Yukon-Kuskokwim Health Corporation
Wind Generation Feasibility Study

Prepared For

U.S. Department of Energy
Golden, CO

Final Report

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On behalf of
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Bethel, AK

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PREFACE

EMCOR Energy & Technologies (EE&T) of San Francisco, California, prepared this document on behalf of Yukon-Kuskokwim Health Corporation (YKHC) for the U.S. Department of Energy (DOE). The authors of this report are Lance C. Kincaid, P.E., and Taylor T. Geer of EE&T. Michael K. J. Anderson, P.E., of EE&T reviewed this report for technical quality. Tom Humphrey, YKHC, David Berlin, YKHC, Gary Kuhn, Alaska Native Tribal Health Corporation (ANTHC), and other YKHC staff assisted with this study. Please note that during the course of this study, EMCOR Energy & Technologies changed its name from Newcomb Anderson Associates as part of a corporate branding initiative.

The purpose of this study is to investigate the technical and economic feasibility of installing wind generation equipment in Bethel, Alaska and surrounding Alaska Native communities in YKHC region. This study identifies existing electric and thermal loads, investigates and evaluates appropriate equipment configurations and sizing options, provides preliminary savings estimates for a selected option, and establishes order of magnitude cost estimates. Some of the assumptions used in this analysis may have a significant impact on project economics and should be confirmed before project implementation.

The optimal methods of accomplishing the recommendations should be determined during the implementation phase. This study does not include specific design instructions. It is not intended as a design document and projects have not been developed to design level. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

ACKNOWLEDGMENTS

EE&T gratefully acknowledges the assistance of Tom Humphrey, YKHC, David Berlin, YKHC, and Gary Kuhn, ANTHC, in coordinating with YKHC, and Lizana Pierce and Lisa Decker in coordinating with the DOE and the National Renewable Energy Laboratory (NREL).

1. EXECUTIVE SUMMARY

The purpose of this study is to investigate the technical and economic feasibility of installing wind generation equipment in Bethel, Alaska and surrounding Alaska Native communities in YKHC region. This study identifies existing electric and thermal loads, investigates and evaluates appropriate equipment configurations and sizing options, provides preliminary savings estimates for a selected option, and establishes order of magnitude cost estimates. Some of the assumptions used in this analysis may have a significant impact on project economics and should be confirmed before project implementation.

Early on in the process, four specific sites were chosen for focused analysis of wind generation potential. These sites were chosen based on the perceived wind resources available and the existing and planned host energy requirements. The sites were also selected based on the ability to conduct the feasibility study activities and potentially establish wind generation facilities without negatively affecting endangered wildlife in the YKHC region. Consideration was also given to benefits that proposed wind generation facilities would confer on the surrounding environment and the people living at or near the chosen sites. Four sites were chosen based on this evaluation, and wind measurement equipment was erected at the following sites:

- On land adjacent to the Yukon-Kuskokwim Delta Regional Hospital (YKDRH) in Bethel, near the local utility power plant,
- Near the new YKHC McCann Treatment Center (Kasayuli Inhalant Clinic) in Bethel,
- Near the YKHC Clinic in Emmonak Village, and
- Near the YKHC Clinic currently being constructed in Newtok Village.

At each of these sites, wind velocity and direction were monitored with 20-meter anemometer towers. Data were collected and logged every 10 minutes for a period of at least one year at each site, with the exception of Newtok, which had a shorter data collection period due to conflicts with construction and other issues. This data collection period lasted from March 2003 to April 2004. Table 1.1 shows a summary of the measured wind data at the four chosen sites.

Based on the energy requirements at the host sites, the YKDRH was matched with a 50 kW nominal capacity wind turbine manufactured by the Atlantic Orient Corporation, and the other three sites were matched with 10 kW nominal capacity wind turbines manufactured by Bergey Windpower, Incorporated. The matching of the 10 kW turbine at the Newtok site is based on the expectation that the clinic currently being constructed there will have loads similar to those experienced by the Emmonak site.

Table 1.1: Monthly Averages and Yearly Extremes of Measured Wind Speed Data

Monthly Average Data								
	Avg. Wind Speeds (mph)				Avg. Wind Speeds (m/s)			
Month	YKDRH	McCann	Emmonak	Newtok	YKDRH	McCann	Emmonak	Newtok
1	11.86	12.94	15.88		5.30	5.79	7.10	
2*	11.75	10.71	14.72		5.25	4.79	6.58	
3*	12.80	11.82	15.13		5.72	5.29	6.77	
4*	11.26	10.76	13.63	9.28	5.03	4.81	6.09	4.15
5	9.75	9.65	11.29	10.83	4.36	4.32	5.05	4.84
6	9.09	9.14	10.80	11.99	4.06	4.09	4.83	5.36
7	10.95	9.93	12.48	13.23	4.90	4.44	5.58	5.92
8	9.15	8.66	10.35		4.09	3.87	4.63	
9	9.83	9.18	11.89		4.40	4.10	5.32	
10	10.86	10.55	12.90		4.86	4.72	5.77	
11	10.73	11.86	13.59		4.80	5.30	6.08	
12	8.63	10.77	11.21		3.86	4.82	5.01	

Yearly Extremes								
	Wind Speeds (mph)				Wind Speeds (m/s)			
	YKDRH	McCann	Emmonak	Newtok	YKDRH	McCann	Emmonak	Newtok
Max	37.00	42.54	43.48	35.87	16.54	19.02	19.44	16.04
Avg.	10.63	10.18	12.70	11.33	4.75	4.55	5.68	5.07
Median	10.03	9.74	12.12	11.93	4.48	4.36	5.42	5.33
Min.**	0.13	0.13	0.15	0.15	0.06	0.06	0.07	0.07

* Where two years of data have been gathered for a given month (Feb to Mar), the values shown represent the average of both years, 2003 and 2004.

** The minimums shown here represent the lowest non-zero measurements recorded. These may indicate zero wind speed readings of the measurement equipment (zero-reading measurement "noise").

The economics of the proposed wind generation facilities were then analyzed, based on the measured wind data specific to each site and manufacturer's performance specifications associated with the matched wind turbine equipment. Annual cost savings were calculated using historical energy rates for each site. Construction cost estimates have been generated using manufacturer supplied information, *RSMeans* estimating data, and information from other wind farms nearby in Alaska. Annual maintenance costs were estimated using manufacturer information and industry standards. See Table 1.2 for an economic summary of the analysis for the four sites.

Additionally, non-quantifiable benefits were identified and discussed. These include environmental benefits, opportunities for employment and skill development among the local residents, and increased self-sufficiency and independence for YKHC and the native peoples it serves. These issues should be considered when evaluating the simple payback periods of the proposed wind generation projects.

This report recommends that wind turbine generation facilities be erected at the two sites with the lowest simple payback periods: 50 kW at YKDRH (approximately 14 year simple payback period) and 10 kW at Newtok Subregional Clinic (approximately 17 year simple payback period). Simple payback periods are over 10 years, but projects are justified based on decreased emissions and increased employment opportunities discussed in previous sections. In addition, any potential future increases in the cost of fossil fuels will make the electricity generated by wind turbines more valuable, and thus simple payback periods will decrease.

The conceptual design of the proposed 50 kW and 10 kW wind generation facilities are discussed in this study, as well as their operation and maintenance. Potential environmental impacts that would result from the construction and operation of these plants include avian interactions, and visual and noise impacts on the surrounding areas. These issues affecting the design are addressed, as well as recommendations for dealing with these issues during the final design development and implementation phases.

Table 1.2: Summary of Analysis

Site	Proposed Wind Generation Capacity (kW)	Estimated Annual Electricity Generated (kWh/yr)	Estimated Annual Energy Cost Savings ($/yr)	Estimated Annual Maintenance Costs ($/yr)	Estimated Annual Net Cost Savings[1] ($/yr)	Estimated Construction Cost ($)	Unit Cost ($/kW)	Estimated Net Simple Payback Period[2] (yrs)
YKDRH	50	84,507	$14,168	$2,000	$12,168	$169,002	$3,380	13.9
McCann Treatment Center	10	10,000	$1,736	$619	$1,117	$71,512	$7,151	64.0
Emmonak Village Clinic	10	17,948	$2,788	$619	$2,169	$71,512	$7,151	33.0
Newtok Village Clinic	10	17,900	$4,819	$619	$4,200	$71,512	$7,151	17.0

[1] Estimated Annual Net Cost Savings = Estimated Annual Energy Cost Savings – Estimated Annual Maintenance Costs
[2] Estimated Net Simple Payback Period = Estimated Construction Cost ÷ Estimated Annual Net Cost Savings

2. BACKGROUND

2.1 Study Overview

The YKHC, in cooperation with the ANTHC and assisted by EE&T, has performed a study of the feasibility of installing new wind turbines on tribal lands in the town of Bethel, Alaska and surrounding communities served by YKHC facilities. YKHC investigated four site locations in and around the communities it serves. These locations are as follows:

- On land adjacent to the YKHC Bethel Hospital (YKDRH) near the local utility power plant,
- Near the new YKHC McCann Treatment Center in Bethel,
- Near the YKHC Clinic in Emmonak Village, and
- Near the YKHC Clinic currently being constructed in Newtok Village.

The primary goal of this project for the communities represented within this study is to achieve energy self-sustainability and reduce the area's dependence on fossil fuel based technologies. In pursuing this project, YKHC has had the opportunity to investigate reducing its dependence on utility supplied power that comes from power plants that utilize diesel driven technologies while creating its own clean energy supply.

This report was provided by EE&T for YKHC.

2.2 Description of DOE Grant Program

This feasibility study was conducted as part of the US DOE Renewable Energy on Tribal Lands Program. The YKHC was one of 14 Native American and Alaskan Native entities selected in 2002 for the program. This study is intended to investigate the technical, economic, and regulatory feasibility of installing small-scale wind turbines to provide power to YKHC facilities. The purpose of the study is to determine technical and economic feasibility and provide a plan for the implementation phase, which would consist of installing and operating wind turbines at the sites that prove feasible. The study analyzes four sites in detail.

2.3 Overview of Tribal Structure, Location and Demographics

The YKHC, a non-profit organization, is a regional health corporation, authorized by resolution of the traditional or IRA councils of its 58 members, to provide health care services to the people of the Yukon Kuskokwim Delta under Title III of the Indian Self-Determination and Education Act. YKHC is a federally recognized village corporation, organized group per the PL 92-638 Compact with the Indian Health Services (IHS) and YKHC.

YKHC is governed by a 21-member Board of Directors elected from 11 Administrative Units in the Yukon-Kuskokwim Delta. YKHC has three divisions: Administrative Services, Community Services, and Hospital Services. The President/CEO, who is hired by the Board of Directors, hires an Executive Vice President who oversees Administrative Services and the Vice Presidents of Community and Hospital Services. The corporation has over 1,000 employees and is steadily growing.

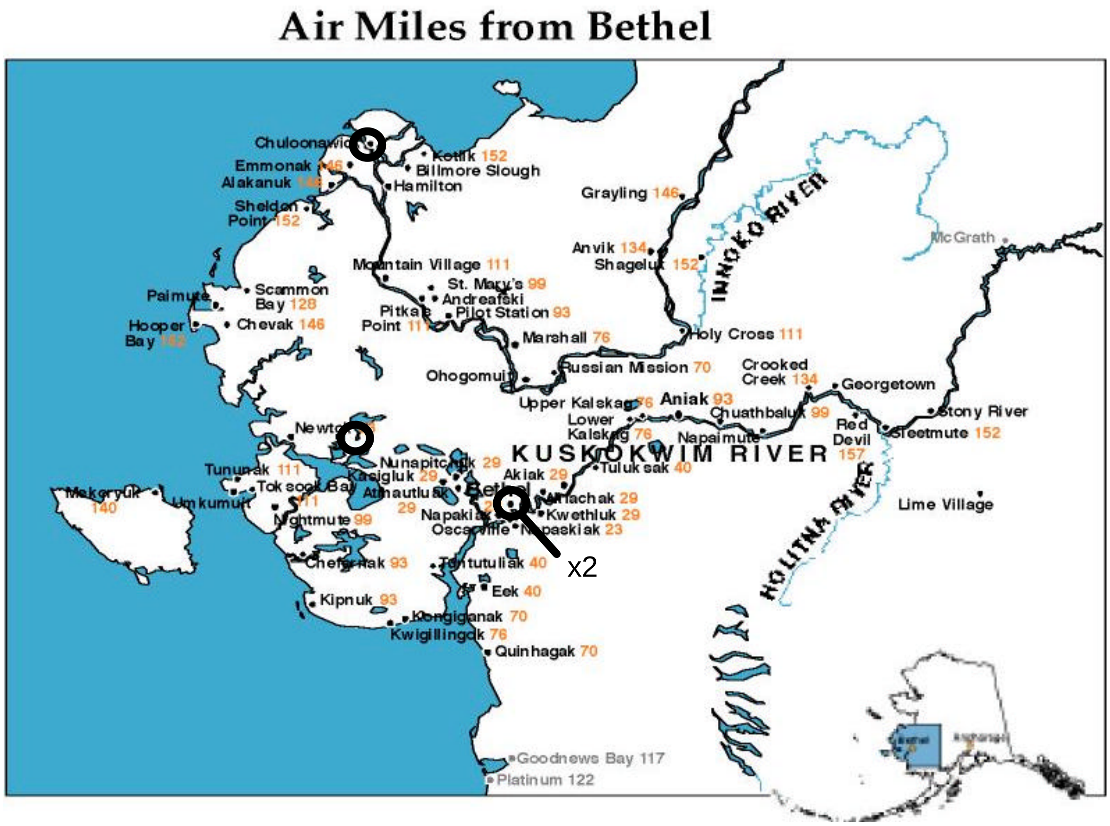
YKHC currently serves 56 western Alaska villages, which include three sub-regional clinics. More and more services are moving out to the villages, where the recipients of those services live. Besides the 50-bed acute care facility in Bethel, YKHC operates 47 village clinics, which are staffed by Village Health Aides who are certified nurses aides. It also supports one sub-regional clinic staffed by physician's assistants and nurse practitioners and there are plans for two additional sub-regional clinics.

The City of Bethel is located in southwestern Alaska, 40 miles from the mouth of the Kuskokwim River, and 400 air miles from Anchorage. One of the largest communities in western Alaska, it lies within the 20-million acre Yukon Delta National Wildlife Refuge, the largest wildlife refuge in the nation. Bethel serves as an administrative and transportation hub for 56 villages in the Yukon-Kuskokwim Delta. Figure 2.1 shows southwestern Alaska with air miles from each village to Bethel.

Bethel has experienced tremendous population growth over the past two decades. U.S. Bureau of Census and Alaska Department of Labor figures show Bethel's population in 1960 at 1,258; 1970 at 2,416; 1980 at 3,576; and 1990 at 4,764. The current population is 5,500. Roughly 2/3 of the population in Bethel is Yup'ik Eskimo. The traditional Yup'ik Eskimo practices and language remain predominant in the area, with subsistence activities and commercial fishing major contributors to residents' livelihoods. There is also a substantial Caucasian presence, plus other Alaska Natives, Aleuts, African Americans, Koreans, Filipinos and Albanians.

Local, state, and federal employment accounts for 50.2% of the jobs in Bethel, with private industry close, at 49.8% of the full-time work force. Almost 30% of the population are high school graduates, with an additional 10.5% having 1-4 years of college education. Many Bethel residents supplement their income with subsistence hunting, fishing, and berry picking activities.

Figure 2.1: Map of Areas Served by YKHC



2.4 Integration With the Cultural, Social and Long-term Self-Sufficiency or Economic Goals of the Tribe

Alternative power generation will provide the opportunity for self-sufficiency and fossil fuel independence in an unstable energy economic environment. Bethel and the surrounding communities are somewhat isolated regional communities in that there are no other sources of power beyond the utility monopoly or self-generation. Local utility power generation is exclusively fossil fuel based, primarily utilizing diesel fuel. Therefore, the more unstable the international oil industry becomes, the greater the impact locally on tribes' resources to meet and pay for their heating and electricity needs.

The local villages served by YKHC have a strong connection and reliance on the environment for the basic necessities of life, including food, water, shelter, and work. In promoting self-sufficiency, the villages gain better control over their resources and have better opportunities to protect the resources against depletion or degradation while harvesting these resources in a more sustainable fashion. Diesel fuel generation technologies typically give off significantly more emissions than other fossil fuels. By offsetting the need for power generated through these plants, local emissions can be lowered significantly.

Through implementation of wind power generation, YKHC will bring to the area new jobs and opportunity for education and training in renewable energy technologies. YKHC construction labor force, consisting of local trades people, would be used throughout the construction phase of any wind power generation project. YKHC maintenance staff would maintain the wind generators long-term.

2.5 Tribal-specific Project Objectives

The primary mission of the YKHC is to provide quality health care to the Alaska Native communities that it serves. Implementation of wind power generation will support that mission by reducing the YKHC's energy costs, freeing up more money for health care.

Another major objective of the YKHC and the Alaska Native communities that it serves is self-sufficiency. By reducing its reliance on diesel fuel that is drilled, refined, distributed, and sold by non-tribal entities, implementation of wind power generation will help achieve that goal. The construction, operation, and maintenance of wind power facilities will be done by YKHC employees, and the YKHC will gain valuable experience in renewable energy and self-generation that will allow it to continue to move toward energy self-sufficiency.

A third objective of the YKHC is the protection of the natural environment. The majority of the Alaska Native population served by the YKHC obtains at least part of its diet from hunting and fishing. They have a direct interest in maintaining a healthy environment. The reduced emissions and reduction in fuel transport and handling resulting from implementation of wind power generation will help maintain the local environment, as well as help address regional and global environmental issues such as acid rain and global warming.

2.6 How the Range of Renewable Energy Technologies Have Been Evaluated to Determine Which Are Technically and Economically Viable and Provide the Greatest Benefits to the Tribal Community

Prior to this study, YKHC undertook a comprehensive energy efficiency study of the Main Hospital Building in Bethel. This energy efficiency study included a preliminary assessment of self-generation potential, which indicated that a wind turbine project could be cost effective. This conclusion was based on the excellent wind resources in Bethel and the surrounding communities, and on the competitive price of wind power. Also, the feasibility of wind power has been successfully demonstrated in Kotzebue, Alaska, which has similar climatic characteristics as Bethel and is located close by to the north.

The technical and economic viability of wind turbine technology have been further evaluated in this feasibility study. Economic benefits have been quantified based on energy cost reductions and employment opportunities versus capital, operations, and maintenance costs. Non-quantifiable benefits are also identified and discussed. The YKHC uses Executive Order 13123 criteria as a basis for evaluating the feasibility of projects in addition to other factors, including those mentioned in this report (environmental, social, cultural, etc.).

2.7 Detailed Description of Chosen Sites

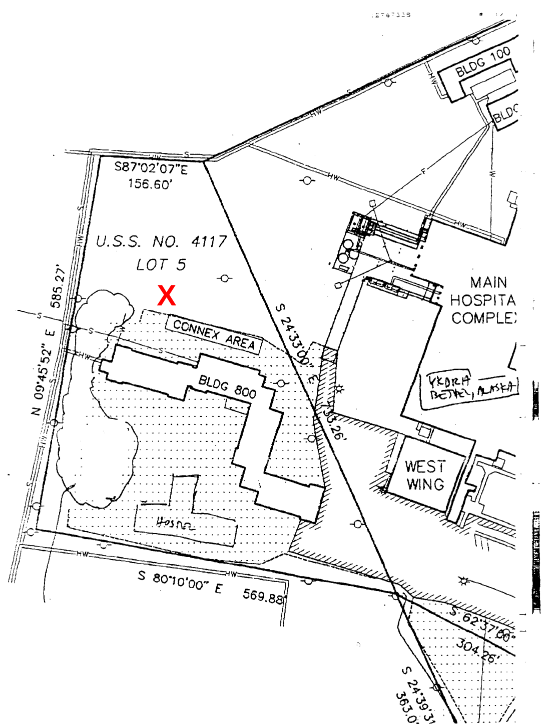
A description of the four sites considered under this study follows. These sites were chosen because of their appropriate electric loads, space available for wind generation facilities, high costs of energy, and expectations of favorable wind resources. These sites were also evaluated based on the U.S. Fish and Wildlife Services' concern for endangered bird species in the area, specifically eider species. The U.S. Fish and Wildlife Service indicated that the feasibility study activities at these sites would have no effect upon the threatened species. Under this study, a wind resource measuring station was erected at each of these sites, such that a year's worth of wind data could be measured.

Yukon-Kuskokwim Delta Regional Hospital - Bethel

YKDRH is located in the City of Bethel. The YKDRH is a 50-bed general acute care medical facility. The single-story, 100,000 square foot steel frame structure is fully accredited by the Joint Commission on Accreditation of Healthcare Organizations. Services located in the hospital include an adult medical-surgical ward, a pediatric ward, an obstetric ward, as well as outpatient family medicine clinics, an emergency room, pharmacy, lab, X-ray, and specialty clinics.

The Bethel Utilities Corporation provides electricity in Bethel. The wind monitoring tower was installed between the hospital and the power plant. The YKDRH and the area where the tower was erected are shown in the map provided below. This also shows the likely location of a wind generation facility, if one were to be constructed.

Figure 2.2: Potential Wind Turbine Area Near YKDRH



McCann Treatment Center – Bethel, Kasayuli Subdivision

The McCann Treatment Center is located in the Kasayuli Subdivision, about a mile and a half from the Bethel Airport. The McCann Treatment Center is a Residential Psychiatric Treatment Center (RPTC) located in Bethel, Alaska, which provides clinical psychiatric and substance abuse services for Alaskan youth between the ages of 10 and 17. The wind-monitoring tower was installed in an empty lot owned by YKHC near the clinic. Construction of this Center was completed and operation began in January 2004.

Pearl E. Johnson Subregional Clinic - Emmonak

Emmonak is a predominantly native village of approximately 800 people. The village is located on Kwiguk Pass, 8 miles from the Yukon River entering into Bering Sea. It is 490 air miles from Anchorage, Bethel, and Nome. A charter service provides transport to surrounding villages and also operates a small hotel. The City of Emmonak has a hotel, cafe, showers, laundromat, and a sauna. A lighted, well-graveled 4,400 foot runway for private and commercial aircraft is located just outside of town. Yukon kayakers and canoeists end Yukon river trips at this village. YKHC operates a subregional clinic in Emmonak, and two buildings are being constructed for YKHC personnel housing. The wind monitoring tower was installed in a clearing behind the housing buildings. Power in Emmonak is supplied by the Alaska Village Electric Cooperative (AVEC).

Village Health Clinic - Newtok Village

Newtok is a predominantly native village of approximately 350 people. YKHC currently operates a village clinic in Newtok and is constructing a new subregional clinic near the existing clinic. The clinic currently under construction is assumed to be similar in size and electric consumption to the subregional clinic YKHC currently operates in Emmonak. The wind monitoring tower was installed next to the water tower near the proposed clinic site. Power in Newtok is supplied by the Tribe-owned Ungusraq Electric Corporation. A diesel generator located near the existing clinic provides power to the Tribe.

A wind turbine was installed in Newtok approximately 15 years ago as part of an experimental State-run program. Due to a malfunction with the turbine electrical system, the building that housed the turbine electrical system, a post office, and city office burned down. Since then the turbine has not been operational. Nick Tom, Jr., of the Newtok Tribal Council, says that the Tribe is still interested in wind power because of the high price of electricity produced by diesel fuel.

The river bank near Newtok is eroding at a rapid rate, and there is some discussion about relocating the entire village to a nearby island, approximately 8 miles away.

3. RESOURCE ASSESSMENT & ECONOMIC ANALYSIS

This study focuses on wind power as the most viable renewable energy resource in the areas served by YKHC. This is evident based on the historically excellent wind resources in Bethel and the surrounding communities, and on the competitive price of wind power. Also, the feasibility of wind power has been successfully demonstrated in Kotzebue, Alaska, which has similar climatic characteristics as Bethel. Maps showing the wind resources in Alaska are provided below.

The wind resource at the four chosen sites served by YKHC has been assessed through analysis of historical recorded wind data and measured data gathered under this study.

Historical utility bills have also been gathered under this study in order to understand the existing energy consumption at the four chosen sites. These bills include information about both electricity and fuel consumption and costs, on a month-by-month basis.

These data have been used to select appropriate wind generation equipment and sites, and to quantify the amount of electricity that will be produced by the turbines.

3.1 Wind Resource Assessment

3.1.1 Historical Wind Data

Figures 3.1 through 3.3 show historical wind resources in the State of Alaska and the YKHC region [ref: http://rredc.nrel.gov/wind/pubs/atlas/maps.html]. It can be seen that much of the areas served by YKHC are historically designated as Wind Power Class 5 or greater. The area under consideration has been boxed in Figures 3.1 and 3.3.

The NREL says the following about Wind Power Classes in their *Wind Energy Resource Atlas of the United States*:

> "The wind resource maps estimate the resource in terms of wind power classes (Table 1-1), ranging from class 1 (the lowest) to class 7 (the highest). Each class represents a range of mean wind power density (in units of W/m2) or equivalent mean wind speed at the specified height(s) above ground. Areas designated class 3 or greater are suitable for most wind turbine applications, whereas class 2 areas are marginal. Class 1 areas are generally not suitable, although a few locations (e.g., exposed hilltops not shown on the maps) with adequate wind resource for wind turbine applications may exist in some class 1 areas.
>
> The wind power estimates apply to areas free of local obstructions to the wind and to terrain features that are well exposed to the wind, such as open plains, tablelands, and hilltops. Within the mountainous areas identified, wind resource estimates apply to exposed ridge crests and mountain summits."

The information shown in the following figures is based on historical data gathered prior to 1979, and then updated in 1983 by the U.S DOE.

Figure 3.3 shows the variation in wind power class at the four sites included in this study. The YKDRH and McCann Treatment Center Sites, both located in Bethel, are shown to be in regions with wind power class 4 to 5. The Emmonak Clinic Site is shown to be in a region with a wind power class of 5 to 6. The Newtok Clinic Site is shown to be in a region with a wind power class of 6 to 7. According to the historical data shown in this figure, all four of the sites included in this study are in regions with wind power classes of 3 or above, which are designated as "suitable for most wind turbine applications", according to DOE publications.

Figure 3.1: Wind Resources in Alaska – Average Annual Wind Resources

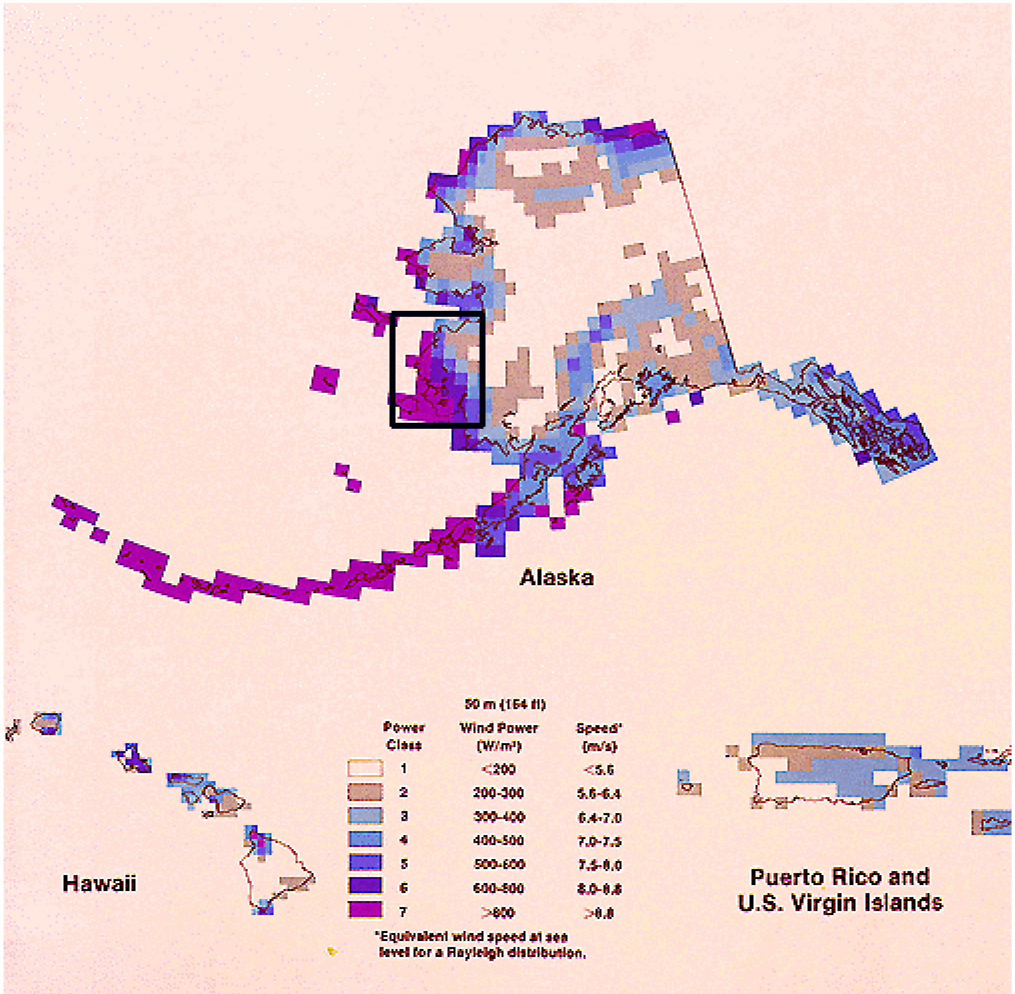
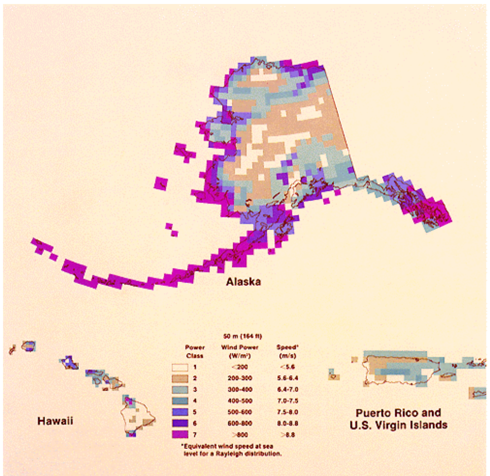
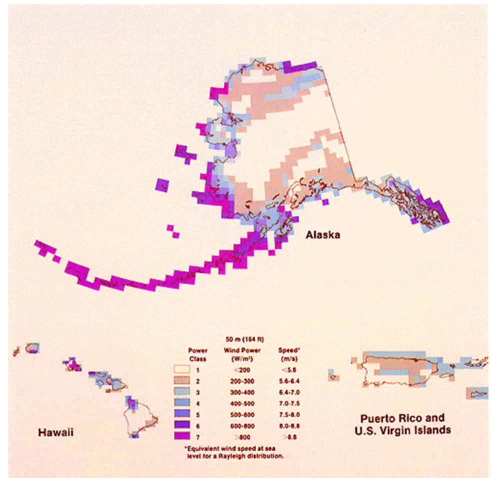


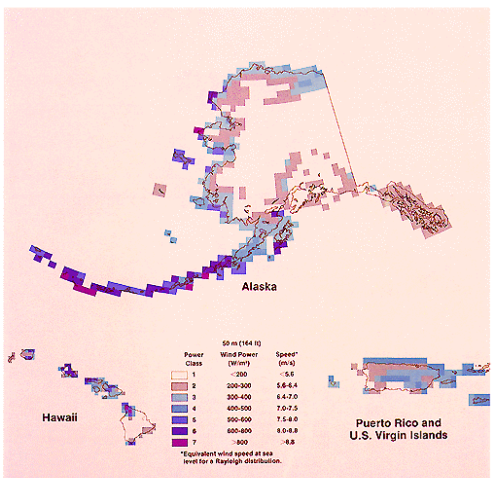
Figure 3.2: Wind Resources in Alaska – Average Seasonal Wind Resources



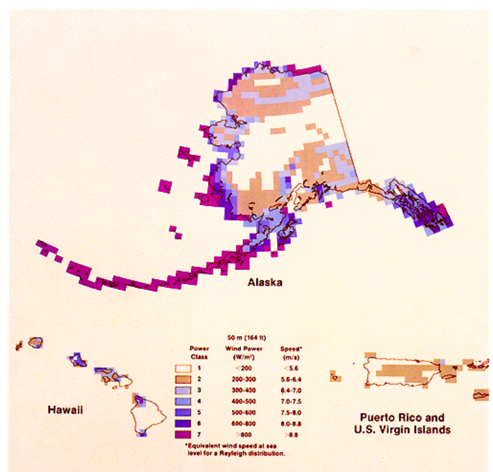
Winter



Spring

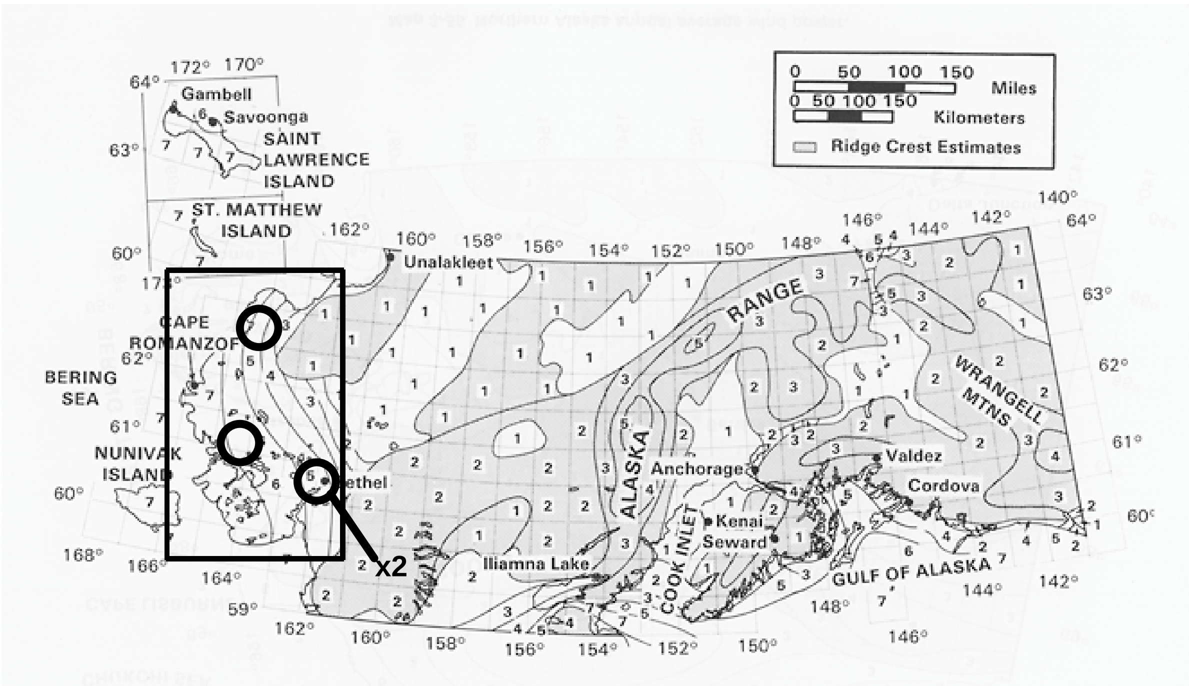


Summer



Autumn

Figure 3.3: Wind Resources in the Area of YKHC – Annual Average Wind Resources



3.1.2 Measured Wind Data Gathered Under this Study

At the specific sites that were included in this study, wind velocity was monitored with 20-meter anemometer towers. The anemometer installed in Newtok was obtained through NREL's Native American Anemometer Loan Program. The anemometers installed at the other three sites were purchased under this study.

