Permitting of Wind Energy Facilities

A HANDBOOK
REVISED 2002

Prepared by the NWCC Siting Subcommittee
August 2002

NATIONAL WIND COORDINATING COMMITTEE

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Preface

This handbook was developed by the Siting Subcommittee of the National Wind Coordinating Committee (NWCC). The NWCC was formed in 1994 as a collaborative endeavor composed of representatives from diverse sectors including electric utilities and their support organizations, state utility commissions, state legislatures, consumer advocates, wind equipment suppliers and developers, green power marketers, environmental organizations, and state and federal agencies. The NWCC identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of an environmentally, economically and politically sustainable commercial market for wind power.

The NWCC Siting Subcommittee was formed to address wind generation siting and permitting issues. In preparing first edition of this handbook, published in 1998, members of the Subcommittee drew from their own experiences in developing and permitting wind projects, reviewed materials used for permitting wind projects at the federal, state and local level, and interviewed over two dozen individuals who have been involved in some aspect of wind project permitting. This 2002 revision of the handbook reflects extensive experience with wind project development in several regions of the united states since 1998, as well as the insights contained in the first edition.

In addition to this handbook, the National Wind Coordinating Committee will be posting and linking to additional permitting-related materials on its web site: www.nationalwind.org. The NWCC also has a series of Wind Energy Issue Papers and Briefs and is developing other resources on wind generation and related siting considerations. For comments on this handbook or questions on wind energy permitting, contact the National Wind Coordinating Committee Outreach Coordinator c/o RESOLVE, 1255 23rd Street NW, Suite 275, Washington, DC 20037; phone (888) 764-WIND, (202) 944-2300; fax (202) 338-1264; e-mail nwcc@resolv.org.

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INTRODUCTION

The power of the wind was first used to generate electricity nearly 100 years ago. Today, wind turbines in the United States play an increasingly important (though still small) role in meeting our electricity needs. They currently produce over 10 billion kilowatt-hours of electricity annually—enough to meet the needs of over 1 million households.[1] Commercial wind energy projects have been permitted in at least half the states. Given wind energy's environmental benefits, coupled with dramatic equipment cost reductions and reliability improvements over the last 20 years, it is anticipated that more wind projects will be proposed for approval in communities throughout the United States.

Why Wind Energy?

The production of energy is one of the most far-reaching of human activities in terms of its environmental impacts. Wind energy and other renewable energy sources, such as solar and geothermal energy, offer the prospect of producing large amounts of electricity with greatly reduced effects on the environment. These and other advantages to developing electricity generation using wind resources include the following.

- There is growing agreement in the scientific community that air pollution is a serious health risk. Electric power plants are a major source of air pollution, emitting 70% of total U.S. sulfur dioxide (SO_2) emissions, 33% of nitrogen oxides (NO_x) emissions, 28% of particulate matter, and 23% of all heavy metals air toxics. Wind farms emit no air pollutants.

- The scientific community also sees the worldwide buildup of greenhouse gases, including carbon dioxide from the combustion of fossil fuels, as a likely contributor to global climate change. U.S. electric power plants are responsible for 34% of the nation's total emissions of carbon dioxide (CO_2), the most important greenhouse gas. Unlike fossil-fueled power plants, wind farms emit no greenhouse gases.

- Wind project operation does not consume surface or groundwater, or discharge wastewater containing heat or chemicals.

- Wind facilities produce electricity without requiring the extraction, processing, transportation, or combustion of fossil fuels.

- The fuel source for electricity generation from wind is free, thereby eliminating fuel cost uncertainty over the life of the facility. The overall price of electricity from wind will be more stable than from fossil-fueled power plants.

- Investments in wind energy development can create jobs, income and tax revenues, especially in rural communities.

- Wind energy development in rural areas can also benefit farmers by providing income opportunities from leasing farmland to wind developers.

- Overall national security can be enhanced by the development of diversified and distributed electricity generation resources, such as wind.

Making Use of this Handbook

This handbook is written for individuals and groups involved in evaluating wind projects: decision-makers and agency staff at all levels of government, wind developers, interested parties and the public. Its purpose is to assist stakeholders to be informed participants in the wind energy development decision-making process. This handbook covers permitting issues that have come to the attention of the NWCC up to this point. The NWCC realizes that as wind development proceeds, other issues will emerge and will need to be addressed.

Some jurisdictions already have energy facility permitting processes, but participants may not be familiar with wind generation technologies and approaches to resolving wind permitting issues. Other jurisdictions may not have dealt with any wind farms. This handbook is designed to benefit stakeholders with varying degrees of experience in wind farm siting. Different readers may make use of all or only portions of the handbook's four main sections:

[1] For updated information on U.S. wind power capacity and on installed wind projects and their locations by state, see the American Wind Energy Association (AWEA) Web site, www.awea.org.

Chapter 1–Overview of Wind Development and Permitting describes the basic features of a wind project and walks the reader through the basic steps in planning, permitting, construction, operation and maintenance and closure of a wind farm.

Chapter 2–Guidelines for Structuring the Wind Farm Permitting Process presents principles, processes and concepts that agencies, developers and the public may want to employ in the consideration and oversight of proposed wind projects.

Chapter 3–Specific Permitting Considerations and Strategies discusses the tradeoffs to be considered in weighing the environmental and other issues that may arise in permitting wind farms at various locations, and provides suggestions on how to deal with those issues.

Chapter 4–Case Studies describes the permitting processes in place in three states, presenting the permitting histories of several wind energy conversion projects to illustrate points raised in Chapters 1-3.

In addition to the above sections, there are appendices to the handbook that refer the reader to additional resources and provide additional information on noise considerations.

> NOTE TO REGULATORY AGENCIES: Permitting issues and process will vary by location and project. Agencies are encouraged to become familiar with all of the issues that this handbook presents, and to apply that information and those tips that are relevant to their authority and setting.

SUMMARY OF KEY POINTS

Distinguishing Features of Wind Farms

Some aspects of wind farm permitting closely resemble permitting considerations for any other large energy facility or other development project. Others are unique to wind farms. Unlike most energy facilities, wind generation farms tend to be located in rural or remote areas. They may extend over a very large area and have a broad area of influence, but physically occupy only three to five percent of the total land area for the turbine towers and associated structures and access roads (Brower et al., 1993). The rest of the land may be left largely undisturbed and available for continued use by the landowner. Chapter 1 describes the major components of a wind project: wind turbines, anemometers, electrical power collection and transmission systems, control and maintenance facilities, and site access and service roads—some or all of which may be present in a given project. It also provides an overview of the major steps in wind project development: planning, permitting, financing, power purchase and transmission agreements, construction, operation and maintenance, and decommissioning.

Structuring the Wind Farm Permitting Process

As with other energy facility permitting processes, the goal of the wind farm permitting process is to reach decisions that are timely, minimize challenges, and ensure project compliance with existing laws and regulations providing for necessary environmental protection. Chapter 2 briefly describes the typical steps in permitting a wind farm: pre-application, application review, decision-making, administrative and judicial review, and permit compliance. The chapter then discusses the following eight guidelines for structuring a permitting process to allow for efficient agency review, meaningful public involvement, and timely and defensible decisions:

1) **Significant Public Involvement**. Providing opportunities for early, significant, and meaningful public involvement is crucial to a successful process, but there is no one simple formula for achieving this.

2) **Issue-Oriented Process**. An issue-oriented approach can help focus the debate, educate the public and decision-makers, and ensure an analytic basis for the eventual decision.

3) **Clear Decision Criteria**. Decision-making criteria should be clear and consistently applied, and made known from the outset to all participants and interested parties.

4) **Coordinated Permitting Process**. Where more than one agency has jurisdiction over permitting, agencies are encouraged to coordinate so that project review can proceed simultaneously and that redundant, conflicting or inconsistent requirements, standards and processes can be avoided.

5) **Reasonable Time Frames**. Delays and associated uncertainties can be minimized if permitting agencies establish reasonable time frames for each of the major phases of the permitting process, and manage the process to stay within those time frames.

6) **Advance Planning**. Both developers and agencies should know as much as possible about the project, the process, the participants, and the issues prior to commencing the formal permitting process.

7) **Timely Administrative and Judicial Review**. Following established procedures designed to systematically narrow the issues of concern and produce factually-based decisions can significantly limit any administrative or judicial appeals and allow them to proceed more efficiently.

8) **Active Compliance Monitoring**. Most agencies include in their permits specific conditions that must be met during construction, operation and maintenance, and project decommissioning. These conditions can best be implemented if they are: specific, measurable, agreed upon by all parties, realistic, set within reasonable time frames, enforceable, and actually enforced.

Specific Permitting Considerations and Strategies

Whether a wind project consists of a large wind farm or a single turbine, a range of considerations may be raised before, during or after project development. Siting decisions inevitably require balancing the various benefits and impacts and making tradeoffs among them. Permitting agencies also need to consider cost-benefit tradeoffs associated with impact mitigation strategies. The permitting process seeks to strike a balance between making a project acceptable to the community and preserving the project's economic viability in a competitive electricity market. A community desire to foster clean energy sources may also be a factor in some cases. The following wind farm siting considerations are discussed in Chapter 3, along with strategies and "tips" for addressing them within the context of the permitting process. All parties need to recognize that the applicability of these considerations will depend on the specific wind project proposal and site conditions. Not every consideration will apply to each wind project.

- **Land Use**. Depending on the site, size and design of the project, wind development may be compatible with a variety of other land uses, including agriculture, grazing, open space preservation, and habitat preservation for some species. Other land uses and resource values need to be considered when siting large wind projects in remote areas. Stakeholders need to understand the full range of land use issues associated with a site before getting locked into development plans, permit conditions, or other requirements.

- **Noise**. Because noise emitted by wind turbines tends to be masked by the ambient (background) noise of the wind itself and falls off sharply with distance, noise-related concerns are likely to center on residences closest to the site, particularly those sheltered from prevailing winds. Advanced turbine technology and preventive maintenance can help minimize noise during project operation. It may also be useful to characterize other sound sources in the affected area for comparison purposes.

- **Birds and Other Biological Resources**. The potential for collisions between birds and bats and wind energy facilities has been a controversial siting consideration. Biological resource surveys can help to determine whether or not serious conflicts are likely to occur. In most cases, biologically significant impacts are unlikely to occur, or can be adequately mitigated; if not, wind development may not be appropriate in a particular location.

- **Visual Resources**. There are a number of ways to reduce the visual impact of wind projects, but there may be tradeoffs to consider. For example, tubular towers may be more attractive at short distances than lattice towers, but they may also be more visible from a distance. Simulations using computer-aided graphics or artists' renderings can be developed to facilitate comparison of what the wind resource area looks like before and after the proposed turbines are installed.

- **Soil Erosion and Water Quality**. Like other construction activities, wind projects are subject to the Clean Water Act. If a project disturbs more than five acres, the developer must prepare a Storm Water Pollution Prevention Plan in order to obtain a National Pollutant Discharge Elimination System (NPDES) compliance permit, which is issued by the state's environmental quality agency.

- **Public Health and Safety**. Most of the safety issues associated with wind energy projects can be dealt with through adequate setbacks, security, safe work practices, and the implementation of a fire control plan.

- **Cultural and Paleontological Resources**. Wind farms, like other developments, are subject to legislation designed to protect important cultural and fossil resource sites. These include: the National Historic Preservation Act of 1966, the Federal Land Policy and Management Act (FLPMA) of 1976, and the American Indian Religious Freedom Act of 1978. Special care may need to be taken to preserve the confidentiality as well as the integrity of certain sensitive resources, or sites sacred to Native Americans.

- **Socioeconomic/Public Services/Infrastructure**. Developers and permitting agencies should coordinate with local public service agencies to determine whether and how the project may affect the community's fire protection and transportation systems, and nearby airports and communications systems.

- **Solid and Hazardous Wastes**. Wind farms, like other developments, are subject to the Resource Conservation and Recovery Act. Normal methods of managing solid waste should be adequate.

- **Air Quality and Climate Change**. Wind projects produce energy without generating any of the conventional pollutants or greenhouse gases produced by fuel combustion. New generation supplied by wind projects results in no additional air pollutant emissions. Temporary local emissions associated with project construction and maintenance can and should be minimized.

EXECUTIVE SUMMARY REFERENCES

Brower, Michael C., Michael W. Tennis, Eric W. Denzler, Mark M. Kaplan, "Powering the Midwest: Renewable Electricity for the Economy and the Environment," Boston: Union of Concerned Scientists, 1993.

Chapter 1
Overview of the Permitting Process

INTRODUCTION

This chapter describes the basic features of a wind project and the steps developers take to get a project on line. Wind energy and other renewable energy sources, such as solar and geothermal energy, offer the prospect of producing an increasing share of US electricity production with greatly reduced effects on the environment. The recoverable portion of the total wind resource in the contiguous US is approximately 1,230,300 average MW, assuming Class 3 wind resources.[2] This is almost 3.5 times the 48 states' total electricity consumption in 1990 (Pacific Northwest Laboratory, 1991). While technical and other issues may limit the contribution of wind energy, its potential is quite large. (For a general overview of the wind energy industry and the status of commercial wind development in the United States, see the American Wind Energy Association's publication, "The Most Frequently Asked Questions about Wind Energy."[3])

ANATOMY OF A WIND PROJECT

Wind projects vary greatly in size, from a few wind turbines ("distributed wind systems") serving individual customers or operating either at substations or at the end of a utility's distribution system, to large arrays of wind turbines ("wind farms") designed for providing wholesale bulk electricity to utilities or to an electricity market.

The role wind generation plays in the electric power system depends on the nature of that system and the relationship between daily and seasonal system needs and wind patterns. In some locales, however, periods of significant electricity demand correlate with periods of high and consistent wind conditions. In the same manner, some electric power systems, such as those that use a significant amount of hydroelectric power, can use wind generation not only to produce power but to help manage other limited resources.

Distributed wind systems. Most distributed wind systems range in size from one kW to about 5 MW, providing on-site power in either stand-alone or grid-connected configurations.[4] When grid-connected, these systems are interconnected to the electricity distribution system rather than to the higher voltage electricity transmission system. Such systems are used by industry, water districts, schools, rural residences, farms, and other remote power users. In cases where wind patterns match well with electricity load patterns on distribution feeder lines, distributed wind systems also can be used by utilities to reduce line loads and voltage variations.

Wind farms. Larger arrays usually are owned and operated by independent power producers which traditionally have sold their power to – or by – electric utilities. These facilities are grid-connected, and are interconnected to the electrical transmission system. Wind farms vary in generating capacity anywhere from five to more than several hundred megawatts and may consist of a few to several thousand wind turbines of the same or different models. The turbines are mounted on towers and often are placed in linear arrays along ridge tops, or sited in uniform patterns on flat or hilly terrain (see Figures 1, 2, and 3).

The wind turbine on its tower is the most noticeable feature of a wind project. Other components may include anemometers (wind measuring equipment), an electrical power collection and transmission system (transformers, substation, underground and/or overhead lines), control and maintenance facilities, and site access and service roads (see Figure 4). Each component is described in the paragraphs that follow.

Wind Turbines

Wind turbines capture the kinetic energy of the wind and convert it into electricity. The primary components of a wind turbine are the rotor (blade assembly), electrical generator, and tower. As the wind blows it spins the wind turbine's rotor, which turns the generator to produce electricity. Figure 5 illustrates a typical turbine design.

The rotor is the part that captures the wind. On most wind turbines the rotor consists of two or three blades which spin about a horizontal axis. "Upwind" turbines have the blades facing into the

[2] A Class 3 wind resource is defined as an annual average wind speed of 11.5-12.5 mph (5.1-5.6 m/s) measured at a height of 33 ft. (10 m).

[3] This publication may be obtained at <http://www.awea.org/pubs/factsheets/FAQUPDATE.PDF>. The AWEA Web site also provides information on installed wind projects and their location by state, and on the total installed wind energy capacity in the United States by year.

[4] A megawatt (MW) is one million watts. A kilowatt (kW) is one thousand watts, a unit of **power** that is measured instantaneously. A kilowatt-hour (kWh) is a unit of **energy** (power supplied over time), specifically, one kilowatt of electricity supplied for one hour.

Figure 1. Rows of wind turbines in the Altamont Pass, sited to take advantage of strong summer winds. Photo courtesy of the American Wind Energy Association (AWEA).

Figure 2. Today's utility-scale (900 kW) wind turbines feed clean energy to utility grids from rural areas. Photo courtesy of NREL.

wind, in front of the generator and tower. The blades on “downwind” turbines are located behind the generator and tower as viewed from the direction of the prevailing wind. Increasingly rare, but still occasionally seen, are the Darrieus (or “egg-beater”) wind turbines, whose rotors spin about a vertical axis. New turbine manufacturers enter the market from time to time with a variety of other designs, but to date, none of these machines has achieved significant commercial sales.

The nacelle, mounted on top of the tower, houses the wind turbine’s electrical generator. A generator’s rating, in kilowatts or megawatts, indicates its potential power output. Actual generation, as kilowatt- or megawatt-hours, will depend on rotor size and wind speed. Larger rotors allow turbines to intercept more wind, increasing power output. The amount of power in the wind is a cubic function of wind speed; thus wind turbines produce an exponentially increasing amount of power as wind speeds increase. For example, if the wind speed doubles, wind power increases eight-fold. Also, since the rotor’s swept area (the area of a circle) is a function of the square of the blade length (the radius of the circle), a small increase in blade length leads to a large increase in swept area and energy capture. Economies of scale are quite significant in wind turbines.

