

Wind Energy Environmental Issues

Wind power plants offer several important environmental advantages over conventional power plants running on coal, oil, or natural gas; namely, they use no fuel, emit no air pollutants, greenhouse gases, or toxic wastes, and consume no water or other scarce resources. Nevertheless, wind plants can raise environmental and community concerns. For example, they generate noise and can be visually intrusive for residents living near them. They also can disturb wildlife habitats and cause injury or death to birds.

Fortunately, despite past mistakes, these and other potential problems need not pose a serious obstacle to wind development in most cases. Through conscientious planning research, and early and frequent consultations with affected communities, wind plant developers can identify and address the most serious issues *before* substantial investments are made in new wind projects. Utilities, government agencies, environmental organizations, and others need to work with developers to ensure that such effective strategies are implemented.

Issues concerning local communities

Building and operating a wind plant involves many of the same activities as building and operating a conventional power plant, including road construction, land clearing, truck traffic, and the construction of transmission lines. Not surprisingly, activities such as these sometimes arouse significant community concerns. In addition, wind projects raise unique community issues, mostly concerning their visual impacts and noise.

Visual impacts

Wind turbines are highly visible structures. Modern wind turbine towers stand 30 to 50 meters (100 to 160 feet) above the ground, not counting the blade rotor, which may be up to 40 meters (130 feet) in diameter.. In addition, the turbines often are deployed in arrays of a dozen or more machines on conspicuous ridges or hilltops.

Whether the visual impact of wind turbines generates complaints depends partly on the setting in which they are located. In agricultural areas of the Midwest, developers have encountered relatively few problems in winning community acceptance of wind projects. This makes sense, considering that windmills were a common sight on American farms until the mid-20th century. It helps, too, that agricultural landowners often directly benefit from wind projects through land rents and fees paid by plant owners.

In other settings community acceptance may be a more serious problem. Wind plants proposed near residential areas have sometimes aroused strong opposition from homeowners and real estate developers. In one case, residents opposing the Cordelia Hills wind project in Solano County, northeast of

San Francisco, reportedly did not want to see turbines sited nearby, even though the hills chosen for the project already had numerous electronic relays and transmission lines. Aesthetic impacts were also a key factor behind opposition to wind development at Tejon Pass, one of the most scenic areas close to Los Angeles. Needless to say, siting a wind project near a national park or wilderness preserve may incite complaints from local environmental organizations and activists.

Whatever the setting, steps can be taken to reduce the number of complaints by making wind turbines less obtrusive and more pleasing to the eye. For example, tubular towers are less offensive than lattice towers, and partly for this reason they now are preferred by most wind developers. Combined with the sleek, minimalist appearance of some modern wind turbine housings and rotors, the overall effect can be quite attractive.

Wind plant developers can address environmental and community issues before substantial investments are made in new projects. Careful attention must be given to how a wind turbine array is set against the landscape. A well-ordered array gives the appearance of purpose and efficiency, whereas one that appears to be scattered haphazardly leaves the impression of aimlessness and confusion. Following the contours of a ridge will make a line of wind turbines blend more easily with the surroundings. Taking steps to avoid scarring the land with unsightly roads and clearings is important, as is eliminating unnecessary clutter by burying transmission lines and hiding buildings and other structures behind ridges or vegetation.

Efforts to educate and inform nearby communities about wind energy and its benefits also can help lessen opposition on aesthetic grounds. For example, there is a tendency for people who pass by a wind power plant to notice the few machines that are not operating rather than the majority that are. This can lead people to think wind technology does not work. Letting people know that it is normal for some turbines to be stopped at any time (because of wind variations and maintenance needs) may help alleviate this public relations problem.

Education in nearby communities about wind energy and its benefits can help lessen opposition on aesthetic grounds. Noise

By and large, those affected by the noise generated by wind turbines live within a few miles of a large wind power plant or within several hundred feet of a small plant or individual turbine. Although the noise at these distances is not great -- a 300-kilowatt (kW) turbine typically produces less noise at 400 feet than does light traffic 100 feet away -- it nevertheless is sufficient to be heard indoors and may be especially disturbing in the middle of the night when traffic and household sounds are diminished. (See table 1.)

