

**ESTABLISHING WIND POWER IN NEW HAMPSHIRE:  
EFFECTIVELY SITING TURBINES**

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May 12, 2005

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## ESTABLISHING WIND POWER IN NEW HAMPSHIRE: EFFECTIVELY SITING TURBINES

With the emergence of recent proposals, there appears to be growing interest in expanding renewable energy sources in New Hampshire. New Hampshire's government has taken several steps to encourage the use of renewables, including setting net metering guidelines for small-scale generators (less than 25 kW) of photovoltaics, hydroelectric, and wind.<sup>1</sup> Net metering guidelines in New Hampshire require that utilities purchase any electricity generated by small scale generators in excess of what they use. Further developing renewables beyond small-scale generation, particularly wind, can help New Hampshire increase the proportion of energy generated from renewable sources. In fact, developing the full potential of wind resources in the state holds great promise for helping to meet the state's energy needs. As of 1999, New Hampshire consumed about 11 million megawatt-hours of electricity per year.<sup>2</sup> The U.S. Department of Energy estimates that about 3 percent of New Hampshire's land area (178,636 acres),<sup>3</sup> much of which is on federal and state lands, may be suitable for wind energy development.<sup>4</sup> If all of New Hampshire's wind energy potential is developed, the Department of Energy estimates that about 5.0 million megawatt-hours of power can produced each year, which is approximately 55% of the entire state's electricity consumption.<sup>4</sup>

The State of New Hampshire encourages small-scale wind generation principally through its net metering program. Net metering offers landowners an incentive to build their own small-scale turbines to provide their homes or businesses with power. Additionally, owners are also exempt from municipal property

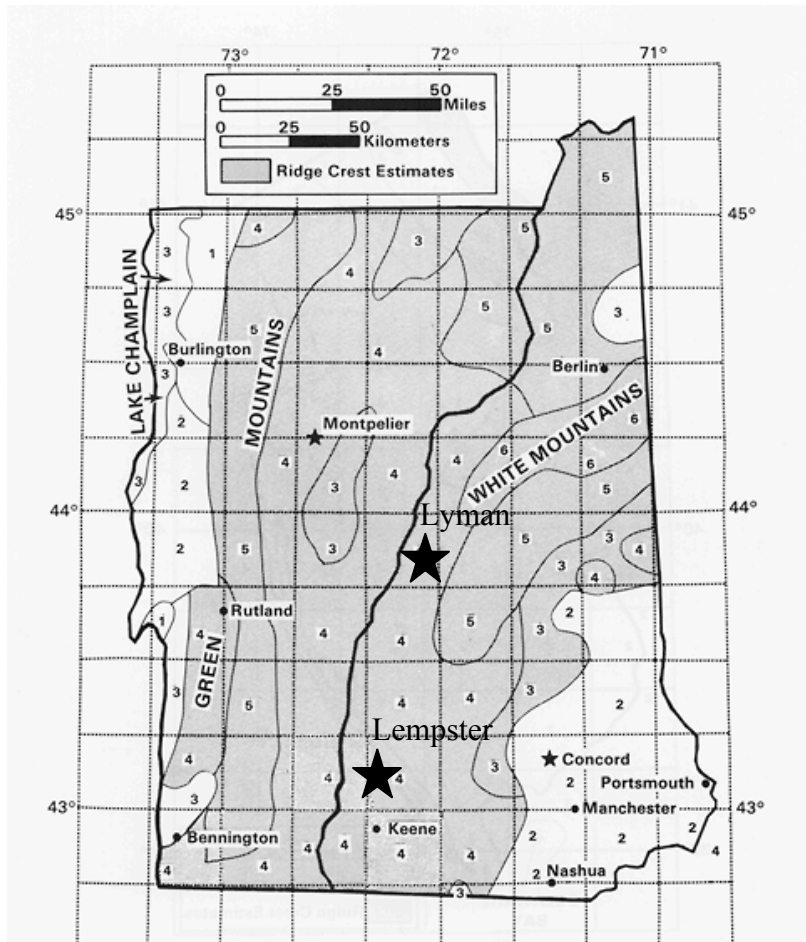


Figure 1: Map showing the wind speed classes in Vermont and New Hampshire (1 = the lowest, 7 = the highest).<sup>7</sup>

taxes on the installation of these systems. Whether on a small scale, such as through net-metering initiatives, or at the larger scale of wind farms, developing new wind energy resources often raises concerns among some citizens about the siting of new turbines and their noise, aesthetic, environmental impacts.

