REPORT OF TOM PRIESTLEY

My name is Thomas Priestley and my business address is 155 Grand Avenue, Suite 1000, Oakland, California, 94612. I am employed by CH2M HILL, a 14,500-person, employee-owned firm that provides engineering, construction, operations, communications, security, environmental, and related services to public and private clients across the U.S. and elsewhere in the world. I am a Senior Environmental Planner who specializes in evaluating the aesthetic effects of proposed projects, and I have oversight over the project aesthetic analysis work that takes place in CH2M Hill's Western Region. A copy of my resume is attached.

For the Kittitas Valley Wind Power Project, I conducted site surveys and analyzed the environmental effects of the project as they relate to aesthetics and to light and glare issues. I participated in the project's environmental impact statement (EIS) process and provided expert testimony. In that capacity, I provided technical assessments and developed recommendations to minimize project impacts based on application of accepted analytical techniques, discussed more fully below.

Recently, Horizon Wind Energy (formerly Zilkha Renewable Energy) redesigned the project layout to respond to comments on project visual aspects, aesthetics, and lighting raised by the Kittitas County Commissioners, County staff, adjacent landowners, and the general public. The project as originally proposed would have entailed installation of up to 150 turbines. Under the layout currently proposed, the number of turbines has been significantly reduced – the project now calls for the installation of 64 to 80 turbines - the precise number will depend upon the specifications of the wind generation equipment that is finally selected. With the reduction in the total number of turbines, it has been possible to eliminate turbines located in the areas about which the greatest levels of public concern about aesthetic impacts had been expressed.

To assess the aesthetic effects of the revised project layout, I conducted a systematic evaluation that applied the same methodology I employed in preparing the original analysis of the project's visual impacts that was included in the Application for Site Certification and later incorporated into the DEIS issued by EFSEC. This evaluation is documented in a technical memorandum (*Analysis of the Visual Resources Impacts of the Revised Kittitas Valley Wind Power Project*, Thomas Priestley, PhD, November 7, 2005). As was the case with the aesthetic analysis I prepared for the original visual analysis, the analysis methodology I used was based on the widely accepted analysis approaches developed by Federal land management agencies and the US Department of Transportation.

Specifically, photographs of views from representative viewpoints were evaluated, using existing views paired with computer-generated simulations that accurately depict the appearance of the proposed project. The simulations of the revised, 64 turbine layout depicted turbines at the upper end of the size range for which the Applicant is seeking approval. The turbines depicted had a hub height of 263 feet, a rotor diameter of 295 feet, and a height to blade tip of 410 feet.

Exhibit 11

The redesigned project layout now being proposed eliminates turbines in areas where the greatest public concerns about visual effects had been expressed. For example, a string of six turbines has been eliminated from the area located to the northeast of turbine H1, along upper Elk Springs Road, a private road not maintained by the County. Because of their proximity to the enclave of residences located on the forested slopes of Section 35, these turbines were eliminated to reduce the project's potential for having impacts on views from the dwellings in this area. In string F which is located on the ridge across from the rural residences along Bettas Road, the number of turbines has been reduced from 13 to 6, eliminating the 5 turbines that had formerly been located north of turbine Al, and allowing the remaining turbines to be more widely spaced. A turbine formerly located to the north of turbine A1, and a string of 3 turbines formerly located to the east of string A have also been eliminated to reduce visual impacts on residences to the north. Along Highway 97, a string of 9 turbines formerly located north of turbine G1 has been eliminated to preserve the existing visual character and quality of the highway corridor as it transitions into the more scenic region to the north of the Project area. The technical memorandum contains the visual simulations of these changes.

With respect to lighting, the only lighting that will be associated with the turbines will be the aviation safety lighting required by the Federal Aviation Administration (FAA). Horizon has committed significant resources to working with the FAA to reduce the amount of lighting it requires. That effort has led to a dramatic reduction in the number of red, night warning lights that must be installed, and the elimination of white daytime warning lights. The lighting plan for the project now being proposed reflects the revised FAA standards, which will substantially reduce the project's potential light impacts. The only other lighting required by the project will be lighting at two specific locations: the operations and maintenance facility and the project substation. The impacts of this lighting will be minimized by restricting the amount and levels of lighting to the minimum needed to meet operational and safety requirements, providing timers and switches so that lighting will be turned on only at times when it is required, and careful placement of lights and use of cutoff fixtures to eliminate skyglow and light trespass in the surrounding area.

The bottom line of my analysis is that from most of the viewpoints evaluated in the original project EIS, the project's aesthetic impacts will be moderately to substantially reduced. For example in Analysis View 2, which is the view looking northbound on Highway 97 at the crest of the ridge, all 9 turbines that would have been visible at close range in this view under the original project have been eliminated, completely eliminating any project impact on this view. In Analysis View 3, which is the view looking south along Highway 97 from the intersection with the northern end of Bettas Road, the number of turbines visible has been reduced from 10 to 3, reducing the level of project aesthetic impact from moderate to low. In Analysis View 1, which is the view looking northbound on Highway 97 from the intersection with Eburg Ranches Road, the number of turbines visible would be reduced from 40 to 30, but the level of impact will remain low to moderate. In Analysis View 4, which is the view from a residence in

Section 35 at the upper end of Elk Springs Road, the number of turbines visible has been reduced from 40 to 15, and all turbines are now located 1.5 miles and further in distance from the residences in this area. . In Analysis View 11, the view from Forest Road 35 on the slopes of Table Mountain northeast of the project site, the number of turbines visible at distances ranging from 3.2 to 5.4 miles from this viewpoint has been reduced from 146 to 60. Although the numbers of turbines visible in Analysis Views 4 and 11 will be substantially reduced and the degree of impact will be attenuated, the level of impact to these views remains moderate to high. In the case of Analysis View 4, it is important to note that of the 32 or so residential and recreational properties in Section 35, because of the topography and forest cover, only a few have views out toward the project area that are as open as those seen in Analysis View 4. As a consequence, the numbers of properties in this area whose views will be directly affected to a substantial degree by the project will be very small. In the case of Analysis View 11, this view would be seen only by occupants of the moderate number of vehicles that use this segment of Forest Service Road 35. Because of the steep slopes and absence of pullouts along this portion of the road, the lands in the area from which Analysis View 11 can be seen are not a recreational destination. In the plateau areas to the north where the recreation takes place, views to southwest toward the project site are generally screened by trees, so the project's visibility to recreational users would be very limited.

In summary, the new project layout and the reduced numbers of turbines substantially reduce the project's level of visual impact. In addition, all of the mitigation measures that had been built into the design of the project as it had been originally proposed have been retained. These measures, which include things like minimizing the surface disturbance required for construction of the project, undergrounding most of the project's electric collection lines, and using earth tone colors for the small cabinets containing pad mounted equipment at the base of each turbine tower will continue to assure that the details of the project's design will be handled in a way that will minimize or eliminate their potential to create visual impacts.

Analysis of the Visual Resources Impacts of the Revised Kittitas Valley Wind Power Project

PREPARED FOR: Chris Taylor
Horizon Energy

PREPARED BY: Thomas Priestley, Ph.D, AISP/ASLA
CH2M HILL

COPIES: Mike Pappalardo/CVO

DATE: November 7, 2005

PROJECT NUMBER: 335601

Purpose and Scope of the Analysis

As described in the revised Application submitted to Kittitas County on September 30, 2005, Sagebrush Power Partners, LLC seeks to develop a wind farm with a capacity of up to 246 megawatts (MW) on an approximately 6,000 acre site located on lands extending approximately one mile on either side of Highway 97 in the area approximately 12 miles north of Ellensburg. The project will entail the installation of anywhere from 64 to 80 turbines - the precise number will depend upon the specifications of the wind generation equipment that is finally selected.

The current project design represents a scaling back of the project that had originally been proposed and submitted to the Washington Energy Facility Site Evaluation Council (EFSEC) for licensing in January, 2003. The project as originally proposed would have entailed the installation of up to 150 turbines. The intent in developing the project layout now being proposed was to eliminate turbines located in areas where the greatest concerns had been expressed about the original project's potential visual effects. The locations of the turbines proposed in the original project and those that are being proposed now can be seen in Figure Vis-7. As review of this figure indicates, a string of six turbines has been eliminated from the area located to the northeast of turbine H1, along upper Elk Springs Road. Because of their proximity to the enclave of residences located on the forested slopes of Section 35, these turbines were eliminated to reduce the project's potential for having impacts on views from the dwellings in this area. In string F which is located on the ridge across from the rural residences that line Bettas Road, the number of turbines has been reduced from 13 to 6, eliminating the 5 turbines that had formerly been located north of turbine A1, and allowing the remaining turbines to be more widely spaced. A turbine formerly located to the north of turbine A1, and a string of 3 turbines formerly located to the east of string A have also been eliminated to reduce visual impacts on residences to the north. Along Highway 97, a string of 9 turbines formerly located north of turbine G1 has been eliminated to preserve the existing visual character and quality of the highway corridor as it transitions into the more scenic region to the north.

This technical memo provides a focused analysis of the visual resources impacts of the revised project. It builds on and revises the analyses of the project's aesthetics light, and glare impacts included in the Visual Resources analysis in the Draft EIS issued by EFSEC in December, 2003. The focus of this analysis is on the project's effects on views along US 97, and other views on which the previous analyses found the project to have the potential to create moderate to high levels of visual impact.

The boundaries of the lands included in the project site, the locations of the proposed turbines, and the locations of the viewpoints that have been selected for analysis are indicated on Figure Vis-1.

Analysis Approach

The procedure followed in evaluating the impacts of the revised project on these views is the same as the procedure followed in preparing the evaluation of the aesthetic impacts of the project originally proposed in 2003. As was the case in the analysis prepared as a part of the EFSEC application, for each of the viewpoints used as the basis for analysis, an assessment was made of the existing level of scenic quality and visual sensitivity. Then, for each view, a photograph depicting the view as it now exists was paired with a simulation of the same view as it would appear with the proposed project in place (Figures Vis 2 – Vis 6). Review of these image pairs provided a basis for identifying the project's degree of visibility from each of the viewpoints and for assessing the implications of the visual changes that the project would bring about.

The assessment of the existing scenic quality of the views evaluated was made based on professional judgment that took a broad spectrum of factors into consideration, including:

- Natural features, including topography, water courses, rock outcrops, and natural vegetation;
- The positive and negative effects of man-made alterations and built structures on visual quality; and
- Visual composition, including an assessment of the vividness, intactness, and unity of patterns in the landscape.[1]

The ratings assigned to each view fit within the rating scale summarized in Table Vis-1. Development of this scale builds on a scale developed for use with an artificial intelligence system for evaluation of landscape visual quality (Buhyoff et al., 1994), and incorporates landscape assessment concepts applied by the U.S. Forest Service and the U.S. Department of Transportation.

[1] Vividness, unity, and intactness are dimensions of landscape quality that are taken into account by the system for landscape evaluation and visual impact assessment developed by Federal Highway Administration and now in widespread use for evaluation of project visual impacts (U.S. Department of Transportation Federal Highway Administration. 1988. Visual Impact Assessment for Highway Projects). Vividness is defined as the memorability of the visual impression received from contrasting landscape elements as they combine to form a striking and distinctive visual pattern. Intactness is defined as the integrity of the visual order in the natural and man-built landscape, and the extent to which the landscape is free from visual encroachment. Unity is defined as the degree to which the visual resources of the landscape join together to form a coherent, harmonious visual pattern, and the term refers to the compositional harmony or degree of inter-compatibility between landscape elements.

Table Vis.-1. Landscape Scenic Quality Scale

Rating	Explanation
Outstanding Visual Quality	A rating reserved for landscapes with exceptionally high visual quality. These landscapes are significant nationally or regionally. They usually contain exceptional natural or cultural features that contribute to this rating. They are what we think of as "picture post card" landscapes. People are attracted to these landscapes to view them.
High Visual Quality	Landscapes that have high quality scenic value. This may be due to cultural or natural features contained in the landscape or to the arrangement of spaces contained in the landscape that causes the landscape to be visually interesting or a particularly comfortable place for people. These landscapes have high levels of vividness, unity, and intactness.
Moderately High Visual Quality	Landscapes which have above average scenic value but are not of high scenic value. The scenic value of these landscapes may be due to man-made or natural features contained within the landscape, to the arrangement of spaces, in the landscape or to the two-dimensional attributes of the landscape. Levels of vividness, unity, and intactness are moderate to high.
Moderate Visual Quality	Landscapes, that are common or typical landscapes which have average scenic value. They usually lack significant man-made or natural features. Their scenic value is primarily a result of the arrangement of spaces contained in the landscape and the two-dimensional visual attributes of the landscape. Levels of vividness, unity, and intactness are average
Moderately Low Visual Quality	Landscapes that have below average scenic value but not low scenic value. They may contain visually discordant man-made alterations, but the landscape is not dominated by these features. They often lack spaces that people will perceive as inviting and provide little interest in terms of two-dimensional visual attributes of the landscape.
Low Visual Quality	Landscapes that have below average scenic value. They may contain visually discordant man-made alterations, and often provide little interest in terms of two-dimensional visual attributes of the landscape. Levels of vividness, unity, and intactness are below average.

Note: Rating scale based on Buhyoff et al., 1994; U.S. DOT Federal Highway Administration, 1988, and United States Department of Agriculture Forest Service. 1995.

The analysis of viewers, viewing conditions, and viewer sensitivity in each viewing area was structured to consider residential viewers, roadway viewers, and, to the extent to which they are present, recreational viewers. To summarize the insights developed through the analysis of viewer sensitivity, overall levels of visual sensitivity at the various viewpoints were identified as being High, Moderate, or Low. In general, High levels of sensitivity were assigned in situations where turbines would be potentially visible within 0.5 mile or less from residential properties, heavily traveled roadways, or heavily used recreational facilities. Moderate levels of sensitivity were assigned to areas where turbines would be potentially visible within 0.5 to 5 miles within the primary view cone of residences and roadways. In distinguishing between moderate and low levels of sensitivity in the 0.5 to 5 mile zone, account was also taken of contextual factors, including the viewing conditions in the immediate foreground of the view. In areas lying 5 miles or more from the closest turbine, where a wind farm would be a distant and relatively minor element in the overall landscape, a low level of sensitivity was assigned.

The computer-generated simulations used to evaluate the project's aesthetic impacts were developed using the Photomontage module of the WindPro software program, a widely accepted and applied program used for planning and assessing wind generation projects. Existing topographic and site data provided the basis for developing an initial digital model. The Applicant provided site plans and digital data for the proposed wind turbines.

The Wind Pro software used these data to create three-dimensional (3-D) digital models of these facilities. These models were combined with the digital site model to produce a complete computer model of the wind farm. For each viewpoint, viewer location was digitized from topographic maps, using 5 feet as the assumed eye level. The WindPro program overlaid computer "wire frame" perspective plots on the photographs of the views from the Analysis Viewpoints to verify scale and viewpoint location. Digital visual simulation images were produced as a next step based on computer renderings of the 3-D model combined with high-resolution digital base photographs.

The visual simulations prepared to serve as a basis for this analysis reflect the site layout depicted on Figures Vis-1 and Vis-7, which include a total of 64 turbines. These turbines are assumed to have a hub height of 80 meters (263 feet), a rotor diameter of 90 meters (295 feet) and a height to the tip of the blade of 125 meters (410 feet).

In evaluating the "after" views provided by the computer-generated visual simulations and comparing them to the existing visual environment, consideration was given to the following factors in determining the extent and implications of the visual changes:

- The specific changes in the affected visual environment's composition, character, and any specially valued qualities,
- The affected visual environment's context,
- The extent to which the affected environment contains places or features that have been designated in plans and policies for protection or special consideration, and
- The relative numbers of viewers, their activities, and the extent to which these activities are related to the aesthetic qualities affected by the expected changes. Particular consideration was given to effects on views identified as having high or moderate levels of visual sensitivity.

Levels of impact were classified as high, moderate, and low. In general, high levels of aesthetic impacts were assigned in situations in which turbines would be highly visible in areas with sensitive viewers, and would alter levels of landscape vividness, unity, and intactness to the extent that there would be a substantial decrease in the existing level of visual quality. Moderate levels of aesthetic impact were assigned in situations in which turbines would be visible in areas with high levels of visual sensitivity in which the presence of the turbines would alter levels of landscape vividness, unity and intactness to the extent that there would be a moderate change in existing visual quality. Moderate levels of visual impact were also found in situations in which the presence of turbines in the view would lead to more substantial changes in visual quality, but where levels of visual sensitivity were moderate to low. Low levels of visual impact were found in situations where the Project would have relatively small effects on overall levels of landscape vividness, unity, and intactness and/or where existing levels of landscape aesthetic quality are low or where there are low levels of visual sensitivity.

Short-Term Construction Period Impact

During the construction period, large earth moving equipment, trucks, cranes, and other heavy equipment will be highly evident features in views toward the Project site from nearby areas. At some times, small, localized clouds of dust created by road-building and other grading activities may be visible at the site. Because of the construction-related grading activities, areas of exposed soil and fresh gravel which contrast with the colors of the surrounding undisturbed landscape will be visible. In close-at-hand views, particularly those seem from the closest residences, the visual changes associated with the construction activities will be highly visible and will have a moderate to high level of visual impact. From more distant viewing locations, the visual effects will be relatively minor and will have little or no impact on the quality of views. It is important to note that because Project construction activities will take place over a period of only 12 months, the construction impacts will be relatively short in duration. After construction is complete, all construction-related debris will be removed from the site and the crane pads adjacent to each tower and any other non-road surface areas disturbed during construction will be replanted to recreate the appearance of their original vegetative cover.

Long-Term Impacts During the Project Operation Phase

The analysis conducted by EFSEC of the project that was originally proposed and which included a larger number of turbines looked at the project's potential aesthetic effects on a total of eleven viewpoints. From four of these viewpoints, the analysis presented in EFSEC's December 2003 Draft EIS found that the project's aesthetic impacts would be low. These viewpoints were:

- Viewpoint 7 - Iron Horse/John Wayne Trail at Taneum Road,
- Viewpoint 8 - Thorp
- Viewpoint 9 - I-90 at Springwood Ranch
- Viewpoint 10 - Lower Green Canyon Road,

From one viewpoint, Viewpoint 1 – US 97 at Eburg Ranches Road looking north, the level of visual impact was found to be low to moderate.

From three viewpoints, the EFSEC analysis found a moderate level of visual impacts. These viewpoints were:

- Viewpoint 3 – US 97 at the northern end of Bettas Road, looking south
- Viewpoint 5 – Bettas Road
- Viewpoint 6 – SR 10 corridor between Morrison Canyon and Swauk Creek.

From three viewpoints, a moderate to high level of visual impacts was found These viewpoints were:

- Viewpoint 2 – US 97 north of the gravel pit, looking north
- Viewpoint 4 –view from a residence in Section 35
- Viewpoint 11 – National Forest Lands/view from Forest Service Road 35 looking southwest

It is assumed that because the project that is currently being proposed entails a smaller number of turbines than the project that was evaluated in 2003, that this project's impacts on the views from Viewpoints 7 (Iron Horse/John Wayne Trail at Taneum Road), 8 (Thorp), 9 (I-90 at Springwood Ranch), and 10 (Lower Green Canyon Road) will also be low.

It is also assumed that because a substantial number of the turbines that had been included in the original project layout have been eliminated, the impacts on Viewpoints 5 (Bettas Road) and 6 (SR 10 corridor between Morrison Canyon and Swauk Creek) will not exceed the moderate level of impact that the original project was found to have.

The analysis presented here of the aesthetic impacts of the project that is currently proposed focuses on the three viewpoints where the EFSEC analysis of the project proposed in 2003 found moderate to high impacts: Viewpoints 2 (Highway 97 north of gravel pit, looking north), 4 (view toward southwest from a residence in Section 35), and 11 (Forest Service Road 35). It also evaluates the project's effects on two views where lower levels of visual impact were found, but which are of special interest because of their location along US 97: Viewpoints 1 (US 97 at Eburg Ranches Road, looking north) and 3 (US 97 at the northern end of Bettas Road, looking south). The Project's aesthetic impacts during the operational period are presented in Table Vis-2. As the analysis presented in this table indicates, the revised project now being evaluated would have:

- no visual impact on the view from Viewpoint 2 (US 97 north of the gravel pit, looking north)
- a low level of impact on the view from Viewpoint 3 (US 97 at the northern end of Bettas Road, looking south)
- a low to moderate level of impact on the view from Viewpoint 1 (US 97 at Eburg Ranches Road looking north), and
- a moderate to high level of impact on the views from Viewpoints 4 (view from a residence in Section 35) and 11 (view from Forest Service Road 35 looking southwest).

Table Vis 2

Analysis of Impacts to Visual Resources During Project Operation

Analysis Views	Existing Level of Visual Quality	Level of Visual Sensitivity	Assessment of Visual Change	Potential Level of Visual Impact
Highway 97 Corridor				
Analysis View 1 (Figures Vis-2a and Vis-2b) Highway 97 at Eburg Ranches Road looking north	Moderately Low	Moderate	Approximately 30 turbines will be visible to one degree or another on the ridge tops in the center of the view at distances of 0.8 to 3 or more miles. The turbines will be sited behind the transmission towers, and in many cases, they will, appear to be either generally similar in scale to these structures. In some cases, they will appear to be slightly larger. Some of the turbines will be visually absorbed by the landscape backdrop, but the rest will be silhouetted against the sky to some degree, which will increase their visual salience. The presence of the turbines will increase the vividness of this view by adding visually striking features. At the same time, the project will reduce the scene's degree of intactness to some extent by introducing a large number of highly visible engineered vertical elements. However, because the pattern that the turbines will form will be consistent with the pattern created by the existing transmission towers, they will not substantially change the scene's degree of visual unity. Overall, the presence of the project will create a low to moderate level of change to the existing character and quality of this view.	Low to Moderate
Analysis View 2 (Figure Vis-3[2]) US 97 north of gravel pit looking north	Moderate	High	Under the version of the project that was submitted to EFSEC in 2003, 9 turbines would have been prominently visible along the ridgeline on the east side of US 97 in this view, creating a moderate to high level of visual impact. Under the project as it is now proposed, those 9 turbines have been eliminated, and as a consequence, the project will no longer have any visual impact on this view.	No Impact

[2] Because under the current project design, no turbines will be visible in this view, only the existing view is presented

Analysis View 3 (Figures 6a and 6b) Highway 97 at northern end of Bettas Road looking south	Moderate	High	3 turbines will be visible in the ridgetop area along the east side of the road. These turbines will be located at distances ranging from approximately 0.9 to 1.2 miles from this viewpoint. These turbines will be seen against the sky at in the mid-distance, and will create a moderate reduction in the visual unity of the view and will alter the view's character to some degree Because of the limited numbers of turbines visible in this view and because the turbines have an attractive design and will be arrayed in an orderly and uncluttered way their presence will not necessarily create a substantial change the in the setting's existing moderate level of visual quality.	Low
Ridgelands East of Highway 97				
Analysis View 4 (Figures 8a and 8b) View looking south from residence in Section 35 at upper end of Elk Springs Road	High	Moderate	In the project as originally proposed, a total of approximately 40 turbines would have been visible from this viewpoint. As review of Figure 8b indicates, under the project that is currently being proposed, the number of turbines visible would be reduced to approximately 15. These turbines would be visible at distances ranging from 1.5 to 4.0 miles. Because of the elevated viewing position, these turbines will be seen against the backdrop of the ridgetop's ground surface. The contrast between the light color of the turbines and the darker color of the ground will create a moderate level of visual contrast, increasing the visibility of the turbines. Because of the elevated position of this viewpoint and its distance from the turbines, the turbines' apparent scale will be consistent with that of other features in the setting. The presence of the turbines will have little effect on the vividness of this view, but will reduce its overall sense of unity and intactness to some extent.	Moderate to High
Wenatchee National Forest Lands				
Analysis View 11 (Figures 6a and 6b) View looking southwest from Forest Service Road 35	Moderately High to High	Moderate to High	Although the level of traffic on this road is not high, the views from this road have a moderate to high level of sensitivity because this road provides access to recreational areas at higher elevations on Table Mountain. From this viewpoint, over 60 turbines will be visible in the valley below at distances ranging from 3.2 to 5.4 miles. Because of the elevated viewing position, these turbines will be backdropped against the ground surface. The contrast between the light color of the turbines and the darker color of the ground will create a moderate level of visual contrast, increasing the	Moderate to High

			visibility of the turbines. Because of the elevated position of this viewpoint and its distance from the turbines, the turbines' apparent scale will be consistent with that of other features in the setting. The presence of the turbines will have little effect on the vividness of this view, but will reduce its overall sense of unity and intactness.	

Light and Glare

To respond to the Federal Aviation Administration's (FAA) aircraft safety lighting requirements, the Project will be marked according to guidelines established by the FAA. FAA guidelines for lighting of wind turbines call for lights that flash red (at 2,000 candela) at night. These lights are designed to concentrate the beam in the horizontal plane, thus minimizing light diffusion down toward the ground and up toward the sky. Previously, the FAA has required warning lights to be mounted on the first and last turbines of each string, and every 1000 to 1400 feet on the turbines in between. Under recently released guidelines, the number of turbines requiring night lighting has been reduced. In addition, the revised guidelines do not require daytime warning lighting if the turbines are painted a light color, as is proposed for this project. Figure Vis-7 is a site layout map indicating the turbines that are likely to be marked with night warning lights in response to the FAA's requirements. The exact number of turbines that will require lighting will be specified by the FAA after it has reviewed final Project plans. Aside from any required aircraft warning lights, the turbines will not be illuminated at night.

Based on experience at the nearby Wild Horse Wind Power Project, the number of nighttime aviation warning lights that will be required is likely to be consistent with the number indicated on Figure Vis-7. This number represents a substantial reduction in the number of nighttime warning lights that it had been anticipated would be required for the project as originally proposed. Because the nighttime aircraft safety lights will be limited in number, red, and highly directional, their potential to create skyglow or backscatter will be minimal. The flashing red lights that the FAA requires be operated at nighttime will introduce a new element into the Project area's nighttime environment. At present, the Project site and surrounding area are relatively dark at night. The major sources of light in the area are flood lights and other outdoor lights at the residential properties located in the vicinity of the Project site, and headlights on the surrounding highways. The flashing red lights will be most noticeable in the areas within a mile or so to the Project, and could be perceived as having an adverse effect on views from residential properties in these areas.

The Project's O&M facility and substation(s) will create sources of light in areas where there are no nighttime sources of light other than the headlights of vehicles on adjacent roadways. However, the impacts of the lighting associated with these facilities will not be substantial. As indicated previously, some night lighting will be required for operational safety and security, but mitigation measures would be put into place to restrict this lighting to the minimum required and to attenuate its effects. High illumination areas not occupied on a regular basis will be provided with switches or motion detectors to light these areas only when occupied. At times when lights are turned on, the lighting will not be highly visible offsite and will not produce offsite glare effects because lighting will be restricted by specification of non-glare fixtures, and placement of lights to direct illumination into only those areas where it is needed. The naturalistic plantings of indigenous trees and shrubs to be installed in the areas around these facilities will further reduce the visibility of their night lighting.

Mitigation Measures

Mitigation measures that have been made an integral part of the Project's design include:

- The current Project layout substantially reduces the number of turbines, and eliminates turbines from areas where concerns had been expressed about the aesthetic effects of the Project as originally proposed.
- During the construction period, areas being graded will be watered down frequently to minimize the creation of dust clouds.
- When construction is complete, areas disturbed during the construction process will be restored to natural appearing conditions
- The wind turbine towers, nacelles, and rotors used will be uniform and will conform to the highest standards of industrial design to present a trim, uncluttered, aesthetically attractive appearance.
- The turbines will have neutral finish to minimize contrast with the sky backdrop.. Because the turbines are most frequently seen against the sky, particularly in close range views where visual concerns are the greatest, the neutral finish is the best choice for minimizing Project aesthetic impacts.
- A low-reflectivity finish will be used for all surfaces of the turbines to minimize the reflections that can call attention to structures in a landscape setting.
- Because of the prevailing wind conditions and the high level of reliability of the equipment being used, the rotors will be turning approximately 80-85%of the time, minimizing the amount of time that turbines will appear to be non-operational, a condition that the public often finds to be unattractive[3]
- The small cabinets containing pad-mounted equipment that will be located at the base of each turbine will have an earth-tone finish to help them blend into the surrounding ground plane.
- The only exterior lighting on the turbines will be the nighttime aviation warning lighting required by the FAA. It will be kept to the minimum required intensity to meet FAA standards. This lighting will conform to the FAA's new standards for marking of wind turbines that will entail lighting far fewer turbines than previously required, and having all the lights be synchronized. No daytime lighting is anticipated, according to the FAA's new turbine lighting Advisory Circular.
- Nearly all of the Project's electrical collection system will be located underground, eliminating visual impacts.
- On the short segments of the electrical collection system that will be above ground, simple wooden poles, non-specular conductors (i.e. conductors that have a low level of reflectivity), and non reflective and non-refractive insulators will be used. One segment of this line parallels two existing sets of overhead high voltage transmission lines and a paved road.
- To the extent feasible, existing road alignments will be used to provide access to the turbines, minimizing the amount of additional surface disturbance required. The roads

[3] This finding is supported by research by Thayer and Freeman (1987), among others.

will have a gravel surface and will have grades of no more than 15%, minimizing erosion and its visual effects.

- The O&M facility building will have a low-reflectivity earth-tone finish to maximize its visual integration into the surrounding landscape.
- The colors of the asphalt and gravel used for circulation and parking areas at the O&M facility will be selected to minimize contrast with the site's soil colors.
- Outdoor night lighting at the O&M facility and the substation will be kept to the minimum required for safety and security, sensors and switches will be used to keep lighting turned off when not required, and all lights will be hooded and directed to minimize backscatter and off-site light trespass.
- At the substation, all equipment will have a low reflectivity neutral gray finish to minimize visual salience.
- All insulators in the substations and on takeoff towers will be non-reflective and non-refractive.
- The control buildings located at each substation would have a low-reflectivity earth-tone finish.
- The chain link fence surrounding the substation will have a dulled, darkened finish to reduce its contrast with the surroundings.
- In the areas surrounding the O&M facility and substations, naturalistic groupings of indigenous trees and shrubs will be established to provide partial screening and to visually integrate the facilities into their landscape settings.

References

Buhyoff, G.J., P.A. Miller, J.W. Roach, D. Zhou, and L.G. Fuller. 1994. "An AI Methodology for Landscape Visual Assessments" AI Applications, 8, 1, pp. 1-13.

EMD. Description of the WindPro software. Available at: www.emd.dk. Accessed, November, 2002.

Gipe, Paul B. 2002. "Design As If People Matter: Aesthetic Guidelines for a Wind Power Future". Chapter in Pasqualetti, Martin J, P. Gipe and R.W. Righter, 2002. Wind Power in View, Energy Landscapes in a Crowded World, San Diego, California: Academic Press.

Hydro-Quebec and Electricite de France. 1996. L' integration dans l'environnement des ouvrages de transport d'energie electrique.

Kittitas County. 1997. Comprehensive Plan, Volume II.

Kittitas County. 1997. Swift Water Corridor Vision.

Kittitas County. 2001. Comprehensive Plan, Volume I.

Pasqualetti, Martin J, P. Gipe and R.W. Righter, 2002. Wind Power in View, Energy Landscapes in a Crowded World, Academic Press, San Diego, California.

Sagebrush Power Partners, LLC. 2005. Kittitas County Community Development Services, Rezone Application for the Kittitas Valley Wind Power Project. Field, September 30, 2005.

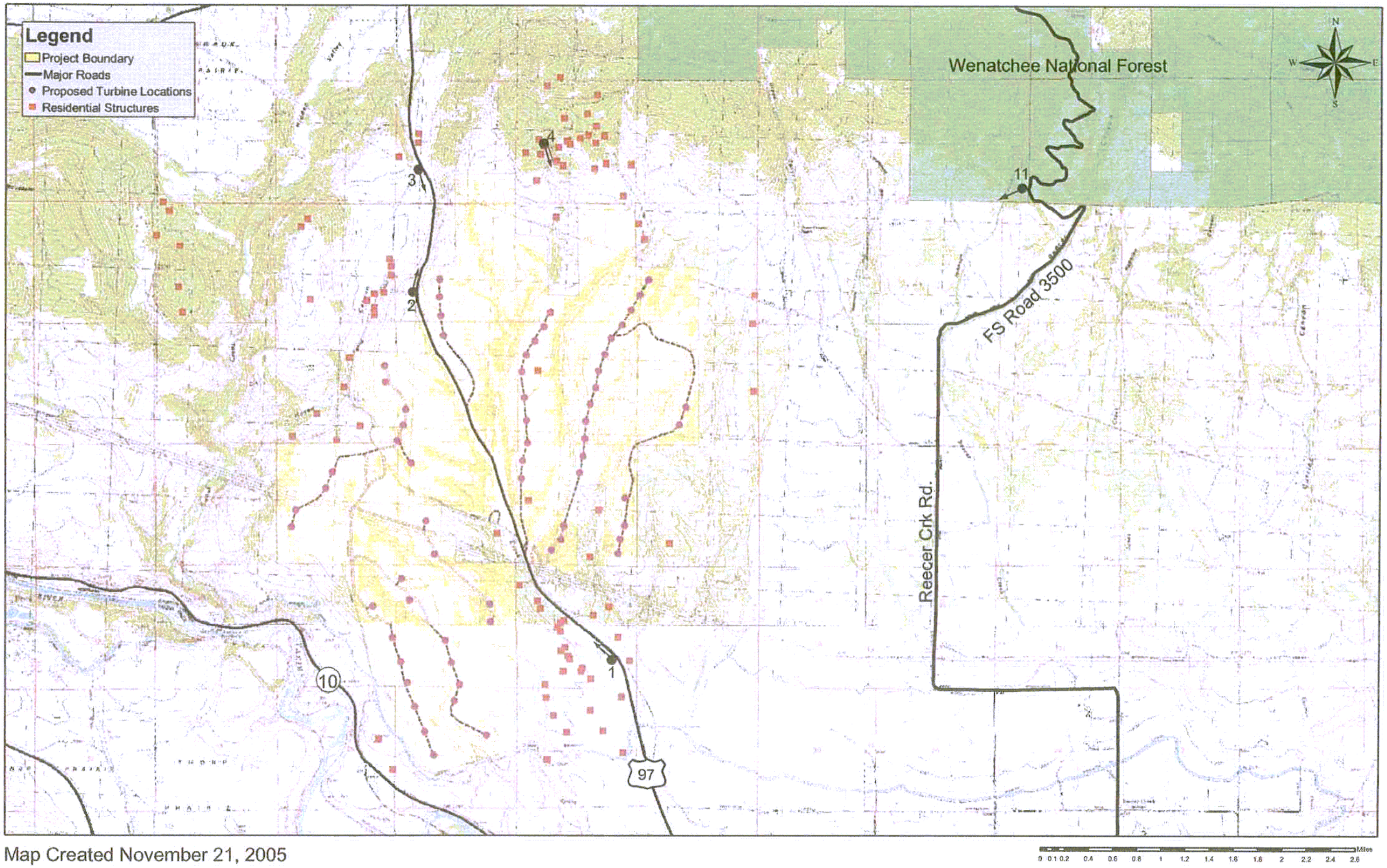
Thayer, Robert L. and C. M. Freeman, 1987, Altamont, Public Perceptions of a Wind Energy Landscape, Landscape and Urban Planning, 14: 379-398.

Thayer, R. L. J. and H.A. Hansen, 1991, Wind Farm Siting Conflicts in California: Implications for Energy Policy, Davis California.

