in industrial and agricultural zones, and often by conditional use in other zones as well. Others have required a specific permitting process to allow detailed consideration by the local governing body (ELI 2011). The state of Washington has promoted the adoption by local governments of wind energy overlay zones to simplify planning and streamline permit reviews (APA 2011).

Most model ordinances developed by state governments, or by state bodies for local governments, have local governments specify the zoning districts within which wind projects are permitted or may be permitted as a conditional or special use (ELI 2011). Minnesota’s model ordinance, for example, provides for conditional use permitting of commercial-scale wind facilities in agriculture, light industry, and heavy industry districts. Wind facilities are well-suited for the continuation of other land uses on the same parcels or among the facilities. The U.S. Department of Energy has advised that compatible uses include farmland because land parcels “are large and sparsely populated, and the amount of land taken out of production as the footprint of wind generators and ancillary roads is small compared to the added revenue to the landowner” (U.S. Department of Energy 2011). Another option that is receiving much interest is siting wind energy projects on brownfields, landfills, and reclaimed mining sites; this has many benefits including lower land costs, sometimes lower development costs, and improved community support for restoring these lands to productive capacity (U.S. Environmental Protection Agency 2012).

Site Safety and Security

As with other types of industrial facilities, site security and safety will be of interest not only to the landowner and project operator but also to the local government. This is in order to ensure that the site will be maintained and that members of the public, including trespassers, are kept from injury. Thus, towers should be designed to prevent unauthorized persons from gaining access and climbing them.

Many ordinances provide for locking and securing access doors, keeping installed climbing aids at a substantial height above the ground to prevent unauthorized climbing, and fencing of substations. Virtually all call for posting of emergency contact information at the site, posting warning signs about dangers (including ice in the winter), locking turbine doors to prevent unauthorized access, and not locating structures near towers that would allow people to climb them. Other regulations call for physical monitoring of the site from time to time to ensure upkeep and detect unauthorized access (ELI

2011). All turbine systems have lightning protection systems; the system of grounding should be designed to prevent injury to workers and bystanders. It is important to note that electrical surges would not extend to local residents because the generating system is independent of the local distribution system (American Wind Energy Association 2008). Electromagnetic fields, if any, at the turbine sites are not likely to affect persons coming and going from the sites and there is little evidence of any long-term health effects (National Institute of Environmental Health Sciences 2012).

Wind developers should be required to provide safety plans which include emergency response as well as design measures to ensure safety and inform potential responders (APA 2011). Local public safety agencies should be prepared to respond to foreseeable events. For example, fires in wind turbines are rare, but local agencies should have a plan for responding.

