Clean Energy States Alliance

State Clean Energy Program Guide

A VISUAL IMPACT ASSESSMENT PROCESS FOR WIND ENERGY PROJECTS

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About the Author

Jean Vissering is a consulting landscape architect in East Montpelier, Vermont. Her work focuses on visual resource planning, visual impact assessment, community planning and design, and residential design. She has developed methodologies for visual impact assessment and scenic resource protection for local and state agencies. She has presented nationally and locally on the subject of the aesthetic impacts of wind energy projects and co-authored a report, Environmental *Impacts of Wind Energy* by National Research Council of the National Academy of Sciences. She believes wind energy will be an important part of our future energy mix, but that there are some locations where wind projects will be inappropriate. She has reviewed numerous wind energy proposals and testified both for and against projects depending on the resources involved. She served as a lecturer at the University Of Vermont's School of Natural Resources and Plant and Soil Science Department for 15 years, and worked for the Vermont Department of Forest's Parks and Recreation as a Park Planner and State Lands Planner.

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Introduction

PURPOSE OF REPORT & GENERAL CONSIDERATIONS FOR AESTHETIC IMPACT ANALYSIS

The purpose of this guide is to facilitate the adoption and use of effective state and local policies, practices, and methodologies to evaluate the visual impacts associated with wind development projects. Visual impacts are often among the issues of greatest concern for surrounding property owners and the community. Public acceptance and confidence in wind development are likely to be enhanced when visual issues are clearly and fairly addressed. This guide provides an effective and objective aesthetic impact assessment review methodology that provides clear guidance for developers, planners, and regulatory decision makers and also ensures the protection of important scenic and cultural resources.[1]

As wind development continues to grow throughout the United States, many state and local governments are in the process of creating or revising their evaluation processes for assessing visual impacts of wind energy projects. Regulatory review processes vary widely from state to state. Additionally, visual impacts are reviewed at different jurisdictional levels (local, county, state) depending on a state's particular regulatory framework and such factors as the size of the project.

There is little consistency as to what information should be submitted by a wind developer to the relevant regulatory review body. The basis for evaluating and determining the degree of visual impacts presented by proposed wind projects is often poorly understood by regulators, developers, and the general public. Establishment of clear and consistent visual impact review processes will assist developers and regulators alike and provide greater public confidence in the integrity and fairness of regulatory decision making for wind project siting.

This report focuses on utility-scale wind energy projects. While the methodology is also applicable to smaller community- and commercial-scaled projects, it should be noted that smaller wind turbines for residential use usually justify a simpler review process than is outlined here because of their small scale.[2]

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[1] Scenic resources may include cultural resources as well to the extent that they contribute to the visual quality of the landscape. Historic values however differ from visual or scenic values.

[2] An example of a methodology can be found at http://publicservice.vermont.gov/energy/ee_files/wind/psb_wind_siting_handbook.pdf.

A. Basic Premises of Aesthetic Review

Many excellent methodologies have been developed over the past half century for evaluating scenic quality and visual impacts of development projects.[3] The unique visual characteristics of wind energy projects require a refinement to these approaches, although the basic principles remain the same.

It is also important to note that the goal of visual impact assessment is not to predict whether specific individuals will find wind energy projects attractive or not. Instead, the goal is to identify important visual characteristics of the surrounding landscape, especially the features and characteristics that contribute to scenic quality, as the basis for determining how and to what degree a particular project will affect those scenic values. This process can be logical, well articulated, and systematic and can be codified for use by relevant professionals.

Studies of public reactions to wind energy projects are useful in providing a broad understanding of general attitudes and also in identifying significant areas of concern. However, in examining a specific project in a particular location, the emphasis should be on evaluating the specific character of the landscape involved, especially the elements that contribute to scenic quality and how the project will affect these scenic resources.

Landscape character can be defined fairly objectively. Usually the focus of visual impact assessments is on the public landscape: views seen from parks, recreation areas, publicly accessible trails, water bodies, highways or roads (especially designated scenic highways), scenic overlooks, publicly accessible historic sites, and village or town centers.

Visual impacts to private property are not a focus of this report.[4] Private property is generally not accessible to those conducting inventories of views and resources. Except for private property owners that have established "party" rights in formal regulatory proceedings, professional visual impact assessments generally only address potential views from public roadways near residential areas.

Planning documents at the local regional, county and/or state levels are an important source of information for aesthetic review as they may identify landscape and cultural features that contribute to scenic quality. These documents, if available, are invaluable in siting wind energy projects and in evaluating their impacts. Such documents are usually adopted through a public process that provides an indication of broad public input and value.

In some regions of the country, the protection of scenic and cultural resources may be less of a priority

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[3] See for example the United States Forest Service's Visual Management System (VMS) (1974) and more recent Scenery Management System (1995); also the Bureau of Land Management (BLM) Visual Resource Management Program (1980) (http://www.blm.gov/nstc/VRM/vrmsys.html), and BLM Wind Energy Programmatic EIS (http://windeis.gov); these systems are based on pre- established visual quality objectives for public lands.

[4] Abutting landowners generally have legal standing in project review proceedings to participate as a full party with appeal rights. Non-abutting property owners usually do not have legal standing but can express concerns at public hearings. Sometimes citizen groups are given standing in the hearing process provided they can demonstrate a material interest in the outcome of the proposed project.

because suitable wind resources may be far removed from either population centers or public lands valued for scenic quality. Therefore, the methodology recommended here may not be appropriate for all parts of the country, or it may be adapted for regional conditions. In some cases, wind projects are located on lands owned by the U.S. Bureau of Land Management or the U.S Forest Service, both of which have their own systems for evaluating visual impacts; although in some cases, individual states also have separate jurisdiction to review and approve projects proposed for federal lands.

It should be recognized that, while it is important to document where a wind project can be seen from, visibility by itself does not mean that a proposed wind project will have significant or unreasonable impacts on visual resources. Rather the significance of these impacts should be determined through an understanding of *how* the project is seen within important views and in light of viewer expectations at viewing locations. Visual impacts are likely to occur for most wind projects. It is important, therefore, for applicable siting guidelines or protocols to provide reasonably clear criteria as to when the threshold between "reasonable" and "unreasonable" visual impacts will be crossed.

In a regulatory proceeding, a developer usually is required to explain in a logical manner why a wind project would not have "unreasonable" or "undue" visual impacts.[5] Intervening stakeholders in the process may make counter arguments. If clear visual analysis criteria are established to apply to a project, the developer and stakeholders will be better able to provide meaningful and useful information and perspectives to the decision making body. If both developers and stakeholders are guided to provide evidence that focuses on the relevant visual assessment issues and factors involved, a well-informed and balanced decision can be more easily made.

B. General Considerations in Visual Impact Review

1. LEVEL OF REVIEW

In most states, visual impact decisions are made through a state siting board or regulatory review commission using a quasi-judicial process that considers developer and stakeholder information and evidence. In other states, projects are reviewed at the local level. In a few states, the local or state jurisdiction for review is determined by the size of the project, with larger projects reviewed by a state commission and smaller projects reviewed at the local level. Even where state-level review preempts local review, however, regulators generally consult local officials and examine local planning and regulatory documents in order to determine whether particular landscape or cultural features are identified by local communities or regional bodies as having scenic, recreational, or cultural value that may be affected by a particular project. Host communities as well as neighboring communities are generally a party in regulatory proceedings.

2. AREA OF REVIEW

Most regulatory processes identify a radius of a certain distance around the project as the area of likely impact and relevant analysis – usually using the outermost turbines of the project as the center of the analysis (not including other project infrastructure). Selecting an appropriate distance for analysis should

[5] The regulatory or planning language used by a state or local jurisdiction often varies but is intended to prevent unreasonable visual effects. The State of California's Environmental Quality Act, for example, uses "significant" as the threshold language.

depend on regional characteristics, the size of the wind project, and the sensitivity and relative location of important scenic resources within the region. The overall size of the project (height, number of turbines, and geographic footprint) will also make a difference in selecting the area of analysis. Modern wind projects using 2.0+ MW turbines are easily visible at 15-20 miles' distance in clear weather conditions, but the most significant impacts are likely to occur in closer proximity, in most cases within 5-8 miles in northeastern landscapes. However, a larger study area provides a more comprehensive understanding of the resources involved within the region, and 10 miles may provide a good guideline for analysis in northeastern regions. An area of analysis of 25 miles will be more appropriate in midwestern and western landscapes, open terrain, drier air, and larger wind projects (hundreds vs. dozens of turbines) creating a larger mass visible over greater distances. For offshore wind projects, larger turbines are used, and the area of analysis may extend to 20 miles and include ¼-½ mile inland along shorelines with views of the project.

The recommended or required area of analysis varies from state to state. For example, Maine now requires analysis within 4 miles of the project and up to 8 miles away if significant visual resources occur beyond 4 miles. New York uses a distance of 5 miles as a guideline, but this distance may be expanded up to 10 miles when significant scenic resources occur beyond 5 miles. Vermont uses 10 miles, and West Virginia uses 20 miles.

Figure 1
A group of 1.5 MW wind turbines in the Cedar Creek wind farm in far northeastern Colorado, viewed at 6 miles away. About a third of the project's 277 turbines are visible in this photo. The open terrain and dry air of the West may make turbines visible at greater distances than in eastern landscapes.

3. RESOURCES EVALUATED

Some states specify the types of scenic resources that should be evaluated. Typically, these include documented resources having state or national significance, such as state parks, state forest preserves, cultural parks, scenic rivers and shorelines, properties on for the National Register of Historic Places, National Natural Landmarks, National Parks, Wilderness Areas, scenic highways and scenic rest areas or pullouts.

Even when local resources are not required to be evaluated, developers have often found that consideration of areas of local concern (roads, parks, and community focal points) promotes goodwill and confidence among people living in the local community that visual impacts will be reasonable. Understanding impacts from adjacent residential properties is also important.

4. PUBLIC PARTICIPATION

Ensuring public input to identify the scenic values of importance to affected communities is critical in ensuring a credible, well-informed evaluation process. Municipal representatives of host communities and neighboring communities as well as adjacent property owners are usually granted rights to participate in any hearing process. Sometimes interest groups are also granted participation rights, if they can demonstrate a material interest in the project’s potential impacts. Developers often work closely with surrounding communities to provide meaningful opportunities for public input, and the typical formal review process usually includes at least one public hearing.

For people who live, work, and recreate in a region, the landscape consists of layers of meaning that may not be understood by a developer or a professional conducting a visual assessment. If local residents and other interested parties are invited to participate in the selection of sites to be inventoried and the simulations to be produced, the result of the process usually is more widely accepted as being credible. Pre-construction surveys of residents, business owners, and tourists may provide useful information to the degree that the surveys reflect expertise in survey design and are free from bias. Surveys may also provide more information about the use of particular scenic areas and attitudes about the values of those resources. These values may also be articulated in public documents.