A wind turbine's blades typically begin spinning as wind speeds reach approximately seven miles per hour (mph). At nine to 10 mph ("cut-in" speed), they will start generating electricity. Rated output is usually reached in 27- to 35-mph winds. To avoid damage, most turbines automatically shut themselves down when wind speeds exceed 55 to 65 mph ("cut-out" speed). Because wind is intermittent, wind turbines will seldom operate at their rated power output for long periods of time. A typical large-scale turbine, however, will generate some electricity 60% to 80% of the time.

Wind turbines typically are mounted on tubular steel or lattice (open framework) towers. The tower's function is to raise the wind turbine above the ground to intercept stronger winds that provide more energy. Taller towers also usually allow turbines to capture less turbulent winds, unimpeded by nearby trees, buildings, and other obstructions. Tubular towers are anchored to concrete foundations 8 to 35 feet (about 2 to 11 meters) deep to prevent them from being toppled by strong winds. Lattice towers typically use four piers.

As the industry has gained experience, rotor diameter, generator rating, and tower height have all increased. During the early 1980s, wind developers were installing turbines with rotor spans of about 33 to 49 feet, or 10 to 15 meters (m) and generators rated at 10 to 65 kW. By the mid- to late 1980s, turbines began appearing with rotor diameters of about 49-82 feet (15 to 25 m) and generators rated up to 200 kW (Gipe, 1995; AWEA, 1993). Today, wind developers are installing turbines rated at 600 kW to 2 MW with rotor spans of about150-260 feet (47 to 80 m).

According to AWEA, today's large wind turbines produce as much as 120 times the amount of electricity as early turbine designs with operations and maintenance (O&M) costs that are only modestly higher, thus dramatically cutting O&M costs per kWh. Improvements in turbine technology and maintenance programs have produced highly reliable, efficient machines. According to AWEA, the turbines used in the early 1980s were available for operation 60% of the time. Today's state-of-the-art wind turbines have an availability rating averaging 98% (NREL, 1999).

Figure 3. Tubular towers in a linear array in South Point, Hawaii. Photo by Paul Gipe.

Anemometers

The instrumentation used for wind resource assessment may be unfamiliar to many people. A wind measurement system includes three major components: (1) anemometers, which are sensors to measure the wind speed and direction, (2) data logger and, (3) a meteorological mast, or tower. Measurement of temperature and pressure, which requires additional sensors, is also common. Meteorological towers typically are lattice towers supported by guy wires.

Anemometers continuously measure and record wind speed. Anemometer towers usually are the first structures built on a site to determine whether it has adequate wind resources for cost-effective development. These towers may be temporary and moved around the potential site (or sites). During operation of a wind facility, permanent anemometers may be used to transmit information about wind speed and direction to each wind turbine and to the control facility, where a record of wind speeds throughout the wind farm is stored. Anemometers can be mounted on towers as high as 350 feet (107 m) or directly mounted on each wind turbine. Wind turbines will begin operating when the anemometers detect sufficient wind speed.

Power Collection and Transmission System

Large arrays of wind turbines require an extensive power collection and electric interconnection system for delivering electricity to the electrical system. This may be to the distribution system, generally in the case of smaller facilities, or to the high voltage transmission system. Power generated by each wind turbine is typically carried by low voltage underground cables at 480 volts[5] to pad-mounted transformers located throughout the wind farm. There may be one transformer adjacent to each wind turbine. Medium voltage underground cables collect the electricity from the transformers and deliver it to an overhead or underground collection line. Power is transmitted by the collection line to the wind farm's substation for further step-up to match the voltage of the line to which it is interconnected.

Supervisory Control and Data Acquisition (SCADA) System

An operations control facility maintains two-way communications with each wind turbine. This system typically is called a Supervisory Control and Data Acquisition (SCADA) system. SCADA allows a central computer system to monitor and control each turbine's operation. The SCADA can be located on- or off-site. Through the use of integrated computer systems, it is possible for a SCADA in one location to monitor and control wind projects in several different locations.

Maintenance Facility

A large wind project will require a maintenance facility for storing trucks, service equipment, spare parts, lubricants, and other supplies. The maintenance facility may be located on- or off-site. Some wind farms combine control and maintenance functions in one building.

[5] A volt is a unit of electromotive force.

Access Roads

There usually will be one or more access roads into and around a wind project. These service roads provide access to each wind turbine, and typically run parallel to a string of turbines.

STEPS AND PARTICIPANTS IN WIND FARM DEVELOPMENT

Development of a wind farm is a complex process involving developers, landowners, utilities, the public, and various local, state, and federal agencies. The amount of time required from initial planning to project operation in an area without existing wind projects will vary, and can range from one to two years or more. The development time for subsequent projects at the same or a nearby site may be reduced by several months, provided that:

- permits are issued for the project as a whole and construction is done in phases;
- a comprehensive environmental review [environmental assessment (EA) or impact statement (EIS)], is prepared in compliance with the National Environmental Policy Act, or a state equivalent. Should the analysis show that the impacts of the first project do not suggest a significant adverse cumulative impact, an equivalent environmental review may not be needed for later projects;
- additional experience and knowledge about wind energy projects removes some of the uncertainties that contribute to lengthy analyses and processes. This handbook provides such information and also lists contacts for additional background.

The major steps in the wind project development process are described below.

- Planning
- Permitting
- Financing
- Power Purchase and Transmission Agreements
- Construction
- Operation
- Decommissioning

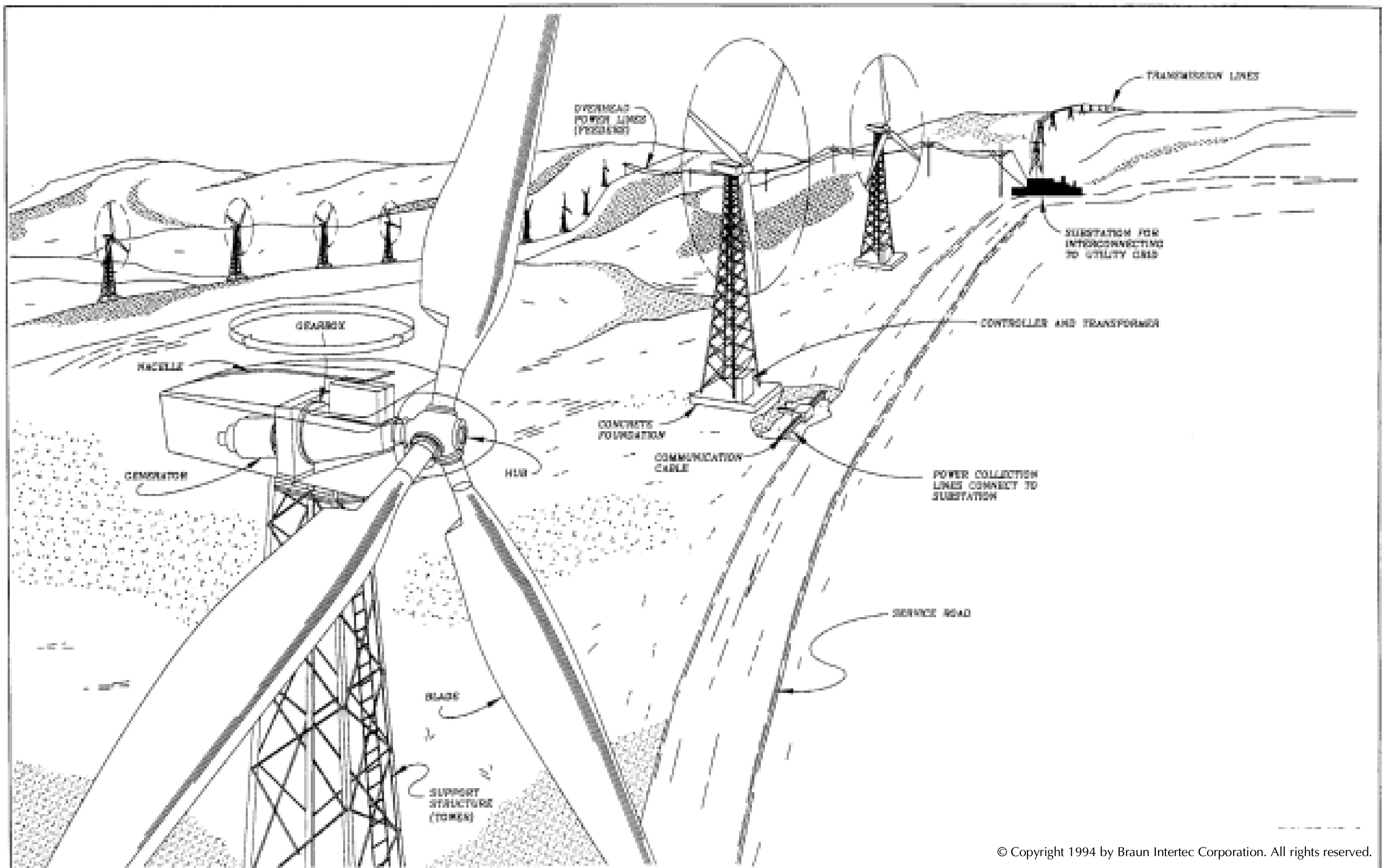

Figure 4. Typical wind farm facility layout.

Figure 5. A large 1.5-MW wind turbine towers over a service car in Trent Mesa, Texas. The hub height for this turbine model varies from 65 to 80 meters. Photo courtesy of AWEA and American Electric Power.

Planning

A wind project may be proposed by an independent company, a local government agency, or a unit of a traditional electric utility. The first step in developing a wind project is to identify a suitable site for the turbine or turbines and a likely market for the project's output. To identify possible wind development areas, developers usually consult published wind resource studies or wind resource maps such as Pacific Northwest Laboratory's Wind Energy Resource Atlas of the United States. The developer also will study maps of the electric power system and the local area. To select a specific site within a region, developers may gather long-term wind information from the nearest wind measurement station. They will also visit project site locations to collect general information, including obvious signs of strong winds (e.g., flagged trees, sand dunes and scours), accessibility of terrain, proximity to an electrical transmission line, and any potential environmental constraints (see Chapter 3 for further discussion).

After finding a potentially suitable site, the developer negotiates to gain access to or control of the properties to conduct further investigations. Developers may secure options for long-term leases or simple anemometer agreements from the landowners. During the option period the developer obtains the landowner's permission to erect anemometers for making site-specific wind measurements. The developer usually collects data at the property for at least one full year to determine the average annual wind speed. More than one year may be needed if site measurements do not correlate well with those made by the closest wind measurement station. If wind data show that the site has economic potential for wind energy generation, the developer will prepare an initial site plan which proposes where to put the wind turbines and electrical facilities that connect to the power grid. In some instances, the ability of the local electrical system to handle the output of the wind farm may have a substantive effect on its location and design. Depending on market prospects, an anemometer agreement may be upgraded to an option or lease at this point if an option or lease has not already been signed.

Permitting

Typically, wind projects are required to obtain a permit from one or more government agencies. A wind project typically can be permitted within 12 months. Early in the project planning and development process, the wind developer should contact all relevant permitting agencies or authorities. Permitting entities at the federal, state, and local levels may have jurisdiction over a wind development. The number of agencies and the level of government involvement will depend on a number of factors particular to each development. These factors primarily include: applicable existing laws and regulations, location of the wind turbines and associated facilities or equipment, need for transmission lines and access roads, size of the wind farm, ownership of the project, and ownership of the land. Chapters 2 and 3 discuss the permitting process and various considerations for agencies that may be involved in permitting wind farms.

Local permitting authorities. In many states the primary permitting jurisdiction for wind farms is the local planning commission, zoning board, city council, or county board of supervisors or commissioners. Typically, these local jurisdictional entities regulate through zoning ordinances. In addition to local zoning approval, permitting under local jurisdiction may require a developer to obtain some form of local grading or building permit to ensure compliance with structural, mechanical, and electrical codes.

State permitting authorities. In some states, one or more state agencies may have siting or review responsibilities for wind developments. State authorities may include natural resource and environmental protection agencies, state historic preservation offices, industrial development and regulation agencies, public utility commissions, or siting boards. Depending on the state where the wind development is proposed, state permits may be required in addition to local or conditional use permits. In other states, state law may supersede some or all local permitting authorities. Where there is state level regulation there may be a lead agency to coordinate the regulatory review process or a "one-stop" siting process housed under one agency.

Whether the permitting jurisdiction is state or local, wind projects may be subject to local and state environmental policy acts. These laws generally adhere closely to the language of the National Environmental Policy Act (see below). The content requirements of these laws parallel those of federal law, except where specific language narrows the scope of the impact statements.

Figure 6. A large crane is used to raise a rotor into position. Photo courtesy of AWEA.

Federal permitting authorities. In some cases (notably in the West), federal land management agencies such as the Bureau of Land Management or the United States Forest Service may be both the manager and the permitting authority. Additionally, agencies such as the Bonneville Power Administration (BPA) or Western Area Power Administration (WAPA) may be either a wind developer or the customer for the power. If the proposed wind farm has the potential to impact aviation, the Federal Aviation Administration (FAA) may be involved. Generally, when structures exceed 200 feet (about 61 m), the FAA is involved. If the project poses potential impacts on wildlife habitat and species protected under the Endangered Species Act, the Bald and Golden Eagle Protection Act, or the Migratory Bird Treaty Act, wind project permitting may involve coordination and consultation with the United States Fish and Wildlife Service and state wildlife agencies.

Federal actions are subject to the requirements of the National Environmental Policy Act (NEPA). Depending on the type of actions and the potential for impacts, the federal agency may have to prepare an environmental assessment or environmental impact statement for the project before it can act. The NEPA process requires public involvement in identifying issues to be considered and in commenting on the agency's analysis. The reviewing agency may use the results of the NEPA review to clarify requirements for mitigation and monitoring to address the project's environmental impacts.

Financing

To secure financing, a wind project developer needs a site with a permit to develop it, a completely defined project, a power purchase agreement, and firm access to a market. The financing entity must have confidence in the performance and reliability of the wind turbine being chosen for the project. There may be several equity holders in a project who together usually supply 10% to 50% of the project's capital costs. The remainder is borrowed from lending institutions, including banks and insurance companies, over a term of about 12 to 20 years.

Wind project developers can lower costs by taking advantage of the wind energy Production Tax Credit (PTC) or Renewable Energy Production Incentive program (REPI) included in the Energy Policy Act of 1992. Under current law, a privately-owned wind farm beginning operation by December 31, 2001, can qualify for a federal tax credit of $0.018 (1.8 cents) per kilowatt-hour (in 2001 dollars; amount adjusted annually for inflation). The federal incentive is applicable to the first 10 years of the farm's operation. A wind farm owned by a public entity receives the production incentive as a payment of $0.018 per kilowatt-hour (if funds have been appropriated on an annual basis).

Power Purchase and Transmission Agreements

The wind farm developer also begins negotiating with a utility or other buyer for a power purchase agreement, a transmission interconnection agreement, or both. Power may be sold to the local utility, a more distant utility, or to a different wholesale or retail customer. The developer will have to work with the local distribution utility or transmission system operator to obtain access to the electric power grid.

While negotiating with a buyer, the developer will obtain exclusive long-term development rights to the property by either buying or leasing the rights from the landowner. If the land is leased, the landowner can negotiate with the developer the terms of the relationship between the wind farm and other uses of the property, the location and type of access roads and other support facilities, and the condition of the land after wind operations cease. Lease conditions may influence some of the permitting considerations discussed in Chapter 3. The developer may also acquire easements from adjacent landowners to assure continuing access to the wind. Easements may restrict vegetation, structures, or other obstacles that would alter the flow of wind to the project site. Easements or leases may also be needed for the right to cross adjacent properties for the construction and maintenance of access roads or transmission lines.

Construction

The amount of time required to construct a wind project will depend on its size and the terrain and climate of the site. A wind project typically can be built and operational within a year of the date construction begins. Wind farm construction requires heavy equipment, including bulldozers, graders, trenching machines, concrete trucks, flat-bed trucks and large cranes. Construction normally begins with grading and laying out the access roads and the service roads that run to the wind turbines.

After the roads are completed, the concrete foundations for the turbine towers and ancillary structures are excavated and poured. Foundation work is followed by digging the trenches for the underground electrical cables, laying the electrical and communication cables, and building the overhead collection system and substation. Subsequent activities include assembling and erecting the wind turbine towers, mounting the nacelles on top of the towers, and attaching the rotors. (See Figure 6.) Once the wind turbines are installed, the electrical connections between the towers and the power collection system are made, and the system is tested.

The construction stage is the point at which some agencies initiate monitoring programs, if needed, to ensure that project construction and subsequent operation complies with any permit conditions; particularly conditions related to development near sensitive environmental or other resources. Monitoring programs are further discussed in Chapter 2.

Operation

A wind farm is almost completely automated, requiring few on-site personnel. The developer may operate the wind farm directly or by contract with an operation and maintenance company. Under normal conditions, wind turbines will operate automatically. Each wind turbine is equipped with a computer for controlling critical functions, monitoring wind conditions, and reporting information to the Supervisory Control and Data Acquisition (SCADA) system. The SCADA system monitors the activity of each wind turbine and diagnoses the cause of any failure. If a wind turbine shuts down and the operators are unable to restart it directly from the SCADA system, a crew of specially-trained mechanics ("windsmiths") are dispatched to perform repairs. SCADA operators also monitor the power output from each wind turbine and from the wind farm as a whole.