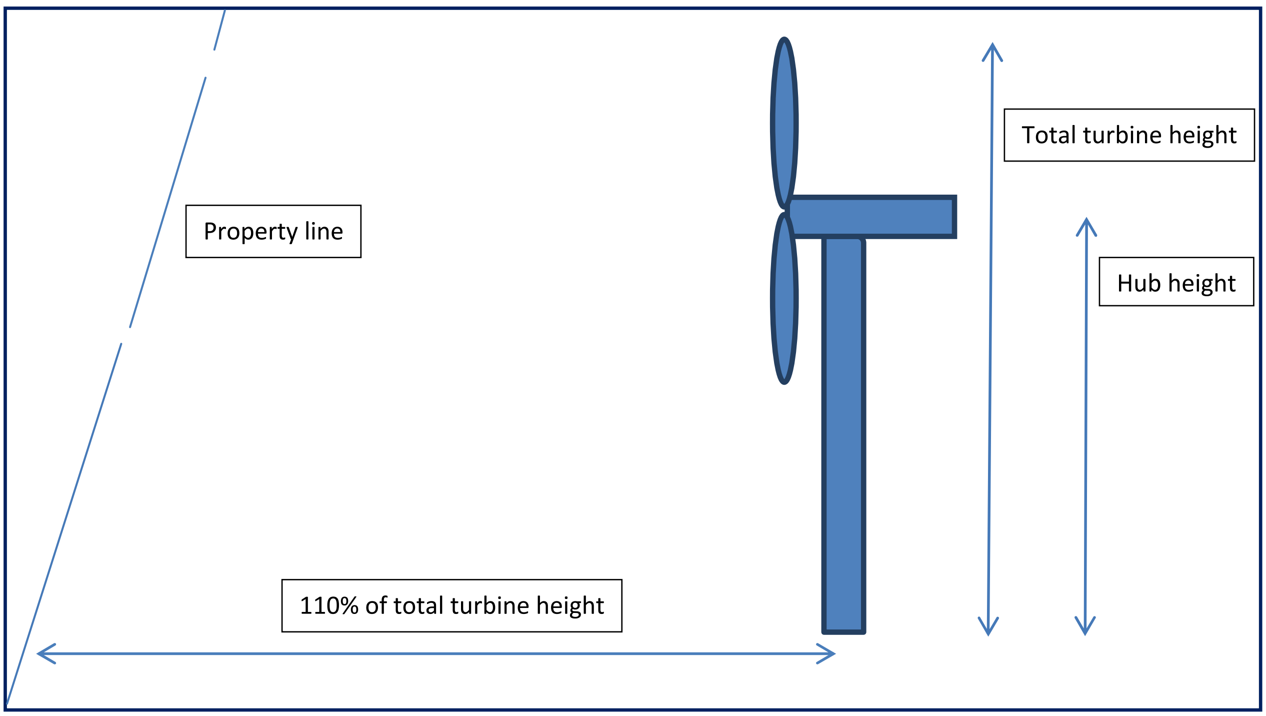
Setbacks from Property Lines and Buildings

Many state and local regulatory regimes establish setback distances for turbines in order to protect adjacent land users and minimize impacts from ice fall or from tower or blade failure. Setbacks provide a margin of safety beyond the primary measures that prevent these occurrences.

Modern turbines are continuously monitored and will shut down if ice accumulates on blades. Ice shedding is almost exclusively limited to the areas directly beneath the turbine (NARUC 2012). The distance ice will travel is a function of wind speed, operating conditions, and the shape of the ice (Ellenbogen 2012). Ice almost always falls within the distance from the tower equal to the total turbine height (including full extension of the blade). Ice from a stationary 2 MW turbine is estimated to fall no more than 50 meters (160 feet) from the base of the turbine, while from moving blades it may fall between 15-100 meters from the base. (Copes & Rideout 2009). Beyond 220 meters from the base there is a negligible chance for ice throw risking injury (Garrad Hassan/Canadian Wind Energy Association 2007). The primary recommended approach for ice throw is to require that ice control measures be in place and to require insurance against damages from such events (NARUC 2012). Warnings should be also be posted to restrict onsite activities near turbines during ice events (Ellenbogen 2012).

Tower failures, while rare, have occurred. In general they are characterized by a vertical collapse, rather than tipping over from the base (NARUC 2012). Thus setbacks of less than total turbine height are ordinarily sufficient for tower failure scenarios, although a margin of safety can be applied (NARUC 2012). The most likely form of failure that might be encountered is a structural failure of a blade or blades. Blade failure is most often caused by turbine overspeed, which stresses the blades beyond their structural capacity. Most wind turbines are equipped with redundant safety systems to shut down the rotor. The safety system should have two mutually independent baking systems (Larwood 2005). For overspeed and blade failure issues, model ordinances (e.g. NY and PA) among others, require all wind turbines to have an automatic braking system (ELI 2011).