United States Department of Agriculture Forest Service. 1973. National Forest Landscape Management Volume 1. Washington, D.C.: Superintendent of Documents.

United States Department of Transportation, Federal Highway Administration (FHWA). 1988. Visual Impact Assessment for Highway Projects

Washington Energy Facility Site Evaluation Council (EFSEC). 2003 Kittitas Valley Wind Power Project Draft EIS. Section 3.9 Visual Resources. December, 2003. Available at: http://www.efsec.wa.gov/kittitaswind/deis/kvdeis.html#deis.



Map Created November 21, 2005

LEGEND:

1 Analysis Viewpoints

FIGURE VIS - 1: LOCATIONS OF ANALYSIS VIEWPOINTS

KITTITAS VALLEY WIND ENERGY PROJECT

CH2MHILL

335601 A1.01_Fig Vis 1 Viewpoints_11/22/05_ccc_sfo

Figure Vis 2a - Analysis View 1: Existing view from Highway 97 at Eburg Ranches Road looking north

Figure Vis 2b - Analysis View 1: Simulated view toward project seen from Highway 97 at Eburg Ranches Road looking north

Figure Vis 3 - Analysis View 2: Existing view from Highway 97 north of gravel pit looking north. With the revisions to the project, no turbines will be visible in this view.

KITTITAS VALLEY WIND ENERGY PROJECT

CH2MHILL

Figure Vis 4a - Analysis View 3: Existing view looking south from Highway 97 at intersection with northern end of Bettas Road

Figure Vis 4b - Analysis View 3: Simulated view looking south from Highway 97 at intersection with northern end of Bettas Road

Figure Vis 5a - Analysis View 4: Existing view looking south from residence in Section 35 at upper end of Elk Springs Road

Figure Vis 5b - Analysis View 4: Simulated view looking south from residence in Section 35 at upper end of Elk Springs Road

Figure Vis 6a - Analysis View 11: Existing view toward project from Forest Road 35

Figure Vis 6b - Analysis View 11: Simulated view toward project from Forest Road 35

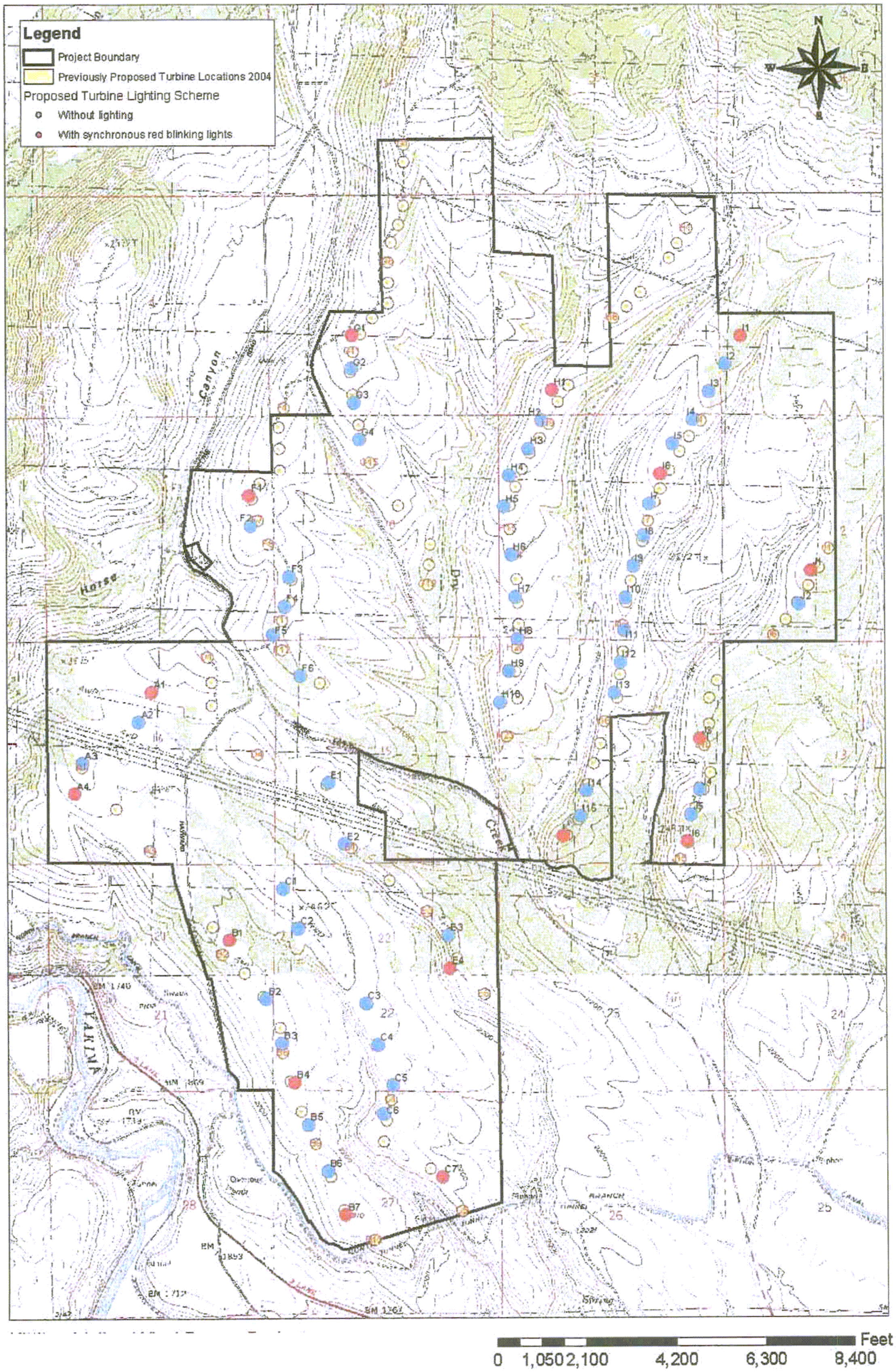


FIGURE VIS-7
PROPOSED FAA LIGHTING SCHEME
KITTITAS VALLEY WIND ENERGY PROJECT

CH2MHILL

335601.A1.01_Kittitas photo page Vis 7_11/18/05_ccc_sfo

Thomas J. Priestley
Senior Environmental Planner

Education

PhD, Environmental Planning, University of California, Berkeley
MLA, Environmental Planning, University of California, Berkeley
MCP, City Planning, University of California, Berkeley
BUP, Urban Planning, University of Illinois

Distinguishing Qualifications

Broad training in planning, natural resources, and applied social science.

Over 20 years of professional experience as an educator, researcher, and professional urban/environmental planner.

Skilled in developing work programs and budgets, assembling and managing interdisciplinary project teams, providing quality control, and integrating study findings into appropriate documentation.

Visual assessment specialist with involvement in over 50 visual assessment efforts.

Experienced in the preparation of California Environmental Quality Act (CEQA)- and National Environmental Policy Act (NEPA)-required documents.

Broad knowledge of methods used for siting electric generation, transmission, and substation facilities and mitigating their land use and aesthetic effects.

Skilled in scoping aesthetic and urban design issues and in developing and implementing the appropriate analyses.

Relevant Experience

Dr. Priestley has more than 20 years of professional experience in urban and environmental planning and project assessment. He is known nationwide for his expertise in evaluating aesthetic, land use, property value, and public acceptance issues related to electric energy projects. His experience includes projecting community land use development trends to determine facility needs and optimal location; assessing land use and visual effects of proposed electric facilities; and conducting studies of public perceptions of project visual effects. Through his project experience and his research conducted for utility clients, Dr. Priestley has developed a broad knowledge of methods used for siting electric generation, transmission, and substation facilities and mitigating their land use, aesthetic, and other environmental effects. As editor or co-author, he has made major contributions to Edison Electric Institute publications related to understanding and evaluating the environmental effects of electric facilities.

In addition to his electricity facility experience, Dr. Priestley is skilled in scoping aesthetic and urban design issues related to other kinds of projects and in developing and implementing the analyses appropriate to address them as part of project assessments. He

Exhibit 11a

has worked on numerous transportation-related projects, including conducting research for the Center for the Study of Urban Transport, France's national institute for research on environmental issues associated with urban rail and highway facilities. Dr. Priestley has developed special expertise in evaluation of aesthetic issues associated with hydro projects, particularly those located at waterfall sites. In addition, he has specialized experience in the analysis of the aesthetic effects of wind power facilities.

Dr. Priestley has prepared environmental assessment documents in response to the requirements of the NEPA, CEQA, the US Forest Service Visual Management System, the Federal Energy Regulatory Commission, and the California Energy and Public Utilities Commissions. As the senior professional in the visual resources practice in CH2M HILL's Western Region, he has oversight of visual resource analysis activities in the western states, with an emphasis on issue scoping, study design, mobilization of appropriate staff and technologies, and senior review of final products.

Representative Projects

Wind Generation Facilities

Kittitas Valley Wind Power Project, Kittitas County, WA. Conducted visual impact studies and prepared the visual impact assessment report for a proposed wind power project entailing installation of 116 1.5 to 2.3 MW turbines on exposed ridge lands in proximity to highways and rural residences.

Altamont Pass Wind Resource Area Repowering, Alameda and Contra Costa Counties, CA. Evaluated the potential visual effects of a program to replace existing wind turbines in the Altamont Pass area with a smaller number of larger, more efficient units. Prepared written analysis for inclusion in the counties' environmental assessment under CEQA.

Thermal Generation Facilities

Power Plant Fatal Flaw Analyses, Various California Locations. Conducted initial scoping of visual issues of candidates sites for the development of combined cycle power plants. Identified visual resource constraints on the use of the site for a power plant and recommended siting and design measures to reduce visual impacts.

Central Valley Energy Center, Fresno County, CA. Prepared the visual resources analysis for the Application for Certification (AFC) for a 1,060 MW natural gas-fired combined cycle power plant and associated 230 kV transmission line proposed for development in an agricultural area at the edge of the City of San Joaquin.

Inland Empire Energy Center, Riverside County, CA. Prepared the AFC visual resources analysis for a 670 MW natural gas-fired combined cycle power plant, associated gas compressor station, and 500 kV transmission line proposed for development in an urban fringe area located east of the City of Perris.

East Altamont Energy Center, Alameda County, CA. Prepared the AFC visual resources analysis for an 1,100 MW natural gas-fired power plant and associated 230 kV transmission line proposed for development in an agricultural area near Byron in the northern San

Joaquin Valley. Prepared written testimony and testified as an expert witness on visual resources during hearings before the California Energy Commission (CEC).

Russell City Energy Center, Alameda County, CA. Assisted with decision-making for the architectural design of a 600 MW natural gas-fired combined-cycle power plant proposed for a highly visible location at the western gateway to the City of Hayward. Prepared the AFC visual resources analysis for the power plant and an associated 230 kV transmission line. Prepared supplemental analysis of the visual impacts of relocation of a cluster of tall radio towers to a new location to accommodate development of the power plant. Prepared written testimony and testified as an expert witness on visual resources during hearings before the CEC.

Los Esteros Critical Energy Facility, Santa Clara County, CA. Prepared the AFC visual resources analysis for an 195 MW natural gas-fired simple-cycle peaking power plant proposed for development adjacent to a proposed server farm in the Alviso District of the City of San Jose. Prepared written testimony and testified as an expert witness on visual resources during hearings before the CEC.

Woodland Generation Station 2, Stanislaus County, CA. This project involved an 80 MW peaking unit for which the Modesto Irrigation District filed a Small Power Plant Exemption (SPPE) with the CEC. In its initial evaluation, CEC contended that the project's steam plumes would create significant visual impacts, the mitigation of which would require substantial modifications of the project's operations. Prepared special analyses of the setting, and of the visibility and visual role of the steam plume within that setting, to provide a basis for reassessment of CEC's conclusions. Provided expert testimony. As a result of the applicant's contestation of staff's findings, plume-related mitigation requirements were dropped.

Gilroy Energy Center Phase I and Phase II Projects, Santa Clara County, CA. Prepared the visual resources analysis for the 21-day and 4-month permit applications for a set of six LM 6,000 natural gas-fired simple-cycle peaking power generation units proposed for installation adjacent to the Gilroy Foods processing plant and the Gilroy Cogeneration Plant on the eastern edge of the City of Gilroy.

Rio Linda Power Plant, Sacramento County, CA. Prepared the AFC visual resources analysis for a 600 MW natural gas-fired power plant and associated 230 kV transmission line proposed for development in an urban fringe area near Rio Linda in the Sacramento metropolitan area.

Metcalf Energy Center, Santa Clara County, CA. Responsible for all aspects of the visual resources analysis for a 600 MW natural gas-fired power plant and associated 230 kV transmission line proposed for development at the southern edge of the City of San Jose. Assisted in review of architectural and landscape treatments, prepared visual resources analysis for the AFC, reviewed and critiqued relevant sections of the CEC's Preliminary Staff Analysis (PSA) and Final Staff Analysis (FSA), and evaluated the visual issues associated with CEC-proposed alternative sites. Testified during hearings before the CEC as an expert witness on visual resources.

Los Medanos Energy Center, Contra Costa County, CA. Provided post-licensing assistance to the client related to visual resource issues associated with this 500 MW combined cycle power plant located in the city of Pittsburg. Assisted the applicant with selection of color treatment for project facilities and with securing of CEC. Consulted on the development of a landscape plan to mitigate the visual effects of a relocated underground transmission line and assisted in securing CEC approval of the mitigation plan.

Elk Hills Power Project, Kern County, CA. Scoped the visual issues and prepared the AFC visual resources analysis for a 500 MW natural gas-fired power plant and associated 230 kV transmission line proposed for development in the former Elk Hills Naval Reserve. Reviewed and critiqued relevant sections of the CEC's PSA and FSA. Testified during hearings before the CEC as an expert witness on visual resources.

Newark Energy Center, Alameda County, CA. Prepared visual resources analyses for a 600 MW natural gas-fired power plant and associated 230 kV transmission line proposed for development in the city of Newark.

Delta Energy Center, Contra Costa County, CA. Scoped the visual issues and prepared the AFC visual resources analysis for an 880 MW natural gas-fired power plant and associated 230 kV transmission line proposed for a site in the city of Pittsburg. Reviewed and critiqued relevant sections of the CEC's PSA and FSA. Prepared written testimony and testified as an expert witness on visual resources during hearings before the CEC. Provided post-licensing assistance to the client for the selection of color treatment for project facilities and to secure CEC approval.

Sutter Power Project, Sutter County, CA. Developed special analyses of land use and visual resource issues associated with this 500 MW natural gas-fired generating facility and associated 230 kV transmission line proposed for a site in an agricultural area within the Sacramento Valley. Testified during hearings before the CEC as an expert witness on land use and visual resources.

Glenwood Springs Cogeneration Plant and Transmission Line, CO. Analyzed the aesthetic impacts of a proposed 25 MW cogeneration/desalinization plant. Assisted with the alignment selection for the transmission line associated with the plant, and evaluated the line's visual effects.

Bay Area Resource Recovery Facility and Transmission Line, San Mateo County, CA. As a consultant to the CEC, analyzed the aesthetic impacts of a cogeneration plant and transmission line proposed for development on a site adjacent to San Francisco Bay.

Kangley-Echo Lake Transmission Line, King and Kittitas Counties, WA. Scoped the visual issues and designed and implemented an analysis plan to assess the potential aesthetic impacts of a proposed 500 kV transmission line on four alternative routes, with a total length of approximately 120 miles through forest, recreation, scenic corridor, and rural and suburban residential areas. Supervised the preparation of photo simulations and the preparation of Geographical Information System (GIS) analyses. Prepared the technical report documenting the analysis.

Jefferson-Martin Transmission Project Proponent's Environmental Assessment, San Mateo County, CA. Senior reviewer and consultant for an analysis of the aesthetic issues associated with the proposed replacement of a 14.7-mile segment of an existing kV transmission line with a 230 kV line on larger towers. The transmission line's location in an open space area prized for its scenic qualities and in proximity to affluent residential areas made the visual issues a sensitive and critical dimension of this project, requiring an intensive degree of analysis.

Tri-Valley Transmission Upgrade Project Proponent's Environmental Assessment, Alameda County, CA. Analyzed aesthetic issues associated with a system of new 230 kV lines and substations being proposed by Pacific Gas and Electric Company (PG&E) to upgrade service to the Livermore/Pleasanton/San Ramon area. Scoped issues and made an evaluation of a large set of candidate routes to aid selection of a smaller set of preferred routes. Conducted detailed visual analyses of the preferred routes, wrote the draft of the visual analysis report, and proposed mitigation measures in preparation for filing of a permit application with the California Public Utilities Commission (CPUC).

Valley-Auld Transmission Line Proponent's Environmental Assessment, Riverside County, CA. Scoped visual issues associated with a proposed 12-mile, 115 kV Southern California Edison transmission line, conducted visual analyses, prepared the visual analysis report, and proposed mitigation measures to reduce project's visual effects to less than significant levels in preparation for filing of a permit application with the CPUC.

Swan Lake/Lake Tyee Transmission Project, Tongass National Forest, AK. Prepared visual section of the Environmental Impact Statement (EIS) for a 60-mile transmission line and associated access roads proposed by Ketchikan Public Utilities for Forest Service lands in Alaska's southeast peninsula. Coordinated with Forest Service planning and visual resource management specialists; reviewed Forest Service Visual Resource Management analyses and policies for the project area; analyzed existing landscape conditions; evaluated the aesthetic effects of similar facilities that already exist in the region; provided advice about siting of the route alternatives; analyzed the visual effects of the alternatives; and developed mitigation strategies.

Geothermal Public Powerline, Lake and Colusa Counties, CA. Consultant to the CEC for evaluation of the aesthetic impacts of a transmission line proposed to link the Geysers geothermal area and the Central Valley. Inventoried landscape conditions and reviewed the project proponent's visual impact assessments. Developed independent evaluations of the project's effects on landscape quality in developed communities, in resort areas, along scenic highway corridors, and in other sensitive areas; proposed mitigation measures.

Colusa County Transmission Line Element, Colusa County, CA. Consultant to a team that developed an element for the Colusa County General Plan to guide the siting and design of new electric transmission lines. Summarized the literature on transmission line effects and on siting and design options for impact mitigation; developed an analysis framework; provided technical review of all final products; and prepared the chapter on aesthetic issues. The aesthetic work included survey and evaluation of the county's current landscape conditions and sensitivities, and development of siting and design guidelines.

International Electric Transmission Perception Project. Project Manager for a multi-year research program sponsored by Hydro-Québec, Electricité de France, BC Hydro, the Bonneville Power Administration and Southern California Edison. Managed a team of planners and social scientists conducting research aimed at development and application of standardized methods for surveying the public's perceptions of the impacts of high-voltage transmission lines. Identified transmission line siting issues and information needs; summarized and evaluated existing research findings; participated in development of a conceptual framework for understanding the public's perceptions; and contributed to the development of a master plan and design for preparation and testing of standardized survey instruments.

Development of a New Method for Considering Aesthetic Issues in Transmission Line Siting, Québec, Canada. For Hydro-Québec, provided conceptual review and research assistance for its efforts to evaluate and revise approaches to treatment of transmission line aesthetic issues in project planning, siting, and design.

Environmentally Sensitive Design of Transmission and Substation Equipment. For Hydro-Québec and Electricité de France, developed an inventory and assessment of the experience of US utilities in developing new transmission and substation equipment designs to reduce aesthetic and other environmental impacts. Activities included literature review, survey of utility engineers and planners, interviews with utility personnel, and documentation and synthesis of findings.

Review of New Design for 500 kV Towers, British Columbia, Canada. Aesthetics specialist on a panel of experts convened by BC Hydro to review a new design for 500 kV transmission towers.

Design Solutions for Mitigation of Substation Impacts. For Hydro-Québec, documented the experience of utilities in the US, Canada, France, and Japan during the development of design solutions for urban substations to aid their integration into their settings. In addition, documented measures used by US utilities to respond to environmental issues associated with modifications of existing substations.

Study of Transmission Line Effects on Property Values, Solano County, CA. Consultant and major contributor to the design and implementation of a research project sponsored by Southern California Edison that used hedonic modeling to evaluate the property value effects of transmission lines in a cross-section of suburban residential neighborhoods.

Review of the Literature on Transmission Line Effects on Property Values. Major contributor to development of an Edison Electric Institute-sponsored bibliography and critical review of post-1975 studies on the relationship between transmission lines and the value of residential property.

Guide to Conducting Research on Transmission Line Property Value and Aesthetic Effects. Co-author of an Edison Electric Institute guidebook for utility staff on the design and implementation of research on the effects of electric transmission lines on perceptions and property values in residential neighborhoods. Co-authored and assisted in the production of an accompanying videotape.

Study of Public Perceptions of a Transmission Line in a Residential Neighborhood, Vallejo, CA. Designed and conducted a survey of resident perceptions of a newly upgraded 115/230 kV transmission line in a neighborhood of single-family homes. Conducted advanced analysis and interpretation of the findings. Published the results as a research report and journal article.

Transmission Line Undergrounding and Under River Crossings. For Hydro Québec, conducted a set of case studies documenting and analyzing controversies over the siting of electric transmission lines in which demands were made for placing lines underground or under water.

Transmission Line Effects on Land Use Development. For the Edison Electric Institute, identified and evaluated transmission line siting cases in which concerns about line impacts on future development were a major concern. Reviewed the literature on transmission line impacts on land use development and proposed a program for further research.

Transmission Line Land Use and Aesthetic Issues. For PG&E, analyzed land use and aesthetic issues associated with transmission lines and prepared policy papers for submission to the CPUC.

Hydroelectric and Water Resources Projects

Red Bluff Diversion Dam, Tehama County, CA. Developed the analysis plan for and directed the assessment of the aesthetic changes associated with a set of alternatives being considered for changes in management of the Red Bluff Diversion Dam to enhance passage for anadromous fish. Changes being considered included construction of a massive pumping facility, new fish ladders, and a dam bypass and elimination of an aesthetically and recreationally important lake created by the dam either entirely, or for all but two or four months of the year. The analysis, which included preparation of simulations, was summarized in an aesthetics chapter prepared to meet the requirements of both the NEPA and CEQA.

Oroville Facilities Hydroelectric Project, Oroville, CA. As part of an Applicant Prepared Relicensing (APR) process, responsible for preparation of initial project documents. Developed outlines and work plans; coordinated with the Department of Water Resources and environmental specialists for each of the issue areas; assembled drafts; edited text; designed final reports; and supervised report production. Responsible for analysis of the visual resource issues associated with the project's reservoir, forebay, afterbay, canals, dam structures, power houses, and fish ladder facility.
Technical advisor to the Land Use, Land Management, and Aesthetics Work Groups, requiring participation in sessions involving agency staff, representatives of Indian Tribes and Non-Governmental Organizations, and members of the general public.

Willamette Falls Hydroelectric Project, Oregon City and West Linn, OR. As part of the APR process, prepared analyses of visual resources issues that include evaluations of the appearance of the falls under varying flow conditions, as well as assessments of the relationship of project structures to the project's landscape setting.

Aesthetic and Site Enhancement Studies, Shoshone Falls Hydroelectric Project, ID. Consultant to Idaho Power on the effects of proposed relicensing of the Shoshone Falls hydroelectric project on the aesthetic qualities of the falls and adjacent park. Provided direction for development of the analysis approach for assessing the effects of changes in flows over the falls on the falls' appearance and public expectations. Evaluated the project in light of local government and land management agency plans and policies, designed and implemented special perception studies, and worked with an advisory committee of representatives of local governments and state agencies. Based on this process, recommended mitigation and enhancement measures. Assisted in preparing a visual analysis report for incorporation into the Exhibit E submitted to Federal Energy Regulatory Commission (FERC).

FERC Exhibit E, Snoqualmie Falls Hydroelectric Project, WA. Analysis of the aesthetic implications of a proposal by Puget Sound Power and Light to increase the capacity of its generating plant at Snoqualmie Falls. Assessed impacts of structural changes and changes to flows over the falls. Developed and applied a methodology for evaluating the effects flow changes would have on the falls' appearance. Prepared the aesthetics section of Exhibit E of the relicense application. Developed the script for a video regarding the aesthetics issues submitted to the FERC.

Ramsey-French Meadow Hydro Project, FERC Initial Scoping, Stanislaus National Forest, CA. Scoped visual issues associated with a hydroelectric project proposed by the Northern California Power Authority for the North Fork of the Stanislaus River. Responsible for coordination with Forest Service landscape personnel, review of Forest Service and county plans, field evaluation of landscape conditions, preparation of the visual effects section of the FERC-mandated Initial Scoping document, and preparation of a plan for the assessment of aesthetic issues.

Environmental Evaluation of Proposed Modifications to Existing Hydroelectric Facilities. On behalf of Hydro-Québec, documented FERC procedures and guidelines for environmental assessment of proposed changes to existing hydroelectric projects. Documented hydro upgrade-related activities undertaken by the US Bureau of Reclamation and the US Army Corps of Engineers. Collected procedures, guidelines, and examples of project environmental assessments and post-construction monitoring studies prepared by or for these agencies.

Visual Assessment/Mitigation Recommendations for the San Joaquin Reservoir, Newport Beach, CA. Evaluated visual impacts of proposed alternative reservoir cover and water treatment plant options for a Metropolitan Water District water supply facility located in an affluent residential area. Developed a proposal for design mitigation measures that led to project acceptance by residents of the neighborhood overlooking the reservoir.

Remediation and Landfill Projects

Relocation of KFAX Radio Towers at the Old West Winton Landfill, Alameda County, CA. Analyzed the aesthetic implications of relocating a set of four 228-foot-high radio transmission towers on a closed landfill site adjacent to a major public open space area. The analysis included development of visual simulations and an investigation of options for establishment of screening landscaping on top of the landfill's cap.

Penn Mine Remediation Project, Calveras County, CA. Evaluated the visual impacts of a mine waste remediation project in the watershed of the East Bay Municipal Utility District's Camanche Reservoir. Assessed the visual implications of the removal of mine spoils, landfilling of the spoils, regrading of slopes, and revegetation of affected lands. The focus was on impacts of these changes on the views experienced by recreational users on the adjacent reservoir.

Environmental Assessments for Transportation Projects

Bay Area Rapid Transit (BART) Warm Springs Extension, Fremont, CA. Analyzed the aesthetic impacts of a proposed 7.8-mile extension of the BART heavy-rail system from the

City of Fremont to Santa Clara County. Prepared the aesthetics section of the CEQA-mandated Environmental Impact Report (EIR).

Santa Clara County T2010 Transportation Plan, San Jose, CA. Evaluated the aesthetic issues associated with the highway, rail, and light rail projects proposed by the Santa Clara County T2010 Transportation Plan and prepared the aesthetics section of the CEQA-mandated EIS.

Urban Freeway Design Research, France and US. Conducted research comparing American and French approaches to planning and design of urban freeways to optimize their integration into the urban environment. Research included literature review, interviews with highway engineers and landscape architects in the US and France, review of plans and environmental assessments, and site visits to exemplary projects.

Chevilly-Larue Roadway Design Evaluation Study, France. Member of a study team that evaluated the effects of urban design measures intended to improve traffic safety and aesthetics that were installed on a heavily-traveled road through the center of a suburban community. Developed a research strategy and questionnaire for documenting resident perceptions before and after the installation of the measures.

Land Use, Natural Resource, and Urban Design Studies

Growth and Development Studies, Northern and Central California. At PG&E, designed, scheduled, and managed studies evaluating growth trends and forecasting future population and land use in urban and rural areas throughout Northern and Central California to provide a basis for planning and siting future electric facilities. Supervised work that included coordination with local planning agencies; data gathering and evaluation; analysis of economic, demographic, environmental, infrastructure, and policy data; development of growth projections; and reporting of findings.

East Anderson Receiving Station Growth Impact Study, Phoenix, AZ. For the Salt River Project, analyzed the land use development implications of a large electric receiving station proposed for a developing area on the edge of Phoenix. Directed collection, mapping, and analysis of demographic, economic, land use, infrastructure, planning, and policy data, and generation of projections of future land use patterns under project and no-project scenarios.

Plum Creek Land Exchange EIS, Mount Baker/Snoqualmie, Wenatchee, and Gifford Pinchot National Forests, WA. Analysis of land status and use, aesthetic, recreation, unroaded area, and wild and scenic river issues associated with the proposed exchange of over 100,000 acres of forest land between the Plum Creek Timber Company and the National Forest system. Assessed public and agency concerns; developed an analysis strategy; used Forest Service GIS data as the basis for map and statistical analyses; collected and made use of supplemental data generated through field work, interviews, and review of published sources; and prepared analyses and summary text for the EIS.

Plum Creek Road Access EIS, Wenatchee National Forest, WA. Analysis of aesthetic, recreation, unroaded area, and wild and scenic river issues associated with the proposed development of over 40 road segments over Forest Service lands to provide access to future timber harvest areas on adjacent Plum Creek Timber Company parcels. Assessed public and agency concerns; developed an analysis strategy; used Forest Service GIS data as the basis for map and statistical analysis; collected and made use of supplemental data generated through field work, interviews, and review of published sources, and prepared analyses and summary text for the project EIS.

Oakland Army Base Disposal and Reuse EIS, Oakland, CA. Analyzed the land use, demographic, aesthetic, odor, and environmental justice issues associated with six different reuse options being considered for the 422-acre Oakland Army Base. Drafted the text for the EIS sections related to these issues. In addition, developed a cumulative effects analysis and summary text that that considered all project environmental issues for each of the reuse options.

Environmental Assessment of Proposed Development Projects, Northern California. For a variety of municipal planning departments, evaluated the aesthetic and urban design issues associated with proposed development projects and prepared the aesthetics sections of the EIRs prepared under CEQA. The projects included a shopping and parking complex located in one of California's most historic town centers, a major suburban hotel complex, a 580-acre residential subdivision, and a set of four downtown parking garages.

Centrage Urban Development Project, Sacramento, CA. For Lennane Properties, developed and applied a methodology for assessing the potential scale and privacy effects of a proposed cluster of high-rise buildings on adjacent single-family residential areas.

Using Land Use Controls to Improve Air and Water Quality, Sonoma County, CA. Contributed to an EPA-sponsored study evaluating links between land use development and air and water quality. Identified and summarized the findings of the relevant literature, developed links with the planning agencies in the study area, and evaluated of the local land use planning and regulatory system to identify its potential role in influencing development to improve air and water quality.

Bay Area Open Space Plan, San Francisco Bay Area, CA. Contributed to the revision of the Association of Bay Area Governments' Bay Area Open Space Plan, evaluating open space as a component of visual quality.

University Teaching

Department of City and Regional Planning, University of California, Berkeley. Lecturer Taught CP 214, "Urban and Regional Physical Infrastructure," a graduate-level course providing a survey of the major infrastructure systems, their characteristics and impacts, and their relationships to the planning of cities and regions.

Department of Urban and Regional Planning, California State Polytechnic University, Pomona. Assistant Professor. Designed and taught undergraduate courses in urban design, and natural factors in planning. Taught studio sections of courses in graphic communication and design and in subdivision design. Conducted activity sections of the introduction to cities and planning course.

Ecole Nationale des Ponts et Chaussées. Paris, France. Visiting Lecturer. Taught "The Urban Environment," a lecture course in English for engineers and planners on environmental quality issues and their treatment in project planning and design.

Departments of Landscape Architecture and City Planning, University of California, Berkeley. Instructor. Co-taught "The Urban Environment" a graduate level course reviewing methods for treating environmental quality issues in the planning and design process. Assisted in teaching "Social Factors in Landscape Design."

Professional Affiliations

American Institute of Certified Planners
American Planning Association
American Society o f Landscape Architects
International Association for Impact Assessment

Selected Professional Reports, Publications and Conference Papers

Public Perception of Electric Facilities, an Advanced Workshop, Washington, DC March 17, 18, 19, 1996: Workshop Summary (editor). Published by the Edison Electric Institute, Washington, DC, 1997.

Perception of Transmission Lines: Summary of Surveys and Framework for Further Research (with Kenneth Craik, Mary Deming, and Selma Monsky). International Electric Transmission Perception Project. Published by Edison Electric Institute, Washington, DC, 1996.

"Environmental Perception, Cognition, and Behavior: Public Responses to Electric Transmission Lines" (with Gary Evans, Ph.D.). Journal of Environmental Psychology 16, 65-74, March, 1996.

L' integration dans l'environnement des ouvrages de transport d'energie electrique. (in collaboration with Aménatech). Prepared for Hydro-Quebec and Electricite de France. 1996.

Environmental Design Issues Associated with Older Substations. (with Aménatech). Report prepared for Hydro-Québec, Vice-présidence Environnement, October, 1995.

"The Public and Electric Facility Siting" (with Daniel Cohen). Article published in Environmental Planning Quarterly, Spring, 1995.

Substations in the Urban Context: Design Issues and Examples. Report prepared for Hydro-Québec, Vice-présidence Environnement, 1994.

"Colusa County Transmission Line Element" Paper given at Edison Electric Institute National Land Management Workshop, Duluth, Minnesota, August 1992 and submitted for inclusion in the workshop proceedings.

Perceived Effects of Electric Transmission Facilities: A Review of Survey-Based Studies. Prepared for the Siting and Environmental Planning Task Force of the Edison Electric Institute. 1992.

The Effects of Overhead Transmission Lines on Property Values: A Review and Analysis of the Literature. (with Cynthia Kroll, Ph.D.) Prepared for the Siting and Environmental Planning Task Force of the Edison Electric Institute. 1992.

A Statistical Analysis of Transmission Line Impacts on Residential Property Values in Six Neighborhoods. (with Patrice Ignelzi) Prepared for the Southern California Edison Company. May, 1991.

Perceptions of a Transmission Line in a Residential Neighborhood: Results of a Case Study in Vallejo, California. (With Gary Evans, Ph.D.) Prepared for the Southern California Edison Company. November, 1990.

Undergrounding of Electric Transmission Lines: A Review of Recent Cases in the United States. Prepared for Vice-présidence Environnement, Hydro Québec. July, 1990.

A Guide to Assessing Transmission Line Impacts in Residential Communities. (with Patrice Ignelzi). Washington, DC, Edison Electric Institute, 1990.

Transmission Line Impacts: Studying Perceptions and Property Values. (videotape, contributing author of script). Washington, DC, Edison Electric Institute, 1990.

"Perceptions of Transmission Lines in Residential Neighborhoods: Results of a California Case Study." Edison Electric Institute Workshop on Transmission Lines in Residential Neighborhoods: Issues in Siting and Environmental Planning, Portland, Oregon, October, 1989.

Aesthetic Quality Issues and Their Treatment in Electric Transmission Line Planning - Towards a New Paradigm. Ph.D. Dissertation, Department of Landscape Architecture, University of California, Berkeley, September, 1988.

"Study of the Effects of An Electric Transmission Line on Perceived Neighborhood Quality." IAPS 10, Delft, Holland, July, 1988.

"The Environment Behavior Perspective and Assessment of Landscape Aesthetics - Powerline Siting and Analysis in North America." in Environment and Human Action, Proceedings, 8th International Conference of the IAPS, West Berlin, July 25-29, 1984. Berlin: Hochscule der Kunst, pp. 51-53. 1984.

"Donald Appleyard's Contribution to Street Livability Research." Proceedings, Fifth Annual Pedestrian Conference. Boulder, CO: Transportation Division, City of Boulder, 1984, pp. 19-27.

Chinatown Urban Design Study. (with Peter Bosselmann, et al.) Berkeley Environmental Simulation Laboratory, 1984.