Repowering/Decommissioning

Repowering of a wind farm entails the removal of individual turbines and foundations, which are then replaced with new, typically larger and more cost-effective, equipment. If a wind project cannot maintain low operating costs but wind turbine technology continues to improve, the economics may support repowering of the site with newer technology. This may allow a site to continue producing power for decades. Over time, however, individual turbines or an entire wind farm may be decommissioned.

The decommissioning of a wind farm entails the dismantling and removal of all wind turbines and towers, as well as the underground and overhead collection and transmission system. Typically, the foundations for the towers and other structures are removed to a specified depth below the ground surface. Depending on the permits and terms of the lease, the wind developer may be required to restore vegetation to the site and return the property to its natural state or prior use. Decommissioning is further discussed under ACTIVE COMPLIANCE MONITORING in Chapter 2, and is touched upon in Chapter 3 as it relates to specific permitting considerations.

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Chapter 2
Guidelines for Structuring the Wind Farm Permitting Process

This chapter describes the typical steps in wind farm permitting, and presents several principles common to many successful permitting processes. Chapter 1 described how permitting can occur at various levels of government and how permitting processes can vary between and within states. Nothing in this handbook is intended to prescribe a specific permitting process or determine which level of government should be responsible for permitting. Each state and local government is encouraged to develop the process best suited to its needs and determine which decision-making considerations are applicable and appropriate. If the potential for wind development exists within their jurisdictions, permitting agencies are encouraged to consider the topics discussed in Chapter 3 in the context of the following suggestions for structuring an effective wind permitting process.

TYPICAL STEPS IN PERMITTING

Most permitting processes for energy facilities, including wind turbines and associated transmission facilities, consist of five basic phases:

1) Pre-application
2) Application Review
3) Decision-making
4) Administrative and Judicial Review
5) Permit Compliance

Pre-application

The pre-application phase occurs before a permit application is officially filed with the permitting agency. This phase may be formal or informal and may be a required part of an agency's permitting process or at the project developer's option. It may occur from a few days to as much as a year prior to filing a permit application. During this phase, a project developer and permitting agencies typically meet to help ensure that both understand the project concept, permitting process, and possible issues. The permitting agency should clearly specify whether environmental analysis or surveys are required or what other information must be submitted with the permit application. The permitting agency may also take this opportunity to become familiar with the project site, establish working relationships with other agencies, and acquaint community leaders and interest groups with the permitting process. Some agencies may review drafts of the permit application, environmental analyses, or other materials during this phase if time allows.

During the pre-application phase, project developers often meet with nearby landowners, community leaders, environmental groups, and other potentially affected interests. This acquaints the developer with their initial concerns and allows the developer to respond to questions regarding the project. In some jurisdictions, the project developer is required to hold public meetings or submit a public notice regarding the project during this phase.

Application Review

For most agencies, the application review begins when the project developer files a permit application. Many agencies may review the filing to ensure that it contains sufficient information for the agency and the public to adequately understand the project and its consequences. If the agency has a time requirement for making a decision on the project, the "clock" often starts once the agency has determined that the application is complete, in that it contains the appropriate type and amount of information.

The activities and time frames of the application review phase vary according to each agency's permitting process requirements. Some processes require public issue identification sessions, meetings, and site visits. Others also allow a "discovery" period where any formal participants in the process can question other participants regarding the project, potential impacts, and mitigation measures or possible alternatives. If a formal process is in place, the "lead" permitting agency may be required to evaluate the short- and long-term consequences of the proposed wind farm. This evaluation and the agency's recommendations on alternatives and requirements for mitigating the impacts, if necessary, frequently are presented to the project developer and the public in an environmental assessment document. These documents may be prepared by the appropriate federal, state, or local permitting agency staff, or by consultants for the agency.

Decision-making

In its decision-making, the agency not only determines whether or not to allow a proposed wind farm to be constructed and operated, but also whether environmental mitigation and other construction, operation, or wind farm decommissioning requirements are needed. This phase frequently includes one or more public hearings. Some permitting processes require that these hearings take place in the community most directly affected by the proposed project, while others are held in the county seat or state capital. For many state agencies, the final decision-maker is a siting board or commission. The City Council, County Board of Supervisors or Township Board of Supervisors is the final decision-maker for most local agencies. However, in some places the local decision-making body may consider a project only after it has been reviewed by a separate Planning Commission.

Administrative Appeals and Judicial Review

Appeals of all or a portion of a final decision are considered during the administrative and judicial review phase. The first avenue of appeal is directed to the decision-maker. Only after all administrative appeals have been exhausted are challenges to the decision reviewed by the courts. Appeals to the courts most frequently are directed at determining whether the permitting process was executed fairly and in accordance with the review requirements. In addition to considering such "procedural errors," the courts occasionally are also asked to consider factual errors that may have arisen during the permitting process.

Permit Compliance

The permit compliance phase extends throughout a wind project's lifetime, and may include inspection or monitoring to ensure that the project is constructed, operated, and decommissioned in compliance with the terms and conditions of its permit and all applicable laws. For some agencies, the permit compliance phase also includes resolving public complaints and expeditiously considering changes or amendments to a previously permitted project. Wind farm closure or decommissioning may also be monitored to ensure that a non-operating project does not represent a health or safety risk or pose environmental concerns, and that it is disposed of either in conformance with the permit conditions, or as warranted at the time operations cease. Agencies may: 1) require wind developers to post bonds after permitting to ensure that decommissioning costs are covered; 2) rely on the project developer to contribute to a decommissioning fund as the project generates revenue; or 3) rely on the salvage value of any abandoned equipment.

PRINCIPLES COMMON TO SUCCESSFUL PERMITTING PROCESSES

The following eight elements are suggested as keys to a successful process for permitting wind farms:

1) Significant Public Involvement
2) Issue-Oriented Process
3) Clear Decision Criteria
4) Coordinated Permitting Process
5) Reasonable Time Frames
6) Advance Planning
7) Timely Administrative and Judicial Review
8) Active Compliance Monitoring

While each of these guidelines may be applied individually, collectively they represent principles for structuring a permitting process to allow for timely agency review, meaningful public involvement, and sound decisions.

Significant Public Involvement

A key feature of a successful permitting process is providing opportunities for early, significant, and meaningful public involvement. The public has a right to have its interests considered in permitting decisions, and without early and meaningful public involvement there is a much greater likelihood of subsequent opposition and costly and time-consuming administrative reviews and judicial appeals.

While each agency's permitting process is likely to differ in the timing, location, and forum for public involvement, methods that have been used to facilitate public participation in a permitting process include:

- developers consulting with potentially affected or interested persons and giving them the opportunity to comment before proposals are submitted for permit approval;
- permitting agencies notifying potentially affected persons (adjacent landowners and the community at large) at the time of filing to inform them that a permitting process is beginning and describing how they can participate;

- permitting agencies holding public information meetings at the beginning of the permitting process to inform the public of the project, the permitting process, possible issues, and ways they can provide input;

- permitting agencies holding meetings or workshops in the community at times when the most people can attend to allow meaningful public involvement throughout the application and review phase;

- permitting agencies sending copies of any analyses or pre-decision documents to affected or interested persons and requesting formal comments;

- permitting agencies providing advanced notice to all affected or interested persons and the community in general of any decision-making hearings or meetings; and

- decision-making agencies allowing formal public involvement in open hearings when making the decision on the proposed project or considering appeals to the decision on the project.

Issue-Oriented Process

Successful siting processes often focus the decision on issues that can be dealt with in a factual and logical manner. No project, whether it is a wind turbine or any other type of development, is without issues. Chapter 3 of this handbook discusses the issues that are most likely to be encountered in permitting wind farms.

A key to dealing with issues objectively and in a timely manner is having appropriate information available early in the permitting process. Because the collection of information or data represents a major up-front cost, agencies need to provide opportunities for project developers to learn about information requirements well in advance of the permitting process. The requirements should be clear, reasonable, consistently applied to all projects (and all developers), and reflect information that actually will be used in the process.

Even with a focus on issues and the development of consistent, up-front information requirements, some issues may not be easily solved from a purely analytical perspective. Issues such as real or perceived public health effects associated with magnetic fields, fear of possible changes in property values, and visual impacts can become emotional. An issue-oriented approach can help focus the debate, educate the public and decision-makers, and ensure an analytic basis for the eventual decision. While this approach may not eliminate all opposition to a proposed project, a focus on issues allows for a clearer understanding of the objections to a project and a decision that is more likely to withstand any administrative or legal appeals of the facts associated with those objections.

Clear Decision Criteria

Knowing in advance the criteria the decision-makers will use in making their decisions is an important feature of a fair and efficient permitting process.

To help provide clear criteria and also more certainty on the likely outcome of a project, some decision-makers have taken one or more of the following steps in drafting ordinances or regulations:

- list all of the findings that need to be made in the decision;

- identify specific criteria to be used in decision-making;

- define which factors will be considered in a decision and how they will be considered and/or weighted;

- specify how environmental impacts, both positive and negative, and mitigation measures, economic considerations and other factors will be balanced in the decision-making process; and

- set minimum requirements to be met by a proposed project.

Specific decision-making criteria or factors will vary depending on the permitting agency involved, the issues or concerns within their jurisdiction, and the resources likely to be affected by wind development.

Most representatives of agencies, environmental interest groups, and members of the public indicate that the primary permitting criterion is a finding that the project either has no significant environmental or public health and safety impacts or that these impacts have been mitigated so that they are not significant. Participants in the permitting process generally rely on existing federal or state laws requiring an environmental assessment document prepared by the permitting agency as the basis for the evaluation of project impacts. However, the type of issues considered and the scope of the analysis can vary depending on: the agency, group, or local public involved; familiarity with the area, the project and the technology proposed; and the impact potential.

Many agencies also stress the importance of making a finding that the project complies with all applicable laws, ordinances, regulations, or standards. These include Federal Aviation Administration standards, Public Utility or Public Service Commission standards for electrical lines, state or federal endangered species laws, and local land use ordinances. Some local agencies believe that the requirements for Conditional Use Permits (CUP) are adequate for wind developments and feel the CUP process is well understood by all of the participants. Other local agencies have determined that their CUP process does not readily apply to wind energy developments and have modified their permit processes to better fit the characteristics and issues of wind projects.

Anticipating the potential for future wind development, some agencies have identified preferred siting areas for wind projects prior to receiving permit applications. In this manner, they have been able to guide development of the initial wind projects toward the least environmentally sensitive lands. This allows wind projects and their potential impacts to be better understood before development is permitted in more sensitive areas.

Some agencies use economic development considerations as decision-making criteria. Agency staff, public interest groups and wind developers have stressed the importance of including economics in the decision-making process and openly presenting the property tax, jobs, and economic development benefits as well as any costs associated with a project.

Wind developers indicate that they generally seek the highest wind sites in known wind resource areas that are economically feasible to construct, close to existing transmission facilities, and have low potential for significant environmental impacts. The developer is responsible for mitigating project-related impacts. With proper construction techniques and restoration practices, the need for additional mitigation may be limited.

Along with criteria related to integrating wind generation into the regional or state electrical system, some agencies also include the “need” for additional generation facilities in their decisions. This may be considered in the context of a state or utility service area “integrated resource plan” or other energy policies or goals such as energy diversity. In moving to a competitive electricity market structure, some states have discontinued the requirement to evaluate “need” because the project’s financial risk is not borne by the electricity ratepayers. Others have dropped the “need” process in cases where wind projects have been mandated by state law.

Coordinated Permitting Process

Project permitting can be one of the significant costs associated with developing wind resources and one of the major sources of uncertainty. Projects can be delayed and developers and agencies can incur significant costs when multiple agencies require separate processes, or where environmental impact assessment and mitigation requirements are inconsistent. This problem may be particularly significant where the wind resource area includes more than one jurisdiction or the proposed wind project and related facilities such as transmission lines or access roads affect multiple agencies with land use or permitting authority.

The most efficient permitting process for energy facilities would be one in which there is little or no duplication of documents or review by permitting entities, no conflicts between the different agencies in resolving issues, and no inconsistencies in permit requirements. Coordinated permitting has been achieved by:

- issuing all state and local permits by one agency in one process;
- making one agency responsible for coordinating the permit review by all other agencies;
- having all agencies agree on concurrent review processes and schedule and on a method for resolving any differences or disputes; or by

- establishing a multi-agency decision-making authority to consider the review and permit requirements of all agencies in one forum.

Coordination also is important in implementing permit requirements, monitoring during construction and operation, and decommissioning wind farms. Inconsistencies can develop when responsibilities shift from one agency or department to another. For example, the applicability of permit conditions and agreements can become confused when responsibilities are transferred from a local Planning Department that had the responsibility for permitting to the Building Department that had no previous involvement in the project but is now expected to monitor a project's compliance. If possible, the agency that developed the permit conditions should also be responsible for monitoring compliance.

Wind developers and agencies within some wind resource areas have found it beneficial to pool their resources to resolve issues and problems that arise during project development, site planning, construction, or operation. Pooled resources have led to ongoing studies of avian mortality, erosion control, noise, and other issues of local concern. For example, Minnesota's avian requirements were pooled so that there was one study that all developers paid for on a per-megawatt basis.

Reasonable Time Frames

In addition to close coordination between regulatory agencies, certainty in permitting can also be provided by establishing clear and reasonable time frames for completing the various steps in the permitting process and reaching a final decision. A principal concern of any developer is that the final decision on their proposed project will be subject to lengthy, unnecessary delays. Developers prefer known "stop points" for providing project information and making significant project changes so they can complete project design and financing arrangements.

Agencies, representatives of interest groups and the general public also need to have some certainty about the permitting schedule so they can plan their activities and make the best use of their resources.

In general, the timing of a permitting process is the responsibility of the permitting agency or agencies. Timing usually can be controlled if either one agency is in the lead for all permitting activities or all agencies involved have agreed to coordinate permitting activities and meet specific time goals. Many permitting agencies have found that the best way to address the concern about unnecessary delay is to specify reasonable time frames for each of the major phases of a permitting process leading to a final permitting decision. They clearly communicate the time frames to all participants throughout the process so that all involved have common expectations on the time available and how it is to be used.

Advance Planning

The successful permitting of any energy facility requires early planning and communication on the part of the developers and the permitting agencies.

Some state and local agencies have geographic-based information systems that identify land use and environmental resources. These may include zoning and land use designations, transmission lines, roads and highways including scenic designations, biological resources, parks, and recreation areas. A few agencies have discussed using this information to identify in advance geographic areas that: have developable wind resources or present opportunities for locating wind farms; are likely to pose permitting problems for wind farms; or where wind development would not be allowed. Establishing communications is another critical function of advance planning. Most participants involved in permitting wind farms – developers, agencies and the public – concur that identifying the key players and initiating communications is important to successful permitting and should be done before the formal permitting process begins whenever possible.

Timely Administrative and Judicial Review

If issues or conflicts raised during a permitting process are not satisfactorily resolved, the dissatisfied party – project developer, concerned public, or even agency staff – typically has an opportunity to appeal the decision to the decision-makers or to a higher administrative body. If the appeal is not resolved or if an administrative appeal process is not available, the conflict can be raised in local, state, or federal courts. While judicial appeals may be filed because of alleged factual or procedural errors, most successful appeals are the result of errors in the actual permitting process. Consequently a major goal of most wind permitting processes is to follow established procedures and produce factually-based decisions so that subsequent judicial appeals may be minimized. Should legal appeals occur, whether in an administrative or a judicial forum, the goal becomes to proceed efficiently and reach a conclusion in a reasonable amount of time.

One method used by many jurisdictions to increase the efficiency of handling appeals is to design the permitting process to systematically narrow the issues of concern. While all potential issues may be reviewed at the beginning of the process, issues that are either not of concern or that can be readily resolved in a manner acceptable to the developer, permitting agency staff, and concerned public may be set aside early in the process through meetings, workshops, or initial environmental documents. As a result, only those issues specifically identified by the parties as being in dispute need to be considered in hearings before the decision-makers. Both the hearings and preliminary decision documents can also be used to further focus the issues. Using a "scoping process," the permitting agency can produce a focused and detailed administrative record which can be used to support their decision. This can significantly limit any administrative or judicial appeals and allow them to proceed more efficiently.

Some of the methods agencies have used to enhance an efficient administrative and judicial review process include:

- using an issue-oriented public hearing process incorporating significant public involvement to reach a permitting decision;
- using a contested case or trial-type hearing process for an administrative review or appeal of the final permitting action;
- allowing consideration only of the record of the contested case proceeding in a judicial appeal;
- limiting the judicial appeal to only those issues identified and unresolved in the administrative appeal;
- defining who has standing to initiate the review;
- specifying time limits within which appeals must be initiated;
- setting standards for review;
- specifying how the costs of appeals will be paid and whether costs can be awarded to a prevailing party; and
- directing that judicial review will be to the highest state court of competent jurisdiction, thereby eliminating any intermediate appellate court review.

Active Compliance Monitoring

Most agencies include in their permits specific conditions that must be met during construction or operation to ensure public health, safety, and environmental protection. These monitoring programs may include annual or periodic site visits, more formal inspections or annual reports on wind farm operations and conditions. Active compliance monitoring also allows agencies to respond rapidly to resolve any public complaints, and to work with project developers to modify permits if project changes are needed.

Not all agencies carry out the compliance monitoring function in the same manner. The degree of monitoring typically depends on the interest and experience of the permitting agency. In some cases, few problems are encountered and the agencies feel little on-site monitoring is necessary. In others, the agency may have a very active program to perform monitoring, complaint resolution and project amendment functions.