Setback distances are largely aimed at addressing tower and blade failure. NARUC concludes: “Both of these are rare occurrences, at least with respect to modern utility scale wind machines, and present evidence suggests that setbacks roughly equivalent to or modestly in excess of the turbine height offer sufficient protection against such risks" (NARUC 2012). Most states and model local ordinances agree on a setback of 1 to 1.5 times the total turbine height from property lines of non-participating landowners, public roads, and rights of way (ELI 2011). A fairly large plurality of model ordinances, state guidelines, and rules prescribe a setback distance of 110% of total turbine height (e.g., Ohio, Wisconsin, Wyoming, Pennsylvania, Illinois, and Utah) (ELI 2011). Some ordinances and rules express the setback in terms of distance from occupied dwellings rather than from property lines. South Dakota requires a setback of the greater of 110% of the tower height or 500 feet; and Minnesota guidelines state that projects (under 25 MW and regulated by local governments) should be set back at least 500 feet from homes. Many setback provisions allow for waivers of the setback distances by adjacent property owners and participating property owners (ELI 2011).



Setback from Property Line

Visual Impacts

Wind energy facilities are very visible. Projects are often located in rural or semi-rural areas where there are not a great many tall structures or are constructed on ridge tops where they can be seen from great distances. As wind energy generation becomes more widespread, wind facilities are going to be constructed in more densely populated areas where more people will see them. In addition, newer generations of wind technology have resulted in taller turbines that can efficiently capture more consistent winds. These taller turbines are increasingly preferred by wind facility developers and utilities. In the most recent decade, commercial-scale wind facilities have moved to install turbines that stand 300 feet above the ground at the hub (APA 2011).

Visual impacts include primarily the turbines, but may also include roads, substations, and electrical lines to convey power to the grid.

Visual impacts are to some degree matters of preference, affected by such variables such as people's perceptions of landscape, aesthetics, culture, and sense of place as defined by residents, visitors, and users of the land (APA 2011; Pasqualetti 2002). Studies indicate that aesthetic judgments related to wind facilities are not purely the result of technical visual appraisal but are often influenced by the viewer's underlying sentiments toward wind energy (APA 2011*;* Molnarova et al. 2012). Economic participants in wind projects and those with favorable attitudes toward renewable energy are more likely to find wind facilities aesthetically pleasing, for example.

Local governments have used a number of tools to address visual impacts. Experience shows that it is especially important to engage with the public early and fully. This may include scheduling forums for disseminating information to the public, requiring interactive computer simulations of visual impacts, conducting surveys on public perceptions and attitudes, and considering both daytime and nighttime impacts (Great Lakes Wind Collaborative 2011).

The National Association of Regulatory Utility Commissioners and the Great Lakes Wind Collaborative have agreed that "best practice" is for the project proponent to carry out a visual impact assessment and make it accessible to the public (NARUC 2012; GLWC 2011). Many state guidelines recommend provisions to ensure that realistic assessments of visual impacts are included in wind project planning and applications (Kansas, Maine, New York, Vermont, and West Virginia, among others). Visual impact analysis should include recognition of significant visual resources on the landscape as well as assessment of the characteristics of the proposed wind facility.

The geographic scope and the scale of a visual impacts assessment will vary with the landscape under consideration. Maine's model ordinance for local governments, for example, requires a visual impacts assessment that considers the significance of a potentially affected "scenic resource," if any, as well as the existing character of the surrounding area, the expectations of the typical viewer, and other factors. The analysis must cover the area within 4 miles of the project and within 8 miles if significant visual resources exist (Maine State Planning Office 2009). In New York the recommended guideline for visual impact analysis is 5 miles, but may be expanded up to 10 for significant visual resources (Vissering 2011).

The overall visual impact of wind facilities can be influenced by requiring similar turbine types, providing for uniformity in color and lighting, reducing above-ground infrastructure, and evaluating the spacing between turbines. Most ordinances set requirements for color, uniformity of design, lighting, prohibition of signage and advertising beyond reasonable identification of the manufacturer or operator, and requiring simulations of projected visual impacts (ELI 2011). Local ordinances and approvals addressing lighting requirements often limit turbine lighting to that which is needed to satisfy FAA aircraft safety regulations (ELI 2011). Recent research done within the Federal Aviation Administration has shown that in some settings turbine safety lights can be limited to specific turbines on the periphery of a facility with spacing of up to half a mile between lit turbines, or an obstacle collision avoidance system to reduce the need for lighting (Patterson 2009). Local government specifications can be influential.