Sun, Wind, and Comfort: A Study of Open Spaces and Sidewalks in Four Downtown Areas. (With Peter Bosselmann, Edward Arens, *et. al.*) Berkeley, CA: Institute of Urban and Regional Development, 1984.

Aesthetic Considerations and Electric Utilities: An Introductory Guide to the Literature. Palo Alto, CA: Electric Power Research Institute, February, 1984.

"The Field of Visual Analysis and Resource Management: A Bibliographic Analysis and Perspective" Landscape Journal. Spring, 1983, pp. 52-59.

Transmission Lines and Land Use Development: Final Report. Prepared for the Community and Regional Planning Task Force of the Edison Electric Institute, 1983.

CH2MHILL

TECHNICAL MEMORANDUM

Revised Kittitas Valley Wind Power Project- Noise Analysis Summary

PREPARED FOR: Chris Taylor
Valerie Schafer

PREPARED BY: Dave Baker
Mark Bastasch

DATE: November 23, 2005

1. Purpose and Scope of the Analysis

As described in the Rezone Application submitted to Kittitas County on September 30, 2005, Sagebrush Power Partners, LLC seeks to develop a wind farm with a capacity of up to 246 megawatts (MW) on an approximately 6,000 acre site located on lands extending approximately one mile on either side of Highway 97 in the area approximately 9 miles north of Ellensburg. The project will entail the installation of anywhere from 64 to 80 turbines - the precise number will depend upon the specifications of the wind generation equipment that is finally selected. The current project design represents a scaling back of the project that had originally been proposed and submitted to the Washington Energy Facility Site Evaluation Council (EFSEC) for licensing in January, 2003. The project as originally proposed would have entailed the installation of up to 121 turbines.

This technical memo provides a focused analysis of the noise impacts of the revised project. It builds on and revises the analyses of the project's noise impacts included in the noise analysis in the Draft EIS issued by EFSEC in December, 2003. The focus of this analysis is on the project's effects on noise for nearby receptors (especially Class A receptors as defined by the Washington Administrative Code (WAC) 173-6--030.

The locations of the proposed turbines and the locations of nearby receptors are shown in the Noise Study Contour Map attached to this memorandum.

2. Modeling Methodology

A noise model of the proposed project was developed using source input noise levels from wind turbine manufacturers' data. The noise levels at residential receptors in the general area due to noise emissions from the project have been calculated. The noise levels presented represent the anticipated steady-state level from the project with all of the wind turbines operating at their expected maximum noise output.

Standard acoustical engineering methods were used in the noise analysis. The computer software noise model used for the analysis, CADNA/A by DataKustik GmbH of Munich, Germany, is very sophisticated and enables one to fully model very complex noise sources. The sound propagation factors used in the model have been adopted from ISO 9613-2

Exhibit 12

Acoustics - Sound Attenuation During Propagation Outdoors (International Organization for Standardization, 1996) and VDI 2714 *Outdoor Sound Propagation.* The model divides the proposed facility into a list of individual point noise sources representing each piece of equipment that produces a significant amount of noise. The sound power levels representing the acoustical performance of each of these noise sources are assigned based either on field measurements of similar equipment made at other existing plants, data supplied by manufacturers, or information found in the technical literature. Using these standard power levels as a basis, the model calculates the sound pressure level that would occur at each receptor from each source after losses from distance, air absorption, blockages, ground effects, and noise reduction methods are considered. The sum of all these individual levels is the total project noise level at the modeling receptor location.

The sound power level used as input to the noise model for each wind turbine was based on the G90 - 2 MW turbine by Gamesa Eolica. Information was provided by Gamesa Eolica on sound power level vs wind speed for wind speeds from 3 meters per second (6.7 miles per hour) to 21 m/s (47 mph). The maximum sound power level listed was 105.3 dBA. This sound power level was used in the modeling. A wind turbine hub height of 67 meters was used for all turbines.

3. Modeling Results

The results of the noise modeling effort are provided below. A figure showing noise level contours, the locations of the wind turbines, and the locations of modeled noise receptors is attached.

A list of all of the noise receptors and their estimated noise levels from the project wind turbines is in Table 1.

TABLE 1: NOISE LEVELS

Receptor Name	ID No.	Estimated Project Noise Level (dBA)
U S TIMBERLANDS YAKIMA LLC	1	25
HARRIGAN, TIMOTHY ETUX	2	28
BORSVOLD, MICHAEL D. &	3	26
RANCH ON SWAUK CREEK LLC, THE	4	29
RANCH ON SWAUK CREEK LLC, THE	5	29
RANCH ON SWAUK CREEK LLC, THE	6	30
FOTHERGILL, REED	7	29
BERGMAN, VINCE L	8	29
HAMPTON, MARK ETUX	9	28
NIELSEN, WAYNE L	10	31
NIELSEN, WAYNE L	11	32
SAUNDERS, GEOFFREY M	12	30

TABLE 1: NOISE LEVELS

Receptor Name	ID No.	Estimated Project Noise Level (dBA)
SAUNDERS, GEOFFREY M	13	30
SIEGL, MICHAEL	14	31
SIEGL, MICHAEL	15	30
CRAMER, WILLIAM A ETUX	16	32
JARNAGIN, JERRY ETUX	17	31
SANDALL, HUBERT S. ETUX	18	32
HAMPTON, MARK ETUX	19	31
HAMPTON, MARK ETUX	20	32
SLAPE, KEN ETUX	21	33
LEGOWSKI, MICHAEL J. &	22	33
SWEEN, TODD ETUX	23	33
MOERY, JOHN T. ETUX	24	33
MOERY, JOHN T. ETUX	25	32
WILSON, JAMES A	26	34
STEWART, PAUL A. ETUX	27	35
STATE OF WASH (DNR)	28	38
LEE, THOMAS &	29	21
DONNELLY, DOUGLAS & JERI	30	21
FOSSETT, SUSAN	31	36
COE, VIRGINIA	32	24
HALL, WILLIAM L ETUX	33	21
RAINBOW VALLEY RANCH LLC	34	37
GEREAN, LEE R. ETUX	35	39
CARRERA, RUBEN &	36	21
KIMBALL, JERRY R ETUX	37	23
AHLES, PETER ETUX	38	38
HENLEY GROUP, LTD. THE	39	37
BRINKMAN, MYRON T ETUX	40	34
KOVALERCHUK, BORIS ETUX	41	27
FITZGERALD, WILLIAM ETUX	42	37
YEAGER, THOMAS F &	43	36

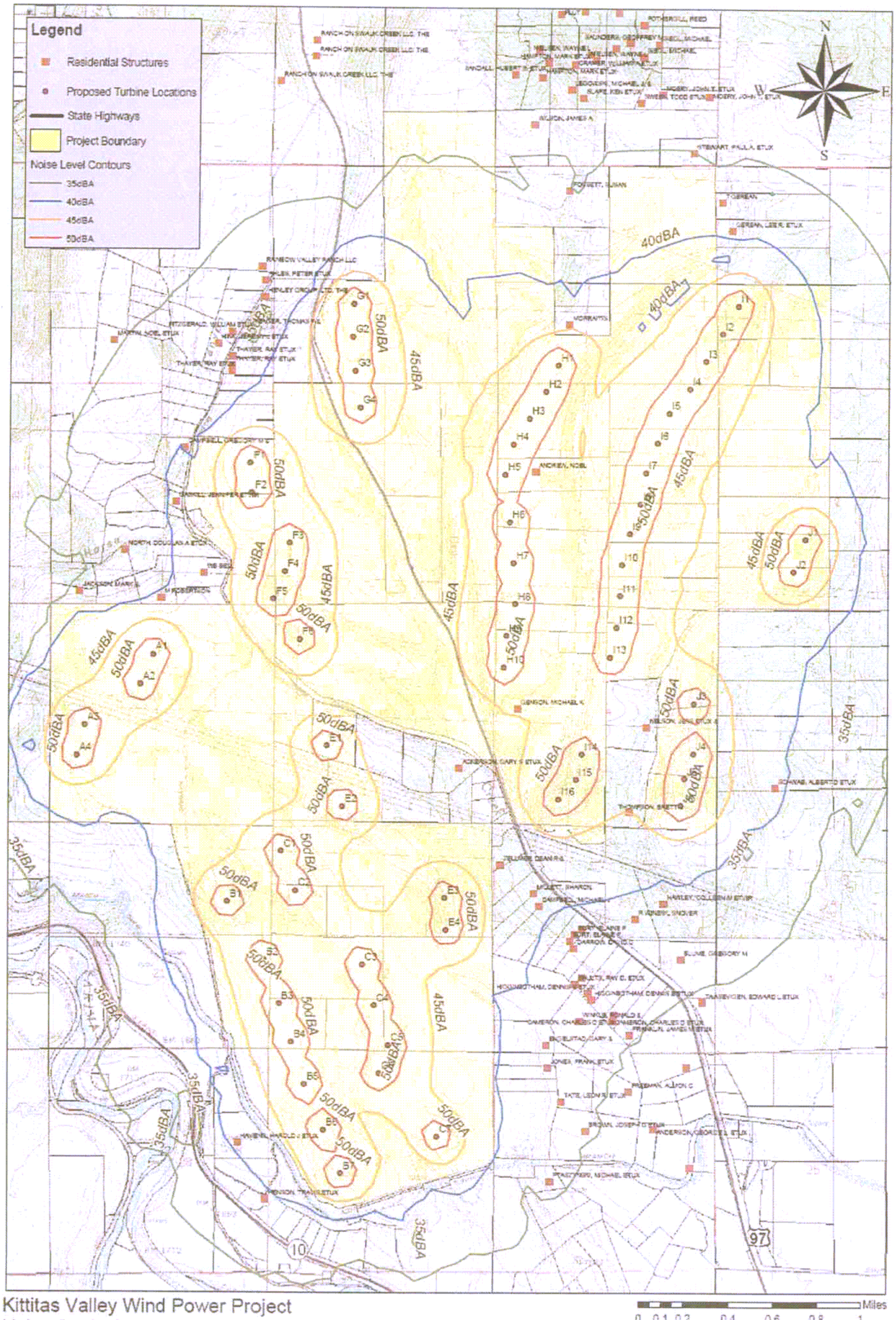
TABLE 1: NOISE LEVELS

Receptor Name	ID No.	Estimated Project Noise Level (dBA)
MARTIN, NOEL ETUX	44	35
HINK, JEREMY J ETUX	45	37
THAYER, RAY ETUX	46	36
DORMAN, GARY D.	47	28
THAYER, RAY ETUX	48	37
THAYER, RAY ETUX	49	37
BEST, ROBERT H. ETUX	50	35
CAMPBELL, GREGORY M &	51	40
ANDREW, NOEL	52	49
GASKILL, JENNIFER ETVIR	53	41
HENRY, GREG	54	36
NORTH, DOUGLAS A ETUX	55	38
TAYLOR, SEAN	56	43
JACKSON, MARK S.	57	37
GENSON, MICHAEL K	58	45
NELSON, JESS ETUX &	59	46
ACKERSON, GARY S ETUX	60	42
THOMPSON, BRETT S	61	45
SCHWAB, ALBERT D ETUX	62	41
ZELLMER, DEAN R &	63	43
R WINES/L SNOVER	64	39
HAWLEY, COLLEEN M ETVIR	65	39
MILLETT, SHARON	66	41
CAMPBELL, MICHAEL J	67	41
BURT, ELAINE F	68	39
BURT, ELAINE F	69	39
BURT, ELAINE F	70	39
DARROW, DAVID C	71	38
SHULTS, RAY D. ETUX	72	38
SHULTS, RAY D. ETUX	73	38
BLUME, GREGORY M	74	36

TABLE 1: NOISE LEVELS

Receptor Name	ID No.	Estimated Project Noise Level (dBA)
HIGGINBOTHAM, DENNIS E ETUX	75	37
HIGGINBOTHAM, DENNIS E ETUX	76	37
CAMERON, CHARLES D ETUX	77	36
CAMERON, CHARLES D ETUX	78	36
FRANKLIN, JAMES M ETUX	79	36
WINKLE, RONALD &	80	37
TAASEVIGEN, EDWARD L ETUX	81	35
ENGELSTAD, GARY &	82	38
TATE, LEON R. ETUX	83	37
Not listed	84	34
FREEMAN, ALMON C	85	35
JONES, FRANK ETUX	86	38
BROWN, JOSEPH G ETUX	87	36
HAVENS, HAROLD J ETUX	88	41
Not listed	89	32
ANDERSON, GEORGE L. ETUX	90	33
PTASZYNSKI, MICHAEL ETUX	91	36
HENSON, TRAVIS ETUX	92	39
ROBERTSON	93	42
MORRIATIS	94	48

Based on the modeling effort, the maximum predicted project noise level at any of the receptors is 49 dBA. The Washington Department of Ecology has established limits for environmental noise in Washington Administrative Code (WAC) 173-60-040. The limit at residential receptors (environmental designation for noise abatement, or EDNA, Class A) for noise generated by from an industrial facility (EDNA C) is 60 dBA during the daytime and 50 dBA during the nighttime. The estimated maximum project noise level at a Class A receptor of 49 dBA complies with the WAC limits.



Kittitas Valley Wind Power Project
Noise Study Contours
Map Revised November 23, 2005

0 0.1 0.2 0.4 0.6 0.8 1 Miles

Kittitas Valley Wind Power Project
Noise Study Contours
Map Revised November 23, 2005

Table 3.12-5: Predicted Noise Levels in KVWPP Area, revised 11/23/05

Landowner	Approx. Distance from Structure to Turbine (feet)	Nearest Turbine to Structure	Est. Noise Level at Structure (dBA)	T/R/S of closest property line	Approx. Distance from Property Line to Turbine (feet)	Est. Noise Level at Property Line (dBA)	Nearest Turbine to Property Line
ACKERSON	2489	I16	42	19-17-15	1959	40-45	I16
AHLES	2178	G1	38	19-17-04	2157	35-40	G1
ANDREW	723	H5	49	PARTICIPATING LANDOWNER			
ARONICA				19-17-01	546	45-50	I1
ARRIOLA				19-17-09	1273	40-45	A1
ASSESSOR #19-17-26000-0016				19-17-26	2891	35-40	C7
BARKL				19-17-23	1254	40-45	E4
BASTERRECHEA				19-17-27	2179	35-40	B7
BELL	1740	F5	43	19-17-09	1079	40-45	F5
BEST				19-17-12	2469	35-40	J1
BISNETT				19-17-09	3864	35-40	F1
BLM				19-17-20	750	35-40	A4
BLUME	3673	J6	36	19-17-23	3230	35-40	J6
BNSF RAILWAY				19-17-28	2675	35-40	B5
BRINKMAN				19-17-01	2184	35-40	I1
BROWN	3549	C7	36	19-17-26	2712	35-40	C7
BURDYSHAW				19-17-02	1437	40-45	H1
BURT	3146	I16	39	19-17-23	2350	35-40	E4
	3112	E4	39				
	2979	E4	39				
CAMERON	4485	E4	36	19-17-23	3903	35-40	J6
	4567	E4	36				
CAMPBELL, G	1595	F1	40	19-17-09	1476	40-45	F1
CAMPBELL, J				19-17-23	1114	40-45	E4
CAMPBELL, M	2244	E3	41	19-17-23	1114	40-45	E4
CHAR				19-17-26	2717	35-40	C7
CORNWALL				19-17-01	2331	35-40	I1
DARROW	3138	E4	38	19-17-23	2762	35-40	E4
DE FACCIO				19-17-28	2753	35-40	B5
DER YUEN				19-17-34	2323	35-40	B7
DNR				PARTICIPATING LANDOWNER			
DOT				19-17-09	1275	40-45	F2
ENGELSTAD	3391	C7	38	19-17-26	2180	40-45	C7
FITZGERALD	2858	G2	37	19-17-04	2442	35-40	G2
FOSSETT	4172	H1	36	19-17-02	3331	35-40	H1
FRANKLIN	5080	E4	36	19-17-23	4299	35-40	J6

*Gray shading: No structure on property with a noise level at greater than 35dBA

Table 3.12-5: Predicted Noise Levels in KVWPP Area, revised 11/23/05

Landowner	Approx. Distance from Structure to Turbine (feet)	Nearest Turbine to Structure	Est. Noise Level at Structure (dBA)	T/R/S of closest property line	Approx. Distance from Property Line to Turbine (feet)	Est. Noise Level at Property Line (dBA)	Nearest Turbine to Property Line
FREEMAN				19-17-26	3727	35-40	C7
GABRIELSON				19-17-12	631	45-50	J1
GALLAGHER				19-17-13	1260	40-45	J2
GARRETT				19-17-13	538	45-50	J3
GASKILL	1816	F2	41	19-17-09	1678	40-45	F2
GENSON	1026	H10	45	PARTICIPATING LANDOWNER			
GEORGE				19-17-28	2239	35-40	B7
GEREAN, L	1800	I1	39	19-17-01	1426	40-45	I1
GEREAN, T	2503	I1	38	19-17-01	2094	40-45	I1
GORDON				19-17-23	3539	35-40	E4
GORSKI				19-17-12	1114	40-45	J1
HAVENS	1994	B6	41	19-17-27	985	40-45	B7
HAWLEY	2386	J6	39	19-17-23	1824	40-45	J6
HENLEY GROUP	2121	G1	37	19-17-04	1905	35-40	G1
HENRY	3060	J1	36	19-17-12	594	45-50	J1
HENSON	1884	B7	39	19-17-27	1480	35-40	B7
HIGGINBOTHAM	3724	E4	37	19-17-23	3582	35-40	E4
	3845	E4	37				
HINK	2935	F1	37	19-17-04	2270	35-40	F1
HOLLISTER				19-17-23	557	45-50	J6
HOLMQUIST				19-17-21	984	40-45	B1
HOLTZ				19-17-09	1497	35-40	F1
JACKSON, MARK S.	2326	A1	37	19-17-09	1823	35-40	A1
JONES	3102	C7	38	19-17-26	1917	40-45	C7
JORGENSON				19-17-09	2203	35-40	F1
KELLY				19-17-28	2837	35-40	B7
KIRCHMAN				19-17-13	775	45-50	J3
KITTITAS CO TAX DEED				19-17-28	3256	35-40	B4
KITTITAS RECLAMATION DISTRICT				19-17-26	713	40-45	B7
KUHN				19-17-13	910	40-45	J2
LOS ABUELOS				PARTICIPATING LANDOWNER			
MARTIN				19-17-04	2757	35-40	F1
MCFARLAND				19-17-28	1462	40-45	B4
MCLEOD				19-17-28	3150	35-40	B5
MILLETT	2098	E3	41	19-17-23	1155	40-45	E4
MEYER				19-17-01	2740	40-45	I1

*Gray shading: No structure on property with a noise level at greater than 35dBA

Table 3.12-5: Predicted Noise Levels in KVWPP Area, revised 11/23/05

Landowner	Approx. Distance from Structure to Turbine (feet)	Nearest Turbine to Structure	Est. Noise Level at Structure (dBA)	T/R/S of closest property line	Approx. Distance from Property Line to Turbine (feet)	Est. Noise Level at Property Line (dBA)	Nearest Turbine to Property Line
MILLER				19-17-15	1284	40-45	I16
MORRAITIS	1000	H1	48	19-17-02	758	45-50	H1
MORSE				19-18-07	3560	35-40	J1
MURPHY				19-17-23	3271	35-40	J6
NELSON CREEK VISIONS				19-17-09	3514	35-40	F2
NELSON	1253	J3	46	19-17-14	538	45-50	I13
NEUMAN				19-17-27	2158	35-40	B7
NORTH	2622	A1	38	19-17-09	1955	35-40	A1
OBERHANSLEY				19-17-02	2662	45-50	H1
PARKER				19-17-01	2277	35-40	I1
PEARSON				19-17-27	1232	35-40	B7
PENTZ				19-18-07	3196	35-40	J1
POLLOCK				19-17-34	2320	35-40	B7
POULIN				19-17-26	1642	35-40	C7
PTASZYNSKI	2904	C7	36	19-17-26	2159	35-40	C7
RAINBOW VALLEY RANCH LLC	2352	G1	37	19-17-04	2039	35-40	G1
RANCH ON SWAUK CREEK LLC, THE				19-17-03	580	45-50	G1
RAND				19-17-09	1412	40-45	F4
REILLEY				19-17-26	1716	40-45	C7
ROBERTSON	1373	A1	42	19-17-09	1239	40-45	A1
ROMERO				19-17-15	1195	40-45	I16
SAFFORD				19-17-09	4325	35-40	F2
SCHALLER				19-17-09	2306	35-40	F1
SCHOBER				PARTICIPATING LANDOWNER			
SCHWAB	2098	J4	41	19-17-13	575	45-50	J4
SHERMAN				19-17-13	854	45-50	J6
SHORETT				19-17-09	2118	35-40	A1
SHULTS	3359	E4	38	19-17-23	1262	40-45	E4
	3448	E4	38				
SIX TEN INVESTMENTS				19-17-26	1355	40-45	C7
SMITH				19-17-15	1492	40-45	I16
SPRINGWOOD RANCH				19-17-28	3281	35-40	B4
STEWART				20-17-35	3321	35-40	I1
STORWICK				19-17-15	1509	40-45	E2

*Gray shading: No structure on property with a noise level at greater than 35dBA

Table 3.12-5: Predicted Noise Levels in KVWPP Area, revised 11/23/05

Landowner	Approx. Distance from Structure to Turbine (feet)	Nearest Turbine to Structure	Est. Noise Level at Structure (dBA)	T/R/S of closest property line	Approx. Distance from Property Line to Turbine (feet)	Est. Noise Level at Property Line (dBA)	Nearest Turbine to Property Line
SWAUK VALLEY RANCH				19-17-17	612	45-50	A4
SZUBA				19-18-07	3215	35-40	J1
TATE	3081	C7	37	19-17-26	2958	35-40	C7
THAYER	2555	F1	36	19-17-04	1880	35-40	G2
	2339	F1	37				
	2227	F1	37				
THOMAS				PARTICIPATING LANDOWNER			
THOMPSON, B	1226	J6	45	19-17-14	575	45-50	I14
THOMPSON, C				19-18-07	3156	35-40	J1
TONSETH				19-17-28	2195	35-40	B5
WEILER				20-17-35	4607	35-40	I1
WHITELEY				19-17-15	1185	40-45	I16
WILKENS				19-17-13	580	45-50	J4
WILSON				20-17-35	4769	35-40	H1
WINES				19-17-23	704	45-50	I16
WINES/SNOVER	2921	J6	39	19-17-23	996	40-45	I16
WINKLE	3869	E4	37	19-17-23	3300	35-40	E4
YEAGER	2442	G2	36	19-17-04	1894	35-40	G2
ZELLMER	1547	E3	43	19-17-23	1220	40-45	I16

*Gray shading: No structure on property with a noise level at greater than 35dBA

CH2MHILL

DAVID M. BAKER, PE—Senior Acoustical Engineer

Background

Mr. Baker is a senior engineer in CH2M HILL's Portland, Oregon office. He has experience in noise measurement, analysis, and control for buildings, transportation projects, power plants, and industrial facilities. He has worked to measure site noise levels for both new and existing noise sources. Noise impacts have been estimated using computer models and standard acoustical calculation techniques. Noise control measures have been evaluated for situations where the noise criteria or regulatory limits were exceeded.

Education

B.S., Mechanical Engineering, Oregon State University

Professional Registrations

Professional Engineer: Oregon (Acoustical, Environmental, and Mechanical)

Experience

- Conducted a noise analysis for the West Cascade Energy 900 MW combustion turbine, natural gas-fired power plant proposed to be located north of Eugene, OR. The facility consisted of two GE 7FA combustion turbines with heat recovery steam generators to operate in combined cycle (600 MW total output) and six LM6000 combustion turbines to operate in simple cycle (300 MW total output). Extensive noise mitigation was included in the analysis because of the close proximity to the plant of several residences. The noise modeling demonstrated that the facility would comply with the absolute noise limits and the limits on allowable noise level increase in the State of Oregon Administrative Rules.

- Evaluated the noise impacts from construction, commissioning, operation, and decommissioning of a proposed gas-to-liquids petroleum plant in Ras Laffan City, Qatar. The estimated noise levels were compared with local and World Bank noise standards to determine the extent of impacts and the need for mitigation.

- Assisted in the evaluation of noise impacts from the Walnut Energy Center constructed by the Turlock Irrigation District in California. This included computer modeling of the noise impacts from the natural gas-fired, combined cycle, combustion turbine facility. Field monitoring of a similar steam generator at a different site was conducted to determine its contribution to the overall noise level and the acoustical performance of its enclosure.

- Provided expert third-party acoustical engineering services for Whatcom County in the State of Washington. Whatcom County had approved the construction of a power plant at the BP Cherry Point Refinery. The approval included requirements for submittal of technical documents concerning noise and a pre-construction ambient noise measurement program. The technical documents were reviewed and the monitoring by BP's acoustical consultant was observed. Review comments were provided to Whatcom County.

- Conducted noise analyses for approximately seven CalPeak peaker combustion turbine installations in California. The installations were all based on Pratt & Whitney twin turbine configurations. Activities

Exhibit 12a

included ambient monitoring, measurement of noise at a similar installation, modeling of construction and operation noise levels (including determination of necessary mitigation), drafting of the required permit applications, and negotiation with the lessors of the selected sites.

- Assisted in the evaluation of noise impacts from the Calpine Peaker Program in California. This program consisted of more than 10 General Electric LM6000 natural gas-fired combustion turbines operating in simple cycle. Noise source information was quantified based on data supplied by equipment manufacturers and from onsite noise measurements made at similar facilities. This information was used as input to a standardized computer model. This approach greatly expedited the noise analysis and permitting process.
- Evaluated the noise impacts from a proposed liquified natural gas (LNG) facility and associated natural gas-fired, simple cycle, combustion turbine powerplant in the Bahamas. Noise from the facility was demonstrated through modeling to comply with the applicable limits.
- Conducted a noise analysis for a gas turbine, combined cycle power plant in Seattle, Washington. Noise levels were measured to establish existing conditions. The major noise sources were identified and quantified. The effect of noise reduction provided by the power plant building and other planned noise control measures was calculated. The resultant noise level at the closest nearby receptor was estimated. This level was found to comply with the local noise regulations.
- Assisted the architect in the design of the city library in Kahului on the island of Maui, Hawaii. The interior noise from the air conditioning system was estimated, as was the exterior noise caused by the air conditioning equipment. A sound wall was used to mitigate exterior noise levels.
- Conducted a study to determine the noise impacts of modifying the mass transit system in urban Seattle, Washington. Noise levels were monitored at 12 sites at various times throughout the day to establish existing conditions. Traffic counts were made simultaneously with the noise measurements. The noise contributions from individual vehicle types were also measured at each site. Future noise levels were estimated from field data obtained during the study and estimated future traffic volumes. Mitigating measures, in particular for diesel buses, were discussed.
- Provided acoustical engineering services for the design of the West Point Secondary Treatment Facilities in Seattle, Washington. This included work on the initial site selection through current efforts to evaluate noise during construction. Noise levels were measured at sensitive receptors near the plant. Estimates were made of the noise that would result from construction and operation activities. Noise mitigation measures were incorporated into the plant design.
- Measured existing noise levels and estimated impacts of a tour bus maintenance and office facility in Seattle, Washington
- Conducted the noise section of an initial siting feasibility study for the placement of a 200-megawatt power plant on the island of Hawaii. Several different types of plants were considered, including coal-fired boilers,

diesel-driven engines, and oil-fired boilers. The island has extremely low allowable noise levels, making noise a major consideration in the siting.

- Determined noise specifications for gas turbines to be installed at Rossman's Landfill in Oregon City, Oregon. He also estimated the noise impacts of a proposed sanitary landfill near Portland, Oregon.
- Conducted post-construction noise monitoring for a sawmill and wood-fired powerplant in Redding, California. The facility was found to exceed permitted levels along one property line. Recommendations were made to further enclose and muffle existing equipment to meet the limits.
- Conducted a noise evaluation for a wood-fired powerplant and sawmill in Burney, California. This included monitoring at the site, estimating construction and operation noise levels, evaluating the projected levels against the local noise limits, and determining the necessity for noise mitigation.
- Evaluated the noise impacts of a biomass-fired powerplant in Woodland, California. Noise measurements were conducted and design recommendations were made to ensure compliance with the local noise regulations.
- Prepared the noise component of an environmental impact statement for an 18-megawatt pelletized wood waste powerplant in Soledad, California. Noise was an important issue of the analysis with induced draft fan and cooling tower noise control measures recommended to comply with the local planning guidelines.
- Measured existing noise levels and estimated impacts of a coal transshipment facility at the Port of Kalama, Washington
- Evaluated noise and vibration impacts from air compressors at the Port of Portland, Oregon.
- Conducted extensive noise evaluations for three sites being considered for a new major landfill to be located in the Portland, Oregon, area. The work included identifying necessary mitigation measures.
- Measured existing noise levels and estimated the noise impacts of a secondary lead refining plant in St. Helens, Oregon.
- Evaluated the noise impacts of a copper mine and related process facilities operated by Exxon in Chile.
- Estimated the noise impacts of a proposed sanitary landfill. Developed a method of predicting noise levels on the basis of bus, truck, and automobile traffic volumes and evaluated noise mitigation measures.
- Evaluated the noise impacts of alternative sites for a proposed major landfill to serve the Portland, Oregon area. The effects of construction, onsite operation, and project-generated traffic were included in the evaluation. A similar study was conducted for a proposed landfill in Clark County, Washington. Mr. Baker assisted in a project to determine noise specifications for gas turbines to be installed at Rossman's Landfill in Oregon City, Oregon.
- Conducted a study of an existing building for the Clark County Public Utility District to determine if it could be used to house an electrical substation without causing noise or vibration problems for other building

residents. Recommendations were made for separate foundation and vibration isolators for the transformers.

- Evaluated the noise impact of a copper mine and related process facilities operated by Exxon in Chile.
- Evaluated the operation of the Southwest Recycling and Transfer Station in Mountlake Terrace, Washington in response to complaints from nearby residents. Noise measurements were made at various times throughout the day and night. The noise levels were found to exceed the State noise limits at two sites. Recommendations were made to mitigate the noise levels.
- Evaluated several sewage pump stations for the Cape May County Municipal Utilities District in Cape May, New Jersey. The pump stations were the cause of complaints from nearby residents. The primary noise sources were determined to be roof-mounted fans for oil cooling and interior pumping equipment. Recommendations were made for reducing the noise from both sources.
- Conducted Highway noise evaluations for the Cornell Road/Sunset Highway interchange and the Tualatin-Sherwood/Edy Road widening in Washington County, Oregon, for Marine Drive and Airport Way in Portland, Oregon, and for highways in San Jose, Pleasonton, and Foster City, California.
- Measured baseline noise levels, estimated the resultant noise levels from increased traffic, and evaluated mitigating measures for a proposed widening of Allen Boulevard in Beaverton, Oregon.

Mark Bastasch

Environmental Engineer, Noise Assessment

Education

MS, Environmental Engineering, William Marsh Rice University, Houston, Texas
BS (cum laude), Environmental Engineering, Cal Poly San Luis Obispo, California

Distinguishing Qualifications

- Experienced in multimedia (air, water, soil, waste, and noise) industrial compliance and permitting
- Specializes in industrial noise measurements, modeling and control, and industrial compliance and permitting
- Experience includes evaluation and measurements of existing noise levels; analysis of noise levels for no-build and build alternatives; feasibility, design, and siting analysis of noise barriers; and preparation of noise and vibration impact assessment reports
- Has conducted numerous noise studies in conjunction with National Environmental Policy Act (NEPA) documents and numerous state's energy facility siting requirements
- Has prepared acoustical analysis or expert testimony for more than 700 megawatts (MW) from wind generation facilities and 6,000 MWs from gas-fired facilities

Relevant Experience

Mr. Bastasch is an environmental engineer with more than 6 years of experience conducting acoustical evaluations, environmental audits, contamination assessments, and multimedia environmental permitting. He has helped clients author, revise, update, and implement their environmental health and safety programs. Mr. Bastasch's regulatory experience includes stormwater permitting, National Pollutant Discharge Elimination System (NPDES) permitting, Title V permitting, hazardous air pollutant studies, prevention of significant deterioration (PSD), Process Safety Management (PSM) and Risk Management Plan (RMP) applicability studies, Form R preparation, spill documentation, response and reporting requirements, and audit preparation for the Oregon Department of Environmental Quality (DEQ) for hazardous waste and City of Portland Bureau of Environmental Services (BES) for stormwater and industrial wastewater.

Mr. Bastasch's acoustical experience includes preliminary siting studies, regulatory development and assessments, ambient noise measurements, industrial measurements for model development and compliance purposes, mitigation analysis, and modeling of industrial and transportation noise.

His field experience includes overseeing more than 250 soil boring and well installations, more than 500 feet of interlocking watertight sheet pile installation, tank decommissioning and associated cleanup, partitioning and conservative tracer tests, groundwater monitoring, and design/contracting/supervision of associated electrical, water and waste handling systems.
In addition, Mr. Bastasch was the on-site field engineer for installing and operating both standard (soil vapor extraction, air sparging, pump, and treat) and innovative (steam injection, cosolvent flushing, surfactant solubalization, surfactant mobilization) in the first side-by-side trial at Hill Air Force Base for the U.S. Environmental Protection Agency (EPA) and SERDP. He was commended by both the EPA project manager and the Air Force for his efforts to successfully complete the project.

Mr. Bastasch's remedial and feasibility investigation skills include identifying reasonable and low-cost solutions for a variety of contaminates including fuels, heavy metals, pesticides, solvents, and polycyclic aromatic hydrocarbons (PAHs).

Representative Projects

Pollution Control and Prevention Plans, Various Industrial Clients. Assisted in evaluating their stormwater pollution control systems, and updating their stormwater pollution control plans and spill prevention control and countermeasure plans (SPCC). Also conducted their hazardous waste awareness, stormwater pollution prevention, and spill prevention training. Most recently, revised a major food processing facility's spill plan. Was able to remove the facility from the federally mandated SPCC program and was commended by the facility for assisting them in passing an internal environmental audit.

Air Emission Inspections and Permitting Audits, Industrial and Government Clients. Air experience includes permitting, reporting, and compliance assessment. Reviewed and prepared Title V Short-term Emission Limits, Form Rs, and annual emissions reports for major industrial clients. Also has completed several hazardous air pollutant inventories, compliance assessments, and PSD applicability studies.

Washwater Evaluation and Design Alternatives Study, Large Intermodal Transportation Facility. Lead project engineer for conducting the study. Developed a preliminary design and permitting strategy that would enable the facility to continue operations with minimal financial impacts. Included negotiations with DEQ and City of Portland BES.

Demolition Waste Characterization Study, Major Pulp and Paper Facility. Authored study for a former acid plant at the facility.

Demolition Waste Characterization Study, Primary Aluminum Smelting Facility. Assisted in the study.

Oil Spill Clean Up and Tank Replacement. Responded to and oversaw the clean up of a 10,000-gallon Bunker C fuel oil tank spill and associated tank replacement under OR-DEQ's spill response program.

Clean Up and Repair of Fuel Dispensing Station, Major Food Processing Client. Identified, contracted, and oversaw the inspection and associated clean up and repair of a malfunctioning oil/water separator at a fuel dispensing station.

Various Groundwater Monitoring Reports. Prepared several reports for high profile clients in the Portland, Oregon, metropolitan area and assisted the client in reducing monitoring requirements.

EPA Superfund, Central California. Provided oversight at a former oil disposal facility.

Deactivation Workplan, Hanford. Assisted in preparing deactivation workplan for a radioactive process and liquid waste sewer at Hanford.