If an agency establishes a compliance monitoring program, the agency should apply the program consistently and should:

- monitor only to ensure that permit conditions actually are being met;
- work closely with project developers to resolve any problems before they become compliance issues;
- establish a complaint resolution process and provide the public with a specific contact and phone number to call in the event of a complaint;
- identify in advance procedures and possible actions to deal with non-compliance;

- develop in advance a process for openly and expeditiously reviewing project amendments;

- establish provisions, in advance, for dealing with repowering, closure, or failure of projects; and

- stay abreast of the status of individual wind developments by maintaining communication with the developers throughout the life of their projects.

Funding of compliance monitoring programs varies with the permitting agency. In some cases, staff and other resources needed to implement monitoring are funded through general state or local revenues (income tax, energy surcharge, or property taxes). In other instances, monitoring activities are funded through a one-time or annual project fee. Most federal agencies have permit requirements for projects located on public lands and monitor these conditions with a portion of the development fees or annual lease payments. Some of these federal lease agreements also include requirements for performance bonding for use of the leased lands to ensure ongoing monitoring of the project and maintenance of the project and the leasehold.

The potential for public health and safety or environmental concerns does not end when construction of a wind project is completed or even when it ceases operation. Many agencies currently include conditions in their permits to deal with project closure or decommissioning and site restoration, including:

- removal of non-operating or downed equipment;

- removal of any residual spills;

- cleanup of storage yards and maintenance shops; and

- restoration of tower pads, access roads, and other areas.

CHAPTER 2 REFERENCES

Many states and localities have (or are putting) wind energy conversion system permitting processes or guidelines in place. The World Wide Web is a good source of current information on specific state and local wind energy permitting laws and guidelines (search on “wind energy” plus “ordinance”, “permitting”, “zoning” or “planning”). Workshop presentations on this subject are accessible through NWCC’s Web site: www.nationalwind.org.

Chapter 3
Specific Permitting Considerations

This chapter examines some of the specific considerations that may need to be addressed in permitting wind projects, whether they are large wind farms which sell power to utilities, one or more turbines constructed to support the existing transmission and distribution system, or single turbines to provide power to a single user. In planning for potential wind energy development or reviewing a proposed project, permitting considerations may include impacts and benefits associated with any or all of the following:

- Land use
- Noise
- Birds and other biological resources
- Visual resources
- Soil erosion and water quality
- Public health and safety
- Cultural and paleontological resources
- Solid and hazardous wastes
- Air quality and climate

Not all permitting considerations apply to every wind project. The relative importance of these issues and appropriate methods for addressing them will vary for each project because of differences in topography, land use, environmental resources, community concerns, agency experience and expertise, permitting processes, project economics, state or local energy policies, electrical system needs and characteristics, local attitudes and politics.

LAND USE

Many federal, state, and local agencies prepare and implement plans or policies that set goals and guidelines for the development and use of lands within their jurisdictions. These are intended to ensure that there is sufficient land available for various uses, that adjacent uses are compatible, and that there is an orderly transition between differing types of uses. In determining whether a proposed project is both consistent with existing plans, goals, and policies and compatible with existing and planned adjacent uses, permitting agencies often consider a project's potential to change the overall character of the surrounding area, disrupt established communities, or physically intrude upon the landscape. Where land use plans and policies exist, they often are critical to the outcome of local or state-level permitting decisions. However, a proposed project which is inconsistent or incompatible with existing land use plans and policies may still be approved if the permitting agency grants a variance.

Planning for wind development. If wind resources exist within a jurisdiction, land use planning agencies are encouraged to consider these resources early in their planning and policy activities. Some agencies, recognizing the potential for wind generation, have prepared maps of the potential wind resource areas showing information such as wind speed and duration, topographic features, site characteristics, existing roads and facilities, potentially sensitive land uses, and environmental considerations. Agencies also should review existing land use plans, zoning designations, and policies to provide appropriate, up-front guidance to developers on where and how to locate wind projects so that they are as consistent as reasonably possible with existing land uses and the environment. (See Figure 7.) These same actions will ensure that other development activities do not preclude the construction and operation of electric generation in prime wind resource areas. Some agencies have formally identified wind resource areas (WRAs) in their plans to facilitate permitting and development of wind generation in preferred locations.

Coordinating to resolve land use issues. As emphasized in Chapter 2, close coordination can benefit all the project stakeholders – including utilities, agencies, the public, and developers – by ensuring continuity, consistency, and certainty. Wind project developers should contact the land use agency or agencies regarding their plans and policies very early in the project planning process. To effectively resolve potential land use concerns, all the agencies involved in reviewing and making land use decisions on proposed wind generation projects must coordinate and communicate with each other in a timely manner throughout the lifetime of the project. It is also essential that staff within various offices or departments of an individual agency work together during the permitting process so that any conditions or requirements are consistent and are monitored throughout the lifetime of the project.

NOISE

Noise may be defined, for the purpose of permitting proposed development projects, as any unwanted sound. Whether a noise is objectionable will vary depending on its type (tonal, broadband, low-frequency, impulsive, etc.) and the circumstances and sensitivity of the individual who hears it (often referred to as the receptor). Primarily because of the wide variation in the levels of individual tolerance for noise, there is no completely satisfactory way to measure the subjective effects of noise, or of the corresponding reactions of annoyance and dissatisfaction. It may, however, be useful for comparison purposes to measure noise of various types from

Table 3.1 Typical Environmental and Industry Sound Levels

Source and Given Distance from that Source	***A-Weighted Sound Level in Decibels (dBA)***	***Environmental Noise***	***Subjectivity/ Impression***
Civil Defense Siren [TONAL]	*140-130*		*Pain Threshold*
Jet Takeoff (200') [BROADBAND and TONAL]	*120*		
	110	*Rock Music Concert*	*Very Loud*
Pile Driver (50') [IMPULSIVE]	*100*		
Ambulance Siren (100') [TONAL]	*90*	*Boiler Room*	
Freight Cars (50') [BROADBAND and IMPULSIVE]			
Pneumatic Drill (50') [BROADBAND] 80		*Printing Press Kitchen with Garbage Disposal Running*	*Loud*
Freeway (100') [BROADBAND]	*70*		*Moderately Loud*
Vacuum Cleaner (100') [BROADBAND and TONAL]	*60*	*Data Processing Center Department Store/Office*	
Light Traffic (100') [BROADBAND]	*50 `*	*Private Business Office*	*Quiet*
Large Transformer (200') [TONAL]	*40*		
Soft Whisper (5')	*30*	*Quiet Bedroom*	
	20	*Recording Studio*	
	10		*Threshold of Hearing*
	0		
Source: Peterson and Gross, 1974			

Figure 7. Agriculture is one example of a wind energy-compatible land use. Here a farmer plows the Earth and will raise crops almost to the foot of the turbines. Photo courtesy of Lisa Daniels, Windustry, and the American Wind Energy Association.

other sources in the area of the project, or to provide sound levels associated with common activities and situations (see Table 3.1). For regulatory purposes, noise limits often are specified at the nearest receptor (property line or residence) to the noise source, or at a given distance from the source.

Noise Considerations

Operating noise produced by wind farms is considerably different in level and nature than that generated by most power plants. Wind farms are typically located in rural or remote areas, with low population densities and low ambient noise levels. Due to the inherently windy nature of these locations, however, and to the quiet nature of modern wind turbines, ambient, or "background", noise generated by the wind often is sufficient to mask sounds generated by the wind farm, even for the very few individuals located close enough to the wind farm to be able to hear it.

A more detailed discussion of noise measurement, including the development of acoustic standards specifically designed for measuring noise from wind turbine generators, is in Appendix B.

Noise produced by wind turbines has diminished markedly as the technology has matured. Orienting rotors on the "upwind" side of the turbine tower avoids the low-frequency sounds associated with the passage of the blades through the tower's wind shadow, as occurs on "down-wind" machines. Also, the few down-wind machines that are being developed or sold have been intensively engineered to reduce low-frequency noise, through techniques such as increasing the distance of the rotor from the tower. Tubular towers and modern nacelles are streamlined, and produce little or no sound with the passage of the wind. Nacelles are more heavily sound proofed, resulting in better containment of sounds generated by the equipment inside them. And as blade airfoils have become more efficient, more of the wind is converted into rotational torque and less into acoustic noise. Under most conditions, modern turbines are quiet, generating primarily broad-band sound levels no higher than those of a moderately quiet room at distances of 750 to 1000 feet (about 230-300 m). (See Table 3.1 for several examples of typical environmental and industry sound levels.)

Construction-related noise generated by wind projects. As with most developments which involve construction, noise levels associated with the construction or decommissioning of wind power projects can be significant. Principal sources of such noise include truck traffic, blasting associated with foundation blasting (if necessary), and operation of heavy equipment. Construction or decommissioning of a project is accomplished within a few months' time. Vehicular traffic during operations typically is minimal.

The most significant impacts associated with construction noises would occur if they disrupt critical life-cycle activities (mating, nesting, etc.) of animal species of concern, or if they occur during off-hours and disturb people living near the site.

Noise Strategies

Strategies employed by some agencies in addressing potential noise concerns have included predicting and measuring noise levels, establishing noise standards, requiring noise setbacks, establishing zoning restrictions, and making turbine modifications. To effectively handle noise concerns that may arise after permitting, some agencies have implemented a noise complaint and investigation process.

BIRDS AND OTHER BIOLOGICAL RESOURCES

Biological resources include a broad variety of plants and animals that live, use or pass through an area. They also encompass the habitat that supports the living resources, including both physical features such as soil and water, and the biological components that sustain living communities. These range from bacteria and fungi through predators at the top of the food chain.

Any construction project can affect the biological resources at the site by disrupting the physical and ecological relationships of the communities living there. Power plants can have direct effects by destroying habitat and resident organisms. There are also indirect effects by releasing pollutants that affect organisms' health or by producing noise, motion, or another disturbance that affects the behavior of animals. These effects may be confined to a small part of the power plant where the disturbance is most acute, or may be dispersed over a wide area.

Biological Resource Considerations

Because wind projects typically are located in rural areas that are either undeveloped or mainly used for farming or grazing, the potential to directly and indirectly affect biological resources varies greatly. Conflicts, if any, will depend on the plants and animals present and the location and design of the wind farms. In a few cases permitting agencies have discouraged or prevented development due to potential adverse consequences to these resources. In cases where sensitive resources were not present or where impacts could be avoided or mitigated, development has been allowed to proceed.

Biological resource concerns associated with wind development may include:

- Causes of direct fatalities, such as bird and bat collisions with turbines, electrocutions, and other direct wildlife impacts;
- Loss of wildlife habitat due to wind farm construction;
- Indirect impacts on wildlife, such as loss of the use of an area due to disturbance; and
- Loss of natural vegetation.

Experience has shown that unless protected plants, animals or their habitat are destroyed or displaced during construction, permitting agencies are likely to find the non-collision consequences of wind development on wildlife to be insignificant. Constructing wind farms to disturb only a small amount of surface area confines habitat losses to only a small part of the entire project. In many cases, impacts on protected plant species can be avoided or minimized by carefully planning and constructing the project.

The impact of collisions between birds and wind farms has been the most controversial biological consideration affecting wind farm siting. In North America, only one wind resource area, with thousands of turbines, combined with site characteristics that attract some types of birds, has produced enough bird collisions and deaths to raise concerns by fish and wildlife agencies and conservation groups. On the other hand, most large wind farms have been operating for years with only minor impacts on birds and bats. To date, the only known concern regarding population effects has arisen in the Altamont Pass WRA. Population effects are a function not of the absolute number or birds or bats killed, but of the number killed relative to the size of the total species population in the region.

Estimates of annual bird fatalities due to collisions with man-made structures in the United States range from 100 million to greater than 1 billion. These structures include vehicles, buildings and windows, power lines, communication towers and wind turbines. Structures such as smokestacks, power lines, and radio and television towers have been associated with far larger numbers of bird kills than have wind farms. Other sources of bird fatalities, such as motor vehicles and pollution, are responsible for a much higher proportion of total bird deaths. Even cats (domestic and feral) account for an estimated 100 million bird deaths per year. Based upon an estimate of 15,000 operating wind turbines in the US, estimates of birds killed by wind turbines are projected at 33,000 bird fatalities per year for all species combined (WEST, Inc. for NWCC, 2001).

Many of the bird fatalities tend to come from common species (many of which are non-natives) such as house sparrows, starlings, gulls and rock doves (pigeons) (WEST, 2001). Raptors are a special concern, due to their low numbers and the protected status of most species. With the exception of

Altamont Pass WRA, even the numbers of this group killed by wind turbines are quite small. Shore and water birds are occasional fatalities at locations near seasonal or year-round water features.

Avian collisions and electrocutions. As with any tall facilities, birds can hit wind turbines. The movement of the blades is unique, and adds the potential for striking birds as they fly, although it is not known whether this increases avian mortality at wind turbines compared with other tall structures. Bats also have been killed by wind turbines. These concerns apply both to the individual animals killed, and the potential for affecting the populations of particularly sensitive species. Studies reporting the losses of raptors (birds of prey such as hawks and eagles) at the Altamont Pass wind resource area in California and soaring birds (storks and vultures) at Tarífa in Spain, have made bird collisions with wind turbines the most publicized biological resource concern associated with wind development. These studies showed that bird collisions can be a serious problem and that it is important to carefully evaluate the potential for collisions before developing any wind resource. Since then, studies in other wind resource areas have shown that bird collisions are not a critical problem at most wind development areas. (For a review of information about avian collisions with man-made structures, see West, Inc. 2001, USFWS 1980, and Banks 1979.)

While collisions with wind turbines are relatively infrequent, they do occur, and birds and bats are killed or seriously injured. Depending on the protective status or the number of individuals involved, these collisions may or may not be considered a biologically or legally significant impact. Because state and federal laws protect most raptors, any threat posed to these animals may present a legal barrier as well as a source of concern to local conservation groups.

Both the wind industry and government agencies have sponsored or are conducting research into collisions, relevant bird behavior, and mitigation and avoidance measures at wind farms. Studies focus on the effects on birds of the wind farm components—for example, comparing mortality at open framed lattice towers and closed tubular towers. They may also focus on the micro-siting of turbines (i.e., exactly where turbines are placed within the wind farm).

Other research is investigating birds' sensory physiology, and how it affects their ability to detect the components of a wind turbine. An example of this kind of study is painting different color patterns on turbine blades and observing whether the birds react to the turbines at a greater distance, or more rapidly (see Howell, Noone and Wardner, 1991; McIsaac, 2001, Hodos, et al., 2001).

Some of these studies are finding that both resident and migratory birds are involved in collisions. Birds typically migrate at altitudes of 1,500 to 2,500 feet (460-760 m). Even migrating songbirds fly at an altitude of 500 to 1,000 feet (150-300 m), well above the top of turbine blades in most locations. Therefore, collisions with wind turbines during actual migratory flights should be, and appear in actuality to be, rare. Studies of bird behavior around wind turbines have shown that when the turbines are visible, birds will change direction to avoid flying directly into turbines. In addition, water birds such as geese and swans tend to avoid the vicinity of turbines, keeping from 800 to 1,600 feet (250 to 500 m) away from them. (See studies by J. E. Winkelman, 1992.) As with other high structures, reduced visibility due to fog, clouds, rain and darkness may be a factor in collisions.

Aviation marker lights installed on turbines over 200 feet (60 m) may also be a factor in bird and bat fatalities. Birds are known to respond to red lights, which they may perceive as navigational clues. However, this has not been shown to be a problem at any wind energy development to date.

In some wind areas and on many transmission systems in the west, large birds have been electrocuted on distribution or transmission lines. This can occur when the bird touches two electrical conductors or one conductor and a grounded wire, either on a power line, at a riser pole, or in a substation. In all cases, when APLIC (Avian Power Line Interaction Committee) standards are applied electrocution potential is substantially mitigated.

The National Wind Coordinating Committee's Avian Subcommittee has produced a guidance document designed to promote standardization of studies to allow comparisons among sites, technologies, groups of birds, etc. Chapter 2 of that document stresses the value of an initial site evaluation in identifying possible risks to avian species:

"When one or more sites are under consideration, some quick and effective methods can be utilized to determine the types of bird resources on and near the site. Information-gathering at this stage can cover many variables and is intended to eliminate problematic surprises late in the permitting process and during operation. By conducting an appropriate assessment, the wind plant proponent and permitting authority will be able to estimate potential bird risk. A written assessment of each site considered should include:

1) Information from existing sources, including:

   - local expertise
   - literature searches
   - natural resource database searches for sen sitive species, for bird species known to be susceptible to collision events, and for areas used by large numbers of birds

2) Reconnaissance surveys

3) Vegetation mapping, habitat evaluation, and wildlife habitat relationships

4) Consideration as to whether the existing information and site visit information will allow compliance with, and be defensible for, regulatory and environmental law purposes." [6]

Overall, bird mortality has been a minor effect of wind energy development in most locations in the Continental United States. The numbers of birds killed have been low. In addition, the species killed do not always match the types and numbers of birds observed in pre-installation counts. This suggests that simple presence and numbers are not always accurate predictors of mortality. The results of numerous studies indicate that abundance and utilization are not clear indicators of potential fatality rates for individual species. The data suggest that just because a species is abundant does not mean it will have a high fatality rate (turkey vultures and ravens in the Altamont are two examples). Conversely, species that have a low abundance and utilization of a WRA do not necessarily have a low fatality rate. An extensive long-term research project was carried out at wind farms in southern California. Those studies indicated that mortality for most species was relatively low, and that raptor fatalities at the level seen at Altamont Pass may be unique. (See studies by Orloff and Flannery, 1996; Thelander and Rugge, 2000 (a) and (b), 2001; Anderson et al. 1996, 2000; Anderson et al. 2002a and 2002b, in preparation.)