Each wind monitoring system consisted of an NRG 20-meter tilt-up tower, an NRG Wind Explorer data logger, an NRG #40 anemometer, an NRG #200P wind direction sensor, and an NRG #110S temperature sensor.

The anemometer towers were erected at the YKDRH, McCann Treatment Center, and Emmonak Subregional Clinic sites at the end of February 2003 and immediately began collecting data. Due to a combination of inclement weather and logistical delays, the tower at the Newtok Clinic site could not be erected until the end of April 2003.

During August 2003, the anemometer tower at the Newtok Clinic site was taken down due to conflicts with the construction of a new clinic building in the village, and data collection was ended at this site. The crews building the new facility found it necessary to take down the tower in spite of prior efforts to locate the tower in a place that would not interfere with construction activities. Village representatives have confirmed that the disassembled tower components remain functional and are currently stored safely.

The measured wind data that were gathered under this study are presented and analyzed in this section. Approximately 580,000 data points were recorded and analyzed, which included measurements of wind speed, wind speed standard deviation, and wind direction, at 10-minute intervals over the course of a year at the four chosen sites.

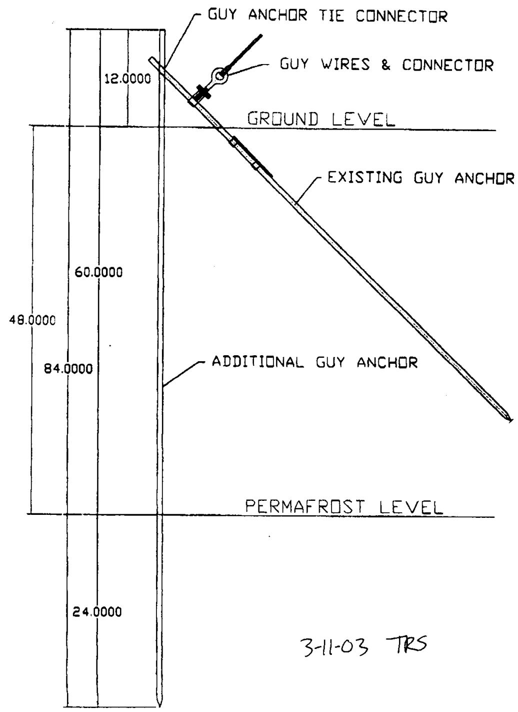
3.1.3 Special Considerations When Erecting the Anemometer Towers

<u>Permafrost</u>

The nature of the ground in the areas where the anemometer towers were erected required that guy-wire anchors be driven deep into the ground, such that they reached the permafrost (year-round permanently frozen layer of ground). If this had not been accomplished, there would have been a danger of the anchors pulling free during the summer when the ground thawed and lost its integrity. The permafrost layer in this region typically begins at a depth of 5 feet.

The tower guy-wires were secured into the permafrost by connecting each (of four sets of two) to two pieces of metal rebar, approximately 7 feet in length. One piece of rebar was driven down perpendicular to the ground surface such that approximately 3 feet of permafrost was penetrated. The other was driven in at an angle, toward the base of the tower, such that the tension of the guy-wires did not pull the anchors out of the ground. Figure 3.4 shows a schematic of this configuration.

Figure 3.4: Guy-wire Configuration[a]



[a] Units are given in inches.

Avian Populations

Special consideration was given to the potential that the anemometer towers would interfere with the flight of local avian populations by outfitting the guy-wires with BIRD-FLIGHT diverters, manufactured by Preformed Line Products. These are designed to make overhead lines and guyed structures visible to birds, and are recommended to be installed at 15-foot intervals along the guy-wires.

Icing

In colder climates such as is studied here, ice can build up on wind measuring equipment, which can lead to faulty data. During an icing event, typically the wind direction measurement vanes will freeze first. Both the average and standard deviation of an iced vane channel will read 0. The data loggers used for this study did not collect standard deviation data for each interval of wind direction data collected, therefore, this signal of icing events was not available for analysis.

The wind speed measurement anemometer can display signs of icing when the standard deviation slowly decreases to lower than normal levels over the course of many 10- minute intervals as the ice builds up on the spinning cups. The additional mass of the ice makes the anemometer act more like a flywheel, responding more slowly to changes in wind speed, hence, the lower standard deviation. After many 10-minute intervals of showing a decreasing standard deviation, the anemometer channel will often show a standard deviation "spike" in the 10-minute interval right before the anemometer stops spinning. That is, the standard deviation will rise sharply in one interval within a few 10-minute intervals of the anemometer stopping and then quickly going to 0.

The data collected for this study were reviewed for evidence of icing events, as displayed by the standard deviation of wind speed measurements, and at each site less than 0.5% of the data points collected exhibited the behavior described above that may have indicated icing was occurring. The conclusion is that the data as presented have not been significantly altered by equipment icing.

3.1.4 Data Collection and Transfer

Measured data were accumulated into modular data plugs located on the base of the anemometer towers. Local YKHC personnel and village residents were hired and trained to swap the data plugs. Each month a new data plug was installed at each of the four sites, and the removed plugs were mailed to NREL offices in Colorado. NREL staff downloaded the information from the plugs and converted the data into Excel spreadsheet format. The converted files were then sent to EE&T for analysis.

3.2 Federal Aviation Administration (FAA) Regulations Affecting Anemometer Towers

Federal Regulation 49 CFR Part 77 establishes standards and notification requirements for objects affecting navigable air space. This notification serves as the basis for determining the potential hazardous effect of proposed construction on air navigation. Notification allows the FAA to identify potential aeronautical hazards in advance, thus preventing or minimizing adverse impacts to the safe and efficient use of navigable air space.

Prior to the erection of the anemometer towers, the FAA office in Anchorage was contacted, and assistance of an Airport Planner (Gabriel Mahns) was obtained. The FAA representative indicated that the sites at YKDRH, McCann Treatment Center, and Emmonak Subregional Clinic were clear of what is deemed navigable air space, but that the Newtok Clinic site would require formal notification due to the nearby Newtok Airport.

The formal FAA notification process was followed for the Newtok Clinic anemometer. On February 25, 2003, the FAA provided approval to proceed with no aeronautical objections to the proposal for 12 months of monitoring.

3.3 Data Analysis

Table 3.1 shows the months for which data were collected for each site. Figures 3.5 through 3.8 show the daily averages of the 10-minute interval wind speed readings at the four sites. Note that due to the nature of computation of daily averages, the following figures are not representative of maximum and minimum wind speeds at the sites under consideration.

Table 3.1: Months of Wind Data Gathered Under Study

YKDRH (Bethel Main Hospital)	Bethel McCann Center (Kasayuli)	Emmonak Clinic	Newtok Clinic
March 2003	March 2003	March 2003	*
April 2003	April 2003	April 2003	*
May 2003	May 2003	May 2003	May 2003
June 2003	June 2003	June 2003	June 2003
July 2003	July 2003	July 2003	July 2003
August 2003	August 2003	August 2003	**
September 2003	September 2003	September 2003	**
October 2003	October 2003	October 2003	**
November 2003	November 2003	November 2003	**
December 2003	December 2003	December 2003	**
January 2004	January 2004	January 2004	**
February 2004	February 2004****	February 2004	**
March 2004		March 2004	
April 2004***		April 2004***	

* Erection of the Newtok Clinic anemometer tower delayed due to weather and logistical delays.
** Tower down due to conflict with construction projects.
*** Only 15 days of data (1/2 month) gathered for April 2004.
**** Only 5 days of data gathered for February 2004.

Figure 3.5: Average Measured Daily Wind Speeds at YKDRH, [20 meters height]

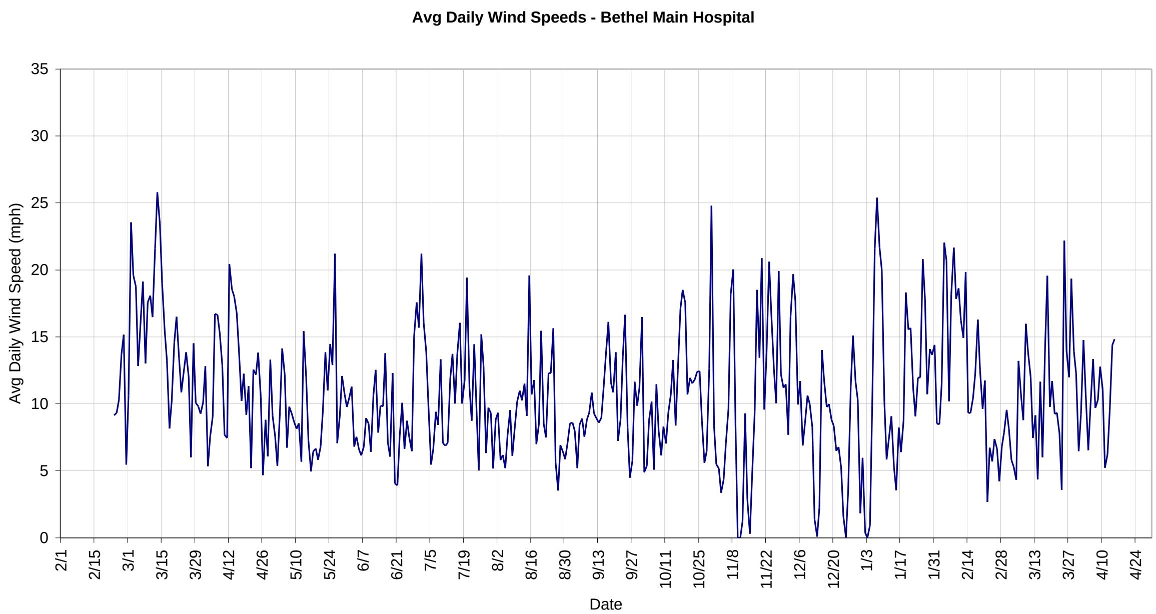


Figure 3.6: Average Measured Daily Wind Speeds at McCann Treatment Center, [20 meters height]

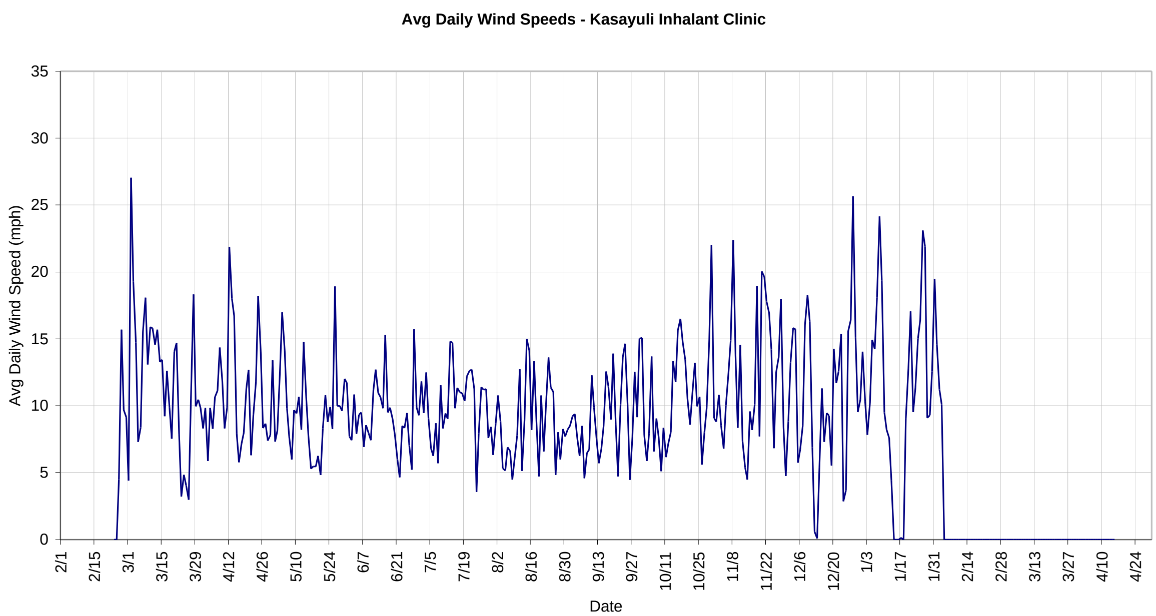


Figure 3.7: Average Measured Daily Wind Speeds at Emmonak Clinic, [20 meters height]

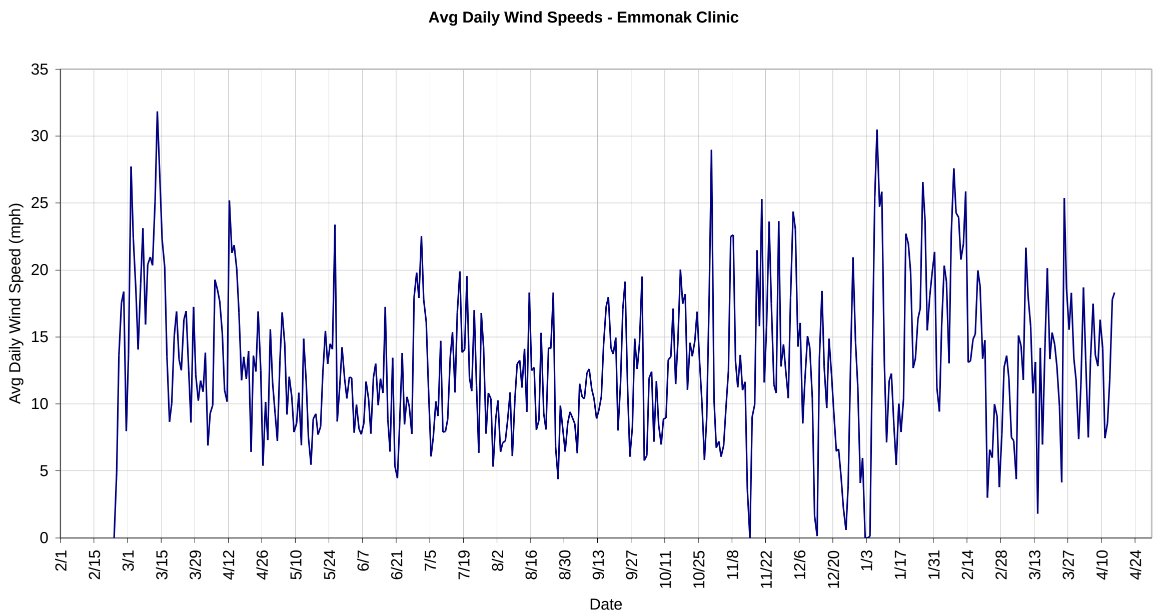


Figure 3.8: Average Measured Daily Wind Speeds at Newtok Clinic, [20 meters height]

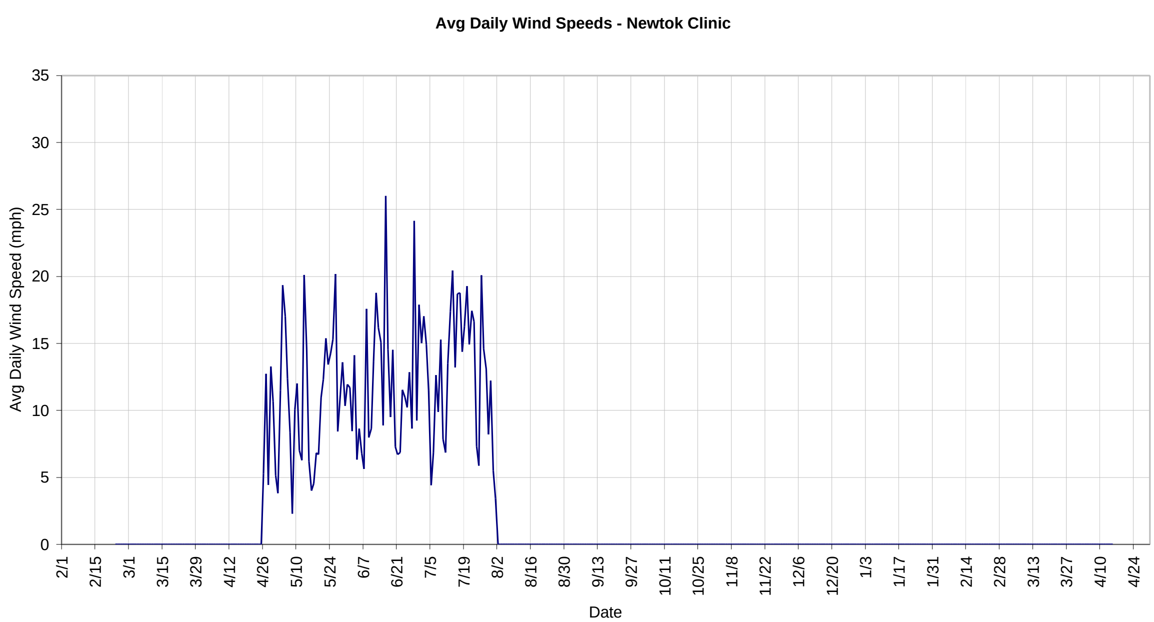


Table 3.2 shows the monthly averages and the annual extreme high and low wind speed measurements taken under this study.

Table 3.2: Monthly Averages and Yearly Extremes of Measured Wind Speed Data

Monthly Average Data								
	Avg. Wind Speeds (mph)				Avg. Wind Speeds (m/s)			
Month	YKDRH	McCann	Emmonak	Newtok	YKDRH	McCann	Emmonak	Newtok
1	11.86	12.94	15.88		5.30	5.79	7.10	
2*	11.75	10.71	14.72		5.25	4.79	6.58	
3*	12.80	11.82	15.13		5.72	5.29	6.77	
4*	11.26	10.76	13.63	9.28	5.03	4.81	6.09	4.15
5	9.75	9.65	11.29	10.83	4.36	4.32	5.05	4.84
6	9.09	9.14	10.80	11.99	4.06	4.09	4.83	5.36
7	10.95	9.93	12.48	13.23	4.90	4.44	5.58	5.92
8	9.15	8.66	10.35		4.09	3.87	4.63	
9	9.83	9.18	11.89		4.40	4.10	5.32	
10	10.86	10.55	12.90		4.86	4.72	5.77	
11	10.73	11.86	13.59		4.80	5.30	6.08	
12	8.63	10.77	11.21		3.86	4.82	5.01	

Yearly Extremes								
	Wind Speeds (mph)				Wind Speeds (m/s)			
	YKDRH	McCann	Emmonak	Newtok	YKDRH	McCann	Emmonak	Newtok
Max	37.00	42.54	43.48	35.87	16.54	19.02	19.44	16.04
Avg.	10.63	10.18	12.70	11.33	4.75	4.55	5.68	5.07
Median	10.03	9.74	12.12	11.93	4.48	4.36	5.42	5.33
Min.**	0.13	0.13	0.15	0.15	0.06	0.06	0.07	0.07

* Where two years of data have been gathered for a given month (Feb to Mar), the values shown represent the average of both years, 2003 and 2004.

** The minimums shown here represent the lowest non-zero measurements recorded. These may indicate zero wind speed readings of the measurement equipment (zero-reading measurement “noise”).

The following Figures 3.9 through 3.12 show the distribution (across all data measurements) of wind direction data as well as the average wind speed measured in each direction at each site. On each of these figures, 0 represents the north direction and 90 represents east.

Figure 3.9: YKDRH Wind Rose 2003-02-23 to 2004-04-15

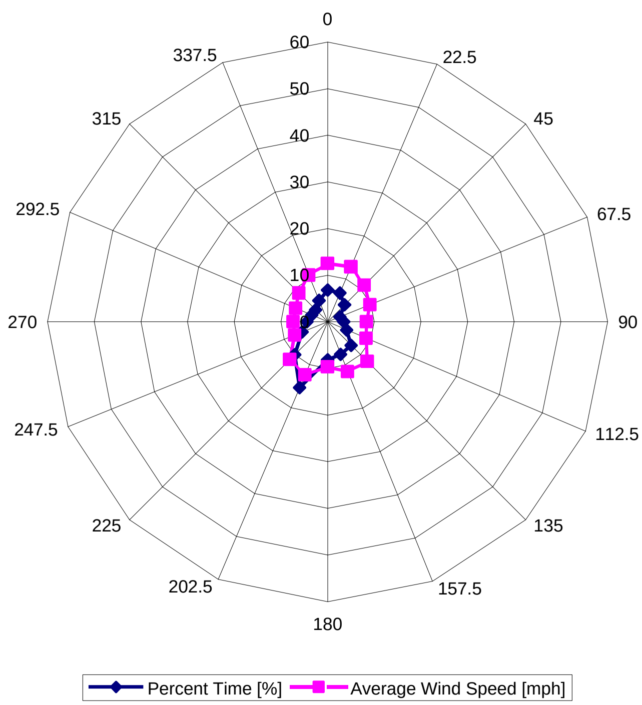


Figure 3.10: McCann Treatment Center Wind Rose 2003-02-23 to 2004-04-15

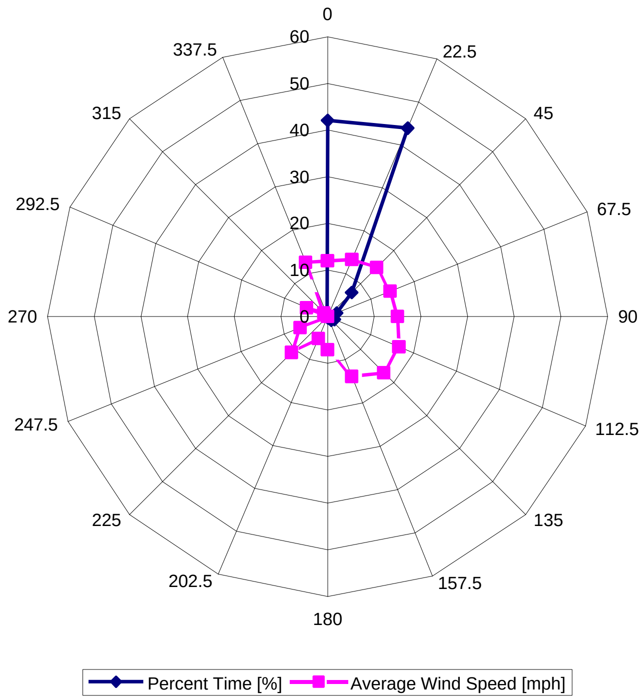


Figure 3.11: Emmonak Wind Rose 2003-02-25 to 2004-02-03

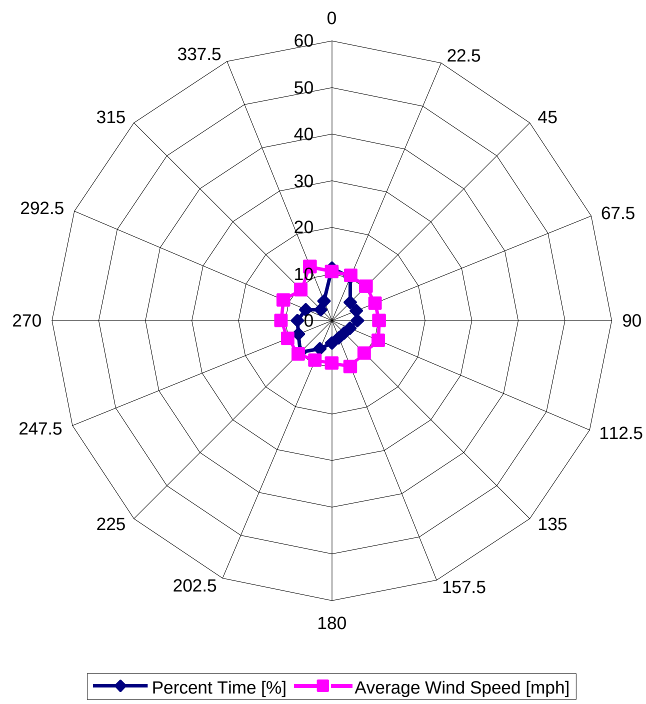


Figure 3.12: Newtok Wind Rose 2003-04-26 to 2003-08-01

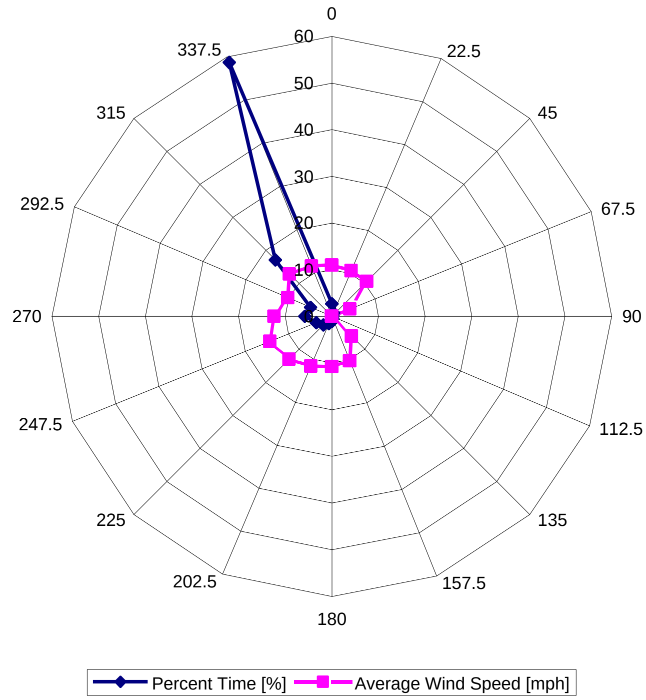
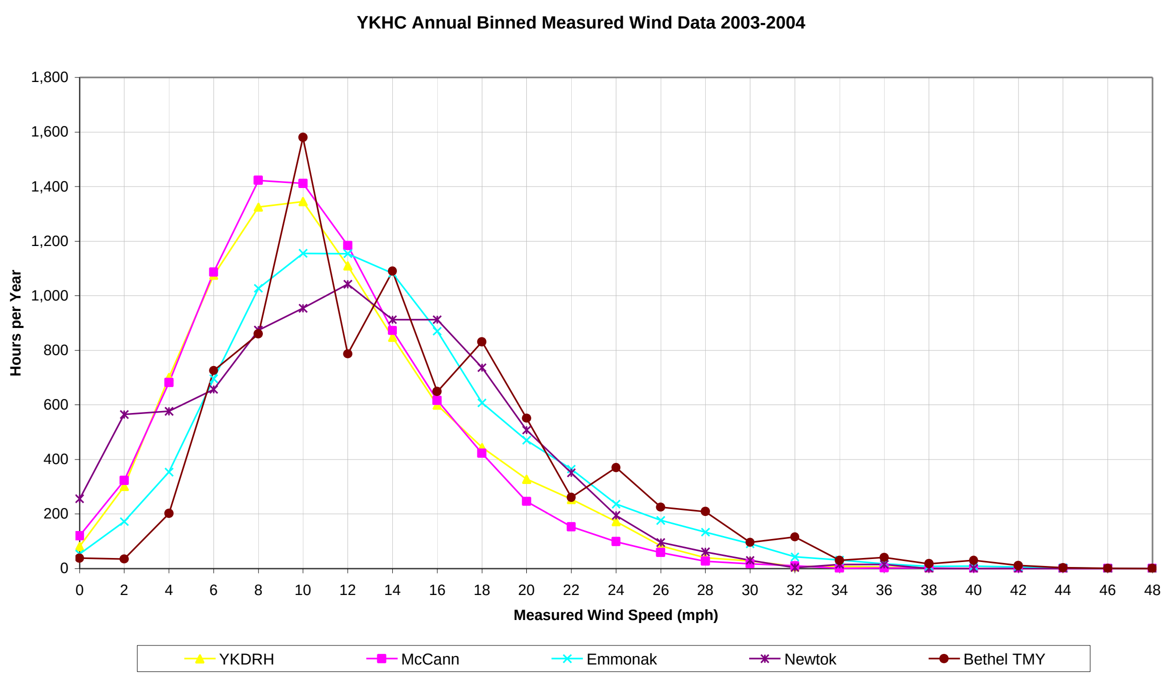


Figure 3.13 shows a bin analysis of the measured wind data gathered under this study. The figure shows how many hours per year the various wind speeds occurred as indicated across the bottom of the graph. The data shown represent a full-year of hourly wind-speeds, or 8,760 hours total per site. Since data were collected at Newtok for only a fraction of the year, the data shown in the figure for that site represents an extrapolation of the collected data to 8,760 hours.