This report discusses many of the common concerns specifically associated with the *siting* of wind turbines in New Hampshire, such as noise, aesthetic, and environmental impacts, and examines policies that other states employ to address these concerns. For a broader discussion of wind energy in other parts of New England, see reports by the University of Vermont Legislative Research Shop (“Wind Power”<sup>5</sup>) and the University of Massachusetts (“Wind Energy Cold Weather Issues”<sup>6</sup>).

## **IDENTIFYING AND EVALUATING POTENTIAL SITES**

### **Topography, Wind Availability, and Current Projects**

The best sites for wind energy development in New Hampshire are located in the White Mountains<sup>7</sup> on treeless hilltops, ridge crests, and mountaintops (See Figure 1).<sup>4</sup> Optimal sites are characterized by elevations between 2,500 and 3,500 feet with no extended or abrupt changes in the grade of the ridgeline for at least one mile.<sup>7</sup> These locations are considered ideal for the construction of new generation facilities because they frequently exhibit “Class 4” wind speeds<sup>7</sup> (15.7 mph at 50 feet<sup>8</sup>), or above. In the White Mountains wind speeds range from 17-28 mph (class 4-7), with a substantial area of the White Mountains reaching class 6 speeds, and the summit of Mount Washington having speeds reaching class 7 levels.<sup>4</sup>

To date there is no commercial-scale wind power in New Hampshire, and very little is being generated at smaller scales. Currently, two wind energy projects are proposed for western New Hampshire. The first is in Lyman. Still in the early planning stages, the proposed 30 MW farm with 10-20 turbines would be located on a hilltop overlooking the town.<sup>8</sup> Likewise, a 20-30 MW wind farm is being considered by the Pennsylvania company, Community Energy, for a site on Lempster Mountain.<sup>109</sup> This is one of what the company hopes will be several new projects in the Lempster-Keene area. Likewise, site exploration has also begun near the towns of Randolph, Berlin, and Gorham.<sup>10</sup> While there are several projects in the exploratory phases, only 2 sites in New Hampshire have applied for the property tax exemption for their wind facilities.<sup>11</sup>

### **Evaluating Sites**

Beyond a site’s specific wind characteristics, careful consideration is often given to several other factors when determining whether to construct wind turbines in a particular place:

- Physical accessibility via access roads
  - Proximity to an existing utility grid
  - Environmental impacts, such as habitat fragmentation and decreased habitat area
  - Noise impacts on surrounding communities
  - Aesthetic impacts on residents and tourists
- > Amount and type of infrastructure needed

These factors represent a balance among optimizing power production, ensuring cost effectiveness, and minimizing the potential visual, aural, and environmental impacts. These impacts may occur during the installation phase or from the ensuing operation of the full complement of facilities needed to produce suitable energy. No specific studies have been conducted in New Hampshire, although studies have examined similar issues in Vermont. Given their close proximity and

similarities in physical and ecological conditions, these Vermont offer some helpful insight for understanding some of the potential impacts in New Hampshire.