Although normally not the most abundant species, raptors appear to be at high risk relative to other types of birds at several sites under study. (Again, however, in terms of actual raptor fatalities at wind projects, the Altamont appears to be unique). Based on what we know from the data, a pre-construction evaluation of species utilization will not predict what species will be killed. However, combined with results from other site studies, an assessment of potential species impact can be made. To date, most studies are not pointing to an issue with migrant songbirds.

Wildlife and habitat loss. Construction and operation of wind farms can affect wildlife through (in descending order of impact):

1) Collision with turbine structures, turbine blades and anemometer guy wires, causing death or injury;

2) Electrocution by contact with two or more phases of a three-phase electrical circuit or between any single phase and a grounded object such as a metal tower;

3) Direct loss of habitat;

4) Habitat alteration as a result of soil erosion, introduction of non-native vegetation, or construction of obstacles to migration; destruction of the nests of ground-nesting birds; increased predation by providing additional perches for raptors; and

5) Indirect habitat loss as a result of increased human presence, noise, or motion of operating turbines.

Because wind farms affect a relatively small proportion of the land they occupy, these effects should be minor in most cases. However, agencies may require them to be evaluated, particularly if pro-

[6] Studying Wind Energy/Bird Interactions: A Guidance Document, Dec. 1999 (www.nationalwind.org), p.12.

tected species are present. A developer who is aware of protected or sensitive species within an area may choose to alter the siting plan in order to minimize the proposed project's impact on those species. (See Chapter 4, "The Stateline Project" for one such example.)

Water quality and fish habitat can be affected if wind project development increases runoff or soil erosion from the site. See SOIL EROSION AND WATER QUALITY for discussion of this consideration.

Increased traffic, noise, night lighting, and other human activities can discourage wildlife from using areas around energy facilities and cause indirect habitat losses. Most of these effects are temporary, occurring only during construction, but some continue during operations at reduced levels. These activities are not likely to result in biologically significant effects for most wind projects. Again, however, agencies may require them to be evaluated.

Wind project construction also may alter an area or its habitats in a way that affects wildlife. For example, non-native plants may invade areas with ground loosened by construction and displace vegetation with higher wildlife food value. A disturbed ground surface can be more suitable for burrowing animals, many of which are attractive prey for raptors and other predators.

In areas subject to development pressure, wind projects can have a positive impact on wildlife by preserving open space and habitat that would otherwise be occupied by suburban housing and commercial development. (See Figure 8.)

Wind farms also may disrupt wildlife movements, particularly during migrations. For example, herd animals such as elk, deer and pronghorn can be affected if rows of turbines are placed along migration paths between winter and summer ranges or in calving areas. However, studies conducted at Foote Creek Rim in Wyoming documented no small-scale displacement effects of pronghorn antelope. Pronghorn use on the Rim has not declined since construction of the wind plant (Johnson, et al., 2000) While this type of effect is unlikely to occur, it should be considered when wildlife experts can substantiate that it is a reasonable possibility.

In the Prairie Pothole region of the Dakotas, concern was expressed about effects of wind project construction and operation on breeding birds. A modeling study was conducted by the Natural Resources Conservation Service for the U.S. Fish and Wildlife Service (Leddy et al, 1999). That modeling effort forecast very small effects on breeding songbirds and waterfowl. Monitoring studies at future operating wind installations in that region should help to verify the forecast.

Natural vegetation loss. The significance of vegetation loss associated with a wind project usually depends on the size of the area disturbed and whether rare or sensitive native plants are affected. Building a wind farm comprised of all of the components described in Chapter 1 disturbs some of the existing surface vegetation. Depending on the project design, these disturbances typically affect only three to five percent of the total surface area of a wind development site.

Site topography and the layout of access roads will affect the extent of vegetation disturbance and loss. Construction in steep areas can produce greater disturbance because these facilities require more extensive "cut and fill" as well as longer, more complex road systems. The establishment of invasive, weedy (noxious) plant species that thrive in disturbed areas may compound these losses. These

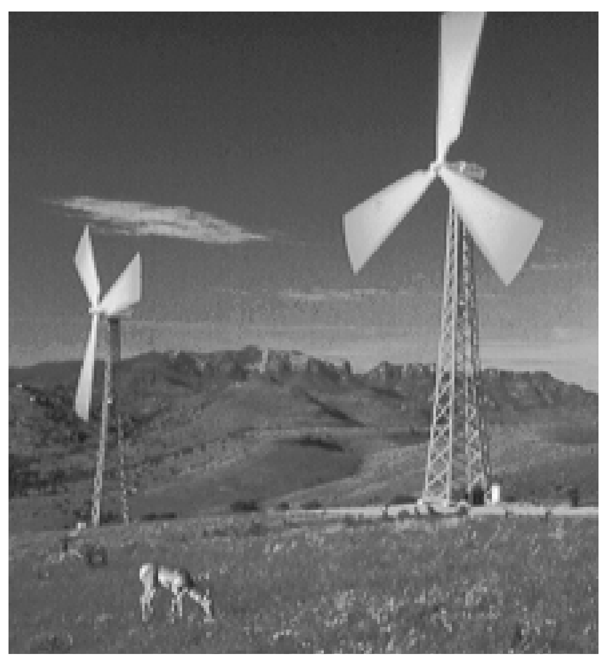

Figure 8. Unconcerned with the rotating blades, a Pronghorn Antelope grazes near these wind turbines in Fort Davis, Texas. Photo courtesy of AWEA.

often must be controlled to allow native vegetation to be re-established. Some wind projects include agreements or requirements to remove or prevent the re-growth of nearby trees that disrupt wind flow and reduce available energy (Gipe, 1995). The extent of the clearing typically depends on the wind speed, duration, and direction; topography; and the relative height and placement of the turbines. In forested areas, selective clearing may be necessary for turbine siting and operation. When applicable, biological resource evaluations of wind projects should consider the need for and effects of tree trimming and removal.

VISUAL RESOURCES

Visual or aesthetic resources refer to those natural and cultural features of an environmental setting that are of visual interest to people. An assessment of whether a project will be visually compatible with the character of the project setting or the natural landscape is based upon a comparison of the setting and surrounding features with simulated views of proposed project structures and facilities, as measured from several key observation points and as perceived by various observers. Questions to ask include:

- Will the project substantially alter the existing project setting (sometimes referred to as the "viewshed"), including any changes in the natural terrain or landscape?
- Will the project be in conflict with directly-identified public preferences regarding visual and environmental resources?
- Will the project comply with local goals, policies, designations, or guidelines related to visual quality? (Walker, 1996)

Visual Resource Considerations

Wind projects have somewhat different impacts on visual resources than most other electric generation technologies. This is in part because they usually have been located in rural or even remote areas, often with few nearby residential developments and only intermittent human visitation and use. The potential for visual resource impacts is sometimes considered as part of the evaluation of land use compatibility among multiple parcels with either similar or a diverse set of uses. The degree to which aesthetic impacts may become an issue during the project permitting process is a function of the value people place on the visual quality of the project setting and many other individual considerations. Elements which may influence visual impacts include the spacing, design and uniformity of the turbines, markings or lighting, roads built on slopes, and service buildings.

Spacing and turbine design. Effective use of wind resources requires maintaining adequate spacing between individual turbines as well as between rows, banks, or tiers of turbines. The spacing of wind turbines is determined by the distance needed for the winds to replenish. Turbines with shorter blades can be placed much closer together than larger turbines. Older, large-scale turbine projects tended to feature a larger number of closely concentrated units; today one new turbine may produce the same power as six to ten of the earlier units. Fewer and wider-spaced turbines may present a more pleasing appearance than tightly-packed arrays (see Figure 9).

Markings and lighting. Most modern wind turbines are of heights that bring them into airspace regulated by the Federal Aviation Agency (FAA). Thus, lighting, and possibly marking, are likely to be required on certain portions of the turbines installed in a wind project. More lights or markings may be required in installations near airports where the project may extend into the flight paths. Tall towers for anemometers or meteorological data gathering also may require similar markings and lighting. Federal regulations require markings on all objects over 200 feet (about 60 m), and state regulations may impose lower thresholds.

Roads on slopes. Where wind turbines are arrayed along ridgelines to capture wind flows over the ridges, the units are visible over greater distances. Against the sloping terrain of the ridges, surfaces newly exposed by construction of access roads and turbine pads may contrast sharply with existing soils and/or vegetative cover. From a distance, the visual impact of roads on slopes may be greater than that of the turbines. Constructing roads on slopes to gain access to the ridge tops also opens the potential for erosion that can produce additional long-term visual changes in the site area. (See Figure 10.)

Buildings and Storage. Service and maintenance buildings located within the project leasehold may visually intrude upon the surrounding landscape. Other visually undesirable aspects of the area may include: crates or stacks of materials stored for project repair; barrels, reels, and piles of waste materi-

Figure 9. Compare the visual effect of widely-spaced turbines at a wind facility in Lake Benton, Minnesota (top) with the visual impact of a more densely-spaced array in California's Tehachapi Pass (bottom). Photos courtesy of the American Wind Energy Association (top) and the California Energy Commission (bottom).

als; and non-functional turbines that are awaiting repair or removal, or have been disposed of on-site.

A valuable process tool for the assessment of potential project impacts to sensitive visual resources is the preparation and use of visual simulations. Evaluation of these simulations allows the project developer, permitting agencies, and the public to see the site as it is, and to see the changes the project will bring to the existing setting and any sensitive resources. After viewing the simulations of important vantage points, all stakeholders can be involved in adjusting project layout and design to minimize potential impacts.

SOIL EROSION AND WATER QUALITY

Soil erosion is a normal process in which soil particles are detached and removed by wind or water. Deposition of this eroded material, especially into waterways, is called sedimentation. Land disturbance resulting from construction and operation of energy generation facilities can remove vegetation and loosen soil particles, allowing them to be swept away by wind or water. This can accelerate the erosion process considerably if proper precautions are not taken, resulting in significant impacts (including both direct and indirect economic costs) both on and off the site.

Wind-induced erosion can increase fine particulate matter in the air which can adversely impact human health and reduce visibility. Water-induced erosion, in addition to removing soil and decreasing its productivity, results in sedimentation which degrades water quality,[7] damages biological resources, exacerbates flooding, and accelerates filling of reservoirs.

With appropriate precautions, the impact of wind projects on soil erosion and water quality should be minimal at most sites.

Developing an area for energy generation facilities changes site and surrounding area runoff and drainage characteristics and may adversely impact resources on and off-site. Uncontrolled runoff from construction sites can cause short-term increases in turbidity and siltation in nearby watercourses. Deposition of this sediment in nearby watercourses may adversely affect sensitive habitats, contribute to flooding, induce stream bank erosion, and alter downstream flow patterns. The costs associated with removing sediment from waterways, culverts

Figure 10. Roads on slopes can have a distinct visual impact, even from a great distance. Photo courtesy of the California Energy Commission.

[7] Uncontrolled erosion and runoff is the major cause of degraded water quality in the United States, depositing not only sediment, but also metals, nutrients and other contaminants in adjacent waterways.

and drains can be significant. Spills resulting from project construction and operation activities, such as refueling heavy equipment, may also impact water quality.

Soil Erosion and Water Quality Considerations

Although more dispersed than most other types of energy generation development, wind projects can still require a significant amount of land disturbance, especially where built on steep slopes. It is important to distinguish between temporary and permanent impacts.

PUBLIC HEALTH AND SAFETY

The public health and safety concerns for electrical generating facilities typically are associated either with the release of emissions into the atmosphere or solid and liquid wastes into surface or ground waters or the soil. Any of these can cause adverse public health impacts, violate standards for public health protection, or represent risks for workers. Wind farms differ substantially from most other electrical facilities in that they do not use a combustion process to generate electricity and hence do not produce any air pollutant emissions. In addition, the only potentially toxic or hazardous materials associated with most wind farms are relatively small amounts of lubricating oils, and hydraulic and insulating fluids. (However, bear in mind that even small leakages of such materials can have ground water or habitat impacts if left unchecked over time. See SOLID AND HAZARDOUS WASTES, below.) Setback requirements – whether part of a formal regulatory process or self-imposed by project developers for operational considerations – provide an adequate buffer between wind generators and consistent public exposure and access. Changes in larger turbine technology and design limit access to operating equipment. Most wind projects are on private land that is posted and not accessible without the permission of the landowner and the plant operator.

CULTURAL AND PALEONTOLOGICAL RESOURCES

Cultural resources are the structural and cultural evidence of the history of human development. They include both prehistoric and historic archaeological resources, as well as ethnographic and ethnic resources. Prehistoric archaeological resources are those materials relating to prehistoric human occupation and use of an area. Historic archaeological resources usually are associated with Euro-American exploration and settlement of an area and the beginning of a written historical record. Ethnographic resources are those materials important to the heritage of a particular ethnic or cultural group. Cultural resources may be encountered as sub-surface deposits or as surface trails, sites, artifacts, or structures. Cultural resources may also be associated with above-ground natural features, with plants or species harvested for traditional purposes, or with the surrounding physical setting.

Paleontological resources are the fossilized remains or trace evidence of prehistoric plants, animals, or very ancient humans preserved in soil or rock. Fossil resources may be found nearly anywhere but are most often found in geologic rock units comprised of water- or wind-borne sedimentary deposits. Fossilized evidence of ancient life-forms and environmental conditions may be weathering out onto the surface or may lie buried far beneath the modern-day ground surface.

Any type of project which includes vegetation clearance, disturbance of the ground surface, or excavation below the ground surface has the potential to affect archaeological and paleontological resources which may be present in the area. Additional impacts may be caused by compaction of the ground by heavy equipment or by the creation of improved public access to rural or previously isolated areas. The potential for impacts to cultural and fossil resources usually is directly correlated to the amount of ground disturbance, but even a "small" project area can contain particularly sensitive and valuable resources.

Cultural and Paleontological Considerations

In all states, cultural and fossil resources are protected by several federal laws, as well as by state and local laws. During project design and site development, cultural and fossil resource sites should be avoided and protected. Usually the location of most wind turbine towers and related access roads, transmission lines, and service or maintenance structures can be adjusted during the design phase to avoid impacts to known surface or subsurface cultural and fossil resources.

If project development impacts cannot be avoided, a program of data and resource recovery can usually mitigate any potential effects to cultural and

Where to Learn More about Controlling Erosion and Runoff

Local conservation districts, the Natural Resource Conservation Service, and the appropriate city or county can provide guidance on development of a storm water management plan, calculating runoff flows and selecting control practices to ensure water quality is protected. Local planning and permitting departments should have information on floodplain locations and expected flood levels and frequency. Inundation maps prepared by the Federal Emergency Management Agency (FEMA) show foot-by-foot inundation contours for most river/creek systems in United States. These FEMA maps should be available for review and copying at local land use planning or management agencies and are specific to the agency's own jurisdictional boundaries.

fossil resources (both of which generally employ similar data recovery techniques). An important first step in choosing appropriate mitigation measures is the evaluation, by a knowledgeable, qualified professional, of the project setting and site topography, to estimate the type and extent of the resources present (or expected) and the type and degree of mitigation, data recovery, and monitoring required. Preparation of an archaeological resource monitoring and mitigation plan will provide a set of contingency measures for previously unknown resources that may be encountered during project construction. The plan should be developed early and taken into account during the design phase of the project.

SOLID AND HAZARDOUS WASTES

A wind project may be spread out over a wide area, and consist of several individual sites. Waste materials will be generated during construction as well as operation of the wind farm. If turbines are not well-designed and maintained, fluid leaks at the turbine may occur, resulting in fluids not only dripping directly downward but flying off the tips of the blades and contaminating the ground below. These may be gearbox oils, hydraulic and insulating fluids. Some fluids may become hazardous wastes when spilled on the ground. On-site storage of new and used lubricants and cleaning fluids also constitutes a hazard.

It is necessary to ensure that construction wastes are collected from all such sites and disposed of at a licensed facility. When the wind farm is operating, waste production may be concentrated at service facilities and control centers, except when units are being serviced. Waste disposal practices should not be different from those required at other power plants or repair facilities.

Problems with fluid leaks can be anticipated and avoided by use of non-hazardous fluids. If any hazardous fluids (or fluids which may become hazardous wastes if spilled) are used, a Hazardous Materials Management Plan should be drawn up to address avoidance, handling, disposal, and clean-up. Turbine maintenance facilities and major turbine repairs can be done off-site. Some permits have banned on-site repairs of construction and maintenance vehicles.

AIR QUALITY AND CLIMATE

Wind generation is a non-combustion process relying on the direct conversion of mechanical energy into electrical energy. Thus unlike conventional fossil-fired electric power plants there are no emissions from the generation process. Indeed, to the extent that energy from wind farms displaces electricity from fossil fuels, pollutant emissions in other areas are reduced. Similarly, to the extent that energy from wind farms displaces existing or additional electricity from fossil fuels, greenhouse gas emissions and the prospect of resulting global climate change impacts are reduced. The extent of such pollutant and greenhouse gas emissions displacement can be calculated using the average emissions of the fuel mix from which the utility or other customer purchasing the wind-generated electricity normally obtains its electricity supply.