The figure demonstrates that each of the sites studied experience wind speeds between 8 and 12 mph for a large number of hours per year. Also shown on the graph is the bin analysis of 20-year, typical meteorological year (TMY) wind speed data for Bethel, for purposes of comparison. The wind data measured under this study are similar to the TMY data.

Figure 3.13: Wind Speed Distribution of Measured Wind Data at All Four Sites and TMY Data for Bethel (8,760 hours total)



As stated above, the *Wind Energy Resource Atlas of the United States* groups regions into seven different wind power classes. This document indicates that locations in regions with a wind power class of 1 are poorly suited to make use of wind power generation, and regions with a wind power class of 2 are marginally suited candidates for wind power. Locations in regions with wind power classes of 3 through 7 are deemed to be good candidates for wind power generation.

Figures 3.14 through 3.17 show the percentage of hours measured at each site that would put the sites into “poor”, “marginal” or “good” classifications for wind power implementation. These figures show this information for the entire year, and provide breakdowns for summer (May through October) and winter (November through April) operation. As is expected for this geographic region, more time is spent in the “good” wind power class territory during the winter half of the year than during the summer half.

Figure 3.14: Percentage of Hours at Various Wind Power Classes – YKDRH

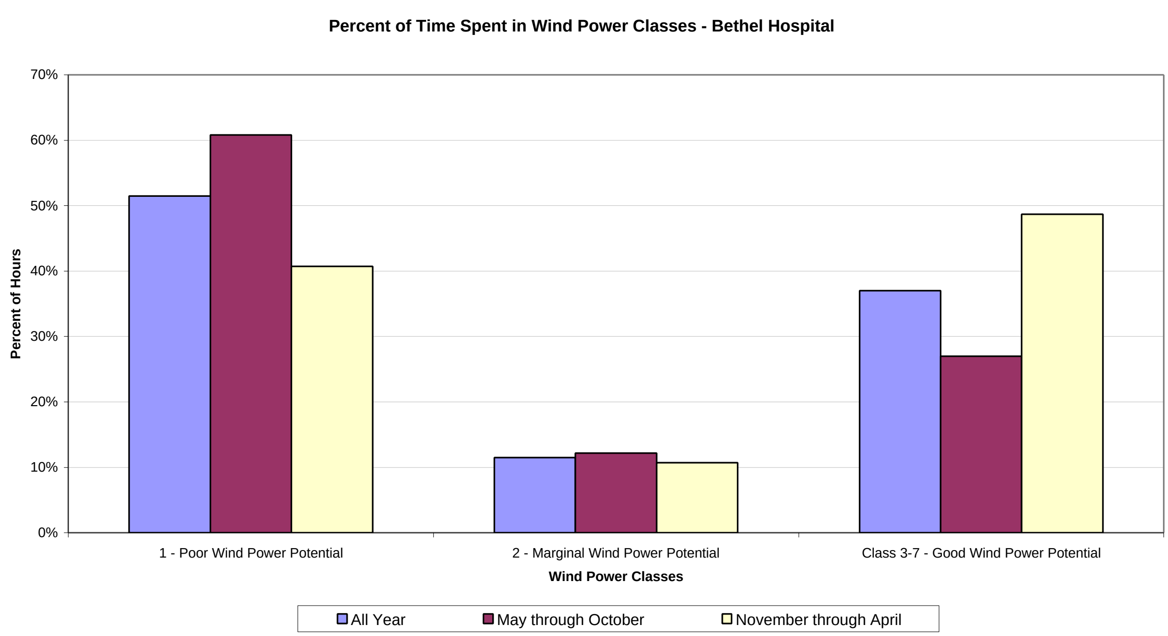


Figure 3.15: Percentage of Hours at Various Wind Power Classes – McCann Center

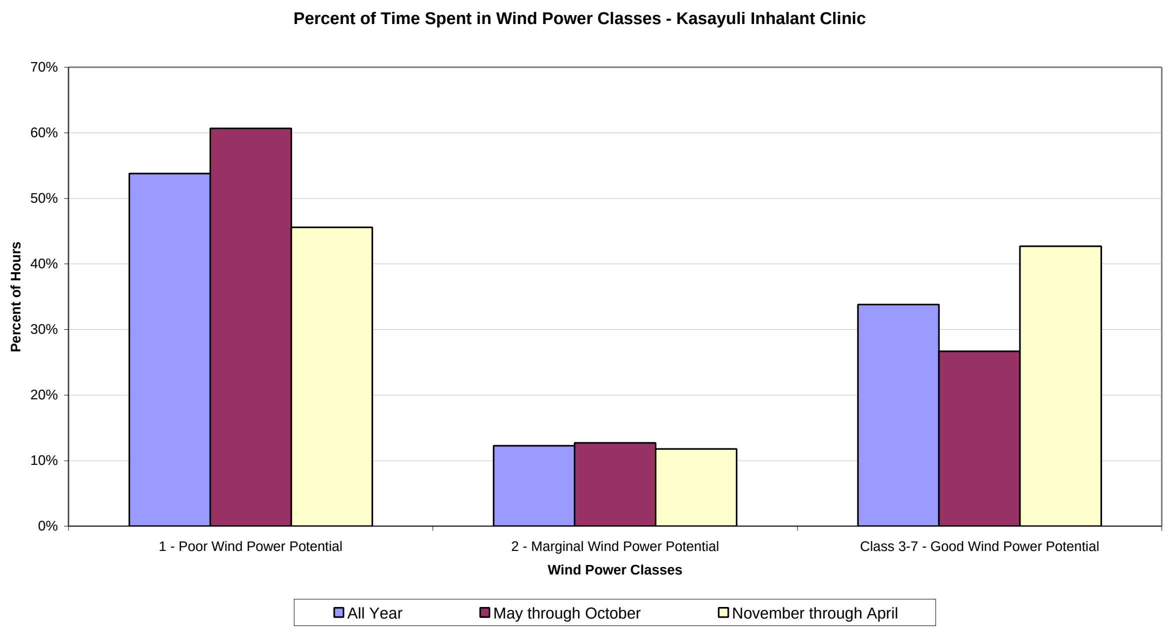
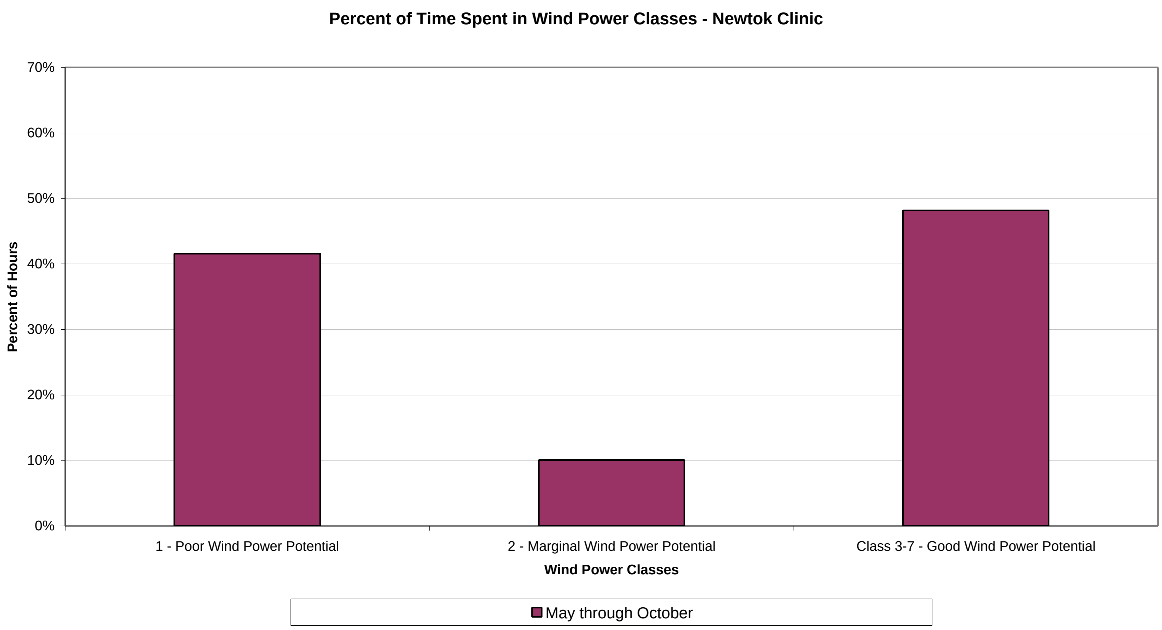


Figure 3.16: Percentage of Hours at Various Wind Power Classes – Emmonak

Figure 3.17: Percentage of Hours at Various Wind Power Classes – Newtok
(No data obtained for winter half of year)



3.4 Existing Site Utility Loads and Savings Potential

The analysis in this study assumes that all of the power produced by subsequent wind turbines will be used by the YKHC facilities located at the specific sites under consideration. It is expected that the power generated at each site will serve a single facility. Equipment selection has been based on historical records of monthly annual electricity use, with the goal of matching turbine output to the facility loads.

The sizes of the wind power generation projects that were considered do not exceed the needs of the community, therefore, the export market has not been analyzed.

The specific design strategy will depend on the connection agreement with the local utility. If the system is connected directly to the grid and net metering is allowed on an annual basis, the design will be based on producing no more than the expected annual electricity use of the facility. If no net metering is allowed, then the design may be based on turbine production not exceeding the minimum site electric demand. Net metering may allow the site to use excess power generated during times of low host requirements to reduce costs when electricity must be purchased from the utility. The “net” effect will still be that the wind generation equipment produces no more electricity per year than the host uses.

3.4.1 Historical Energy Use

As part of this study, the historical electricity use of the facilities to be served has been studied. Expected changes in facility operation that will affect energy use have also been considered.

3.4.1.1 YKDRH - Bethel

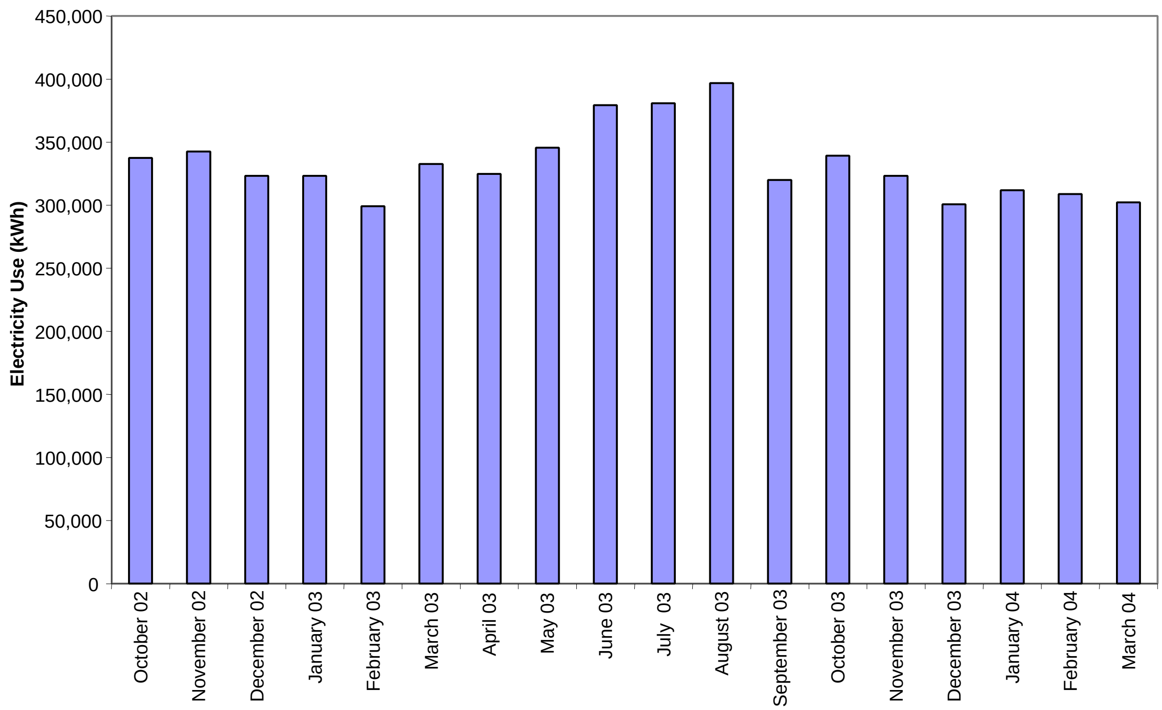
YKDRH is provided electricity by Bethel Utilities Corporation, Inc. (BUC). The total electricity produced by BUC is approximately 39,000,000 kWh per year.

A detailed energy audit of the YKDRH was conducted prior to this wind generation feasibility study, and was completed in 2001. In the 12-month period from April 2000 to March 2001, this facility used 3,916,800 kWh of electricity. Its maximum monthly demand during that period was 656 kW in July 2000.

According to more recent bills gathered during this study, this facility used 4,033,600 kWh of electricity in the 12-month period from April 2003 to March 2004. The average demand during this period was 460 kW. Average maximum monthly demand during this period was 688 kW. It follows that from 2000 to 2004, the electric loads at the YKDRH have remained relatively constant and represent approximately 10% of the load served by BUC.

Figure 3.18 shows historical monthly electricity consumption at the YKDRH.

Figure 3.18: Monthly Electricity Consumption at YKDRH



The BUC has a flat rate structure that charges $0.1054 per kWh for energy and $22.21 per kW, per month billing demand. Billing demand is calculated as the maximum average rate of energy use for any 15-minute interval during the billing month. There is a demand ratchet at 80% of the maximum billing demand for the previous 11 months.

A "Cost of Power Adjustment Surcharge" and a "Regulatory Cost Charge" also appear on the Hospital's electricity billing statements. During the month of January 2004, the final month for which a copy of a billing statement was obtained, the Cost of Power Adjustment Surcharge was $0.0757/kWh, and the Regulatory Cost Charge was $0.000392/kWh. Based on copies of billing statements from another site in Bethel (Kasayuli Inhalant Center/McCann Center), it appears that the Cost of Power Adjustment Surcharge varied from $0.0654 to $0.0757 per kWh from May 2003 to April 2004, with an average of $0.0682 per kWh.

If a wind generation facility were to be implemented at this site, the electricity generated at the facility would be valued at the equivalent cost of electricity purchased from the local utility, not including demand costs. In the most recent year of electricity bills examined, this value is equivalent to $0.168/kWh.

Based on the typical charges outlined above, it is estimated that YKDRH typically pays $420,000 per year for electrical energy and $200,000 per year for electricity demand (assuming 4,000,000 kWh/yr consumption and 750 kW average peak monthly demand). Cost of Power Adjustment Surcharges add approximately $273,000 per year.

The YKDRH site consumes #2 fuel oil (diesel) in an incinerator, humidification units, laundry, and kitchen. The fuel purchased for the Hospital is also used by a neighboring facility, the Community Health Services Building (CHSB). Fuel is purchased from Bethel Fuel Sales, and is delivered by the Hoffman Company. From May 2003 to April 2004, the site consumed approximately 9,600 million Btu of #2 fuel oil (69,000 gallons), at a total cost of approximately $143,000. The average unit cost of #2 fuel oil is $14.90 per million Btu.

The site also purchases hot water (190°F - 195°F) from the BUC, which is used for space heating and domestic water heating. From May 2003 to April 2004, the site consumed approximately 13,200 million Btu of hot water, at a total cost of approximately $162,000. The average unit cost of hot water was approximately $12.30 per million Btu.

3.4.1.2 McCann Treatment Center – Bethel, Kasayuli Subdivision

The BUC also provides electricity to the McCann Treatment Center. This facility just recently began operation, therefore, a limited amount of historical utility consumption data exists. Copies of billing statements for the months when the center has been fully operational (January 2004 to April 2004) show that the average electricity consumption is approximately 5,940 kWh per month, or 71,280 kWh per year, and that the average peak monthly demand is approximately 19 kW.

If a wind generation facility were to be implemented at this site, the electricity generated at the facility would be valued at the equivalent cost of electricity purchased from the local utility, not including demand costs. In the most recent year of electricity bills examined, this value is equivalent to $0.174/kWh.

Based on the typical charges indicated above, the McCann Treatment Center is expected typically to pay $7,500 per year for electrical energy and $6,200 per year for demand. Cost of Power Adjustment Surcharges add approximately $4,900 per year.

3.4.1.3 Subregional Village Clinic - Emmonak

The YKHC subregional clinic in Emmonak is currently provided electricity by the Alaska Village Electric Cooperative (AVEC).

From March 2003 to April 2004, the YKHC Subregional Clinic at Emmonak Village consumed approximately 122,000 kWh of electricity. During that same period, the peak demand was approximately 38 kW and the average demand was approximately 14 kW. The site purchases electricity at two rates. Rate 1 applies to the first 1,500 kWh consumed each month, equal to $0.14 per kWh. Rate 2 applies to all electricity purchased in excess of the first 1,500 kWh, equal to $0.06 per kWh.

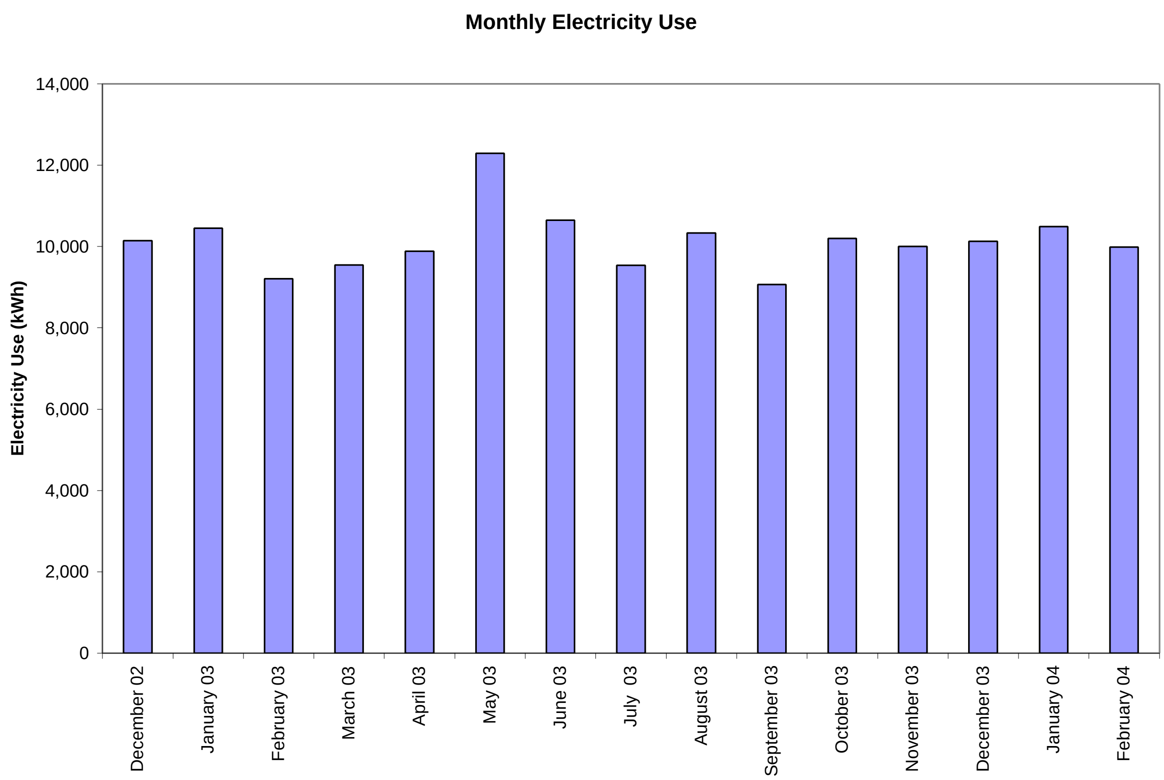
From December 2002 to February 2004, AVEC charged the site $45 per kW for billed demand, except for the period from February 2003 to June 2003, when this charge was omitted. During the period being examined, AVEC also charged a "Fuel Charge" of $0.0824 per kWh.

If a wind generation facility were to be implemented at this site, the electricity generated at the facility would be valued at the equivalent cost of electricity purchased from the local utility, not including demand costs. In the most recent year of electricity bills examined, this value is equivalent to $0.155/kWh.

Based on the typical charges outlined above, Emmonak Village Clinic can be expected to pay approximately $8,800 per year for electrical energy and $17,300 per year for demand (assumes 122,000 kWh/yr consumption and 32 kW average maximum monthly demand). Additional Fuel Charges could potentially add approximately $10,000 per year to the electricity costs.

Figure 3.19 shows the historical monthly electricity consumption at the Emmonak Village Clinic operated by YKHC.

Figure 3.19: Monthly Electricity Consumption at Emmonak Clinic, Similar to Newtok Clinic Currently Under Construction



3.4.1.4 Newtok Village Clinic

YKHC is currently constructing a new, larger clinic building at the Newtok site. This clinic will be similar to the subregional clinic currently operating at Emmonak. Once the new Newtok Clinic building is completed, it is assumed that its electricity use profile will be similar to that of the existing Emmonak Clinic. Because this construction is currently ongoing at Newtok, future electrical consumption can only be estimated. Electricity use is estimated to be approximately 122,000 kWh per year, and maximum and average demand are estimated to be approximately 38 kW and 14 kW, respectively.

The existing village clinic in Newtok purchases electricity from Ungusraq Power Company. Based on the most recent billing information available (January 2001 to November 2002), electricity costs in Newtok averaged $0.54 per kWh consumed. A “PCE discount” was subtracted from this charge, averaging $0.2688 per kWh, leaving a net average annual electricity cost to the site of $0.2712 per kWh. No demand charges are imposed by the local utility.

If a wind generation facility were to be implemented at this site, the electricity generated at the facility would be valued at the equivalent cost of electricity purchased from the local utility. In the most recent year of electricity bills examined, this value is equivalent to $0.2712/kWh.

By assuming that the electric loads at the new clinic currently under construction will be similar to the existing electric loads at the Emmonak subregional clinic, and that electricity rates will continue as indicated in the most recent Newtok bills examined, an annual electricity cost of approximately $33,000 is estimated.

3.4.2 Expected Cost Savings - Project Economic Analysis

How the Economic Viability of the Proposed Project Has Been Evaluated

The viability of this project, in general, will include an economic analysis and will consider environmental and social impacts. Typically, Executive Order 13123 economic criteria are used when evaluating the economic viability of projects. Executive Order 13123 outlines a 10-year simple payback period for approval of any project. However, the environmental and social benefits of the project may be significant enough to warrant modification of the payback requirement.

Executive Order 13123 explicitly points out goals of reducing greenhouse gas production (Section 201), promotion of renewable energy (Section 204), and reduction of the use of petroleum (Section 205), all of which will result from implementation of the wind generation projects outlined in this study.

The economic benefit of the project has been quantified by determining the expected amount of electricity that will be generated by the proposed wind generation facilities, and calculating the effect on the proposed sites' annual energy costs. Utility rates and expected electricity use and electric demand have been analyzed. Additional economic benefits include short-term and long-term employment in construction and operation and maintenance, respectively. Where possible and reasonable, these benefits have been quantified as well.

Anticipated Economic Benefits to the Tribe and Tribal Community

The primary anticipated economic benefits from this measure will result from decreased energy costs. Monies not spent to purchase electricity from the utility will be available to deliver YKHC's core health care services. The project will result in increased local employment opportunities for construction, operation, and maintenance of the wind turbines.

Summary of Economic Benefits of the Wind Generation Projects

At the YKDRH, a nominal 50 kW output wind turbine has been deemed the best fit. Atlantic Orient Corporation manufactures this turbine, and it is the same model used by the Kotzebue Electric Association located nearby in Kotzebue, AK. Kotzebue Electric Association has been successfully operating three of these units since July 1997 and seven additional units since May 1999.

At the other three sites, Bethel McCann Center (Kasayuli), Emmonak Village Clinic, and Newtok Village Clinic, nominal 10 kW output wind turbines are proposed. This study used the 10 kW turbines manufactured by Bergey Windpower for its analysis.

These wind turbine models were chosen for consideration based on their ability to match the electric load of the YKHC facilities located at the four sites under consideration. Some consideration was given to using the electrical output of the wind turbines for heating purposes, thus displacing either heating hot water purchases at the YKDRH, or direct fuel fired heating at the other sites. However, the economic benefits of displacing electricity purchases were shown to be greater than those associated with reducing hot water purchases or heating fuel consumption, so this approach was disregarded from the economic justification analysis.

Table 3.3 shows a summary of the economic analysis of the wind generation projects considered at each of the four sites. For each site, a regular-tower and a tall-tower scenario is presented. The tall-tower scenarios are expected to produce greater amounts of electricity due to better wind resources at higher elevations above ground, but will cost more to construct and have to greater visual impacts on the surrounding areas.

The table shows the amount of electricity that would likely be generated from a wind generation facility at each site, given the wind resources measured under this study as described in the previous section. These amounts of wind-generated electricity would be equivalent to the reduction in electricity that YKHC would have to purchase annually from the sites' local utilities. The estimated economic value of these reductions in electricity purchases is also indicated in the table. The electricity cost savings numbers presented here do not include demand cost savings because the wind generation systems will occasionally need to be taken offline for maintenance activities. Finally, the table presents the expected annual reduction in electric utility power-plant emissions that would result from on-site wind power generation.

The calculations leading to the values presented in Table 3.3 can be found in the appendices of this report.

Table 3.3a: Summary of Wind Generation Projects Considered

Location	**Bethel Main Hospital (YKDRH)**		**Bethel McCann Center**	
Site Annual Electricity Use	4,033,600 kWh		71,280 kWh	
Site Peak Demand	688 kW		19 kW	
Average Cost of Electricity (Not Incl. Demand)	$0.168 /kWh		$0.174 /kWh	
Number of Wind Turbines	1		1	
Type/Model	Atlantic Orient AOC 15/50		Bergey BWC Excel-S	
Nominal Turbine Rating	50 kW		10 kW	
Tower Type	Lattice		Lattice	
Hub Height	**26.5 m**	**30.5 m**	**24 m**	**37 m**
Estimated Availability	95.0%	95.0%	95.0%	95.0%
Estimated Average Wind Speed	11.63 mph	11.87 mph	10.94 mph	11.63 mph
Estimated 12-month Production	79,733 kWh	84,507 kWh	8,338 kWh	10,000 kWh
Estimated Time Turbines Generating	57.2%	57.2%	82.8%	82.8%
Percentage of Site Load Generated by Wind	2.0%	2.1%	11.7%	14.0%
Estimated Net Annual Cost Savings	$11,385	$12,186	$829	$1,117
Estimated Construction Cost	$164,082	$169,002	$69,175	$71,512
Estimated Unit Construction Cost	$3,282 /kW	$3,380 /kW	$6,918 /kW	$7,151 /kW
Simple Payback Period	14.4 yrs	13.9 yrs	83.5 yrs	64 yrs
Emissions Reductions				
NO_X	38 lb/yr	41 lb/yr	4 lb/yr	5 lb/yr
SO_X	150 lb/yr	159 lb/yr	16 lb/yr	19 lb/yr
CO_2	46,262 lb/yr	49,032 lb/yr	4,838 lb/yr	5,802 lb/yr

Table 3.3b: Summary of Wind Generation Projects Considered

Location	**Emmonak Village Clinic**		**Newtok Village Clinic**	
Site Annual Electricity Use	122,157 kWh		122,000 kWh	
Site Peak Demand	38 kW		38 kW	
Average Cost of Electricity (Not Incl. Demand)	$0.155 /kWh		$0.271 /kWh	
Number of Wind Turbines	1		1	
Type/Model	Bergey BWC Excel-S		Bergey BWC Excel-S	
Nominal Turbine Rating	10 kW		10 kW	
Tower Type	Lattice		Lattice	
Hub Height	**24 m**	**37 m**	**24 m**	**37 m**
Estimated Availability	95.0%	95.0%	95.0%	95.0%
Estimated Average Wind Speed	13.8 mph	14.68 mph	14 mph	15 mph
Estimated 12-month Production	15,362 kWh	17,948 kWh	15,400 kWh	17,900 kWh
Estimated Time Turbines Generating	88.7%	88.7%	88.7%	88.7%
Percentage of Site Load Generated by Wind	12.6%	14.7%	12.6%	14.7%
Estimated Net Annual Cost Savings	$1,767	$2,169	$3,500	$4,200
Estimated Construction Cost	$69,175	$71,512	$69,175	$71,512
Estimated Unit Construction Cost	$6,918 /kW	$7,151 /kW	$6,918 /kW	$7,151 /kW
Simple Payback Period	39.1 yrs	33.0 yrs	19.8 yrs	17.0 yrs
Emissions Reductions				
NO_X	7 lb/yr	9 lb/yr	7 lb/yr	9 lb/yr
SO_X	29 lb/yr	34 lb/yr	29 lb/yr	34 lb/yr
CO_2	8,913 lb/yr	10,414 lb/yr	8,935 lb/yr	10,386 lb/yr

4. DESIGN AND CONSTRUCTION

4.1 Decision Making and Sources of Funding

Plans to Obtain a Tribal Council Resolution to Implement the Wind Generation

The YKHC Board of Directors represents the communities served by YKHC, thus project approval can be obtained through a simple Board vote.

Potential Sources of Funding for Project Implementation and Plan to Obtain Financing

In order to pay for construction of wind generation facilities, YKHC will likely seek third-party funding in the form of public sector grants or loans, private party cash, third-party insurance reimbursement, or other sources, as available.

4.2 Conceptual Design

YKDRH Bethel – 50 kW AOC 15/50 Wind Turbine

A wind generation system consisting of ten 50 kW Atlantic Orient Corporation wind turbines, similar to the one being proposed here, is currently installed and operating in Kotzebue, Alaska. Kotzebue is nearby, to the north of the site under consideration in Bethel. The design of the proposed wind generation facility at the YKDRH would be similar to the design of the installation in Kotzebue.

The proposed wind turbine generation system would likely be constructed at or near the site where the anemometer tower associated with this study is currently erected.

The proposed system would consist of a single 50 kW nominal output model AOC 15/50 wind turbine mounted on an 80-foot to 100-foot tall steel lattice, free-standing tower. The tower has three footings that will rest on concrete foundations. The hub of the wind turbine is mounted to the top of the tower. A crane would be required during construction in order to erect the tower.

The proposed wind turbine consists of three air foil blades, each 23.7 feet in length. The swept diameter of the wind turbine is 49.2 feet. The blades are connected to a hub, which in turn is connected to the power output shaft.

The power output shaft transmits the mechanical energy gathered from the wind into electrical generator via a gearbox. The power output shaft, gearbox, and electrical generator are all housed at the top of the wind turbine tower. The generator produces 480V, three phase, AC power. A pair of flexible cables carry electrical power from the generator to a junction box at the tower base, and control signals to and from the turbine.

The proposed wind generation system would produce electricity for use at the Bethel Main Hospital, and feed the facility electricity in parallel with Bethel Utility Corporation's local grid. The size of the proposed wind turbine (50 kW) is such that it should never exceed the demand of the Main Hospital, and therefore electricity should never be exported onto BUC's system. When the proposed wind turbine is down due to failure or planned maintenance activities, BUC's system would support the entire Main Hospital electric load. Constant supervision of the proposed system is not expected nor accounted for in the operating cost assumptions.

The turbine has several braking mechanisms designed to keep the rotor spinning at proper speeds and protect the equipment from damage in high winds. Braking mechanisms include tip brakes on the ends of the blades to assist in slowing and stopping the rotor, a parking brake, and a dynamic braking system using the residual power of the generator to help slow the rotor.

A computer control system is used to operate the turbines. The controller reads wind speeds and the turbine's status and then makes control decisions, sending signals to regulate the speed or shut down the rotors when necessary.