Preliminary Site Assessments, Federal Projects. Conducted assessments for SERDPs (EPA, Department of Energy, and Department of Defense) dense non-aqueous-phase liquid remediation pilot project.

Environmental Review and Audit, Portland, Oregon. Reviewed and audited environmental documents and costs associated with redeveloping the city's Pearl District.

Contamination Feasibility Report. Prepared feasibility decision/evaluation matrix for a former wood-treating site (pentachlorophenol contamination).

Noise Assessment/Noise Analysis

Maiden Wind, Prosser, Washington. Acoustical technical lead. Prepared operational and construction noise assessment of a 300-MW wind generating facility for local, state, and federal authorities. Tasks included ambient noise measurements and detailed modeling of both NEG Micon and Enron Wind Turbines. Developed mitigation and permitting strategy that gave client flexibility to postpone final turbine selection.

Stateline Wind Project, Oregon and Washington. Acoustical technical lead for a 263-MW wind farm in northeast Oregon (Umatilla County) and southeast Washington (Walla Walla County). Tasks included monitoring at existing Vestas wind turbines and proposed turbine locations, authoring a noise impact evaluation, and preparing environmental documentation to comply with both Oregon and Washington standards.

Stateline Wind Expansion, Oregon. Prepared acoustical analysis documenting compliance with Oregon's 10-decibel degradation standard for an additional 40 MWs. Assisted legal counsel with regulatory interpretation and assessment.

Klondike Wind, Northwestern Wind Power, Oregon and Washington. Northwestern Wind is looking at several sites in three counties in Washington and Oregon. It currently has a 25-MW pilot project in Sherman County, Oregon, which uses the Enron Wind 1.5-MW generators. Subsequent phases would add up to 400 MWs of wind generation. Provided preliminary acoustical modeling and permit assistance at the local and state levels and developed a noise monitoring protocol. Helped draft alternatives for revisions to the state noise standard as it applies to wind energy facilities.

Calpine Gilroy Peaker Program, Calpine Corporation, Dublin, California. Project manager and acoustical lead for Calpine's Peaker Program. Prepared California Environmental Quality Act level noise assessments for more than 10 LM6000-based peaking power plants located throughout northern California. Developed a flexible and streamlined program to accurately and quickly prepare acoustical assessment. Tasks included regulatory review and interpretation of city and county noise standards, ambient measurements and analysis, development of a standardized model that included several levels of optional mitigation and field verification at operating facilities, and regulatory negotiating.

Metcalf Energy Center, San Jose, California. Acoustical technical lead for a 600-MW power plant. Tasks include the following: evaluating and measuring background noise levels; modeling and comparison of expected noise levels with the City of San Jose, County of Santa Clara standards, and the California Energy Commission's (CEC) 5 dBA over background guideline; recommendations to acquire additional property; preparing Application for Certification submitted to the CEC; regulatory negotiation; and review of Conditions of Certification, testimony at public hearings, and CEC evidentiary hearings, which included detailed cross-examination. Successful negotiations saved the client more than $5 million in capital expenditures.

Los Esteros Critical Energy Facility, San Joaquin Valley Energy Center, East Altamont Energy Center, Delta Energy Center, Calpine Corporation, California. Services similar to Metcalf Energy Center. Prepared Applications for Certification or testimony.

Renewable Northwest Project, Oregon. Provided technical assistance and testimony in modifying the Oregon noise rule as it applies to wind projects.

Cosumnes Power Plant, Sacramento Municipal Utility District, California. Prepared Application for Certification for combined-cycle gas fired generation facility at Rancho Seco. Prepare amendments to include a natural gas transmission line and required gas compressors. Expert witness testimony before California Energy Commission.

Peoples Energy Resources Corporation (PERC), COB Energy Facility, Klamath County, Oregon. PERC proposes to construct and operate a 1,150-MW combined-cycle gas-fired generation facility in southern Oregon, approximately 3 miles south of Bonanza. Because of the project's size, it must go through Oregon's Energy Facility Siting Council review, a rigorous and lengthy process that requires evaluation of a broad range of environmental issues. Prepared site certificate for the plant and associated transmission line.

Power Projects, Confidential Client, California. Prepared detailed regulatory analysis of all projects permitted and currently being permitted by the State of California, including Altamont Pass Wind Farm.

Starbuck Power Plant, PPL Global, Starbuck, Washington. Acoustical technical lead for a proposed 600-MW power plant and transmission line. Tasks included monitoring, modeling, and preparation of required environmental documentation.

Grizzly Power Plant, Cogentrix, Madras, Oregon. Prepared site certificate application.

Power Plant, Confidential Client, California. Acoustical technical lead for an internet data center and an onsite 50-MW power plant, chiller plant, and backup diesel generators. Tasks include monitoring, negotiations with the city's consultant, and preparing an environmental impact report.

Power Plant, Confidential Client, Chicago, Illinois. Acoustical technical lead for preliminary power plant siting study. Tasks included review and summarization of all applicable laws, ordinances, regulations, and standards.

Multiple Landfill Clients, Washington and California. Acoustical consultant to a municipal landfill design team. Tasks included evaluating background noise levels and applicable laws, ordinances, regulations, and standards to determine setback requirements for facility expansion.

Various Transportation Projects. Acoustical technical lead for numerous transportation projects in California, Colorado, Oregon, Washington, Alaska, and Idaho. Tasks include monitoring, modeling, and mitigation recommendations in accordance with all applicable laws.

Professional Registrations

Registered Acoustical Engineer: Oregon
Professional Environmental Engineer: Oregon
Professional Civil Engineer: Oregon
Certified Water Rights Examiner: Oregon
Member, Institute of Noise Control Engineers
40-hour HAZWOPER Certified
8-hour HAZWOPER Site Supervisor Certification
12-hour Site Safety Coordinator Certification

Report of Daniel Kammen

Qualifications

My name is Daniel Kammen and my business address is 310 Barrows Hall Berkeley, CA 94720-3050. I am the Class of 1935 Distinguished professor and director of the Renewable and Appropriate Energy Laboratory of the University of California at Berkeley. I hold joint appointments as Professor of Energy and Society with the Energy and Resources Group, Professor of Nuclear Engineering in the Department of Nuclear Engineering, and Professor of Public Policy at the Goldman School of Public Policy, all at the University of California at Berkeley. I teach courses and conduct research on a variety of topics primarily related to energy and its impacts, with an emphasis on renewable energy sources, as well as risk analysis and communication. Exhibit A is a résumé of my educational background, expertise and employment experience.

I received my undergraduate degree in physics from Cornell University (1984), and my masters and doctorate in physics from Harvard (1986 & 1988) for work on theoretical solid state physics and computational biophysics. I was then the Wezmann & Bantrell Postdoctoral Fellow at the California Institute of Technology in the Divisions of Engineering, Biology, and the Humanities (1988 - 1991). First at Caltech and then as a Lecturer in Physics and in the Kennedy School of Government at Harvard University, I developed a number of projects focused on renewable energy technologies and environmental resource management. At Harvard I also worked on risk analysis as applied to global warming and methodological studies of forecasting and hazard assessment. I received the 1993 21st Century Earth Award, recognizing contributions to rural development and environmental conservation from the Global Industrial and Policy Research Institute and *Nihon Keizai Shimbun* in Japan.

From 1993 – 1998, I was an Assistant Professor of Public and International Affairs in the Woodrow Wilson School of Public and International Affairs at Princeton University. I played a key role in developing the interdisciplinary Science, Technology, and Environmental Policy (STEP) Program at Princeton, that awards undergraduate and masters certificates and a doctoral degree. I was STEP Chair from 1997 - 1999 and co-chair before that. In July of 1998, I joined the interdisciplinary Energy and Resources Group (ERG) at the University of California, Berkeley as an Associate Professor of Energy and Society. I am a Fellow of the American Physical Society and a Permanent Fellow of the African Academy of Sciences.

My research interests include: the science, engineering, management, and dissemination of renewable energy systems; health and environmental impacts of energy generation and use, and energy forecasting and risk analysis. I am the author of over 90 journal publications, a book on environmental, technological, and health risks *(Should We Risk It?* Princeton University Press, 1999) and numerous reports on renewable energy and development. I have been featured on radio, network and public broadcasting television and in print as an analyst of energy, environmental, and risk policy issues and current events. My recent work on energy R&D policy appeared in *Science*, and *Environment*, and has been featured on PBS, KQED, CNN, and in many newspapers via the Reuters news service.

I advise the U. S. and Swedish Agencies for International Development, the World Bank, and the US President's Committee on Science and Technology (PCAST), and am a member of the Intergovernmental Panel on Climate Change (Working Group III and the Special Report on Technology Transfer). I serve on the technical review board for the Global Environmental Facility (the STAP), am a lead author for the Special Report on Technology Transfer of the

Intergovernmental Panel on Climate Change, and advise the World Bank and the American Academy of Arts and Sciences and well as the African Academy of Sciences.

I have published a book, *Should We Risk It* (Princeton University Press, 1999) on the methodologies and practicalities of performing risk assessments as well as peer reviewed journal articles on the subject of risk analysis and have taught the subject at both the undergraduate and graduate levels. I have also testified before U. S. House of Representatives' Science Committee panels on these issues.

I am an expert with regard to risk analysis.

Risk Analyses Principles, Techniques and Methods

Risk analysis generally begins with identifying the potential sources of risk posed by the activity or facility to be evaluated. This involves identifying the conditions that could create a hazard and evaluating both the probability of those conditions occurring and the likely consequences if they were to occur. These risks are then quantified using accepted risk calculation methodologies, including an analysis of sensitivities. The resulting quantified risk calculations are then evaluated and compared to the risks of other common or related activities to determine whether they are significant or not.

Currently there are no local or national regulatory standards for public safety risks relating to wind turbines in the United States. Guidance documents have been developed for this subject in some European countries, but there are no uniform international regulatory standards. However, third party certification programs for wind turbines (such as RISO, DNV and GL) do incorporate safety features and performance in their review of turbines for certification.

There are no uniform standards that, for instance, state that the individual risk posed by any prospective energy facility should be less than or equal to 1 in a million or some other specific risk level. Certain types of facilities that are regulated by the federal government, such as nuclear plants and interstate petroleum pipelines, are subject to national safety-related standards, but these are not based on uniform risk criteria.

Currently, federal and state government agencies do not utilize a consistent, uniform approach to establishing "acceptable" risk limits for various activities. In many instances, no explicit risk level is stated for regulatory purposes (for example operating a motor vehicle). In other cases, regulatory agencies have adopted specific risk thresholds for various types of activities such as the remediation of contaminated sites and the allowable levels of certain potentially carcinogenic or otherwise hazardous substances in drinking water or food. While there is no uniform risk standard for regulatory purposes in the US, the most common risk standard, where such standards exist, is 1 in a million risk of death.

Risk Analysis Study for the Kittitas Valley Wind Power Project

I was requested to analyze and evaluate the potential public safety risks posed by the proposed Kittitas Valley Wind Power Project, specifically the risk of a turbine blade becoming detached, the risk of a turbine tower collapsing and the risk of ice being thrown from turbine blades. I was also asked to compare the risks of these wind turbine related scenarios to other types of risks that have already been quantified in order to put them in perspective.

The following is the methodology we used for the study:

1. First, we researched available information on the frequency and probability of the wind turbine related risks we were asked to evaluate. We sought information on the documented frequency of occurrence of these potential hazards as well as published sources regarding appropriate mitigations or setbacks to minimize these risks.
2. Then we utilized the information regarding the proposed types and sizes of turbines proposed for the Kittitas Valley Wind Power Project as well as the proposed locations of the turbines relative to roads and other areas with humans present to calculate the potential public safety risk of tower collapse, blade throw or ice throw.
3. We then compared the calculated risk levels for the proposed project to other, already quantified risks to evaluate their significance.

Exhibit B is a copy of the risk analysis referred to above that I conducted for the Kittitas Valley Wind Power project. Exhibit B is incorporated herein as part of this Report and Testimony.

The following is a summary and brief description of the study.

1. We compiled available research regarding the risks of tower collapse, blade throw and ice throw, based on published studies available up to 2004, as well as industry guidance documents from the US and Europe. We then calculated probabilities of the various hazards based on the available research and the specific type and sizes

of turbines being proposed for this project (60 meter RD to 90 meter RD) and the specifics of the particular project site location (such as proximity to homes, roads, etc.) We then compared the calculated risk levels to other, known risk levels for common activities to evaluate their significance.

2. The only reported case of a member of the public being killed by a wind turbine that we were able to find was a parachutist in Germany who jumped into a wind turbine.

3. We used the actual average daily traffic volumes (ADT) for the public roads within the project area as well as the project layout map as of 2004 showing the location of all project facilities relative to roads and other areas where human presence is most likely to evaluate the probability of a person or vehicle actually being at the precise location where a falling blade, tower or piece of ice might land. We also took into consideration the Applicant's proposed setback distances as shown in the 2004 layout for all turbines from roads, property lines and houses as well as the fact that the Applicant has stated that the project facilities will be located behind fences with locked gates. The results of our analysis indicate that Highway 97, with 2,800 vehicles passing per day in 2001 according to data from WA DOT, is the location within the project area with the highest probability of a blade or piece of ice thrown from a wind turbine striking a member of the public. Using the average daily traffic of 2,800 vehicles, and the probability of a blade or large piece of ice being thrown far enough to reach Highway 97, we estimated that the probability of a car being struck by ice or a blade from a turbine to be less than one in one billion. This analysis is conservative because the design has been changed, and the present layout decreases the number of turbines and increases setbacks.

4. Our results indicated that based on the proposed layout as it existed in 2004, turbine size and other factors, the probability of a wind turbine at the proposed project killing or seriously injuring a member of the public as a result of blade throw, tower collapse or ice throw is less than 1 in 1 billion This is based on a 1 in one million chance of a blade or other object being thrown (per the European wind power handbooks we referenced) and the actual frequency of cars passing along Highway 97 in the project area, which we believe is the area within the project site with the highest probability of a blade or piece of ice thrown from a wind turbine striking a member of the public. Again, this analysis is conservative because the design has been changed, and the present layout decreases the number of turbines and increases setbacks.
5. The resulting risk level is low and insignificant compared to either other energy generating technologies or many common activities, as described below.
6. The risks of many common activities have already been quantified and reported in published sources. These are often used in communicating the results of risk analyses so that decision makers and members of the public can evaluate the significance of the risk level of a given activity or proposal relative to the risks of other activities that are more familiar. As described in Exhibit B, our analysis concludes that the risk of a person being killed or seriously injured from a blade being thrown, a tower collapsing, or ice being thrown from a turbine is less than the following risks (risk source in parentheses):
    - Traveling in automobile for 300 miles (accident)
    - Riding a bicycle 10 miles (accident)
    - Having one chest x-ray at a modern hospital (cancer caused by radiation)
    - Living for 2 days in New York or Boston (air pollution)

- Drinking half a liter of wine (cirrhosis of the liver)
- Eating 40 tablespoons of peanut butter (liver cancer caused by aflatoxin B)
- Drinking 30 12 oz. cans of diet soda (cancer caused by saccharin)
- Eating 100 charcoal-broiled steaks (cancer from benzopyrene)

Conclusion of Study and Analysis

The potential public health and safety risks posed by this project are insignificant and less than the risks posed by other common energy generating technologies and countless other common activities.

Analysis of Potential Safety Risks of the proposed Kittitas Valley Wind Power Project

The objective of this analysis is to provide an initial assessment of the sensitivity of potential public health and safety risks associated with the proposed Kittitas Valley Wind Power Project in Kittitas County, Washington. This analysis is to be submitted as expert testimony for EFSEC's consideration.

The purpose of the analysis is to evaluate the potential human health risks to the public of operating the proposed project. This analysis consists of two main components:

1) Perform actual risk calculations on the potential risks posed by wind turbines and comparing those risk levels with the risks of other common activities[1]
2) Quantify the risks and evaluate whether they are significant or not.

General Risks Posed by Wind Turbines

There are no existing standards in the US for the acceptable risk level for wind power projects. Wind turbines do, however, have to comply with many safety rules, for example as a result of the certifying of wind turbine components (DNV, GL, RISO, etc.). Currently, there are no specific regulatory minimum distances for wind turbines to other infrastructure and building based on safety conditions. In general, there are no definitive national or state risk standards for most types of energy facilities. The specific concerns that have been raised regarding public safety risks in relation to the proposed Kittitas Valley project, and thus are the subject of this risk assessment are:

- Separation and throwing of whole or partial rotor blade
- Tower collapse
- Throwing of ice from the turbine blades

A structural failure of a wind turbine might lead to loss of blade (or parts of it) and thus cause a risk to nearby people and property. To deal with risks of wind turbine in a rational manner, the contents of several national handbooks (from Denmark, Germany and the Netherlands) with procedures for the risk assessment of wind turbines [2,3,4] have been used. A large data set representing 43,000 turbines in 3 countries and over 15,000MW of capacity was used to evaluate the actual risks of the aforementioned events.

The Kittitas Valley wind project is in the planning and permitting phase, thus the exact type of turbine to be used is not yet known. However, the developer, Zilkha Renewable Energy, has proposed using a range of turbine sizes from 60 to 90 meters in rotor diameter. For that reason, generic turbine data such as hub height, rotor diameter, rotor speed, potential throwing distances of blades, and risk contours as a function of the rated power have been collected. The data are based on turbine model for a range from 60 meter rotor diameter (RD) 1 MW turbines up to 90 meter RD 3 MW. The developer has indicated that the most likely wind turbine model for this project will be in the range of 1.5 MW turbines (with a rotor diameter of 70.5 meters).

Kammen Exhibit B

Calculation method for theoretical risk of blade throw

Individual Risk (IR) = the probability that a member of the public will die from an accident at a plant (or any other hazardous activity) if he/she is permanently at a certain place without protection. The conservative maximum value for the IR based on *European Wind Turbine Standards (EWTS)*[5] is 1 in a million (10^{-6}) per year.

The IR is usually presented as contours with equal IR values around a plant or turbine. These contours indicate at what distance from the turbines vulnerable objects should be considered in the risk analysis. That distance equals the maximum throwing distance of a blade under overspeed conditions (equal to two times rated speed). The above mentioned criteria appear to be applicable for evaluating the probability of a blade or any other component directly hitting a person, or a group of persons.

The tip wind speed of a rotor blade is as high as 80m/s. Bearing in mind the weight of several tons of a single blade, the kinetic energy of a modern wind turbine is a possible hazard to the public, although the probability of blade failure is very low. The trajectories of blade fragments are calculated taking into account the site layout and wind turbine type specific data. Several tens of thousands of trajectories are calculated to quantify the probability of an impact on a certain location. These probabilities are the basis for the risk analysis.

The method used to determine the probability that a blade (or any other turbine component) may hit a person assumes that the centre of gravity of the blade follows a ballistic lift curve. The method further includes the size of the blade (or any other component), the size of the object or area, and if relevant, the velocity. The computer program "Probabilistic Design Tool for Wind Turbines" – PRODETO by Risø National Laboratory[6,7] has been used in order to calculate the probability of failure of wind-turbine rotor blades.

Fig. 1 shows an example of the results of the risk modeling of the IR contours for a 2 MW turbine. Fig. 1A shows the IR contours resulting from the 3 individual scenarios: Loss of entire blade, collapse of entire turbine, and collapse of rotor and/or nacelle.

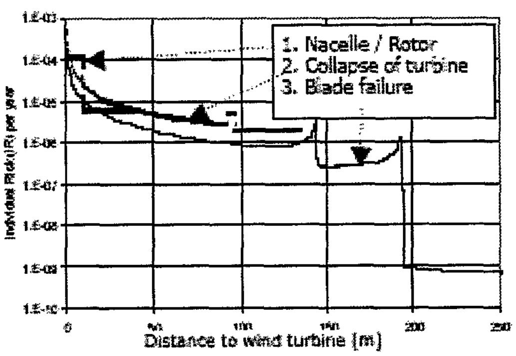


Fig. 1A: *Individual Risk (IR) per year versus distance to wind turbine resulting from the individual scenarios for a 2 MW wind turbine.*

Fig. 1B shows the sum of all IR values.

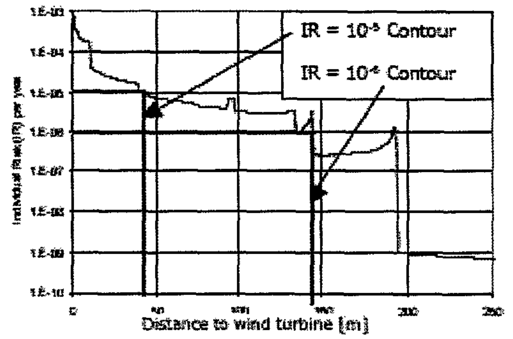


Fig. 1B: Individual Risk (IR) per year versus distance to wind turbine for a 2 MW wind turbine, including all scenarios of Table 1.

Using this modeling, different contours have been plotted for turbines in the range of 1000 kW up to 2 MW (60 m RD to 90 m RD).
Table 2 shows values for the IR = 1 in 100,000 (10^{-5}) and IR = 1 in a million (10^{-6}) contours (deaths per million people within a given distance of the wind turbine) as a function of the turbine size, these values have been acquired from the modeling plots.

Table 1. *IR contours (distance to wind turbine) as a function of turbine size*[8]

Type of turbine			
Rated Power [MW]	1.0	1.5	2.0
Rotor Diameter [m]	60	70	80
IR = 10^{-6} contour [m]	124	134	144
IR = 10^{-5} contour [m]	28	37	39

As is shown in Table 1 above, the IR = 1 in 100,000 (10^{-5}) contour equals half the rotor diameter and the IR = 1 in a million (10^{-6}) contour equals the maximum throwing distance of a blade at rated rotor speed.

It should be noted that the towers from the proposed Kittitas Valley Wind Power Project will be mostly on private land that is behind locked gates and in no case will be within tip height of any house or property line. The closest turbines are approximately 1000 feet (300 meters) from any house; in that case the house is owned by the same person on whose land the turbine will be located. From these calculations it can be said that for three bladed turbines in the range of 1MW to 2MW the IR = 1 in a million (10^{-6}) contours vary from 120m to 150m.

Calculation method for Ice Throw

Ice throw is a concern related to the fact that any object at the end of the rotating blades is traveling at a high rate of speed. In the case of a 60 meter RD turbine (about 200 feet), rotating at 20 RPM, the tip of the blade is traveling at just over 140 mph. If the turbine diameter increases to 80 meters, the tip speed increases to just over 187 mph. There are published reports (see footnote 9, Seifert *et al*) of ice having accumulated at the tip of the turbine and upon breaking loose, traveling up to 100 meters.

While there are theoretical claims that ice can travel great distances when sent flying from an operating turbine, most use the simplifying assumption that there is no air resistance. This assumption leads to very significant errors. Recent studies have been done using computer modeling which includes the influence of air resistance on ice throw[9,10]. These studies included validation of the computer model by comparison with field observations. While their recommendation is to use the complex computer models to evaluate each site, there are some general conclusions. The research on wind turbine ice shedding in Europe has resulted in a recommendation of a setback distance that is 1 ½ times the height of the tower from areas where the public has access.

Using D = 1.5 (tip height), where D is the set back distance, tip height is the height of blade tip at its highest point. For the most likely turbine scenario proposed for this project, a 1.5 MW turbine with a 70.5 meter RD and tip height of 100 meters, this would require a safety setback of 150 meters or 495 feet from houses, roads or other areas with high incidence of human traffic.

Actual Probability of Falling Object (blade, ice) Striking a Member of the Public

The risk levels for a blade or ice thrown from a wind turbine presented above depends on the assumptions one makes about the probability of a person(s) being at the exact spot where a flying object might land at that exact moment in time. Given the rural, sparsely populated nature of the area, and the fact that the developer has stated the area will be fenced off, that probability appears to be very low.

At the proposed project site, the area with by far the highest frequency of human presence is Highway 97, which runs through the middle of the project area. It is logical then to calculate the probability that a vehicle would be present at the time a blade or ice fragment were thrown to determine more accurately the risk of a vehicle being struck. As noted in Section 3.10 of the Application of Site Certification, the Average Daily Traffic volume for 2001 for this section of Highway 97 is reported by WA DOT to be 2,800 vehicles. Making some simple assumptions about the average size of vehicles and their travel speed, and factoring in the distance from Highway 97 to the nearest proposed turbine, the probability of a blade or any other component hitting a car is less than one in one billion ($p = 6\times10^{-10}$). This assumes that any object thrown from a wind turbine and striking a vehicle leads to mortal accident (which is a very conservative assumption). In reality not all thrown objects that could hit a car will lead to a mortal accident so the added risk is actually smaller .

Risk Comparisons

In order to evaluate the calculated risk levels presented by the proposed project, it is useful to compare them to the risks of other activities that are perhaps more familiar to most people. The following table lists a variety of activities that all increase the chance of death per year by one in one million. Comparing the risk level of an object thrown from a wind turbine actually striking a person or vehicle at the proposed project site calculated above (one in one billion) to the following list of activities that all present a risk of one in one million it is clear that the proposed project is less likely to result in death than many very common activities. The likelihood of any of the following increasing the chance of death is 1,000 times greater than the calculated risk level presented by the proposed project. It appears reasonable, therefore, to determine that the proposed project does not present a significant risk to public health or safety.

Table 2. Risks that increase chance of death per year by 10^{-6} (one chance in one million)

Activity	Cause of Death
Smoking 1.4 cigarettes	cancer, heart disease
Drinking .5 liter of wine	cirrhosis of the liver
Spending 1 hour in a coal mine	black lung disease
Spending 3 hours in a coal mine	accident
Living 2 days in New York or Boston	air pollution
Traveling 6 minutes by canoe	accident
Traveling 10 miles by bicycle	accident
Traveling 300 miles by car	accident
Flying 1000 miles by jet	accident
Flying 6000 miles by jet	cancer caused by cosmic radiation
Living 2 months in Denver	cancer caused by cosmic radiation
Living 2 months in average stone or brick building	cancer caused by natural radioactivity
One chest X ray taken in a good hospital	cancer caused by radiation
Living 2 months with a cigarette smoker	cancer, heart disease
Eating 40 tablespoons of peanut butter	liver cancer caused by aflatoxin B
Drinking Miami drinking water for 1 year	cancer caused by chloroform
Drinking 30 12 oz cans of diet soda	cancer caused by saccharin
Living 5 years at site boundary of a typical nuclear power plant	cancer caused by radiation
Drinking 1000 24-oz soft drinks from plastic bottles	cancer from acrylonitrile monomer
Living 20 years near a polyvinyl chloride plant	
Living 150 years within 20 miles of a nuclear power plant	cancer caused by radiation
Living 50 years within 5 miles of a nuclear power plant	cancer caused by radiation
Eating 100 charcoal-broiled steaks	cancer from benzopyrene

Wilson, R., "Analyzing the Daily Risks of Life." *Technology Review*, 81, 1979

Note: These data are based on simple extrapolations from population averages. Some data are based on actuarial statistics (e.g., coal mine accidents) and others are based on theoretical models (e.g., cancers from chlorinated water).

References

[1] D.M. Kammen and D.M. Hassenzahl. Should we risk it? Princeton Ed. 1999.

[2] *Guidelines on the Environmental Risk of Wind Turbines in the Netherlands. H. Braam L.W.M.M. Rademakers. 2002* .Netherlands Agency for Energy and the Environment).

[3] Committee for the Prevention of Disasters. Guidelines for Quantitative Risk Assessment. CPR 18E. Den Haag, Sdu: 1999. This report documents the methods to calculate the risks due to dangerous substances using the models and data available. Calculation of the risks relates, on the one hand, to stationary installations and, on the other hand, to transport and related activities. The report consists of two parts. Part 1 describes the methods to calculate the risks of stationary installations. Part 1 was written by the National Institute of Public Health and the Environment (RIVM) under a supervisory committee of representatives from the subcommission on Risk Evaluation of the Committee for the Prevention of Disasters (CPR-RE). Part 2 describes the calculation of the risks connected with the transport of dangerous goods, based on the approach developed in accordance with the Ministry of Housing, Spatial Planning and the Environment.

[4] The incidents reported are gathered in the German WMEP database from ISET a Danish database from Energie og Miljødata, and a Dutch database. Windenergie Report Deustschland 2002 by Institut für Solare Energieversorgungstechnik (ISET) in Kassel is the continuation of a series of practical reports on the operation and performance of wind turbines in Germany. The annual reports for the Scientific Measurement and Evaluation Program, or WMEP for its German acronym, will continue at least into 2004.

[5] European Wind Turbine Standards (EWTS). J.W.M. Dekker J.T.G. Pierik (Editors). The determination of the target values for structural reliability can be done empirically. However, a probabilistic approach is preferred. This probabilistic method has been applied already in other branches of industry like offshore and civil engineering, but is not introduced in the wind energy branch yet. The code of realibility which is not local to a country, but shall be applied Europe-wide, is the Eurocode 1. Therefore, it is recommended to apply the safety level of the Eurocode to wind turbines, which would mean a yearly safety index of 4.7, corresponding to a failure probability of 10^{-6}/year.

[6] A Probabilistic Design Tool for Wind Turbines. H. Braam, J. J. D. van Dam, ECN; C. J. Christensen, M. L. Thøgersen, G. C. Larsen, Risø; K. O. Ronold, DNV Risø National Laboratory, December 1998, ISBN 87-550-2466-3.

[7] Braam, H. et al: "Handboek Risicozonering Windturbines" Handbook Risk Assessment of Wind Turbine, May 2002.

Rotor Blade Failure - Risk Analysis for the Surrounding of a Wind Turbine T. Hahm, J. Kröning, TÜV-Nord e.V.

[8] The IR contours as a function of the turbine size data given in Table 3 are acquired from the Handbook Risk Assessment Handbook (edited by NOVEM).

[9] Risk Analysis of Ice Throw From Wind Turbines by Henry Seifert et al, DEWI (German Wind Energy Institute)

[10] Technical Requirements For Rotor Blades Operating In Cold Climate by Henry Seifert, DEWI (German Wind Energy Institute)

DANIEL M. KAMMEN

Energy and Resources Group (ERG)
310 Barrows Hall
University of California
Berkeley, CA 94720-3050
Tel: 510-642-1139 (Office)
Fax: 510-642-1085
Tel & Fax: 510-643-2243 (**RAEL**)
Tel: 510-642-1640 (ERG Desk)
http://socrates.berkeley.edu/~erg

1 Weybridge Court
Oakland, CA 94611

Email: kammen@socrates.berkeley.edu
http://socrates.berkeley.edu/~kammen
http://socrates.berkeley.edu/~rael

U. S. Citizen, Married, daughter (Folasadé)

CV and Publications • http://socrates.berkeley.edu/~kammen
Renewable and Appropriate Energy Laboratory (RAEL) • http://socrates.berkeley.edu/~rael

---

RESEARCH INTERESTS

Science and technology policy focused on energy, development and environmental management. Technology and policy questions in developing nations, particularly involving: the linkages between energy, health, and the environment; technology transfer and diffusion; household energy management; renewable energy; women; minority groups. Global environmental change including deep cuts in greenhouse gas emissions and resource consumption. Environmental and technological risk. Management of innovation and energy R&D policy. Geographic expertise: Africa; Latin America.

EDUCATION

Ph.D.	Harvard University	Physics	June 1988
M.A.	Harvard University	Physics	June 1986
A.B.	Cornell University	Physics	May 1984

POSITIONS HELD

2001 -	Professor of Public Policy in the Goldman School of Public Policy, University of California, Berkeley
2001 -	Professor of Energy and Society, University of California, Berkeley
2001 -	Professor of Nuclear Engineering, University of California, Berkeley
1999 -	Director, (**R**enewable and **A**ppropriate **E**nergy **L**aboratory; **RAEL**) University of California, Berkeley
1999 - 2001	Associate Professor of Nuclear Engineering, University of California, Berkeley

Exhibit 13a

1998 - 2001	Associate Professor of Energy and Society, Energy and Resources Group (ERG), University of California, Berkeley
1997 - 1999	Chair, Science, Technology & Environmental Policy Program (STEP), Woodrow Wilson School of Public and International Affairs, Princeton University
1997 - 1999	Class of 1934 Preceptor, Woodrow Wilson School of Public and International Affairs
1993 - 1999	Assistant Professor of Public and International Affairs, Woodrow Wilson School of Public and International Affairs, Princeton University
1993 - 1999	Research Faculty, Center for Energy and Environmental Studies, School of Engineering and Applied Science, Princeton University
1993 -	Permanent Fellow, African Academy of Sciences
1991 - 1993	Research Associate, Northeast Regional Center for Global Environmental Change, and the Department of Physics, Harvard University
1991 - 1993	Affiliate Fellow, Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University
1988 - 1991	Weizmann & Bantrell Postdoctoral Research Fellow in the Division of Engineering and Applied Science, and the Division of Biology, California Institute of Technology

TEACHING

University of California, Berkeley

- Environmental Classics (ER290) (with Dr. Isha Ray)
- Methods in Interdisciplinary Studies ('Tricks of the Trade') (ER292B)
- Freshman Seminar: The Century of Fossil Fuels, the Century of Global Warming (ER24)
- Energy and Society (ER100/200)
- Renewable Energy (ER120)
- The Politics of Climate Change Policy (ER290) [faculty advisor]
- Energy and Development (ER290)
- Group Studies in Energy Research (ER298)
- Individual Research in Energy (ER299)
- Issues in Nuclear Science and Technology (NE39) (team taught)
- Honors Research – Environmental Science, Policy and Management (ESPM, College of Natural Resources, H196)

Princeton University

- Environment and Development (WWS 571b)
- Technology Transfer and Development (WWS 571c)
- Methods in Science, Technology and Public Policy (WWS 589)
- Process and Methods in Science and Technology Policy (WWS 308)
- Topics in Renewable Energy Conversion (MAE 319) (team taught)
- Science, Technology and Public Policy (WWS 304)
- Environmental Science and Policy (ENV 201) (team taught)

Harvard University

- Senior Engineering Thesis Research (Engineering Sciences 96r)

- Biomass, Land Management, and Environmental Change (Chair, Working Group) John F. Kennedy School of Government

California Institute of Technology

- Tropical Development and Conservation (Biology 23)

POSTDOCTORAL ADVISEES

2000 - Timothy Lipman (Ph.D. 1999) University of California, Davis, Environmental Policy Analysis/Graduate Group in Ecology; Institute of Transportation Studies - Davis)

2000 - 2002 Antonia Herzog (Ph.D. 1997, University of California, San Diego, Physics). UC Presidential Postdoctoral Fellow, 2000 – 2001
Current: Senior Policy Researcher, Natural Resources Defense Council, Washington, DC.

1998 - 2001 Lloyd Connelly (Ph.D. 1998, University of California, Berkeley, Mechanical Engineering).
Current: Enrolled in Medical School, University of California, Davis.

1997 - 1999 Daniel Klooster (Ph.D. 1997, University of California, Los Angeles, Geography)
Current: Assistant Professor of Geography, Florida State University

1996 – 1997 Lisa Naughton (Ph.D. 1996, University of Florida, Wildlife Ecology)
Current: Assistant Professor of Geography, University of Wisconsin, Madison.

DOCTORAL DISSERTATION ADVISEES (UCB students unless indicated)

2002 - Tracey Osborne, "Biomass and Development in the Caribbean"

2001 - Kamal Kapadia, 'Renewable Energy for Development'

2000 - Nate Hultman, "Carbon Markets, Climate Change Science and Policy", NASA Earth Sciences Doctoral Fellow, 2000 - 2003

1999 - 2001 Andrew MacAllister, "Renewable energy infrastructure", Link Energy Fellow, 1999-00

2000 - Joanna Lewis, "Wind Energy Infrastructure in China"

1999 - Donna Green, "Solar battery charging, development, and politics in Thailand".