Outline of Visual Assessment Process

A. Necessary Graphic Information for Effective Evaluation

- Project Map
- Viewshed Mapping (Zone of Visual Influence)
- Identification of Public Natural and Cultural Resources and Features
- Identification of Viewpoints
- Documentation of the Area's Existing Character (Photo Illustrations)
- Simulations (Visualizations)

B. Key Questions for Evaluation of Visual Impacts

1. What Are the Project's Visual Impacts?
   a. Project Description
   b. General Landscape Character
   c. Scenic Resource Attributes and Sensitivity Levels
      - Scenic Quality and Intactness of Resource
      - Viewer Expectations
      - Uniqueness of Resources
      - Number of Users
   d. How will the Project be Seen and Experienced from Important Viewing Locations in the Surrounding Area?
      - Project Scale (Size)
      - Distance from Viewpoints
      - View Duration
      - Angle of View/Area of View Occupied
      - Panoramic vs. Narrow View
      - Project Relation to Regional Focal Points
      - Numbers of Turbines in Views
      - Visual Clutter
      - FAA Lighting
      - Shadow Flicker
2. Will the Project have Unreasonable or Undue Visual Impacts?
   a. Documentation of Scenic Values: Will the project violate a clear written standard intended to protect the scenic values or aesthetics of the area or a particular scenic resource?
   b. Degree of Dominance: Will the project dominate views from highly sensitive viewing areas or within the region as a whole?
   c. Mitigation Measures Taken: Has the developer failed to take reasonable measures to mitigate the project's impacts?

I . Visual Assessment Process

A. GRAPHIC INFORMATION REQUIRED FOR AN EFFECTIVE ASSESSMENT

To ensure an effective visual assessment for a proposed wind project, the following information is useful to provide objective and quantitative data about the visual characteristics of the project and its setting.

- **Project Map**

A detailed map showing locations of turbines, access roads with related cutting, filling and grading, clearing limits, meteorological towers, collector lines, substation location, new transmission lines, lay-down or temporary storage areas, and any buildings or structures.

- **Viewshed Mapping**

Viewshed maps (sometimes called Zone of Visual Influence or ZVI maps) combine Digital Elevation Model (DEM) data, GIS data, and viewshed mapping software to illustrate potential project visibility within the identified radius or area of analysis. The viewshed analysis may be displayed over a USGS topographic map, aerial photo, or other appropriate base, and include other location information such as state and national forests, parks, scenic destinations, municipalities, and other receptor locations.

The viewshed is generally mapped using the highest point of the turbine at the tip of the blade in an upright position. Two viewshed mapping versions may be represented: a) potential visibility assuming topographic shielding only (no vegetative interference); and b) potential visibility considering screening by both topography and forested areas based on GIS vegetative data layers and a tree height observed on site visits or an assumed conservative tree height (often 40' or 12 meters in eastern landscapes). The former provides a "worst case scenario" but must be used with caution, as actual visibility is most likely to occur only within non-forested areas such as fields, grasslands, water bodies, or road corridor openings. More detailed analysis of individual turbine visibility is also possible using viewshed software.

It is important to note that viewshed mapping provides only a preliminary tool and that field assessment is necessary to determine the extent and characteristics of the views (see below). Viewshed mapping is very useful in confirming areas where visibility is not possible. Viewshed mapping at nacelle height can illustrate the potential visibility of FAA required lights.

Helium balloons may be a useful way for the public to visualize small wind projects (1-3 turbines), especially in more populated areas. However, on larger projects or sites with a good wind resource, it can be extremely difficult to fly balloons in a vertical position or to adequately represent all the turbines. Viewshed analysis and photographic simulations combined with site visits are more common and effective methods for visualizing the appearance of wind projects from specific locations. See Figure 1 below.

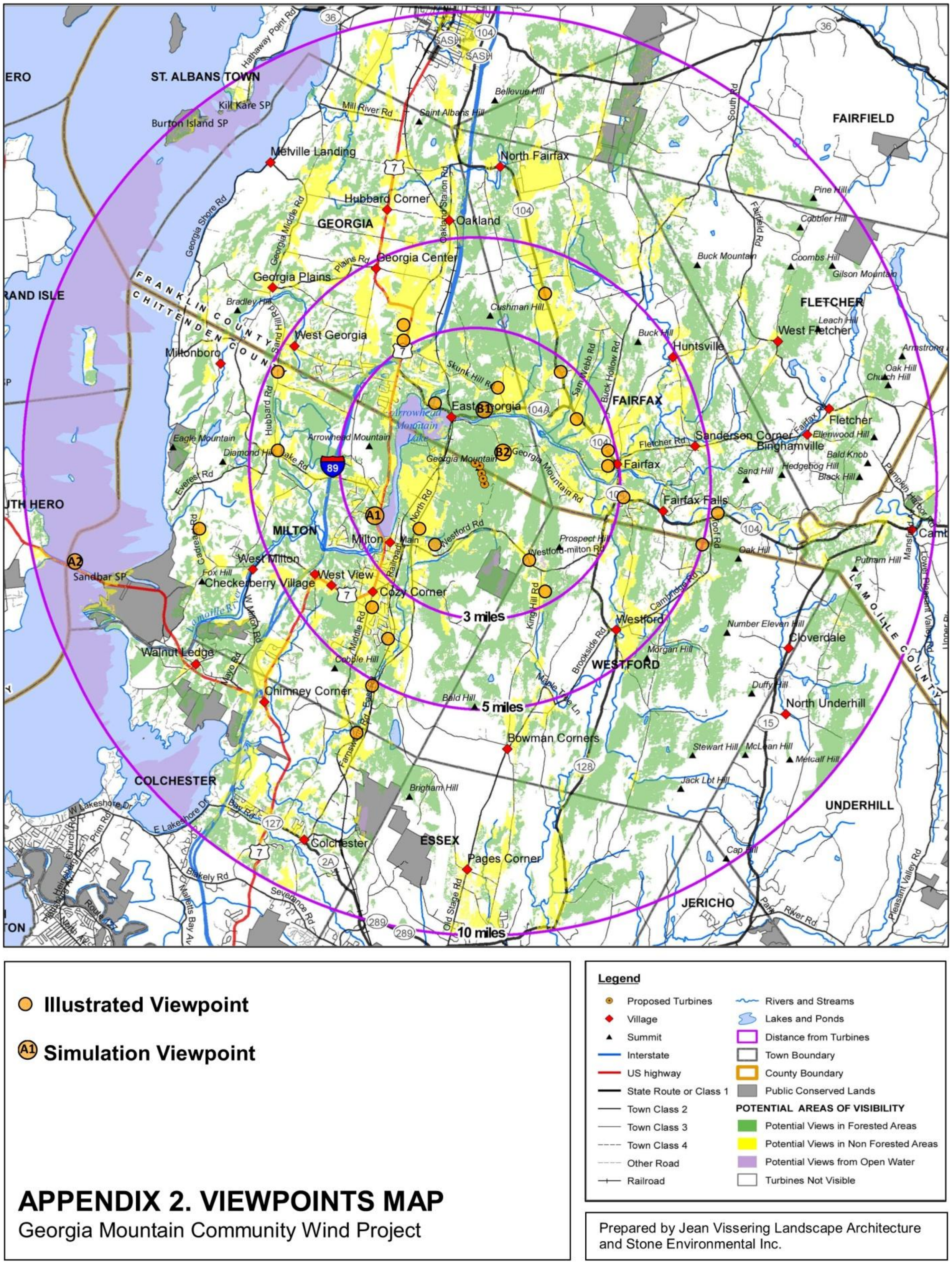

Figure 2 - Example of Viewpoints illustrated on a Viewshed Analysis Map (prepared by Stone Environmental for Jean Vissering and the Vermont Department of Public Service).

- **Identification of Natural and Cultural Resources and Features**

All area features should be identified on maps, including named mountains; rivers; lakes and ponds; parks; natural areas; local, state, and federal highways; and town centers and historic sites open to the public. These should be shown on a completed viewshed map(s) along with viewpoints.

- **Identification of Viewpoints**

Viewshed analysis helps focus field assessment work in those areas where views of the project are likely and intersect with public resources such as parks, scenic highways, and town centers. Ideally, all public viewpoints should be identified. Where many viewpoints exist, representative locations may be selected that illustrate the areas of highest scenic quality and greatest visibility. Other viewing areas may also be illustrated, especially if they are well used or concern has been expressed, such as near residential areas. Visually sensitive areas[6] are publically accessible areas of identified and/or documented scenic, recreational, or cultural importance. These points should be included on a viewshed map and linked to photographs and written descriptions of the character of the area.

- **Photographs of Existing Character**

Photographs based on field visits should illustrate all of the important public viewing areas. At a minimum, views from public parks, trails, recreation areas, water bodies, major travel routes, scenic overlooks, town centers, and historic sites open to the public should be documented. Photographs should be taken at a focal length of 50-52.5mm or the digital equivalent (the exact digital setting varies from camera to camera). This is referred to as a “normal view” and most closely represents human eyesight relative to landscape scale.[7]

Wide-angle views tend to diminish the relative size or prominence of the project ridge or setting, while telephoto views exaggerate it. Photographic panoramas (stitched together photographs) or wide-angle photographs are useful for illustrating larger projects that extend beyond a single frame or the broader context of the scene. However, if panorama views are included, full-size, single-frame photographs must also be provided to illustrate the correct proportional relationship between the project site and the viewer.

To illustrate existing character, photographs should be taken in good weather conditions if possible and in locations of maximum project visibility, as these will provide the most detail. Photos illustrating important regional features and focal points can provide useful contextual information, even if the project is not visible from or near these locations. A project’s relation to area focal points will be an important consideration in evaluating its impact. GPS points should be recorded for all photographs.

- **Simulations (Visualizations)**

The most common method of simulating proposed wind projects is to insert turbines and other project infrastructure onto a photograph from an identified viewpoint. This is done using digital terrain modeling (DEM) data combined with simulation software designed for illustrating wind energy

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[6] Visually sensitive sites are those identified in public documents as having scenic or recreational value; or publically accessible locations with high scenic quality. Most wind projects will be visible from visually sensitive sites, but visibility by itself is not inherently problematic. The determination of the degree of impact is discussed in the Evaluation Process.

[7] Some professionals believe 70mm more accurately represents the way humans view the landscape. This may be because the eye is much sharper than the camera lens, especially as it represents objects in the distance, so that the 70mm lens seems to more accurately portray the level of detail we are used to seeing. Nevertheless, 50mm is an accepted standard.

projects.[8] Accurate portrayals require training in the particular simulation software and should be done by someone with experience and knowledge of these programs. Photographs should be taken with a 50-52.5mm focal length (or digital equivalent)[9] and illustrate clear weather conditions if possible.[10]

The modeling software should be used to replicate the exact conditions of the photographs based on date and time. Minor adjustments in the modeling or post-production software may be applied to represent the lighting and atmospheric conditions shown in the photograph. This may mean that they appear silhouetted, white, or partially lit depending on the angle of the sun.

Simulated panorama views (two or more merged 50mm photos) illustrating the project in its larger context are particularly useful in illustrating larger projects in which a single frame cannot capture all the turbines visible from a particular viewpoint. They may also be used to illustrate the larger context in which the project occurs. However, single frames should also be included to illustrate a more accurate representation of the project's appearance from a particular viewpoint.[11]

Animated simulations are increasingly being used to illustrate blade rotation. Combined with video, a panoramic view can be illustrated by moving the camera from left to right from a single viewpoint, or the experience of moving along a road or path.[12]

Viewpoints illustrated should be those that are most visually sensitive[13], i.e. locations of scenic or cultural value. Areas of heavy public use or those identified as visually important by local officials or in public meetings may also be selected for viewpoint analysis. Simulations should also be provided illustrating the appearance of roads, clearing, and other project infrastructure (e.g. transmission lines, substations) if they would be visible from sensitive viewing locations. The number of simulations required will depend upon the degree of visibility of the project and the number of visually sensitive viewing areas potentially affected.

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[8] MAX and Visual Nature Studio are among the more advanced visualization software programs available. Wind Pro is commonly used by developers and is adequate for most topographic situations as are other 3D CAD visualization software programs.