<u>Kasayuli/Bethel McCann Center, Emmonak Village Clinic, & Newtok Village Clinic – 10 kW Bergey Windpower BWC Excel-S Wind Turbine</u>

The future electric loads at these sites would likely accommodate the output of a 10 kW capacity wind turbine and, under normal conditions, all of the electricity produced would be used within the YKHC facilities.

Bergey Windpower produces the 10 kW wind turbine considered for these applications under this study. This model was introduced in 1983 and has reportedly been installed at over 800 sites around the world. The electric output from these turbines is typically used in either water pumping, battery charging, or grid-connected applications.

The proposed wind turbine generation systems would likely be constructed at or near the locations at these sites where the anemometer towers associated with this study are currently erected.

The proposed systems would consist of a single 10 kW nominal output model BWC Excel-S wind turbine mounted on an 80-foot to 120-foot tall steel lattice, guyed tower, at each site. The tower lattice structure has three footings that will rest on concrete foundations. The guy-wires steadying the tower are secured to the ground at three anchor bolts, also mounted in concrete foundations. The hub of the wind turbine is mounted to the top of the tower. The tower can be erected using a crane if available, but tilt-up construction kits are also available if crane access is not possible.

The proposed wind turbine consists of three blades, and the swept diameter of the wind turbine is 22 feet. The blades are connected to a hub, which in turn is connected to the power output shaft. Blades can be painted black for enhanced ice-shedding capabilities.

The power output shaft transmits the mechanical energy gathered from the wind into the electrical generator. The power output shaft and electrical generator are all housed at the top of the wind turbine tower. The generator produces DC power, which is converted to AC power by the GridTek 10 power processor (inverter), also provided by Bergey. The inverter would be mounted at ground level, where it can be easily accessed. This inverter produces

240V, single-phase, AC electricity that can be connected to an existing circuit breaker panel. Operation of the system is fully automatic.

The proposed wind generation systems would produce electricity for use at the YKHC centers and clinics at the sites, and feed the facilities electricity in parallel with the local utilities' electric grids. The size of the proposed wind turbines (10 kW) is such that it should never exceed the demand of the YKHC facilities at the sites, and therefore electricity should never be exported onto the local utilities' systems. When the proposed wind turbines are down due to failure or planned maintenance activities, the local utilities' systems would support the entire electric load. Constant supervision of the proposed system is not expected nor accounted for in the operating cost assumptions.

The turbine has several speed control mechanisms designed to keep the rotor spinning at proper speeds and protect the equipment from damage in high winds. Braking mechanisms include blades that flex in the wind ("auto-furling"), which prevent turbine overspeed during high winds, and a furling winch that can be manually operated to stop the turbine from the base of the tower.

5. OPERATION AND MAINTENANCE

5.1 Preliminary Operation and Maintenance Plan

The proposed wind generation facilities will be designed and implemented in order to ensure long-term sustainability. YKHC employees or other local persons will perform the construction, operation, and maintenance. Training will be provided as part of the implementation of wind generation. The operating costs of the wind turbines that will be installed are minimal, especially since maintenance will be provided in-house, by YKHC employees. The turbines, towers, controls, and other components will be selected to ensure a long lifetime. A wind farm installed in 1997 in Kotzebue, Alaska has proven the viability of wind technology in extreme weather conditions.

YKHC employees will operate and maintain the entire project with training provided by the selected equipment vendor. Table 5.1 describes a typical maintenance schedule[1].

The annual maintenance costs have been estimated to be equivalent to 2.5% of the capital costs of the turbines themselves, for the purpose of establishing net annual savings amounts. This is approximately $2,000/year for the 50 kW units, and $600/year for the 10 kW units. This represents the high end of the range typically accepted by the wind industry and it agrees well with the estimate of 40 hours/year for each 50 kW obtained from Katzebue Electric Association.

Table 5.1: Typical Maintenance Schedule for 50 kW Wind Turbine Generation Facility

Monthly • Visually inspect turbine/site for obvious problems • Record meter & run time readings • Inspect dynamic brake components • Look for loose fasteners Yearly • Re-calibrate control system (as needed) • Replace anemometers (if needed)	Every 6 Months • Tower fasteners visual inspection with random torque check • Check/clean electrical connections as needed • Check all accessible fasteners (emphasis on rotor) • Inspect yaw bearing/lock • Inspect tip brakes • Inspect generator-connections and fasteners • Inspect gearbox for leaks • Inspect main shaft • Inspect rotary transformer • Re-grease yaw bearing and yaw lock • Inspect transmission vent for blockage

[1] From Atlantic Orient Corporation "AOC 15/50 Wind Turbine Generator Customer Information Packet." Similar or less rigorous maintenance schedule anticipated for the 10 kW capacity turbines.

5.2 Preliminary Training and Infrastructure Development Plans

If wind generation were implemented at YKHC sites, the selected equipment vendor will provide training on equipment operations and maintenance. A training program will consist of a formal on-site program, documentation support in the form of detailed manuals, and ongoing vendor technical support.

Implementation of wind generation at YKHC would provide the opportunity for key personnel in YKHC and ANTHC to gain valuable experience in wind power technology and self-generation projects. This process of gaining experience has already begun over the course of this feasibility study. YKHC personnel will receive specific training and will experience the process that is required to implement these projects. This will position them as leaders in future energy-related projects. It is anticipated that the successful completion of this project will lead to more projects in YKHC region and other Alaska Native communities. As a result, the YKHC and ANTHC will have in-house expertise in the planning, financing, management, design, construction, and operation of these projects.

6. OTHER RELATED ISSUES

6.1 Description of the Anticipated Economic, Environmental, Cultural, and Social Benefits to the Tribe(s) and Tribal Members as a Result of Implementation of Wind Generation

The potential economic benefits to the tribal community will primarily derive from decreased energy costs. As stated previously, the City of Bethel and the surrounding communities are 100% reliant on power supplied by the local utilities. This power is derived from fossil fuels that have a very volatile market price. Budgeting for the communities' energy needs is becoming increasingly difficult. Decreased energy costs due to the displacement of electricity purchases with self-generated electricity mean that the YKHC can focus more of its spending on its core mission, to provide quality health care to the Alaska Native communities it serves.

An additional economic benefit to the tribal community is the employment that the construction, operation, and maintenance of this project will provide. It is anticipated that the wind generation facilities will be constructed using a local workforce, with supervision provided by the selected turbine manufacturer. YKHC personnel will also be trained to operate and maintain the turbines. The goal is for this to be a pilot project that will provide the YKHC with training and experience in wind energy projects. Successful completion of wind generation projects could lead to further projects throughout the YKHC service area and beyond, with YKHC positioned in a leadership role.

The primary environmental benefits to the tribal community will derive from the reduction in emissions from the diesel-fired power plants that currently provide power. Power generation in the region is based primarily on diesel fuel technologies. Diesel fuel is considered one of the dirtier fossil fuels and is relatively high in emissions. EMCOR Energy & Technologies' preliminary analysis of wind generation found significant potential for reduction of NO_x, SO_2, and CO_2 emissions. NO_x and SO_2 are local pollutants that can cause respiratory health problems and contribute to acid rain. CO_2 is the major contributor to anthropogenic global warming. Wind technology, on the other hand, does not deplete natural resources and is a clean technology with no combustion requirements when producing electricity.

An additional environmental benefit is the reduced environmental hazards associated with fuel handling. This project will reduce the amount of diesel fuel that must be transported to the communities, thereby reducing the chance of accidental fuel spills. Diesel fuel is a toxic substance, and fuel spills pose a health threat to communities through direct contact and potential contamination of water and food supplies.

The cultural and social benefits of this project include increased self-sustainability. The local communities place great importance on being able to meet all local needs through local resources. Commercial fishing is an important source of income in the region; over 200 residents hold commercial fishing permits, primarily for salmon and herring roe net fisheries. Subsistence activities contribute substantially to villagers' diets, particularly salmon, freshwater fish, game birds, and berries. The existing dependence on imported or local fossil fuel power generation is contrary to this concept as it poses potential threats to the ecosystems the region relies so heavily upon.

6.2 Plan for Assessing the Environmental Benefits and Impacts of the Project

This feasibility study has quantified the reductions in emissions and fuel handling that will result from implementation of wind generation, and it has identified the environmental benefits resulting from those reductions. Anticipated benefits include improved local air quality and a reduction in potential fuel spills, resulting in reduced instances of respiratory illness and health problems arising from contaminated water and food supplies.

Potential environmental impacts of the measure have also been addressed. Anticipated impacts include aesthetic and noise impacts, and potential for avian mortality. The aesthetic and noise impacts have been addressed by working closely with the local populations to ascertain the level of concern over these issues, and to identify ways to mitigate these impacts through proper siting and equipment selection. The avian mortality issue has been addressed by reviewing studies of potential impacts on birds, mitigation strategies, and by talking with experts about the local bird populations, migration patterns, etc. The goal has been to minimize and mitigate any possible negative impacts resulting from this project, during the feasibility study phase, and during the proposed construction and operation phases. These are discussed in more detail below.

Environmental Impacts

- Avian Interaction
  In determining at which sites to install the wind monitoring towers, a list of all YKHC sites in regions of potentially good wind resources was sent to the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service personnel ranked the sites as high concern, medium concern, or low concern for the Spectacled Eider and Stellar's Eider. The four selected sites are all low concern for these species. U.S. Fish and Wildlife Service indicated that the wind monitoring activities and wind turbine projects would have no impact on these endangered species at these sites. It is recommended that U.S. Fish and Wildlife Service be further consulted as specific plans to implement wind generation move forward. Please see Appendix B for copies of correspondence between the study authors and the U.S. Fish and Wildlife Service offices in Anchorage, including a list of YKHC sites in addition to the four discussed here and U.S. Fish and Wildlife Service's associated levels of concern for impacts on endangered species.

- Visual
  The wind turbines will be highly visible in all of the selected sites. They will be the tallest structures in the area. During the design and siting phases of any potential wind generation project, care should be taken to work with residents and stakeholders in the surrounding area to ensure that visual impacts are mitigated. The tower heights considered under this study are up to approximately 100 feet for the 50 kW wind turbines and up to approximately 120 feet for the 10 kW wind turbines.

- Noise
  Wind turbines do make a certain amount of noise, both from the movement of the mechanical parts and the wind blowing around the blades, tower, and guy wires. Manufacturer's test data for the 10 kW Bergey wind turbine report that from 20 to 50 feet away, the operating wind turbine creates approximately 5 dBA of noise above the

ambient, and that at distances of 100 feet away and greater, there was no additional noise created above the ambient. According to these tests, the idle wind turbine structure was found to create no noise above ambient levels. See Appendix D for a copy of the manufacturer's Noise Test Report.

The 50 kW wind turbine manufactured by AOC and proposed for installation at the YKDRH has the potential to become a more significant noise impact. This is because it incorporates a “downwind” design, meaning that wind hits the tower and generator first and then passes over the turbine blades. On downwind designs, where the wind hits the tower first, its "shadow" can cause a thumping noise each time a blade passes behind the tower.

A wind farm (meaning multiple wind turbines at a single site) is generally accepted to generate between 35-45 dBA at a distance of 350 meters [ref: The Scottish Office, Environment Department, Planning Advice Note, PAN 45, Annes A: Wind Power, A.27. Renewable Energy Technologies, August 1994]. This range can be used as an upper limit guideline for the expected noise generated from the single 50 kW unit wind generation facility proposed at YKDRH, which is at the smaller end of the spectrum of wind turbines available in the market.

A noise analysis can be done based on the operating characteristics of the specific wind turbine that will be used, the type of terrain in which the project will be located, and the distance to nearby residences. Particular attention will need to be paid if residences are sheltered from the wind.

Also, pre-construction noise surveys can be conducted to ascertain the normally-occurring background noise levels at the site, and to determine later how much, if anything, the wind project has added to those levels.

The most common method for dealing with a potential noise issue is to simply require a "setback," or minimum distance between any of the wind turbines in the project and the nearest residence. The size of a setback that is sufficient to reduce the sound level to a regulatory threshold will need to be determined.

Noise at the YKDRH site and the Newtok site is not expected to be a problem because both sites are near the city power plants, which create a significant amount of noise that would drown out the noise of the wind turbines. The McCann Center site and the Emmonak site are located near residential buildings, and noise should be a consideration in equipment selection and siting.

Environmental Benefits

Many of the persons served by YKHC rely on traditional subsistence activities such as fishing and hunting for some part of their livelihood. Changes in the environment due to increased CO_2 and other emissions resulting from the combustion of fossil fuels threatens many of these traditional activities.

Implementation of clean, renewable wind generation will supplant the use of electricity that is typically generated by burning diesel fuels in this region. Diesel fuels are considered to be especially "dirty" sources of combustion, generating high levels of emissions per unit of electricity generated when compared with other fossil fuels, such as natural gas. The quantity of reduction of harmful emissions that would result from implementation of wind generation at these sites has been estimated and can be found in Table 3.3 a,b. These reductions in NO_x, SO_x, and CO_2 given off to the atmosphere would be realized at existing power plants where electricity is currently being generated.

In addition to the reduction in airborne emissions associated with combustion of fossil fuels, implementation of wind generation will also reduce the amount of fuel that needs to be transported to the existing power plants. This reduction in fuel handling requirements will likely result in a drop in the occurrence of spill accidents, which are another path by which harmful substances reach the local environment.

Non-quantifiable Benefits

- Increased Self-sufficiency
  A primary goal of YKHC and the Alaskan Native peoples it serves is greater self-sufficiency. Currently, YKHC is dependent on local utilities to provide power; oil companies to drill, refine and transport fuel to the local utilities; and, in most cases, the state government to subsidize the cost of electricity through the Power Cost Equalization Program. Using wind power produced with YKHC-owned wind turbines will increase the self-sufficiency and independence of the YKHC organization and these Native peoples.

7. CONCLUSIONS

7.1 Recommendation

It is recommended that wind turbine generation facilities be erected at the two sites with the lowest simple payback periods: 50 kW at YKDRH and 10 kW at Newtok Subregional Clinic. Payback periods are over 10 years, but the projects are justified based on decreased emissions and increased employment opportunities discussed in previous sections. In addition, any potential future increases in the cost of fossil fuels will make the electricity generated by wind turbines more valuable, and thus simple payback periods will decrease.

7.2 Moving Forward with Wind Generation Implementation – Roles, Responsibilities, and Capabilities

YKHC will be the point of contact for this project. Tom Humphrey, P.E., of YKHC, is the project manager. YKHC has been responsible for wind monitoring activities, including procuring anemometers through the NREL Native American Anemometer Load Program, installing anemometers, downloading data, and returning anemometers. YKHC has a technical staff of approximately 50, including mechanical and electrical engineers, technicians, electricians, and maintenance personnel.

ANTHC has been the primary advisor for YKHC, with EMCOR Energy & Technologies acting as the primary technical consultant to YKHC. ANTHC has a technical staff of approximately 200, consisting primarily of mechanical, electrical, and civil engineers, technicians, electricians and maintenance personnel. The specific roles of the ANTHC staff are undetermined at this time, but it is expected that ANTHC will provide programmatic and engineering support. Mr. Gary Kuhn, P.E., of ANTHC has coordinated and will continue to coordinate all ANTHC activities. Mr. Kuhn will lend YKHC the required technical assistance and resources to ensure a successful project outcome and promote renewable resource utilization as a replacement for fossil fuel energy production. Mr. Kuhn is a registered Electrical Engineer in the State of Alaska and has attained proficiency in power generation, distribution, demand-side management and alternative energy efficiency project design, construction and project and program management, and healthcare environmental engineering.

EMCOR Energy & Technologies has helped conduct and oversee the data collection, analysis and reporting activities associated with this feasibility study and conceptual design. EMCOR Energy & Technologies is a leader in the, analysis, design, and implementation of energy efficient systems and efficient power generation. It has provided energy engineering services to ANTHC and YKHC in the past and currently is under contract with ANTHC to provide energy engineering services. Michael K. J. Anderson, P.E., Chief Engineer of EMCOR Energy & Technologies, will be responsible for overseeing engineering activities. Lance C. Kincaid, P.E., has been the EMCOR Energy & Technologies project manager and lead engineer for this feasibility study.

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APPENDICES

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Appendix A
Copy of Executive Order 13123

federal register

Tuesday
June 8, 1999

Part IV

The President

Executive Order 13123—Greening the Government Through Efficient Energy Management

Federal Register
Vol. 64, No. 109
Tuesday, June 8, 1999

Presidential Documents

Title 3—

The President

Executive Order 13123 of June 3, 1999

Greening the Government Through Efficient Energy Management

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the National Energy Conservation Policy Act (Public Law 95–619, 92 Stat. 3206, 42 U.S.C. 8252 *et seq*.), as amended by the Energy Policy Act of 1992 (EPACT) (Public Law 102–486, 106 Stat. 2776), and section 301 of title 3, United States Code, it is hereby ordered as follows:

PART 1—PREAMBLE

Section 101. *Federal Leadership*. The Federal Government, as the Nation's largest energy consumer, shall significantly improve its energy management in order to save taxpayer dollars and reduce emissions that contribute to air pollution and global climate change. With more than 500,000 buildings, the Federal Government can lead the Nation in energy efficient building design, construction, and operation. As a major consumer that spends $200 billion annually on products and services, the Federal Government can promote energy efficiency, water conservation, and the use of renewable energy products, and help foster markets for emerging technologies. In encouraging effective energy management in the Federal Government, this order builds on work begun under EPACT and previous Executive orders.

PART 2—GOALS

Sec. 201. *Greenhouse Gases Reduction Goal.* Through life-cycle cost-effective energy measures, each agency shall reduce its greenhouse gas emissions attributed to facility energy use by 30 percent by 2010 compared to such emissions levels in 1990. In order to encourage optimal investment in energy improvements, agencies can count greenhouse gas reductions from improvements in nonfacility energy use toward this goal to the extent that these reductions are approved by the Office of Management and Budget (OMB).

Sec. 202. *Energy Efficiency Improvement Goals.* Through life-cycle cost-effective measures, each agency shall reduce energy consumption per gross square foot of its facilities, excluding facilities covered in section 203 of this order, by 30 percent by 2005 and 35 percent by 2010 relative to 1985. No facilities will be exempt from these goals unless they meet new criteria for exemptions, to be issued by the Department of Energy (DOE).

Sec. 203. *Industrial and Laboratory Facilities.* Through life-cycle cost-effective measures, each agency shall reduce energy consumption per square foot, per unit of production, or per other unit as applicable by 20 percent by 2005 and 25 percent by 2010 relative to 1990. No facilities will be exempt from these goals unless they meet new criteria for exemptions, as issued by DOE.

Sec. 204. *Renewable Energy*. Each agency shall strive to expand the use of renewable energy within its facilities and in its activities by implementing renewable energy projects and by purchasing electricity from renewable energy sources. In support of the Million Solar Roofs initiative, the Federal Government shall strive to install 2,000 solar energy systems at Federal facilities by the end of 2000, and 20,000 solar energy systems at Federal facilities by 2010.

Sec. 205. *Petroleum.* Through life-cycle cost-effective measures, each agency shall reduce the use of petroleum within its facilities. Agencies may accomplish this reduction by switching to a less greenhouse gas-intensive, nonpetroleum energy source, such as natural gas or renewable energy sources; by eliminating unnecessary fuel use; or by other appropriate methods. Where alternative fuels are not practical or life-cycle cost-effective, agencies shall strive to improve the efficiency of their facilities.

Sec. 206. *Source Energy.* The Federal Government shall strive to reduce total energy use and associated greenhouse gas and other air emissions, as measured at the source. To that end, agencies shall undertake life-cycle cost-effective projects in which source energy decreases, even if site energy use increases. In such cases, agencies will receive credit toward energy reduction goals through guidelines developed by DOE.

Sec. 207. *Water Conservation.* Through life-cycle cost-effective measures, agencies shall reduce water consumption and associated energy use in their facilities to reach the goals set under section 503(f) of this order. Where possible, water cost savings and associated energy cost savings shall be included in Energy-Savings Performance Contracts and other financing mechanisms.

PART 3—ORGANIZATION AND ACCOUNTABILITY

Sec. 301. *Annual Budget Submission.* Each agency's budget submission to OMB shall specifically request funding necessary to achieve the goals of this order. Budget submissions shall include the costs associated with: encouraging the use of, administering, and fulfilling agency responsibilities under Energy-Savings Performance Contracts, utility energy-efficiency service contracts, and other contractual platforms for achieving conservation goals; implementing life-cycle cost-effective measures; procuring life-cycle cost-effective products; and constructing sustainably designed new buildings, among other energy costs. OMB shall issue guidelines to assist agencies in developing appropriate requests that support sound investments in energy improvements and energy-using products. OMB shall explore the feasibility of establishing a fund that agencies could draw on to finance exemplary energy management activities and investments with higher initial costs but lower life-cycle costs. Budget requests to OMB in support of this order must be within each agency's planning guidance level.

Sec. 302. *Annual Implementation Plan.* Each agency shall develop an annual implementation plan for fulfilling the requirements of this order. Such plans shall be included in the annual reports to the President under section 303 of this order.

Sec. 303. *Annual Reports to the President.* (a) Each agency shall measure and report its progress in meeting the goals and requirements of this order on an annual basis. Agencies shall follow reporting guidelines as developed under section 306(b) of this order. In order to minimize additional reporting requirements, the guidelines will clarify how the annual report to the President should build on each agency's annual Federal energy reports submitted to DOE and the Congress. Annual reports to the President are due on January 1 of each year beginning in the year 2000.

(b) Each agency's annual report to the President shall describe how the agency is using each of the strategies described in Part 4 of this order to help meet energy and greenhouse gas reduction goals. The annual report to the President shall explain why certain strategies, if any, have not been used. It shall also include a listing and explanation of exempt facilities.

Sec. 304. *Designation of Senior Agency Official.* Each agency shall designate a senior official, at the Assistant Secretary level or above, to be responsible for meeting the goals and requirements of this order, including preparing the annual report to the President. Such designation shall be reported by each Cabinet Secretary or agency head to the Deputy Director for Management of OMB within 30 days of the date of this order. Designated officials shall participate in the Interagency Energy Policy Committee, described in section

306(d) of this order. The Committee shall communicate its activities to all designated officials to assure proper coordination and achievement of the goals and requirements of this order.

Sec. 305. *Designation of Agency Energy Teams.* Within 90 days of the date of this order, each agency shall form a technical support team consisting of appropriate procurement, legal, budget, management, and technical representatives to expedite and encourage the agency's use of appropriations, Energy-Savings Performance Contracts, and other alternative financing mechanisms necessary to meet the goals and requirements of this order. Agency energy team activities shall be undertaken in collaboration with each agency's representative to the Interagency Energy Management Task Force, as described in section 306(e) of this order.

Sec. 306. *Interagency Coordination.* (a) *Office of Management and Budget.* The Deputy Director for Management of OMB, in consultation with DOE, shall be responsible for evaluating each agency's progress in improving energy management and for submitting agency energy scorecards to the President to report progress.

(1) OMB, in consultation with DOE and other agencies, shall develop the agency energy scorecards and scoring system to evaluate each agency's progress in meeting the goals of this order. The scoring criteria shall include the extent to which agencies are taking advantage of key tools to save energy and reduce greenhouse gas emissions, such as Energy-Savings Performance Contracts, utility energy-efficiency service contracts, ENERGY STAR® and other energy efficient products, renewable energy technologies, electricity from renewable energy sources, and other strategies and requirements listed in Part 4 of this order, as well as overall efficiency and greenhouse gas metrics and use of other innovative energy efficiency practices. The scorecards shall be based on the annual energy reports submitted to the President under section 303 of this order.

(2) The Deputy Director for Management of OMB shall also select outstanding agency energy management team(s), from among candidates nominated by DOE, for a new annual Presidential award for energy efficiency.

(b) *Federal Energy Management Program.* The DOE's Federal Energy Management Program (FEMP) shall be responsible for working with the agencies to ensure that they meet the goals of this order and report their progress. FEMP, in consultation with OMB, shall develop and issue guidelines for agencies' preparation of their annual reports to the President on energy management, as required in section 303 of this order. FEMP shall also have primary responsibility for collecting and analyzing the data, and shall assist OMB in ensuring that agency reports are received in a timely manner.

(c) *President's Management Council.* The President's Management Council (PMC), chaired by the Deputy Director for Management of OMB and consisting of the Chief Operating Officers (usually the Deputy Secretary) of the largest Federal departments and agencies, will periodically discuss agencies' progress in improving Federal energy management.

(d) *Interagency Energy Policy Committee.* This Committee was established by the Department of Energy Organization Act. It consists of senior agency officials designated in accordance with section 304 of this order. The Committee is responsible for encouraging implementation of energy efficiency policies and practices. The major energy-consuming agencies designated by DOE are required to participate in the Committee. The Committee shall communicate its activities to all designated senior agency officials to promote coordination and achievement of the goals of this order.

(e) *Interagency Energy Management Task Force.* The Task Force was established by the National Energy Conservation Policy Act. It consists of each agency's chief energy manager. The Committee shall continue to work toward improving agencies' use of energy management tools and sharing information on Federal energy management across agencies.

Sec. 307. *Public/Private Advisory Committee.* The Secretary of Energy will appoint an advisory committee consisting of representatives from Federal agencies, State governments, energy service companies, utility companies, equipment manufacturers, construction and architectural companies, environmental, energy and consumer groups, and other energy-related organizations. The committee will provide input on Federal energy management, including how to improve use of Energy-Savings Performance Contracts and utility energy-efficiency service contracts, improve procurement of ENERGY STAR® and other energy efficient products, improve building design, reduce process energy use, and enhance applications of efficient and renewable energy technologies at Federal facilities.

Sec. 308. *Applicability.* This order applies to all Federal departments and agencies. General Services Administration (GSA) is responsible for working with agencies to meet the requirements of this order for those facilities for which GSA has delegated operations and maintenance authority. The Department of Defense (DOD) is subject to this order to the extent that it does not impair or adversely affect military operations and training (including tactical aircraft, ships, weapons systems, combat training, and border security).

PART 4—PROMOTING FEDERAL LEADERSHIP IN ENERGY MANAGEMENT

Sec. 401. *Life-Cycle Cost Analysis.* Agencies shall use life-cycle cost analysis in making decisions about their investments in products, services, construction, and other projects to lower the Federal Government's costs and to reduce energy and water consumption. Where appropriate, agencies shall consider the life-cycle costs of combinations of projects, particularly to encourage bundling of energy efficiency projects with renewable energy projects. Agencies shall also retire inefficient equipment on an accelerated basis where replacement results in lower life-cycle costs. Agencies that minimize life-cycle costs with efficiency measures will be recognized in their scorecard evaluations.

Sec. 402. *Facility Energy Audits.* Agencies shall continue to conduct energy and water audits for approximately 10 percent of their facilities each year, either independentlyor through Energy-Savings Performance Contracts or utility energy-efficiency service contracts.

Sec. 403. *Energy Management Strategies and Tools.* Agencies shall use a variety of energy management strategies and tools, where life-cycle cost-effective, to meet the goals of this order. An agency's use of these strategies and tools shall be taken into account in assessing the agency's progress and formulating its scorecard.

(a) *Financing Mechanisms.* Agencies shall maximize their use of available alternative financing contracting mechanisms, including Energy-Savings Performance Contracts and utility energy-efficiency service contracts, when life-cycle cost-effective, to reduce energy use and cost in their facilities and operations. Energy-Savings Performance Contracts, which are authorized under the National Energy Conservation Policy Act, as modified by the Energy Policy Act of 1992, and utility energy-efficiency service contracts provide significant opportunities for making Federal facilities more energy efficient at no net cost to taxpayers.

(b) *ENERGY STAR® and Other Energy Efficient Products.*

(1) Agencies shall select, where life-cycle cost-effective, ENERGY STAR® and other energy efficient products when acquiring energy-using products. For product groups where ENERGY STAR® labels are not yet available, agencies shall select products that are in the upper 25 percent of energy efficiency as designated by FEMP. The Environmental Protection Agency (EPA) and DOE shall expedite the process of designating products as ENERGY STAR® and will merge their current efficiency rating procedures.

(2) GSA and the Defense Logistics Agency (DLA), with assistance from EPA and DOE, shall create clear catalogue listings that designate these

products in both print and electronic formats. In addition, GSA and DLA shall undertake pilot projects from selected energy-using products to show a ''second price tag'', which means an accounting of the operating and purchase costs of the item, in both printed and electronic catalogues and assess the impact of providing this information on Federal purchasing decisions.

(3) Agencies shall incorporate energy efficient criteria consistent with ENERGY STAR® and other FEMP-designated energy efficiency levels into all guide specifications and project specifications developed for new construction and renovation, as well as into product specification language developed for Basic Ordering Agreements, Blanket Purchasing Agreements, Government Wide Acquisition Contracts, and all other purchasing procedures.

(4) DOE and OMB shall also explore the creation of financing agreements with private sector suppliers to provide private funding to offset higher up-front costs of efficient products. Within 9 months of the date of this order, DOE shall report back to the President's Management Council on the viability of such alternative financing options.

(c) *ENERGY STAR® Buildings.* Agencies shall strive to meet the ENERGY STAR® Building criteria for energy performance and indoor environmental quality in their eligible facilities to the maximum extent practicable by the end of 2002. Agencies may use Energy-Savings Performance Contracts, utility energy-efficiency service contracts, or other means to conduct evaluations and make improvements to buildings in order to meet the criteria. Buildings that rank in the top 25 percent in energy efficiency relative to comparable commercial and Federal buildings will receive the ENERGY STAR® building label. Agencies shall integrate this building rating tool into their general facility audits.

(d) *Sustainable Building Design.* DOD and GSA, in consultation with DOE and EPA, shall develop sustainable design principles. Agencies shall apply such principles to the siting, design, and construction of new facilities. Agencies shall optimize life-cycle costs, pollution, and other environmental and energy costs associated with the construction, life-cycle operation, and decommissioning of the facility. Agencies shall consider using Energy-Savings Performance Contracts or utility energy-efficiency service contracts to aid them in constructing sustainably designed buildings.

(e) *Model Lease Provisions.* Agencies entering into leases, including the renegotiation or extension of existing leases, shall incorporate lease provisions that encourage energy and water efficiency wherever life-cycle cost-effective. Build-to-suit lease solicitations shall contain criteria encouraging sustainable design and development, energy efficiency, and verification of building performance. Agencies shall include a preference for buildings having the ENERGY STAR® building label in their selection criteria for acquiring leased buildings. In addition, all agencies shall encourage lessors to apply for the ENERGY STAR® building label and to explore and implement projects that would reduce costs to the Federal Government, including projects carried out through the lessors' Energy-Savings Performance Contracts or utility energy-efficiency service contracts.

(f) *Industrial Facility Efficiency Improvements.* Agencies shall explore efficiency opportunities in industrial facilities for steam systems, boiler operation, air compressor systems, industrial processes, and fuel switching, including cogeneration and other efficiency and renewable energy technologies.

(g) *Highly Efficient Systems.* Agencies shall implement district energy systems, and other highly efficient systems, in new construction or retrofit projects when life-cycle cost-effective. Agencies shall consider combined cooling, heat, and power when upgrading and assessing facility power needs and shall use combined cooling, heat, and power systems when life-cycle cost-effective. Agencies shall survey local natural resources to optimize use of available biomass, bioenergy, geothermal, or other naturally occurring energy sources.

(h) *Off-Grid Generation.* Agencies shall use off-grid generation systems, including solar hot water, solar electric, solar outdoor lighting, small wind turbines, fuel cells, and other off-grid alternatives, where such systems are life-cycle cost-effective and offer benefits including energy efficiency, pollution prevention, source energy reductions, avoided infrastructure costs, or expedited service.

Sec. 404. *Electricity Use.* To advance the greenhouse gas and renewable energy goals of this order, and reduce source energy use, each agency shall strive to use electricity from clean, efficient, and renewable energy sources. An agency's efforts in purchasing electricity from efficient and renewable energy sources shall be taken into account in assessing the agency's progress and formulating its score card.