1999 - Robert Bailis, "Renewable energy and development", FLAS Fellow, 1999-2000.

1998 - Arne Jacobson, "Renewable energy and development" Link Energy Fellow, 2000 – 2001.

1998 - Chris Greacen, "Renewable energy and development", US EPA STAR Fellow, 1998 - 2001).

1997 - 2001 Richard D. Duke (STEP, Princeton) "Economics of renewable energy technologies" (Link Energy Foundation Fellow, '98 - '99; US EPA STAR Fellow, 1998 - 2001). Thesis: *Clean Energy Technology Buydowns: Economic Theory, Analytic Tools, and the Photovoltaics Case*
Current: Senior Financial Analyst, MacKenzie Consulting, New York City, NY.

1996 - 1999 Katherine Purvis (Chemistry, Princeton) "Toxic Paint Solvents and Worker Exposure in Kenya" (PEI-RISE; with S. Bernasek, Chemistry)

Current: Assistant Professor of Chemistry and Environmental Studies, The Claremont Colleges, Claremont, California

1996 - 2001 Robert Margolis (STEP, Princeton) "US energy R&D and innovation"

1995 - 2000 David Hassenzahl (STEP, Princeton). Thesis: *Comparative Environmental Regulation and Risk Management*
Current: Assistant Professor of Science Policy, UNLV (Greenspun School of Public Policy)

1995 - 2000 Majid Ezzati, (STEP, Princeton). Thesis: *Energy Technology, Indoor Air Pollution, and Respiratory Infections in Developing Countries: A Field Study from Central Kenya* (SSRC International Pre-Dissertation Fellow, '97 - '98).
Current: Fellow, Resources for the Future, Environment and Risk Group (Washington, DC).

1994 - 1997 Amy F. Richardson (WWS, Princeton), *People, Preferences, Parties and PAC's: Constituent Representation in the Senate on Environmental Issues* (with L. M. Bartels).
Current: Senior Fellow, Environmental Policy Analysis, Mackenzie Consulting, Pittsburgh, PA.

Dissertation Committees:

1997 – 2001 Teresah Holloway, Atmospheric and Oceanic Studies, Princeton University
Current: Postdoctoral Fellow,

1993 – 1997 Georgios Kassinis, WWS, Princeton University
Current: Assistant Professor of Public Policy, University of Cyprus, Greece.

UNDERGRADUATE THESIS ADVISEES

1999 – 2000 Advised 4 undergraduate senior projects (UC Berkeley), departmental honors (3)

1998 – 99 Advised 7 senior thesis (Princeton University)

1996 - 97 Advised 6 senior theses (Princeton University)
Student honors include: Marshall Fellowship, a Fulbright Scholarship (to Kenya); the Westoff Prize in Demography; Woodrow Wilson School Senior Thesis Prize; Princeton Environmental Institute Senior Thesis Prize; Civil Engineering and Operations Research Senior Thesis Award (CEOR Prize).

1995 - 96 *On leave:* Advised 1 senior thesis (Princeton University)
Student honors include: the Lieutenant John A. Larkin, Jr. Memorial Prize (WWS); and the Environmental Studies Senior Thesis Award from the Princeton Environmental Institute.

1994 - 95 Advised 7 senior theses (Princeton University)
Student honors include: a Rhodes Fellowship; a Marshall Fellowship; Princeton University's Pyne Prize; and a Fulbright Scholarship (to Mexico)

1993 - 94 Advised 5 senior theses (Princeton University)
Student honors include: the Gaile F. Johnson Prize in Public Affairs (WWS); and a Fulbright Scholarship (to Kenya)

1992 - 93 Advised 2 senior theses (Harvard University)
Including one nominated for a Hoopes Prize

1991 - 92 Advised 2 senior theses (Harvard University)

EXTERNAL RESEARCH FUNDING AWARDS (Principal Investigator unless noted)

Pending:

"Climate Dynamics and Health in Sub-Saharan Africa", with D. Balk (Columbia University), submitted to the US National Institute of Health, $450,000.

"Integrative Methods and Models in Global Carbon Management", National Science Foundation – Biocomplexity. Co-PI with J. Harte, D. M. Kammen, R. Norgaard, $950,000.

"Local approaches to energy management and indoor air quality", US AID, $95,000.

Current & Past Support:

2003 -	"A Review of Approaches to Advanced Power Technology Programs in the United States and Abroad Including Linked Mobile and Stationary Sector Developments", California Air Resources Board, $63,000.
1999 -	"Research, education and outreach on energy and sustainable societies" The Energy Foundation, (San Francisco, CA), $250,000.
2000	Solo Energy Corporation. Unrestricted gift to support RAEL, $40,000.
2000 – 2001	Core Management Team (with E. Vine [LBL], J. Sharpless [former CEC Commissioner], J. Quinn [UC Davis], K. Birkinshaw [CEC]), California Energy Commission, Public Interest Environmental Research – Environmental Area (PIEREA), $10,500,000 annual program budget.
2001 – 2002	"UV Water Purification Technology for Development", Award Winning Entry, the World Development Marketplace Competition, $100,500. http://www.developmentmarketplace.org/html/results.html#DMAward
2000 – 2001	Faculty Research Grant (COR), "Sustainable Renewable Energy Markets", $5600.
2000 – 2001	"Resources Policy Internship Program", California Public Utilities Commission, $815,000.
2000-2002	"Biomass Energy For Sustainable Economic, Social, And Environmental Development In Zimbabwe", Shell Environmental Initiative (London, UK), $260,000.
1999 - 2000	"Photovoltaic System Field Evaluation and Training Program for East Africa", $54,000, The Lewis Anthony Dexter Charitable Trust (Chicago, Illinois, USA).
1999 - 2000	"Dissemination of Small-scale UV Water Disinfection Systems in Southern Mexico: Support and Evaluation", $12,000, The Lewis Anthony Dexter Charitable Trust (Chicago, Illinois, USA).
1998 - 2000	Co-PI (w/Lisa Naughton, University of Wisconsin) "Resource Access and Environmental Change: An Analysis of the Linkages Between Forest Property Rights, Biofuel Management, and Ecological Impacts in western Uganda", $50,000, National Science Foundation Grant SBR 98-10144; Division of Geography and Regional Science.

1996 - 1998 "Community Energy, Ecology and Health Management: Laikipia, Kenya". The Summit Foundation, Washington, DC, $198,000.

1996 - 1998 "Sustainable development in Molo, Kenya," $95,211. The Dubois Fund, Houston, TX.

1996 - 1998 "Community Energy, Ecology and Health Management: Laikipia, Kenya". The Compton Foundation, Menlo Park, CA, $25,000.

1995 - 1996 MacArthur Foundation grant for student-faculty collaborative research, $7,600.

1993 - 1995 "Engineering and policy analysis of renewable energy technology transfer: solar and nuclear energy," Department of Energy, Northeast Regional Center for Global Environmental Change, $66,500.

1993 - 1994 Research Fellowship: Program on Environment, The East-West Center for Cultural and Technical Exchange, Honolulu, Hawaii, $9,000.

1993 *Award Recipient*: 21st Century Award from Nihon Keizai Shimbun, Inc. and the Global Industrial and Social Progress Research Institute: ¥5 m ($45,000).

1992 - 1996 Center for Field Research (*Earthwatch*): $94,000; "Solar and wind energy for Kenya." An additional local expertise research and training components were supported by: Green Cross International (1995), UNESCO (1994) to provide scholarships to African scholars and community activists working in the area of renewable energy and the environment.

AWARDS

Aldo Leopold Environmental Leadership Fellow (2001) (*Declined).*

Development Marketplace (2000) Award Winner, the World Bank. "Low Cost UV Water Disinfection System for Household Use in Lesser-Developed Nations (Dr. Lloyd Connelly and D. M. Kammen).
WWW: http://www.developmentmarketplace.org

Class of 1934 Preceptor, 1996 - 1999 (Woodrow Wilson School)

Bronze Medal (with Danielle A. Gordon) *Chicago Quantitative Alliance 1995 Academic Competition* for the paper, "Uncertainty and overconfidence in time series forecasts: application to the Standard & Poor's 500 stock index", *Applied Financial Economics*, **6 (3)**, 189 – 198 (1996).

Awarded the ANBAR Management Intelligence Citation of Excellence (1997): http://www.anbar.co.uk/anbar/excellence/authors.htm

Fellow, American Physical Society (1994). Citation:
For his efforts to foster development with culturally appropriate renewable energy projects and to link local sustainable development with programs to mitigate global environmental degradation.

1993 21st Century Earth Award: for research addressing the amelioration or solution of such global environmental problems as climate change, deforestation or biodiversity preservation. Citation:

For research aimed at reducing greenhouse gas emissions and improving environmental health in developing nations: a proposal for energy management, cooking technology, and education.

Teaching Award (Biology Undergraduate Student Curriculum Committee, California Institute of Technology, 1991).

Weizmann & Bantrell Postdoctoral Fellowship in the Division of Engineering and Applied Science (1988-89), Division of Biology (1989-91); California Institute of Technology.

Cornell University A. B., *Cum Laude* (1984).

Westinghouse Science Talent Search: Honors Group (1980).

EDITORIAL BOARDS

Annual Review of the Environment (2001 – 2005)
Global Change Science (journal developed from *Chemosphere*), 1999 –
Chemosphere, Editor, Global Change Science and Policy Section, 1993 – 1999

ADVISORY COMMITTEES

University of California Green Buildings/Clean Energy Steering Committee, 2003.
Elected At Large Member, Section on Societal Impacts of Science and Engineering (Section X), American Association for the Advancement of Science (AAAS), 1998 – 2002.
California Energy Commission, Core Management Team, Public Interest Environmental Research – Environmental Area (PIEREA), $10,500,000 annual budget, 2000 – 2002.
Roster of Experts, Scientific and Technical Advisory Panel (STAP); Global Environment Facility (GEF), 1996 -
The Annapolis Center for Risk Analysis, 1995.
Team Leader, Evaluation of Energy, Environment, and Development Programme, Africa Division, Swedish International Development Cooperation Agency (Sida), 1996 - 1997
U. S. Environmental Protection Agency (Climate Change Division)
Editorial Advisory Council, *African Technology Forum,* 1994 - 1996
U. S. Department of Energy: National Institute for Global Environmental Change, 1993 – 1995
Elected Member, The Council of Advisors: Energy Section (http://www.thecouncils.com/)

REFEREE

Journals:

Ambio, Appropriate Technology, Atmospheric Environment, Energy Policy, The Energy Journal, Energy - The International Journal, Environment, Environmental Health Perspectives, Environmental Science & Technology (EST), Global Biogeochemical Cycles, Global Change Science, Nature, Risk Analysis, Science, Scientific American, *Solar Energy, Strategic Environmental Management, World Bank Research Observer, Whole Earth, World Development*

Publishers:

Cambridge University Press, Island Press, McGraw Hill, MIT Press, Resources for the Future, UNDP, World Resources Institute, Yale University Press

Funding Agencies:

Compton Foundation, Earthwatch, GEF/UNDP, National Institute of Health, National Science Foundation, US AID, US EPA, US NIH, Winrock International Foundation

LANGUAGES & TECHNICAL SKILLS

Spanish (conversant), Swahili (conversant)
Private Pilot (PPL: Single Engine, Land)
Concert electrical wiring (*Grateful Dead*, Summer 1988)
Computer Programming: BASIC, C++, FORTRAN, PASCAL, STATA

REFERENCES: Available Upon Request

UNIVERSITY SERVICE, RESEARCH AND PROGRAM ADMINISTRATION

At the University of California, Berkeley:

2002 Executive Committee, Berkeley 'Future of the Planet' program.
2002 Harry S. Truman Fellowship Selection Committee, 2001 – 2003.
2003 Udall Fellowship Selection Committee, 2001 – 2003.
2004 Chair, Faculty Search Committee, "Science, Technology and Environmental Policy", ERG Search.
2005 Search Committee, Dean of the College of Natural Resources, 2001 – 2002.
2006 Committee on Status of Women and Ethnic Minorities (SWEM), 2001 – 2002.
2007 Chair, Faculty Search Committee, "Environmental and Development Sociology", Energy and Resources Group (2000 – 2001). Successful recruitment of Dr. Isha Ray
2008 Search Committee Member, "Science, Technology and Environmental Policy", joint search between ERG and the Goldman School of Public Policy (1999 – 2001)
2009 Campus Representative - Advisory Committee of the University of California Energy Institute (UCEI), 1999 – 2002.
2010 Co-Chair, Curriculum Committee, Energy & Resources Group, 1999-
2011 Faculty Affiliate, African Studies Program, 1998-
2012 Faculty Affiliate, Center for Risk Analysis, 1998-
2013 Faculty Affiliate, Health, Environment and Development (HED) Program, 1998-

At Princeton University:

- Faculty Fellow, Princeton Society of Fellows, 1998 - 1999
- Labouisse Development Studies Fellowship Selection Committee, 1996 - (Chair, 1998-1999)
- Chair, Science, Technology & Environmental Policy (STEP) Program, 1997 - 1999
- Co-Chair, Program on Science, Technology and Public Policy, 1993 - 1997
- Woodrow Wilson School Student-Faculty Diversity Committee, 1996 - 1997

- Associate Faculty, Princeton Environmental Institute, 1996 - 1999
- Faculty Fellow, Forbes College, Princeton University, 1994 - 1999
- Princeton Environmental Initiative, Planning committee, 1993 - 1994.
- Program Director, conference: "Polluted or Pristine? Scientific, cultural, and policy implications of pre-industrial anthropogenic impact on the global carbon cycle", hosted by the Program on Environment, East-West Center, Honolulu, Hawaii. September 17 - 19, 1993.
- Woodrow Wilson School: Undergraduate Prize Committee, 1993 - 1994
- Woodrow Wilson School: Ph.D. Admissions Committee, 1993 - 1995, 1996 - 1999
- Woodrow Wilson School Undergraduate Committee, 1993 - 1995, 1996 -1999
- Princeton University Committee on African Studies, 1993 - 1999

At Harvard University:

- Harvard University Committee on African Studies, 1991 - 1993.

INTERNATIONAL ORGANIZATIONS

- Advisor, Energy Sector, Asian Development Bank, 2000 -
- Coordinating Lead-Author, Intergovernmental Panel on Climate Change (IPCC), Special Report on Technology Transfer (1998 - 2000)
- Global Environment Facility (GEF/UNDP), Scientific and Technical Review Panel, 1997 - 2002
- Co-Chair (with Stephen Karekezi) Princeton-AFREPREN (African Energy Policy Research Network) Visiting Fellows Program for emerging scholars from developing nations.
- AAAS Member-at-Large, Section Committee on Societal Impacts of Science and Engineering, 1998 - 2002 (elected member).
- American Physical Society, 1983 - 1987, 1993 -
  Elected to the Executive Committee: *Forum on Physics and Society*, 1995 - 1998
  Nominating Committee, 1997 - 1998
- American Association of Geographers, 1992 - 1997
- American Wind Energy Association, 1994 -
- National Council, Federation of American Scientists, 1995 - 2000
- African Academy of Sciences, Elected Permanent Fellow, 1995

PUBLIC OUTREACH AND ACTIVISM

Chairman of the Advisory Panel, EcoEquity (http://www.ecoequity.org)

BOOKS & EDITED VOLUMES

In preparation:

Energy Farmers: An exploration of old and new modes of thinking about, and managing energy resources.

Where There's Smoke: Uncovering the World's Number One Killer
Book on energy, health, and development. This book, intended for a popular audience is represented by the literary agency of Sanford J. Greenburger Associates.

The Road to Celebration: Adventures in Energy and Development in route to Sandinista Nicaragua (Contract with Columbia University Press: New York). Manuscript complete.

In print:

2002 Climate Technology Initiative, Contributing Author (2002) *Technology Without Borders: Case Studies of Successful Technology Transfer* (International Energy Agency: Paris, France).
URL: http://www.iea.org/public/studies/cti.htm

2000 Intergovernmental Panel on Climate Change Working Groups II and III (2000) *Methodological and Technological Issues in Technology Transfer* (Cambridge University Press: New York, Cambridge UK and New York, NY). Coordinating Lead Author. ISBN 0-521-80494-9.

1999 Kammen, D. M. and Hassenzahl, D. M. *Should We Risk It? Exploring Environmental, Health and Technological Problem Solving*, in press, Princeton University Press. ISBN 0-169-00426-9, 406 pages, 77 tables, 82 illustrations.
WWW: http://socrates.berkeley.edu/~kammen/#book
• Book Club Selection: *Library of Science*. Reviewed in *Science*, *Risk Analysis*, *Scientific American*, *WholeEarth*.

1996 Nditu, M. and Kammen, D. M. *Solar Cookbook: Less Wood, Less Smoke, Better Health* (Academy Science Publishers: Nairobi, Kenya). ISBN 9966-831-32-0.

1996. Kiswahili version of *Solar Cookbook*. *Kitabu cha Upishi Ukitumia Kawi ya Jua*. ISBN 9966-831-33-9.

1994 Kammen, D. M., Smith, K. R., Rambo, A. T. and Khalil, M. A. K (editors) Preindustrial Human Environmental Impacts: Are there Lessons for Global Change Science and Policy? *Chemosphere* (Pergamon Press: Oxford UK), **Vol. 29 (5)**, 317 pages.

JOURNAL PUBLICATIONS, BOOK CHAPTERS & ARTICLES

In preparation or review:

Kammen, D. M. and Karakezi, S. (2002) "The Power of Development: Energy Policies to Empower, Not Build Technological Imperialism", in preparation.

Chiu, W. A., Cox, L., Kammen, D. M. (2002) "A new model of one- and two-stage carcinogenesis and low-dose risk response", in preparation.

Hassenzahl, D. M., Goble, R. L., Kammen, D. M. and Hattis, D. B. (2002) "When can a risk assessment conclude that there is no risk?" *Risk Analysis*, in review.

Kammen, D. M. (2002) "Energy and Equity" in *The Encyclopedia of Energy*, C. Cleveland (ed.), (Academic Press, San Diego, CA).

Kammen, D. M. (2002) "A Taxonomy of Renewable Energy" in *The Encyclopedia of Energy*, C. Cleveland (ed.), (Academic Press, San Diego, CA).

Kammen, D. M. and Pacca, S., (2003) "The true costs of energy", *Annual Review of Energy and the Environment*, **28**.

NOTE: MOST OF THE ARTICLES LISTED BELOW ARE AVAILABLE IN PDF FORMAT FROM:
http://socrates.berkeley.edu/~rael/papers.html

FOR THE FOLLOWING ARTICLES IN PRINT: • = REFEREED PUBLICATION (85 OF 133 TOTAL)

2003

133. • Bailis, R., Ezzati, M., and Kammen, D. M. (2003) "Greenhouse Gas Emissions from Cooking Technologies in Kenya", *Environmental Science & Technology*, in press.

2002

132. • Hultman, N. E. and Kammen, D. M. (2002) "Equitable Carbon Revenue Distribution under an International Emissions Trading Regime", Conference Paper No. 5; Available at: http://www.umass.edu/peri/pdfs/CDP5.PDF

131. • Lipman, T. E. and Kammen, D. M. "Renewable Energy: Now a Realistic Challenge to Oil", in *The Future of Oil as a Source of Energy*, 87 – 107.

130. • Duke, R. D. and Kammen, D. M. (2002) "Energy for Development: Solar Home Systems in Africa and Global Carbon Emissions "*Climate Change for Africa: Science, Technology, Policy and Capacity Building*, Pak Sum Low, editor (Kluwer Academic Publishers), 250-266.

129. • Ezzati, M., and Kammen, D. M. (2002) "Health effects of biomass use for rural cooking in developing nations", *Indoor Air*, June, 2002.

128. • Bailis, R., Ezzati, M., and Kammen, D. M. (2002) "An Estimate of Greenhouse Gas Emissions from Common Kenyan Cookstoves Under Conditions of Actual Use", *Indoor Air*, June, 2002.

127. • Ezzati, M. and Kammen, D. M. (2001) "The Health Impacts of Exposure to Indoor Air Pollution from Solid Fuels in Developing Countries: Knowledge, Gaps, and Data Needs", *Environmental Health Perspectives*, **110 (11)**, 1 - 12.

126. • Kammen, D. M. (2002) "Innovation, Energy, and the Environment", in *Energy for Sustainable Development: Getting it Right*, Goldemberg, J. and Johansson, T. (eds.), United Nations Development Programme (New York, NY, USA).

125. • Ezzati, M. and Kammen, D. M. (2002) "Household Energy, Indoor Air Pollution and Public Health: Research and Policy Needs in Developing Countries", *Annual Review of Energy and the Environment*, **27**, 1 - 38.

124. Herzog, A. V. and Kammen, R. D. (2002) "Energy R&D investment challenge", *Materials Today*, May, 28 – 33.

123. Herzog, A. V., Lipman, T., Edwards, J. and Kammen, D. M. (2002) "U. S. Needs Renewable Energy Targets", *World Rivers Review*, **17 (1),** 9.
URL: http://www.irn.org

122. Kammen, D. M. (2002) "Time for a real energy policy", *Environmental Law News*, **10 (3)**, 13 – 16.
URL: http://www.calsb.org

121. • Ezzati, M. and Daniel M. Kammen (2001) "Evaluating the health benefits of transitions in household energy technologies in Kenya:", *Energy Policy,* **30**, 815 - 826

120. • Duke, Richard. D, Jacobson, Arne, and Daniel M. Kammen (2002) "Product quality in the Kenyan solar home industry", *Energy Policy,* **30 (6)**, 477-499.

2001

119. • Purvis, K. L., Jumba, I. O., Wandiga, S., Zhang, J. and Kammen, D. M. (2001) "Worker exposure and health risks from volatile organic compounds utilized in the paint manufacturing industry in Kenya", *Applied Occupational and Environmental Hygiene*, **16 (11)**, 1035 – 1042.

118. Kammen, D. M. (2001) "Spreading the word: Dissemination of photovoltaic systems in Kenya", in *Technology Without Borders: Case Studies of Successful Technology Transfer* (Climate Technology Initiative: United Nations Environment Program: OECD/IEA, Paris, France).

117. • Herzog, A. V., Lipman, T., Edwards, J. and Kammen, D. M. (2001) "Renewable Energy: A Viable Choice", *Environment*, **43 (10)**, 8 – 20.

116. Jacobson, D. and Kammen, D. M. (2001) "What the Governor could do to prevent the next energy crisis", *The San Francisco Chronicle*, Friday, September 28, page A25.

115. • Ezzati, M., Singer, B.H., and Kammen, D. M. (2001) "Towards an Integrated Framework for Development and Environmental Policy: The Dynamics of Environmental Kuznets Curves," *World Development*, **29 (8)**, 1421-1434.

114. Kammen, D. M. (2001) "Forum: Energy Policy", *Issues in Science and Technology*, Summer, 5.
URL http://bob.nap.edu/issues/17.4/forum.htm

113. Kammen, D. M. (2001) Testimony for the 'Hearing on the Role of Tax Incentives in Energy Policy' for the U. S. Senate Committee on Finance, July 11 (United States Senate: Committee on Finance).
URL http://www.senate.gov/~finance/071101dktest.pdf

112. Kammen, D. M. (2001) Testimony for the Hearing on 'Technology and Policy Options for Climate Change' for the U. S. Senate Committee on Commerce, Science, and Transportation, July 10 (United States Senate: Senate Committee on Commerce, Science, and Transportation).
URL http://www.senate.gov/~commerce/

111. Kammen, D. M. (2001) "Renewable energy and energy policies and the California Energy Crisis", in *Controller's Quarterly: Energy in California* (Office of Cathleen Connell, California State Controller), Summer, 19 – 21.
URL http://sco.ca.gov

110. • Kammen, D. M., Van Boskirk, S, and Nditu, M., (2001) "Solar oven construction manual", in *Field Guide to Appropriate Technology*, B. Hazeltine and C. Bull (eds) (Academic Press: San Diego, CA).

109. • Kammen, D. M. (2001) "Exposure to indoor air pollution from biofuel stoves in rural Kenya", in *Field Guide to Appropriate Technology*, B. Hazeltine and C. Bull (editors) (Academic Press: San Diego, CA).

108. • Dove, M. R. and Kammen, D. M. (2001) "Vernacular models of development: Analysis of Indonesia under the 'New Order', *World Development*, **29 (4)**, 619 – 639.

• "Amorphous Silicon PV Panels: Are They a Good Value for the Money?" (2001) Jacobson, A., Duke, R. D. and Kammen, D. M. *African Technology Forum*, April.
URL http://home.att.net/~africantech/solar/amorphous/amorphous1.htm

106. • Margolis, R. M. and Kammen, D. M. (2001) "Energy R&D and Innovation: Challenges and Opportunities" in Schneider, S, A Rosencranz, and J. Niles, editors *A Reader in Climate Change Policy* (Island Press: Washington, DC).

105. • Ezzati, M. and Kammen, D. (2000) "Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: An Exposure-response study", *The Lancet*, **358**, 619 – 624.

104. Kammen, D. M. (2001) "Research, development and commercialization of the Kenya Ceramic Jiko" in Dorf. R. C. (ed.) *Technology, Humans and Society: Toward a Sustainable World* (Academic Press: San Diego, CA), pages 310 – 321.

103. Baer, P., Harte, J., Herzog, A., Holdren, J., Hultman, N., Kammen, D. M., Kresch, B., Norgaard, R., and Raymond, L. (2001) "Atmospheric equity: Response to Westing", *Science* **291**, 827-828.

102. • Ezzati, M. and Kammen, D. M. (2001) "Quantifying the effects of exposure to indoor air pollution from biomass combustion on Acute Respiratory Infections in developing countries", *Environmental Health Perspectives*, **109 (5)**, 481 – 489.

2000

101. Baer, P., Harte, J., Herzog, A., Holdren, J., Hultman, N., Kammen, D. M., Kresch, B., Norgaard, R., and Raymond, L., "Emission Rights and Climate Change," *Earth Affairs*, Columbia Earthscape,
URL https://wwwc.cc.columbia.edu/sec/dlc/earthscape/ea1frame.html.

100. • Baer, P., Harte, J., Herzog, A., Holdren, J., Hultman, N., Kammen, D. M., Kresch, B., Norgaard, R., and Raymond, L. (2000) "Equal per capita emission rights: the key to a viable climate change policy", *Science* **289**, 2287.

99. • Kammen, D. M. (2000) "Case Study #1: Research, development, and commercialization of the Kenya Ceramic Jiko (KCJ)", in *Methodological and Technological Issues in Technology Transfer* (Cambridge University Press: New York, Cambridge UK and New York, NY), 383 – 384.

98. • Kammen, D. M. (2000) "Case Study #5: The Commercial Dissemination of Photovoltaic Systems in Kenya", in *Methodological and Technological Issues in*

Technology Transfer (Cambridge University Press: New York, Cambridge UK and New York, NY), 391 – 392.

97. Duke, R., Jacobson, A., Hankins, M. and Kammen, D. M. (2000) "Field Assessment of the Performance of Amorphous Silicon Solar Modules Sold Commercially in Kenya", *Boiling Point*, **45**, in press.

96. Jacobson, A., Duke, R.D., and Kammen, D.M., (2000) "Amorphous Silicon PV Panels: Are They a Good Value for the Money?", *Solarnet*, **2 (2)**, 7 – 14.

95. • Haines, A. and Kammen, D. M. (2000) "Renewable energy systems and public health", *Global Change and Human Health*, **1**, 78 – 87.

94. • Masera, O., Saatkamp, B. D., and Kammen, D. M. (2000) "From fuel switching to multiple cooking fuels: A critique of the energy ladder model in rural households", *World Development*, **28 (12)**, 2083 - 2103.

93. • Ezzati, M., Saleh, H., and Kammen, D. M. (2000) "The contributions of emissions and spatial microenvironments to exposure to air pollution from biomass combustion in Kenya", *Environmental Health Perspectives*, **108**, 1 – 7.

92. • Saatkamp, B. D., Masera, O., and Kammen, D. M. (2000) "Energy and health transitions in development science and planning: Fuel use, stove technology, and morbidity in Jarácuaro, México," *Energy for Sustainable Development*, **4 (2)**, 5 – 14.

91. Duke, R. D. and Kammen, D. M. (2000) "PV Market Transformation: The virtuous circle between experience and demand and the strategic advantage of targeting thin-film photovoltaics", workshop proceedings of the *IEA Workshop "Experience Curves for Policy Making: The Case of Energy Technologies*, Stuttgart, 10-11 May, 1999 (IEA Volume), 77 – 100.

90. • Jacobson, A., Duke, R. D., Kammen, D. M.; Hankins, M. (2000) "Field Performance Measurements of Amorphous Silicon Photovoltaic Modules in Kenya", in Conference Proceedings of the American Solar Energy Society (ASES), Madison, Wisconsin, June 16-21.

89. • Ezzati, M., Mbinda, B. M., and Kammen, D. M. (2000) "Comparison of emissions and residential exposure from traditional and improved cookstoves in Kenya", *Environmental Science & Technology (ES&T)*, **34 (2)**, 578-583.

88. Jacobson, A., Duke, R. D., Hankins, M., Kammen (2000) "Measuring the performance of photovoltaic modules in the field: A case study of amorphous silicon photovoltaic modules in Kenya", *World Renewable Energy Congress – IV.*

87. Jacobson, A., Duke, R. D., Graham, S., Hankins, M., Kammen, D. M., Osawa, B., Pulver, S., and Walther, E. (2000) "Evaluating the field performance of amorphous silicon (a-Si) photovoltaic systems in Kenya", *World Renewable Energy Congress – IV.*

1999

86. Ezzati, M., Kammen, D. M., and Mbinda, B. M. (1999) "Field research programme on energy technology, health, and the environment", *Boiling Point*, **43,** 33 – 34.

85. Kammen, D. M. (1999) "Wind and sun power for Kenya", *Regional Energy News*, **5 (1/2)**, 8 – 10.

84. Margolis, R. and Kammen, D. M. (1999) "Energy R&D and innovation: Challenges and opportunities", Proceedings of the *National Institute for Global Environmental Change* conference, "Energy Generation and Environmental Planning" 19 – 21 April, 1999, Sacramento, California.

83. Kammen, D. M. (1999) Review of *From Space to Earth: The Story of Photovolaic Electricity*, by John Perlin (Aatec Press: Ann Arbor, MI), *Whole Earth*, Winter, 47.

82. • Hibbert, R. Bai, Z., Navia, J., Kammen, D. M., Zhang, J. (1999) "High lead exposures resulting from pottery production in a village in Michoacan State, Mexico", *J. Exposure Analysis and Environmental Epidemiology*, **9**, 343 – 351.

81. • Kammen, D. M. and Margolis, R. M. (1999) "The R&D Corner: Under-investment: The energy technology and R&D policy challenge", *Deregulation Weekly,* **2 (15)**, 8 - 11. WWW: http://socrates.berkeley.edu/~rael/dw_news_8_15_99.pdf

80. • Kammen, D. M., M. Ezzati, M. and Mbinda, B. M. (1999) "The Determinants of Exposure to Indoor Air Pollution from Biofuel Stoves," *The Proceeding of Indoor Air 99: The 8th International Conference on Indoor Air Quality and Climate, Edinburgh, Scotland*, **3**, 171 - 176.

79. • M. Ezzati, Kammen, D. M., and Singer, B. H. (1999) "The health impacts of exposure to indoor air pollution from biofuel stoves in rural Kenya", *The Proceeding of Indoor Air 99: The 8th International Conference on Indoor Air Quality and Climate, Edinburgh, Scotland*, **3**, 130 - 135.

78. Kammen, D. M. (1999) "Bringing power to the people: Promoting appropriate energy technologies in the developing world", *Environment*, **41 (5)**, 10 – 15, 34 - 41.

77. • Duke, R. D., and Kammen, D. M. (1999) "The economics of energy market transformation initiatives", *The Energy Journal*, **20 (4)**, 15 – 64. WWW: http://socrates.berkeley.edu/~kammen/dukekammen.pdf

76. • Kammen, D. M. and Margolis, R. (1999) "Evidence of under-investment in energy R&D in the United States and the impact of Federal policy", *Energy Policy*, **27 (10)**, 575-584. WWW: http://www.energyinfo.net/cgi-bin/headway/X/pass/JRNL/V00027N010/99000531.pdf

75. • Margolis, R. and Kammen, D. M. (1999) "Underinvestment: The energy technology and R&D policy challenge", *Science,* **285**, 690 - 692.
WWW: http://socrates.berkeley.edu/~rael/Margolis&Kammen-Science-R&D.pdf

74. • Ezzati, M., Singer, B. and Kammen, D. (1999) "Towards an integrated framework for development policy: The dynamics of environmental Kuznets curves", Princeton University, Center for Energy and Environmental Studies Report PU/CEES No. 315.

73. Kammen, D. M. and Hassenzahl, D. (1999) "Cancer clusters" *Star-Ledger*, Friday, March 5, p. IX.

72. • Hibbert, R., Bai, Z., Navia, J., Kammen' D. M., and Zhang, J. (1999) "High lead exposures resulting from pottery production in a village in Michoacan State, Mexico", *J Exposure Analysis and Environmental Epidemiology*, **9**, 343 – 351.

71. • Chiu, W. A., Hassenzahl, D. M., and Kammen, D. M. (1999) "A comparison of regulatory implications of traditional and exact two-stage dose-response models", *Risk Analysis*, **19 (1)**, 15 – 22.

1998

70. • Dong, F., Lew, D., Li, P., Kammen, D. M., and Wilson, R. (1998) "Strategic options for reducing CO_2 in China: Improving energy efficiency and Using Alternatives to fossil fuels" in *Energizing China: Reconciling Environmental Protection and Economic Growth*, Eds. M. B. McElroy, C. P. Nielsen, & P. Leiden, (Cambridge, MA: Harvard University Press), 119 – 166.

69. Kammen, D. M. and Kinzig, A. P. (1998) "Energy Research and Development to Meet the Short and Long-Term Challenges of Climate Change", *Energy and Resources Group Newsletter* (University of California, Berkeley), Fall, 1 – 2.
WWW: *http://socrates.berkeley.edu/~erg/Pages/newsfall98.html#anchor4111*

68. Kammen, D. M. and Kinzig, A. P. (1998) "Aiming for equity: Investing in climate insurance and development", *Tiempo: Global Warming and the Third World*, **29**, 2 – 12.
WWW: http://www.cru.uea.ac.uk/tiempo/floor0/recent/issue29/t29a1.htm

67. • Kammen, D. M., Goble, R. L., and Hattis, D. B. (1998) "Can risk assessments conclude that there is no risk?" *Society for Risk Analysis,* Proceedings Annual Meeting, 6 - 9 December (Phoenix, Arizona).

66. • Kinzig, A. P. and Kammen, D. M. (1998) "National trajectories of carbon emissions: Analysis of proposals to foster the transition to low-carbon economies", *Global Environmental Change*, **8 (3)**, 183 - 208.

65. Saatkamp, B. D., Masera, O., and Kammen, D. M. (1998) "Social versus technical visions of the energy ladder: Fuels, stoves, and indoor air pollution in Jarácuaro, México,"*Boiling Point*, **40**, 16 - 18.

64. Kammen, D. M. (1998) "Power to the people", a review of *Rural and Renewable Energy: Perspectives from Developing Countries*, edited by Venkata Ramana P. (Tata Energy Research Institute: New Delhi, India, 1997, viii + 317 pages), *Environment*, **40 (5)**, 26 - 27.