[9] Accurate field data collection is critical including the use of GPS units with (preferably) sub-meter accuracy, noting landscape reference points and using a tripod for steadying the camera. Simulation software will recommend a protocol for ensuring accuracy in making the base photograph. See also standards developed for preparing visualizations in Scotland, see http://www.highland.gov.uk/NR/rdonlyres/3AB93631-8D75-46C7-B4E2-07B1FE3842FE/0/VisualisationStandardsforWindEnergyDevelopmensamended200510.pdf.

[10] Clear weather conditions not only provide the "worst-case scenario" but also provide more information regarding the visibility of landscape features within the scene.

[11] To portray a project accurately, panorama views need to be printed at a size much larger than 11x17, and with very high resolution to accurately illustrate the project. The viewing distance must be specified.

[12] See for example: http://www.macroworks.ie/Downloads/presentation140710.swf

[13] Visually sensitive sites are those identified in public documents as having scenic or recreational value; or publically accessible locations with high scenic quality. Most wind projects will be visible from visually sensitive sites and visibility from sensitive viewing areas is not inherently problematic. The determination of the degree of impact is discussed in the Evaluation Process.

Some landscape architects prefer using digital 3-D visualization models in which the scene is entirely digitally created. Photographs from site visits then are used to refine detail in a digital terrain model. These images are not dependent on weather conditions to illustrate the appearance of the turbines, and they can be easily modified to represent a range of different lighting conditions (e.g. dusk, bright sun, cloud cover). “Fly-through” and animated turbine motion can also provide a sense of the project appearance. However, it is often more difficult to provide realistic detail with a digital image. Photographic simulations are sometimes criticized for under-representing the sharpness of turbines, while digital simulations may actually exaggerate the sharpness and clarity of turbines. In general, simulations are best used in understanding the general size of the turbines in relation to surrounding landscape features, and the visibility of the project from particular viewpoints, rather than in precisely representing the way people see and experience the landscape. Image representations are best reproduced on 11X17” paper or poster size using a high-quality printing process. An approximately 8.4X15.7” photograph can be accurately viewed at arm’s length, while a poster-sized image can be viewed at about 4-5 feet away. (See Appendix B for illustrations of different approaches to simulations.)

Figure 3 - Simulation of proposed wind energy project in New York (By Saratoga Associates for Invenergy Wind LLC)

There is debate as to whether or not project lighting (FAA-required obstruction lighting) can be accurately simulated. Lighting is affected by numerous variables. Observing existing obstruction lighting is the best approach. Videography approaches are improving and combined with simulation software such as 3D Studio Max, which can compensate for variables such as refraction, reflected light, the source light, and shadows, reasonable lighting simulations can be created. Nevertheless, professionals who have created these simulations agree that they need to be adjusted using field comparisons of similar lighting situations. They will also be affected by viewing conditions such as room lighting, computer brightness settings, etc. Professionals agree that lighting simulations cannot be accurately printed as still images.

B. EVALUATION OF VISUAL IMPACTS

The tools described above provide essential graphic information regarding where a project will be seen from and what it will look like. However, they do not address how significant the impacts will be. To determine the degree and significance of the visual impacts, two evaluative steps are needed. The first step is to clearly define what the visual impacts will be by describing and illustrating how the project will be seen from various viewpoints, the scenic values of these viewpoints, and the expectations of viewers. The second step then is to determine whether or not these impacts rise to the level of "undue" or "unreasonable" using the following three criteria:

1. Does the project violate a clear written aesthetic standard intended to protect the scenic values or aesthetics of the area or a particular scenic resource;
2. Does the project dominate views from highly sensitive viewing areas or within the region as a whole; and/or
3. Has the developer failed to take reasonable measures to mitigate the significant or avoidable impacts of the project?

In regulatory processes, decision makers also seek to weigh the public benefits of a proposed project against the project's impacts including visual impacts to determine the regulatory acceptability of the project. (See Appendix E Case Studies for examples of wind projects which were found to have reasonable and unreasonable aesthetic impacts.)

STEP 1: Defining the Project's Visual Impacts

The first step in a visual assessment process is to determine what the visual impacts of the project will be (or whether there will be visual impacts at all). This requires a detailed understanding of the project itself, its landscape context, the scenic resources in the surrounding area, how the project will be seen from important views and in relation to scenic resources, and the viewer expectations for particular viewing areas. The following descriptive information should be provided and supported with the graphic illustrations outlined above.

a) What are the Visual Attributes of the Project?
A clear description of the visual elements of the entire project is necessary, including the physical attributes of the turbines, permanent meteorological towers, lighting, clearing required for turbine pads, roads, collector lines, transmission line, substation, and operations and maintenance buildings.

b) What is the Surrounding Landscape Character and What Are Its Distinctive Features?
The developer should provide a general description of the surrounding area of analysis, its typical landscape character, land uses, and any distinctive features. The description of existing character provides the foundation for understanding the existing condition.

Landscape character is the combination of both natural and human or built landscape features. All landscapes are composed of unique combinations of topography (land forms), vegetative patterns, and water features (lakes, rivers, streams, wetlands) that contribute to visual character.

Superimposed on the natural landscape is the human or cultural landscape, also characterized by distinct patterns. For example, patterns of towns or villages may contrast with patterns of farms, fields, and forests. Some regions are characterized by numerous hills and ridges, while others have only a few distinct and prominent ridges or mountains or may be almost perfectly flat.

In some landscapes, certain natural or cultural features become focal points. Forestry practices, mining, suburban development, and recreational structures also are superimposed on the landscape and become part of its overall visual character. Political designations (e.g. zoning) and land protection efforts may also be relevant.[14]

c) **Are Important Scenic Resources Present and What Are Their Sensitivity Levels?** Scenic, natural, and cultural resources and landscape features should be illustrated effectively on maps. These resources and features also should be carefully described in terms of their scenic values and sensitivity levels. Scenic resources will include public parks, water bodies, trails, state and federal highways (especially any designated as scenic corridors), town centers or other cultural focal points, and historic sites open to the public. Some states and localities specifically identify resources of value in state, regional, and/or local planning documents.

All the aesthetic characteristics of the scenic resource should be considered, including attributes that may contribute to or detract from its scenic quality. Sensitivity levels will be determined by considering the combination of the factors described below.

Scenic Quality and Intactness of Resource

The degree of existing scenic quality is usually correlated with landscape diversity – the more natural diversity, generally, the greater the scenic quality. Landscape diversity can be evaluated through a reasonably objective process and will be relative to other landscapes at the local, regional, state, or national level. (See Appendix A.)

Another relevant factor in determining scenic quality is the intactness of the landscape. A lack of landscape degradation contributes to the "intactness" of the landscape. Degradation most often is a result of development that erodes existing natural and historic scenic landscape patterns, or land uses that become unintended focal points due to their contrast in form, color, or pattern with their surroundings. In contrast, natural landscape focal points such as distinctive mountains and lakes with diverse shorelines contribute to scenic quality.[15]

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[14] This provides information about the project's context but may also be relevant to the extent that they may provide a clear written community standard (see section 2a).

[15] The U.S. Forest Service, the Bureau of Land Management, and the Federal Highway Administration have developed systems for evaluating scenic quality that may also provide useful guidance. *See* USFS Visual Management System (1974); BLM Visual Resource Management Program (1980); FHWA Visual Assessment of Highway Projects, Publication FHWA-HI-88-054.

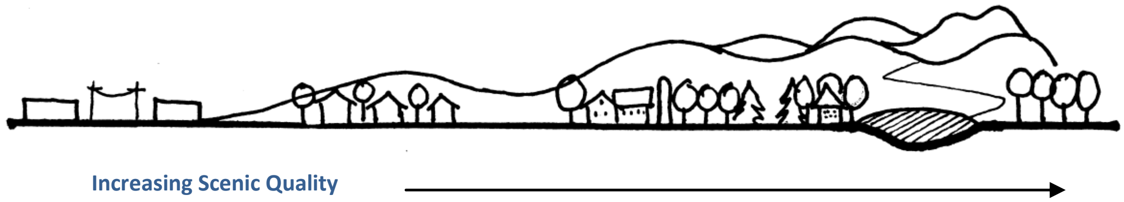

Figure 4
Scenic quality generally increases with increasing natural diversity, e.g. topography, vegetation, water.

Figure 5
This "working" cultural landscape has low to moderate diversity, but is relatively intact. Wind turbines are not dissimilar in form and color to the vertical silos and grain elevators typical in this landscape, and may "fit" reasonably well in some of these landscapes.

Viewer Expectations

For certain uses, there may be public expectations of a primitive or natural setting (e.g. remote camping) or for a cultural landscape in which change is to be kept within narrowly defined parameters. For example, recreational areas restricted to non-motorized uses are likely to be more sensitive to changes involving built elements than other settings. Designated historic sites or landscapes may provide an opportunity to experience cultural patterns of the past. Other uses or user groups such as snowmobilers, motor-boaters, or hunters may be less concerned about visual impacts but nevertheless should always be provided opportunities to comment.

Figure 6
These three scenes illustrate settings for which there may be differing viewer expectations for scenic quality or for a natural setting.

Uniqueness of the Resource

Scenic resources that have distinctive and outstanding value are often specifically noted in public documents and serve as regional focal points or landmarks. In a region noted for its many lakes or mountains, any one lake or mountain may not be unique unless it has distinctive attributes that may make it especially notable. However, in a region where mountains are unusual, a single prominent peak may represent a unique resource.

Figure 7- Some scenic resources are exceptional due to their distinctive form, their height, or their isolation; or may in provide a unique experience such as an opportunity for non-motorized paddling or remote hiking. (Photo credit right: The Nature Conservancy)

Numbers of Users

Heavily used public areas, such as a heavily traveled road or a popular recreation area,[16] are sometimes considered to be more visually sensitive than other areas. Good information about public use may not be readily available, but where it is, the amount of use of the particular resource should be compared with other similar uses. For example, the use of a hiking trail should be compared with the use of other hiking trails, not with the use of a public beach or highway.[17]

d) How will the Project be Seen and Experienced from Identified Viewpoints in the Surrounding Area?

As noted above, project or turbine visibility by itself does not determine the degree of visual impact even when seen from highly scenic areas. Field investigation as well as photographic and written documentation is necessary to provide an understanding of how the project will be seen from public viewpoints. Relevant to this understanding is the proximity of views, the duration of views (over time or distance), the number of turbines, the breadth of the view occupied by the project, the scenic quality of the view, expectation of users at viewpoints, and the prominence of the project or project setting within views.

The following factors are relevant in determining the degree of visual impact and should be considered in assessing visibility effects (see Appendices A, B, and C for further illustrations).

Project Scale (Size)

We perceive the size of an object in relation to its surroundings. Vertical scale (apparent height) in relation to the associated landmass and horizontal scale (breadth or visible horizontal area occupied in views) are relevant considerations in combination with other factors described below.

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[16] Specific use data for a resource such as a park, trail, or scenic pullout may not be available.

[17] Arguments have been made that a relative lack of use can contribute to a sense of remoteness, which may be a high value for some people. Remoteness (which is a characteristic of wilderness areas) needs to be considered separately. Reviewers should rely on public documentation to determine whether remoteness is a value that has been specifically identified as an important attribute of the area in question and how any visibility of the proposed project might affect these values.