Local governments typically address the physical characteristics of wind facilities (color, uniformity, lighting, signage), but may also address broader viewshed issues by seeking particular configurations of wind turbine arrays or even (in a few cases) by excluding wind facilities from certain very important viewsheds as Waubansee County did in the scenic Flint Hills region of Kansas (APA 2011).

It is important to note that most energy-related land uses also have visual impacts (such as from mining, natural gas production, cooling towers, smokestacks, solar arrays, pipelines and transmission). So wind facilities can be understood in the broader context of energy choices that may affect visual resources in multiple landscapes.

Sound Impacts

Sounds emanating from operating wind facilities have also been of interest to local governments. Sounds originate from the mechanical components of the nacelle of the turbine, producing a relatively constant hum when the turbine is in operation; airflow passing across the rotating blades can also produce a rhythmic "swoosh" as the blades pass in front of the towers (West Michigan Wind Assessment 2010). Nearly all modern commercial-scale turbines have been designed to minimize sound. The sound produced by wind turbines varies by turbine type, speed of rotation (determined by operational design and size of the turbine), and local conditions – specifically topography, wind direction, time of year, and weather (Ellenbogen 2012)

Sound impacts are typically measured in decibels (dB) of sound pressure; and regulatory standards are typically expressed using dB in order to provide objective measures when approving a land use activity and enforcing an ordinance. Regulatory and ordinance standards in most contexts use either an "A-weighted" scale (dBA, sometimes written "dB(A)"), or a "C-weighted" scale (dBC, or "dB(C)"). "The A-weighted scale is intended to measure the sounds as they are subjectively perceived by the human ear. The C-weighted scale is highly sensitive to low-frequency sound and is therefore normally used to assess sound levels more commonly associated with occupational exposures" (NARUC 2012). Environmental standards, including those used in wind facility siting, are expressed in dBA. Decibels are based on a logarithmic scale, and thus an increase of 10 dbA will be experienced as a doubling of the sound pressure.

Sounds generated at the hub and blades attenuate fairly rapidly over distance. The National Research Council (NRC) notes that in general within 100 feet of the base of a single commercial-scale turbine, the sound pressure will be at 50-60dbA, a range which encompasses ranges of human conversation (NRC 2007).

From a community perspective, acceptable levels of sound will vary based on time of day (expectations of quiet at night), background sounds (urban or rural), and concerns about noise impacts on local residents. For these reasons, commercial-scale wind facilities can expect to be subject to regulations (state or local) which limit the acceptable dBA level at the property line or at nearby dwellings. Apart from concerns about perceived sounds, some people have also expressed concerns about direct effects of infrasound (low frequency sound), and health effects including psychological distress characterized as “wind turbine syndrome.” However, the most thorough technical reviews do not support these associations. The independent expert panel conducting the *Wind Turbine Health Impact Study* for the Massachusetts Department of Environmental Protection and Department of Public Health found no evidence to indicate expected infrasound impacts on the human vestibular system from wind turbines, and no evidence for the claimed syndrome (Ellenbogen 2012).