1997

63. • Kammen, D. M. and Dove, M. R. (1997) "The virtues of Mundane Science", *Environment.* **39 (6)**, 10 - 15, 38 - 41.

62. • Dove, M. R. and Kammen, D. M. (1997) "The epistemology of sustainable resource use: Managing forest products, swiddens, and high-yielding variety crops," *Human Organization*, **56 (1)**, 91 - 101.

61. • Kammen, D. M. and Ezzati, M. (1997) "Gender and innovation in rural health, energy, and resource management: Integrating issues and techniques in Laikipia, Kenya", Proccedings of the *Technology and Development: Strategies for the Integration of Gender* Conference, TOOL/TOOLConsult, Amsterdam, June 5 - 6, 1997.

60. Margolis, R., Faber, J. S. and Kammen, D. M. (1997) "Solar decisions: developing PV markets in Kenya vs. South Africa," *Sustainable Energy News*, **No. 16**, 15 - 17.

1996

59. Hassenzahl, D., Muller-Landau, H., and Kammen, D. M. (1996) "The facts about recycling: the garbage *does* add up," *The Daily Princetonian*, October 1 (Tuesday), page 10; also published as, "Don't give up on recycling," *The Trenton Times*, November 3, (Sunday) editorial page CC2, (focus article for *Public Forum* recycling and incineration debate, *http://www.nj.com/mercer*).

58. Kammen, D. M. (1996) "A personal introduction to opportunities and resources for research and activism in energy and environmental science & policy", *Physics and Society*, **25**, insert.
WWW: *http://www.wws.princeton.edu/faculty/kammenpapers/energy-jobs.html.*

57.• Acker, R. and Kammen, D. M. (1996) "The quiet (Energy) revolution: the diffusion of photovoltaic power systems in Kenya," *Energy Policy*, **24**, 81 - 111.
WWW: http://socrates.berkeley.edu/~kammen/Kammen-PV-EPolicy.pdf

56. • Gordon, D. A. and Kammen, D. M. (1996) "Uncertainty and overconfidence in time series forecasts: application to the Standard & Poor's 500 stock index," *Applied Financial Economics*, **6 (3)**, 189 - 198. [Paper awarded the Bronze Medal in Forecasting by the *Chicago Quantitative Alliance* (1995 Academic Competition), and reproduced in the *CQA* Journal].

55. Kammen, D. M. (1996) Review of *Forest resources and wood-based biomass energy as rural development assets* (edited by W. R. Bentley and M. M. Gowan), *Society & Natural Resources,* **9 (4)**, 431 - 433.

54. Kammen, D. M. (1996) "Household power in a new light: Policy Lessons, and Questions, for Photovoltaic Technology in Africa", *Tiempo: Global Warming and the Third World*, **20**, 1 - 8.
WWW: http://socrates.berkeley.edu/~rael/tiempo.htm

1995

53. Kammen, D. M. (1995) "Cookstoves for the developing world," *Scientific American*, **273**, 72 - 75. Translations: Arabic; French; German; Italian; Japanese; Portuguese. http://www.wws.princeton.edu:80/programs/stpp.articles/cookstoves.html

52. • Smalera, A. and Kammen, D. M. (1995) "Design and field testing of a Savonius windpump in Kenya," *Windpower '95* (American Wind Energy Association: Washington, D. C.), 525 - 534.

51. Nditu, M., Osawa, B., Kithome, J. and Kammen, D. M. (1995) "Community energy management: the 'Sun and Wind Power' project in East Africa", paper presented at the *Second Annual Kenya Solar Oven Conference, Kakamega, Kenya,* September 22 - 24.

50. • Kammen, D. M. (1995) "From energy efficiency to social utility: Improved cookstoves and the *Small is Beautiful* Model of development," in *Energy as an instrument for socio-economic development*, Goldemberg, J. and Johansson, T. B. (eds.) (United Nations Development Programme: New York), 50 - 62.

1994

49. • Kammen, D. M., Shlyakhter, A. I., Broido, C. and Wilson, R. (1994) "Quantifying credibility of energy projections from trends in past data: the U. S. energy sector," *Energy Policy*, **22**, 119 - 131.

48. Kammen, D. M. (1994) "Cooking can kill: An update on extreme smoke exposure from traditional cooking fuels," *African Technology Forum*, **7 (1)** , 29 - 32.

47. • Kammen, D. M., Smith, K. R., Rambo, A. T. and Khalil, M. A. K. (1994) "Pre-industrial human environmental impacts: are there lessons for global change science and policy?" *Chemosphere*, **29**, 827 - 833.

56. • Kammen, D. M. (1994) "Industrial and non-industrial anthropogenic inputs to the global biogeochemical cycles: implications for intertemporal environmental policy," *Chemosphere*, **29**, 1121 - 1133.

45. Kammen, D. M. (1994) "Linking health and energy development policy: reducing indoor air pollution and promoting renewable energy technologies," in *Developments in solar*

cookers: Proceesings of the Second Woeld Conference on Solar Cookers: Use and Technology, Nandwani, S., Pejack, E. R., and Blum, B. L. (eds), (Universidad Nacional: Heredia, Costa Rica), 338 – 344.

44. Kammen, D. M., Van Boskirk, S., and Nditu, M. (1994) "Solar oven construction manual," *African Technology Forum*, **7(3)**, 21 - 27.

43. • Kammen, D. M. (1994) "Reducing greenhouse gas emissions and improving environmental health in developing nations," *Boiling Point*, **34**, 18 - 25.

42. • Kammen, D. M., Shlyakhter, A. I., and Wilson, R. (1994) "What is the risk of the impossible?" *J. Franklin Institute*, **331A**, 97 - 116.

1993

41. • Kammen, D. M. and Marino, B. D. (1993) "On the origin and magnitude of pre-industrial CO_2 and CH_4 emissions," *Chemosphere*, **26**, 69 - 86.

40. • England, S. B. and Kammen, D. M. (1993) "Energy resources and development in Vietnam," *Annual Review Energy & Environment*, **18**, 137 - 167.

39. • Kammen, D. M., Shlyakhter, A. I., Broido, C. L. and Wilson, R. (1993) "Non-Gaussian uncertainty distributions: historical trends and forecasts of the United States Energy sector, 1983 - 2010," Proceedings of the Second International Symposium on Uncertainty Modeling and Analysis, *IEEE Computer Society Press*, 112 - 119.

38. • Shlyakhter, A. I. and Kammen, D. M. (1993) "Uncertainties in modeling low probability/high consequence events: application to population projections and models of sea-level rise," Proceedings of the Second International Symposium on Uncertainty Modeling and Analysis, *IEEE Computer Society Press*, 246 - 253.

37. • Kammen, D. M. (1993) "Reducing greenhouse gas emissions and improving environmental health in developing nations: a program for energy management, cooking technology and education," *Nikkei Science*, **260 (5)**, S6 - S19 [Japanese language version of *Scientific American*], and *Global Industrial and Social Progress Research Institute Quarterly* (in English).

36. • Kammen, D. M. (1993) *The role of alternative energy systems in global change and environmental health: from case studies to a paradigm for development*, Princeton University Center for Energy and Environmental Studies Report, **PU/CEES 280**.

35. Kammen, D. M. and Wilson, R. (1993) "The science and policy of risk," *Science*, **260**, 1863.

34. Tunbridge, L. and Kammen, D. M. (1993) "Solar ovens and deforestation in Kenya" *Living on Earth: National Public Radio*, **No. 129**, Originally aired: September 17, 1993.

33. • Lancaster, J. *et al.* (1993) *Developing methodology and tools for integrated assessment of the risks of global environmental change: Analyzing uncertainty, risk assessment, risk perception, expert judgement, and a case study on sea level rise* (Report of the Northeast Regional Center of the National Institute of Global Environmental Change: NE NIGEC).

1992

32. Kammen, D. M. (1992) "The Kenya solar box: Appropriate technology dissemination in Africa," *African Technology Forum*, **5 (1)**, 12 - 13.

31. Kammen, D. M. (1992) "Participatory rural appraisal: environmental resource accounting and management," *African Technology Forum*, **5 (2)**, 22 - 24.

30. • Kammen, D. M. (1992) "Energy resources and renewable energy technology: solar ovens and windmills in Kenya," *American Society of Mechanical Engineers: ECO World '92*, 75.

29. Shlyakhter, A. and Kammen, D. M. (1992) "Sea level rise or fall?" *Nature*, **357**, 25.

28. Kammen, D. M. and Fayemi Kammen, B. (1992) "Energy, food preparation and health in Africa: The roles of technology, education, and resource management," *African Technology Forum*, **6 (1)**, 11 - 14.

27. • Kammen, D. M., Niebur, E. and Schuster, H. G. (1992) "Systems of relaxation oscillators with time-delayed coupling," in: *Complex Dynamics in Networks*, J. G. Taylor, E. R. Cainiello, R. M. J. Cotterill and J. W. Clark (eds.), (Springer-Verlag: Berlin), 226 - 233.

1991

26. Kammen, D. M. and Lankford, W. F. (1991) "Designing better solar cookers," *Nature*, **351**, 21.

25. England, S. B. and Kammen, D. M. (1991) "Renewable energy and disaster relief/development: a critic of the dominant paradigm," *Nature*, **352**, 752.

24. • Niebur, E., Schuster, H. G. and Kammen, D. M. (1991) "Collective frequencies and metastability in networks of limit cycle oscillators with time delay", *Physical Review Letters*, **67**, 2753 - 2756.

23. Kammen, D. M. (1991) "Technology for development: sustaining, not obliterating, the environment," *National Geographic Research & Exploration*, **7**, 3 - 5.

22. • Niebur, E., Schuster, H. G., Kammen, D. M., and Koch, C. (1991) "Oscillator phase coupling for different two-dimensional network connectivities," *Physical Review A*, **44**, 6895 - 6904.

21. • Niebur, E., Kammen, D. M., Koch, C., Ruderman, D. and Schuster, H. G. (1991) "Phase coupling in two-dimensional networks of interacting oscillators," in: D. S. Touretzky (ed.), *Advances in Natural Information Processing Systems,* **3**, (Morgan Kaufman Inc.: San Mateo, CA), 124 - 132.

20. • Softky, W. R. and Kammen, D. M. (1991) "Correlations in high dimensional or asymmetric data: Hebbian neuronal processing," *Neural Networks*, **4**, 337 - 347.

19. Niebur, E., Kammen, D. M. and Koch, C. (1991) "Phase locking in 1-D and 2-D networks of oscillating neurons," in: *Nonlinear Dynamics and Neuronal Networks*, W. Singer and H. Schuster (eds.), (VCH Verlag: Weinheim, Germany), 173 - 204.

18. • Kammen, D. M. and Yuille, A. (1991) "Self-organization in development and biological computing," *Advances in Control Networks and Large Scale Parallel Distributed Processing Models*, M. D. Fraser (ed.) (Ablex Publishing: Norwood, NJ), 1 - 57.

1990

17. Kammen, D. M. and Lankford, W. F. (1990) "Cooking in the sunshine," *Nature*, **348**, 385 - 386.

16. Kammen, D. M. and Kammen, D. A. (1990) "Borneo by boat: a jungle crossing," *Harvard Magazine*, November/December, 34 - 41.

15. • Kammen, D. M., Holmes, P. J. and Koch, C. (1990) "The dynamics of oscillatory neuronal populations," in D. S. Touretzky (ed.) *Advances in Neural Network Information Processing Systems*, **2**, (Morgan Kaufman Inc.; San Mateo, CA), 76 - 83.

14. • Softky, W. and Kammen, D. M. (1990) "Hebbian Learning in a Structured Environment," in D. S. Touretzky (ed.) *Advances in Neural Network Information Processing Systems*, **2**, (Morgan Kaufman Inc.; San Mateo, CA), 125 - 132.

13. Kammen, D. M., Holmes, P. J. and Koch, C. (1990) "Collective Oscillations in Neuronal networks: Functional Architecture Drives the Dynamics," *Neural Networks Supplement*, I-181 - I-184.

12. Wörgötter, F., Kammen, D. M. and Brandt, B. (1990) "Temporal Dynamics in Neuronal Microcircuitry", in *Parallel Processing in Neural Systems and Computers*, R. Eckmiller, G. Hartmann and G. Hasuke (eds.) (Elsevier Science Publishers: North Holland), 147 - 151.

11. • Kammen, D. M. and Lankford, W. F. (1990) "Comparative study of box-type solar cookers in Nicaragua," *Solar & Wind Technology*, **7**, 463 - 472.

1989

10. Kammen, D. M., Holmes, P. J. and Koch, C. (1989) "Cortical architecture and oscillations in neuronal networks: feedback versus local coupling," in: *Models of Brain Function*, R. M. J. Cotterrill (ed.) (Cambridge University Press: Cambridge) 273 - 284.

9. • Yuille, A. L. and Kammen, D. M. (1989) "Models for the development of the visual cortex", in *The Computing Neuron*, R. Durbin, C. Miall and G. Mitcheson, (eds.) (Addison-Wesley Publishers Ltd.: New York) 393 - 410.

8. Kammen, D. M. (1988) *Self-Organization in Neural Networks*, Ph.D. Thesis, Harvard University (University Microfilms: Ann Arbor, MI).

1988

7. • Kammen, D. M. and Yuille, A. L. (1988) "Spontaneous symmetry-breaking energy functions and the emergence of orientation selective cortical cells," *Biological Cybernetics*, **59**, 23 - 31.

6. • Yuille, A. L., Kammen, D. M. and Cohen, D. (1988) "Quadrature and the development of orientation selective cortical cells by Hebb rules," *Biological Cybernetics*, **61**, 183 - 194.

5. Yuille, A. L. and Kammen, D. M. (1988) "Spontaneous symmetry-breaking energy functions, orientation selective cortical cells, and hypercolumnar cell assemblies," *Neural Networks Supplement*, **1**, 153.

1987

4. • Kammen, D. M., Gosnell, T. R., Tkach, R. W. and Sievers, A. J. (1987) "Vibrational relaxation dynamics of matrix-isolated $BH_2D_2^-$," *J. Chem. Physics*, **87**, 4371 - 4375.

3. • Daugman, J. G. and Kammen, D. M. (1987) "Image statistics, gasses, and visual neural primitives," *Proceedings of the IEEE First Annual International Conference on Neural Networks*, IV-163 -- IV-175.

1986

2. • Daugman, J. G. and Kammen, D. M. (1986) "Pure orientation filtering: A scale-invariant image-processing tool for perception research and data compression," *Behavior Research Methods, Instruments & Computers*, **18**, 559 - 564.

1985

1. • Duffey, T. P., Kammen, D. M., Schawlow, A. L., Svanberg, S., Xia, H. R., Xiao, G. G., and Yan, G. Y. (1985) "Laser spectroscopy using beam-overlap modulation," *Optics Letters*, **10**, 597 - 599.

REPORTS

9. Bradford, P., Casten, T. R., Davis, J. M., DeCanio, S. J., Detchon, R., Gibbons, J. H., Gilinsky, V., Kammen, D. M., Kelly, H., Lovins, A. B., McKinney-James, R., Ming, C. M., Nitze, W. A., Riggs, J. A., Simon, G. D., Smart, B., Sweeney, J. L., Thomas, C. E., and White, B. (2002) National Energy Policy Initiative, Expert Group Report.

8. • Kammen, D. M., Bailis, R., and Herzog, A.V. (2001) "Clean Energy for Development and Economic Growth: Biomass and Other Renewable Energy Options to Meet Energy and Development Needs in Poor Nations," UNDP report for the 7th Conference of the Parties to the UN Framework Convention on Climate Change (COP7-UNFCCC): Marakech, Morocco (October 29 - November 9),
WWW: http://socrates.berkeley.edu/~rael/RAEL_UNDP_Biomass_CDM.pdf

7. Ahearne, J., Bennett, R., Budnitz, R., Kammen, D. M., Taylor, J., Todreas, N., and Wolfe, B. (2001) *Nuclear Energy: Present Technology, Safety, And Future Research Directions*, Panel on Public Affairs (POPA): American Physical Society.

6. • Duke, R. D., Graham, S., Hankins, M., Jacobson, A., Kammen, D. M., Khisa , D., Kithokoi, D., Ochieng, F., Osawa, B., Pulver, S. and Walther. E. (2000) *Field Performance Evaluation of Amorphous Silicon (a-Si) Photovoltaic Systems in Kenya: Methods and Measurements in Support of a Sustainable Commercial Solar Energy Industry*, Report of Energy Alternatives Africa (EAA) & Renewable Appropriate Energy Laboratory (RAEL) and the Energy and Resources Group (ERG), University of California, Berkeley. 73 pages + 21 tables + 40 figures.

5. • Kammen, D. M. (1999) *Building Institutional Capacity for Small-Scale and Decentralized Energy Research, Development, Demonstration, and Deployment (ERD3) in the South,* Commissioned Paper for the President's Committee of Advisors on Science and Technology (PCAST) Panel on: US Government Roles in International Cooperation on Energy Research, Development, Demonstration, and Deployment (ERD3) (Office of Science and Technology Policy: Executive Office of the President, 32 pp.

4. • Kammen, D. M., Wahhaj, and Yiadom, M. A. (1999) *Broad-Search Annotated Bibliography on Acute Respiratory Infections (ARI) and Indoor Air Pollution With an Emphasis on Children Under Five in Developing Countries* (Washington, DC: Environmental Health Project, US AID), 165 pp.
WWW: http://www.crosslink.net/~ehp/aribib2.htm

3. • Kammen, D. M. (1997) *Energy, Environment & Development Program (EEDP) of the Stockholm Environmental Institute* Swedish International Development Cooperation Agency (Sida) **Evaluation 97/37**, Department for Research Cooperation, SAREC (79 pp. + 4 appendices). Prepared for SIDA, Stockholm, Sweden (ISBN 91 586 7568 X).

2. Kammen, D. M. (1995) *Evaluation of the Environmental Quality Program in Jiangsu, China for the China and Mongolia Division, The World Bank* (29 pp + 4 appendices). Prepared for China and Mongolia Division, The World Bank, Washington DC.

1. • Shlyakhter, A. I. and Kammen, D. M. (1992) "The probability of extreme events: the effect of systematic uncertainties in energy and population forecasts," *Center for Science and International Affairs, Discussion Paper 92-06*, (J. F. Kennedy School of Government, Harvard University: 25 pp + 5 figures).

MULTIMEDIA, VIDEO, & AUDIO

6. "There goes the sun: Will we squander our clean-energy future" (2000) D. M. Kammen interview in *World Rivers Review,* **June,** 8 – 9, 14 – 15.

5. "Investing in future energy sources" (2000) D. M. Kammen interview in *Environmental Review*, **7 (3)**, 8 – 14.
http://www.igc.apc.org/envreview.

4. *Green Means*, Season #4, "Kenya Solar", PBS KQED-TV (San Francisco, CA) Available as streaming video: http://gm.kqed.org/4/14/

3. Press Release (April 9, 2000) *Study finds that small size a-Si modules perform well in field*
http://socrates.berkeley.edu/~rael/outreach.html

2. *Green Mean #213*, "Solar Ovens", PBS KQED-TV (San Francisco, CA)
http://www.kqed.org/tv/productions/greenmeans/gm2descriptions.html

1. Tunbridge, L. and Kammen, D. M. (1993) "Solar ovens and deforestation in Kenya" *Living on Earth: National Public Radio*, **No. 129**, Originally aired: September 17, 1993.

INVITED TALKS AND PRESENTATIONS (listing of past three years only)

2003 • "Emerging clean energy markets", Institute for International Studies, Stanford University, January 30.

2002 • Ezzati, M. and D. M. Kammen (2002) "Indoor Air Pollution from Biomass Combustion as a Risk Factor for Acute Respiratory Infections in Kenya" The Proceedings of Indoor Air 2002: the 9th International Conference on Indoor Air Quality and Climate; Monterey, CA, July 2002, 4, 970-975

• Bailis, R., M. Ezzati and D. M. Kammen (2002) "An Estimate of Greenhouse Gas Emissions from Common Kenyan Cookstoves under Conditions of Actual Use" The

Proceedings of Indoor Air 2002: the 9th International Conference on Indoor Air Quality and Climate; Monterey, CA, July 2002, 2, 225-230

2001 • 'Energy and Development', Yale University School of Forestry and the Environment (1/20/01)
• 'Re-defining development', J. F. Kennedy School of Government, Harvard University (4/16/01)
• Hearing Testimony, U. S. Senate Committee on Commerce, Science and Transportation (7/10/01)
• Hearing Testimony, U. S. Senate Committee on Finance (7/11/01)
• Hearing Testimony, U. S. Senate Committee on Commerce, Science and Transportation
• 'Energy R&D and Innovation', CALPIRG Economists Summit on Energy, State Capital, Sacramento, CA (9/5/01).

2000 • UNDP/World Bank Experts Meeting on Making a Difference in Emerging Photovoltaics • Markets, Marrakech, Morocco (9/25-28/00).
• Energy Options for Development, Addis Ababa University, Ethiopia (6/28/00)
• New Challenges in Tropical Medicine, Oxford, UK (9/20/00)
• Human Dimensions of Climate Change Meeting, Carnegie Mellon University (7/19/00)
• Health Impacts of Indoor Air Pollution and Household Energy Use in Developing Countries, Washington, DC (5/3-4/00)

1999 • International Energy Division, Lawrence Berkeley Laboratory
• Center for International Studies, Stanford University
• Stanford Linear Accelerator Center (SLAC)
• Department of Engineering and Public Policy, Carnegie Mellon University
• The World Bank, Washington, DC
• Columbia University: School of Engineering
• Tata Energy Research Institute, New Delhi, India
• Energy and Resources Group, University of California, Berkeley

Updated: 2-2-2003

Report of Michael Bernay

Qualifications

My name is Michael Bernay and my business address is 3101 W. Coast Hwy; Newport Beach, CA 92663. I am the Executive Vice President of WorldLink Specialty Insurance Services. We are an insurance broker specializing in the design, development and management of insurance programs for various industries including wind power projects. I have responsibilities for the day-to-day operations of our programs. Our largest single program based on premium volume is WindPro, which is designed specifically for developers, contractors, owners, operators and manufacturers of wind power projects and the wind industry. Exhibit A is a résumé of my educational background, expertise and employment experience.

I have been involved with the placement of insurance of wind power projects since 1985. WindPro is presently the largest single Insurance Facility in the world offering coverage to wind power projects. WindPro presently insures more than 8000 MW of wind energy for a total of more than 20,000 wind turbines. We presently insure wind turbines in 20 countries around the world including the United States, where we insure wind projects in 25 different states. We presently insure approximately 60% of the 3rd party insured wind power projects in the US

Please describe the.

Wind power projects that our firm has been less successful in insuring are those owned by major energy and utility corporations. Often times these companies carry large self insured deductibles or are involved in corporate captives, which include a wide variety of energy assets. In these cases wind assets tend to make up a smaller portion of the portfolio. For these accounts, we often still provide insurance during the construction phase and can be involved the operating phase if the owner elects to segregate the wind turbines and insure the wind assets separately.

History of the Technological Improvements in Wind Turbines

I have observed significant technological improvements in wind turbines during my career.

It is common to refer to the wind industry as having experienced, at least, 5 generations of technology here in the US. The "First Generation" was the Early to Mid- 1980. Projects used smaller machines (25-45 kW rating) that were not very dependable by today's standards. The "Second Generation" was the mid to late 1980's. The machines became a bit larger (65 to 120 kW in rating), but the technology was still less reliable than today's technology. Many of the Second Generation turbines were retrofitted with more reliable operating systems and components and some were retrofitted with slightly taller towers to improve energy capture.

The "Third Generation" of turbines started arriving in the US in the early 1990's with increasingly larger machines with nameplate ratings of a few hundred kilowatts (200-300 kW) and up. Although the Third Generation machines were more expensive, they generated significantly more energy and revenues on a per KW basis than any of the earlier generations. With this third generation of larger, more reliable and costly machines, far more time and money were spent improving on overall project maintenance and safety programs, as the value of their assets increased and represented significant investments.

The "Fourth Generation" of turbines began arriving in the US in 1994. The nameplate capacity of the turbines continued to increase to the half or ¾ MW range (500-750 kW). Improvements in turbine design were significant with more sophisticated and powerful microprocessor based control systems, more rugged blade and drive train construction, and improved blade aerodynamics. The size of an average wind power project increased and developers and owners started to use more conventional financing structures that were formerly not possible with the earlier, smaller turbines and smaller project capital investments.

The 'Fifth Generation" of wind turbines started arriving in the US in 1999–2000 and are commonly called "Megawatt Class" turbines. Projects started using turbines with ratings of 1 MW (1,000 kW) and above. The introduction of these larger, more efficient and highly reliable machines resulted in significant energy production cost savings and wind energy started to reach 3 to 4 cents per kWh range in regions with an adequate wind resource. Manufacturing and design improvements to the blades, towers, lightning protection systems, gearboxes, drive trains, etc. resulted in manufacturers providing availability and performance guarantees exceeding 95% for their equipment.

Certification of Wind Turbines and Its Importance to the Industry.

Independent, third party certification is very important to the insurance industry. We require that an independent third party specializing in turbine design and efficiency certify all turbines in order to qualify for our insurance programs. Having a third party certification means that a turbine has been scrutinized according to a set of industry standards, typically IEC (International Electrotechnical Commission) and other safety, quality and design codes to ensure that it complies in the way that is was engineered, designed, tested, manufactured, installed and operated.

It is important to know what is meant by "certification". Certification is like a stamp of approval. An independent third party reviewing group or certifying agency issues the certificate. The certification process for wind turbines is rigorous and includes scrutiny of many aspects of the wind turbine including its design, engineering analysis, review of compliance with safety codes and standards, testing verifications for noise, and performance, manufacturing, and commissioning and operations procedures to mention a few. Certification provides assurances that the turbine is made according to specification, complies with well-proven codes and standards and will continue to operate safely and efficiently for years to come.

The most established and experienced third party certifying groups for wind turbines are Germanisher Lloyd of Germany, RISØ of Denmark and Det Norske Veritas of Norway. These groups have expertise in the design, engineering, manufacturing, testing and safety compliance regarding large equipment. Underwriters Laboratories (UL) in the USA has just started to offer their certification for turbines; however, they presently have far less experience than their European counterparts.

Types of Liabilities Covered

Our firm provides coverage for first party claims and third party liabilities. There have been only two third party claims that have been processed and paid since we have been in business. These third party claims were made by landowners and were related to brush fires. The cause of first fire was a discarded cigarette and the second resulted from some field welding.

The majority of other claims are those for lost revenues or business interruption made by the owners of wind projects, or first party claims. Some examples of the causes of these business interruptions are lightning damage or electro-mechanical failures on facilities, which are not under the control of the project owners (such as sub-stations and transmission lines) that cause extended periods of downtime and revenue loss. The majority of our losses are due to lightning, accounting for more than 50% of our claims. Our largest single loss occurred as a single point failure due to the mechanical breakdown of a substation, which was being shared by three different projects to deliver power to the grid.

Most of the lightning damage claims occur on projects with older turbines located in areas with a combination of many turbines and frequent thunder and lightning storms. Although the blades of modern turbines are very large and well designed, a powerful lightning strike can damage the blade and take the turbine out of commission preventing the turbine from generating power. As a result, the blade has to be replaced. Blades cost depends on the size of the turbine. A typical blade cost for MW scale turbines is approximately $250,000. Therefore there is a significant financial incentive to protect from lightning. The number of lightning damage insurance claims is far less on the new turbines. The turbine manufacturers have spent a lot of time and resources testing and developing more sophisticated lightning protection systems.

Wind Pro has had a no claims for the collapse of a wind turbine tower

Wind Pro has never had a claim for a wind turbine throwing ice. It has only had one claim for a wind turbine losing a blade. This happened on an older second-generation turbine from the 1980s. The Turbine was in a runaway situation, which means it did not shut off properly when the brake system was applied. Turbines will shut themselves off if the wind is too strong. This particular one did not. In this instance employees of the project decided to take a parachute that was in the storage area and throw it over the blades from a boom truck to bring it to a stop.

Instead the rotor continued to run and the parachute broke off the blade and the blade was thrown about 10 yards from the turbine. There was no damage from the thrown blade, other than the blade itself. It has also had one claim related to mechanical failure due to faulty installation which caused a rotor to become immediately detached upon its first startup. The rotor fell straight down to the base of the tower.

The new turbines, such as the type that will be installed for the Kittitas Valley Wind Power project have had no problems with blade throws or ice-throws.

Michael J. Bernay

433 Tustin Newport Beach, Ca 92663 949-439-6875

HIGHLIGHTS OF QUALIFICATIONS

- 25 years experience in the commercial insurance industry, including both insurance company and broker experience.
- Presently manage the program department for WorldLink Insurance Services which is in excess of $30,000,000 in premium
- Responsible for the WindPro insurance facility that is placed in Lloyds of London. WindPro writes wind business in 25 countries around the world and is presently the largest single broker of wind energy business.
- Started writing wind business in 1985-86 in California during the first generation of wind energy.

WORK HISTORY

1996-Present	Executive Vice President	WorldLink Insurance Services, Newport Beach, Ca.
1992-96	Vice President/Manager	Randall Louis Insurance, Irvine, Ca.
1985-92	Vice President/ Branch Manager	Pacific Insurance Agency, Irvine, Ca.
1982-85	Account Executive	Olliver-Pilcher Insurance, Phoenix, Az.
1979-82	Account Manager	Reed Stenhouse, Boston, Ma.
1978-79	Claims and Underwriting	Commercial Union Assurance, Boston, Ma.

SPECIALIZED TRAINING AND EDUCATION

Commercial Union Assurance Co: Claims and Underwriting; Management Training Program

Certified Insurance Counselor

B.A./A.B, Williams College, Williamstown, Ma. 1978

Exhibit 14a

Subject: Shadow-Flicker Modeling
Kittitas Valley Wind Power Project, WA.

Customer: Horizon Wind Energy
210 SW Morrison, Suite 310
Portland, OR 97204

Project type: Modeling

Prepared by: Arne Nielsen, Wind Engineers, Inc.

Distribution: Valerie Schafer, Chris Taylor; Horizon

Revision: 3

Date: Nov. 23, 2005

1. Introduction

This Project Briefing provides a brief explanation of the shadow-flicker phenomenon, the modeling approach employed and relevant explanations to the shadow-flicker reports. The corresponding shadow flicker reports are based on analysis of the layout submitted by the applicant September 30, 2005 and revised in November 2005. The analysis uses the same software modeling as the original analysis prepared for the EFSEC DEIS in December 2003.

2. Shadow-Flicker Background

Shadow flicker caused by wind turbines is defined as alternating changes in light intensity caused by the moving blade casting shadows on the ground and stationary objects, such as a window at a dwelling. No shadow will be cast when the sun is obscured by clouds/fog or when the turbine is not operating.
Shadow-flicker can occur in project area homes if the turbine is located near a home and is in a position where the blades interfere with very low-angle sunlight. The most typical effects are the visibility of an intermittent shadow in the rooms of the residence facing the wind turbines and subject to the shadow-flicker. Such locations are typically called shadow-flicker receptors. Obstacles such as terrain, trees, or buildings between the wind turbine and a potential shadow-flicker receptor significantly reduce or eliminate shadow-flicker effects.

The spatial relationships between a wind turbine and receptor, as well as wind direction are key factors related to shadow flicker duration. General industry practices place turbines at least 1000 ft from sensitive receptors. At these distances shadow flicker usually only occurs at sunrise or sunset when the cast shadows are sufficiently long. For situations where the rotor plane is in-line with the sun and receptor (as seen from the receptor), the cast shadows will be very narrow (blade thickness), of low intensity, and will move quickly past the stationary receptor. When the rotor plane is perpendicular to the sun-receptor "view line", the cast shadow of the blades will move within a circle equal to the turbine rotor diameter.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance and low visibility weather conditions, such as haze, or fog.

The analysis performed for this report does not evaluate the level of shadow flicker intensity, but rather focuses on the total amount of time (hours and minutes/year) that shadow flicker can potentially occur at receptors regardless of whether the shadow flicker is in the barely noticeable range or otherwise.

Consequently, it is likely that all receptors would experience less shadow flicker impact than is reported here. It is further likely that marginally affected receptors may not experience shadow-flicker at all.

The shadow-flicker frequency is related to the rotor speed and number of blades on the rotor. The modeling results presented are based on a wind turbine with a 3-bladed, 90 m diameter rotor, 80 meter hub height and a nominal rotor speed of 16 RPM which translates to a blade pass frequency of 0.8 Hz (less than 1 alternation per second). This is within the range of turbine sizes under consideration for the project and since the rotor diameter and hub heights are at the high end, the results represent what would be considered worst case in terms of the distance of the shadow flicker zone from the turbines.
Health wise, such low frequencies are harmless. Frequencies higher than 3 Hz but below 10 Hz are widely used in discotheques and the Epilepsy Foundation has made a statement that frequencies below 10 Hz are not likely to trigger epileptic seizures.

3. Modeling Approach

A near worst case approach has been adopted for reporting the shadow-flicker results. Additional general site and receptor-specific assessments such as obstacles, mountains outside of the range of the model and diurnal and seasonal cloud and fog patterns may further reduce the reported shadow flicker impacts. The analysis assumes windows are situated in direct alignment with the turbine to sun line of sight. Even when windows are so aligned, the analysis does not account for the difference between windows in rooms with primary use and enjoyment (e.g. living rooms) and other less frequently occupied rooms.

The shadow-flicker model uses the following input:

- Turbine locations (coordinates)
- Shadow Flicker receptor (residence) locations (coordinates)
- USGS 1:24,000 topographic and USGS DEM (height contours)
- Turbine rotor diameter
- Turbine hub height
- Joint wind speed and direction frequency distribution
- Sunshine hours (long term monthly reference data)

The model calculates detailed shadow-flicker results at each assessed receptor location and the amount of shadow-flicker time (hours/year) everywhere surrounding the project (on an iso-line plot). A receptor in the model is defined as a 1 m^2 area 1 meter above ground level. This omni-directional approach produces shadow-flicker results at a receptor regardless of the direction of windows and provides similar results as a model with windows on various sides of the receptor.

The sun's path with respect to each turbine location is calculated by the software to determine the cast shadow paths every 2 minutes, every day over a full year.

The turbine run-time and direction (seen from the receptor) are calculated from the site's long-term wind speed and direction distribution.

Finally, the effects of cloud cover are calculated using long term reference data (monthly average sunshine hours) to arrive at the projected annual flicker time at each receptor.

Output from the model includes the following information:

- Calculated shadow-flicker time at selected receptors
- Tabulated and plotted time of day with shadow flicker at selected receptors
- Map showing turbine locations, selected shadow-flicker receptors and iso-line contours indicating projected shadow-flicker time (hours per year).

4. Conclusion

The shadow-flicker model assumptions applied to this project are very conservative and as such, the analysis is expected to over-predict the impacts. Additionally, many of the modeled shadow flicker hours are expected to be of very low intensity.

The results are therefore prudent projections of the anticipated shadow flicker levels that would be experienced at the nearby residences.

The number of shadow-flicker hours calculated at the nearby residences is common and comparable to other wind power projects installed around the USA.