The cost-effectiveness of wind energy development depends on the strength and consistency of winds as well as the site's physical accessibility. Ridgelines in the White Mountains offer the highest and most consistent wind energy generation potential.<sup>4</sup> However, because these mid to high elevation ridges are largely undeveloped, with the exception of commercial ski areas and mountain top communication facilities,<sup>12</sup> these areas are highly valued by residents and tourists for their value as wilderness and for their scenic views.<sup>15</sup> The low degree of development in many of these areas also makes them difficult to access without constructing new roads.<sup>16</sup>

Installing wind turbines requires physical access for equipment and machinery via existing or new roads.<sup>7</sup> Moreover, the operation of wind turbines for energy consumption requires connection to the utility grid. This involves constructing transmission lines to transfer power from the turbines to a substation.<sup>7</sup> These activities have been found to decrease available habitat and increase habitat fragmentation and possibly negatively affect some species of Vermont wildlife, such as Bicknell's Thrush, moose, black bear, and bobcats.<sup>18</sup> Turbine operation can also lead to direct wildlife mortality, especially for birds and bats.<sup>18</sup>

There are also concerns about the aesthetic and noise impacts on surrounding landowners and communities. One conflict in Vermont has been between the use of scenic trails and the impact wind turbines might have on tourists, especially along the Appalachian Trails. Scenic views and relatively large undeveloped landscapes are among the expectations hikers have when using these trails.<sup>15</sup> Wind turbines on ridgelines will be highly visible and may affect the viewshed of surrounding areas. Furthermore, there have been concerns regarding safety issues that may limit the people's access to proximate areas, as wind turbines can throw damaging ice chunks distances of up to 820 feet.<sup>16</sup>

## **OTHER STATES AND POLICY OPTIONS FOR ADDRESSING COMMON CONCERNS**

Wind energy projects typically elicit concerns about noise, aesthetics, and detrimental consequences to specific wildlife species. Many states have developed guidelines and recommendations to address these concerns, often by attempting to minimize the impacts. Local noise ordinances or state guidelines may specifically limit the permissible noise from a wind project. Likewise, there are a variety of turbine designs that may or may not be aesthetically pleasing in particular settings, and guidelines in many places recommend that developers consider the visual impact of wind energy projects, especially in scenic areas. Wind projects affect wildlife through direct kills of birds and bats and indirectly through habitat loss. Hence guidelines exist for turbine designs that are less attractive to birds and bats and to encourage development in areas of poor quality habitat.

### **Noise**

The noise produced by wind turbines is a concern to some neighbors and in some communities adjacent to existing projects. While the degree to which turbine noise is bothersome differs from individual to individual, it is possible to compare the noise levels for a range of common activities (Table 1).

*Table 1.* Noise level for common activities (Source: The Scottish Office, Environment Department 1994).

| Source/Activity            | Indicative Noise Level (dBA) |
|----------------------------|------------------------------|
| Threshold of hearing       | 0                            |
| Rural nighttime background | 20-40                        |
| Quiet bedroom              | 35                           |
| Wind farm at 350m          | 35-45                        |
| Car at 40mph at 100m       | 55                           |
| Busy general office        | 60                           |
| Pneumatic drill at 7m      | 95                           |
| Jet aircraft at 250m       | 105                          |
| Threshold of pain          | 140                          |

Compared to these common activities, at a distance of 750 to 1,000 feet an operational wind farm produces noise similar to that of a kitchen refrigerator in a moderately quiet room. Many methods can be adopted to reduce this noise. For example, more aerodynamic tower designs reduce the noise that is created by wind passing the turbine, and soundproofing and mounting equipment on sound-dampening buffer pads reduces mechanical noise produced by the generator, gears and other moving parts in the turbines. Wind turbine blades are constantly being redesigned to make them more efficient and to reduce the noise they generate. Across the country, states deal with these issues in a number of ways.

*Oregon* - Oregon requires that wind energy facilities comply with established state standards for noise emissions, as determined by the Oregon Environmental Quality Commission. A wind energy facility must satisfy two tests: 1) the “Table 8 test” and 2) the “ambient degradation test.” The “Table 8 test” sets the maximum permissible turbine noise level during different periods of the day (Table 2). The “ambient degradation test” sets the maximum permissible ambient noise level increment to be 10dBA per hour in comparison to noise level during the previous hour.<sup>13</sup> In 2003, the Oregon Department of Energy proposed amendments loosening certain rules.<sup>14</sup> To demonstrate compliance with the noise rules, the developer of a wind energy facility must provide noise measurement data under very specific wind conditions. “It is impossible to predict when those conditions will occur, and therefore impossible to know when to send noise consultants out to the field to collect noise data.”<sup>14</sup> Thus, data collection for the purpose of demonstrating compliance with the rule is complicated and expensive.