Federal, state, and local air quality plans are concerned with particulate matter less than 10 microns in diameter, known as PM10. Production of particulate matter is the only air quality impact likely to occur in conjunction with a wind farm, and is primarily associated with construction activities. These pollutants will be largely confined to the project area. No negative long-term air quality impacts are likely to occur.

During the siting and permit processes, the question of whether construction and operation of the wind generation project will impact air quality often is addressed. While it is difficult to accurately estimate project construction emissions, the potential for construction impacts on ambient air quality generally can be adequately mitigated during sensitive operations so that the overall impact is likely to be relatively small and temporary. The permit process will determine whether the project will comply with the applicable federal, state, and local air quality requirements.

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FURTHER REFERENCES

For further information about one or more of the permitting issues discussed in this chapter, see Appendix A (Additional Resources) and B (Noise Measurement).

Chapter 4
Case Studies

This chapter presents the permitting histories of several wind energy conversion projects. Sited in Oregon, Minnesota, and Wisconsin, these case studies illustrate the range of permitting processes in place in different locations. Although far from exhausting all the possible permutations of process and project experience, these cases do begin to indicate the range of project settings, developer approaches, and key permitting issues – as well as a variety of outcomes.

THE STATELINE PROJECT (OREGON)

Size of project

FPL Energy Vansycle LLC (FPL) proposed to construct and operate a wind energy facility in Oregon and Washington with an overall capacity of about 282 megawatts (MW), of which about 84 MW would be built in Oregon. (References to the "proposed facility" are references to the Oregon portion of the overall Stateline Wind Project, which spans the Oregon/Washington border.)

The proposed facility in Oregon would consist of 127 Vestas V47-660-kilowatt wind turbines with a total nominal electric generating capacity of 83.8 MW (127 turbines, each with a capacity of 0.66 MW). The proposed energy facility site occupies an area of approximately 15 square miles. Within that area, 127 wind turbine towers, four meteorological towers and approximately 17 miles of new or improved access roads would cover a total of about 60 acres of land surface. Turbines would be arrayed in nine strings along natural ridges within the facility site area. The number of turbines per string would vary from 4 to 37. The distance between turbines would be approximately 250 feet. Underground 34.5-kV cables connected to the substation in Washington would collect the electrical output of each Oregon turbine string.

The project is expected to have at least a 30-year life, maybe longer with repowering.

Location of project

The Stateline project would be constructed on privately owned land in Umatilla County, Oregon, and Walla Walla County, Washington. The project would connect to the Bonneville Power Administration (BPA) 115-kilovolt (kV) Franklin-Walla Walla electric transmission line approximately 3 miles north of the Walla Walla River and to the PacifiCorp 230-kV line approximately 1 mile south of the Walla Walla River through a project substation in Washington. The Oregon portion of the proposed facility is located north and east of Helix in Umatilla County and extends north to the Oregon-Washington border. The wind turbines would be located on ridge tops east of the Columbia River and south of the Walla Walla River. There are very few trees and no forests in the immediate area. The predominant forms of vegetation are agricultural crops and native grasses.

The proposed energy facility and its related or supporting facilities would occupy and permanently disturb about 60 acres of land. The facility is located on land that is zoned for exclusive farm use, most of which is either planted with dry-land wheat or grazing crops or is planted with native grasses under the Conservation Reserve Program (CRP). In addition to the permanently disturbed areas, about 117 acres of land would be temporarily disturbed during construction.

Permitting process and/or regulatory framework in place

The Washington portion of the project was not subject to a state-level review. On November 15, 2000, Walla Walla County granted a conditional use permit to the project, following a Washington state environmental policy act process. (A NEPA process had been initiated by BPA in the spring of 2000, but BPA withdrew after FPL decided to sell the entire output of the facility to PacifiCorp.) Construction began in Washington in January 2001.

In Oregon, under Oregon Revised Statutes (ORS) 469.320 in effect at the time the application was submitted, an applicant for an electric generating power plant with a nominal electric generating capacity of 25 megawatts or more of wind power from a single energy generation area must obtain a site certificate from the Oregon Energy Facility Siting Council (Council) before beginning construction.[8] The Council is a seven-member citizen commission appointed by the Governor. Staff work in support of the Council is done by the Oregon Office of Energy (OOE). OOE staff are sensitive to the public interest, the rules and standards of the Council, and the needs of the developer.

[8] The Oregon Legislature amended ORS 469.320 in HB 3788, which became effective in June 2001. Under Section 7, paragraph 9, of that law "an electric power generating plant with an average electric generating capacity of less than 35 megawatts produced from wind energy at a single energy facility…may elect to obtain a site certificate." The election is final upon submission of an application for a site certificate.

Under ORS 469.503 and OAR 345-022-0000(1), the Council must determine, before issuing a site certificate, that a preponderance of the evidence on the record supports the following conclusions:

1. The proposed facility complies with the standards adopted by the Council pursuant to ORS 469.501.

2. Except as provided in ORS 469.504 for land use compliance and except for those statutes and rules for which the decision on compliance has been delegated by the federal government to a state agency other than the Council, the facility complies with all other Oregon statutes and administrative rules identified in the project order as applicable to the issuance of a site certificate for the proposed facility.

3. The facility complies with the statewide planning goals adopted by the Land Conservation and Development Commission.

The Oregon siting process is explained on the web site of the Oregon Office of Energy. See http://www.energy.state.or.us/siting/process.htm for a general introduction to the Oregon energy facility siting process.

Primary issues that emerged during the permitting process

The primary issue that emerged during the siting process was what level of wildlife monitoring (particularly post-construction monitoring) would be adequate to assure the Council that the proposed facility would comply with the Council's Fish and Wildlife Habitat Standard.

Oregon law required the Siting Council to follow established standards, two of which relate specially to wildlife issues (the Fish and Wildlife Habitat Standard and the Threatened and Endangered Species Standard). Several sensitive wildlife species and species protected federally were known to occur in the region. Since the project lacked any federal nexus, no federal wildlife statutes (other than the Migratory Bird Treaty Act (MBTA)) applied to the project. It is unclear, legally and practically, how wind turbines will impact habitat quality per se, since very little wildlife habitat is lost by building wind turbines and much of the area is already intensively farmed. In other words, although disturbance caused by construction is known to alter access to habitat by animals, it is not clear how extensively wind turbine development at this proposed site will impact wildlife habitat. It is anticipated that data collected by FPL will begin to answer this question.

Several raptor species, including golden eagles, prairie falcons, Swainson's hawks and ferruginous hawks (a species of concern because of its rare status and known high sensitivity to any type of disturbance) are known to nest in the area of the project. At the same time, there is essentially no information on migrant numbers or species that use the area. As a result, there was never any question that some post-construction wildlife monitoring would be required.

Initially the OOE preferred a more substantial program of monitoring than FPL first proposed. The applicants emphasized that no endangered bird species were likely to be impacted, so little mitigation or monitoring would be warranted. The OOE staff and consultants emphasized that until the initial monitoring of the project occurred, no assessment could accurately be made of the possible impacts of the project.

The OOE consultants used data provided by the proponent's biologists, and standard statistical methods, to determine sample sizes needed to achieve statistically rigorous and thus reliable results (e.g., power analysis). Power analysis was conducted, but the proponent's biologist disagreed with the approach used, and the results. The consultants' results showed that to achieve a reasonable level of detectability, especially for such a rare event as a bird collision, all of the turbines being proposed needed to be systematically surveyed for three consecutive years.

The proponents argued that this was excessive sampling and that the level of detectability used in the power analysis was too high. The OOE's proposed plan originally called for surveying 120+ turbines for three years. In addition, the proponents attempted to estimate the cost of the proposed 3-year carcass monitoring effort. Their estimate, though never disclosed or supported, indicated that the money needed could be better used for habitat improvement than to monitor the turbines. Thus, the proponents' plan proposed surveying 50% of the turbines one year, and the other 50% of the turbines in the second year.

During the discussion on sample size and carcass monitoring, FPL informed OOE that, based on pre-construction monitoring, the Washington ground squirrel, a state-listed endangered species, occupied habitat in (or near) where 27 of the turbines were to be located. At least one member of the Oregon legislature threatened to introduce a bill to specifically exempt the wind energy project from the state's endangered species protection legislation and to allow the 27 turbines to stay in the project where they were originally proposed. A bill that would have had this effect was passed by the Oregon Legislature but vetoed by Governor Kitzhaber. Instead, FPL opted to exclude these turbine locations from the project, avoiding the affected area.

Determination of an appropriate wildlife monitoring protocol was the most contentious issue at stake in this case, but it was not the only issue that required careful review and analysis. Other significant issues included whether the facility complied with the statewide land use planning goals. Because the facility would preclude more than 20 acres of farmland from use, the Council had to decide whether an exception to the state's agricultural lands goal was warranted. In addition, substantial analysis was needed to determine the cost of site restoration, to address cultural and archeological issues and to assess potential seismic hazards, scenic impacts and noise generated by the wind turbines. Public comment also raised the issue of local economic benefit to the county, although the Council's standards do not directly address the question.

How were the issues resolved?

As part of the siting process, the Oregon Office of Energy (OOE) contracted with a biological consulting firm experienced with wind energy issues relating to bird and bat collisions. The OOE staff needed technical support on avian collisions, monitoring programs, and other technical input specific to wind developments. (The decision to hire an outside wildlife consultant was made by OOE in consultation with the Oregon Department of Fish and Wildlife (ODFW).) The OOE was reimbursed for the cost of the consultant through application fees paid by the project proponent, but the consultant worked directly for the OOE staff.[9]

The OOE consultant was provided with copies of the project's formal application and the proposed monitoring plan for natural resources, especially birds and bats. In this case, the proponent's project included wind facilities in Washington and Oregon, but the application process required separate proceedings in each state. A previously built wind facility existed in the general vicinity, and data on bird use were made available from that project to assist with determining possible impacts from the proposed project.

After much discussion, the OOE and FPL compromised on a monitoring protocol which was much less intensive than the one OOE had initially preferred, but much more intensive than the one FPL had first proposed. The plan now allows for additional monitoring beyond the first two years, based on analysis of the results. One concern about the proposed proponents' carcass monitoring plan was that it may not recognize that all turbines possess an equal probability for bird fatalities. The agreed-upon approach emphasizes the average number of kills per turbine per year, and will be largely insensitive to the kill rates of individual turbines. However, the OOE will be provided with all field data collected, not just the field averages.

In addition to fatality surveys (which will include searcher efficiency and searcher bias assessments), the monitoring effort will include: raptor nesting surveys, burrowing owl surveys, continued monitoring of pre-construction transects (to determine whether the operation of the facility results in loss of habitat quality), and, the utilization of a database to record bird and bat carcasses found by construction and maintenance personnel (Wildlife Response and Reporting System).

The Council approved a site certificate for the Stateline Project on September 14, 2001.

Lessons learned?

The value of the Oregon energy facility siting process is that it provides a deliberative structure in which difficult siting issues can be addressed and

[9] Oregon law provides that the applicant must pay all expenses of the Siting Council and Office of Energy in the review of a site certificate application. This includes hiring outside consultants. In this case, to help with noise, site restoration and seismic issues, OOE also hired a general energy consulting firm, which subcontracted with a structural engineer.

resolved. It is a process structured to allow input from all affected state agencies, local governments and tribes. It is a process that allows for public participation, comment and access to information.

Resolution of issues requires the ability and willingness of the developer to respond to Siting Council (Oregon Office of Energy) staff requests for additional information. The developer must be prepared to invest additional resources, if necessary, to meet the need for complete information in a timely manner. In this case, the applicant's delayed filing, coupled with its desire to complete construction before the expiration of the production tax credit, put unusual pressure on the Office of Energy to expedite the permitting process.

It is critical for the developer to plan for sufficient time for the siting process. This is particularly important if the economic feasibility of the project depends on completing construction by a certain date. At a minimum, the developer should assume that the Oregon state siting process will take twelve months to complete.

Secondly, potential avian impacts need to be identified before construction, and suitable monitoring plans need to be developed to adequately assess impacts in the early stages of operation so that mitigation strategies can be implemented to minimize impacts.

Recent changes to the regulatory review process

Since the permitting process for the Stateline project began, the Oregon Legislature has enacted legislation making Siting Council jurisdiction optional for wind facilities with an "average electric generating capacity" of less than 35 megawatts. The conversion of peak or nominal generating capacity to "average electric generating capacity" is written into the law. For a wind facility, an average electric generating capacity of 35 megawatts equates to a facility of 105 megawatts nominal capacity. Because the Stateline Wind Project (Oregon portion) has a nominal capacity of approximately 84 MW, it could have chosen a county-level review under the new law.

However, the Legislature also included language in the legislation that allows the developer of a wind facility of less than 35 average megawatts electric generating capacity to elect to obtain a site certificate. That is, the developer may choose the Siting Council process rather than going through a local permit process and dealing with state agencies individually. The Office of Energy has been working on a model ordinance and guidebook for county permitting of small-scale energy facilities. (These tools are not yet available as of this writing.)

PERMITTING LARGE WIND ENERGY SYSTEMS IN MINNESOTA

Size of projects

Since 1995, the Minnesota Environmental Quality Board (MEQB) has permitted seven large wind energy conversion systems (LWECS) greater than 5 megawatts. The projects range in size from a 10.2-MW facility consisting of 17 600-kW turbines to a 130.5-MW wind farm consisting of 87 1.5-MW turbines and a 107.25-MW wind farm comprising 143 750-kW turbines. More details about individual projects can be obtained from the MEQB's Web site at: www.mnplan.state.mn.us/eqb/wind. Several small wind energy conversion systems (SWECS), less than 2 MW, have also been built in Minnesota. Local units of government, typically counties, approve SWECS.

Location of projects

The projects permitted by the MEQB encompass approximately 40,000 acres of land in southwestern Minnesota in the counties of Lincoln, Pipestone and Murray. Known as Buffalo Ridge, this area is a 100-kilometer segment of the Bemis Moraine that runs diagonally from the northwest to the southeast, separating the Missouri and Mississippi River watersheds. It is located in the Coteau des Prairies physiographic region and ranges in elevation from 1,790 to 2,000 feet above sea level.

These wind farms are located within a lightly populated rural agricultural area, characterized by farm fields, farmsteads, fallow fields, pasture, native prairie, large open vistas and gently rolling topography. Local vegetation on the Buffalo Ridge is predominantly pasture with corn, small grains and forage crops, creating a low uniform cover. A mix of deciduous and coniferous trees planted for windbreaks surrounds farmsteads. Typically, the farmsteads and residences are located at lower elevations to avoid the winter winds. In the swales, there is occasional riparian growth of native willows, cattails, sedges and rushes. The transportation system in this area is composed of state, county and township roads.

Permitting process and/or regulatory framework in place

In 1994, after completing an Environmental Assessment Worksheet for the state's first proposed (25 MW) wind energy installation, the MEQB appointed a citizens' advisory task force to make recommendations on whether wind energy facilities should be regulated and, if regulated, who should have authority to regulate the permitting of large wind energy conversion systems. The task force, comprised of county commissioners, interested citizens and others, reviewed a number of issues related to wind energy development and made specific recommendations to the MEQB. Upon acceptance of these recommendations, the MEQB submitted proposed legislation in 1995, and the wind siting act was passed. This act declared it to be the policy of the state to site large wind energy conversion systems (LWECS) in an orderly manner compatible with environmental preservation, sustainable development and the efficient use of resources.

The legislation (Minnesota Session Laws 1995, chapter 203, codified at Minnesota Statutes sections 116C.691 to 116C.697), requires that any person seeking to construct a large wind energy conversion system in Minnesota obtain a Site Permit from the Minnesota Environmental Quality Board. A Large Wind Energy Conversion System (LWECS) is a combination of wind turbines that generates 5,000 kilowatts (5 MW) or more. Features of this legislation provide for:

1. EQB authority to issue site permits for all wind energy facilities larger than 5 megawatts.

2. A streamlined regulatory and review process

3. Issuance of a permit within 180 days (typically permitting takes from 60 to 90 days)

4. Environmental review as part of the permitting process

The act gives the MEQB rulemaking authority that provides: 1) an expedited process for LWECS; 2) a uniform and consistent review procedures for LWECS larger than 5 megawatts; 3) requirements for environmental review of the LWECS; 4) conditions in the site permit for turbine type and designs; site layout and construction; and operation and maintenance of the LWECS, including the requirement to restore, to the extent possible, the area affected by construction; 5) procedures for notification to the public of the application and for the conduct of a public information meeting and a public hearing on the proposed LWECS; 6) revocation or suspension of a site permit when violations of the permit or other requirements occur; and 7) that the MEQB site permit be the only site approval required. In April, 2002, the MEQB adopted permanent rules (Minnesota Rules, chapter 4401) for siting Large Wind Energy Conversion Systems. (These rules are available on the MEQB's Web site at: http://www.mnplan.state.mn.us/eqb/wind.)

Primary issues that emerged during (and after) the permitting process

Development issues. These permitted wind projects encountered very few issues during the review and permitting process. To date, issues have been raised in the permitting process primarily by other wind developers, and have included topics such as: wind rights acquisition, which developer was entitled to use the wind rights when they were held by a third party, real projects versus phantom projects, and requirements for proceeding with a project and project production data reporting.

In addition to these issues, the potential for avian and bat impacts has been raised, and the Minnesota Department of Natural Resources (MDNR) has expressed concern about the placement of turbine access roads and turbines in native prairie.