Arne Nielsen
Wind Engineers, Inc.
Tel.: 951 789 5281
Fax: 909 494 4069
Cell.: 951 237 1277
Email: Arne@WindEngineers.com

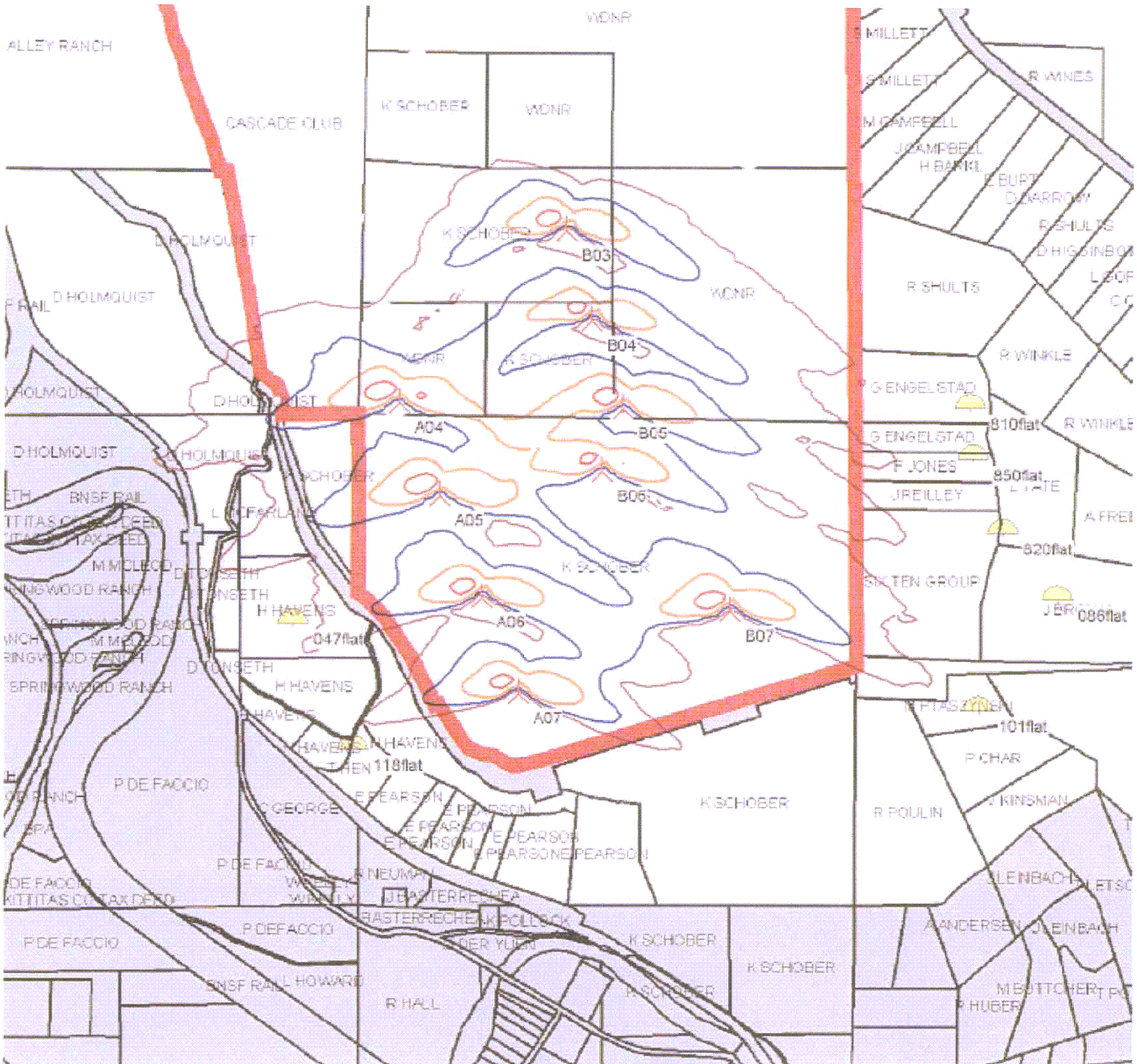
Table 3.4-2: Kittitas Valley Wind Power Project Wind Turbine Shadow-Flicker Analysis

Residence	# Days/Year with Shadow Flicker	Max # Hours/Day with Shadow Flicker	Expected #Hour/Year with Shadow Flicker
Ackerson	186	0:52	26:28
Ahles	138	0:30	14:21
Andrew	297	1:44	84:07
Anthony	247	0:40	29:42
Archambeau	140	0:24	16:32
Brown	125	0:22	9:48
Burt (#084)	198	0:22	15:25
Burt (#670)	186	0:22	13:00
Burt (#690)	194	0:24	15:52
Campbell	233	0:42	22:29
Darrow	183	0:22	16:00
Engelstad	190	0:22	10:29
Franklin	113	0:14	4:10
Gaskill	247	0:38	28:55
Genson	257	1:06	30:54
Gerean, L	16	0:04	0:08
Hawley	34	0:14	2:22
Henley Group	173	0:30	19:13
Henry	50	0:22	3:14
Higginbotham (#740)	114	0:20	9:24
Higginbotham (#750)	141	0:20	9:52
Hink	138	0:22	15:08
Jackson	140	0:32	11:00
Jones	196	0:26	15:20
Millett	169	0:36	18:54
Nelson	220	1:30	41:10
North	120	0:20	10:48
Pearson (#047)	160	0:34	21:38
Pearson (#118)	75	0:28	8:46
Ptaszynski	108	0:26	10:50
Rainbow Valley Ranch	134	0:28	12:18
Robertson	149	0:26	17:06
Schwab	192	0:42	35:52
Shults (#710)	141	0:22	11:30
Shults (#720)	121	0:22	10:23
Tate	155	0:22	12:27
Taylor	240	0:40	39:44
Thayer (#450)	120	0:24	13:32
Thayer (#470)	119	0:24	14:35
Thayer (#480)	108	0:24	13:10
Thompson/Giesick	162	1:30	56:40
Wines/Snover	53	0:16	3:44
Yeager	191	0:28	24:28
Zellmer	273	0:50	25:24

Project:	Description:	Printed/Page
030326 Kittitas	SIEMENS 90m 2.3 MW MkII at 80m hub height Shadow receptor Pearson North (047flat), Brown (086flat), PTASZYNSKI (900flat), Pearson South (118flat), ENGELSTAD (810flat), JONES (850flat), TATE (820flat) Monthly sunshine percentage applied Joint frequency distribution applied (for run-hours and direction) Turbines A-04-07, B-03-07	11/12/05 10:23 / 16 Licensed user: **Wind Engineers, Inc.** 7660 Whitegate Avenue US-RIVERSIDE, CA 92506 Calculated: 11/12/05 00:43/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051111 SF, A, B and G, on 047, 086, 118, 810, 820, 850, 900 **File:** kv simply parcels 110405, wt_2.bmi



0 250 500 750 1000m

Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 674,523 North: 5,220,112

New WTG   Shadow receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25   50   100   200

Project:
030326 Kittitas

Description:
SIEMENS 90m 2.3 MW MkII at 80m hub height
Shadow receptor Rainbow Valley Ranch (041flat), Archambeau (042flat), Ahles (370flat), Henley (380flat), Yeager (420flat), Hink (440flat), Thayer (470flat and 480flat)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines F-01, F-02, G-01 through G-04

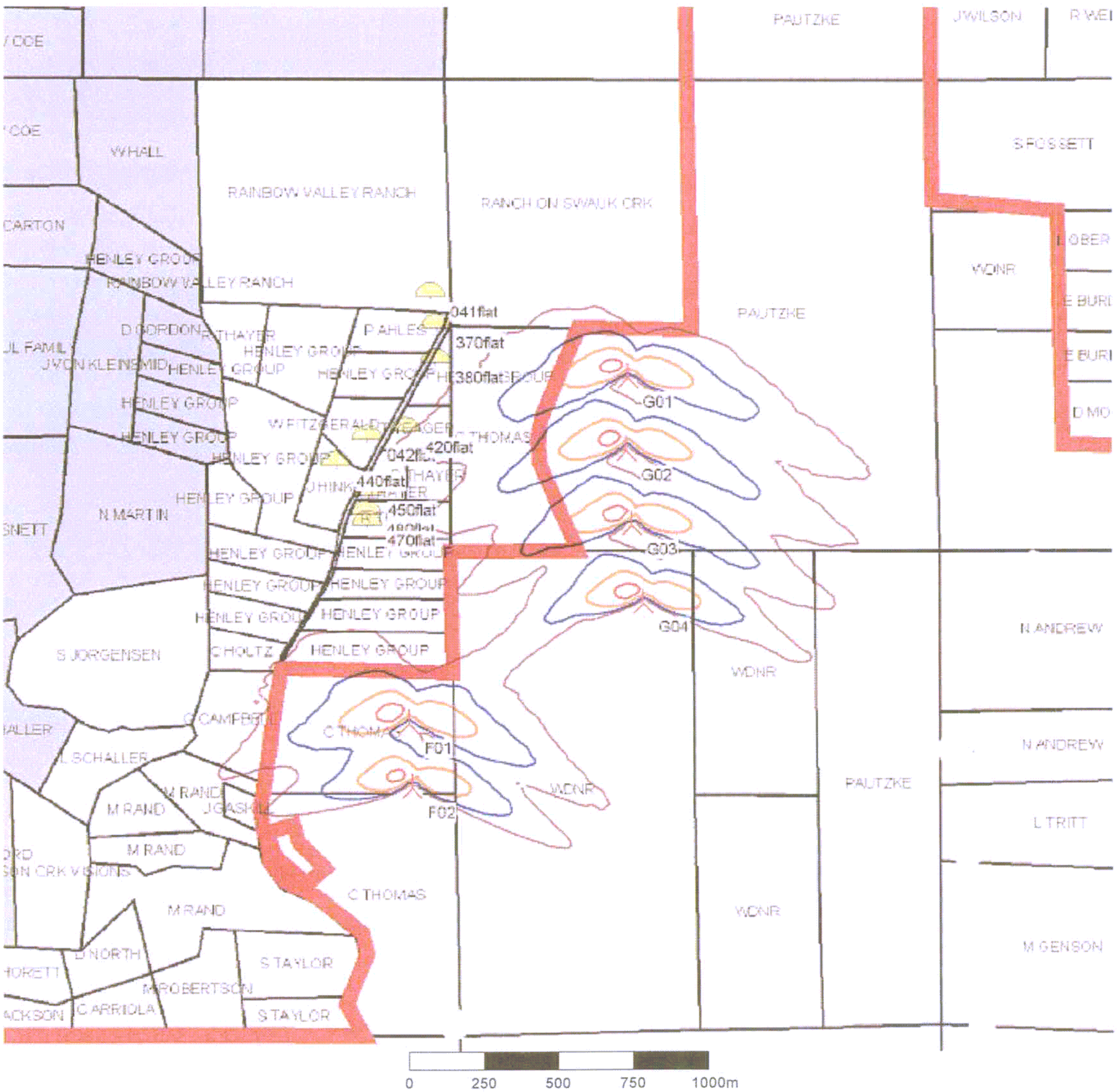
Printed/Page
11/09/05 01:25 / 21

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
US-RIVERSIDE, CA 92506

Calculated:
11/08/05 22:04/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051108 SF, F-G, on 041, 042, 370-380, 420, 440, 450, 470, 480 **File:** kv simply parcels 110405, wt_2.bmi



Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 674,023 North: 5,225,412

New WTG | Shadow receptor

Isolines showing shadow in Shadow hours|per year. Real value calculation.

25 | 50 | 100 | 200

Project:
030326 Kittitas

Description:
SIEMENS 90m 2.3 MW MkII at 80m hub height
Shadow receptor Anthony (043flat), Gaskill (044flat), Taylor (045flat), Jackson (149flat), North (150flat), Robertson (555flat)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines E-02-05, F-01-06, G-01-04 (no E-01)

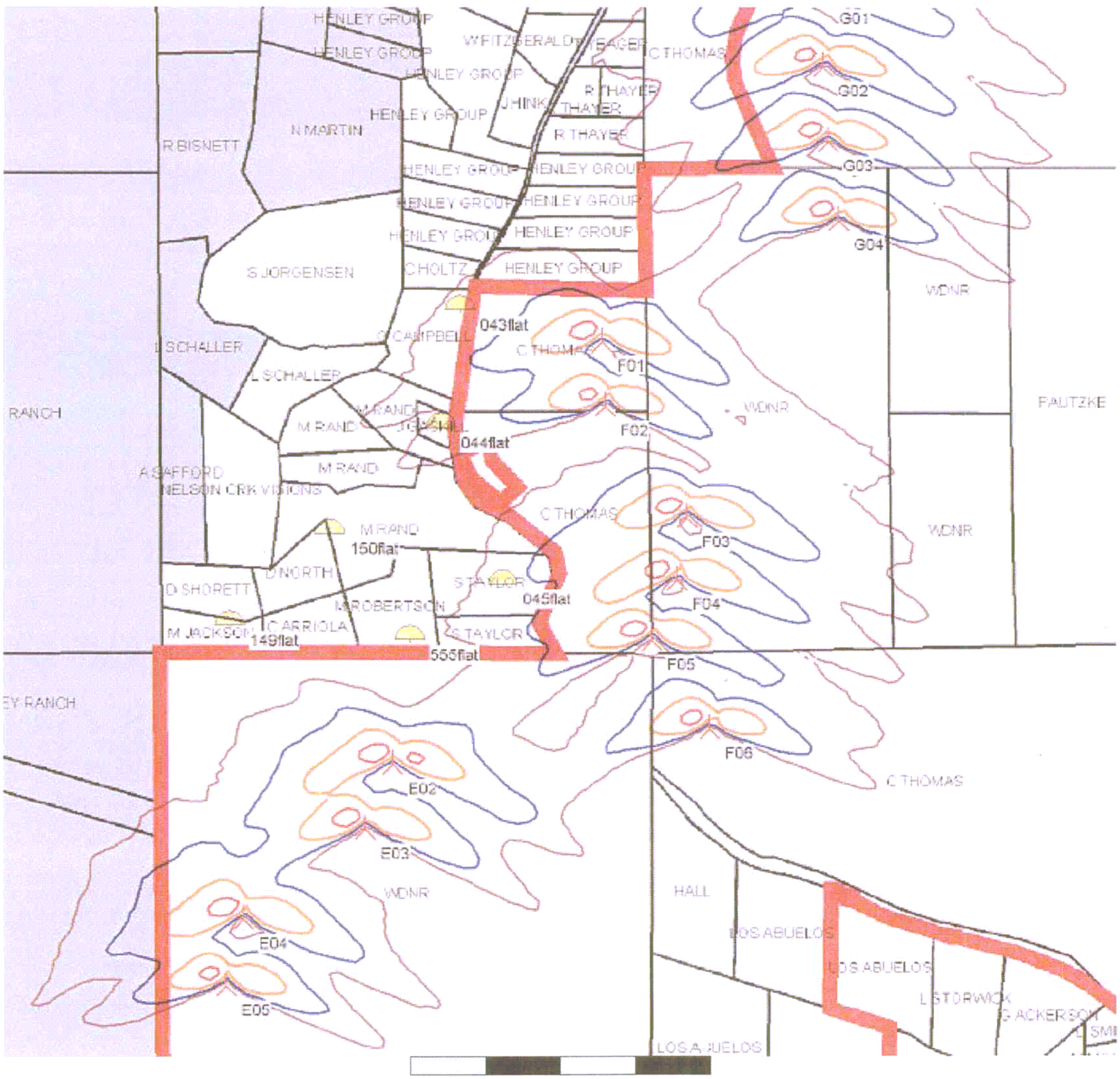
Printed/Page
11/10/05 10:39 / 16

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
US-RIVERSIDE, CA 92506

Calculated:
11/10/05 09:26/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051110 SF, E (-1), F and G, on 043-045, 149-150, 555 **File:** kv simply parcels 110405, wt_2.bmi



Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 673,423 North: 5,224,112

New WTG   Shadow receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25   50   100   200

WindPRO version 2.4.0.67 Dec 2004

Project:	Description:	Printed/Page
030326 Kittitas	SIEMENS 90m 2.3 MW MkII at 80m hub height Shadow receptor Andrew N (510flat) Monthly sunshine percentage applied Joint frequency distribution applied (for run-hours and direction) Turbines H-01-07, I-03-10	11/09/05 05:12 / 5 Licensed user: **Wind Engineers, Inc.** 7660 Whitegate Avenue US-RIVERSIDE, CA 92506 Calculated: 11/09/05 04:29/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051108 SF, H and I, on 510 **File:** kv simply parcels 110405, wt_2.bmi

Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,023 North: 5,224,662

New WTG Shadow receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25 50 100 200

Project:
030326 Kittitas

Description:
SIEMENS 90m 2.3 MW MkII at 80m hub height
Shadow receptor (216flat), STATR OF WASH DNR (270flat), STATR OF WASH DNR (930flat), GEREAN (340flat)
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines H-01-03, I-01-05

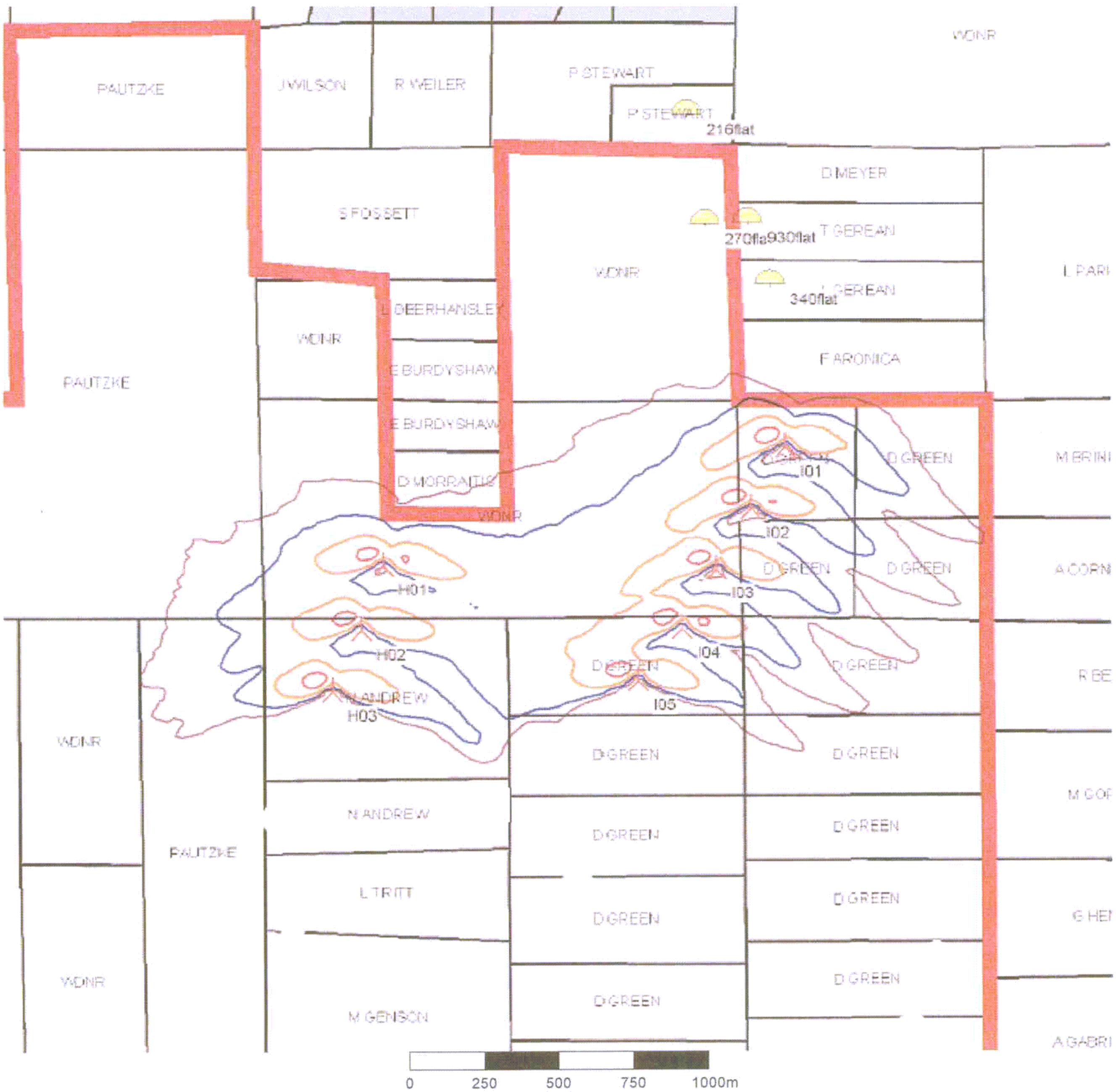
Printed/Page
11/09/05 13:55 / 7

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
US-RIVERSIDE, CA 92506

Calculated:
11/09/05 13:20/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051109 SF, H and I, on 216, 270, 930, 340 **File:** kv simply parcels 110405, wt_2.bmi



Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,273 North: 5,225,712

New WTG   Shadow receptor

Isolines showing shadow in Shadow hours|per year. Real value calculation.

25   50   100   200

Project:
030326 Kittitas

Description:
SIEMENS 90m 2.3 MW MkII at 80m hub height
Shadow receptor HENRY, GREG (530flat)

Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines K-01-02

Printed/Page
11/09/05 13:53 / 4

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
US-RIVERSIDE, CA 92506

Calculated:
11/09/05 13:51/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051109 SF, K, on 530 **File:** kv simply parcels 110405, wt_2.bmi

Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 677,623 North: 5,224,012

New WTG   Shadow receptor

Isolines showing shadow in Shadow hours per year. Real value calculation.

25   50   100   200

Project:
030326 Kittitas

Description:
SIEMENS 90m 2.3 MW MkII at 80m hub height
Shadow receptor GENSON (570), NELSON (580), ACKERSON (590), THOMPSON (600)
SCHWAB (610) all flat
Monthly sunshine percentage applied
Joint frequency distribution applied (for run-hours and direction)
Turbines B-01-02, C, D, F-03-06, H-06-10, I-10-16, J, K

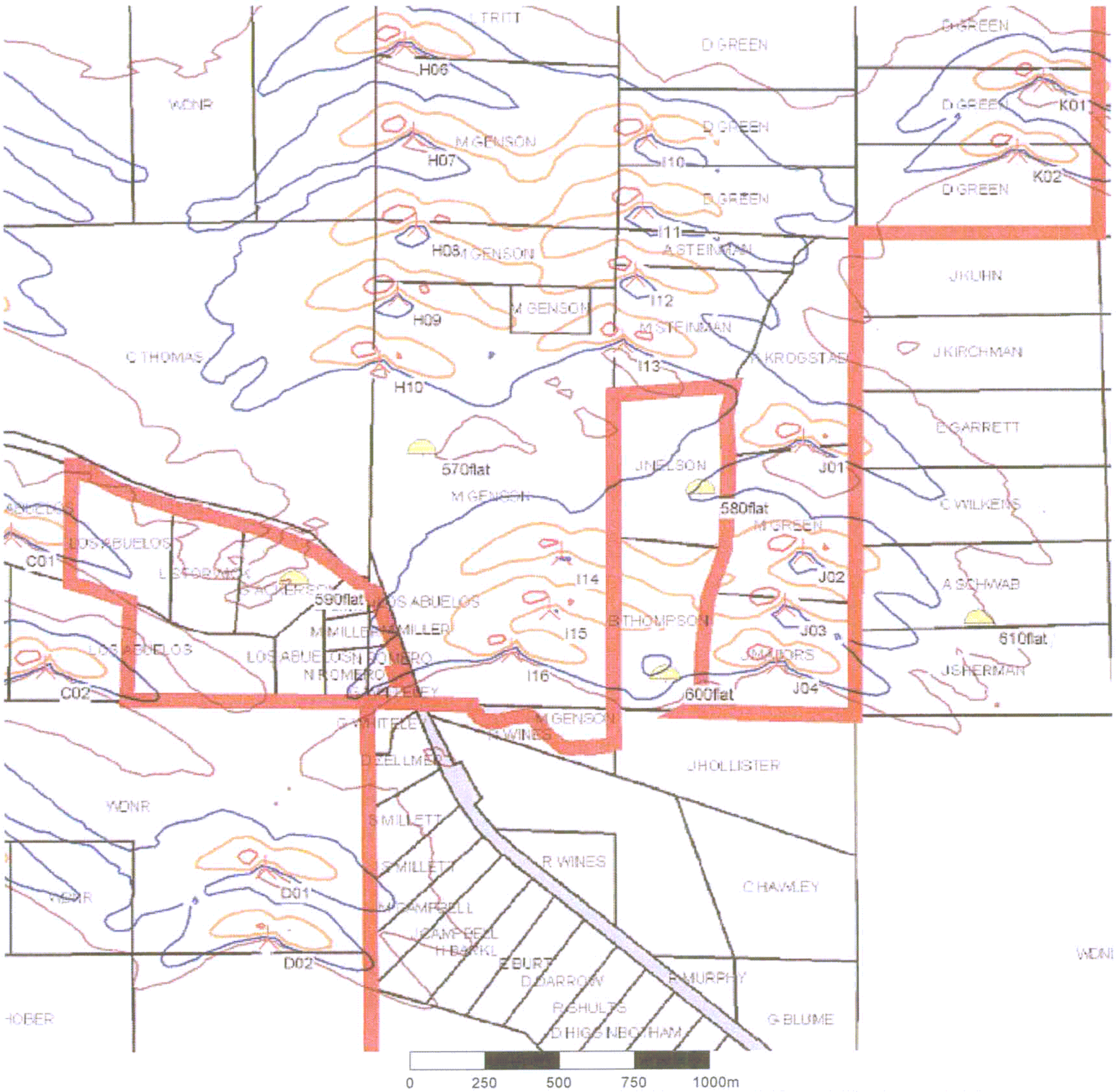
Printed/Page
11/13/05 09:01 / 14

Licensed user:
Wind Engineers, Inc.
7660 Whitegate Avenue
US-RIVERSIDE, CA 92506

Calculated:
11/13/05 02:33/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051112 SF, B, C, D, F, H I, J, K on 570, 580, 590, 600, 610 **File:** kv simply parcels 110405, wt_2.bmi



Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 676,000 North: 5,222,790

New WTG   Shadow receptor

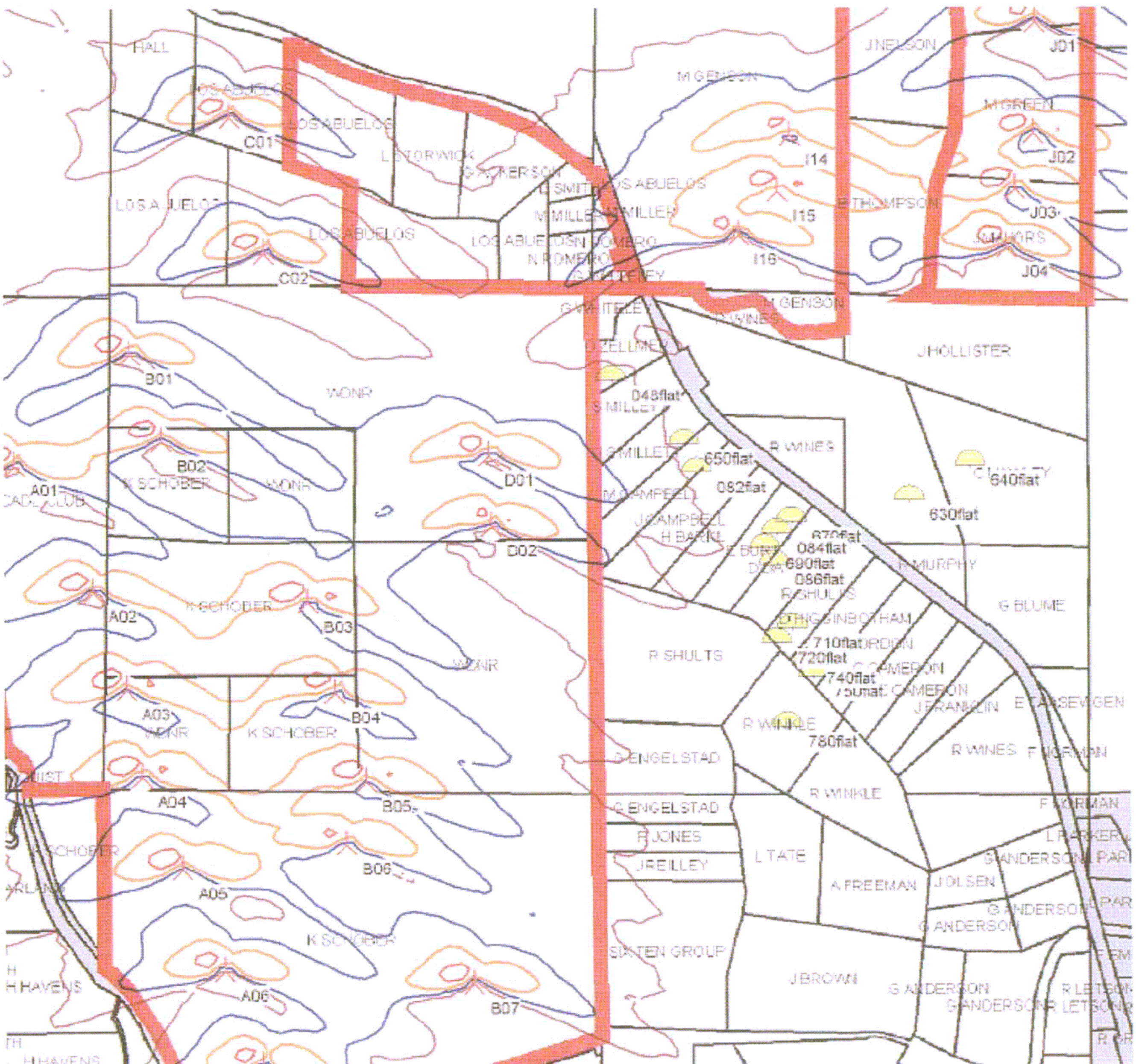
Isolines showing shadow in Shadow hours|per year. Real value calculation.

25   50   100   200

Project:	Description:	Printed/Page
030326 Kittitas	SIEMENS 90m 2.3 MW MkII at 80m hub height Shadow receptor Zellmar (048), MILLETT (650), Campbell (082), BURT (670, 084, 690), Darrow (086) SHULTS (710, 720), HIGGINSBOTHAM (740, 750), FRANKLIN (780), HAWLEY (640) WINES/SNOVER (630) all flat Monthly sunshine percentage applied Joint frequency distribution applied (for run-hours and direction) Turbines A01-07, B01-07, C-01-02, D-01-02, I-14-16, J-01-04 on 048	11/11/05 08:09 / 32 Licensed user: **Wind Engineers, Inc.** 7660 Whitegate Avenue US-RIVERSIDE, CA 92506 Calculated: 11/11/05 04:04/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051110 SF, A, B, C, D, I, J on 048, 650, 082, 670, 084, 690, 086, 710, 720, 740, 750, 780, 630, 640 **File:** kv simply parcels 110405, wt_2.bmi



0 250 500 750 1000m

Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,322 North: 5,221,362

New WTG — Shadow receptor

Isolines showing shadow in Shadow hours|per year. Real value calculation.

25 — 50 — 100 — 200

Project:	Description:	Printed/Page
030326 Kittitas	SIEMENS 90m 2.3 MW MkII at 80m hub height Shadow receptor Morriatis (flat) Monthly sunshine percentage applied Joint frequency distribution applied (for run-hours and direction) Turbines G-01-04, H-01-06, I-01-07	11/22/05 07:54 / 5 Licensed user: **Wind Engineers, Inc.** 7660 Whitegate Avenue US-RIVERSIDE, CA 92506 Calculated: 11/22/05 05:07/2.4.0.67

SHADOW - kv simply parcels 110405, wt_2

Calculation: 051122 SF, G, H and I, on Morriatis **File:** kv simply parcels 110405, wt_2.bmi

Map: kv simply parcels 110405, wt_2 , Print scale 1:20,000, Map center UTM NAD27 Zone: 10 East: 675,923 North: 5,224,577

New WTG   Shadow receptor

Isolines showing shadow in Shadow hours|per year. Real value calculation.

25   50   100   200

CURRICULUM VITAE
ARNE NIELSEN

WORK EXPERIENCE

5/00 – present Wind Engineers, INC.
Position: Project Consultant / Owner

- Certification by Risø in the use and implementation of WAsP modeling. The certification included aspects of wind resource assessments. Risø is recognized as banks engineers for wind resource assessments and project due diligence.
- Development and installation of precise and conventional anemometry packages, anemometry contributing to the largest uncertainty in wind resource assessments in non-complex terrain.
- Preparation of wind reports and wind resource assessments. Preparation of 3rd
- party wind reports including uncertainties and detailed confidence levels.
- Responsible for computer modeling of: noise, shadow-flicker, photomontage,
- wind farm visibility (ZVI) and modeling of wind variations due to terrain (WAsP) and structured array optimization.
- Responsible for power performance testing and site calibration campaigns including supervision of equipment installation, calibration, monitoring and preparation of reports.
- Development and preparation of wind resource maps showing the most energetic sites within a given boundary.
- Responsible for validation of wind modeling efforts by conducting precise short term anemometry measurement campaigns.
- Preparation of reports and briefings on power quality, utility performance standards and utility interconnection requirements. Conducted studies on wind farm power fluctuations, ramp rates and frequency variations on isolated utility systems. Evaluation of short term storage techniques, economics and controls.
- Early development of wind sites, identification of sites, installation of met. Towers and identification of long term reference wind monitoring stations.
- Preparation of bidding packages for utility RFP's.
- Development and implementation of state of the art methods for turbine siting (GPS, 3D moving map).
- Assigned by enXco to develop wind energy projects in Turkey. Spent 5 months in Izmir Turkey monitoring potential project sites. Implemented early development processes – development conditions being vastly different than European and American conditions.

Exhibit 15a

10/98 – 5/00 NEG-MICON USA, INC.
Position: Project Director

- Responsible for most elements of installation, commissioning and power performance testing of approximately 550 wind turbines.
- Review of contracts and supply agreements for installation, commissioning and testing of NEG-Micon's 750 kW turbines.
- Negotiations with customers and vendors.
- Performed analyses of the progress of installation work. Developed progress reports and made recommendations for adjustments in order to close projects on time.

10/95 - 10/98 SAME MARINE SYSTEMS, INC.
Position: Project Consultant / Owner

- Preparation of documentation for park and turbine efficiencies in wind parks using state of the art software (WindPRO). Recommendations and consulting during project development phase in cooperation with meteorologists.
- Preparation of documentation for noise and shadow-flicker impacts from wind parks using state of the art software (WindPRO). Recommendations and consulting during project development and permitting process.
- Project management and responsible for noise reduction of current line of wind turbines at Zond Energy Systems, Inc., including in depth scrutinization of design of blades, gearboxes, generators, brake systems, yaw motors and yaw gears, towers and yaw decks, hydraulic motors and pumps.
- Preparation of spreadsheets for data treatment and graphing of results of the sound tests. Preparation of engineering memo's and reports according to current international sound standards.
- Made strain gauge, oil temperature, oil pressure measurements and power curve measurements on Vestas, Danwin, NedWind, Advanced Energy Corporation wind turbines using equipment and software especially developed for use on wind turbines. This equipment and software has been developed over the years on an as needed basis for the harsh environmental conditions in the desert.
- Prepared reports on measurements made including charting, data analysis and calibration of equipment.
- Designed and installed oil cooling units Bonus turbines.
- Development of improvements for Apollo Energy Corporation's wind turbine power plant on Hawaii including high voltage power collection system, substation, wind turbines and communication system.
- Responsible for ongoing supervision of service crews on Apollo Energy Corporation's site on Hawaii. Frequent site visits are made where updates, retrofits and improved procedures are implemented.