Zoning ordinances developed by some communities for wind developments address this problem by specifying setbacks and allowable noise levels to minimize disturbance to neighbors. Palm Springs, for example, requires that no wind turbine be located closer than 1,200 feet from any residence, hotel, hospital, school, library or convalescent home, except where topography permits an exception to be made. At specified distances, noise is required to be less than 55 decibels, approximately the volume generated by wind blowing through trees 40 feet away.

Source	Distance (ft.)	Sound Pressure Level - dB(A)
Threshold of pain		140
Ship siren	100	130
Jet engine	200	120
Freight train	100	70
Vacuum cleaner	10	70
Freeway	100	70
Small (10-kW) wind turbine	120	57
Large transformer	200	55
Wind in trees	40	55
Light traffic	100	50
Average home		50
300-kW wind turbine	400	45
USW 56-100 turbine	800	45
Soft whisper	5	30
Sound studio/ quiet bedroom		20
Threshold of hearing		0

Source: Gipe, *Wind Energy Comes of Age*, p. 375.

Significant progress has been made in reducing turbine noise since the first machines were installed in the early 1980s. The larger machines now on the market generate less noise (per unit of energy output) than the smaller machines they replaced, in part because of slower rotor tip speeds and careful design and manufacture of blade airfoils and trailing edges.

Overall, wind turbine noise should be of minor concern to communities near wind projects under development today. With proper attention to setback distances and sound-reduction engineering, few, if any, residents will be affected.

Protecting wildlife and wilderness areas

Birds

The potential effects of wind energy development on wildlife and wilderness areas have attracted attention in recent years. The issue first rose to prominence in the late 1980s when it was found that birds especially federally protected golden eagles and red-tailed hawks -- were being killed by wind turbines and high-voltage transmission lines-at California's Altamont Pass. The discovery sparked opposition to the Altamont Pass project among some environmental activists and aroused the concern of the U.S. Fish and Wildlife Service, which is responsible for enforcing federal species-protection laws.



Since then, problems have been noted in other locations. Birds have been reported killed at wind power plants in Tarifa, Spain (one of two major points of bird migration across the Mediterranean Sea), and at various wind plants in northern Europe. These incidents have resulted in a heightened awareness of wind power's potential environmental impacts among both U.S. and European conservation groups.

The long-term implications of the bird issue for the wind industry are as yet unclear, however. It seems likely that serious conflicts will be confined mainly to areas where large numbers of birds congregate or migrate (as in Tarifa), or where protected species are affected (as in Altamont Pass). This could encompass quite a few locations, however, because some of the traits that characterize a good wind site also happen to be attractive to birds. For example, mountain passes are frequently windy because they provide a channel for winds passing over a mountain range; for precisely the same reason, they are often the preferred routes for migratory birds.

Just because birds frequent a particular area does not necessarily mean a wind power plant should not be built there. Several factors need to be considered in making this decision. One is whether the birds are likely to come into conflict with the wind turbines. Research on bird numbers and behavior can give an indication of the likelihood that birds will encounter wind turbine blades.

Another consideration is the likely significance of bird deaths and injuries for local bird populations. The ideal is for no birds to be killed, but this will not be practical in many cases. A more scientifically meaningful standard for measuring the severity of impact might be whether the deaths will result in a significant decrease in the total population or a significant increase in the total mortality of the affected species.

If preliminary research indicates that a wind project is unlikely to seriously affect bird populations, further studies may be needed to verify this conclusion. These could include monitoring baseline bird populations and behavior before the wind project begins, then simultaneously observing both a control area and the wind site during construction and initial operation. In certain cases, operational monitoring might have to continue for years.

For existing wind plants where bird conflicts are already a concern, the immediate task is to develop and implement practical ways to reduce the number of bird deaths and injuries. Research is being carried out to determine which strategies are most effective in different situations. Proposals include changing the color of wind turbine blades, eliminating places on towers where birds are likely to perch, and using radar

to alert wind project operators to the imminent passage of large flocks of birds so that parts of the wind plant can be shut down. Deaths from high-voltage transmission lines and equipment can be avoided by methods such as discouraging perching near uninsulated wires.