Post-construction issues. Minnesota's wind farms have generally been well accepted by the public and nearby residents. However, several issues have been identified such as television reception. Several residents in proximity to the wind farms have reported the inability to receive a clear picture on their television set. Another, but more isolated issue is caused by loose pieces of material within the blade. At lower wind speeds when the turbine is freewheeling, the centrifugal force is not strong enough to eliminate material bouncing around inside the blade. Cleanup of materials associated with turbine or blade modifications also has been a minor problem.

More recently the MEQB has received comments from residents who do not like the appearance of structures on the horizon. This comment has been more common in areas where the telephone lines and electric distribution lines have been placed underground.

Avian issues were addressed by the board's site permit condition that established avian monitoring studies requirements for the Buffalo Ridge Wind Resource Area. The permit also established a mechanism for equitably sharing the costs of implementing the study among the various developers of wind projects within the Buffalo Ridge Wind Resource Area. The proposed study establishes protocols for evaluating the cumulative effects on birds of proposed wind energy development in the Buffalo Ridge area of southwestern Minnesota. That study was terminated in 2000, when the board determined that avian impacts were minimal in southwestern Minnesota. However, because of the number of bat fatalities that were identified during the avian studies, the board has required wind developers on Buffalo Ridge to fund the costs of a Buffalo Ridge Windplant/Bat Interaction Study.

MDNR's concern about the placement of turbine access roads and turbines in native prairie has been addressed in the board's site permit for each project.

Lessons learned?

Minnesota's site permit requirements have established high standards for wind farm projects, designed to protect the interests of counties, communities and residents. Minnesota's site permit review and permitting for wind facilities also provides an environmental review for developers that is flexible, timely and efficient, but also has the ability to resolve issues before they become problems.

If projects are to be successful for the developer and for the community in which they are located, wind developers must be aware of local issues and proactive in addressing them.

SITING WIND POWER IN WISCONSIN: MAKING THE CASE AT THE LOCAL LEVEL

The state of Wisconsin has sought to encourage the development of renewable energy resources, specifically including wind power, by a number of means. Independently-owned power plants under 100 MW require only local land use permits, and state law limits the types of siting restrictions that can be placed on wind (and solar) energy systems at the local level. Wisconsin also has required utilities to build or acquire new renewable generating capacity, and has established a renewable portfolio standard designed to increase the contribution of renewable power sources to the state's electric power mix. Over 16,000 Wisconsin residential and business customers purchase electricity from green power programs.

Size of projects

Not all of the wind turbines in Wisconsin were built in response to policy requirements. However, this case study focuses on three wind energy projects subject primarily to local approval under the new legislation. The projects were:

1. Madison Gas & Electric (MG&E) – 17 turbines totaling 11.2 MW
2. FPL Energy (FPL) – 28 turbines totaling 25.2 MW in eastern Wisconsin
3. FPL Energy (FPL) – 20 turbines totaling 30 MW in western Wisconsin

Location of projects

Madison Gas & Electric – Calumet and Kewaunee Counties

Madison Gas & Electric sought to locate 17 turbines either in the Township of Stockbridge in Calumet County, or in the Townships of Lincoln and Red River in Kewaunee County. The Calumet County site was the utility's preferred location.

Stockbridge (Calumet County). The Town of Stockbridge is on the Eastern Shore of Lake Winnebago. The Niagara Escarpment forms an extended bluff near the lakeshore. The bluff is nearly 300 feet high in places. On top of the Escarpment, the flat to gently rolling terrain slopes gently downward to the east. Farms average 80-120 acres in eastern Wisconsin, more suitable for dairying than for crop production. Many parcels have been divided into 1- to 20-acre lots, ready for residential development. Since 1990, population has increased at the rate of 1% a year, with many new homes built along the bluff for a view of Lake Winnebago. Unlike other Wisconsin towns where wind farms have been erected, Stockbridge does not have a local zoning ordinance.

Lincoln and Red River (Kewaunee County). These two adjoining Towns are in the northwest corner of Kewaunee County, bordering Door County. Here, the Escarpment is lower than in Calumet County. Unlike the shoreline communities of Door County, the two towns see very little tourist traffic. As in Calumet County, farms tend to be small dairies, and there are fewer rural residential developments. Total population of both towns, excluding villages within their boundaries, was about 2,300 in 1990. The population of both towns has remained fairly constant since then, with an increase in the numbers of non-farm residents, mostly commuters to Green Bay.

FPL Energy – Washington County

In October 1998, in response to the incentives incorporated into Wisconsin's Electric Reliability Act (1997 Act 204), FPL Energy Wisconsin Wind LLC (FPL, a division of Florida Power & Light) advanced a proposal for developing a wind farm in the Town of Addison in western Washington County. Wisconsin Electric Power and Alliant Energy selected FPL's proposal to meet their Act 204 renewable requirements, and signed power purchase agreements with the developer in April 1999.

Addison Township. The Town of Addison is about five miles west of West Bend, and about 45 miles northwest of Milwaukee, accessible from a major four-lane highway. Parts of the County are growing rapidly, including more rural towns like Addison. Household income in Washington County is substantially higher than in more rural Iowa and Kewaunee Counties. North-south running U.S. Highway 41, and east-west running State Highway 33, divide the town into four roughly equal quadrants. The Niagara Escarpment runs east of Highway 41, although not as prominently as in Calumet County. Most of the turbines would be located in the southeast quadrant, where a few subdivisions have been built in recent years. Washington County farms tend to be smaller than those in Kewaunee, with more non-farm neighbors.

FPL Energy – Iowa County

Representatives from Enron Wind Energy Company began reviewing potential wind farm sites in western Iowa County and contacting landowners in June 2000. The project was eventually sold to FPL Energy.

Eden Township. The Town of Eden, in western Iowa County, is about an hour's drive west from Madison. Farming still dominates the economy. Farms are larger than in eastern Wisconsin, and population density is very low. Development pressure in Iowa County (and Eden Township) is light, and confined to the eastern flank of the county and the fringes of the cities. The Military Ridge in the Driftless Area of Southwestern Wisconsin extends from just southwest of Madison into Grant County, running straight across Eden just south of U.S. Highway 18. It is not as high as the Niagara Escarpment, and the wind resource is less. However, the land is relatively flat, open, and treeless, and can more easily fit larger groups of wind turbines.

Permitting process and/or regulatory framework in place

In 1994, Wisconsin adopted legislation to increase the state's use of renewable energy resources. Non-combustion renewables are ranked just below demand-side measures. The same legislation (1993 Wisconsin Act 414) limits the scope of local government's regulation of wind energy systems. Specifically, local restrictions on wind energy are permissible only if they: 1) serve to preserve or protect public health and safety; 2) do not significantly increase the cost of the system or decrease its efficiency; or 3) allow for an alternative system of comparable cost and efficiency. This was supported in March 2001, when the Court of Appeals reversed a lower court decision that upheld the local Board of Appeals' decision to deny two landowners permission to construct a wind turbine on their land. The higher court instructed the local Board to reconsider the conditional use permit applications in light of the statutory restrictions placed on local regulation of wind energy systems.

Electric reliability legislation adopted in 1998 (1997 Wisconsin Act 204) obligated four eastern Wisconsin utilities to build or acquire a total of 50 MW of new renewable generating capacity by December 31, 2000. Act 204 also changed the definition of "large generation facilities", requiring state review, from anything over 12 megawatts to anything over 99 MW. This effectively handed siting authority over to local governments. Non-utility wind projects under 100 MW need only local land use approvals.

Primary issues that emerged during the permitting processes

Given the regulatory framework in place, the primary issues to emerge during the three permitting processes were of a local nature, focusing on the concerns of local residents and property owners (particularly farm vs. non-farm property owners) in the Townships where land use permits were being sought.

Madison Gas & Electric

In April 1998, Madison Gas & Electric (MG&E) hosted informational meetings in Calumet County and Kewaunee County. The following month, the utility filed two applications for Construction Authority to install 17 Vestas V-47 turbines, either in the Township of Stockbridge (Calumet Co.) or in the Townships of Lincoln and Red River (Kewaunee Co.)

The following month, a resolution was introduced before Calumet County Board of Supervisors in opposition to MG&E's wind development proposal, and in July 1998 the Calumet Board adopted an anti-windpower resolution. At issue were the aesthetic impacts of wind turbines in a rural setting. The primary opponent of the proposed project was an individual wealthy landowner. MG&E then shifted its focus to Lincoln and Red River Townships in Kewaunee County.

In August 1998, MG&E signed agreements with area landowners to site nine turbines in the Township of Red River and eight in the Township of Lincoln. The utility began discussing with local government officials the procedures for obtaining permission to build a wind farm.

Although formal opposition did not crystallize as quickly and effectively as it did in Stockbridge, concerns were raised about potential noise problems and aesthetic impact, and participating landowners were slow to rally in support of the project.

Some of the objections stemmed from an earlier failed effort to develop windpower in the Township of Lincoln. In 1994, several landowners had signed options with New World Power, which had proposed to develop a wind farm and sell the power to a utility. According to some reports, when its bid was not selected, New World was slow to honor its agreements with participating landowners.

FPL Energy – Washington County

The FPL Energy (FPL) project team prepared its proposal to construct a 20.7-MW windpower project, consisting of 33 900-kW wind generators, and signed power purchase agreements with the utilities prior to receiving approval from Addison Township to erect three meteorological towers in June 1999. FPL did not submit a zoning application to the Township until September 1999. Newspaper articles reported on the developer's agreements with Wisconsin Electric and Alliant Energy, and also chronicled some complaints regarding sound impacts from Wisconsin Public Service's wind turbines in the Township of Lincoln.

In October, FPL withdrew its application in response to public opposition, and proceeded instead to host a series of informational meetings on the proposed project. Project opponents organized the Town of Addison Preservation Group (TAPG), while host landowners and other windpower supporters organized themselves as the Taxpayers for Addison Wind Farm. As in Kewaunee and Calumet Counties, the core issue is whether project benefits – which accrue primarily to individual farm owners – offset the aesthetic impact of erecting wind turbines in a rural area experiencing suburban growth.

FPL submitted a revised conditional use permit (CUP) application in December 1999, which it subsequently withdrew in response to a Federal Aviation Agency determination that some of the proposed turbine locations were too close to a private airport. TAPG continued its campaign against the project, noting that the 33 proposed turbines would be some of the tallest in the world (over 350 feet tall), and that there are 800 existing homes in "immediate proximity" to the proposed turbine sites.

FPL Energy – Iowa County

Enron Wind Energy Company submitted an application to Iowa County to situate 20 1.5 MW turbines in the Township of Eden in August 2000. Because two of the town's three board members are project participants, the application was taken up by the Iowa County Zoning Committee, which held a hearing and determined that the project area land would have to be reclassified from A-1 Agricultural to M-1 Industrial. At the hearing, one county resident expressed concerns over potential impacts, but did not oppose the project outright.

No formal objections or other significant issues were raised.

How were the issues resolved?
Madison Gas & Electric (MG&E)
Both the Townships of Lincoln and Red River issued CUPs to MG&E in October 1998, and in June, 1999 all 17 of MG&E wind turbines were placed in service. However, shortly after the dedication ceremony, both townships adopted 18-month moratoria on siting windpower. A Lincoln Moratorium Study Committee formed to discuss possible changes to the local zoning ordinance that would apply to future windpower proposals. Lincoln Township's moratorium was extended in January 2001, while Red River Township's moratorium passed uneventfully.

Although MG&E had quickly abandoned the Stockbridge site in response to anti-windpower resolutions adopted by the Calumet County Board of Supervisors, in September 1998 the Calumet Board went on to adopt a moratorium on constructing wind towers over 100 feet along the Niagara Escarpment.

FPL Energy – Washington County
In August 2000, Wisconsin Electric Power and Alliant Energy terminated their power purchase agreements with FPL, citing their obligation to fulfill their Act 204 renewable requirements by the end of the year. In October, FPL submitted its third CUP application to Addison officials. The application sought to build a 25.2-MW project, consisting of 28 (rather than 33) 900-kW turbines. TAPG filed a lawsuit seeking a judgment on the Township's authority to regulate windpower development within its borders. The suit was subsequently withdrawn following the Court of Appeals decision described earlier, which affirms statutory limitations on regulating wind energy systems by local governments. However, as of this writing, FPL has opted not to pursue wind energy project development in Addison Township.

FPL Energy – Iowa County
In September 2000, the Iowa County Zoning Committee approved Enron's request to rezone 15.65 acres of prime agricultural land as M-1 industrial, and also approved a conditional use permit allowing installation of 20 turbines. The Iowa County Board approved the project, which Enron subsequently sold to FPL Energy. Wisconsin Electric agreed to purchase the output from 17 turbines (25.5 MW), helping the utility to fulfill its Act 204 renewable generating capacity obligation. Alliant Energy agreed to purchase power from the remaining three turbines (4.5 MW), enabling the developer to complete the project as permitted. FPL completed construction and commissioning of all 20 turbines in June 2001.

Lessons learned?
Letting external deadline pressures drive project timetables is a recipe for trouble. Madison Gas & Electric accelerated its outreach and education efforts to beat the impending expiration of the federal Production Tax Credit (PTC). At both sites under consideration, the community learned of MG&E's intentions only a month before it filed an application for Construction Authority. This didn't allow time to communicate informally with local community leaders, potential project participants, and their neighbors. The compressed timetable aroused needless concern among local residents and started the local permitting process off on the wrong foot.

It is critically important to cultivate local champions early and avoid making implacable foes. MG&E's hasty action prevented them from becoming familiar with the communities, including their history with windpower. In both Stockbridge and Kewaunee, opposition arose before MG&E could gain any local support. In Stockbridge, MG&E was opposed by a wealthy landowner, who perceived wind turbines as an adverse change in his area and was able to support a lawsuit and other opposition tactics long after MG&E had abandoned plans for the site. In Kewaunee, at least one of the strong opponents had opposed the earlier New World Power proposal. Familiarity with this project would have allowed MG&E to anticipate his opposition and try to address it proactively.

When project opponents take the initiative, participating landowners tend to avoid public discussions, and may not actively defend their interests, for fear of further dividing the community. Intimidation by more forceful opponents can also be a factor. In Kewaunee, this put the utility in the position of trying to sell the project without apparent local support. It was a long time before the participating landowners began to publicly assert their interests. If the landowners had more time before permitting to explain their decision to lease land for wind turbines, the process may have been less divisive.

In Iowa County, by contrast, outreach to landowners as well as county officials began before the developer submitted a formal siting application. Moreover, the turbine layout proposed for the Eden Township project helped forge a united and committed base of landowners, who in turn acted as project advocates and persuaded their neighbors and elected officials to support the project. Beyond the initial phase of outreach, the project developer did not need to play the role of prime persuader.

The risk of opposition increases in areas experiencing significant (>1%/year) population and/or housing growth. Residential growth in an area with good technical potential for wind generation complicates the siting and permitting process. As the number of houses near to, or with a view of the installation increases, the likelihood of aesthetic or economic objections seems to increase. To the extent that new homeowners were attracted by the area's rural character, do not view their land as a source of livelihood, nor identify with the farmers in the area who earn their living working their land, these "commuter" households are less likely to support a proposed wind project. They do not understand the economic situation of resident farmers, and the extent to which wind energy revenues may act as a buffer against the fluctuations of the farm economy.

Suburban development pressure may not be a fatal problem if the remaining farmers still control the local government. In both Kewaunee and Addison, however, neither the old-line farm families nor the newcomers hold a distinct political advantage. This may help explain why the future of wind development is still unresolved in these towns.

Finding ways to address the concerns of neighboring non-participating farmers needs to become a higher priority. Some of the opponents to the Addison project are farmers without turbines proposed on their land. Opposition leaders may direct existing tensions onto the wind proposal. Developers may wish to consider compensating the community in some fashion that benefits even non-participants, such as impact payments to the township. Resulting benefits, such as reduced property taxes, may help to address concerns about inequities.

Local governments need help with the permitting process. The first towns approached by wind developers had no zoning classifications that directly addressed this type of facility. After the contentious Kewaunee County experience, several counties have passed ordinances specific to wind development, some fairly restrictive. It is very difficult for project developers to gain a variance from an existing ordinance without demonstrating hardship. Without state assistance to help local governments establish a procedure for reviewing wind projects, conflicts at the local level are likely to occur, especially for larger projects.

Limited experience suggests that it is easier to develop wind turbines in western Wisconsin than in eastern Wisconsin. Even though the wind resource is better along the Niagara Escarpment, siting turbines is more difficult there, due to smaller farm sizes and higher population densities. Also, local governments in western Wisconsin tend to be more responsive to the needs of farmers than those in the east. Perhaps this is because there is less likely to be political power split between farmers and non-farming homeowners in the West.

Appendix A: Additional Resources

GENERAL

American Wind Energy Association (AWEA). Publications include: Wind Energy Weekly and Windletter. Fax-on-request service: 1-800-634-4299. Web Site: http://www.awea.org. For a complete publications list, call (202) 383-2500. AWEA is the national trade association of the U.S. wind energy industry.

Appalachian Mountain Club (AMC). General Policy on Windpower. Revised draft approved by AMC Conservation Programs Committee June 1996. Boston, Ma.: AMC, 1996.

Landowner's Guide to Wind Energy in the Upper Midwest. Nancy Lange and William Grant. Minneapolis: Izaak Walton League of America, 2001 (2nd ed.). Handbook written for landowners in the Upper Midwest interested in opportunities for wind power development. Discusses how landowners can evaluate their wind resources, how they can evaluate the economics of wind energy under different development scenarios, and the contractual issues between landowner and wind developer.