10/94 - 10/95 VESTAS AMERICAN WIND TECHNOLOGY, INC.
Position: Project Manager

- Responsible for preparation of turn-key quotes for wind power plants. Quotes included wind turbines, towers, foundations, central monitoring system, transformers, transmission lines, sub-stations and other high and low voltage power collection system as well as other infrastructure.
- Participated in due diligence studies on wind parks. Re-design and evaluation of wind power plant layouts. Scrutinization of especially re-powering projects for possible increase of overall plant efficiencies.
- Responsible for wind turbine micro siting including terrain influences, array loss calculations, transmission line loss estimates, etc.
- Coordination and information exchange between potential finance sources and developers / wind plant owners.
- Located and worked with suppliers and construction companies for wind plant installations. Negotiated pricing, terms, bonds etc.
- Project development and pricing of numerous wind plants, wind / pumped hydro storage systems and power regulation / management systems.
- Development of detailed spreadsheet for quotation purposes.
- Worked on market development on an ongoing basis with Vestas' agents and representatives i.e. by attending trade shows and company visits. Developed working relationships with potential agents and customers in the US, Canada and Mexico.
- Acquiring wind data and other environmental data for production verification and estimation purposes and for data base purpose.
- Explored power quality delivered from various wind turbine types. Introduced power quality measurement scheme usable for wind plants and complying with IEEE519 recommendations.
- Performed power quality measurements on wind turbines using state of the art measurement equipment. Reporting of results and comparisons of various production scenarios.
- Project development with CFE (Comision Federal de Electricidad) in Mexico, based on exchange of information, coarse pricing and detailed discussion of wind power plant type and layouts. Different options in construction principles and methods were treated in detail.
- Investigations for optimizing the high voltage collection system, lightning protection and transformer configurations for a proposed 27 MW wind power plant in La Venta, Mexico.
- Follow-up on existing wind park installation in La Venta, Mexico. Responding to and assisting New World Power and New World Entec in performing trouble finding, repair and O&M.
- Performed parallel power curve measurements for production verification purposes. Data treatment and brief reporting of results.
- Collection and formatting of wind data from weather stations and data processing and reporting of collected wind data using Microsoft Access.

1992 - 10/94 SAME MARINE SYSTEMS, INC.
Position: Project Consultant / Owner

- Project manager on various test and measurement projects. Mainly for wind turbine production increase and load determination purpose. Coordination with and reporting to domestic and foreign organizations and companies involved in the test projects, i.e. Apollo Energy Corporation, Dutch Energy Corporation, Dutch Pacific Partners, NedWind, Det Norske Veritas, Risø, SeaWest, BTM Consult Corp., Enerpro, Windgineering (Danwin), Danish Energy Agency, LM Glasfiber, HPA Trading, Dansk Vindteknik.
- Representative in US for Mita Teknik, Denmark. The largest manufacturer of wind turbine microprocessor controllers and a major manufacturer of electronic control & communication equipment.
- Development and installation of lightning and over voltage protection systems, electronic control equipment and microprocessor software for wind turbines.
- Installation of wind turbine monitoring equipment and wind farm management systems. Coordination between software developers.
- Development, purchase, installation and monitoring of state of the art test and data acquisition equipment including systems for i.e.:
  - Advanced anemometry.
  - Precise power production measurements.
  - Precise load and vibration measurements.
- Data treatment, analysis and preparation of test reports including i.e.:
  - Wind potential analysis and documentation.
  - Power curve comparisons and documentation.
  - Lifetime fatigue load spectra and fatigue load comparisons.
  - Determination on PSD and sources.
  - Documentation of test equipment accuracy and calibration.
- Engineering and consulting for various companies, i.e. Apollo Energy Corporation, Dutch Energy Corporation, Vestas, NedWind, Dutch Pacific Partners, SecondWind, SeaWest, Difko, BTM Consult Corp., Enerpro, Field Service & Maintenance, Whitewater Service Corporation, Mita Teknik, Thorsted Maskiner and HPA Trading on an ongoing basis.
- Development and implementation of US manufactured components into various Danish wind turbines.
- Measurements and recommendations for optimizing operational characteristics of various electrical and mechanical components in wind turbines.
- Recommendations for optimizing wind turbine rotor performance.
- Development of software for PC based measurements on wind turbines. Mainly for production verification, enhancement and optimization purposes.
- Custom fit / re-design of comprehensive science, engineering and graphic computer programs (Turbo Pascal) for data acquisition, analyzing and reporting purpose.

- Re-developing of procedures and software for determination of wind potentials at remote sites where little long-term anemometry has been recorded.
- Development and implementation of ISO 9000 series Quality Control procedures at organization level.

1988 - 1992 BONUS WIND TURBINES, INC. / TURBINE MAINTENANCE CORPORATION, BOTH US DIVISIONS OF BONUS ENERGY, BRANDE, DENMARK.
Position: Retrofit Engineer

- Development and dimensioning of retrofit kits for existing wind turbines with Bonus Energy, Denmark.
- Responsible for the testing and optimization of the wind turbine retrofit kits.
- Assistance in the estimation of minor repairs on large wind farms.
- Start-up and monitoring of an extensive retrofit program consisting of 550 108 kW wind turbines owned by Difko Administration, including i.e. setup of shop facilities, cranes and equipment, supervision and some hiring.
- Coordination and development of special equipment with local subcontractors for the production line and installation process at the wind farm.
- Responsible for the development, re-design and implementation of wind turbine controller hardware and software with Mita Teknik, Denmark.
- Assisting in the implementation of a practical functional quality assurance system (ISO 9000, Norske Veritas) for the retrofit program.
- Optimization and follow-up on the dimensioning of the retrofit kits by making comprehensive strain gage measurements, data treatment and reports.
- Development of user friendly wind turbine controller operation features with Mita Teknik, Denmark.
- Writing and implementing functional Service, Operation and Maintenance manuals including complete electrical and hydraulic schematics and trouble finding procedures.
- Re-design of PC science, engineering and graphic computer programs for data acquisition, analyzing and reporting purpose.

1985- 1988: Danish Wind Power A/S Kauslunde, Denmark.
POSITION: R&D Engineer

- Responsible for the design and upgrade of a 65 kW wind turbine to a 110 kW.
- Re-design and dimensioning of tower, yaw system, rotor, hydraulic brake system and canopy with subcontractors (Lindenau Verft, Germany. Dannebrog Værft, Denmark. Parker Hydraulics, Denmark).
- Assistance in the re-design of the gearbox at Kumera OY's plant in Finland.
- Responsible for the preparation of all dimensioning documentation including strain gage measurements on the prototype turbine.
- Test and implementation of the hydraulic brake system with Sabroe Værft, Denmark and Parker Hydraulics, Denmark.

- Preparation of all structural documentation and obtained approvals from Risø, the Danish test and approval facility for wind turbines.
- Specification of controller functions and operation features and implementation of a state of the art controller design from KK-Electronic, Denmark.
- Follow-up on quality control at various subcontractors in Denmark, Germany, Portugal and Finland.
- Supervision and hands on experience during the installation and commissioning of 50 110 kW turbines in Tehachapi, Ca.
- Follow-up on component malfunctions and repairs. Development and implementation of procedures for replacements and repairs.
- Total responsible for the development, design and dimensioning of new integrated 150 kW turbine. Subcontractors were i.e. Dorstener Maschinenfabrik, Germany, LM Glasfiber, Denmark. Sabroe Værft, Denmark. Efacec, Portugal. Parker Hydraulics, Denmark. KK-Electronic, Denmark.
- Responsible for the preparation of all the documentation and testing necessary to meet construction codes, sales information and safety requirements from Arbejds Tilsynet, Denmark - the Danish safety approval facility.
- Obtained approval from Risø, the turbine being the largest commercial manufactured wind turbine at that time.
- Writing and implementing an Operation, Service and Maintenance manual.
- Introduced the 150 kW turbine to the Indian market. The Indian partners were ABB (Asea Brown Bovery) Baroda, Delhi, Madras, Bombay.
- Supervision during installation and commissioning of a pilot wind turbine at DCW Chemicals, a remote site near Tutticorin, Tamil Nadu, India without any kind of modern equipment.
- Development of a reliable short-term wind potential measurement program, utilized at several Indian Government owned Meteorological Stations, parallel with different remote locations in India.
- Negotiation and initialization of know-how transfer to the Indian partners.
- Preparation and design of a 22.5 MW wind turbine power plant in India, including micro siting and dimensioning of the electrical systems.
- Education and training of Indian engineers and technicians, including the writing of all educational pamphlets.
- Total responsible for development, design and dimensioning of a 65 kW integrated wind turbine for the German market. Obtained approval from Germanischer Lloyd.
- Installed, commissioned and followed up on the 65 kW prototype in Germany.

EDUCATION

1978 - 1985: Odense Teknikum

Engineering degree and agricultural degree.

Bachelor Degree in Mechanical Engineering. Specialty achievements in electrical controls and regulation.

PRESENT POSITION

Biometrician/Project Manager
Western EcoSystems Technology, **Inc.**, 2003 Central Ave, Cheyenne, WY 82001.
Telephone: (307) 634-1756. Fax: (307) 637-6981, email: werickson@west-inc.com

PREVIOUS POSITIONS

1998-2000	Research Assistant, University of Wyoming.
1990-1991	Research Assistant, University of Wyoming.
1990-1991	Field Scientist, University of Alaska, Fairbanks.
1989	Research Assistant, Alumni Office, Winona State University.

EDUCATION

PHD	expected 2006	University of Wyoming	Statistics
M.S.	1992	University of Wyoming	Statistics
B.S.	1989	Winona State University	Statistics/Mathematics

RELEVANT EXPERTISE AND TRAINING

Generalized Linear Models	Logistic Regression
Sampling Theory	Multivariate Statistics
Experimental Design	Randomization/Permutation Tests
Spatial Statistics	Monte Carlo Methods (e.g., Bootstrap)
Non-Parametric Statistics	Geographic Information Systems
Resource/Habitat Selection	Good Laboratory Practices (GLP)
Wind Project Permitting	

SPECIALTY AREAS

Mr. Wallace P. Erickson has been a statistician/project manager with WEST since 1991. He has over 14 years of consulting experience related to the design and analysis of environmental and wildlife studies. His primary research interests include habitat selection methodology with applications to GIS, and study designs and analysis for detecting impacts from environmental perturbations. He has been lead statistician and WEST project manager for baseline studies, environmental permitting, and/or operational monitoring/research at wind energy projects in over 11 states (California, Minnesota, Montana, Oregon, Washington, West Virginia, Colorado, Wisconsin, Texas, Maine, Wyoming). He is an author/co-author on over 35 professional journal articles, book chapters or peer reviewed proceedings papers, and is co-author of the 2nd edition of the book "Resource Selection by Animals". He has presented over 25 papers/posters at national/regional meetings. He has worked on numerous projected funded by the USFS, USFWS, USGS BRD as well as projects funded by industry. He has designed and otherwise participated in (e.g. report writing) over 25 pre-construction studies and over 10 post-construction studies for predicting impacts of wind projects on wildlife. He was selected as a principal investigator for the bat research conducted in the fall 2004 in the eastern United States as part of the Bat Wind Energy Cooperative, a collaborative research effort among the wind industry, USFWS, Bat Conservation International, and others.

His duties with WEST Inc. involve using current state-of-the-art statistical principles in designing ecological studies and analyzing subsequent data. He has taught workshops on the following topics: 1) Statistics for Spatially Correlated GIS Data, 2) Resource Selection, 3) Computer Intensive Statistics, and 4) Basic Statistics for Biologists and Field Ecologists. He is currently working on a Ph.D. in Statistics at the University of Wyoming. The topic of his dissertation is on methods for estimating wildlife fatality rates in field study situations.

SCIENTIFIC ORGANIZATION MEMBERSHIPS

American Statistical Association	Biometrics Society
The Wildlife Society	The National Audubon Society

PROFESSIONAL PUBLICATIONS/PROCEEDINGS

Kerns, J.,E. W. Erickson and E. Arnett. 2005. Bat and bird fatality at Wind Energy Facilities in Pennsylvania and West Virginia. Title Of Chapter. Pages 24-95. In E. B. Arnett, Technical Editor, Relationships Between Bats And Wind Turbines In Pennsylvania And West Virginia: An Assessment Of Bat Fatality Search Protocols, Patterns Of Fatality, And Behavioral Interactions With Wind Turbines. A Final Report Submitted To The Bats And Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Anderson, R. N. Neuman, J. Tom, W.P. Erickson, M.D. Strickland, M. Bourassa, K.J. Bay, and K.J. Sernka. 2004. Avian monitoring and risk assessment at the Tehachapi Pass Wind Resource Area. NREL. Period of Performance: October 2, 1996 – May 27, 1998. NREL/SR-500-36416.

Erickson, W.P., G.D. Johnson, and D.P. Young. 2004. Summary of anthropogenic causes of bird mortality. Proceedings of the 2002 International Partner's in Flight Conference, Monterrey, California.

McDonald, L.L., J.R. Alldredge, M. Boyce and W.P. Erickson. 2004. Measuring availability and vertebrate use of terrestrial habitats and foods. In Wildlife Techniques Manual. The Wildlife Society. Anderson, R. N. Neuman, J. Tom, W.P. Erickson, M.D. Strickland, M. Bourassa, K.J. Bay, and K.J. Sernka. 2004. Avian monitoring and risk assessment at the Tehachapi Pass Wind Resource Area. Period of Performance: October 2, 1996 – May 27, 1998. NREL/SR-500-36416.

Johnson, G. D., M. D. Strickland, W. P. Erickson, and D. P. Young, Jr. 2004. Use of data to develop mitigation measures for wind power development impacts to birds. In M. Ferrer, G. Janss and M. de Lucas, editors. Birds and windpower. Quercus Press, Spain. In Press.

Johnson, G.D., M.K. Perlik, W.P. Erickson, and M.D. Strickland. 2004. Bat activity, composition and collision mortality at a large wind plant in Minnesota. *Wildlife Society Bulletin* 32: in Press.

Erickson, W.P., R. Nielson, R. Skinner, B. Skinner and J. Johnson. 2004. Applications of resource selection modeling using unclassified Landsat Thematic Mapper imagery In Resource Selection Technique and Applications. Huzurbazar, editor. Omnipress, Madison Wisconsin.

Howlin, S., W.P. Erickson, and R. Nielson. 2004. Techniques for assessing predictive ability of resource selection functions. In Resource Selection Technique and Applications. Huzurbazar, editor. Omnipress, Madison Wisconsin.

Manly, B.F.J., L.L. McDonald, D. Thomas, T. McDonald and W.P. Erickson. 2002. Resource Selection by Animals, Statistical Design and Analysis of Field Studies. Kluwer Academic Publishers.

Erickson, W.P. 2002. Bird mortality from anthropogenic causes. 2003. In Proceedings of the Wind Power 2002 Conference, Portland Oregon.

Erickson, W.P., G.D. Johnson, and D.P. Young. 2004. Summary of anthropogenic causes of bird mortality. Proceedings of the 2002 International Partner's in Flight Conference, Monterrey, California. In Press.

Johnson, G.D., M.K. Perlik, W.P. Erickson, M.D. Strickland, D.A. Shepherd, and P. Sutherland, Jr. 2003. Bat interactions with wind turbines at the Buffalo Ridge, Minnesota Wind Resource Area: An assessment of bat activity, species composition, and collision mortality. Electric Power Research Institute, Palo Alto, California, and Xcel Energy, Minneapolis, Minnesota. EPRI report # 1009178.

Young, D., W. Erickson, M. Dale Strickland, Rhett Good, and S. Howlin. 2002. Comparison of avian effects from UV light reflective paint applied to wind turbines, Foote Creek Rim Wind Plant, Carbon County, Wyoming. National Renewable Energy Laboratory. Golden, Colorado 80401-3393

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. *Wildlife Society Bulletin* 30:879-887.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *The American Midland Naturalist* 150:332-342.

Anderson, R., W.P. Erickson , M.D. Strickland, M Bourassa, J. Tom, and N. Neumann. 2001. Avian monitoring and risk assessment at Tehachapi Pass and San Gorgonio Pass Wind Resource Areas, California. Proceedings of the National Avian-Wind Power Planning Meeting IV. National Wind Coordinating Committee, c/o RESOLVE, Inc. Washington, D.C.

Strickland, M.D., W.P. Erickson, G. Johnson, D. Young, and R. Good. 2001. Risk reduction avian studies at the Foote Creek Rim Wind Plant in Wyoming. Proceedings of the National Avian-Wind Power Planning Meeting IV. National Wind Coordinating Committee, c/o RESOLVE, Inc. Washington, D.C.

Strickland, M.D., G. Johnson, W.P. Erickson and K. Kronner. 2001. Avian studies at wind plants located at Buffalo Ridge Minnesota and Vansycle Ridge Oregon. Proceedings of the National Avian-Wind Power Planning Meeting IV. National Wind Coordinating Committee, c/o RESOLVE, Inc. Washington, D.C.

PROFESSIONAL PUBLICATIONS/PROCEEDINGS (continued)

Erickson, W.P., T.L. McDonald, K. Gerow, J. Kern and .S. Howlin. 2001. Statistical issues in resource selection studies with radio-marked animals. Pages 209-242 in J. J. Millspaugh and J. M. Marzluff, editors. Radio Tracking and Animal Populations. Academic Press, San Diego, California, USA.

Erickson, W.P., G. D. Johnson, M. D. Strickland, D. P. Young, Jr., K.J. Sernka and R.E. Good. 2001. Avian collisions with wind turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee Publication. http://www.nationalwind.org/pubs/default.htm

Peterson, C. H., L. L. McDonald, R. H. Green, and W. P. Erickson. 2001. Sampling design begets conclusions: the statistical basis for detection of injury to and recovery of shoreline communities after the Exxon Valdez oilspill.. Mar Ecol Prog Ser 210:255-283.

Hupp, J. W., A.B. Zacheis, R.M. Anthony, D.G. Robertson, W.P. Erickson and Kelly C. Palacios. 2001. Snow cover and snow goose *Anser caerulescens caerulescens* distribution during spring migration. Wildlife Biology, 7(2): 65-76.

Arnett, E.B., R.J. Anderson, C. Sokal, F. Isaacs, R.G. Anthony and W.P. Erickson. 2001. Relationships between nesting bald eagles and selective logging in south-central Oregon. Wildlife Society Bulletin 29:795-803.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *The American Midland Naturalist* 150:332-342.

Irons, D.B., S.J. Kendall, W.P. Erickson, L.L. McDonald, and B.K. Lance. 2000. Nine years after the *Exxon Valdez* oil spill: effects on marine bird populations in Prince William Sound, Alaska. The Condor. 102: 723-737.

Erickson, W.P., M.D. Strickland, G.D. Johnson, and J.W. Kern. 2000. Examples of statistical methods to assess risk of impacts to birds from windplants. Proceedings of the National Avian-Wind Power Planning Meeting III. National Wind Coordinating Committee, c/o RESOLVE, Inc., Washington.

McDonald, T. L., W. P. Erickson, and L.L. McDonald. 2000. BACI analysis for count data. JABES. 5:262-279.

Strickland, M.D., D.P. Young , Jr., G.D. Johnson, W.P. Erickson, and C.E. Derby. 2000. Wildlife monitoring studies for the SeaWest Wind power Plant, Carbon County, Wyoming. Proceedings of the National Avian Wind Power Planning Meeting III. National Wind Coordinating Committee, c/o RESOLVE, Inc., Washington, D.C.

Strickland, M.D., G.D. Johnson, W.P. Erickson, S. Sarappo, and R. Halet. 2000. Avian use, flight behavior and mortality on the Buffalo Ridge, Minnesota Wind Resource Area. Proceedings of the National Avian Wind Power Planning Meeting III. National Wind Coordinating Committee, c/o RESOLVE, Inc., Washington, D.C.

Ward, D.H., R. A. Stehn, W. P. Erickson,and D. V. Derksen. 1999. Response of fall-staging brant and Canada geese to aircraft overflights in Alaska. J. Wildl. Manag. 63:382-391.

Erickson W.P., G. D. Johnson, M. D. Strickland, and K. Kronner. 1999. Avian baseline study at the proposed CARES Windplant, Goldendale WA. NREL/SR-500-259.

Erickson, W.P., T. Nick and D.H. Ward. 1998. Investigating flight response of brant on the Izembek NWR, Alaska, using logistic regression techniques. in "Statistical Case Studies: A Collaboration Between Academe and Industry". eds, R. Peck, L.D. Haugh, and A. Goodman ASA/SIAM, Philadelphia, PA pp. 155-171.

Erickson, W.P. T. McDonald, and R. Skinner. 1998. Habitat selection using GIS data: A case study. JABES. 3: 296-310.

Strickland M.D., Johnson, G.D., W. Erickson, S. Sarappo and R. Halet. 1997. Assessing impacts to birds from the Buffalo Ridge, Minnesota windplant development. Proceedings from the American Wind Energy Association Conference, June 15-18, in Austin TX. Pp. 281-290.

Johnson, G., D. Young, W. Erickson, and D. Strickland. 1996. Assessing river habitat selection by waterfowl wintering in the South Platte River, Colorado. Wetlands. 16: 542-547.

Highsmith, R.C., T.L. Rucker, M.S. Stekoll, S.M. Saupe, M.R. Lindeberg, R. Jenne and W.P. Erickson. 1996. Impact of the *Exxon Valdez* oil spill on intertidal biota. In Rice, S. D., R. B. Spies, D. A. Wolfe, and B. A. Wright (eds). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18.

Stekoll, M.S., L. Deysher, R.C. Highsmith, S.M. Saupe, Guo, W.P. Erickson, L.L. McDonald and M.D. Strickland. 1996. Coastal habitat injury assessment: intertidal communities and the *Exxon Valdez* oil spill. In Rice, S. D., R. B. Spies, D. A. Wolfe, and B. A. Wright (eds). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18: 177-192.

Erickson, W. P., and L.L. McDonald. 1995. Tests for bioequivalence of control media and test media in studies of toxicity. Journal of the Society of Environmental Toxicology and Chemistry. 14:1247-1256.

PROFESSIONAL PUBLICATIONS/PROCEEDINGS (continued)

Barber, W.E., L.L. McDonald, W.P. Erickson, and M. Vallarino. 1995. Effect of the *Exxon Valdez Oil Spill* on

intertidal fish: a field study. Trans. Amer. Fish. Soc. 124: 461-476.

Marr, J.C.A., H.L. Bergman, M. Parker, J. Lipton, D. Cacela, W. Erickson, and G.R. Phillips. 1995. Relative sensitivity of brown and rainbow trout to pulsed exposures of an acutely lethal mixture of metals typical of the Clark Fork River, Montana. Can. J. Fish. Aquat. Sci. 52: 2005-2015.

McDonald, L. L. M.D. Strickland and W. P. Erickson. 1995. Coastal Habitat Injury Assessment: Design, Analysis and Statistical Inference. In *Exxon Valdez Oil Spill:* Fate and Effects in Alaskan Waters. P. G. Wells, J. N. Butler, and J.S. Hughes, eds. ASTM STP 1219, Atlanta, GA.

McDonald, L.L. and W.P. Erickson. 1994. Testing for bioequivalence in field studies: Has a disturbed site been adequately reclaimed. Proceedings of the Statistics in Ecology and Environmental Monitoring Conference. pp. 183-197.

McDonald, L. L., D. J. Reed, and W. P. Erickson. 1991. Analysis procedures for habitat and food selection studies. In Proceedings 4th North American Caribou Workshop. [eds. C. E. Butler and S. P. Mahoney] Newfoundland and Labrador Wildlife Division, St. John's, Newfoundland. pp. 429-474.

PAPERS PRESENTED AT REGIONAL AND NATIONAL MEETINGS

Erickson, W.P. Wildlife Impact and Risk Assessment Methods for Wind Energy Projects. Presentation at the 2005 American Wind Energy Association. Denver, CO.

Erickson, W.P. Prevention and Mitigation of Avian Impacts at Wind Energy Projects. Invited presentation at the 2005 Grassland Birds Conference, Fort Collins, CO.

Erickson, W.P. Bat Fatalities at Two Eastern Wind Power Projects. Invited Presentation at the 2005 Western Bat Working Group Meeting. Portland OR.

Erickson, W.P. Update on Bird and Bat Impacts at Wind Energy Projects. Presentation at the 2004 TWS Conference, Calgary.

Erickson, W.P. Bat Fatality Monitoring Methods, Fall 2004. Mountaineer and Meyersdale. Invited presentation at the 2004 NWCC Research Meeting, November, Washington D.C.

Erickson, W.P. Preliminary Fatality Results:, Meyersdale Wind Energy Facility Fall 2004. Invited presentation at the 2004 NWCC Research Meeting, November, Washington D.C.

Erickson, W.P. 2004. Direct and Indirect Impacts of Wind Projects on Wildlife. Invited presentation at the Michigan Audubon Societies Annual Meeting. East Lansing Michigan, March 5th and 6th, 2004.

Erickson, W.P. 2004. Update of Bird and Bat Mortality and Collision Risk at Wind Projects, the Latest Data and Science. AWEA 2004 Conference, Chicago, Illinois.

Erickson, W.P. 2004. Perspectives Regarding Avian Mortality, What Are the Messages?Invited Presentation to Environment Canada's National Wind Power and Environmental Assessment (EA) Workshop on May 11-12, 2004. Montoc, New Brunswick.

Erickson, W.P. Update on Bird and Bat Mortality and Risk at wind projects. Paper at the 2003 Biological Significance Workshop, NWCC Wildlife Working Group, Washington, Washington, D.C. November 2003.

Erickson, W.P. Bird mortality at wind projects. Invited paper at the 2002 American Bird Conservancy Policy Council Meeting, Washington, D.C. December 2002.

Erickson, W.P. Bird Mortality at Wind Projects and from Other Anthropogenic Sources. Invited paper at the 2002 Minnesota Ornithological Union Conference, Minneapolis, MN. December 2002.

Erickson, W.P. Avian collisions with wind turbines: a summary of existing data and a comparison to other sources of bird mortality. Contributed paper at the Windpower 2002 Conference, Portland, OR, June 2002.

Erickson, W.P. Summary of anthropogenic causes of avian mortality. Invited paper at the 2002 International Partner's In Flight Meeting, March, 2002. Monterrey, California.

Erickson, W.P. Avian collisions with wind turbines. Invited paper at the International Conference on Utility Structures, March, 2002. Fort Collins, Colorado.

Erickson, W.P. Avian mortality from anthropogenic causes. Invited paper at the Washington State Audubon Meeting, September 2001, Walla Walla, WA.

Erickson, W.P. Statistical methods for estimating wildlife fatality rates. 2001 TWS Meeting, Reno, NV.

Erickson, W.P. Modeling moose habitat. January 2000. Workshop organizer and presenter for state and federal agency personnel in Alaska.

Erickson, W.P. 1999. Statistical issues in resource selection studies. Invited paper presented at the symposium "Modeling Species Occurrences", Snowbird, UT.

PAPERS PRESENTED AT REGIONAL AND NATIONAL MEETINGS (continued)

Erickson, W.P. 1999. Statistical issues in resource selection studies with radio-marked animals. Invited paper in the radio-telemetry session at the Wildlife Society Meeting, Dallas TX.

Erickson, W.P., October 1999. Use Of GIS in monitoring impacts of windplants on wildlife. Invited paper presented at the EPPL7 User's Conference, St. Paul, MN.

Erickson, W.P., and M.D. Strickland. 1997. Assessing Impacts to Birds from the Buffalo Ridge, Minnesota Windplant Development. Invited paper presented at the AWEA Meeting, Austin, TX.

Erickson, W.P., M.D. Strickland, G. Johnson, and J. Kern. 1998. Examples of Risk Assessment Methods for Studying Impacts of Birds from Windplants. Invited paper presented at the NWCC Meeting, San Diego, CA.

Erickson, W.P. and M.D. Strickland. 1997. Assessing impacts to birds from the Buffalo Ridge, Minnesota Windplant Development. Invited paper presented at the AWEA Meeting, Austin, TX.

Erickson, W.P. 1997. Resource selection techniques with GIS data. Invited talk presented at the BLM/DU Satellite Imagery Conference, Anchorage, AK.

Erickson, W.P. 1997. Design and analysis issues when assessing environmental impacts to wildlife populations. Invited talk at Winona State University, Winona MN.

Erickson, W.P. 1997. Statistical considerations in observational field studies: What can you infer? Invited paper at the Northwest Chapter of the Wildlife Society Meeting, Sun River, Oregon.

Erickson, W.P. and T. McDonald. 1996. Resource selection techniques using GIS. Poster presented at the National Wildlife Society Meeting in Cincinnati, OH.

Erickson, W.P. and T. Nick. 1996. Investigating flight response of brant on the Izembek NWR, Alaska, using logistic regression techniques. Poster presented at the ASA meeting in Chicago.

Erickson, W.P., November 1995. Habitat selection by moose on the Innoko National Wildlife Refuge in West-Central Alaska. Invited paper presented at the EPPL7 User's Conference, St. Paul, MN.

Erickson, W.P., M.D. Strickland and L. Sharp. September 1995. Experimental design for the study of wind power effects on wildlife. Poster presented at the National Wildlife Society Meeting in Portland, Oregon.

Erickson, W.P. and L.L. McDonald. July 1995. Practical aspects of adaptive sampling. Invited paper presented at the Western North American Region of the Biometrics Society, Stanford, CA.

McDonald, L.L. and W.P. Erickson. November 1994. A shift in paradigm for statistical analysis in risk assessment. Paper presented at the Society of Environmental Toxicology and Chemistry, Denver, CO.

Erickson, W. P. November 1994. An approximate solution to the Behran-Fisher's problem with application to NRDA and toxicity testing. Paper presented at the Society of Environmental Toxicology and Chemistry, Denver, CO.

Erickson, W. P.and L. L. McDonald. November 1992. Formulations of hypotheses of assumed effect in bioassay. Paper presented at the Society of Environmental Toxicology and Chemistry, Cincinnati, OH.

ANDREW H. YOUNG

4952 SE 28^{th} Avenue # 648
Portland, Oregon 97202
Tel. (503)-222-9400

EDUCATION

1997 — **Contractor's State Licence Schools, Riverside, California**
- State of California Contractor's State Licence #738309

1986-1992 — **University of Waterloo, Ontario, Canada**
- Honours Bachelor of Applied Science Degree in Mechanical Engineering

April to December 1991 — **University of Braunschweig, Germany**
- participated in a university sponsored student exchange program
- completed courses in Energy Conversion, Environmental Pollution Control, Wind Turbine Aerodynamics and Design, and Turbo-machines

WORK EXPERIENCE

March 2001 to Present — **Project Development Director** (Wind Power Projects)
Zilkha Renewable Energy, Portland, Oregon
- managing the development of 500 MW of new wind power projects including land acquisition, permitting and power purchase agreement negotiations
- prepared the business and marketing plan for wind projects in the Northwest US
- prospecting for new wind power project sites in the Northwest
- prepared and submitted multiple bid proposals to various utilities including BPA, Puget Sound Energy, Eugene Water and Electric Board and others
- prepared and submitted multiple applications for transmission system interconnection and wheeling and led technical review of power flow studies
- analysis and evaluation of wind energy production estimates and forecasts
- design of wind power project layouts and plant configurations

February 1998 to March 2001 — **Project Manager** (Wind Power Project Development and Construction)
enXco, inc., Palm Springs, California
- managed the development of 170 MW of new wind power projects
- managed the full turnkey engineering, procurement and construction (EPC) of a 42 MW wind power plant in Iowa including all prime and sub-contract negotiations
- developed a 2 MW wind project for a Coop Utility Group's green power program including land acquisition, permitting and power purchase agreement negotiations
- prospected for new wind power project sites around the US on the basis of wind resource, transmission availability and land suitability
- prepared bid packages for wind power projects throughout the USA

June 1995 to February 1998 — **Project Engineer** (Wind Power Projects)
Vestas-American Wind Technology, Inc., Palm Springs, California
- managed the turnkey installation of a 1.5 MW wind project in Canada
- prepared successful bid proposals for wind power projects in the USA, Canada and Mexico including: cost estimating, technical design (civil & electrical) and wind data analysis (energy production estimates)
- supported smaller developers with PPA review and wind resource assessment
- led technical seminars on project design, power quality and wind data analysis

Exhibit 17

- prepared marketing plans and sales forecasts for Canada and the United States

January to March 1995	**Technical Consulting Engineer** (Diesel Electric Generators) **ICEMASTER GmbH, Paderborn, Germany: Panda Generators** - analysed the design of a synchronous generator to optimise magnetic flux paths and improve performance - translated technical manuals and marketing literature for generator power systems - provided technical sales support to customers at trade shows in Germany
February 1993 to August 1994	**Manufacturing Process Engineer** (Automotive Electric Motors) **SIEMENS Electric Ltd., London, Ontario, Canada** - analysed a resistance welding process theoretically and experimentally for the development of a new closed loop control system - performed economic analyses to justify new manufacturing tooling and techniques - designed and tested new armature core configurations to enhance motor manufacturability, quality and performance - prepared an armature manufacturing system strategy based on technologies and operations visited at Siemens facilities in both North America and Germany
May to September 1992	**Project and Design Engineer** (Transformer Manufacturing Systems) **ASEA Brown Boveri (ABB) Ltd., Guelph, Ontario, Canada** - designed and implemented manufacturing tooling for improved transformer coil quality, worker ergonomics, and reduced manufacturing time - prepared business plans to prove pay back and profitability of new tooling investments - led manufacturing method studies to determine optimal material flow and handling procedures
September to December 1991	**Aerodynamics and Design Project Engineer** **DEWI (Deutsches Windenergie-Institut), Wilhelmshaven, Germany** - designed field computer data acquisition systems for the measurement of rotor blade fatigue loads - coded rotor blade aerodynamic performance calculations using FORTRAN - led presentations in German on potential flow calculation techniques - translated and prepared technical reports for international wind energy conferences
May to August 1990 and January to April 1991	**Junior Stress Engineer** **Dowty Aerospace Toronto, Ajax, Ontario, Canada** - performed detailed stress analyses manually and with Finite Element Modelling for the Canadair CL-601 RJR (Regional Jet) main landing gear - interacted with the Test Engineering Department to ensure safe final design conforming to FAR and JAR air worthiness standards
January to August 1989	**Mechanical Design Engineer** **IBM Deutschland GmbH, Böblingen, Germany** - led detailed studies and design projects on printers and other devices intrinsic to banking machines (CRS 5 DOF arm robot) - produced design drawings using IBM CADAM - researched and tested design prototypes for machine applications
May to	**Junior Automation and Robotics Engineer**

August 1988	**IBM Canada Limited, Toronto, Ontario, Canada** - automated a manufacturing process using a gantry head fluid dispensing robot - researched and tested the capabilities of the robot in different manufacturing environments
September to December 1987	**Computer Support Specialist** **IBM Canada Limited, Toronto, Ontario, Canada** - coded and implemented various programs in REXX for use on IBM's mainframe operating system - consulted employees on technical problems in using various PC hardware and software
January to May 1987	**Junior Contract Administrator** **Ontario Hydro, Darlington Nuclear Generating Station, Canada** - analysed and monitored the progression of various piping construction contracts using LOTUS 123 software - inspected installation and construction completion of conventional pipelines, valves, hangers and pumps
SPECIFIC SKILLS	- fluent German (written and spoken), elementary French - WINDOWS, UNIX, DOS, VM/VMS, LOTUS-123, EXCEL, WORD, WP, REXX, FORTRAN, Machine Assembler, CADAM, WAsP, WA System, Decibell, Park
AWARDS	- Sanford-Fleming Award for outstanding achievement in technical oral presentations - awards for outstanding Engineering work term reports - London Conference Track & Field Champion in Javelin. 1986