*Table 2.* Statistical Noise Limits for Industrial and Commercial Sources. (Source: Oregon Department of Energy 2003).

| Statistical Descriptor* | Maximum Permissible Statistical Noise Levels (dBA) |                               |
|-------------------------|--|-------------------------------|
|                         | Daytime<br>(7:00AM – 10:00PM)                      | Nighttime<br>(10:00PM-7:00AM) |
| L <sub>50</sub>         | 55   | 50                            |
| L <sub>10</sub>         | 60   | 55                            |
| L <sub>1</sub>          | 75   | 60                            |

\*Defined as the noise level equaled or exceeding 50%, 10% and 1% of the hour, respectively.

*Kansas* - Concerns about noise are determined based on distances from potentially conflicting uses. The Kansas Environmental and Siting Committee and the Kansas Renewable Energy Working Group provide guidelines for wind power stakeholders to consider potential problems that could be

generated in residential areas and the possibility of adopting sound reduction technology. The Noise Management Guidelines include:

- Prospective sites should be evaluated according to the adequacy of setbacks from residential areas and rural homes. Special attention is given to residential units that may be in relatively less windy or quieter locations. These guidelines specifically recognize that existing residents who support the wind system may some day be replaced by others who will object to the noise.
- In cases where acoustic levels are critical because of nearby residences and/or natural surroundings, the wind power project stakeholders are supposed to examine possibilities for using sound reduction technology on appropriate turbines.<sup>15</sup>

*Wisconsin* - Wisconsin’s model ordinance establishes a flat threshold of 50 dBA, measured at residences, schools, hospitals, churches and public libraries and requires that the developer place turbines far enough from these points of measurement to keep noise level at or below the permitted level. This 50dBA threshold is a standard used by most similar ordinances and laws around the country. Local officials in Wisconsin are authorized to consider and, where there are unique characteristics within their communities, set different levels. For example, “some officials prefer that the noise measurements be taken at the property line of neighbors rather than at the structure.”<sup>16</sup>

*Table 3.* Summary of state regulations to address noise impacts of wind energy projects

| Noise Regulations and Recommended Actions                         | OR | KS | WI | NJ |
|---|----|----|----|----|
| Set maximum permissible noise levels for turbine noise            | ✓  |    | ✓  |    |
| Set maximum permissible ambient noise level increment             | ✓  |    |    |    |
| Consider adequate setbacks from residential areas and rural homes |    | ✓  | ✓  |    |
| Recognize the wind system may be objected by future residents     |    | ✓  |    |    |
| Examine possibilities for using sound reduction technology        |    | ✓  |    |    |

**Aesthetics**

Despite the fact that aesthetics are often individual-specific and sometimes an emotionally charged issue, it is possible to develop some guidelines for turbine design (Table 4). Variables such as turbine height, illumination of each turbine, coloring, symbols the owner places on the turbines and facilities, spacing and placement, affect a project’s impact on visual resources. For example, taller turbines, which are usually more cost-effective, are also visible from a longer distance, while smaller and shorter turbines, which are less cost-effective, tend to rotate faster and are often placed closer to one another and in larger numbers. Access roads to and from wind farms, particularly within mountainous and moorland areas, have a significant aesthetic impact, **Error! Bookmark not defined.** but this impact could be lessened on relatively flat terrains.<sup>16</sup>

Aversion to towers by citizens in local communities, as well as local planning or zoning boards, is common. Some counties consider towers a "special use," and require a time consuming and expensive permitting process. Local regulations may limit tower height and location for aesthetic reasons. This may include blocking or changing a historic landscape or blocking a neighbor's view. However, local regulations can set their own tower heights to reduce aesthetic impact while maintaining turbine efficiency.