Figure 8
This simulation photograph illustrates a proposed 19-turbine wind project in southern Vermont as viewed from Harriman Reservoir at approximately 4 miles away (the number of turbines proposed has since been reduced to 15). In this view, 9 2-MW (Gamesa G80) turbines are visible along with approximately 5 older .5 MW turbines (right). The simulation illustrates several concepts related to project scale. First, the turbines appear to be lower in overall elevation than foreground hills closer to the viewer, thus reducing their prominence. Also, only 9 of the 19 proposed turbines are visible from this viewpoint. The photo also provides a useful comparison between the larger 2 MW (almost 400 feet at tip of blade) and smaller, older turbines (just under 200 feet at tip of blade) (Simulation by VERA for Iberdrola).

Despite the height of modern wind turbines, it is difficult for most people to distinguish between a 200-foot turbine and a 400-foot turbine unless they are side by side. Both appear much larger than surrounding trees and buildings. The size becomes relevant only when turbines appear to diminish the size and importance of a nearby natural feature such as a ridgeline. Often fewer, higher-output turbines (e.g. 2.0+ MW) appear less visually intrusive than an equivalent output using 1.5 MW turbines.

The higher-rated turbines are only minimally larger in size, but fewer turbines provide an equivalent output of power, often resulting in a better aesthetic solution. Simulations are useful in illustrating the relative height of turbines in the landscape. Because wind turbines are relatively slender, their overall mass is more limited.

Horizontal scale (breadth of a project) also contributes to the relative prominence of a project throughout the region. Certain western and midwestern landscapes can accommodate larger projects better than some eastern landscapes, which tend to have a smaller, more intimate scale. All wind projects should be appropriately scaled to their local and regional settings. (See also Numbers of Turbines Visible, below.)

Figure 9
1.5 MW wind turbines, part of a 220-turbine wind farm near the town of Peetz in northeastern Colorado. In the western U.S. wind projects may include up to 1,000 turbines.

Proximity (Distance from the Project)

In closer proximity, turbines will appear larger, more prominent, and seen more clearly with more visible detail. The concepts of foreground, middleground, and background are often used to describe our visual experience of the landscape from different distances.[18] Due to the size and high visibility of wind turbines, the distance zones historically used in visual analysis may need to be reconsidered. Certainly views of wind projects in middleground to background areas are an important consideration.

Turbines viewed at distances of less than ½ mile (foreground) are likely to have the greatest impacts, and viewers will recognize a higher level of detail. At this distance, turbines appear as part of one's immediate surroundings. They may also be audible in certain conditions within this distance.

Between ½ and 4 miles away (middleground), turbines are more likely to be seen as part of a larger landscape. Nevertheless, landscapes at these distances are often an integral part of a scenic view. Beyond 4-5 miles (background), haze may begin to lend a bluer cast to landforms and objects (less so in drier weather conditions). However, depending on the sensitivity of the viewing area, the orientation of views, and the size of the project, adverse visual impacts can occur even at distances up to 8 or 10 miles away, and even farther away for more open Midwestern and western landscapes.

The sense of proximity can be affected by a number of variables, including landscape scale and topography. When turbines are seen on the closest ridge to the viewer, for example, they may appear very close even at 5 miles away. By contrast, if the turbines appear behind another closer ridge or hill, they may *seem* farther away.

In general, visual impacts are greater when objects are seen at close range. Wind turbines may be seen from 15-25 miles and even farther under optimal atmospheric conditions, but individual turbines appear very small at such distances and as small portions of a larger panorama.

[18] The U.S. Forest Service originally referred to foreground areas as within ½ mile, middleground as up to 4-5 miles away, and background areas as beyond 4 miles. While these distances are still useful in understanding our perception of detail in the landscape and how turbines relate to this experience, other factors such as the overall visibility and size of the project itself will be equally relevant. *See* USFS Visual Management System (1974); BLM Visual Resource Management Program (1980).

Figure 10 - The simulated project (above) is viewed from just under 3 miles. Foreground peaks rise to either side just out of the photo frame (see panorama view in Figure 9 below). Since the project appears lower than and behind the foreground hills in the panorama below, it appears less prominent. (Simulation by TRC for TransCanada).

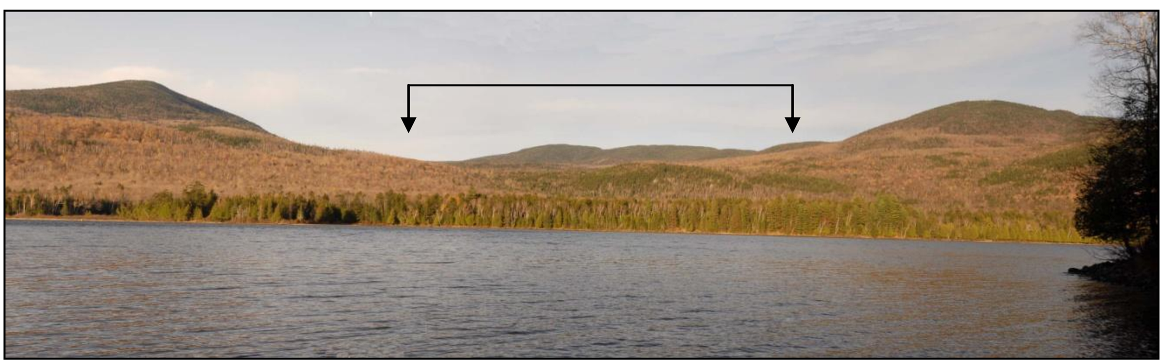

Figure 11 – Panoramic view (note: this image does not contain turbines but rather illustrates the context of the project ridgeline.

Figure 12 - These turbines are viewed at about 4 miles away but are viewed along an adjacent ridge from a similar elevation as the observer. (Simulation by Appalachian Trail Conservancy; project layout has since changed).

Figure 13 - At 4.6 miles, the turbines in this scene are less noticeable due to the rising foreground landforms on either side and because they are receding from view into the distance. The lower viewing angle also means that lower portions of the turbines are somewhat screened. (Simulation by TRC for TransCanada)

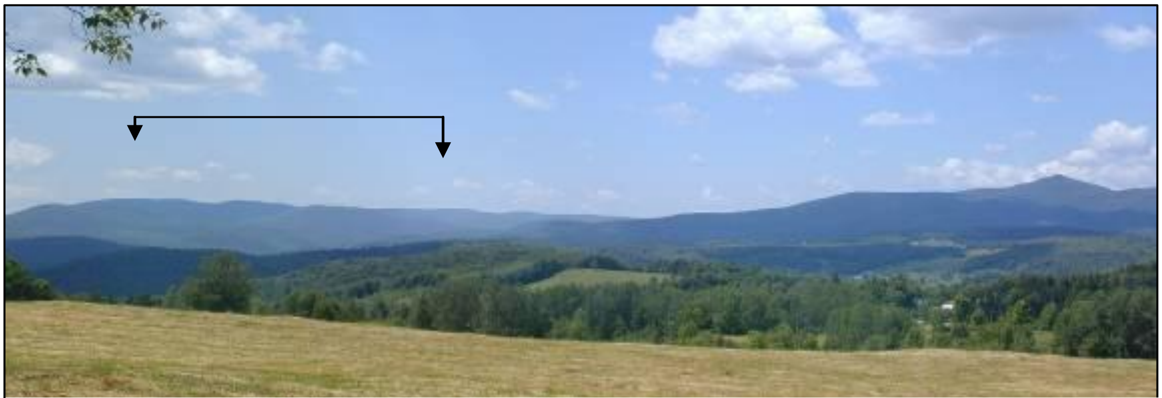

Figure 14 - This panorama view illustrates a prominent regional focal point to the right (Haystack Mountain in Vermont). A proposed wind project would be located along the ridges to the left (see arrows), which appears both lower in elevation and less distinctive in form within the view. Other factors that help reduce the overall impacts of the project from this scenic viewpoint are the distance from the viewer, the cultural (vs. natural) context of the view, and the limited portion of the view occupied by the project. See detail image below (Figure 15).

Figure 15- Simulation showing proposed wind project along the ridge illustrated above. (Simulation by VERA for Iberdrola).

View Duration

View duration refers to how long a project is visible as one drives along a road, paddles along a lake, or hikes along a trail. In many cases, views of a project may be intermittent and seen through groupings of trees or buildings as a person moves through the landscape, and this may lessen the adverse impacts.

Duration also is influenced by the speed one is traveling. If one has reason to linger (a public beach or mountain summit, for example), the duration will be longer than if one is proceeding along a linear corridor.

As with all considerations, view duration should be evaluated along with other factors such as the distance of the project, sensitivity of the viewing area, angle of view, and prominence of the land feature involved.

Angle of View

When a project will be seen directly ahead, it is likely to be more of a focal point in contrast to being viewed to one side. Seeing a project from above usually makes roads and site clearing more visible than if seen from below.

Panoramic vs. Narrow View

Highly scenic panoramic views may be more sensitive to wind development. However, when one sees a project as part of a wide panorama, it may appear to occupy a relatively small part of the view and have a lower degree of impact – unless a particular landscape feature or other factors make it a focal point. Locations with dramatic panoramic views are often, however, scenic destinations, giving them greater sensitivity. Narrow or limited views may provide only a quick glimpse and are often of less concern unless the project becomes a focal point from many sequential narrow views.

Project Relation to Landscape Focal Points

Distinct cultural or natural focal points often enhance scenic quality. The development of a wind project will generally be more adversely perceived if it conflicts with or degrades the visual quality and prominence of an important focal point. On the other hand, as long as an important focal point remains a prominent feature (by virtue for example of overall elevation, visibility within views, or distance from the project), it may help to diminish the prominence of a wind project within the region (see Figure 8).

Numbers of Turbines Visible and Area of View Occupied

The number of turbines visible at any one time also affects the prominence or relative scale of a project and its degree of impact. Generally, we experience the landscape as a sequence of views (driving along a road, paddling down a lake, or hiking along a trail), and the project is likely to appear differently from different locations. The area of the view occupied can also be relevant to the degree of visual impact; that is, do the turbines occupy a large portion of the view or are they seen as a narrow part of a panoramic view? Views of large numbers of turbines from sensitive viewing locations will increase visual impacts.

Visual Clutter

The accumulation of diverse built elements on a site, especially elements that contrast with their surroundings in form, color, texture, or pattern, can result in visual clutter. While it may seem logical to place wind-energy projects in already built landscapes, too much development can result in an increasingly chaotic or cluttered landscape. Several different turbine types and sizes can have a similar effect. Because wind-energy projects involve the repetition of like elements, they often result in greater unity and less clutter than some other types of development.

FAA Hazard Lighting

Hazard lighting is one of the most difficult visual aspects of a wind-energy project to evaluate, but it is an increasing concern. The Federal Aviation Administration (FAA) determines required hazard lighting or markings on a case-by-case basis. Usually wind turbines are required to be lit at night only (provided the turbines are white or off-white) with flashing red (L864) (white L-865 may also be used) located every ½ mile along turbine strings.[19]

The nighttime landscape is often observed differently than the daytime landscape as there is less visible context and lights are more likely to be seen in isolation. In many landscapes where wind projects have been built or proposed, there currently is little night lighting. While red lights have less contrast than white lights in the night sky, they differ markedly from colors typically observed in the night landscape; the flashing on and off makes them particularly noticeable. Of greatest concern will be visibility from outdoor areas where night use occurs and there is an expectation of a natural landscape setting such as from natural parks or primitive camping areas.

Lighting is most intense when seen from above due to a -1° cutoff on light fixtures. Since hazard lighting only needs to be seen, not light up an entire area, it is of relatively low intensity and is less likely to affect dark skies.