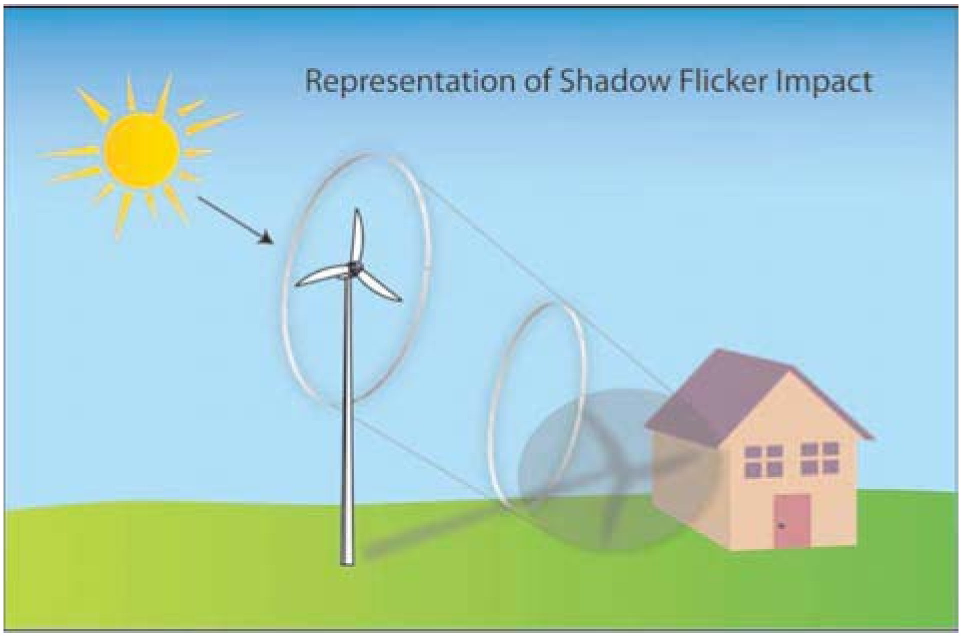
Local governments’ attention to sounds and changes in sounds from proposed wind facilities will focus on measurable sound impacts that affect neighboring property uses and residents. This is the same kind of assessment that local governments make in considering many other commercial or industrial uses of land. In general, regulatory standards will be expressed as a dBA limit at the property line or at some other suitable point, such as the nearest occupied dwelling. For example, Michigan’s sample ordinance for local governments provides that “the sound pressure shall not exceed 55 dB(A) measured at the property lines or the lease unit boundary, whichever is farther from the source of the noise.” The Michigan model standard provides further that “this sound pressure level shall not be exceeded for more than three minutes in any hour of the day.” It provides that if ambient sound pressure in the area already exceeds 55 dBA , the wind standard at the property boundary or lease boundary shall be the ambient level plus 5 dBA. Using another approach, the Wisconsin Public Service Commission rule setting standards for local ordinances in Wisconsin provides that “the noise attributable to the wind energy system [shall] not exceed 50 dBA during daytime hours and 45 dBA during nighttime hours” as measured just outside non-participating occupied buildings (ELI 2011).

Nighttime limits have been specified to reflect protection of residential uses. Based on potential for sleep disturbance, the World Health Organization recommends a nighttime sound limit of 40 dB(A)for a variety of sources (not specifically wind turbines), as measured outside affected residences and averaged over an entire year, to minimize possible sleep disturbance of vulnerable populations (Ellenbogen 2012). Again focusing on buildings rather than property lines, NARUC recommends 45dbA measured outside residences as an appropriate regulatory limit, with 40 dBA as an “ideal” design goal when developing a proposed project (NARUC 2012, citing Hessler/NARUC 2011).

Predictive sound propagation modes can help planners understand the sound impacts a proposed project will have on neighboring properties, and be used to take into account seasonal variation, alternative location of turbines within a wind farm site to meet sound standards, and strategies such as varying rotational speeds (WMWA 2010).

Shadow Flicker

Shadow flicker is a specific visual impact that results from the shadows cast on stationary objects by rotating wind turbine blades which cause alternating changes in sun light (perceived as a “flicker”). Shadow flicker occurs for certain periods of the day, and at certain times of the year based on the height of the sun and consequent length and direction of the shadow. The National Research Council has observed that with proper siting, shadow flicker on adjacent property rarely is experienced for more than a half hour in any day and only during a few weeks in the winter season when the sun is low in the sky (NRC 2007).



American Wind Energy Association, used by permission.