*Oregon* - The Energy Facility Siting Council, the authority issuing site certificates to developers of large energy facilities in Oregon, does not attempt to reconcile conflicting opinions about the general visual impacts of a specific facility. Instead, existing standards focus narrowly on evaluating the “scenic and aesthetic values identified as significant or important in applicable federal land management plans or in local land use plans” for the analysis area. As part of this evaluation, the Siting Council must answer two questions: 1) Have the applicable land use plans identified any “significant or important” scenic values? 2) Would the visual features of the facility be likely to result in “significant adverse impact” to those values? If the council determines there is a significant impact, the applicant is required to mitigate the impact through implementation of corresponding design measures or by relocating the relevant parts of the proposed facility.<sup>17</sup>

*Kansas* -The Kansas Environmental and Siting Committee and the Kansas Renewable Energy Working Group have developed a set of guidelines to inform the general public about a project’s potential impacts, to elicit input from the stakeholders about these impacts, and to consider adopting various methods to minimize them. These guidelines include:

- Evaluate visual impacts of potential projects by using accurate visual representations of these projects;
- Provide information to landowners, the general public and other key stakeholders regarding the visual impact of wind power projects;
- “Listen to communities and stakeholders in all project phases”;<sup>16</sup>
- Consider adapting the project design to minimize visual exposure from visual sensitive areas;
- Evaluate the possibility of and weigh the benefits of using road-less project designs or designs that rely on existing roads; and
- Identify designated scenic byways and popular vistas, and avoid sites that are readily visible from those points.<sup>15</sup>

*Wisconsin* – Under Wisconsin state law municipalities are prohibited from placing additional requirements on wind project developers based solely on aesthetic reasons. State law explicitly states that “[p]reserving the aesthetic character of the town or similar language should not appear as an explicit purpose of an ordinance or use permit.” At the same time, the state assumes that requiring neutral paint and limiting lighting and signage can address most visual issues. Project developers see this approach as a way of addressing aesthetic concerns while reducing impacts.<sup>16</sup>

Table 4. Summary of state regulations to address aesthetic impacts of wind energy projects

| Aesthetic Impact Regulations                              | OR | KS | WI | NJ |
|---|----|----|----|----|
| Evaluate visual impacts                                   | ✓  | ✓  |    |    |
| Consider implementing corresponding design measures       | ✓  | ✓  | ✓  |    |
| Relocate the relevant parts of the proposed facility      | ✓  |    |    |    |
| Provide information to landowner and the public           |    | ✓  |    |    |
| Consider road-less project designs                        |    | ✓  |    |    |
| Avoid sites visible from scenic byways and popular vistas |    | ✓  |    |    |
| Limit the maximum height of a turbine                     |    |    |    | ✓  |

### **Habitat and Wildlife Impacts**

Wind turbines affect wildlife populations through direct mortality, behavioral modification, habitat fragmentation and habitat reduction. Specifically, turbine blades may kill birds and bats or may cause them to alter flight paths. Nationwide, an estimated 100 million to over 1 billion birds are killed each year in collisions with man-made structures, but less than 1% of this mortality results from collisions with wind turbines (Table 5).<sup>18</sup> Most studies on bird and bat mortality from collisions with wind turbines have been conducted in western and Midwest states at wind energy projects in open areas such as grasslands and livestock grazing areas.

Table 5. Estimated annual avian mortality in the U.S. from collisions with man-made structures (Source: National Wind Coordinating Committee 2001).<sup>18</sup>

| Collision Source              | Estimated Annual Bird Mortality |
|-------------------------------|---------------------------------|
| Vehicles                      | 60 – 80 million                 |
| Buildings (including windows) | 98 – 980 million                |
| Power lines                   | Tens of thousands – 174 million |
| Communication towers          | 4 – 50 million                  |
| Wind turbines                 | 10,000 – 40,000                 |