In areas where there is high sensitivity to views of lights, consideration has been given to Audio Visual Warning Systems in which lights remain off but are activated by motion at a certain distance away.[20] This type of system is more expensive to install but could help reduce concerns about wind energy projects in certain areas.[21]

Shadow Flicker

Shadow flicker occurs when the sun is shining directly behind a wind turbine and the turning blades cast moving or flickering shadows on nearby residences or public use areas. This occurs only during low sun angles and usually only a few hours per year, but it can present an annoyance to nearby residents. Shadow flicker can be a health risk if the shadow flicker reaches certain frequencies (hertz). Modern turbines turn too slowly to trigger epileptic seizures, but combined shadows from overlapping turbine blades could increase the overall frequency. The potential number of hours per year that shadow flicker is likely to occur at nearby homes can be modeled using specialized software. Guidelines often permit a maximum of 20-30 hours per year. Since the overall effect diminishes with distance, some states require setbacks to minimize the effects of shadow flicker on residences and properties. Often, setbacks are established to address a combination of shadow flicker, noise, and safety issues.

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[19] See: http://www.airporttech.tc.faa.gov/safety/downloads/TN05-50.pdf

[20] One system that is currently in use for a range of different project types such as transmission lines, airports and hydroelectric projects is the Obstacle Collision Avoidance System (OCAS). The system has received FAA approval for at least one wind energy installation.

[21] This system has not yet been used in the United States. For more information, see www.ocasinc.com.

STEP 2: Determination of Whether the Project's Impacts are Unreasonable

Once a wind project's visual impacts are clearly described as suggested in step one, it is then possible to make an informed determination as to whether or not these impacts rise to the level of "undue" or "unreasonable." Three useful criteria are:

a. does the project violate a clear written standard intended to protect the scenic values or aesthetics of the area or a particular scenic resource;
b. does the project dominate views from highly sensitive viewing areas or within the study area as a whole; and/or
c. has the developer failed to take reasonable measures to mitigate significant or avoidable impacts of the project?

a. Inconsistent with Clear Written Aesthetic Standard[22]

Public documents that identify and describe aesthetic or scenic resources are invaluable to developers, concerned citizens, and to permitting bodies as they can provide clear guidance as to the particular values of natural and cultural landscape features. Relevant documentation can be found in state law or local, regional, state, or national planning documents. Citations within publically adopted planning documents to studies or reports may also be relevant as a written aesthetic standard.

To be considered an aesthetic "standard," however, there must be clear and unambiguous language as to particular aesthetic values that are to be protected. The standard should be based on a rigorous aesthetic study performed with input from professional planners or landscape architects. A document establishing an aesthetic standard should be specific enough to clearly identify the particular regional or state resource or particular viewpoint and the features within the view that are specifically valued and why. It should be noted that outright bans of wind projects in particular locations by zoning or town plans are not the equivalent of an aesthetic standard. Also, vague or general statements in planning documents (for example, statements about protecting views generally along a scenic corridor or protecting rural character in a community) do not provide meaningful guidance upon which to evaluate the value and importance of scenic resources potentially affected by a wind project, and do not constitute an aesthetic standard as defined in this report.

In order to be considered a clear written standard, documentation of the aesthetic resource should have the following characteristics:

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[22] The three criteria outlined here have been modified from similar criteria used by the State of Vermont. Under Vermont's Act 250 land use law, the Environmental Board has adopted the so-called Quechee test, which has been employed also by the Vermont Public Service Board in reviewing the aesthetics of an energy generating facility, such as a wind project. For explanation of this Vermont regulatory test, *see In re Amended Petition of UPC Vermont Wind, LLC*, Docket 7156, Order of 8/8/2007 at 64-65. The use of a "clear written standard" places responsibility on communities and state agencies to clearly define the resources they wish to protect through a public process. Established documentation that was in place prior to consideration of a wind project should hold greater weight than recently adopted standards designed to prevent wind energy projects.

- The standard and related documentation should be based on a rigorous scenic value study performed by objective professional planners or landscape architects.
- The documentation should clearly and specifically identify the particular scenic or aesthetic resource of regional or state significance that would be potentially affected by development.
- The documentation should clearly and specifically identify the scenic or visual characteristics of the resource that are valued (they must be scenic or aesthetic values, not just recreational, cultural, or historic values).
- The documentation should provide specific guidance as to what types of development might affect the resource visually and what steps might be possible to mitigate the visual impacts.
- The documentation should be in, or referenced by, a publically adopted plan at the local, state, or federal level.

For illustration purposes, here is a hypothetical example of how an aesthetic standard might be established and relevant to a wind project:

> A statewide study of lakes and ponds is conducted that identifies relative scenic attributes of lakes and ponds over a certain size. The study's stated purpose is to protect the scenic resource values of these lakes and ponds. The relative scenic quality is divided into three categories based upon clear and identified criteria. Important landscape features are identified in a written description of each lake or pond, and in some cases particular mountains are identified as significant contributors to scenic quality. The study is cited or included in a state planning document that is used by the state development siting review board. A wind project is proposed near a lake that is rated by the statewide study as a lake of very high scenic quality and noted as being a very intact natural landscape with minimal surrounding development. The ridge on which the project would be located is identified in the study as a contributing feature. The proposed wind project would be visible in relatively close proximity to the lake and its users. This scenario would likely be considered a violation of a clear written aesthetic standard.

b. High Degree of Dominance: Would the project dominate views from highly sensitive viewing areas or within the region as a whole?

The evaluation above (Step 1) identifies the adverse impacts that will result from the project. If, using the Step 1 information, a project dominates the views from highly sensitive viewpoints to such an extent that it would significantly harm scenic resources that are clearly valued within the region, it is likely to have unreasonable or undue visual impacts.

In evaluating the impacts of development, use *contrast* as a typical evaluative criteria. The "contrast" of many development projects can be softened through changes in form, color, or through vegetative screening. These are not options available with most wind projects. Wind turbines inherently result in a high degree of contrast due to their visual characteristics (large scale, white color, moving blades) and required siting locations (rural landscapes, often higher elevations). The degree of contrast may be useful to examine, but only as part of a number of other considerations (described above).[23] The concepts of

[23] Contrast can be useful in evaluating many types of development projects within cultural landscape contexts such as housing developments, transmission line corridors, and forestry practices and can be used to examine the

degree of prominence and *dominance* may be more useful, because they examine how a wind project will be seen within its context – not in terms of color, form, or texture, but rather by its overall visibility, its relationship to specific valued landscape features, and the expectation of users. “Dominance” may occur from multiple views, from a single highly sensitive scenic resource, or from a combination of views from several high-value scenic resources. It may occur as a result of a high number of turbines being visible in relative close proximity from several highly sensitive vantage points. “Dominance” occurs when the project would cause a change in the balance or feel of the character of the surrounding area or create a very dominant focal point that detracts from other important natural or cultural focal points.[24]

The following factors affect the degree of dominance, but it is nearly always a combination of these factors that results in unreasonable visual impacts.

Viewed in Close Proximity

The closer a project is located to the viewer, the larger and more dominant the turbines are likely to appear. As noted above, “proximity” is a relative term given the size of wind turbines and will depend on the characteristics of the landscape. In mountainous areas, turbines located on the next ridgeline may be 5 miles away, but they still appear “adjacent” or “proximate.” If the project is seen along a ridgeline behind more proximate ridgelines, the appearance of “proximity” may be reduced.

Long Duration of View

High visibility over a long distance or time period from publically accessible resources will exacerbate impacts. Speed of travel by the viewer may also make a difference as well in determining the relative dominance of a wind project. For example, a wind project viewed for one-half mile along a roadway while traveling at 60 mph in a car is likely to be less dominant than seeing the project for one-half mile while hiking along an open alpine ridgeline. Views from places where one might linger, such as a remote campsite, mountain summit, or a public beach, will also result in longer viewing duration (although with varying viewer expectations).

Expectation for Natural or Intact Landscape Setting[25]

A landscape where users expect an experience of a natural setting may result in much greater visual impact from a wind project. Levels of expectation vary. For example, expectations for a natural setting are lower for lakes and ponds with camps and motorboats or for trails within areas of frequent logging, as compared to primitive campsites where only low rpm motorboats are allowed or on hiking trails within protected landscapes.

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overall degree to which wind energy projects alter the landscape. Despite the high degree of contrast, there is evidence to suggest that many people find wind energy projects attractive. Their simplicity of form, repetition of like objects, and easy functional readability (the movement of the blades makes the wind visible) may contribute to their appeal. Nevertheless the focus of appropriateness should be on the inherent aesthetic values of the site itself and how a project is viewed in the landscape.

[23] In some instances a wind project can become a dominant feature in the landscape in a positive way such as the graceful arc of wind turbines in Copenhagen, Denmark’s harbor. In otherwise featureless landscapes, a wind project may become a visual feature that contributes diversity.

[25] Other conditions might exist in which there would be an expectation of minimal landscape alteration. A designated historic landscape could provide such an example provided documentation of the resource clearly identifies visual or scenic quality of the landscape as critical to the reason for its historic designation.

Unique Scenic Resource

All scenic resources have distinctive characteristics, but some stand out due to their distinctive form, vegetative patterns, isolation, or other factors. Often these are prominent landmarks or unique focal points in the landscape and may be well-known state or national destinations for recreationists.

Project Viewed Directly Ahead in Typical Direction of Travel

When a wind project is viewed directly ahead over extended distances, it is more likely to become a focal point in the landscape. This factor alone does not create an unreasonable visual impact, but in combination with other factors listed here (duration, viewer expectations, numbers of turbines visible, etc.) it may create an excessive dominance in the surrounding landscape.

Large Numbers of Turbines Visible in Many Views

Where numerous turbines are seen from many highly sensitive viewpoints, impacts are likely to be exacerbated, especially in combination with the other factors described here. How a project is seen varies considerably from site to site. In diverse terrain, a project may come in and out of view with only a few turbines seen from most viewing areas. And what constitutes a "large number of turbines" is relative to the context. Some landscapes can accommodate larger numbers of turbines due to existing landscape character, complexity, and scale. Some landscapes can accommodate hundreds of turbines, while in others the difference between 15 and 40 turbines may be significant. Turbines can fit well in many types of landscapes. However, even within the flat to rolling agricultural landscapes of the country, in which wind turbines and farming may seem a logical combination, aesthetic impact issues may arise when the number of turbines overwhelms the immediate context.

c. Mitigation Measures Taken: Has the developer failed to take reasonable measures to mitigate the impacts of the project?

Some visual impacts will be inevitable with any wind energy project. However, best practices can often be incorporated into the design and siting of a project to reduce its visual impacts to a reasonable degree. If an evaluation indicates that there are documented and important scenic values that are negatively affected by the project's degree of dominance, appropriate mitigation measures may be available to reduce the impacts to a reasonable level. For wind energy projects, appropriate initial siting is the most important variable in minimizing visual impacts.

***Appropriate Siting*:** This critical mitigation technique involves avoiding a site that is located within areas of regionally valued and highly scenic resources. Selecting a site that can comfortably accommodate the proposed number of turbines without visually overwhelming sensitive scenic resources is critical to wind project planning. Appropriate siting may also need to address potential issues of cumulative impacts so that a particular area or landscape is not overburdened with wind-energy development.

Additional mitigation measures that should be considered to reduce otherwise unreasonable visual impacts include:

***Downsizing*:** Reducing the scale of the project (numbers of turbines or height of turbines) may help a visually dominant project fit more comfortably into its context and surroundings. In some locations, even a small number of turbines may be particularly prominent from sensitive viewpoints, or the overall scale of the project may overwhelm the particular land form or surrounding landscape. The height difference between a 200-foot turbine and a 360-foot turbine (hub or nacelle height) can be difficult to perceive.