(a) *Competitive Power.* Agencies shall take advantage of competitive opportunities in the electricity and natural gas markets to reduce costs and enhance services. Agencies are encouraged to aggregate demand across facilities or agencies to maximize their economic advantage.

(b) *Reduced Greenhouse Gas Intensity of Electric Power.* When selecting electricity providers, agencies shall purchase electricity from sources that use high efficiency electric generating technologies when life-cycle cost-effective. Agencies shall consider the greenhouse gas intensity of the source of the electricity and strive to minimize the greenhouse gas intensity of purchased electricity.

(c) *Purchasing Electricity from Renewable Energy Sources.*

(1) Each agency shall evaluate its current use of electricity from renewable energy sources and report this level in its annual report to the President. Based on this review, each agency should adopt policies and pursue projects that increase the use of such electricity. Agencies should include provisions for the purchase of electricity from renewable energy sources as a component of their requests for bids whenever procuring electricity. Agencies may use savings from energy efficiency projects to pay additional incremental costs of electricity from renewable energy sources.

(2) In evaluating opportunities to comply with this section, agencies should consider: my Administration's goal of tripling nonhydroelectric renewable energy capacity in the United States by 2010; the renewable portfolio standard specified in the restructuring guidelines for the State in which the facility is located; GSA's efforts to make electricity from renewable energy sources available to Federal electricity purchasers; and EPA's guidelines on crediting renewable energy power in implementation of Clean Air Act standards.

Sec. 405. *Mobile Equipment.* Each agency shall seek to improve the design, construction, and operation of its mobile equipment, and shall implement all life-cycle cost-effective energy efficiency measures that result in cost savings while improving mission performance. To the extent that such measures are life-cycle cost-effective, agencies shall consider enhanced use of alternative or renewable-based fuels.

Sec. 406. *Management and Government Performance.* Agencies shall use the following management strategies in meeting the goals of this order.

(a) *Awards.* Agencies shall use employee incentive programs to reward exceptional performance in implementing this order.

(b) *Performance Evaluations.* Agencies shall include successful implementation of provisions of this order in areas such as Energy-Savings Performance Contracts, sustainable design, energy efficient procurement, energy efficiency, water conservation, and renewable energy projects in the position descriptions and performance evaluations of agency heads, members of the agency energy team, principal program managers, heads of field offices, facility managers, energy managers, and other appropriate employees.

(c) *Retention of Savings and Rebates.* Agencies granted statutory authority to retain a portion of savings generated from efficient energy and water management are encouraged to permit the retention of the savings at the facility or site where the savings occur to provide greater incentive for that facility and its site managers to undertake more energy management initiatives, invest in renewable energy systems, and purchase electricity from renewable energy sources.

(d) *Training and Education.* Agencies shall ensure that all appropriate personnel receive training for implementing this order.

(1) DOE, DOD, and GSA shall provide relevant training or training materials for those programs that they make available to all Federal agencies relating to the energy management strategies contained in this order.

(2) The Federal Acquisition Institute and the Defense Acquisition University shall incorporate into existing procurement courses information on Federal energy management tools, including Energy-Savings Performance Contracts, utility energy-efficiency service contracts, ENERGY STAR® and other energy efficient products, and life-cycle cost analysis.

(3) All agencies are encouraged to develop outreach programs that include education, training, and promotion of ENERGY STAR® and other energy-efficient products for Federal purchase card users. These programs may include promotions with billing statements, user training, catalogue awareness, and exploration of vendor data collection of purchases.

(e) *Showcase Facilities.* Agencies shall designate exemplary new and existing facilities with significant public access and exposure as showcase facilities to highlight energy or water efficiency and renewable energy improvements.

PART 5—TECHNICAL ASSISTANCE

Sec. 501. Within 120 days of this order, the Director of OMB shall:

(a) develop and issue guidance to agency budget officers on preparation of annual funding requests associated with the implementation of the order for the FY 2001 budget;

(b) in collaboration with the Secretary of Energy, explain to agencies how to retain savings and reinvest in other energy and water management projects; and

(c) in collaboration with the Secretary of Energy through the Office of Federal Procurement Policy, periodically brief agency procurement executives on the use of Federal energy management tools, including Energy-Savings Performance Contracts, utility energy-efficiency service contracts, and procurement of energy efficient products and electricity from renewable energy sources.

Sec. 502. Within 180 days of this order, the Secretary of Energy, in collaboration with other agency heads, shall:

(a) issue guidelines to assist agencies in measuring energy per square foot, per unit of production, or other applicable unit in industrial, laboratory, research, and other energy-intensive facilities;

(b) establish criteria for determining which facilities are exempt from the order. In addition, DOE must provide guidance for agencies to report proposed exemptions;

(c) develop guidance to assist agencies in calculating appropriate energy baselines for previously exempt facilities and facilities occupied after 1990 in order to measure progress toward goals;

(d) issue guidance to clarify how agencies determine the life-cycle cost for investments required by the order, including how to compare different energy and fuel options and assess the current tools;

(e) issue guidance for providing credit toward energy efficiency goals for cost-effective projects where source energy use declines but site energy use increases; and

(f) provide guidance to assist each agency to determine a baseline of water consumption.

Sec. 503. Within 1 year of this order, the Secretary of Energy, in collaboration with other agency heads, shall:

(a) provide guidance for counting renewable and highly efficient energy projects and purchases of electricity from renewable and highly efficient energy sources toward agencies' progress in reaching greenhouse gas and energy reduction goals;

(b) develop goals for the amount of energy generated at Federal facilities from renewable energy technologies;

(c) support efforts to develop standards for the certification of low environmental impact hydropower facilities in order to facilitate the Federal purchase of such power;

(d) work with GSA and DLA to develop a plan for purchasing advanced energy products in bulk quantities for use in by multiple agencies;

(e) issue guidelines for agency use estimating the greenhouse gas emissions attributable to facility energy use. These guidelines shall include emissions associated with the production, transportation, and use of energy consumed in Federal facilities; and

(f) establish water conservation goals for Federal agencies.

Sec. 504. Within 120 days of this order, the Secretary of Defense and the Administrator of GSA, in consultation with other agency heads, shall develop and issue sustainable design and development principles for the siting, design, and construction of new facilities.

Sec. 505. Within 180 days of this order, the Administrator of GSA, in collaboration with the Secretary of Defense, the Secretary of Energy, and other agency heads, shall:

(a) develop and issue guidance to assist agencies in ensuring that all project cost estimates, bids, and agency budget requests for design, construction, and renovation of facilities are based on life-cycle costs. Incentives for contractors involved in facility design and construction must be structured to encourage the contractors to design and build at the lowest life-cycle cost;

(b) make information available on opportunities to purchase electricity from renewable energy sources as defined by this order. This information should accommodate relevant State regulations and be updated periodically based on technological advances and market changes, at least every 2 years;

(c) develop Internet-based tools for both GSA and DLA customers to assist individual and agency purchasers in identifying and purchasing ENERGY STAR® and other energy efficient products for acquisition; and

(d) develop model lease provisions that incorporate energy efficiency and sustainable design.

PART 6—GENERAL PROVISIONS

Sec. 601. *Compliance by Independent Agencies.* Independent agencies are encouraged to comply with the provisions of this order.

Sec. 602. *Waivers.* If an agency determines that a provision in this order is inconsistent with its mission, the agency may ask DOE for a waiver of the provision. DOE will include a list of any waivers it grants in its Federal Energy Management Programs annual report to the Congress.

Sec. 603. *Scope.* (a) This order is intended only to improve the internal management of the executive branch and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable by law by a party against the United States, its agencies, its officers, or any other person.

(b) This order applies to agency facilities in any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Northern Mariana Islands, and any other territory or possession over which the United States has jurisdiction. Agencies with facilities outside of these areas, however, are encouraged to make best efforts to comply with the goals of this order for those facilities. In addition, agencies can report energy improvements made outside the United States in their annual report to the President; these improvements may be considered in agency scorecard evaluations.

Sec. 604. *Revocations.* Executive Order 12902 of March 9, 1994, Executive Order 12759 of April 17, 1991, and Executive Order 12845 of April 21, 1993, are revoked.

Sec. 605. *Amendments to Federal Regulations.* The Federal Acquisition Regulation and other Federal regulations shall be amended to reflect changes made by this order, including an amendment to facilitate agency purchases of electricity from renewable energy sources.

PART 7—DEFINITIONS

For the purposes of this order:

Sec. 701. ''Acquisition'' means acquiring by contract supplies or services (including construction) by and for the use of the Federal Government through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, and evaluated. Acquisition begins at the point when agency needs are established and includes the description of requirements to satisfy agency needs, solicitation and selection of sources, award of contracts, contract financing, contract performance, contract administration, and those technical and management functions directly related to the process of fulfilling agency needs by contract.

Sec. 702. ''Agency'' means an executive agency as defined in 5 U.S.C. 105. For the purpose of this order, military departments, as defined in 5 U.S.C. 102, are covered under the auspices of DOD.

Sec. 703. ''Energy-Savings Performance Contract'' means a contract that provides for the performance of services for the design, acquisition, financing, installation, testing, operation, and where appropriate, maintenance and repair, of an identified energy or water conservation measure or series of measures at one or more locations. Such contracts shall provide that the contractor must incur costs of implementing energy savings measures, including at least the cost (if any) incurred in making energy audits, acquiring and installing equipment, and training personnel in exchange for a predetermined share of the value of the energy savings directly resulting from implementation of such measures during the term of the contract. Payment to the contractor is contingent upon realizing a guaranteed stream of future energy and cost savings. All additional savings will accrue to the Federal Government.

Sec. 704. ''Exempt facility'' or ''Exempt mobile equipment'' means a facility or a piece of mobile equipment for which an agency uses DOE-established criteria to determine that compliance with the Energy Policy Act of 1992 or this order is not practical.

Sec. 705. ''Facility'' means any individual building or collection of buildings, grounds, or structure, as well as any fixture or part thereof, including the associated energy or water-consuming support systems, which is constructed, renovated, or purchased in whole or in part for use by the Federal Government. It includes leased facilities where the Federal Government has a purchase option or facilities planned for purchase. In any provision of this order, the term ''facility'' also includes any building 100 percent leased for use by the Federal Government where the Federal Government pays directly or indirectly for the utility costs associated with its leased space. The term also includes Government-owned contractor-operated facilities.

Sec. 706. ''Industrial facility'' means any fixed equipment, building, or complex for production, manufacturing, or other processes that uses large amounts of capital equipment in connection with, or as part of, any process or system, and within which the majority of energy use is not devoted to the heating, cooling, lighting, ventilation, or to service the water heating energy load requirements of the facility.

Sec. 707. ''Life-cycle costs'' means the sum of the present values of investment costs, capital costs, installation costs, energy costs, operating costs, maintenance costs, and disposal costs, over the lifetime of the project, product, or measure. Additional guidance on measuring life-cycle costs is specified in 10 C.F.R. 436.19.

Sec. 708. ''Life-cycle cost-effective'' means the life-cycle costs of a product, project, or measure are estimated to be equal to or less than the base case (i.e., current or standard practice or product). Additional guidance on measuring cost-effectiveness is specified in 10 C.F.R. 436.18 (a), (b), and (c), 436.20, and 436.21.

Sec. 709. ''Mobile equipment'' means all Federally owned ships, aircraft, and nonroad vehicles.

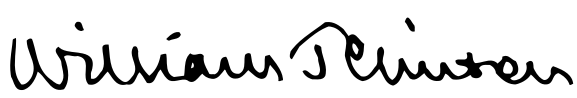
Sec. 710. ''Renewable energy'' means energy produced by solar, wind, geothermal, and biomass power.

Sec. 711. ''Renewable energy technology'' means technologies that use renewable energy to provide light, heat, cooling, or mechanical or electrical energy for use in facilities or other activities. The term also means the use of integrated whole-building designs that rely upon renewable energy resources, including passive solar design.

Sec. 712. ''Source energy'' means the energy that is used at a site and consumed in producing and in delivering energy to a site, including, but not limited to, power generation, transmission, and distribution losses, and that is used to perform a specific function, such as space conditioning, lighting, or water heating.

Sec. 713. ''Utility'' means public agencies and privately owned companies that market, generate, and/or distribute energy or water, including electricity, natural gas, manufactured gas, steam, hot water, and chilled water as commodities for public use and that provide the service under Federal, State, or local regulated authority to all authorized customers. Utilities include: Federally owned nonprofit producers; municipal organizations; and investor or privately owned producers regulated by a State and/or the Federal Government; cooperatives owned by members and providing services mostly to their members; and other nonprofit State and local government agencies serving in this capacity.

Sec. 714. ''Utility energy-efficiency service'' means demand side management services provided by a utility to improve the efficiency of use of the commodity (electricity, gas, etc.) being distributed. Services can include, but are not limited to, energy efficiency and renewable energy project auditing, financing, design, installation, operation, maintenance, and monitoring.



THE WHITE HOUSE,
June 3, 1999.

[FR Doc. 99–14633
Filed 6–7–99; 8:45 am]
Billing code 3195–01–P

EMCOR
Energy & Technologies

Appendix B
Correspondence Between Study Authors and U.S. Fish and Wildlife Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services Anchorage
605 West 4th Avenue, Room 62
Anchorage, Alaska 99501-2249

2003238

in reply, refer to:
AFWFO

JAN - 2 2003

Timothy R. Sears, P.E.
Newcomb Anderson Associates
505 Sansome Street, Suite 1600
San Francisco, CA 94111

Re: Proposed assessment anemometers and towers in 33 sites in Alaska; consultation number 2003238

Dear Mr. Sears:

Pursuant to section 7 of the Endangered Species Act of 1973, (16 U.S.C. 1531 et seq: 87 stat 884, as amended) (Act), this is in reply to your November 25, 2002, request for an endangered species list and additional information for 33 sites in Alaska. The following listed species occur in the project area:

SPECIES		ESA STATUS
Spectacled eider	(*Somateria fischeri*)	Threatened
Steller's eider (AK breeding pop)	(*Polysticta stelleri*)	Threatened

You have indicated that you intend to erect anemometers on 20-m high towers to assess the suitability of these sites for wind turbines. We have received two different disparate lists from you indicating proposed project sites and have compiled the two lists into the single comprehensive list below. Our initial electronic reply to your information request did not provide a site specific species list, but we have done so in this letter. We have also indicated our preliminary level of concern for each area, and provided brief statement explaining our eider-related concerns, if any, for each site.

For those areas where we indicate a low level of concern, it can be assumed that the proposed 20-m high anemometer assessment towers will have no affect upon listed species. No further consultation is needed for these sites .

For those areas where we have indicated moderate concern, informal section 7 consultation should be initiated as soon as possible and additional information should be provided to us so that we may make a more well-informed assessment of whether the proposed project is likely to adversely affect listed species. The additional information provided should include: 1) a large-scale map or aerial photograph showing the proposed site of the anemometer tower, 2) the tower type (e.g. lattice, solid steel pylon, wooden pole), 3) whether guy wires will be used to stabilize the tower, 4) tower lighting information (e.g. light color, strobe or solid continuous light), 5) the proposed construction date of the tower, 6) the duration of the assessment period, and 7) the ultimate fate of the tower (i.e. will it be removed upon the conclusion of the test).

For those areas where we have indicated a high level of concern, informal section 7 consultation should be initiated as soon as possible and the same additional information requested in the paragraph above should be provided. However, be advised that we have preliminarily determined that formal section 7 consultation may be necessary for these sites. The formal consultation process entails a series of regulatory responsibilities within prescribed deadlines for both the action agency and the Service (please see the formal section 7 consultation procedure outline below). Be advised that the completion of the formal section 7 consultation process may not fit within your existing project deadlines.

1.	Toksook Bay:	High concern due to the village's proximity to Steller's eider migratory route and to spectacled eider breeding area
2.	Chefornak	Moderate concern because village is within historic breeding range for both eider species.
3.	Chevak	High concern due to the village's proximity to critical habitat for both species and its proximity to high density spectacled eider breeding areas and to one or more known Steller's eider nest sites.
4.	Hooper Bay	High concern due to the villages proximity to critical habitat for both species and its proximity to high density spectacled eider breeding areas and to one or more known Steller's eider nest sites.
5.	Kipnuk	High concern due to the village's proximity to Steller's eider migratory route, to a major Steller's eider molting and staging area, and to its location within historic spectacled eider breeding range.
6.	Kongiganak	High concern due to the village's proximity to Steller's eider migratory route and presence within historic breeding range of the spectacled eider.
7.	Mekoryuk	High concern due to the village's proximity to Steller's eider migratory route. Spectacled eiders may also stage and migrate past this point.
8.	Newtok	Low concern.

9.	Nightmute	Moderate concern due to the village's location near spectacled eider critical habitat and known breeding area.
10.	Scammon Bay	High concern due to the village's location along the Steller's eider migration route. Spectacled eiders may also migrate past this point.
11.	Sheldon Point	Moderate concern due to the village's proximity to spectacled and Steller's eider migration routes.
12.	Kwigillingok	High concern due to the village's proximity to Steller's eider migratory route and presence within historic breeding range of the spectacled eider.
13.	Emmonak	Low concern.
14.	Alakanuk	Low concern.
15.	Eek	Low concern.
16.	Kasigluk	Low concern.
17.	Bethel	Low concern.
18.	Atmautluak	Low concern.
19.	Pitkas Point	Low concern.
20.	Nunapitchuk	Low concern.
21.	Oscarville	Low concern.
22.	Akiak	Low concern.
23.	Akiachak	Low concern.
24.	Kwethluk	Low concern.
25.	Kotlik	Low concern.
26.	Mountain Village	Low concern.
27.	Pilot Station	Low concern.
28.	Tununak	High concern due to the village's proximity to Steller's eider migratory route. Spectacled eiders may also stage and migrate past

this point.

29.	Tuntutuliak	Low concern.
30.	Napaskiak	Low concern.
31.	Napakiak	Low concern.
32.	Oscarville	Low concern.
33.	Quinhagak	High concern due to the village's proximity to Steller's eider migratory route.

THE SECTION 7 CONSULTATION PROCESS

1. Federal agency (action agency) or its designated non-Federal representative proposes action (2)
2. Federal agency requests species list from Service (3)
3. Service responds within 30 days of receipt of request with list of proposed and listed threatened and endangered species (including proposed and designated critical habitat) that may occur in the action area (4)
4. Action agency determines if there are potential impacts to species provided by Service (4a, 4b)
   a. Action agency determines "no affect"; informal consultation stops
   b. Action agency determines "may affect"; informal consultation continues (5)
5. Action agency determines if the proposed action is "major construction" (5a, 5b)
   a. Proposed action is not major construction; informal consultation continues (6)
   b. Proposed action is "major construction"; action agency prepares a biological assessment; informal consultation continues (6)
6. Action agency makes preliminary determination regarding whether proposed action is or is not likely to adversely affect a listed species or critical habitat and requests Service concurrence in their determination (6a, 6b, 6c)
   a. Action agency determines "is not likely to adversely affect listed species" and Service concurs (within 30 days); informal consultation stops
   b. Action agency determines "is not likely to adversely affect listed species" and Service does not concur (6bi, 6bii)
      i. Action agency modifies project design to minimize affects; informal consultation continues (4)
      ii. Action agency submits biological assessment and requests formal consultation; Service responds (within 30 days) to either initiate formal consultation or request additional information (7)
   c. Action agency determines "is likely to adversely affect listed species" and Service concurs
      i. Action agency modifies project design to minimize affects; informal consultation continues (4)
      ii. Action agency submits biological assessment and requests formal consultation; Service responds (within 30 days) to either initiate formal consultation or request additional information (7)
7. If either the action agency or the Service determines that the action is likely to adversely affect then formal consultation is required and the Service writes a biological opinion. The BO has

two purposes (7a, 7b)

a. To determine the proposed action's potential to "jeopardize" the listed species or result in "destruction or adverse modification" of critical habitat (7ai, 7aii)
    i. "Jeopardy" or "destruction or adverse modification" would not result (7b)
    ii. "Jeopardy" or "destruction or adverse modification" would likely result (7aii1)
        1. The Service develops Reasonable and Prudent Alternatives (7b)
b. To determine if the proposed action will result in incidental take (harm, harassment) either directly or indirectly (7bi, 7bii)
    i. The proposed action will not result in incidental take (8)
    ii. The proposed action will result in incidental take (7bii1)
        1. An incidental Take Statement is included in the BO, including mandatory Reasonable and Prudent Measures and their associated Terms and Conditions, which are designed to reduce the amount and/or extent of incidental take of the proposed action. (8)

8. Formal consultation concludes with issuance of the BO (135 day process; 90 days to evaluate and negotiate; 45 days to write). In the case of "jeopardy" and "destruction or adverse modification" BOs, the action agency may apply for an exemption. See 50 CFR Part 451 for procedures.

This letter relates only to endangered species under our jurisdiction. It does not address species under the jurisdiction of National Marine Fisheries Service, or other legislation or responsibilities under the Fish and Wildlife Coordination Act, Clean Water Act, the Migratory Bird Treaty Act, or the National Environmental Policy Act.

Thank you for your cooperation in meeting our joint responsibilities under section 7 of the Endangered Species Act. If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact me at:

Phone:	907/271-2778
Fax:	907/271-2786
Email:	greg_balogh@fws.gov

Sincerely,

Gregory R. Balogh

Gregory R. Balogh
Endangered Species Branch Chief

NEWCOMB
ANDERSON
ASSOCIATES

March 20, 2003 1611.01

Mr. Greg Balogh
United States Fish and Wildlife Service
605 W. 4th Ave. Room 61
Anchorage, AK 99501

Re: Wind Power Generation in the Yukon-Kuskokwim Delta Region

Dear Mr. Balogh:

We wrote you on November 25, 2002 regarding a project that we are working on for the Yukon-Kuskokwim Health Corporation (YKHC). The project is to evaluate the feasibility of wind power generation at YKHC facilities in Bethel and other communities in the YK Delta region. We requested your guidance on the selection of communities according to the potential impact on the listed species in the area.

Your letter on January 2 of this year identified each of the potential villages as a high, moderate or low level of concern for the USFWS. The letter indicated that no further consultation is needed for sites of low concern.

We have selected the following sites for evaluation. Each of these is identified in your letter as a location of low concern. The sites are Bethel (two locations), Emmonak, and Newtok. We are in the process of installing anemometer towers in these locations. YKHC has borrowed one NRG 20 meter TallTower from DOE and purchased three similar towers for the other sites. The test period is one year.

We would like to discuss the wind turbine project project further with you to identify the steps that should be taken with the USFWS for the review and approval of wind turbine installations in each of these locations. Note that the anticipated turbine size for each of these sites is as follows:

Bethel Hospital	50 kW
Bethel Clinic	10 kW
Emmonak Clinic	10 kW
Newtok Clinic	1 kW

Please le us know when you would be available to further discuss this project. Thank you for your time and assistance.

Sincerely,

Timothy R. Sears, P.E.
Mechanical Engineer
Newcomb Anderson Associates

TRS/jsb

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

in reply refer to
AFWFO

April 7, 2003

Timothy R. Sears, P.E.
Newcomb Anderson Associates
505 Sansome Street, Suite 1600
San Francisco, CA 94111

Re: Installation of anemometer towers in three villages (*consultation number 2003-0238*)

Dear Mr. Sears,

Thank you for your letter, which we received on March 27, 2003, informing us that four 20-meter tall anemometer towers will be erected at three villages: 1) Bethel, 2) Emmonak, and 3) Newtok. We understand that the purpose of installing the anemometers is to evaluate the feasibility of establishing wind turbines for power generation.

As we stated in our January 2003 letter, Bethel, Emmonak, and Newtok are areas of low concern for wind power development, with regard to federally listed species. That is, while our records indicate that there may be spectacled or Steller's eiders occurring within or near some of the areas, our best available information suggests that wind turbine projects at these sites are not likely to adversely affect these species.

That said, I'm sure you are aware that another of the Service's Trust Resources, migratory birds, can suffer significant mortality from collisions with towers, blades and associated infrastructure such as guy wires. The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior.

While the MBTA has no provision for allowing unauthorized take, it must be recognized that some birds may be killed at structures such as wind turbines even if all reasonable measures to avoid it are implemented. While it is not possible under the Act to absolve individuals or companies from liability if they follow recommended guidelines, the Division of Law Enforcement and Department of Justice have used enforcement and prosecutorial discretion in the past regarding individuals or companies who have made good faith efforts to avoid the take of migratory birds.

On February 25th and 26th, the Service sponsored a workshop on wind power development in Alaska. I recall meeting Michael Anderson from your group at the workshop. During the workshop, we discussed issues of concern with regard to wind power development and the Service's Trust Resources. I have attached a summary document from the workshop, and would suggest that you consider developing a bird monitoring strategy for your wind development sites. You can find out from local folks, including wildlife professionals from Yukon Delta National Wildlife Refuge, about which birds might be migrating and nesting in or through your proposed wind sites, and from that information determine when to concentrate your monitoring efforts. Monitoring should occur before erecting your turbines, while the anemometers are up. Furthermore, I would recommend mortality checks be conducted in the vicinity of the anemometer towers on a regular basis. Predation may be high at your proposed wind sites. Because the sites are within communities, the mortality checks should not come at great cost or inconvenience. Finally, you should consider bird deterrent devices (a.k.a. bird diverters) if the towers require guy wires. Currently, bird deterrent devices are in the form of coils around the wires or "flappers" attached to wires. There are many styles to choose from and prices vary, but are relatively inexpensive. But I must tell you honestly that we really don't know how effective these devices are during low visibility conditions, as is common in coastal Alaska.

We appreciate your interest in endangered, threatened, and other Trust Species, and we encourage you to continue your assessment of impacts to birds resulting from wind power development. I would be happy to talk with your further about your projects. Please contact me at (907) 271-1467, or Greg Balogh at (907) 271-2778.

Sincerely,

Ellen W. Lance
Endangered Species Biologist

Enclosure

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EMCOR
Energy & Technologies

Appendix C
Project Calculations

YKHC Wind Generation Feasibility Study
Project Summary

Summary of Proposed Wind Generation Projects

Location	**Bethel Main Hospital**		**Bethel McCann Center**		**Emmonak Village Clinic**		**Newtok Village Clinic**	
Site Annual Electricity Use	4,033,600 kWh		71,280 kWh		122,157 kWh		122,000 kWh	
Site Peak Demand	688 kW		19 kW		38 kW		38 kW	
Average Cost of Electricity (Not Incl. Demand)	$0.168 /kWh		$0.174 /kWh		$0.155 /kWh		$0.271 /kWh	
Number of Wind Turbines	1		1		1		1	
Type/Model	Atlantic Orient AOC 15/50		Bergey BWC Excel-S		Bergey BWC Excel-S		Bergey BWC Excel-S	
Nominal Turbine Rating	50 kW		10 kW		10 kW		10 kW	
Tower Type	Lattice		Lattice		Lattice		Lattice	
Hub Height	**26.5 m**	**30.5 m**	**24 m**	**37 m**	**24 m**	**37 m**	**24 m**	**37 m**
Predicted Availability	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%
Predicted Average Wind Speed	11.63 mph	11.87 mph	10.94 mph	11.63 mph	13.8 mph	14.68 mph	14 mph	15 mph
Predicted 12-month Production	79,733 kWh	84,507 kWh	8,338 kWh	10,000 kWh	15,362 kWh	17,948 kWh	15,400 kWh	17,900 kWh
Predicted Time Turbines Generating	57.2%	57.2%	82.8%	82.8%	88.7%	88.7%	88.7%	88.7%
Percentage of Site Load Generated by Wind	2.0%	2.1%	11.7%	14.0%	12.6%	14.7%	12.6%	14.7%
Predicted Net Annual Cost Savings	$11,385	$12,186	$829	$1,117	$1,767	$2,169	$3,500	$4,200
Predicted Construction Cost	$164,082	$169,002	$69,175	$71,512	$69,175	$71,512	$69,175	$71,512
Predicted Unit Construction Cost	$3,282 /kW	$3,380 /kW	$6,918 /kW	$7,151 /kW	$6,918 /kW	$7,151 /kW	$6,918 /kW	$7,151 /kW
Simple Payback Period	14.4 yrs	13.9 yrs	83.5 yrs	64 yrs	39.1 yrs	33.0 yrs	19.8 yrs	17.0 yrs
Emissions Reductions								
NO_X	38 lb/yr	41 lb/yr	4 lb/yr	5 lb/yr	7 lb/yr	9 lb/yr	7 lb/yr	9 lb/yr
SO_X	150 lb/yr	159 lb/yr	16 lb/yr	19 lb/yr	29 lb/yr	34 lb/yr	29 lb/yr	34 lb/yr
CO_2	46,262 lb/yr	49,032 lb/yr	4,838 lb/yr	5,802 lb/yr	8,913 lb/yr	10,414 lb/yr	8,935 lb/yr	10,386 lb/yr

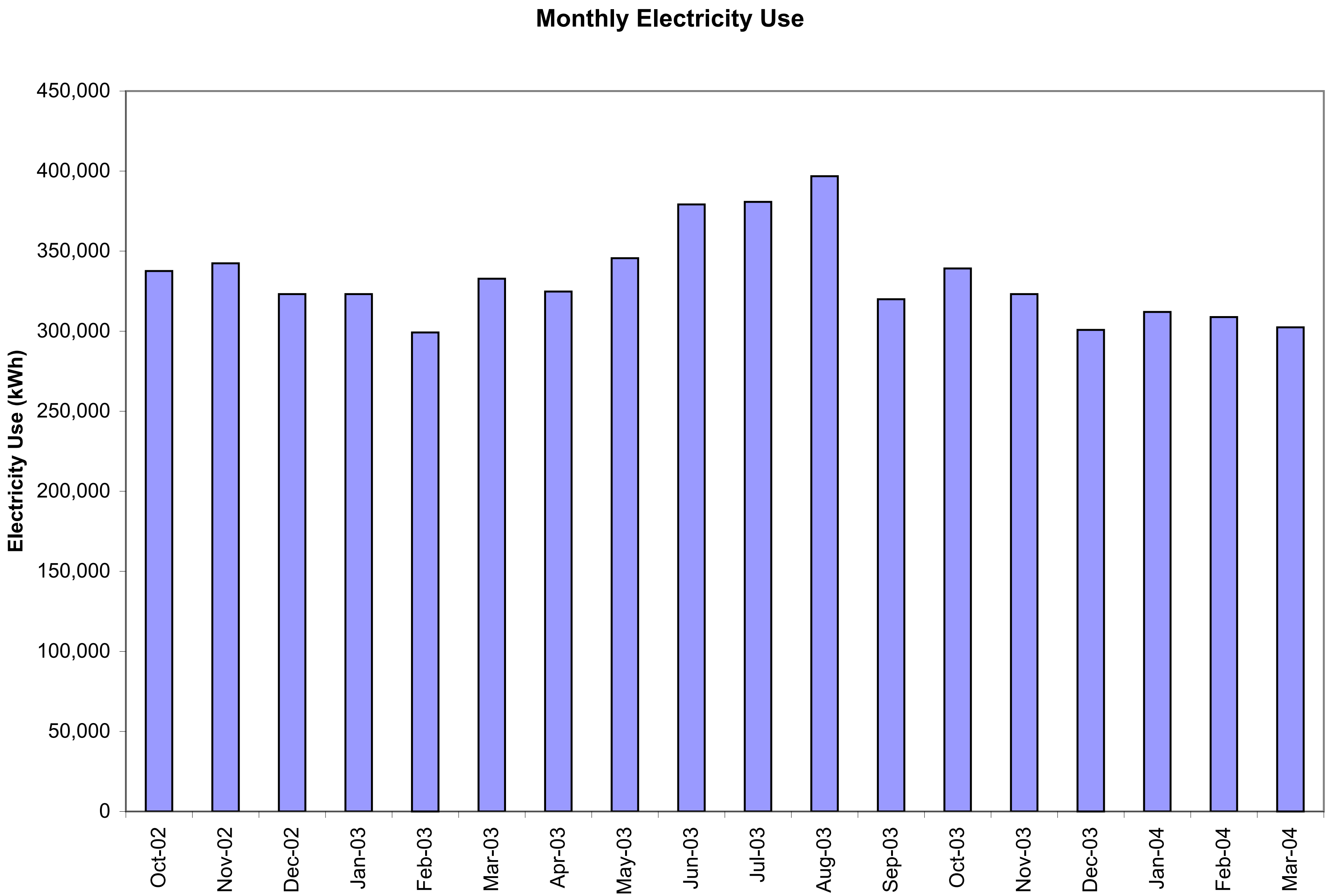
YKHC Wind Feasibility Study
Historical Utility Data for Bethel