These data translate to a range of less than 1 to 7.5 bird deaths/turbine/year,<sup>19,20,21,22</sup> with most mortalities coming from common resident species and raptor mortality being “virtually non-existent”<sup>21</sup> despite active raptor nests within several miles of study sites. Several other studies confirm that bird mortality from wind turbines is similar in magnitude to mortality from other man-made structures.<sup>23,24</sup> However, there have been few studies on New England species, because the wind energy market in this region is relatively new and because much of the concern over avian mortality from wind turbines stems from the large number of bird kills at the Altamont Pass Wind Resource Area in California.<sup>25</sup> Flight patterns of East Coast bird species suggest that turbines located along ridge tops may pose a greater threat to birds than turbines in valleys or plains,<sup>19</sup> despite the generally low avian mortality rate from collisions with turbines.

Estimates for bat mortality range from less than 1 to 47.5 deaths/turbine/year,<sup>19,20,21,22</sup> with most estimates at the lower end of this range. Bat mortality is less well studied than bird mortality, but Bat Conservation International recently conducted a three-year study, for which the results have yet to be published, to better understand the issue.<sup>19</sup>

There are fewer studies on how wind turbines affect bird behavior. Some results suggest that the effects on flight paths are minimal.<sup>26</sup> A study of geese in Denmark found a smaller avoidance



distance for turbines arranged in lines or near already disturbed land compared to turbines arranged in clusters.<sup>27</sup>

Wind turbines and turbine construction can lead to habitat fragmentation and reduction. Using existing roads for construction and building wind farms in areas of poor quality habitat, such as agricultural areas, can minimize this impact.<sup>19</sup>

Several states have guidelines for minimizing wind energy's negative impacts on birds and bats that are similar to those proposed by The American Bird Conservancy (ABC)<sup>19</sup> (Table 6). These guidelines include conducting preliminary studies, avoiding migration routes and nesting areas, building near already disturbed areas, avoiding construction styles that encourage perching or are difficult for birds and bats to see (guy wires, lattice work, above-ground transmission lines), and minimizing the use of aircraft warning lights that attract birds. The ABC recommends special consideration for areas that might contain endangered or threatened species.<sup>19</sup>

*Washington* - The Washington Department of Fish and Wildlife (WDFW) guidelines for siting and developing wind power projects consist of a recommended pre-project assessment and a habitat mitigation process.<sup>28</sup> The preliminary assessment includes a review of existing information regarding local species and habitats, habitat mapping, and biological surveys (of raptor nests, avian use, and threatened and endangered species). The Wind Power Guidelines include recommendations to minimize impact on the environment:

- Develop in already disturbed lands using existing roads/transmission corridors;
- Avoid guy wires, lattice towers;
- Use underground power lines;
- Minimize tower lights;
- Control noxious invasive weeds after construction disturbance; and
- Include plans for decommissioning and site restoration program when operations cease.

Additionally, the WDFW suggests that developers set up a Technical Advisory Committee, composed of stakeholders such as state and federal wildlife agencies, the energy company, environmental groups, and local landowners, to monitor data from the project and suggest adjustments.

Washington State's Wind Power Guidelines specify that "[p]roject developers are responsible for acquiring [and managing] replacement habitat" for lands that are permanently or temporarily degraded from wind power projects. The guidelines include specific instructions for mitigation, which is required except for projects located in areas of "little or no habitat value",<sup>28</sup> such as land that is being cultivated, under long-term development, or disturbed by a road.

*Kansas* - The Kansas Renewable Energy Working Group (KREWG) issued wind power project guidelines<sup>15</sup> covering nine total subject areas. Of these, three address environmental concerns (Land Use, Natural and Biological Resources, and Soil Erosion and Water Quality). In terms of Land Use, KREWG recommends that wind energy developers consider local compatibility issues and regulations, promote turbines on already developed land, and give special consideration to areas with rare, endemic habitat. The guidelines for Natural and Biological Resources closely follow

recommendations from the American Bird Conservancy that are designed to minimize impacts on birds and other wildlife:

- Conduct preliminary studies of the prospective site;
- Work with wildlife agencies, university groups, environmental groups;
- Review wildlife habitats, migration corridors, breeding areas;
- Give special consideration to threatened/endangered species;
- Avoid large areas of native vegetation;
- Use below-ground power lines;
- Disallow perches or lattice construction on turbines;
- Minimize warning lights;
- When it is “impossible to avoid significant ecological damage” consider mitigation such as restoration or easements; and
- Consider a broader scale of cumulative impact from multiple regional wind projects.