Shadow flicker through windows or as experienced outdoors can be perceived as an annoyance. Some people have raised concerns about possible health effects, suggesting that shadow flicker may bring on disorientation, migraine headaches, or even seizures. However, shadow flicker from wind turbines cannot produce epileptic seizures because induced seizure effects occur only at much higher frequency ranges (5-30 Hertz) than those produced by rotating wind turbines (0.6-1 Hertz) (NARUC 2012, citing Priestley 2012). Relatively few studies have examined the possible other effects, which have been reported anecdotally. Upon reviewing the available scientific literature, the independent expert panel assembled by the Massachusetts Department of Environmental Protection and Department of Health noted only "limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects" (Ellenbogen 2012). A scientific review conducted for the Ontario Public Health Agency found no evidence of health effects from shadow flicker (Copes & Rideout 2009). The United Kingdom's Department of Energy and Climate Change (DECC) commissioned a report, peer reviewed by independent experts, which found that shadow flicker does not pose a significant risk to heath, and that where it causes annoyance, mitigation measures have been effective (Parsons Brinckerhoff/DECC 2011).

It is important to recognize that shadow flicker is real, but seasonal and transitory. Even at the relevant times of year, shadow flicker will not occur absent sunlight or if the turbines are not turning. Wind direction also matters; as turbines turn to face the winds they cast a different shadow profile. Shadow flicker can be predicted and modeled, and its impact on human habitation often is avoided entirely or mitigated by careful siting of turbines using the models (APA 2011).

Shadow flicker does not produce demonstrated health impacts, but can be a nuisance for nearby properties. Nearly all state and local governments that address shadow flicker by regulation or ordinance do so by applying a cap on hours of impact. The United Kingdom's DECC study recommends that shadow flicker upon neighboring dwellings and offices not exceed 30 hours per year or 30 minutes per day with normal variation in wind directions and assuming clear skies (Parsons Brinckerhoff/DECC 2011). A review of ordinances and model ordinances across the United States indicates a typical cap of no more than 30 hours per year of shadow flicker on specified locations – usually defined as nonparticipating residences, other occupied buildings, and sometimes public roads (ELI 2011).

Electromagnetic Interference

Like all tall structures, wind turbines can create interference with communication or radar signals, and can do so when the tower or rotating blades interrupt the signal (DOE 2011). These effects can be predicted, modeled, and mitigated. The extent to which a turbine may cause radar interference is dependent upon turbine height, rotor sweep area, rotational speed, and surrounding landscape characteristics. The Federal Aviation Administration and Department of Defense have examined these issues, and have made siting recommendations where needed. "Most turbine and radar interaction problems concerning the FAA can be addressed using available software upgrades." The Department of Defense has occasionally interposed objections, where adequate mitigation for radar is not available (DOE 2011). Such consultation is an ordinary part of wind siting activities conducted by the project proponent (AWEA 2008).

As for localized effects on radio or television signal reception, or other communication, most can be avoided and averted through preconstruction analysis and careful site selection (APA 2011). Model ordinances that address this issue often prescribe that operation of the project must not unduly interfere with public or private television, radio, or telecommunication signals and that if such reduction occurs the operator must restore reception. Others simply prescribe consultation with service providers, including emergency service providers reliant on microwave transmission (ELI 2011).

Road Impacts

Construction of wind power projects has effects on existing public roads, and wind projects often require the construction of on-site roads connecting the turbine pads to one another. In the construction phase, oversized trucks are used to carry the tower segments and the long blades that will be affixed to the turbines. This sometimes means that road upgrades, repairs, or post-construction rehabilitation may be needed – particularly if the public roads serving the site are not constructed to handle heavier vehicles (which is sometimes the case in rural areas). On-site roads will need to be constructed and maintained so as not to cause erosion or other impacts during and after the construction process (AWEA 2008; ELI 2011).