Electric Utility			Bethel Utilities Corporation, Inc.										*	0.139 MMBtu/gallon						
	$4,033,600	$601	$425,141	$197,591	$251,992	$240	$20,481	$895,445					$69,418	$9,649	$143,397	$181	$1,321,205	$13,212	$162,466	$12.30
Month	kWh Billed (kWh)	80% of Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)	Cost of Power Adjustment Surcharge ($)	Customer Charge ($)	Regulatory Cost Charge ($)	Total ($)	Energy Rate ($/kWh)	Demand Rate ($/kW)	Cost of Power Adjustment Rate ($/kWh)	Regulatory Cost Rate ($/kWh)	Oil (gallons)	Oil* (MBtu)	Oil Cost ($)	Oil Rate ($/MBtu)	Waste Heat (10k x Btu)	Waste Heat (MBtu)	Waste Heat Cost ($)	Oil Rate ($/MBtu)
Jan-04	312,000	550	$32,884.80	$12,792.96	$23,618	$20.00	$122.30	$69,438.46	$0.1054	$23.24	$0.0757	$0.000392	4,999	695	$10,943	$15.75	162,315	1,623	$20,298	$12.51
Feb-04	308,800	566	$32,547.52	$15,712.16	$20,196	$20.00	$121.05	$68,596.25	$0.1054	$27.76	$0.0654	$0.000392	4,948	688	$10,831	$15.75	134,360	1,344	$16,802	$12.51
Mar-04	302,400	536	$31,872.96	$14,879.36	$19,777	$20.00	$118.54	$66,667.82	$0.1054	$27.76	$0.0654	$0.000392	11,069	1,539	$24,230	$15.75	134,653	1,347	$16,839	$12.51
Apr-04																				
May-04																				
Jun-04																				
Jul-04																				
Aug-04																				
Sep-04																				
Oct-04																				
Nov-04																				
Dec-04																				
Total	**923,200**		**$97,305.28**	**$43,384.48**	**$63,590.88**	**$60.00**	**$361.89**	**$204,702.53**	**$0.1054**		**$0.0689**		**21,016**	**2,921**	**46,004**	**$15.75**	**431,328**	**4,313**	**53,939**	**$12.51**
Jan-03	323,200	573	$34,065.28	$15,906.48	$19,812.16	$20.00	$2,094.12	$71,898.04	$0.1054	$27.76	$0.0613	$0.006479	8,600	1,195	$4,824	$4.04	167,944	1,679	$19,129	$11.39
Feb-03	299,200	548	$31,535.68	$15,212.48	$18,340.96	$20.00	$1,953.27	$67,062.39	$0.1054	$27.76	$0.0613	$0.006528	8,600	1,195	$4,824	$4.04	138,349	1,383	$15,759	$11.39
Mar-03	332,800	589	$35,077.12	$16,350.64	$20,400.64	$20.00	$2,155.45	$74,003.85	$0.1054	$27.76	$0.0613	$0.006477	8,600	1,195	$4,824	$4.04	143,375	1,434	$16,331	$11.39
Apr-03	324,800	595	$34,233.92	$16,517.20	$19,910.24	$20.00	$2,120.44	$72,801.80	$0.1054	$27.76	$0.0613	$0.006528	6,740	937	$13,379	$14.28	118,591	1,186	$13,508	$11.39
May-03	345,600	657	$36,426.24	$18,238.32	$21,185.28	$20.00	$2,276.10	$78,145.94	$0.1054	$27.76	$0.0613	$0.006586	2,500	348	$4,963	$14.28	95,898	959	$10,923	$11.39
Jun-03	379,200	688	$39,967.68	$19,098.88	$23,244.96	$20.00	$2,469.95	$84,801.47	$0.1054	$27.76	$0.0613	$0.006514	5,300	737	$10,733	$14.57	53,904	539	$6,378	$11.83
Jul-03	380,800	662	$40,136.32	$18,377.12	$22,924.16	$20.00	$2,443.73	$83,901.33	$0.1054	$27.76	$0.0602	$0.006417	8,400	1,168	$17,951	$15.37	50,883	509	$6,291	$12.36
Aug-03	396,800	676	$41,822.72	$18,765.76	$23,887.36	$20.00	$2,534.88	$87,030.72	$0.1054	$27.76	$0.0602	$0.006388	2,800	389	$7,180	$18.45	61,659	617	$7,623	$12.36
Sep-03	320,000	660	$33,728.00	$18,321.60	$19,264.00	$20.00	$2,140.01	$73,473.61	$0.1054	$27.76	$0.0602	$0.006688	2,800	389	$6,180	$15.88	83,585	836	$10,611	$12.69
Oct-03	339,200	563	$35,751.68	$15,628.88	$20,419.84	$20.00	$2,154.61	$73,975.01	$0.1054	$27.76	$0.0602	$0.006352	5,600	778	$12,902	$16.58	124,552	1,246	$15,576	$12.51
Nov-03	323,200	567	$34,065.28	$15,739.92	$19,456.64	$20.00	$2,078.46	$71,360.30	$0.1054	$27.76	$0.0602	$0.006431	7,450	1,036	$17,165	$16.58	128,935	1,289	$16,124	$12.51
Dec-03	300,800	487	$31,704.32	$13,519.12	$18,108.16	$20.00	$1,900.55	$65,252.15	$0.1054	$27.76	$0.0602	$0.006318	6,812	947	$6,940	$7.33	171,870	1,719	$21,493	$12.51
Total	**4,065,600**		**$428,514.24**	**$201,676.40**	**$246,954.40**	**$240.00**	**$26,321.55**	**$903,706.59**	**$0.1054**		**$0.0607**	**$0.006474**	**74,202**	**10,314**	**111,865**	**$10.85**	**1,339,545**	**13,395**	**159,746**	**$11.93**
Jan-02	337,600	599											10,345	1,438	$20,535	$14.28	112,531	1,125	$12,818	$11.39
Feb-02	342,400	627											5,900	820	$11,712	$14.28	136,916	1,369	$15,595	$11.39
Mar-02	323,200	572											2,430	338	$4,824	$14.28	171,961	1,720	$19,587	$11.39
Apr-02																				
May-02																				
Jun-02																				
Jul-02																				
Aug-02																				
Sep-02																				
Oct-02	337,600																			
Nov-02	342,400																			
Dec-02	323,200																			
Total													**18,675**	**2,596**	**37,071**	**$14.28**	**421,408**	**4,214**	**48,000**	**$11.39**

YKHC Wind Feasibility Study
Historical Utility Data for Bethel

Month	kWh Billed (kWh)	80% of Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)	Cost of Power Adjustment Surcharge ($)	Customer Charge ($)	Regulatory Cost Charge ($)	Total ($)	Energy Rate ($/kWh)	Demand Rate ($/kW)	Cost of Power Adjustment Rate ($/kWh)	Regulatory Cost Rate ($/kWh)	Oil (gallons)	Oil* (MBtu)	Oil Cost ($)	Oil Rate ($/MBtu)	Waste Heat (10k x Btu)	Waste Heat (MBtu)	Waste Heat Cost ($)	Oil Rate ($/MBtu)
Electric Utility			Bethel Utilities Corporation, Inc.										*	0.139	MMBtu/gallon					
	$4,033,600	$601	$425,141	$197,591	$251,992	$240	$20,481	$895,445					$69,418	$9,649	$143,397	$181	$1,321,205	$13,212	$162,466	$12.30
	3,916,800	656																		
Jan-01	297,600	528.00																		
Feb-01	286,400	524.80																		
Mar-01	307,200	544.00																		
Apr-01																				
May-01																				
Jun-01																				
Jul-01																				
Aug-01																				
Sep-01																				
Oct-01																				
Nov-01																				
Dec-01																				
Total	**891,200**																			
Jan-00	337,600	576																		
Feb-00	300,800	560																		
Mar-00	326,400	592																		
Apr-00	323,200	592																		
May-00	320,000	608																		
Jun-00	361,600	656																		
Jul-00	377,600	656																		
Aug-00	366,400	624																		
Sep-00	302,400	624																		
Oct-00	337,600	560																		
Nov-00	300,800	528																		
Dec-00	336,000	544																		
Total	**3,990,400**																			

Most Recent 12 Months	
Total Electricity Use	4,033,600
Total Cost	$895,444.84
Average Cost	$0.2220
Total Energy and Fuel Costs	$677,132.96
Average Energy and Fuel Cost	$0.1679



Monthly Electricity Use
Electricity Use (kWh)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04

YKHC Wind Feasibility Study
Historical Utility Data for Kasayuli Inhalant Center

Electric Utility Bethel Utilities Corporation, Inc.

Month	kWh Billed (kWh)	80% of Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)	Cost of Power Adjustment Surcharge ($)	Customer Charge ($)	Regulatory Cost Charge ($)	Total ($)	Energy Rate ($/kWh)	Demand Rate ($/kW)	Cost of Power Adjustment Rate ($/kWh)	Regulatory Cost Rate ($/kWh)
Jan-04	6,160	19.2	$649.26	$533.04	$466.31	$20.00	$2.41	$1,671.03	$0.1054	$27.76	$0.0757	$0.000392
Feb-04	5,800	19.2	$611.32	$515.27	$379.32	$20.00	$2.27	$1,528.18	$0.1054	$26.84	$0.0654	$0.000392
Mar-04	6,120	19.2	$645.05	$497.50	$400.25	$20.00	$2.40	$1,565.20	$0.1054	$25.91	$0.0654	$0.000392
Apr-04	5,680	19.2	$598.67	$533.04	$374.31	$20.00	$2.23	$1,528.25	$0.1054	$27.76	$0.0659	$0.000392
May-04												
Jun-04												
Jul-04												
Aug-04												
Sep-04												
Oct-04												
Nov-04												
Dec-04												
Total	**23,760**		**$2,504.30**	**$2,078.85**	**$1,620.19**	**$80.00**	**$9.31**	**$6,292.66**	**$0.1054**		**$0.0682**	**$0.000392**
	5,940											
			$7,512.91	$6,236.55	$4,860.58	$240.00	$27.94					

Most Recent 12 Months (Extrapolated from 4 months data)

Total Electricity Use	71,280
Total Cost	$18,877.98
Average Cost	$0.2648
Total Energy and Fuel Costs	$12,373.49
Average Energy and Fuel Cost	$0.1736

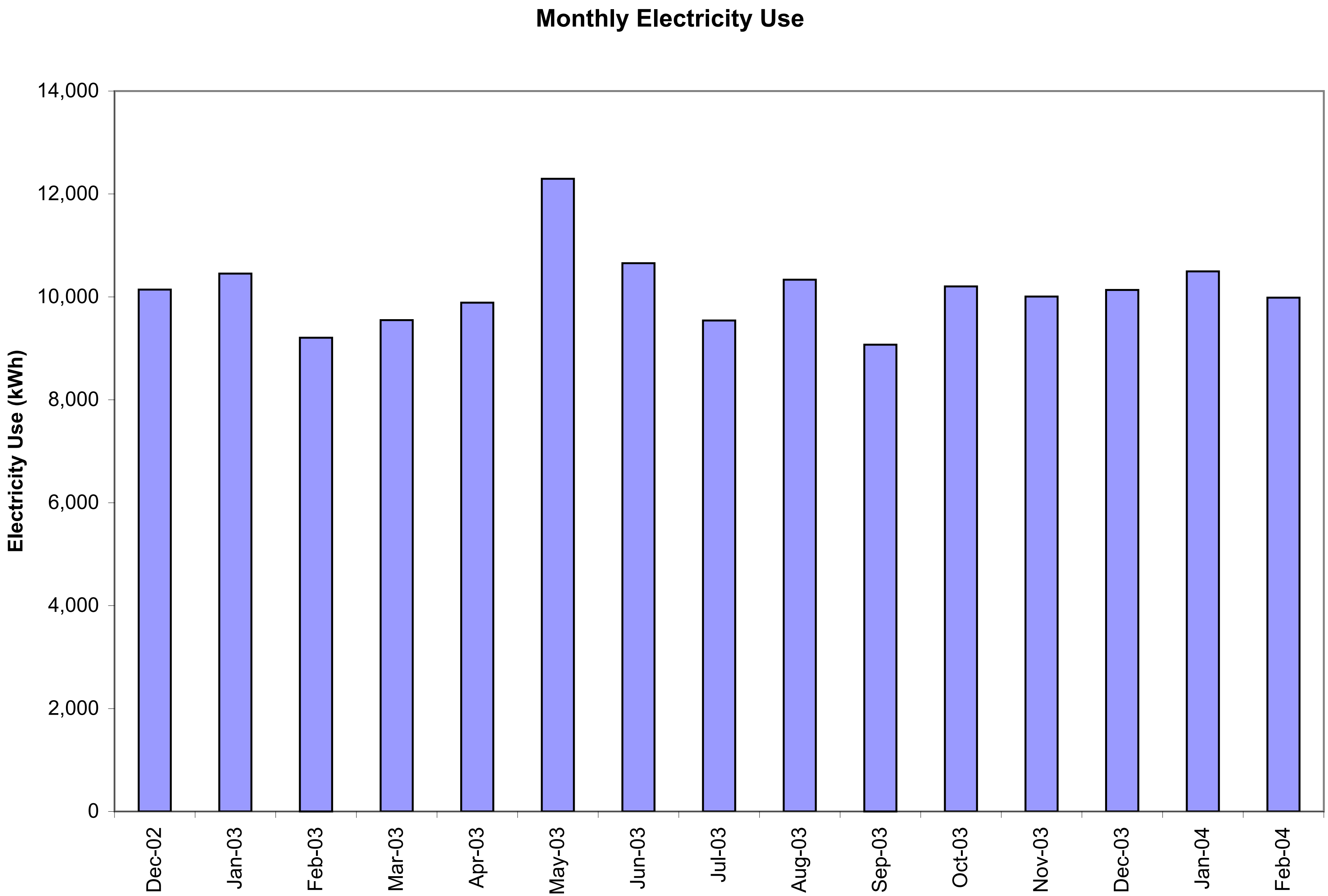
YKHC Wind Feasibility Study
Historical Utility Data for Emmonak - 1201612

Electric Utility			Alaska Village Electric Cooperative				$13.94						0.14	0.14	0.06	
	122156.5	38.0														
Month	kWh Billed (kWh)	Demand (kW)	Energy Charge ($)	Demand Charge ($)	Fuel Cost ($)	Customer Charge ($)	Sales Tax ($)	Total ($)	Energy Rate ($/kWh)	Demand Rate ($/kW)	Fuel Rate ($/kWh)	Sales Tax (%)	Cost for 1st 500 kWh	Cost for kWh 501-1500	Cost for kWh 1501+	Total Energy Cost
Jan-04	10,495	32.3	$749.70	$1,453.50	$864.79	$45.00	$93.39	$3,206.38	$0.0714	$45.00	$0.0824	3.00%	$70.00	$140.00	$539.70	$749.70
Feb-04	9,986	32.3	$719.16	$1,453.50	$822.85	$45.00	$91.22	$3,131.72	$0.0720	$45.00	$0.0824	3.00%	$70.00	$140.00	$509.16	$719.16
Mar-04																
Apr-04																
May-04																
Jun-04																
Jul-04																
Aug-04																
Sep-04																
Oct-04																
Nov-04																
Dec-04																
Total	**20,481**		**$1,468.86**	**$2,907.00**	**$1,687.63**	**$90.00**	**$184.60**	**$6,338.10**	**$0.0717**		**$0.0824**	**3.00%**				
Jan-03	10,453	29.8	$747.18	$1,341.00	$1,174.92	$45.00	$99.24	$3,407.34	$0.0715	$45.00	$0.1124	3.00%	$70.00	$140.00	$537.18	$747.18
Feb-03	9,207	31.0	$672.42	$0.00	$1,034.87	$45.00	$52.57	$1,804.86	$0.0730	$0.00	$0.1124	3.00%	$70.00	$140.00	$462.42	$672.42
Mar-03	9,548	29.5	$692.85	$0.00	$924.82	$45.00	$49.88	$1,712.55	$0.0726	$0.00	$0.0969	3.00%	$70.00	$140.00	$482.85	$692.85
Apr-03	9,888	28.0	$713.28	$0.00	$814.77	$45.00	$47.19	$1,620.24	$0.0721	$0.00	$0.0824	3.00%	$70.00	$140.00	$503.28	$713.28
May-03	12,295	38.0	$857.70	$0.00	$1,013.11	$45.00	$57.47	$1,973.28	$0.0698	$0.00	$0.0824	3.00%	$70.00	$140.00	$647.70	$857.70
Jun-03	10,654	32.0	$759.24	$0.00	$877.89	$45.00	$50.46	$1,732.59	$0.0713	$0.00	$0.0824	3.00%	$70.00	$140.00	$549.24	$759.24
Jul-03	9,542	32.3	$692.52	$1,453.50	$786.26	$45.00	$89.32	$3,066.60	$0.0726	$45.00	$0.0824	3.00%	$70.00	$140.00	$482.52	$692.52
Aug-03	10,334	33.9	$740.04	$1,525.50	$851.52	$45.00	$94.86	$3,256.92	$0.0716	$45.00	$0.0824	3.00%	$70.00	$140.00	$530.04	$740.04
Sep-03	9,071	32.3	$664.26	$1,453.50	$747.45	$45.00	$87.31	$2,997.52	$0.0732	$45.00	$0.0824	3.00%	$70.00	$140.00	$454.26	$664.26
Oct-03	10,204	32.3	$732.24	$1,453.50	$840.81	$45.00	$92.15	$3,163.70	$0.0718	$45.00	$0.0824	3.00%	$70.00	$140.00	$522.24	$732.24
Nov-03	10,006	32.3	$720.36	$1,453.50	$824.49	$45.00	$91.30	$3,134.66	$0.0720	$45.00	$0.0824	3.00%	$70.00	$140.00	$510.36	$720.36
Dec-03	10,134	32.3	$728.04	$1,453.50	$835.04	$45.00	$91.85	$3,153.43	$0.0718	$45.00	$0.0824	3.00%	$70.00	$140.00	$518.04	$728.04
Total	**121,336**		**$8,720.13**	**$10,134.00**	**$10,725.95**	**$540.00**	**$903.60**	**$31,023.68**	**$0.0719**		**$0.0884**	**3.00%**				
Jan-02	9,694	31.00	$701.64	$1,395.00	$893.79	$45.00	$91.06	$3,126.49	$0.0724	$45.00	$0.0922	3.00%	$70.00	$140.00	$491.64	$701.64
Feb-02	7,749	27.20	$584.94	$1,224.00	$714.46	$45.00	$77.05	$2,645.45	$0.0755	$45.00	$0.0922	3.00%	$70.00	$140.00	$374.94	$584.94
Mar-02	8,754	27.70	$645.24	$1,246.50	$983.95	$45.00	$87.62	$3,008.31	$0.0737	$45.00	$0.1124	3.00%	$70.00	$140.00	$435.24	$645.24
Apr-02	8,147	26.35	$608.82	$1,185.75	$915.72	$45.00	$82.66	$2,837.95	$0.0747	$45.00	$0.1124	3.00%	$70.00	$140.00	$398.82	$608.82
May-02	9,336	31.50	$680.16	$1,417.50	$1,049.37	$45.00	$95.76	$3,287.79	$0.0729	$45.00	$0.1124	3.00%	$70.00	$140.00	$470.16	$680.16
Jun-02	9,411	31.20	$684.66	$1,404.00	$1,057.80	$45.00	$95.74	$3,287.20	$0.0728	$45.00	$0.1124	3.00%	$70.00	$140.00	$474.66	$684.66
Jul-02	9,534	33.90	$692.04	$1,525.50	$1,071.62	$45.00	$100.02	$3,434.18	$0.0726	$45.00	$0.1124	3.00%	$70.00	$140.00	$482.04	$692.04
Aug-02	8,476	28.90	$628.56	$1,300.50	$952.70	$45.00	$87.80	$3,014.56	$0.0742	$45.00	$0.1124	3.00%	$70.00	$140.00	$418.56	$628.56
Sep-02	8,235	28.05	$614.10	$1,262.25	$925.61	$45.00	$85.41	$2,932.37	$0.0746	$45.00	$0.1124	3.00%	$70.00	$140.00	$404.10	$614.10
Oct-02																
Nov-02																
Dec-02	10,143	32.40	$728.58	$1,458.00	$1,140.07	$45.00	$101.15	$3,472.80	$0.0718	$45.00	$0.1124	3.00%	$70.00	$140.00	$518.58	$728.58
Total	**89,479**		**$6,568.74**	**$13,419.00**	**$9,705.09**	**$450.00**	**$904.27**	**$31,047.10**	**$0.0734**		**$0.1085**	**3.00%**	**$700.00**	**$1,400.00**	**$4,468.74**	**$6,568.74**

YKHC Wind Feasibility Study
Historical Utility Data for Emmonak - 1201612

Electric Utility			Alaska Village Electric Cooperative				$13.94						0.14	0.14	0.06	
	122156.5	38.0														
Month	kWh Billed (kWh)	Demand (kW)	Energy Charge ($)	Demand Charge ($)	Fuel Cost ($)	Customer Charge ($)	Sales Tax ($)	Total ($)	Energy Rate ($/kWh)	Demand Rate ($/kW)	Fuel Rate ($/kWh)	Sales Tax (%)	Cost for 1st 500 kWh	Cost for kWh 501-1500	Cost for kWh 1501+	Total Energy Cost
Jan-01	5,842	22.10	$470.52	$994.50	$486.64	$45.00	$59.90	$2,056.56	$0.0805	$45.00	$0.0833	3.00%				
Feb-01	6,584	26.60	$515.04	$1,197.00	$548.45	$45.00	$69.16	$2,374.65	$0.0782	$45.00	$0.0833	3.00%				
Mar-01	7,201	23.50	$552.06	$1,057.50	$599.84	$45.00	$67.63	$2,322.03	$0.0767	$45.00	$0.0833	3.00%				
Apr-01	8,209	26.20	$612.54	$1,179.00	$683.81	$45.00	$75.61	$2,595.96	$0.0746	$45.00	$0.0833	3.00%				
May-01	6,658	22.40	$519.48	$1,008.00	$554.61	$45.00	$63.81	$2,190.90	$0.0780	$45.00	$0.0833	3.00%				
Jun-01	5,652	25.40	$459.12	$1,143.00	$470.81	$45.00	$63.54	$2,181.47	$0.0812	$45.00	$0.0833	3.00%				
Jul-01	6,692	27.80	$521.52	$1,251.00	$557.44	$45.00	$71.25	$2,446.21	$0.0779	$45.00	$0.0833	3.00%				
Aug-01	6,538	24.60	$512.28	$1,107.00	$544.62	$45.00	$66.27	$2,275.17	$0.0784	$45.00	$0.0833	3.00%				
Sep-01	6,055	24.10	$483.30	$1,084.50	$558.27	$45.00	$65.13	$2,236.20	$0.0798	$45.00	$0.0922	3.00%				
Oct-01	9,331	29.50	$679.86	$1,327.50	$860.32	$45.00	$87.38	$3,000.06	$0.0729	$45.00	$0.0922	3.00%				
Nov-01	9,779	30.90	$706.74	$1,390.50	$901.62	$45.00	$91.32	$3,135.18	$0.0723	$45.00	$0.0922	3.00%				
Dec-01	8,678	25.80	$640.68	$1,161.00	$800.11	$45.00	$79.40	$2,726.19	$0.0738	$45.00	$0.0922	3.00%				
Total	**87,219**		**$6,673.14**	**$13,900.50**	**$7,566.54**	**$540.00**	**$860.40**	**$29,540.58**	**$0.0765**		**$0.0868**	**3.00%**				
Jan-00																
Feb-00																
Mar-00																
Apr-00																
May-00																
Jun-00																
Jul-00																
Aug-00																
Sep-00																
Oct-00																
Nov-00	3,166		$766.52		$201.67	$5.00	$29.20	$1,002.39	$0.2421		$0.0637	3.00%				
Dec-00	7,437	26.50	$1,706.14	$1,192.50	$473.74	$45.00	$68.32	$3,485.70	$0.2294	$45.00	$0.0637	2.00%				
Total	**10,603**		**$2,472.66**	**$1,192.50**	**$675.41**	**$50.00**	**$97.52**	**$4,488.09**	**$0.2332**		**$0.0637**	**2.22%**				

Most Recent 12 Months	
Total Electricity Use	122,157
Total Cost	$32,149.59
Average Cost	$0.2632
Total Energy and Fuel Costs	$18,973.19
Average Energy and Fuel Cost	$0.1553


Monthly Electricity Use
Electricity Use (kWh)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Aug-03
Sep-03
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04

YKHC Wind Feasibility Study
Historical Electric Data
Newtok Village Clinic

Electric Utility Ungusraq Power Co.

Month	Year	Electricity Use (kWh)	Energy Charge ($)	PCE Discount ($)	Total Bill ($)	Energy Rate ($/kWh)	PCE Rate ($/kWh)	Total Rate ($/kWh)
Jan	2001	763	$335.72	$244.16	$91.56	$0.4400	$0.3200	$0.1200
Feb	2001	741	$326.04	$237.12	$88.92	$0.4400	$0.3200	$0.1200
Mar	2001	839	$369.16	$221.33	$147.83	$0.4400	$0.2638	$0.1762
Apr	2001	738	$324.72	$194.68	$130.04	$0.4400	$0.2638	$0.1762
May	2001	689	$303.16	$181.76	$121.40	$0.4400	$0.2638	$0.1762
Jun	2001	553	$243.32	$107.95	$135.37	$0.4400	$0.1952	$0.2448
Jul	2001	600	$264.00	$145.56	$118.44	$0.4400	$0.2426	$0.1974
Aug	2001	622	$273.68	$154.88	$118.80	$0.4400	$0.2490	$0.1910
Sep	2001	551	$242.44	$137.20	$105.24	$0.4400	$0.2490	$0.1910
Oct	2001	684	$300.96	$170.32	$130.64	$0.4400	$0.2490	$0.1910
Nov	2001	704	$309.76	$175.30	$134.46	$0.4400	$0.2490	$0.1910
Dec	2001	711	$312.84	$177.04	$135.80	$0.4400	$0.2490	$0.1910
Total		8,195	$3,605.80	$2,147.30	$1,458.50	$0.4400	$0.2620	$0.1780
Average Demand		0.9	kW					

Month	Year	Electricity Use (kWh)	Energy Charge ($)	PCE Discount ($)	Total Bill ($)			
Jan	2002	705	$310.20	$175.55	$134.65	$0.4400	$0.2490	$0.1910
Feb	2002	733	$322.52	$158.77	$163.75	$0.4400	$0.2166	$0.2234
Mar	2002	764	$336.16	$165.48	$170.68	$0.4400	$0.2166	$0.2234
Apr	2002	668	$293.92	$144.68	$149.24	$0.4400	$0.2166	$0.2234
May	2002	652	$286.88	$141.22	$145.66	$0.4400	$0.2166	$0.2234
Jun	2002	606	$266.64	$108.29	$158.35	$0.4400	$0.1787	$0.2613
Jul	2002	532	$234.08	$120.98	$113.10	$0.4400	$0.2274	$0.2126
Aug	2002	530	$233.20	$142.96	$90.24	$0.4400	$0.2697	$0.1703
Sep	2002	545	$239.80	$146.50	$93.30	$0.4400	$0.2688	$0.1712
Oct	2002	693	$374.22	$186.28	$187.94	$0.5400	$0.2688	$0.2712
Nov	2002	422	$227.88	$113.43	$114.45	$0.5400	$0.2688	$0.2712
Dec	2001	711	$312.84	$177.04	$135.80	$0.4400	$0.2490	$0.1910
Total		7,561	$3,438.34	$1,781.18	$1,657.16	$0.4547	$0.2356	$0.2192
Average Demand		0.9	kW					

Most Recent	
Average Rate	$0.5400
PCE	$0.2688
Rate w/ PCE	$0.2712

Binned Weather Data

Vr / Va = (Zr / Za)^1/7
ref: Wind Energy Resource Atlas of the United States, Appendix A, Vertical Adjustment

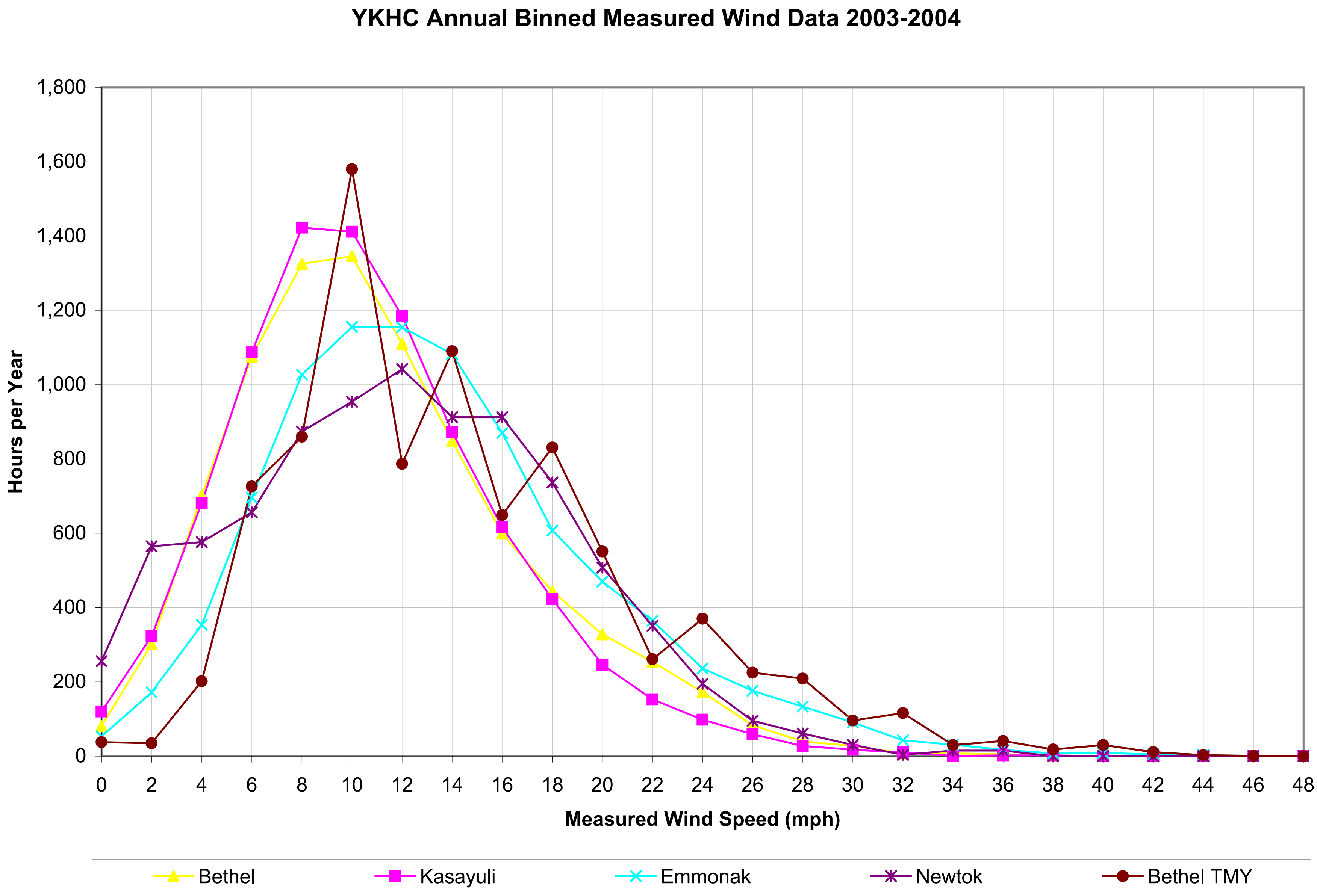
Windspeed Bin (mph)	Actual Data at 20 meters Windspeed (mph)	Bin Distribution - Actual Data Bin Hours (hrs/yr) Bethel	Kasayuli	Emmonak	Newtok	Bin Distribution - Extrapolated to Full Year Bin Hours (hrs/yr) Bethel	Kasayuli	Emmonak	Newtok	Bethel TMY
0 - 1	0	76	110	50	67	82	120	53	256	38
1 - 3	2	281	295	161	148	301	323	172	565	35
3 - 5	4	654	623	331	151	701	682	354	576	202
5 - 7	6	1,003	993	651	172	1,075	1,087	696	657	726
7 - 9	8	1,236	1,300	961	229	1,325	1,423	1,027	874	860
9 - 11	10	1,255	1,290	1,081	250	1,346	1,412	1,156	954	1580
11 - 13	12	1,035	1,082	1,080	273	1,110	1,184	1,155	1,042	787
13 - 15	14	791	797	1,013	239	848	872	1,083	912	1090
15 - 17	16	559	563	814	239	599	616	870	912	649
17 - 19	18	414	386	568	193	444	423	607	737	831
19 - 21	20	306	225	440	133	328	246	470	508	551
21 - 23	22	237	140	341	92	254	153	365	351	261
23 - 25	24	161	90	221	51	173	99	236	195	370
25 - 27	26	78	54	165	25	84	59	176	95	225
27 - 29	28	37	25	125	16	40	27	134	61	209
29 - 31	30	26	16	85	8	28	18	91	31	96
31 - 33	32	7	9	40	1	8	10	43	4	116
33 - 35	34	7	1	29	4	8	1	31	15	30
35 - 37	36	5	2	16	4	5	2	17	15	41
37 - 39	38	2	2	7	0	2	2	8	0	18
39 - 41	40	0	0	8	0	0	0	9	0	30
41 - 43	42	0	1	5	0	0	1	5	0	11
43 - 45	44	0	0	3	0	0	0	3	0	3
45 - 47	46	0	0	0	0	0	0	0	0	1
47 - 49	48	0	0	0	0	0	0	0	0	0
		8,170	8,004	8,195	2,295	8,760	8,760	8,760	8,760	8,760
					Avg Speed	11.2	10.7	13.4	12.1	14.5