Soil Erosion and Water Quality guidelines are generic and apply to any major construction project in less well-developed areas. These guidelines suggest that construction take place on flat ground, during seasons when the ground is less susceptible to erosion (i.e. frozen or dry soil), and that preexisting roads be used where possible.

*Wisconsin* - Wisconsin defers to federal regulations, such as The Endangered Species Act and the Migratory Bird Treaty Act, to address the issue of bird kills on wind farms. Wisconsin has developed a model ordinance regarding wind power development for communities throughout the state. This model ordinance requires that project developers comply with all federal and state laws.<sup>16</sup>

*Oregon* - The Oregon Department of Energy, Energy Facility Siting Council requires that the design, construction, operation, and decommissioning of wind power projects take place in accordance with all state laws regarding protected plant and animal species.<sup>29</sup> State administrative rules state that wind power development is prohibited in federally and state designated protected areas, such as national parks, state parks, wilderness areas, wildlife areas, and recreation and scenic areas.

*Minnesota* - The State Environmental Quality Board (EQB) issues permits for wind energy projects that are designed in a “manner compatible with environmental preservation, sustainable development, and the efficient use of resources.” Permit applications must address potential environmental impacts, mitigation activities and unavoidable adverse environmental effects. Before the EQB approved the state’s first major wind energy project in 1995, it required a four-year study on how turbines would affect local avian species. A subsequent two-year study on how turbines affect local bat populations was commissioned,<sup>30</sup> though these results are not yet available.

Table 7. Summary of state regulations and recommendations to address habitat and wildlife impacts of wind energy projects

| <b>Regulations and Recommended Actions</b>                        | <b>WA</b> | <b>KS</b> | <b>WI</b> | <b>OR</b> | <b>MN</b> |
|---|-----------|-----------|-----------|-----------|-----------|
| Conduct preliminary studies                                       | ✓         | ✓         |           |           |           |
| Location restrictions   |           |           |           |           |           |
| Build in poor quality habitats/already disturbed areas            | ✓         | ✓         |           |           |           |
| Avoid migration routes, nesting areas                             |           | ✓         |           |           |           |
| Use existing roads  | ✓         | ✓         |           |           |           |
| Avoid large areas of native vegetation                            |           | ✓         |           |           |           |
| Prohibit projects in state/national parks, recreation areas, etc. |           |           |           | ✓         |           |
| Construction restrictions   |           |           |           |           |           |
| Minimize guy wires  | ✓         |           |           |           |           |
| Minimize lattice work   | ✓         | ✓         |           |           |           |
| Use below-ground transmission lines                               | ✓         | ✓         |           |           |           |
| Minimize aircraft warning lights                                  | ✓         | ✓         |           |           |           |
| Build on flat ground  |           | ✓         |           |           |           |
| Build when soil is frozen/dry                                     |           | ✓         |           |           |           |
| Special consideration for threatened/endangered species, habitat  | ✓         | ✓         | ✓         | ✓         | ✓         |
| Mitigation  | ✓         | ✓         |           |           | ✓         |
| Control noxious invasive weeds after construction                 | ✓         |           |           |           |           |
| Work with variety of stakeholders                                 | ✓         | ✓         |           |           |           |
| Defer to federal regulations                                      |           |           | ✓         |           |           |

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**Disclaimer:** This report was written by undergraduate students at Dartmouth College under the guidance of Professor Andrew Samwick (Director of the Nelson A. Rockefeller Center) and Dr. Patrick Hurley (Research Associate at the Nelson A. Rockefeller Center). All material presented in this report represents the work of these individuals and does not represent the official views or policies of Dartmouth College.

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