Typically state departments of transportation handle approvals for oversize vehicles. Counties and local governments sometimes have such powers, particularly for locally-maintained roads, bridges, and public rights-of-way. Approvals may be needed to construct on-site roads, and particularly for the location and configuration of intersections with public roads. Local governments and conservation districts may also have influence over the construction and closure or abandonment of temporary roads, including requirements for barriers, re-vegetation, and other requirements to prevent unauthorized access and to ensure that sediment and erosion impacts are minimized (AWEA 2008).

Where a local government has such authority, it is typical for it to review plans for transportation and construction involving use of public roads (in order to coordinate public safety and anticipate and address possible impacts); and to provide for road maintenance agreements and provisions for post-construction repairs where needed (GLWC 2011). Location and management of planned on-site roads may be considered in the context of visual impacts analysis, site safety, and wildlife impacts, discussed in other parts of this Guide.

Wildlife Impacts

Wind facilities can affect wildlife and wildlife habitat, which may be of interest to local governments. A survey conducted by the American Planning Association found that 48 percent of respondents had identified wildlife impacts as a challenge in their communities when considering wind projects (APA 2011). While more studies remain to be done, there is a solid basis of information to guide wind project developers and government agencies in identifying and addressing possible impacts. Many local governments will defer consideration of wildlife issues to their state wildlife agencies and the U.S. Fish & Wildlife Service, which have expertise in these areas.

The most direct impacts on wildlife generally come from collisions of birds or bats with turning wind turbine blades and collisions with other project structures such as towers or power transmission lines. Indirect impacts come from habitat disruption or fragmentation where wind turbine pads and connecting roads affect habitat continuity and quality, and from animal avoidance of wind sites. Wind towers can attract some bird species, including raptors, resulting in potential collisions. Federal and state laws, including the Endangered Species Act and the Migratory Bird Treaty Act, provide much of the framework for understanding and addressing anticipated impacts.

Reviews of wind projects show a broad range of bird fatalities between 0.95 and 14 per MW per year (APA 2011, citing NRC 2007 and National Wind Coordinating Committee 2010). However these rates have decreased dramatically in more recent projects, thanks to improved project planning and siting (APA 2011). In a survey of results conducted by a committee of conservation and wind industry experts, most wind developments reported fewer than 4 bird fatalities per MW per year (NWCC 2010). "Songbird collisions typically account for roughly three quarters of bird casualties at U.S. wind facilities (Erickson et al. 2001; Johnson et al. 2002) and result in spring and fall peaks of bird casualty rates at most wind facilities (Johnson et al. 2002; Erickson et al. 2004). However, current turbine-related fatalities are unlikely to affect population trends of most North American songbirds (NRC 2007; Kingsley and Whittam 2005; Kuvlesky et al. 2007; Manville 2009)" (NWCC 2010). Bird collisions with turbines and associated structures, while significant, cumulatively account for fatality rates that are several orders of magnitude lower than those from common collisions with other structures such as buildings, windows, vehicles, power transmission lines and communication towers (NWCC 2010 citing Erickson et al. 2001; NRC 2007; Manville 2009).

Wind facility impacts on bats have become more recognized in recent years. A review of over 40 studies on bat fatalities suggest fatality rates between 0 and 40 per MW per year (NWCC 2010), heavily dependent upon siting. Bat fatalities are highest among migratory species in late summer and fall when they are migrating (APA 2011, citing Arnett et al. 2008). Turbine-related bat deaths have been reported at each wind facility studied (U.S. Government Accountability Office 2005; Kingsley and Whittam 2005; Kunz et al. 2007; Kuvlesky et al. 2007; NRC 2007; Arnett et al. 2008), from collisions with turbines, meteorological towers, or power transmission lines (NWCC 2010). Indirect fatalities may also occur from injury to bats' internal organs resulting from the sudden change in air pressures in the environment around rotating blades; bats flying near these blades can experience these "barotraumas" resulting in death (Baerwald et al. 2008).