In recognition of the potential seriousness of the bird issue, the wind energy industry is collaborating with federal and state agencies and environmental organizations to develop a suitable avian research program and siting guidelines. While disagreements are inevitable, all parties recognize their common interest in seeing wind energy succeed in the United States without causing serious harm to birds and other wildlife.

Wilderness habitat

Some studies have shown that birds and other animals tend to avoid nesting or hunting for food in the immediate vicinity of wind turbines. In addition, activities such as road construction and tree clearing can destroy or disrupt habitats and allow the introduction of unwanted species. The problem is compounded by the fact that some of the best prospective wind sites are located in remote, mountainous areas that are home to many different species of plants and animals.

Some of the traits that characterize a good wind site also are attractive to birds. Because of these concerns, some ecologically sensitive areas (even if not explicitly protected by federal or state laws) should be off-limits to wind power projects. In other cases, however, options may exist for mitigating or offsetting any habitat impacts that occur. For example, developers can invest in off-site remediation, such as tree planting or the creation of habitats for species displaced by wind projects. The exact measures needed, if any, will depend on the particular location and species concerned and should be determined in consultation with appropriate federal and state agencies and environmental organizations.

Soil erosion

Some wind power development has led to soil erosion. Observers at Tehachapi Pass in California, for example, have noted deep gullies created by the force of rain sweeping off access roads and around wind turbine foundations. This sort of problem can be avoided through appropriate attention to soil conservation and erosion control measures early in the design of the project; the same degree of care, in fact, that should be applied to any construction project in an area vulnerable to erosion. Measures to prevent erosion include building only the minimum number of roads, following natural terrain contours as much as possible, and restoring as quickly as possible any land that is disturbed by construction.

Conclusions

The environmental issues raised by wind power plants in the 1980s caught the wind energy industry by surprise. The industry's inexperience with these issues resulted in mistakes. Wind turbines were designed and installed initially with little regard to visual or aesthetic effects, needlessly arousing complaints from local residents. Wind power plants also were built without sufficient consideration for the effects on birds and other wildlife or on soil erosion. This created conflicts with environmental activist organizations that might otherwise have been among the industry's strongest allies.

Some of the best prospective wind sites are located in remote, mountainous areas that are home to a wide variety of plants and animals. Most such problems can be avoided through careful attention to research, design and consultation with affected communities. While the specific strategies to follow will vary widely depending upon the circumstances of different wind projects, all situations will require wind developers to be sensitive and responsive to concerns raised by federal and state agencies, environmental organizations, citizens groups, and others. Friction and disputes inevitably will surface as involved parties seek to balance the environmental benefits of wind power with its local impacts and find solutions that are practical, effective, and not unduly expensive. Such an approach will, in the long run, most effectively ensure that environmental issues do not greatly hamper the increased use of wind energy.

For further reading

Paul Gipe, *Wind Energy Comes of Age* (New York: J. Wiley & Sons, 1995).

Robert L. Thayer and Heather A. Hansen, *Wind farm Siting Conflicts in California: Implications for Energy Policy*, Center for Design Research, Department of Environmental Design, University of California at Davis, 1991.

National Renewable Energy Laboratory, *Proceedings of the National Avian-Windpower Planning Meeting*, July 20-21, 1994 (Golden, Colo., 1994).

Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1997 (Sacramento, Calif.: California Energy Commission, 1992).

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National Wind Coordinating Committee

The content and form of the papers in this series have been reviewed and approved by the National Wind Coordinating Committee. Committee members include representatives from investor-owned utilities, public utilities, state legislatures, state utility commissions, state land commissions, consumer advocacy offices, state energy offices and environmental organizations. The purpose of the National Wind Coordinating Committee is to ensure the responsible use of wind power in the United States. The committee identifies issues that affect the use of wind power, established dialogue among key stakeholders and catalyzes appropriate activities.

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