However, size may make a difference if the height of the landform begins to be overwhelmed by the height of the turbines. Often, fewer, larger turbines can result in a better visual outcome than a larger number of small turbines.

Relocation: Relocation of several of the most prominent turbines in an overall proposed project layout may be sufficient to avoid proximity to residences or visual prominence from sensitive viewing areas. For example, turbines may appear particularly dominant when they appear at the top of a nearby prominent peak. On the other hand, moving turbines entirely off a ridge to a lower elevation often results in minimal aesthetic benefit but a fairly significant reduction in energy production.

Lighting: Lighting impacts often are of concern to residents and recreational users and should be minimized to the greatest extent possible. The lighting requirements are usually determined by FAA, however, and developers may have limited control. Any new technologies or modification of FAA lighting requirements that can further reduce lighting for wind turbines ideally should be incorporated into design standards where feasible.

Turbine Pattern: In most cases, turbines are located to take advantage of small rises in the land or other site features that determine their pattern or organization on the ground. Some studies suggest that turbine configurations can be designed to respond in meaningful or visually pleasing ways to their surroundings. For example, a less rigid or linear arrangement may be preferable even in flatter terrain. Simulations provide a useful way to study the effects of different turbine patterns from sensitive viewing areas.

Infrastructure Design, Siting, and Screening: Careful siting of project infrastructure such as roads, substations, transmission and collector lines, and project buildings is important to reducing visual impacts. Generally, it is advisable to screen project infrastructure from view to the greatest extent feasible. Indigenous plants typical of the area should be used where plantings are needed to provide screening. Project roads may require considerable cut and fill, especially in more rugged terrain. Therefore, siting and design of roads and other infrastructure to minimize off-site visibility from visually sensitive areas should be an important consideration.

Color: A recent FAA study showed that daytime lighting could be eliminated provided that turbines are white. White often is regarded as more cheerful and less industrial than other colors, which may be part of the reason some people find wind turbines more visually appealing than, for example, cell towers. Bright patterns and obvious logos should be avoided. Use of unobtrusive colors to minimize contrast is important for other project infrastructure such as operations buildings, transmission support poles, and road surface materials. In general, darker colors are less noticeable when viewed against a vegetated background.

Maintenance: Studies show that people find wind turbines more visually appealing when the blades are rotating than when they are still.[26] Requirements for prompt repairs of wind turbines can be part of permit requirements. The replacement of wind turbines with visually different wind turbines can result in visual clutter, so replacing wind turbines with the same or a visually similar model over the lifetime of the project may be an important requirement.

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[26] Pasqualetti, M.J., P. Gipe, and R.W. Righter, eds. 2002. Wind Power in View: Energy Landscapes in a Crowded World. San Diego: Academic Press.

Effective Decommissioning Plan: Once a project or individual turbine can no longer function, requirements for removing the project infrastructure and reclaiming the site are important.

Non-Reflective Materials: Use of materials that will minimize light reflection should be used for all project components.

Minimizing Vegetation Removal**:** Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads and around turbine pads, substations, and other project infrastructure.

Burial and Sensitive Siting of Power Lines**:** Collector lines are often buried between turbines, and this is especially important where they could be visible from adjacent scenic or high-elevation locations. Burial of transmission lines is extremely costly but may be warranted in unusually sensitive scenic locations. Collector and transmission lines should be sited to avoid views of cleared right-of-ways from scenic public viewing areas. Small trees can be retained or planted at intersections with scenic road corridors and other scenic viewing locations to help screen views of the transmission line corridor.

II. Additional Considerations[27]

A. PUBLIC PARTICIPATION AND SURVEYS

Communities around the country have used a range of techniques for eliciting public opinions about proposed wind projects and their local impacts, but the effectiveness of these approaches needs further study.

Much of what we know about public reactions to wind energy projects is anecdotal. Statistically valid and independently conducted pre- and post-construction surveys can provide useful information about public perceptions of wind-energy projects and help determine what factors are important in public perceptions. One of the few such surveys was conducted by James Palmer for the Searsburg Wind Project in Searsburg, Vermont.[25] More recently, Palmer developed a survey to evaluate both the amount of use and attitudes of hikers to a viewpoint on Spruce Mountain in Maine. Such surveys are commonly conducted in Europe, but much less often in the U.S.

While such surveys can provide useful data in understanding user attitudes, they must be carefully designed by an independent professional to avoid bias. Findings made from one locality or project can

[27] In addition to the considerations discussed in this report, two related issues that are not addressed are noise and cumulative impacts. Noise impacts are generally evaluated in detail and although they are an aesthetic consideration, noise is often considered under review of health or air quality impacts. Many states also are beginning to address the issue of cumulative impacts. Few comprehensive examples exist in the U.S. of effective cumulative impact analysis or methodologies (but see Angus Windfarms: Landscape Capacity and Cumulative Impacts Study (http://www.angus.gov.uk/DevControl/LandscapeCapacityandCumulativeImpactAssessmentFinal.pdf).

be difficult to transfer to another situation, with different landscape characteristics or community attitudes.

B. NUMERICAL ASSESSMENT SYSTEMS

In some instances, numerical or scoring systems have been developed to evaluate development projects. These systems can work for evaluating the visual effects of some kinds of developments where variables are very limited.[28] However, for utility-scaled wind energy projects that are visible over large areas and from many types of landscapes and scenic resources, the visual evaluation required is much too complex to make numerical assessments systems useful. For example, the assignment of a generic-type score, such as "moderate impact" vs. "high impact," does not provide meaningful information to the decision maker unless it is clearly explained how the project is seen, in what context, and what the value of the resource is. In contrast, the strength and merits of a written visual analysis rely on a qualified or informed person preparing the evaluation to present his/her arguments in a logical fashion, addressing specific site and project characteristics and effects in a manner that informs the judgment of a reviewing body.

C. PEER REVIEW OR PANEL REVIEW

In some states, a panel of experts is asked to review the visual impacts of a particular project in addition to an aesthetic impact professional hired by the developer. This approach can provide a more robust and diverse discussion of the issues than is presented by a single analyst. Other states hire an independent professional to review the work prepared by the expert hired by a developer.

[28] The author developed a numerical evaluation system for small wind turbines (for individual use): see *Siting a Wind Turbine on Your Property: Putting Two Good Things Together, Small Wind Technology & Vermont's Scenic Landscape*, Public Service Board, December 2002.

Conclusion

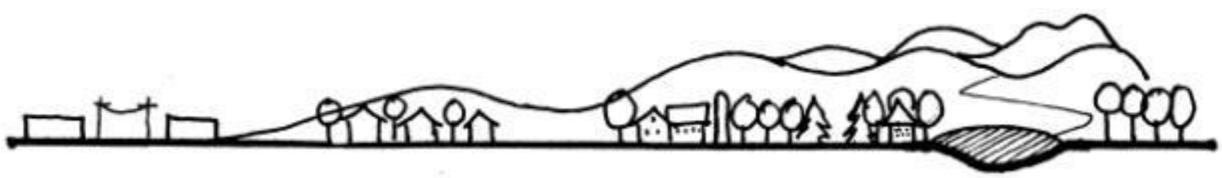
Wind energy projects can be integrated successfully into many types of landscapes, from town centers to agricultural landscapes to mountain ridges. Siting of larger projects usually occurs where access to good wind resources and available transmission facilities exist. Sometimes those locations also intersect with highly valued scenic resources. As in all natural resource evaluations, decisions regarding a project's appropriateness will be complex and difficult, requiring the balancing of competing interests and values. But at the same time, they can be based on good information, logically articulated, and the result of an effective methodology informed with meaningful criteria – as described in this report.

APPENDIX A

Principles for Determining Scenic Quality

The degree of existing scenic quality is usually correlated with landscape diversity – the more natural diversity, generally, the greater the scenic quality. Landscape diversity can be evaluated through a reasonably objective process and will be relative to other landscapes at the local, regional, state, or national level. The following are factors and principles often considered for determining scenic quality.

Visual Diversity (Variety Type): The US Forest Service uses the term "variety class" to describe a fundamental principle of landscape aesthetics: the greater the variety or diversity in the landscape, the more scenic it is likely to be. See USFS Visual Management System (1974). For example, landscapes with greater diversity in vegetation and topography are more likely to be scenic than flat landscapes with uniform vegetation. Water features such as rivers or ponds tend to add diversity as do natural rock outcroppings. The principle of visual diversity relating to scenic quality holds for both natural and built landscapes. High scenic quality often results from the contrast among landscape features such as field and forest, steep and flat or rolling terrain, village and countryside. Particularly dramatic landscape features often stand out due to their contrast in form, line, color or pattern (texture).



Increasing Scenic Quality ⟶

Intactness (Order): Landscapes in which there is a clear underlying order or logic tend to be more visually appealing. Natural landscapes exhibiting little evidence of human alteration (e.g. an intact prairie landscape) are likely to have high visual as well as natural value. In the human (built) landscapes, too much diversity can lead to visual chaos or clutter; for example, strip development in which every business vies for one's attention by looking different from its neighbor. However, landscapes that retain nineteenth- or early twentieth-century landscape patterns are often visually appealing in their simplicity and clear connections of use to the land itself. Sometimes wind projects can work well in such landscape because the use of natural resources (farming) can appear consistent with the "farming" of the wind resource. Wind projects may also tend to fit reasonably well into some cultural landscapes because the repetition of identical elements (turbines) tends to create a sense of order that is often less characteristic of other types of development. It should also be noted, however, that in some situations, highly intact cultural landscapes with historic associations are designated as historic landscapes, and may also be noted for their scenic values, causing challenges for the appropriate siting of wind projects.

Focal Point: Focal points are elements in the landscape that stand out due to their contrasting shape (form), color or pattern. Often distinct focal points enhance scenic quality. They can be natural elements such as a lake, river or mountain; or they can be built elements such as an important public building, or a central town green. Some focal points are locally important, while others are regionally important and become landmarks that are visible from many vantage points.

Appropriate siting and design can often prevent wind projects from becoming domineering regional focal points. Development should not conflict with or degrade important regional focal points.

Unique Visual Resources: There are visual resources that may not meet the threshold of highly scenic or sensitive, but that may have visual value due to the uniqueness of the resources. Examples include a scenic lake limited to non-motorized boat travel, or large tracks of wild or undeveloped land (which might even appear bleak and desolate). Some historic landscapes may also fall into the category of unique resources. When such values are publically recognized and documented, they may be relevant to the evaluation of the visual affect of development projects.

Note:

The US Forest Service, the Bureau of Land Management, and the Federal Highway Administration have developed systems for evaluating scenic quality which may also provide guidance. *See* USFS Visual Management System (1974); BLM Visual Resource Management Program (1980); FHWA Visual Assessment of Highway Projects, Publication FHWA-HI-88-054. All are based upon similar concepts. For example, the Federal Highway Administration (FHWA) uses the following criteria to determine scenic quality: Visual Quality = Vividness + Intactness + Unity

Vividness: The memorability of the visual impression received from contrasting landscape elements (land form, water form, vegetative form, and human built form) as they combine to form a striking and distinctive visual pattern.

APPENDIX B

Illustrations of Simulations

The following simulations illustrate several different approaches to visualization of a project in its surroundings. The first example (Figure 1) shows a page layout with relevant data about the viewpoint location, turbine type and dimensions, viewing distance and other technical data. The next several simulations (Figures 2-3) illustrate the difference between a “normal view” taken at 50mm versus the digital equivalent and panorama views. A normal view provides the most accurate way to represent a photographic simulation on typical paper or computer screen sizes. Simulation images are best viewed at arm’s length (about 23”) at an approximate size of 8.5x16,”, or at poster size from 4-5 feet away. Viewed in this manner, they should accurately represent the size of the turbines as they will appear from the specific viewpoint.