Best practices for wildlife impacts include identifying exclusion zones based on information available about critical habitat and protected and endangered species, requiring pre- and post-construction monitoring of wildlife and habitat, and requiring mitigation for disturbance of habitats that have not been avoided (NARUC 2012). The U.S. Fish &Wildlife Service (FWS) has adopted detailed voluntary guidelines, in conjunction with a multi-stakeholder committee including conservationists, government agencies, and wind industry representatives, who considered the issues over a five-year process, culminating in the Land-Based Wind Energy Guidelines issued in 2012 (FWS 2012). The Guidelines recommend using a tiered approach for considering risks and minimizing impacts on wildlife:

Tier 1: Preliminary site evaluation (landscape-scale screening of possible project sites)
Tier 2: Site characterization (broad characterization of one or more potential project sites)
Tier 3: Field studies to document site wildlife and habitat and predict project impacts
Tier 4: Post-construction studies to estimate impacts
Tier 5: Other post-construction studies and research

Many states have developed state-specific guidelines and recommendations. Local governments can ascertain that there is an appropriate wildlife review for the project, often in consultation with state or federal officials. Preliminary assessments and site characterization can indicate if there are species of concern and should identify actions that can minimize or completely avoid impacts (NWCC 2010).

Decommissioning

When wind turbines reach the end of their design lives, which will typically be at the same time for turbines in a project that was constructed in one phase, it is important to understand how these large structures will be dealt with when they cease operation. Of course, wind projects can be upgraded, maintained, and replaced over time, but communities should be prepared to ensure that a project that is no longer generating electric power does not become a continuing burden on the community. Decommissioning requirements address responsibility for removal of towers, turbines, and equipment, and may also address site reclamation.

NARUC recommends setting clear requirements for what events trigger decommissioning – such as turbines that are beyond their design life coupled with non-use for some period of time (NARUC 2012). The American Planning Association notes that cessation of operations for more than a year, particularly at the end of a turbine's life, could be used to define a decommissioning obligation (APA 2011). Decommissioning requirements may include plans describing how the project will be decommissioned, and the procedures for equipment removal, demolition, and site restoration (GLWC 2011). They may also include requirements for funds or financial guarantees (APA 2011; NARUC 2012).

For Further Information

The Environmental Law Institute has analyzed approaches to wind siting regulation across the 50 states, focusing on local government powers, including providing links to model ordinances, available at http://www.elistore.org/reports_detail.asp?ID=11410.

The National Association of Counties (NACO) in collaboration with the Distributed Wind Energy Association in 2012 released a guide for best practices in developing county wind ordinances, *County Strategies for Successfully Managing and Promoting Wind Power*, available at http://www.naco.org/programs/csd/Documents/Green%20Government/NACo%20County%20Strategies%20for%20Successfully%20Managing%20and%20Promoting%20Wind%20Power%20in%20America%27s%20Counties.pdf. NACO previously developed a wind energy issues guide for county commissioners. http://www.naco.org/programs/csd/Green%20Government%20Documents/EE_Report%20-%20Wind%20Energy%20Guide%20for%20County%20Commissioners.pdf.

The American Wind Energy Association, the trade association for the U.S. wind industry, has useful information on industry practices, participants, and current locations of wind projects at www.awea.org. AWEA's very accessible "siting guide" identifies what the industry considers good practice. http://www.awea.org/sitinghandbook/download_center.html.

The U.S. Department of Energy provides information on wind energy research, siting, and regulatory activities at http://www.windpoweringamerica.gov/. The Department's Wind Program includes informational resources, videos, and statistics. http://www1.eere.energy.gov/wind/index.html. The Department's Wind Powering America resources include links to 140 local ordinances. http://www.windpoweringamerica.gov/policy/ordinances.asp.

The American Wind and Wildlife Institute is a science-based collaboration between the nation's leading wildlife protection groups and the wind industry. AWWI has produced and identified numerous resource publications on best practices to protect wildlife. www.awwi.org.

Opponents of the wind industry have collected citizen concerns, news stories, and anecdotes at www.windaction.org.

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