Windspeed Bin (mph)	Adjusted to Tower Height (meters) 24 Windspeed (mph)	26.5 Windspeec (mph)	30 Windspeec (mph)	30.5 Windspeec (mph)	37 Windspeed (mph)
0 - 1	0.00	0.00	0.00	0.00	0.00
1 - 3	2.05	2.08	2.12	2.12	2.18
3 - 5	4.11	4.16	4.24	4.25	4.37
5 - 7	6.16	6.25	6.36	6.37	6.55
7 - 9	8.21	8.33	8.48	8.50	8.73
9 - 11	10.26	10.41	10.60	10.62	10.92
11 - 13	12.32	12.49	12.72	12.75	13.10
13 - 15	14.37	14.57	14.83	14.87	15.29
15 - 17	16.42	16.66	16.95	16.99	17.47
17 - 19	18.47	18.74	19.07	19.12	19.65
19 - 21	20.53	20.82	21.19	21.24	21.84
21 - 23	22.58	22.90	23.31	23.37	24.02
23 - 25	24.63	24.98	25.43	25.49	26.20
25 - 27	26.69	27.07	27.55	27.62	28.39
27 - 29	28.74	29.15	29.67	29.74	30.57
29 - 31	30.79	31.23	31.79	31.86	32.76
31 - 33	32.84	33.31	33.91	33.99	34.94
33 - 35	34.90	35.39	36.03	36.11	37.12
35 - 37	36.95	37.48	38.15	38.24	39.31
37 - 39	39.00	39.56	40.27	40.36	41.49
39 - 41	41.06	41.64	42.39	42.49	43.67
41 - 43	43.11	43.72	44.50	44.61	45.86
43 - 45	45.16	45.80	46.62	46.73	48.04
45 - 47	47.21	47.89	48.74	48.86	50.23
47 - 49	49.27	49.97	50.86	50.98	52.41

12.1 mph
5.41 m/s

Average Monthly Data

Month	Avg Wind Speeds (mph) Bethel	Emmonak	Kasayuli	Newtok	Avg Wind Speeds (m/s) Bethel	Emmonak	Kasayuli	Newtok
1	11.86	12.94	15.88		5.30	5.79	7.10	
2	11.75	10.71	14.72		5.25	4.79	6.58	
3	12.8	11.82	15.13		5.72	5.29	6.77	
4	11.26	10.76	13.63	9.28	5.03	4.81	6.09	4.15
5	9.75	9.65	11.29	10.83	4.36	4.32	5.05	4.84
6	9.09	9.14	10.8	11.99	4.06	4.09	4.83	5.36
7	10.95	9.93	12.48	13.23	4.90	4.44	5.58	5.92
8	9.15	8.66	10.35	3.45	4.09	3.87	4.63	1.54
9	9.83	9.18	11.89		4.40	4.10	5.32	
10	10.86	10.55	12.9		4.86	4.72	5.77	
11	10.73	11.86	13.59		4.80	5.30	6.08	
12	8.63	10.77	11.21		3.86	4.82	5.01	
Latitude	60.8 N	62.8 N	60.8 N	60.9 N	60.8 N	62.8 N	60.8 N	60.9 N
Longitude	161.8 W	164.5 W	161.8 W	164.6 W	161.8 W	164.5 W	161.8 W	164.6 W


YKHC Annual Binned Measured Wind Data 2003-2004
Hours per Year
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Measured Wind Speed (mph)
Bethel
Kasayuli
Emmonak
Newtok
Bethel TMY

 415/434-2600

Yukon Kuskokwim Hospital - 80 ft tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Atlantic Orient Corporation's (AOC) 15/50 wind turbine model.

Analysis			Notes:
Electricity Rate (without demand)	$0.1679	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	50	kW	(2)
Turbine Max Rated Windspeed	25.3	mph	(2)
Turbine Cut-in Windspeed	10.2	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$2,000	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	82	0	0	$0
1-3	2.08	301	0	0	$0
3-5	4.16	701	0	0	$0
5-7	6.25	1,075	0	0	$0
7-9	8.33	1,325	0	0	$0
9-11	10.41	1,346	1	716	$120
11-13	12.49	1,110	6	5,819	$977
13-15	14.57	848	12	9,854	$1,654
15-17	16.66	599	19	11,098	$1,863
17-19	18.74	444	29	12,154	$2,040
19-21	20.82	328	37	11,414	$1,916
21-23	22.90	254	44	10,578	$1,776
23-25	24.98	173	51	8,369	$1,405
25-27	27.07	84	56	4,422	$742
27-29	29.15	40	60	2,265	$380
29-31	31.23	28	63	1,666	$280
31-33	33.31	8	64	456	$77
33-35	35.39	8	65	460	$77
35-37	37.48	5	65	333	$56
37-39	39.56	2	64	128	$21
39-41	41.64	0	63	0	$0
41-43	43.72	0	64	0	$0
43-45	45.80	0	60	0	$0
45-47	47.89	0	11	0	$0
47-49	49.97	0	0	0	$0
TOTALS		8,760		79,733	$13,385

Net Annual Savings	**$11,385**	/yr	(10)

Yukon Kuskokwim Hospital - 80 ft tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Wind Turbine (AOC 15/50)	1	$80,000	Ea.	$80,000	(11)
Shipping	1	$15,000	Ea.	$15,000	(12)
Foundation	1	$32,000	Ea.	$32,000	(11)
Crane Rental	1	$3,200	Ea.	$3,200	(12)
Electrical (Transformers, Disconnects, etc.)	1	$3,200	Ea.	$3,200	(11)
Subtotal				$133,400	
Subcontractor Adder		15%		$20,010	(12)
Engineering Adder		8%		$10,672	(12)
Total				**$164,082**	
		Reasonable, based on Kotzebue numbers >>		**$3,282**	per kW

Simple Payback 14.4 years

Notes:

(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.

(2) Per manufacturers literature for AOC 15/50 turbine.

(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.

(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.

(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 26.5 meter AOC 15/50 hub height.
Vr / Va = (Zr / Za)^1/7

(7) Per Power Curve (Net Power Output vs. Windspeed) for AOC 15/50 turbine, as experienced in Kotzebue, AK in
Reference: AOC 15/50 Turbine, Ref: "TVP PROJECT-AT-A-GLANCE"
http://www.epri.com/attachments/197566_KEA-PAAG.pdf

(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)

(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)

(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)

(11) Budget prices per AOC. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.

(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

Yukon Kuskokwim Hospital - 100 ft tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Atlantic Orient Corporation's (AOC) 15/50 wind turbine model.

Analysis			Notes:
Electricity Rate (without demand)	$0.1679	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	50	kW	(2)
Turbine Max Rated Windspeed	25.3	mph	(2)
Turbine Cut-in Windspeed	10.2	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$2,000	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	82	0	0	$0
1-3	2.12	301	0	0	$0
3-5	4.25	701	0	0	$0
5-7	6.37	1,075	0	0	$0
7-9	8.50	1,325	0	0	$0
9-11	10.62	1,346	1	1,214	$204
11-13	12.75	1,110	6	6,568	$1,103
13-15	14.87	848	13	10,659	$1,789
15-17	16.99	599	21	11,878	$1,994
17-19	19.12	444	30	12,837	$2,155
19-21	21.24	328	38	11,885	$1,995
21-23	23.37	254	46	10,991	$1,845
23-25	25.49	173	52	8,597	$1,443
25-27	27.62	84	57	4,531	$761
27-29	29.74	40	61	2,285	$384
29-31	31.86	28	64	1,683	$283
31-33	33.99	8	64	456	$77
33-35	36.11	8	65	463	$78
35-37	38.24	5	65	332	$56
37-39	40.36	2	64	128	$21
39-41	42.49	0	64	0	$0
41-43	44.61	0	63	0	$0
43-45	46.73	0	60	0	$0
45-47	48.86	0	0	0	$0
47-49	50.98	0	0	0	$0
TOTALS		8,760		84,507	$14,186

Net Annual Savings	**$12,186**	/yr	(10)

Yukon Kuskokwim Hospital - 100 ft tower **By:** **LCK**
Wind Turbine Analysis **Check:** **TTG**

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Wind Turbine (AOC 15/50)	1	$80,000	Ea.	$80,000	(11)
Premium for Taller Tower (30.5m)	1	$4,000	Ea.	$4,000	(13)
Shipping	1	$15,000	Ea.	$15,000	(12)
Foundation	1	$32,000	Ea.	$32,000	(11)
Crane Rental	1	$3,200	Ea.	$3,200	(12)
Electrical (Transformers, Disconnects, etc.)	1	$3,200	Ea.	$3,200	(11)
Subtotal				$137,400	
Subcontractor Adder		15%		$20,610	(12)
Engineering Adder		8%		$10,992	(12)
Total				**$169,002**	
		Reasonable, based on Kotzebue numbers >>		**$3,380**	per kW

Simple Payback 13.9 years

Notes:

(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
(2) Per manufacturers literature for AOC 15/50 turbine.
(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 30.5 meter AOC 15/50 hub height.
Vr / Va = (Zr / Za)^1/7
(7) Per Power Curve (Net Power Output vs. Windspeed) for AOC 15/50 turbine.
Reference: AOC 15/50 Turbine, Ref: "TVP PROJECT-AT-A-GLANCE"
http://www.epri.com/attachments/197566_KEA-PAAG.pdf
(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
(11) Budget prices per AOC. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.
(13) EMCOR Energy & Technologies estimate.

Kasayuli/Bethel McCann Center - 24 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis			Notes:
Electricity Rate (without demand)	$0.1736	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	10	kW	(2)
Turbine Max Rated Windspeed	31	mph	(2)
Turbine Cut-in Windspeed	8	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$619	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	120	0.00	0	$0
1-3	2.05	323	0.00	0	$0
3-5	4.11	682	0.00	0	$0
5-7	6.16	1,087	0.01	10	$2
7-9	8.21	1,423	0.17	230	$40
9-11	10.26	1,412	0.48	644	$112
11-13	12.32	1,184	0.83	934	$162
13-15	14.37	872	1.34	1,110	$193
15-17	16.42	616	1.93	1,130	$196
17-19	18.47	423	2.83	1,136	$197
19-21	20.53	246	3.80	889	$154
21-23	22.58	153	4.95	720	$125
23-25	24.63	99	6.10	571	$99
25-27	26.69	59	7.26	408	$71
27-29	28.74	27	8.46	220	$38
29-31	30.79	18	9.74	162	$28
31-33	32.84	10	10.82	102	$18
33-35	34.90	1	11.59	12	$2
35-37	36.95	2	11.88	25	$4
37-39	39.00	2	11.63	24	$4
39-41	41.06	0	11.24	0	$0
41-43	43.11	1	10.72	11	$2
43-45	45.16	0	10.21	0	$0
45-47	47.21	0	9.70	0	$0
47-49	49.27	0	3.47	0	$0
TOTALS		8,760		8,338	$1,447

Net Annual Savings	**$829**	/yr	(10)

Kasayuli/Bethel McCann Center - 24 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 24 m tower	1	$930	Ea.	$930	(11)
Tilt-up Guyed Tower, 10 kW, 24 m tower	1	$9,990	Ea.	$9,990	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, et	1	$3,600	Ea.	$3,600	
Subtotal				$56,240	
Subcontractor Adder		15%		$8,436	(12)
Engineering Adder		8%		$4,499	(12)
Total				**$69,175**	
				$6,918 per kW	

Simple Payback 83.5 years

Notes:

(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
(2) Per manufacturers literature for Bergey Excel-S turbine
(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 24 meter Bergey Excel 10 kW Tower hub height.
$Vr / Va = (Zr / Za)^{1/7}$
(7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S
(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
(11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

Kasayuli/Bethel McCann Center - 37 meter tower
Wind Turbine Analysis

By: LCK
Check: TTG

Background

The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis

			Notes:
Electricity Rate (without demand)	$0.1736	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	10	kW	(2)
Turbine Max Rated Windspeed	31	mph	(2)
Turbine Cut-in Windspeed	8	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$619	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	120	0.00	0	$0
1-3	2.18	323	0.00	0	$0
3-5	4.37	682	0.00	0	$0
5-7	6.55	1,087	0.04	41	$7
7-9	8.73	1,423	0.25	338	$59
9-11	10.92	1,412	0.59	791	$137
11-13	13.10	1,184	1.03	1,159	$201
13-15	15.29	872	1.57	1,301	$226
15-17	17.47	616	2.39	1,399	$243
17-19	19.65	423	3.35	1,345	$233
19-21	21.84	246	4.54	1,062	$184
21-23	24.02	153	5.76	838	$146
23-25	26.20	99	6.99	654	$114
25-27	28.39	59	8.24	463	$80
27-29	30.57	27	9.61	250	$43
29-31	32.76	18	10.79	179	$31
31-33	34.94	10	11.60	109	$19
33-35	37.12	1	11.86	12	$2
35-37	39.31	2	11.59	24	$4
37-39	41.49	2	11.13	23	$4
39-41	43.67	0	10.58	0	$0
41-43	45.86	1	10.04	10	$2
43-45	48.04	0	9.31	0	$0
45-47	50.23	0	0.00	0	$0
47-49	52.41	0	0.00	0	$0
TOTALS		8,760		10,000	$1,736

Net Annual Savings	**$1,117**	/yr	(10)

Kasayuli/Bethel McCann Center - 37 meter tower
Wind Turbine Analysis

By: LCK
Check: TTG

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 37 m tower	1	$1,070	Ea.	$1,070	(11)
Tilt-up Guyed Tower, 10 kW, 37 m tower	1	$11,750	Ea.	$11,750	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, et	1	$3,600	Ea.	$3,600	
Subtotal				$58,140	
Subcontractor Adder		15%		$8,721	(12)
Engineering Adder		8%		$4,651	(12)
Total				**$71,512**	
				$7,151 per kW	

Simple Payback 64.0 years

Notes:

(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
(2) Per manufacturers literature for Bergey Excel-S turbine
(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 37 meter Bergey Excel 10 kW Tower hub height. Vr / Va = (Zr / Za)^1/7
(7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S
(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
(11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

Emmonak Village Clinic - 24 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis			Notes:
Electricity Rate (without demand)	$0.1553	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	10	kW	(2)
Turbine Max Rated Windspeed	31	mph	(2)
Turbine Cut-in Windspeed	8	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$619	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	53	0.00	0	$0
1-3	2.05	172	0.00	0	$0
3-5	4.11	354	0.00	0	$0
5-7	6.16	696	0.01	7	$1
7-9	8.21	1,027	0.17	166	$26
9-11	10.26	1,156	0.48	527	$82
11-13	12.32	1,155	0.83	910	$141
13-15	14.37	1,083	1.34	1,378	$214
15-17	16.42	870	1.93	1,595	$248
17-19	18.47	607	2.83	1,632	$254
19-21	20.53	470	3.80	1,698	$264
21-23	22.58	365	4.95	1,714	$266
23-25	24.63	236	6.10	1,369	$213
25-27	26.69	176	7.26	1,217	$189
27-29	28.74	134	8.46	1,074	$167
29-31	30.79	91	9.74	841	$131
31-33	32.84	43	10.82	440	$68
33-35	34.90	31	11.59	341	$53
35-37	36.95	17	11.88	193	$30
37-39	39.00	8	11.63	83	$13
39-41	41.06	9	11.24	92	$14
41-43	43.11	5	10.72	54	$8
43-45	45.16	3	10.21	31	$5
45-47	47.21	0	9.70	0	$0
47-49	49.27	0	3.47	0	$0
TOTALS		8,760		15,362	$2,386

Net Annual Savings	**$1,767**	/yr	(10)

Emmonak Village Clinic - 24 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 24 m tower	1	$930	Ea.	$930	(11)
Tilt-up Guyed Tower, 10 kW, 24 m tower	1	$9,990	Ea.	$9,990	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, etc	1	$3,600	Ea.	$3,600	
Subtotal				$56,240	
Subcontractor Adder		15%		$8,436	(12)
Engineering Adder		8%		$4,499	(12)
Total				**$69,175**	
				$6,918 per kW	

Simple Payback 39.1 years

Notes:
- (1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
- (2) Per manufacturers literature for Bergey Excel-S turbine
- (4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
- (5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
- (6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 24 meter Bergey Excel 10 kW Tower hub height. Vr / Va = (Zr / Za)^1/7
- (7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S
- (8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
- (9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
- (10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
- (11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
- (12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

Emmonak Village Clinic - 37 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis			Notes:
Electricity Rate (without demand)	$0.1553	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	10	kW	(2)
Turbine Max Rated Windspeed	31	mph	(2)
Turbine Cut-in Windspeed	8	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$619	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	53	0.00	0	$0
1-3	2.18	172	0.00	0	$0
3-5	4.37	354	0.00	0	$0
5-7	6.55	696	0.04	26	$4
7-9	8.73	1,027	0.25	244	$38
9-11	10.92	1,156	0.59	648	$101
11-13	13.10	1,155	1.03	1,130	$175
13-15	15.29	1,083	1.57	1,615	$251
15-17	17.47	870	2.39	1,976	$307
17-19	19.65	607	3.35	1,932	$300
19-21	21.84	470	4.54	2,028	$315
21-23	24.02	365	5.76	1,995	$310
23-25	26.20	236	6.99	1,568	$244
25-27	28.39	176	8.24	1,381	$214
27-29	30.57	134	9.61	1,220	$189
29-31	32.76	91	10.79	932	$145
31-33	34.94	43	11.60	472	$73
33-35	37.12	31	11.86	349	$54
35-37	39.31	17	11.59	188	$29
37-39	41.49	8	11.13	79	$12
39-41	43.67	9	10.58	86	$13
41-43	45.86	5	10.04	51	$8
43-45	48.04	3	9.31	28	$4
45-47	50.23	0	0.00	0	$0
47-49	52.41	0	0.00	0	$0
TOTALS		8,760		17,948	$2,788

Net Annual Savings	**$2,169**	/yr	(10)

Emmonak Village Clinic - 37 meter tower
Wind Turbine Analysis

By: LCK
Check: TTG

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 37 m tower	1	$1,070	Ea.	$1,070	(11)
Tilt-up Guyed Tower, 10 kW, 37 m tower	1	$11,750	Ea.	$11,750	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, et	1	$3,600	Ea.	$3,600	
Subtotal				$58,140	
Subcontractor Adder		15%		$8,721	(12)
Engineering Adder		8%		$4,651	(12)
Total				**$71,512**	
				$7,151	per kW

Simple Payback 33.0 years

Notes:
- (1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
- (2) Per manufacturers literature for Bergey Excel-S turbine
- (4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
- (5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
- (6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 37 meter Bergey Excel 10 kW Tower hub height. Vr / Va = (Zr / Za)^1/7
- (7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S
- (8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
- (9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
- (10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
- (11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
- (12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

Newtok Village Clinic - 24 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis

			Notes:
Electricity Rate (without demand)	$0.2712	/kWh	(1)
Quantity of Wind Turbines Proposed	1		
Turbine Nominal Capacity	10	kW	(2)
Turbine Max Rated Windspeed	31	mph	(2)
Turbine Cut-in Windspeed	8	mph	(2)
Estimated Availability	95%		(4)
Annual Maintenance Costs	$619	/yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6) (14)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	53	0.00	0	$0
1-3	2.05	172	0.00	0	$0
3-5	4.11	354	0.00	0	$0
5-7	6.16	696	0.01	7	$2
7-9	8.21	1,027	0.17	166	$45
9-11	10.26	1,156	0.48	527	$143
11-13	12.32	1,155	0.83	910	$247
13-15	14.37	1,083	1.34	1,378	$374
15-17	16.42	870	1.93	1,595	$433
17-19	18.47	607	2.83	1,632	$443
19-21	20.53	470	3.80	1,698	$460
21-23	22.58	365	4.95	1,714	$465
23-25	24.63	236	6.10	1,369	$371
25-27	26.69	176	7.26	1,217	$330
27-29	28.74	134	8.46	1,074	$291
29-31	30.79	91	9.74	841	$228
31-33	32.84	43	10.82	440	$119
33-35	34.90	31	11.59	341	$93
35-37	36.95	17	11.88	193	$52
37-39	39.00	8	11.63	83	$22
39-41	41.06	9	11.24	92	$25
41-43	43.11	5	10.72	54	$15
43-45	45.16	3	10.21	31	$8
45-47	47.21	0	9.70	0	$0
47-49	49.27	0	3.47	0	$0
TOTALS		8,760		15,362	$4,166

Net Annual Savings	**$3,547**	/yr	(10)

Newtok Village Clinic - 24 meter tower
Wind Turbine Analysis

By: LCK
Check: TTG

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 24 m tower	1	$930	Ea.	$930	(11)
Tilt-up Guyed Tower, 10 kW, 24 m tower	1	$9,990	Ea.	$9,990	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, et	1	$3,600	Ea.	$3,600	
Subtotal				$56,240	
Subcontractor Adder		15%		$8,436	(12)
Engineering Adder		8%		$4,499	(12)
Total				**$69,175**	
				$6,918	per kW

Simple Payback 19.5 years

Notes:

(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.

(2) Per manufacturers literature for Bergey Excel-S turbine

(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.

(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.

(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 24 meter Bergey Excel 10 kW Tower hub height. Vr / Va = (Zr / Za)^1/7

(7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S

(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)

(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)

(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)

(11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.

(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.

(13) The bin hour distribution shown here is equal to that of Emmonak, due to only part of the year being measured at the Newtok Site. Conflicts with construction prevented full-year of data collection at Newtok

Newtok Village Clinic - 37 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Background
The site has relatively good wind potential, and installation of a wind turbine to generate electricity for the hospital is evaluated in this spreadsheet. The analysis is based on the Bergey Excel-S wind turbine model.

Analysis		Notes:
Electricity Rate (without demand)	$0.2712 /kWh	(1)
Quantity of Wind Turbines Proposed	1	
Turbine Nominal Capacity	10 kW	(2)
Turbine Max Rated Windspeed	31 mph	(2)
Turbine Cut-in Windspeed	8 mph	(2)
Estimated Availability	95%	(4)
Annual Maintenance Costs	$619 /yr	(5)

Windspeed Bin (mph) (6)	Windspeed (mph) (6)	Bin Hours (hrs/yr) (6) (14)	Power Output (kW) (7)	Electricity Produced (kWh/yr) (8)	Energy Savings ($) (9)
0-1	0.00	53	0.00	0	$0
1-3	2.18	172	0.00	0	$0
3-5	4.37	354	0.00	0	$0
5-7	6.55	696	0.04	26	$7
7-9	8.73	1,027	0.25	244	$66
9-11	10.92	1,156	0.59	648	$176
11-13	13.10	1,155	1.03	1,130	$306
13-15	15.29	1,083	1.57	1,615	$438
15-17	17.47	870	2.39	1,976	$536
17-19	19.65	607	3.35	1,932	$524
19-21	21.84	470	4.54	2,028	$550
21-23	24.02	365	5.76	1,995	$541
23-25	26.20	236	6.99	1,568	$425
25-27	28.39	176	8.24	1,381	$374
27-29	30.57	134	9.61	1,220	$331
29-31	32.76	91	10.79	932	$253
31-33	34.94	43	11.60	472	$128
33-35	37.12	31	11.86	349	$95
35-37	39.31	17	11.59	188	$51
37-39	41.49	8	11.13	79	$22
39-41	43.67	9	10.58	86	$23
41-43	45.86	5	10.04	51	$14
43-45	48.04	3	9.31	28	$8
45-47	50.23	0	0.00	0	$0
47-49	52.41	0	0.00	0	$0
TOTALS		8,760		17,948	$4,868

Net Annual Savings	**$4,249** /yr	(10)

Newtok Village Clinic - 37 meter tower **By: LCK**
Wind Turbine Analysis **Check: TTG**

Cost Estimate

Description	Quantity	$ per Unit	Units	Total Cost	
Tower Wiring Kit, 10 kW, 37 m tower	1	$1,070	Ea.	$1,070	(11)
Tilt-up Guyed Tower, 10 kW, 37 m tower	1	$11,750	Ea.	$11,750	(11)
Jackstand	1	$380	Ea.	$380	(11)
Raising Kit	1	$1,990	Ea.	$1,990	(11)
Wind Turbine (Bergey BWC Excel-S/60)	1	$24,750	Ea.	$24,750	(11)
Shipping	1	$11,000	Ea.	$11,000	(12)
Foundation	1	$3,600	Ea.	$3,600	
Electrical (Transformers, Disconnects, Inverter, etc	1	$3,600	Ea.	$3,600	
Subtotal				$58,140	
Subcontractor Adder		15%		$8,721	(12)
Engineering Adder		8%		$4,651	(12)
Total				**$71,512**	
				$7,151 per kW	

Simple Payback 16.8 years

Notes:
(1) Per electric rate schedule. Using rate without demand is conservative because there will be days in each month with little or no wind and billing demand will be set during those periods.
(2) Per manufacturers literature for Bergey Excel-S turbine
(4) Typical number accepted by wind industry. Checked against historical availability of AOC turbines installed by Kotzebue Electric Association.
(5) Based on 2.5% of capital cost of turbines. This is high end of typical range accepted by wind industry, and it agrees well with estimate of 40 hrs/yr labor per turbine from Kotzebue Electric Association.
(6) Bin Data based on one year's worth of site measurements made at 20 meters above ground tower elevation. Windspeeds adjusted to account for 37 meter Bergey Excel 10 kW Tower hub height. Vr / Va = (Zr / Za)^1/7
(7) Per Power Curve (Net Power Output vs. Windspeed) for Bergey Excel-S
(8) Electricity Produced (kWh/yr) = Power Output (kW) x Bin Hours (hrs/yr) x Availability (%)
(9) Energy Savings ($/yr) = Electricity Produced (kWh/yr) x Electricity Rate ($/kWh)
(10) Net Savings ($/yr) = Energy Savings ($/yr) - Maintenance Costs ($/yr)
(11) Budget prices per Bergey. Bethel city cost multiplier of 1.6 is applied to foundation and electrical costs. Foundation and electrical work would be done by other parties.
(12) EMCOR Energy & Technologies estimate. Crane rental cost includes Bethel city cost multiplier of 1.6.
(13) The bin hour distribution shown here is equal to that of Emmonak, due to only part of the year being measured at the Newtok Site. Conflicts with construction prevented full-year of data collection at Newtok

Customer: **YKHC** **By:** LCK
Site: **Bethel, Alaska** **Check:** TTG

Site	Bethel Main Hospital		Bethel McCann Center		Emmonak Village Clinic		Newtok Village Clinic			
Tower Height	26.5	30.5	24	37	24	37	24	37	meters	
Inputs										Notes:
Electricity Savings	79,733	84,507	8,338	10,000	15,362	17,948	15,400	17,900	kWh/yr	(1)
On-site Fuel Savings	0	0	0	0	0	0	0	0	MBtu/yr	(2)
Electricity Generation Fuel Type	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil		(3)
On-site Fuel Type	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil	Distillate Fuel Oil		(4)
State	AK	AK	AK	AK	AK	AK	AK	AK		
Electricity Emissions Reductions										
NOx Emission Rate	0.140845	0.140845	0.140845	0.140845	0.140845	0.140845	0.140845	0.140845	lb/MBtu	(5)
SOx Emission Rate	0.552817	0.552817	0.552817	0.552817	0.552817	0.552817	0.552817	0.552817	lb/MBtu	(5)
CO_2 Emission Rate	170	170	170	170	170	170	170	170	lb/MBtu	(5)
NOx Emissions Reduction	38	41	4	5	7	9	7	9	lb/yr	(6)
SOx Emissions Reduction	150	159	16	19	29	34	29	34	lb/yr	(6)
CO_2 Emissions Reduction	46,262	49,032	4,838	5,802	8,913	10,414	8,935	10,386	lb/yr	(6)
On-site Fuel Emissions Reductions										
NOx Emission Rate	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	lb/MBtu	(7)
SOx Emission Rate	0.32307	0.32307	0.32307	0.32307	0.32307	0.32307	0.32307	0.32307	lb/MBtu	(7)
CO_2 Emission Rate	170	170	170	170	170	170	170	170	lb/MBtu	(7)
NOx Emissions Reduction	0	0	0	0	0	0	0	0	lb/yr	(8)
SOx Emissions Reduction	0	0	0	0	0	0	0	0	lb/yr	(8)
CO_2 Emissions Reduction	0	0	0	0	0	0	0	0	lb/yr	(8)
Total Emissions Reductions										
NOx Emissions Reduction	38	41	4	5	7	9	7	9	lb/yr	(9)
SOx Emissions Reduction	150	159	16	19	29	34	29	34	lb/yr	(9)
CO_2 Emissions Reduction	46,262	49,032	4,838	5,802	8,913	10,414	8,935	10,386	lb/yr	(9)

Notes:

(1) Net reduction in electricity use at site.
(2) Net reduction in on-site fuel combustion (not for electricity production).
(3) Type of fuel used to generate electricity.
(4) Type of fuel used for on-site combustion (not for electricity production).
(5) Per "An Introduction to Externalities" Table 3a, http://www.theenergyguy.com/externalities.html
(6) Emissions Reduction (lb/yr) = Electricity Savings (kWh/yr) x 3,413 (Btu/kWh) / 1,000,000 (Btu/MBtu) x Emission Rate (lb/MBtu).
(7) Per "An Introduction to Externalities" Table 3b, http://www.theenergyguy.com/externalities.html
(8) Emissions Reduction (lb/yr) = On-Site Fuel Savings (MBtu/yr) x Emission Rate (lb/MBtu).
(9) Total Emissions Reductions (lb/yr) = Electricity Emissions Reductions (lb/yr) + On-site Fuel Emissions Reductions (lb/yr).