The images below are slightly smaller, but they represent the correct proportions. Comparing the normal views with the panorama views it is evident that both the turbines and the landforms on which they occur seem smaller in the latter view. Panorama views are useful in illustrating the larger context but not in providing an accurate portrayal of turbine size. Figures 4a and 4b compare a photographic simulation in which the turbines are superimposed on a photographic image with a similar view that is an entirely digitally constructed image. Digital images can be easily manipulated to illustrate a range of atmospheric conditions, and varying viewing positions including “fly-through” sequences. The last image illustrates a simulation which includes project roads (Figure 5).

The simulations were provided by the following firms or individuals: TRC in Augusta, Maine and Lowell, Massachusetts; Saratoga Associates (New York); Terrance J. DeWan & Associates (Maine); Matt Robinson of the Appalachian Trail Conservancy (West Virginia); Erik Crews of the US Forest Service; and James Zack of Xtra Spacial Communications (New York).

Viewpoint 11 – Route 100 in Heartwellville

Project Location: Readsboro and Searsburg, Vermont

Project Description: Five Gamesa G80 and two Gamesa G87 2 MW turbines on the Eastern Ridge and eight Gamesa G87 2 MW turbines on the Western Ridge

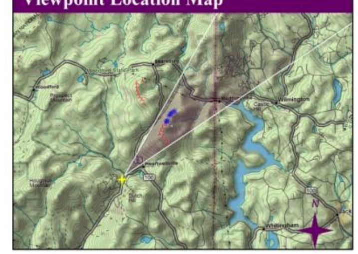
Turbine Information	
Hub Height	256 ft (78 m)
G80 Rotor Diameter	262 ft (80 m)
G87 Rotor Diameter	285 ft (87 m)

Camera Information	
Latitude (N)	42°49.512'
Longitude (W)	72°00.131'
Elevation above sea level	1804 ft (550 m)
Focal Length in 35mm	50mm
Viewing angle (deg from north)	31°
Distance to turbines	2.3 miles (3.7 km)

Technical Information	
Software	WindPRO 2.5
Digital elevation data	SRTM (1 arc sec)
DEM source	http://seamless.usgs.gov

Existing View

Viewpoint Location Map



Viewpoint 11

Deerfield Wind Project Route 100 in Heartwellville (Readsboro) **February 2010**

Prepared For: IBERDROLA RENEWABLES **Prepared By:** VERA

Figure B - 1. Example of Photographic Simulation Page Layout Including Relevant Technical Information

Figure B - 2. Simulation of a 5-turbine wind project in Georgia Vermont from a public road at a distance of approximately .7 miles (to closest turbine). Two frames were required to illustrate the entire project as a normal view (see Figure B – 3 below).

Figure B - 3. This photograph overlaps the one above with only the turbine on the right out of the photo above. Compare Figure B – 2 and Figure B - 3 photos with the panorama view below in Figure B - 4.

Figure B - 4. This panorama view is useful in illustrating the larger context, but the turbines appear smaller than they do in the “normal view” simulations above (Figures B-2 and B-3).

Figure B - 5. Normal view of wind turbines from a mountain top in Maine at a distance of approximately 7.7 miles from the closest turbine (note: the turbine layout has been revised for this project).

Figure B - 6. Panorama view from viewpoint above. Note that while the simulation illustrates a broader context, individual landforms and the project appear smaller in this image.

Figure B - 7. Simulation from mountain summit in Maine illustrating turbine placement on a 50mm (or digital equivalent) photograph.

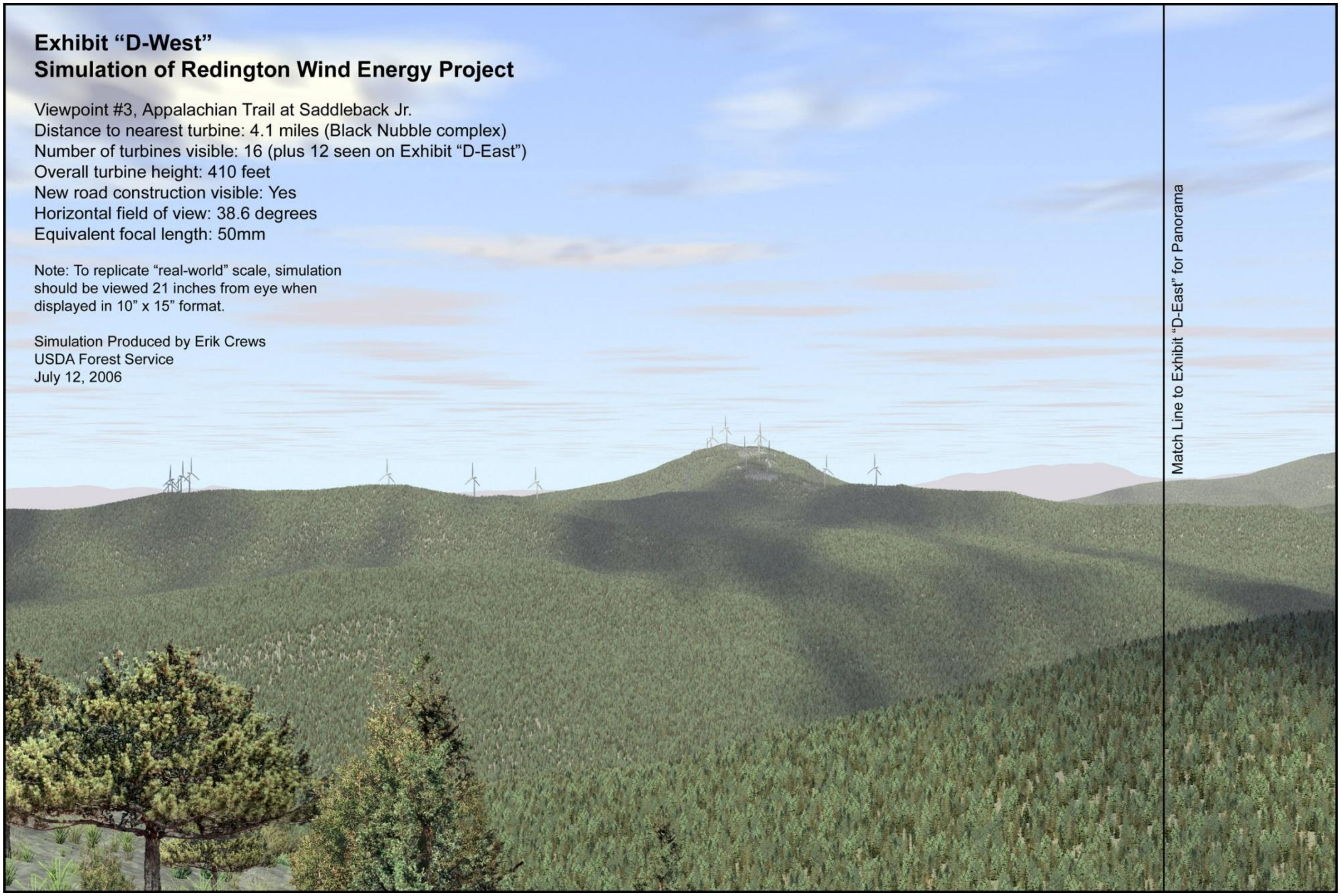


Figure B - 8. Illustration of a digitally created image from the same viewpoint above.

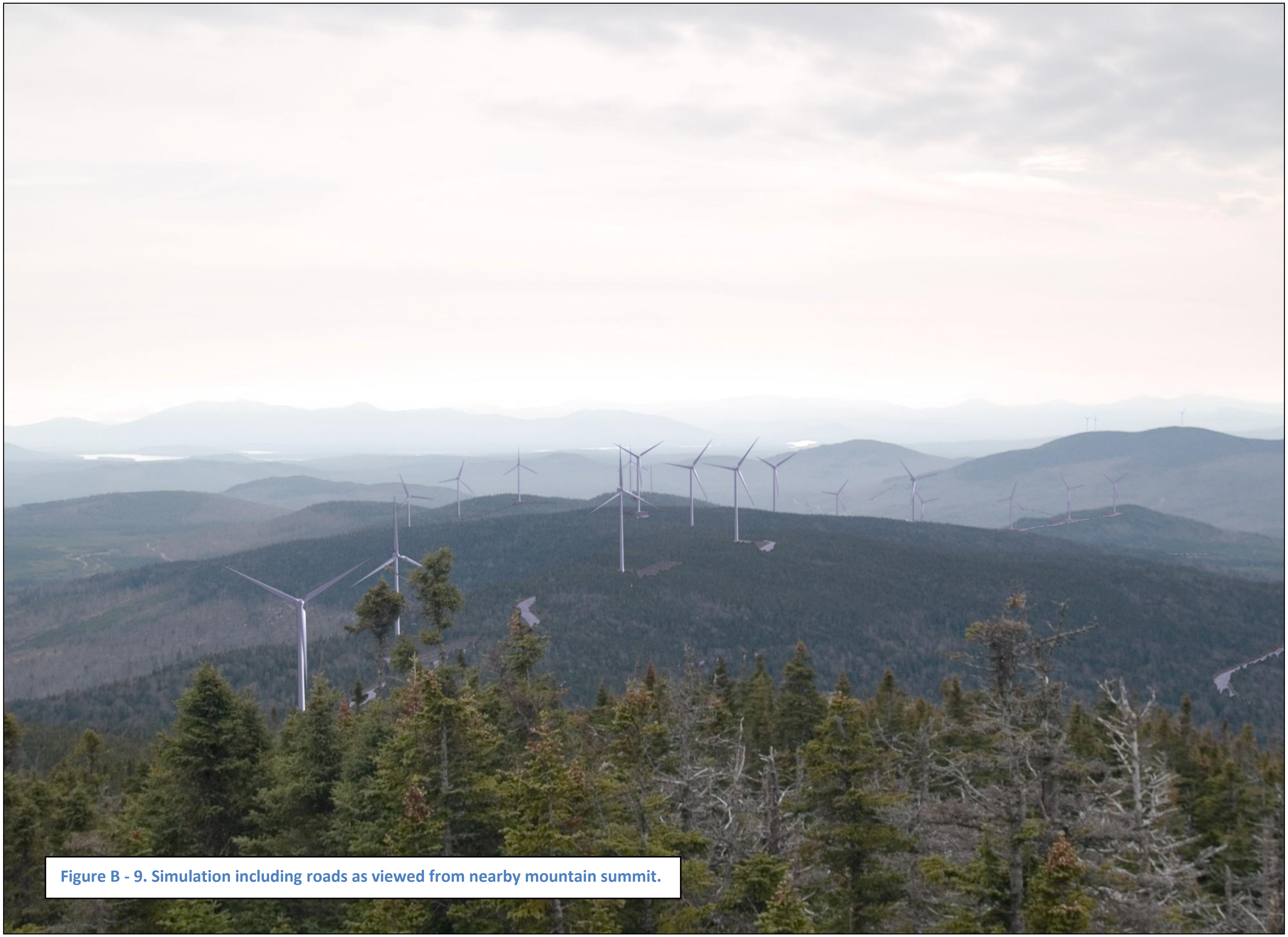


Figure B - 9. Simulation including roads as viewed from nearby mountain summit.