Wind Energy Comes of Age. Paul Gipe. New York: John Wiley & Sons, Inc., 1995. Provides a comprehensive review of the wind energy industry. Addresses development of wind turbine technology, environmental costs and benefits of wind energy, and future development potential of wind energy.

Wind Energy in America: A History. R. W. Righter. University of Oklahoma Press, 1996.

Wind Energy Resource Atlas of the United States. Elliott, D.L., C.G. Holladay, W.R. Barchet, H.P. Foote, W.F. Sandusky.

DOE/CH10093-4. Richland, Washington: Pacific Northwest (Battelle) Laboratory, 1987. http://rredc.nrel.gov/wind/pubs/atlas.

Wind Energy Series. Issue Papers and Briefs released by the National Wind Coordinating Committee. Prepared by M. Brower, J. Chapman, K. Conover, J. Hamrin, R. Putnam. Washington, D.C.: 1997. Available from RESOLVE, Inc., (202) 944-2300 and www.nationalwind.org. Titles include 1) The Benefits of Wind Energy, 2) Wind Energy Environmental Issues, 3) Siting Issues for Wind Power Plants, 4) Wind Energy Resources, 5) The Effect of Wind Energy Development on State and Local Economies, 6) Utility Procurement of Wind Resources, 7) Wind in a Restructured Electric Industry, 8) Incorporating Wind into Resource Portfolios, 9) Wind Energy Transmission & Utility Integration, 10) Wind Performance Characteristics, and 11) Wind Energy Costs.

Wind Energy System Operation and Transmission Issues Related to Restructuring. Prepared by Christopher T. Ellison, Andrew B. Brown and Nancy A. Rader for the National Wind Coordinating Committee. Washington, D.C.: NWCC, 1998.

Wind Power for Home & Business: Renewable Energy for the 1990s and Beyond. Paul Gipe. Post Mills, Vermont: Chelsea Green Publishing Co., 1993.

Windy Landowner's Guide to Wind Farm Development. Sam Sadler, et al. Livingston, Montana: Windbooks, 1984.

Windpower Monthly News Magazine. Grand Junction, Colorado.

SITING PROCESS

Energy Aware Planning Guide: Energy Facilities. California Energy Commission: 1996.

Energy Infrastructure of the United States and Projected Siting Needs: Scoping Ideas, Identifying Issues and Options – Draft Report of the Working Group on Energy Facility Siting to the Secretary of the Department of Energy. Department of Energy. December, 1993.

Minnesota State Legislature. Wind Siting Act [Minnesota Statutes, chapter 116C.691-116C.697]. An act relating to energy; exempting wind energy conversion systems siting from the power plant siting act; authorizing rulemaking; proposing coding for new law in Minnesota Statutes.

Model State Certification and Siting Code for Electric Transmission Facilities—Final Staff Report of a Keystone Policy Dialogue. The Keystone Center. March, 1994.

Wind/Soar: A Regulatory Guide to Leasing, Permitting, and Licensing in Idaho, Montana, Oregon, and Washington. Don Bain. Portland, Oregon: The Bonneville Power Administration, 1992.

NOISE

See Appendix C for resources related to noise measurement and control.

BIRDS AND OTHER BIOLOGICAL RESOURCES

Effects of Wind Energy Development: An Annotated Bibliography. California Energy Commission (CEC), March 1996.

Avian Monitoring and Risk Assessment at Tehachapi Pass Wind Resource Area, California: 1995 Progress Report. Available from the California Energy Commission, (916) 654-4166.

Proceedings: Avian Interactions with Utility Structures International Workshop. Electric Power Research Institute and Avian Powerline Impact Committee (APLIC), December 1993.

Proceedings of the National Avian-Wind Power Planning Meeting, Denver, Colorado, July 20-21, 1994. Proceedings published April, 1995. DE95004090. Available from NTIS, US Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161. (703) 487-4650. Available on the web at http://www.nrel.gov/wind/avian.html.

Proceedings of the National Avian-Wind Power Planning Meeting II, Palm Springs, California, September 20-22, 1995. Proceedings published October, 1996. NREL/CP-500-23821. Available from NTIS, US Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161. (703) 487-4650. Available on the web at http://www.nrel.gov/wind/avian.html.

Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego, California, May 27-29, 1998. Proceedings published June, 2000.. Available on the web at http://www.nrel.gov/wind/avian.html.

Proceedings of the National Avian-Wind Power Planning Meeting IV, Carmel, California, May 16-17, 2000. Proceedings published May, 2001. Available on the web at http://www.nrel.gov/wind/avian.html.

VISUAL RESOURCES

Foundations for Visual Project Analysis. Richard C. Smardon, James F. Palmer, and John P. Felleman, eds. New York: John Wiley & Sons, 1986. Includes chapters on “Landscape Visibility,” “Countryside Landscape Visual Assessment,” “Simulating Changes in the Landscape,” and “Decision-Making Model for Visual Resource Management and Project Review.”

Visual Resource Management Program. US Bureau of Land Management (BLM), 1980. Stock No. 024-011-00116-6. US Government Printing Office, Washington, DC 20402. The BLM’s Visual Resource Management (VRM) procedure assigns numerical ratings to Scenic Quality, Sensitivity Level, and Distance Zones to determine the degree of modification allowable on a given parcel of BLM land. Designed primarily for use in remote, rural areas.

Wind Turbines in harmony with the landscape. Working report prepared for Logstor Municipality by Moller & Gronborg, architects and planners, AS. Analysis of wind turbines in a Danish municipality and alternative scenarios for replacing them, with consideration given to visual impacts.

SOIL EROSION AND WATER QUALITY

Biotechnical Slope Protection and Erosion Control. D.H. Gray and A.T. Lester. New York: Van Nostrand Reinhold, 1992. Handbook combines engineering and revegetation approaches to erosion control that are accessible to the layperson as well as the professional.

California Stormwater Best Management Practice Handbook, Construction Activity. Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning Associates, 1993.

Erosion and Sediment Control Handbook. S.J. Goldman, K. Jackson, T.A. Bursztynsky. New York: McGraw-Hill Inc., 1986.

Erosion Control. Bimonthly publication of the International Erosion Control Association presents informative articles accessible to the layperson on all aspects of erosion control in the U.S.

Journal of Soil and Water Conservation. Bimonthly journal of the Soil and Water Conservation Society. Oriented to agricultural issues, but also contains informative articles on all aspects of erosion control and water quality protection.

Land and Water. Foster Communications. Bimonthly magazine with brief, informative articles on recent developments in erosion and runoff control.

Manual of Standards for Erosion and Sediment Control Measures. Association of Bay Area Governments. Oakland, California: Second edition, 1995.

Reducing the Impacts of Stormwater Runoff from New Development. New York State Department of Environmental Conservation, Division of Water, Bureau of Water Quality Management, 1992. Handbook reviews storm water principles and issues for the layperson.

Revegetation of Disturbed Land in California. L. Van Kekerix and B.L. Kay. California Department of Conservation, Division of Mines and Geology, 1986. Handbook evaluates the issues involved in the revegetation of disturbed sites. Information applicable to arid portions of the western US.

Virginia Erosion and Sediment Control Handbook. Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation. Third edition, 1992. Technical handbook presents planning guidelines and technical design information, including standards and specifications.

Water Quality, Prevention, Identification and Management of Diffuse Pollution. V. Novotny and H. Olem. New York: Van Nostrand Reinhold, 1994.

CULTURAL AND PALEONTOLOGIC RESOURCES

National Historic Preservation Act of 1966. Includes amendments through 1992. [Title 16, United States Code, section 470]. This act was adopted by the US Congress to establish a national policy to preserve for public use historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the United States.

Executive Order 11593, “Protection of the Cultural Environment,” May 13, 1971. [36 Code of Federal Regulations, section 8921 as incorporated into Title 16, United States Code, section 470a]. This order requires the protection and enhancement of the cultural environment through providing leadership, establishing state offices of historic preservation, and developing criteria for assessing resource values.

Federal Land Policy and Management Act (FLPMA): 1976. [Title 43 United States Code, sections 1701-1784]. Requires the Secretary of Interior to retain and maintain public lands in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric water resource, and archaeological values [section 1701(a)(8)]. The Secretary, with respect to the public lands, shall promulgate rules and regulations to carry out the purposes of this Act and of other laws applicable to public lands (section 1740). Based on the directives of this Act, the Department of Interior has developed guidelines for paleontologic resource protection and impact mitigation.

American Indian Religious Freedom Act, 1978. [title 42 United States Code, section 1996]. This act protects Native American religious practices, ethnic heritage sites, and land uses.

Archaeology and Historic Preservation: Secretary of Interior's Standards and Guidelines. [As published in Part IV of the Federal Register on September 29, 1983]. Developed and published for use by the National Park Service and now used by other federal, state, and some local agencies.

Regulations of the Advisory Council on Historic Preservation Governing the Section 106 Review Process. Revisions effective October 1, 1986. [36 Code of Federal Regulations, Part 800: Protection of Historic Properties]. Section 106 of the National Historic Preservation Act of 1966 requires a federal agency head to take into account the effects of an agency's undertakings on properties included in, or eligible for inclusion in, the National Register of Historic Places. These regulations set forth the steps that must be taken to identify, evaluate, and protect eligible or potentially eligible properties.

Native American Graves Protection and Repatriation Act. 1990. [Title 25, United States Code section 3001, et seq]. Defines "cultural items," "sacred objects," and "objects of cultural patrimony;" establishes an ownership hierarchy; provides for review; allows excavation of human remains but stipulates return of the remains according to ownership; sets penalties; calls for inventories; and provides for return of specified cultural items.

Curation of Federally-Owned and Administered Archaeological Collections: Final Rule. [As published in Part III of the Federal Register on September 12, 1990]. Developed and published for use by the National Park Service and now used by other federal, state, and some local agencies.

Appendix B: Noise Measurement

INTRODUCTION

Sound is typically measured in decibels (dB). The decibel scale is logarithmic and results in the following relationships:

- except under laboratory conditions, a change in sound level of 1 dB cannot be perceived;
- outside of the laboratory, a 3 dB change in sound level is considered a barely discernable difference;
- a change in sound level of 5 dB will typically result in a noticeable community response; and
- a 10 dB increase is subjectively heard as an approximate doubling in loudness, and almost always causes an adverse community response.

In determining responses to changes in noise, analysts usually measure noise in decibels on a weighted scale or dB. This scale is similar to the response of the human ear. Other statistical descriptors are used to describe the time-varying character of ambient noise, and to account for greater sensitivity to nighttime noise levels. (See Table 3-1.)

In a typical community or habitation, ambient (background) noise is typically a conglomeration of noise from nearby and distant sources, relatively steady and homogeneous, with no particular source identifiable within it. Manmade noise is noticeable to many receptors when it exceeds the naturally occurring background noise by about 3 dB. Tonal (distinct frequency) noise is much more noticeable at the same relative loudness level because it is composed of one or more distinct tones, which stand out against broadband (multi-frequency) background noise.

WIND TURBINE ACOUSTICS STANDARDS

A number of noise measurement techniques have been developed that are specific to wind energy systems:

- "A Proposed Metric for assessing the Potential of Community Annoyance for Wind Turbine Low Frequency Noise Emissions" (SERI/TP-217-3261). Published in November, 1987 by the Solar Energy Research Institute (now the National Renewable Energy Laboratory) based in Golden, Colorado. In this publication, Neil Kelly proposed a low frequency noise metric.
- "Procedure for Measurement of Acoustic Emissions from Wind Turbine Generator Systems, Tier 1 - 2.1" Published by the American Wind Energy Association (AWEA), Washington, DC, 1989. Copies of AWEA's measurement procedure are available from AWEA's Publications Department at (202) 383-2520.

Types of Noise Which May be Generated by Wind Turbine Operation

Broadband. Noise characterized by a continuous distribution of sound pressure with frequencies greater than 100 Hertz (Hz). Often caused by the interaction of wind turbine blades with atmospheric turbulence. Also described as a characteristic "swishing" or "whooshing" sound.

Tonal. Noise at discrete frequencies. Caused by wind turbine mechanical components such as meshing gears, by non-linear boundary layer instabilities interacting with a rotor blade surface, by vortex shedding from a blunt blade trailing edge, or unstable shear flows over holes or slits.

Impulsive (RARE). Short acoustic impulses or thumping sounds that vary in amplitude as a function of time. Caused by the interaction of wind turbine blades with disturbed air flow around the tower of a downwind machine (one on which the rotor faces away from the prevailing wind). ***Very few machines being installed today are downwind units.***

Low Frequency (RARE). Noise with frequencies in the range from 20 Hz to 100 Hz associated mostly with older-model downwind turbines. Caused when wind turbine blades encounter localized flow deficiencies due to the flow around a tower, wakes shed from the other blades, etc.

In addition to these, a standard measurement document has been adopted by the International Electrotechnical Commission (IEC). To obtain the most current information about the status of this standard, contact the IEC at:

International Electrotechnical Commission
3, rue de Varembe
P.O. Box 131
1211 Geneva 20
Switzerland
Phone: 011-41-22-919-0211
Fax: 011-41-22-919-0300

ADDITIONAL NOISE MEASUREMENT REFERENCES/RESOURCES

California Department of Health Services, Office of Noise Control. Guidelines for Preparation and Content of Noise Elements in General Plans, 1976.

California Department of Health Services, Office of Noise Control. Model Community Noise Control Ordinances, 1977.

Charles M. Salter Associates, Inc. Guidelines for Preparing Environmental Impact Statements on Noise. National Research Council / National Academy of Sciences, 1977.

Peterson, Arnold P. G. and Ervin E. Gross, Jr. Handbook of Noise Measurement, 7th ed. GenRad, Concord, Mass., 1974.

Suter, Alice H., "Noise Sources and Effects - A New Look." Sound and Vibration, January 1992.

Thumann, Albert and Richard K. Miller, Fundamentals of Noise Control Engineering. Prentice-Hall, 1986.

U.S. Environmental Protection Agency (EPA). Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (55/9-74-004), 1974.

Definition of Some Technical Terms Related to Noise

Decibel, dB	*A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).*
Frequency, Hz	*The number of complete pressure fluctuations per second above and below atmospheric pressure.*
A-Weighted	*The sound pressure level in decibels as measured on a Sound Level*
Sound Level, dB	*Meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this paper are A-weighted.*
L10, L50, & L90	*The A-weighted noise levels that are exceeded 10%, 50%, and 90% of the time, respectively, during the measurement period. L90 is generally taken as the background noise level.*
Equivalent Noise Level Leq	*The average A-weighted noise level during the Noise Level measurement period.*
Community Noise	*The average A-weighted noise level during a 24-*
Equivalent Level, CNEL	*hour day, obtained after addition of 5 decibels to levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night between 10 pm and 7 am.*
Day-Night Level, Ldn	*The Average A-Weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured between 10 p.m. and 7 a.m.*
Ambient Noise Level	*The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.*
Intrusive Noise	*That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.*

Source: California Department of Health Services, 1976.

NWCC members include representatives from:

Alliance of Energy Suppliers
American Electric Power
American Wind Energy Association
Atlantic Renewable Energy Corporation
Bonneville Power Administration
California Energy Commission
Center for Resource Solutions
City of Lake Benton, MN
Community Energy Inc.
CSGServices Inc.
EAPC Architects Engineers
Ed Holt & Associates
Electric Power Research Institute
Energy and Environmental Research Center
Enron Wind Corporation
Environmental & Energy Study Institute
Exeter Associates
FPL Energy
Greenmountain Energy Co.
Green Marketer
Iowa State Legislature
Kansas Corporation Commission
Kansas State Representative
Land & Water Fund of the Rockies
Last Mile Electric Co-op
Lincoln County Enterprise Development Corporation
Midwest Renewable Energy Corporation
Minnesota Environmental Quality Board
Montana Public Service Commission
National Association of Regulatory Utility Commissioners
National Association of State Energy Officials
National Conference of State Legislatures
National Renewable Energy Laboratory
North Dakota Office of Community Assistance
North Dakota State Representative
Nebraska Public Power District
NEG Micon USA, Inc.
Oregon Office of the Governor
PacifiCorp
Pennsylvania Public Utilities Commission
Renewable Energy Consulting Services, Inc.
South Dakota Governor's Office
South Dakota Public Utilities Commission
Union of Concerned Scientists
U.S. Department of Agriculture
U.S. Department of Energy
U.S. Department of Interior/ BLM
Utility Wind Interest Group
Vermont Environmental Research Associates, Inc.
Vermont Public Service Board
Western Resources
Wind Management, LLC
Windustry Project
Wyoming Business Council
Xcel Energy

The NWCC is a collaborative endeavor formed in 1994 that includes representatives from electric utilities and their support organizations, state legislatures, state utility commissions, consumer advocacy offices, wind equipment suppliers and developers, power marketers, environmental organizations, and state and federal agencies. The National Wind Coordinating Committee identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of an environmentally, economically, and politically sustainable market for wind power.

For additional information or to schedule a wind permitting workshop, please contact

Outreach Coordinator
National Wind Coordinating Committee
c/o RESOLVE
1255 23rd Street, Suite 275
Washington, DC 20037

Phone: 202-944-2300 or 888-764-WIND
Fax: 202-338-1264
E-mail: nwcc@resolv.org

This complete document is available on NWCC's website: http://www.nationalwind.org.