APPENDIX C

Simulated Views of Wind Projects at Varying Distances

The following images illustrate wind projects viewed at distances ranging from 0.7 miles to 17 miles. Simulations at distances greater than 8 miles are more difficult to portray. The turbines occupy too few pixels for adequate detail and clarity unless extremely high resolution photographs and printing techniques are used. The simulations were prepared by the following firms: Saratoga Associates, Vermont Environmental Research Associates, and TRC.

Figure B - 10. Distance = 0.7 miles

Figure B - 11. Distance = 2.5 miles

Figure B - 12. Distance = 3.2 miles

Figure B - 13. Distance = 5.3 miles

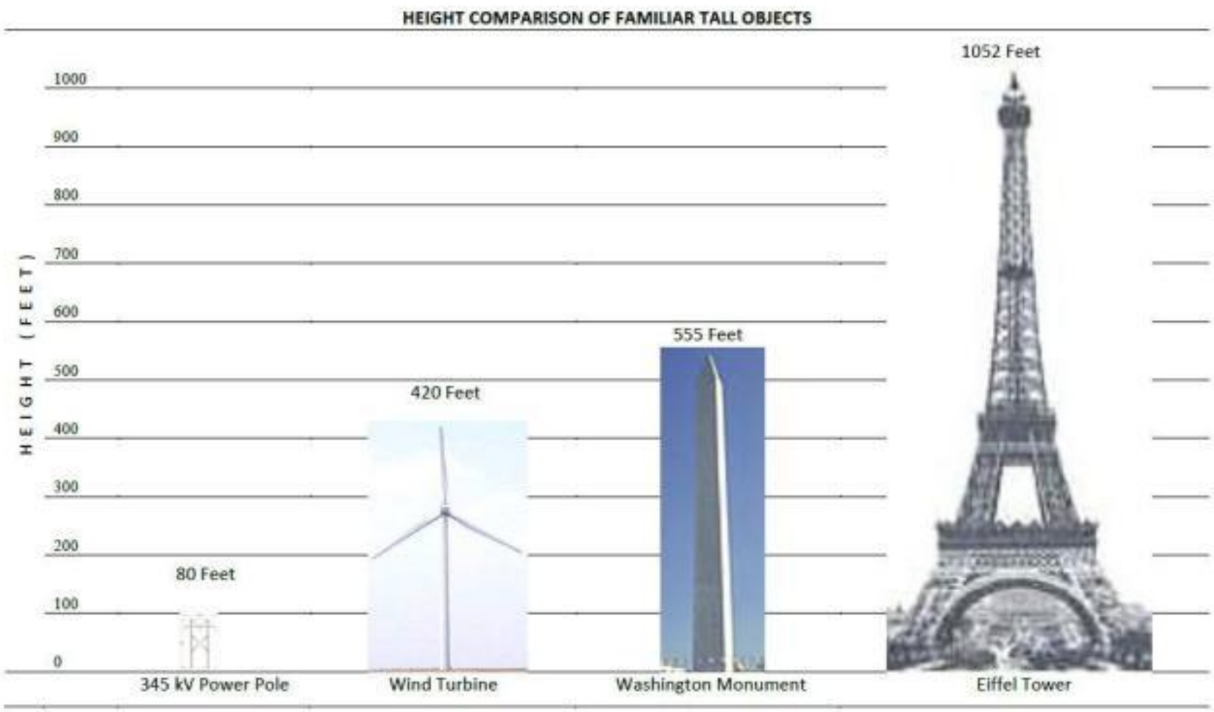
Figure B - 14. Distance = 8 miles

Figure B - 15. Distance = 17 miles

APPENDIX D

Height Comparison of Familiar Objects

Size of objects in the landscape is always experienced in relation to their surroundings (mountains, trees, buildings) and will appear differently depending on distance away and angle of view (see photographic illustrations throughout the report). The graph below compares the actual size of a typical 3 MW wind turbine with other familiar objects.



APPENDIX E

Case Studies

The following case studies provide a description of aesthetic issues involved in a number of wind project regulatory review proceedings. The cases outlined below were among the more controversial projects that have been reviewed by state and local regulators. There are many other examples of projects that were approved with relatively minimal public concern. There also are instances in which projects were withdrawn due to strong public opposition. It should also be noted that developers now are often very willing to find ways to alter projects to make them more acceptable and to improve public relations.

Redington Wind Project/Black Nubble Wind Project

Redington Township, Maine

Project Denied by the Maine Land Use Regulatory Commission

The Redington Wind Project was proposed by Maine Mountain Power LLC (MMP), initially as a 90 MW project consisting of 30 wind turbines. The turbines were to be located along two ridgelines: Redington Mountain (3,984 feet in elevation) and Black Nubble (3,670 feet), east of Rangeley and south of Stratton, Maine. The project was later scaled back to involve only 18 proposed wind turbines (54 MW) along the Black Nubble ridgeline.

The Appalachian Trail runs along a series of ridges to the south and east of the proposed project, and approximately 30 miles of trail are located within 10 miles of the project, including 10 peaks with open views toward the project. The National Park Service (NPS), the Appalachian Trail Conservancy, and Appalachian Trail Club were interveners in opposition to the proposed project. The project was reviewed by the Maine Land Use Regulatory Commission, which denied the permit for the project, agreeing with the concerns raised by the NPS. See in *re: Maine Mountain Power, LCC, Denial of Zoning Petition ZP 702*, Maine LURC Findings of Fact and Decision, June 6, 2007.

Principal concerns noted in the Commission's Decision were that the Appalachian Trail (AT) arced around the proposed project and the project would be visible from numerous high-elevation alpine summits and other openings along a 50-mile section of the AT including 6 open ridges at distances ranging from 3 to 6.5 miles away. This portion of the AT contains 7 of Maine's 13 highest peaks and is noted as one of the most remote and scenic sections of the entire length of the AT. In addition to the establishment of a mile-wide protected corridor along the AT, considerable additional land protection efforts have occurred over many decades in the immediate area, contributing to a sense of remoteness along this section of trail. In addition to the turbines, the roads would also be visible from many high-elevation vantage points. While two ski areas are located on two mountains in close proximity to the AT, visibility of these ski areas is very limited from the trail. This is the result, in part, of specific agreements made between the ski areas and the Appalachian Trail Conservancy. The AT is also noted as a highly valued resource providing opportunities for primitive hiking experiences in the Land Use Regulatory Commission's Comprehensive Plan, the State Trails Act, and the Flagstaff Regional Plan.

Numerous development projects have been proposed near the AT, which had not been opposed by any of the trail groups. It was the particular characteristics of this site that raised concerns.

The case illustrates that there are highly sensitive scenic locations in which a wind project will present undue adverse visual impacts that cannot be mitigated adequately. Developers should avoid siting turbines and infrastructure in locations that are highly visible and that involve significant, well-recognized scenic values, as established by state and federal designations and that conflict with specific land use management standards that call for protection of these specific scenic public values.

UPC Vermont Wind, Sheffield, Vermont

Project Approved, but Modified

The Vermont Public Service Board (PSB) approved a 16-turbine, 40 MW project in 2007 in the town of Sheffield, Vermont. Originally, the project was also proposed along ridges within the Town of Sutton, but opposition to the project from Sutton led the developer to remove the turbines within that township.

The project area is a rural area typical of much of Vermont. Interstate 91 runs in close proximity, and the project will be visible from portions of this highway. The most sensitive visual resource from which nearly the entire project will be directly visible is Crystal Lake State Park, a day-use area with a sandy beach. The project will be located approximately 5.6 miles from the State Park beach. The Vermont Public Service Board (PSB) noted:

> The landscape at Crystal Lake State Park is highly scenic, with rock cliff shorelines and smooth, reflective water. In the foreground is an open viewshed, and in the background is the ridgeline upon which the Project would be located. That ridgeline serves as the visual terminus of the park. Crystal Lake, with its presently unaltered mountain background, is symbolic of Vermont's landscape.

See in *re Amended Petition of UPC Vermont Wind, LLC*, Docket 7156, Order of 8/8/2007, Finding 185.

However, despite finding that the area had important scenic values, the PSB determined that "the majority of the views of the Project are from a distance such that the size would not be overwhelming." *Id.* at 69. Other factors that the Board considered in approving the Project were that (1) the foreground landscape is a cultural landscape, with motorboats, jet skis, camps, parking areas, changing areas and other development; (2) the project would occupy only a portion of the background view, and (3) the developer had taken steps, including painting the proposed turbines colors to blend more easily with the sky, siting the project near an existing transmission line, and placing the turbines and associated infrastructure to minimize the aesthetic impact of the project. *Id.* at 68-69.

In the case, the Town of Sutton argued that the Northeastern Vermont Development Association Regional Plan provided a "clear written community standard intended to protect scenic resources or aesthetics of the area" by indicating that the location where the project is proposed is a "rural area" district in which there should be "little commercial or industrial development unless it occurs in an established industrial park in an area specifically designated in the local zoning law." However, the PSB determined that the language of the regional plan did not constitute a clear, written community standard but rather a "high-level planning document that does not identify specific areas or views that should be protected." Moreover, the PSB noted that the Plan's language was not specifically written to protect aesthetics or scenic beauty. *Id.* at 66.

The Town of Sutton further argued that views of the project from the Crystal Lake bathhouse, which is listed on the National Register of Historic Sites, would violate a document written by the Vermont Division of Historic Preservation entitled "Criteria for Evaluating the Effect of Telecommunications Facilities on Historic Resources," which should constitute a “clear written community standard.” However, the PSB found that the State’s documentation for the historic values of the Bathhouse did not identify specific scenic resources worthy of protection.

The Vermont case provides several lessons:

- A regulatory review board’s review of a wind project’s visual impacts can be significantly improved and designed to reach objective visual determinations if the regulatory body employs an established methodology and clear criteria, which allows all stakeholders to offer relevant, meaningful evidence on the project’s aesthetic impacts, and ensures a transparent decision.

- Careful siting and layout of a wind project to ensure the project is in the background and distant from scenic focal points can significantly reduce potential aesthetic impacts.

- Communities should develop clear, written community standards that specify specific scenic resources that deserve consideration in the development review process to have a meaningful voice in guiding the siting of wind projects.

- There are many reasonable steps that developers can take to reduce the visual impacts of wind projects and improve the project’s harmony with its surroundings, such as avoiding highly prominent, scenic resources; minimizing lighting impacts, and carefully siting infrastructure to reduce its visibility through screening or micro-siting techniques.

For more information see **Final Order:** **http://www.state.vt.us/psb/document/7156upc/7156finalorder.pdf**

ABOUT CLEAN ENERGY STATES ALLIANCE

Clean Energy Clean Energy States Alliance (CESA) is a national nonprofit coalition of state clean energy funds and programs working together to develop and promote clean energy technologies and markets. CESA provides information sharing, technical assistance services and a collaborative network for its members by coordinating multi-state efforts, leveraging funding for projects and research, and assisting members with program development and evaluation.

Many states across the U.S. have established public benefit funds to support the deployment and commercialization of clean energy technologies. Eighteen states make up the core base of CESA membership. Though these clean energy funds, states are investing hundreds of millions of public dollars each year to stimulate the technology innovation process, moving wind, solar, biomass, and hydrogen technologies out of the laboratory and toward wider use and application in business, residential, agricultural, community and industrial settings. State clean energy funds are pioneering new investment models and demonstrating leadership to create practical clean energy solutions for the 21st century.

Founded in 2003, CESA, managed by Clean Energy Group, is headquartered in Montpelier, Vermont, with staff based in Washington, D.C. and Philadelphia.
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