YKHC Wind Study **By: TRS**
Heating Analysis **Check: LCK**

Background:
One possible strategy for the use of wind turbines in YKHC sites is to use the electricity for heating. Many of the clinics have a much larger thermal load than electric load, and fuel is expensive in many of the remote villages. This calculation compares the value of wind generated heat with the value of wind generated electricity.

Analysis:			Notes:
Fuel Oil Cost	$2.50	$/gallon	(1)
Heating Value of Fuel	140,000	Btu/gallon	(2)
Boiler Efficiency	80%		(3)
Electric Rate (no demand)	$0.1119	/kWh	(4)
Conversion	3,413	Btu/kWh	
Wind Turbine Capacity Factor	40%	kW	(5)
1-kW Turbine			
Turbine Capacity	1	kW	
Annual Electricity Output	3,504	kWh/yr	(6)
Value of Electricity	$392.10	/yr	(7)
Fuel Oil Displaced	106.8	gal/yr	(8)
Value of Displaced Fuel Oil	$266.95	/yr	(9)
Approximate Cost of Turbine	$10,000		(10)
Electricity Simple Payback	25.5	yr	
Heating Simple Payback	37.5	yr	
10-kW Turbine			
Turbine Capacity	10	kW	
Annual Electricity Output	35,040	kWh/yr	(6)
Value of Electricity	$3,920.98	/yr	(7)
Fuel Oil Displaced	1,067.8	gal/yr	(8)
Value of Displaced Fuel Oil	$2,669.45	/yr	(9)
Approximate Cost of Turbine	$55,000		(10)
Electricity Simple Payback	14.0	yr	
Heating Simple Payback	20.6	yr	

Conclusion:
Using wind turbines for electic resistance heating does not appear to be cost effective based on typical YKHC fuel rates. The power produced by the turbines is approximately two times more valuable as electricity than as heat, even assuming low electric rates and high fuel rates.

Notes:
(1) Assumed fuel rate is higher than rates in Bethel and Toksook Bay.
(2) Approximate heating value of distillate fuel oil.
(3) Estimated boiler/furnace efficiency for YKHC sites.
(4) Assumed electricity rate is avoided fuel cost for Toksook Bay. This is minimum value of electricity.
(5) Assumed capacity factor is relatively high in order to give a "best case" simple payback.
(6) Annual electricity output (kWh/yr) = turbine capacity (kW) x 8,760 (hr/yr) x wind turbine capacity factor (%).
(7) Value of electricity ($/yr) = annual electricity output (kWh/yr) x electric rate ($/kWh).
(8) Fuel oil displaced (gal/yr) = annual electricity output (kWh/yr) x 3,413 (Btu/kWh) / heating value of fuel (Btu/gal) / boiler efficiency (%).
(9) Value of displaced fuel oil ($/yr) = fuel oil displaced (gal/yr) x fuel oil rate ($/gal).
(10) Cost estimates are approximate and are meant to give an order of magnitude simple payback period.

 415/434-2600

Appendix D
Manufacturer's Noise Test Data for 10 kW Wind Turbine

BARK
BARK

WILD
SANCTUARY

CLICKCLICKCLIK

RRRRRRRRRRRRRR

12 July 2001

Michael L. S. Bergey
Bergey Windpower Co., Inc.
2001 Priestley Ave.
Norman, OK 73069

RE: Wind Turbine Noise Output Evaluation

Dear Mr. Bergey:

Per your request, on the afternoon of 9 July 2001, accompanied by John Stalcup, your representative in Glen Ellen, California, we traveled to a Bergey installation located in Solano County at Ledgewood Creek Vineyard to measure the sound pressure level generated by the Bergey Model BWC Excel 10kW Class Wind Turbine.

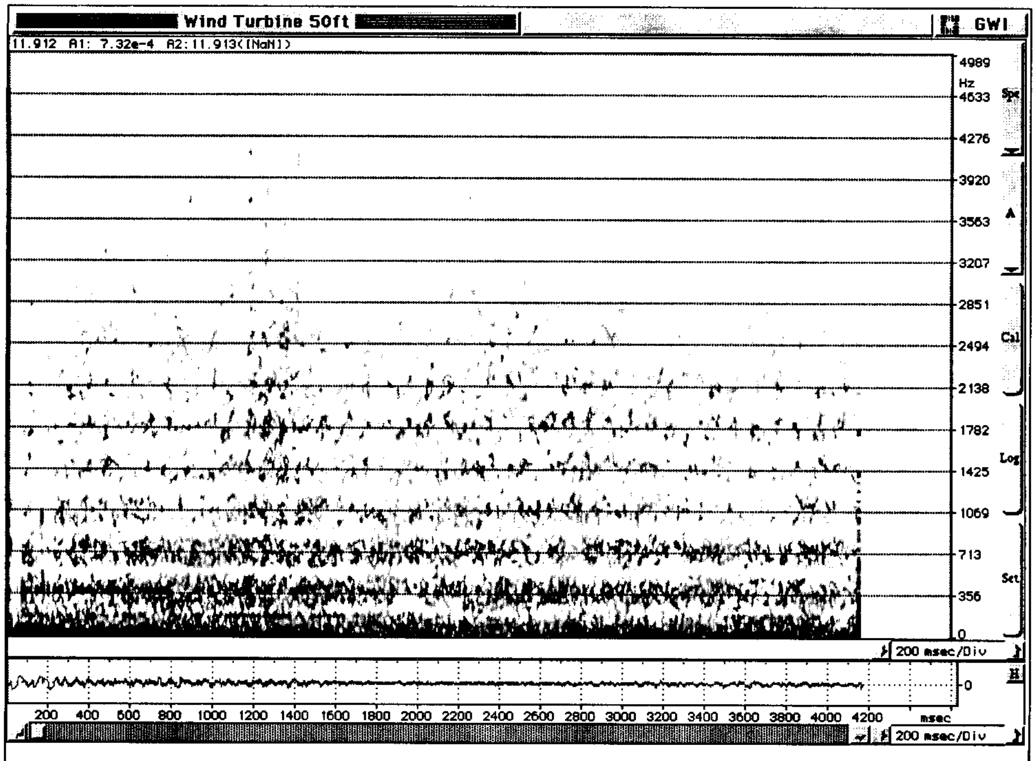
The wind during the time of measurement was gusting between 19 and 24 mph generally from a SE direction. It was mutually decided once on site to sample at distances of 20, 50, 100, 150, and 200 feet, respectively. The temperature was in the mid-70s with mostly clear skies. The sound pressure meter was a calibrated Rion Integrating Sound Level Meter, Model NL-06, Ser. # 00892560, featuring a NH 19, 1/2 inch capsule and windscreen. The meter was set to measure dBA sound pressure levels (SPL) each 200ms over a period of 20 seconds time with the average expressed in the chart below. We measured only from a downwind position since the SPL upwind and to the sides was measurably less. As the measurement was made in a vineyard at ground level, the SPL generated by the BWC Wind Turbine was often masked by the rustling of nearby grape leaves and vines, which by this time of year had fully matured (with the exception of the grapes).

We also attempted to record the samples using an M-S system consisting of a Sennheiser MKH 30 and a MKH 40 pair of mics, with Aerco pre-amp and a Sony PCM M1 DAT (digital audio tape) recorder. Despite the usual high wind effect attenuation precautions we took, this operation was not generally successful because of the unusually high gusts obviating collection of consistently useful data during this test. We were, however, able to obtain brief moments of sound spectrum data that might be helpful and are included with this evaluation report.

The following SPL measurements were made in relationship to the tower:

Distance	Wind Turbine "on"	Wind Turbine "off"
20 ft.	**50.1dBA**	**45.7dBA**
50 ft.	**49.3dBA**	**45.8dBA**
100 ft.	**46.9dBA**	**48.1dBA**
150 ft.	**44.2dBA**	**44.4dBA**
200 ft.	**44.1dBA**	**44.3dBA**

Sound spectrum data (below) reflects a sample of recorded sound taken at 50 feet. As the spectrogram shows, the sound output generated by the turbine during wind gusts of between 19 and 24 mph is similar in character to that of ocean waves, a stream, and wind effect in tall grasses or blowing through trees densely foliated with leaves and is a common element in acoustics not generally known to cause discomfort or stress in any culture.



Bergey Wind Turbine spectrogram recorded 7/9/01 at Ledgewood Creek Vineyard from a distance of 50 feet downwind. This 8 second sample (time on the "x" axis/frequency to 5kHz on the "y" axis) demonstrates acoustic characteristics common to natural sounds such as waves, leaves and grasses rustling as a result of wind, and stream sounds.

Conclusion. At distances of 20 and 50 feet, respectively, the level of noise generated by the rotating blades of the turbine, was never in excess of 5dBA greater than the ambient noise (with the turbine shut down). As far as we could detect, there was no measurable noise from the turbine, itself, at any distance. From measurements in excess of 100 feet, the ambient sound of grape leaves tended to be louder in every case than the sound of the turbine blades.

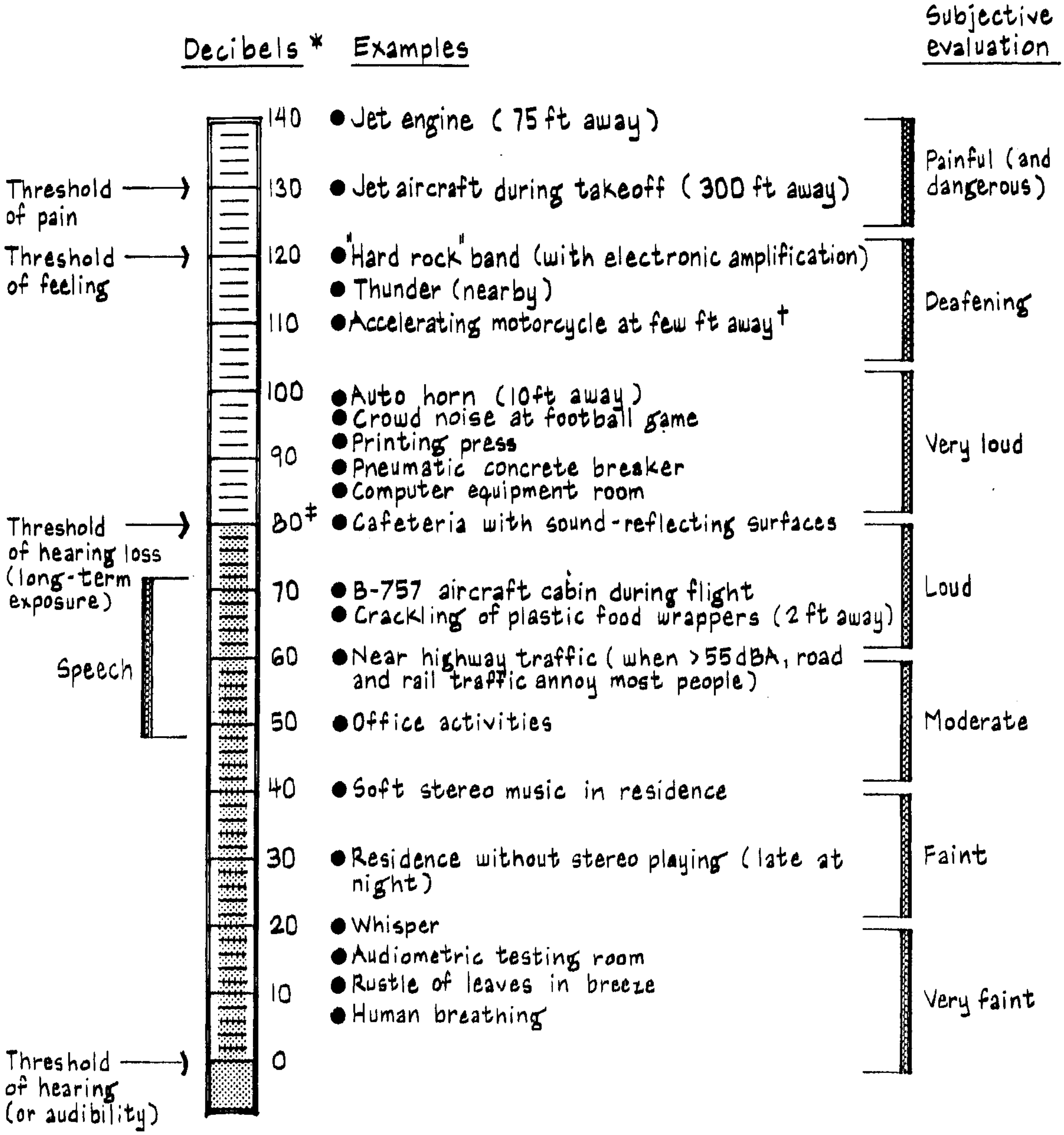
The nature of the sound generated by the blades was the same class of *white* or *pitched* noise commonly experienced by humans in the natural world. No sound type emanating from the wind turbine at any level was present that would be considered objectionable within the classes of industrial sound commonly thought of as such.

Very truly yours,

Bernard L. Krause, Ph.D.
President
Wild Sanctuary, Inc.
BLK/er
CC: John Stalcup - AirSource

COMMON SOUNDS IN DECIBELS

Some common, easily recognized sounds are listed below in order of increasing sound levels in decibels. The sound levels shown for occupied rooms are only example activity levels and do *not* represent criteria for design. Note also that thresholds vary among individuals.



*dBA are weighted values measured by a sound level meter. See page 31 for details of electronic weighting networks which modify the sensitivity of meters.

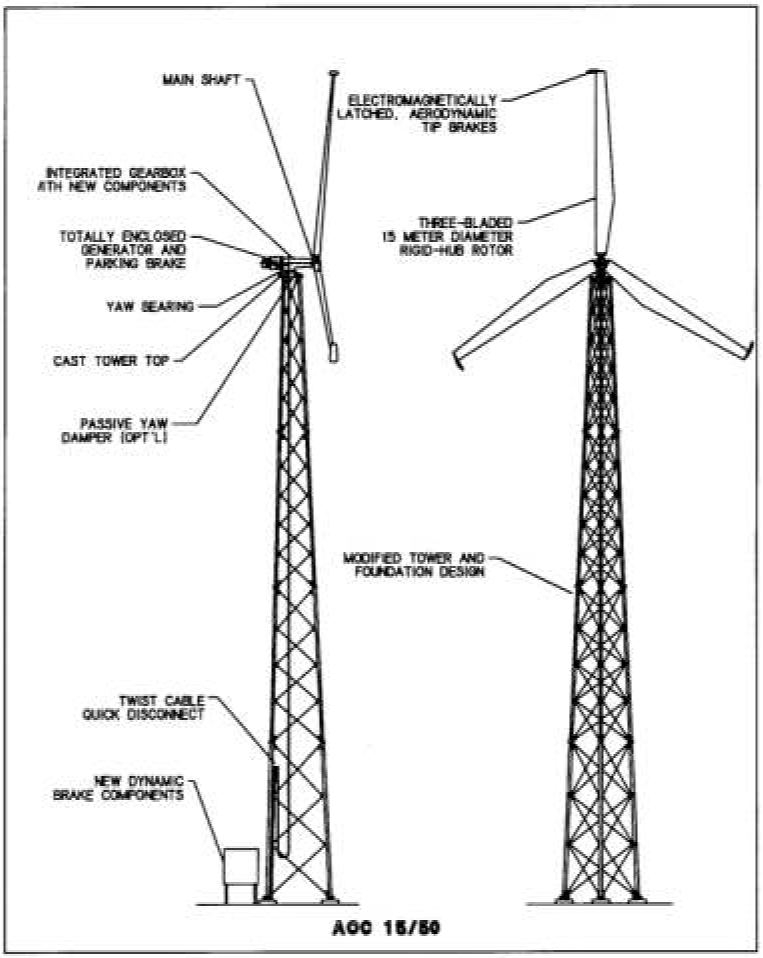
†50 ft from a motorcycle can equal the noise level at less than 2000 ft from a jet aircraft.

‡Continuous exposure to sound energy above 80 dBA can be hazardous to health and can cause hearing loss for some persons.

EMCOR Energy & Technologies

Appendix E
AOC Manufacturer Data

Atlantic Orient 15/50 Turbine Features



AOC 15/50 Tower and Turbine Schematic

- Absolute Simplicity and Minimal Maintenance Requirements
- Designed for 30 Year Life in Extreme Environmental Conditions
- Downwind, Passive Yaw Configuration
- Integrated Drive Train Provides Efficient Load Path
- Single Piece Casting for Hub, Gearbox Housing, and Tower Top
- Redundant Failsafe Braking: Tip Brakes, Dynamic Brake, and Parking Brake
- Engineered for Use in High Penetration Wind / Diesel Hybrid Systems
- NREL Thick Airfoil; Well Proven (Durable) Composite Glass Epoxy
- Efficient Over Wide Spectrum of Wind Speeds
- Features For Arctic Environment Include:
    - Turbine Metallurgy Selected for Arctic Conditions
    - Pitch Adjustments for Higher Air Density
    - Modified Tower to Accommodate Icing Loads
    - Optional Gearbox and / or Control System Heater(s)

- Test Standard for National Certification Laboratories
- Engineered for use in high penetration wind/diesel hybrid systems.
- PLC based control system

Atlantic Orient 15/50 Development History

Description

The AOC 15/50 wind turbine consists of a 15 meter rotor which produces 50 kW at an 11.3 m/s wind speed (60 Hz model). The turbine was developed in conjunction with the U.S. Department of Energy and the National Renewable Energy Laboratory (NREL) under their Advanced Wind Turbine (AWT) Program. The goal of this cost shared program was to produce economic wind generated electricity in a moderate average wind resource. This was achieved with simplicity in design, high availability and failsafe reliability.

The philosophy of Atlantic Orient Corporation is reflected in every stage of machine development. We have taken a long term view of our market and product development. Each component of the machine was designed and tested to ensure that actual field performance meets or exceeds design specifications. We have successfully designed a state-of-the-art wind turbine generator and have proven results from our current installations.

Recent Research and Development

The AOC 15/50 wind turbine was developed with a series of R&D cost-shared contracts administered by the National Renewable Energy Laboratory to comply with International Electro-Technical Commission standards. The Dutch Laboratory ECN has conducted a Failure Modes Effects Analysis (FMEA) on the 15/50 wind turbine. Field testing continues in several locations in the United States and Canada, as well as component qualification testing in our Fairlee, Vermont and Prince Edward Island, Canada facilities.

AOC 15/50 Prototypes Tested at Four Major International Test Centers

U.S. Department of Agriculture Test Site
Bushland, Texas

National Wind Turbine Test Center
Boulder, Colorado

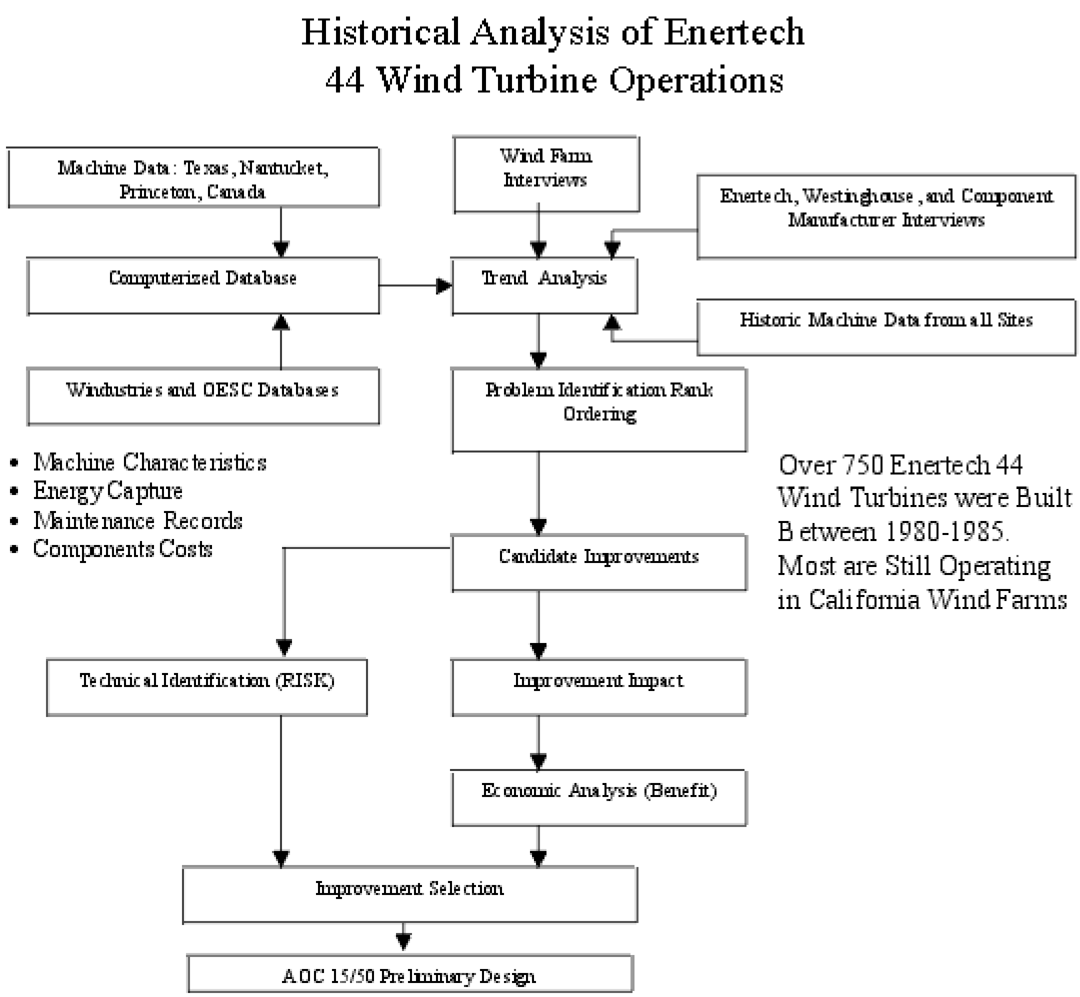
Atlantic Wind Test Site
Prince Edward Island, Canada

Greek National Laboratory (CRES)
Near Athens, Greece

One of the most important safety criterion in the design of the AOC 15/50 is the ability to safely control the wind turbine in normal and extreme conditions. This has lead to the development of redundant failsafe control mechanisms. The ultimate goal above and beyond low cost and high reliability is the protection and safe operation of the wind turbine in all specified conditions.

Evolution from Enertech Beginnings

In conjunction with the U.S. Department of Energy and the National Renewable Energy Laboratory's (NREL) Advanced Wind Turbine Program, Atlantic Orient Corporation developed a next generation 50 kW wind turbine based upon the concept of simplicity. By adhering to a design philosophy, this turbine produces energy at competitive rates for distributed generation, village electrification, diesel based utilities and purchased power displacement for agriculture, industry and municipalities.



From 1982 through 1986 approximately 750 Enertech wind turbines, designated as the E44 series, were installed in wind power stations throughout the United States and several other countries (most of them are still operating today). Atlantic Orient Corporation evaluated the historic performance of a significant number of the E44 series wind turbines. Problem areas were identified and rank ordered according to their contribution to turbine downtime. Specific potential solutions to downtime related problems were conceptualized and the impact of the various options was evaluated on an economic and risk basis to further define the benefits of each candidate improvement.

Enertech 44 kW AC machines deployed in a wind farm application

As a result of this analysis, Atlantic Orient Corporation developed the preliminary design of a 50 kW wind turbine designated the AOC 15/50. The results of this effort were so encouraging that final design and prototyping of the AOC 15/50 were initiated under separate NREL contracts. The Dutch National Laboratory for Renewable Energy (ECN) performed an independent reliability analysis and concluded that the AOC 15/50 was of fundamentally sound design.

Turbine and Component Qualification Testing	
Test Article	**Results**
Blade Root Bolt Receptors Pull Test	High Pullout Strength
Blade Fatigue Test	Failure achieved at 55,733 cycles of 2800 Lb Load block - 2nd Test to Qualify Aerpac Blades Complete
Tip Brakes	22,500 Braking Cycles
Drive Train	10^6 cycles at design load 10^6 cycles 20% overload
Dynamic Brake	Model Verification
Prototype at USDA Bushland Modal Test Performance Testing Loads Testing	 Frequency Measurements Power Curve as Expected Loads Well Within Design Limits
Pre-production Prototype at SeaWest San Gregonio Performance Testing Loads Testing	Analytical Models Successfully Verified

After an extensive review and analysis of the operating history of existing wind turbines, AOC's design team incorporated many design features in the AOC 15/50 which enhance energy production. These features include the following:

- Advanced Modified NREL Thick Airfoils
- High Strength to Weight Ratio Wood/Epoxy Blades
- Electromagnetically Controlled Tip Brakes
- Single Piece Hub Casting
- Innovative Split Core Rotary Transformer to transfer power to the Tip Brakes

- Integrated Gearbox with Improved Internal Components
- Totally Enclosed Generator
- Single Piece Cast Tower Top with Larger Yaw Bearings
- Uniformly Tapered Galvanized Lattice Tower
- Enhanced Dynamic Brake
- Advanced Controller based upon a Programmable Logic Controller

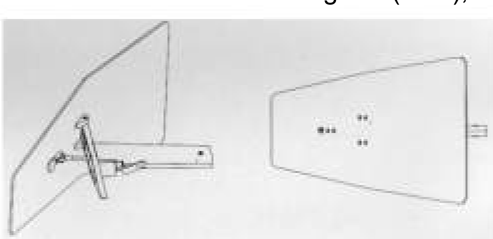
R&D Undertaken with NREL/DOE for 15/50	
NREL/DOE Contracts	Performance Period
System Stability and Penetration Study for Wind Diesel Hybrid Systems Operation and Performance Cooperative Agreement DE-FC027-87-CH10344	Complete 9/87-12/88
Advanced Wind Turbine AWT 15/50 Conceptual Design Subcontract No. Ag-0-19090-1	Complete 8/90-6/92
Fabrication and Testing of Advanced SERI Thick Airfoil Blades for the AOC 15/50 Wind Turbine Subcontract No. AO-2-11101-3	Complete 1/93-1/94
Multi-Functional Soft Start Subsystem for AOC 15/50 NREL P.O>1622631	Complete 11/99
Near Term Prototype Testing Project Subcontract No. ACU-6-15077-03	80% Complete 11/95-12/00
Support Contract Round Robin Developmental Test of AOC 15/50	50% Completed

The 15/50 designation refers to the 15-meter wood/epoxy rotor and its rated output of 50 kW at 11.3 m/s wind speed in the 60 Hz version.

The tower top casting provides a rigid, low cost solution to interfacing the gearbox with the tower. The low speed shaft has sufficient diameter and material strength to accommodate the structural and fatigue loads. The hub consists of a single piece casting, again, focusing on design simplicity.

Our design team has fulfilled the goal of design simplicity. The heart of the design is the integrated gearbox, which consists of a single piece, cast housing. The generator is flange-mounted to the planetary gearbox with the parking brake directly coupled to the totally enclosed generator. There is no nacelle.

The design of the dynamic brake is based upon the proven design used on the Enertech E44 turbines. However, brake design has been significantly enhanced through our use of the Alternative Transient Program (ATP), software that models electromagnetic transients.



This design package has been validated through extensive bench testing. A passive resistor-capacitor network is connected to the output of the generator. The brake is operated from the control system and is triggered by either detection of faults or by high wind speed. As the result of our control strategy, the frequency of operation of the dynamic brake is greatly reduced which decreases the resulting stresses on the generator and transmission.

The AOC 15/50 aerodynamic tip brakes are electromagnetically latched and released based upon instructions from the control system. In the normal stopping mode, both the dynamic brake and the tip brake are deployed simultaneously. All components are designed for fail safe operation. A spring/damper is incorporated to soften deployment of the tip brakes.

Atlantic Orient 15/50 Design Specifications Chart

The AOC 15/50 Drivetrain Assembly

- AOC 15/50 50 Hz Spec Sheet
- AOC 15/50 60 Hz Spec Sheet

Download 50 Hz Spec Sheet in .PDF
Download 60 Hz Spec Sheet in .PDF

AOC 15/50 50 Hz	
SYSTEM:	
Type	Grid Connected
Configuration	Horizontal Axis
Rotor Diameter	15 m (49.2 ft)
Centerline Hub Height	25 m (82 ft)
PERFORMANCE PARAMETERS:	
Rated Electrical Power	50 kW @12.0 m/s (26.8 mph)
Wind Speed	@hub height 25 m (82 ft)
cut-in	4.6 m/s (10.2 mph)
shut-down (high wind)	22.4 m/s (50 mph)
peak (survival)	59.5 m/s (133 mph)
Calculated Annual Output	
@ 100 % availability	5.4 m/s (12 mph) 85,000 kWh
	6.7 m/s (15 mph) 145,000 kWh
	8.0 m/s (18 mph) 199,000 kWh
ROTOR	
Type of Hub	Fixed Pitch
Rotor Diameter	15 m (49.2 ft)
Swept Area	177 m² (1902 ft²)
Number of Blades	3
Rotor Solidity	0.077
Rotor Speed @ rated wind speed	62 rpm
Location Relative to Tower	Downwind
Cone Angle	6°
Tilt Angle	0°

Rotor Tip Speed	48.6 m/s (109 mph) @ 50 Hz
Design Tip Speed	6.1
BLADE	
Length	7.2 m (23.7 ft)
Material	Epoxy/Glass Fiber
Airfoil (type)	NREL, Thick Series, modified
Twist	7° outer blade
Root Chord	457 mm (18 in) @ 4% 279 mm (11in)
Max Chord	749 mm (29.5 in) @ 39% 2925 mm (115 in)
Tip Chord	406 mm (16 in) @ 100 % 7500 mm (295 in)
Chord Taper Ratio	± 2:1
Overspeed Device	Electro-magnetic tip brake
Hub Attachment	Embedded female bolt receptors
Blade Weight	150 kg (330 lbs) approximate
GENERATOR	
Type	3 phase/4 pole asynchronous
Min. Ambient Temp.	-25°c
Frequency (Hz)	50 Hz
Voltage (V)	400, 3 phase @ 50 Hz
kW @ Rated Wind Speed	50 kW
kW @ Peak Continuous	55 kW
Speed RPM (nominal)	1500 @ 50 Hz
Winding Configuration	Ungrounded WYE
Insulation	Class F
Enclosure	Totally Enclosed Air Over (TEAO)
Frame Size	365 TC
Mounting	Direct mount to transmission
Options	Arctic low temp. shafting (-40°c)
TRANSMISSION	
Type	Planetary
Housing	Ductile iron-integrated casting
Ratio (rotor to gen. speed)	1 to 24.57 (50 Hz)
Rating, output horse power	88
Lubrication	Synthetic gear oil/non toxic
Filtration	Service filtration cartridge @ scheduled maintenance.
Heater (option)	Arctic version, electric
YAW SYSTEM	
Normal	Free, rotates 360 degrees
Optional	Yaw damping-required when known conditions frequently exceed 50° yaw rate per second.
DRIVE TRAIN TOWER INTERFACE	
Structural	Yaw bearing mounted on tower top casting
Electrical	Twist Cable
TOWER	
Type	Galvanized 3 legged, bolted lattice, self-supporting
Tower Height	24.4 m (80 ft)
Options	30.5 m (100 ft)
Tilt down	24.4 m (80 ft)

FOUNDATION	
Type	Concrete or special
Anchor Bolts	Certified ASTMA-A-193-Grade B7
CONTROL SYSTEM	
Type	PLC based
Control Inputs	Wind speed, generator shaft speed
Control Outputs	Line interconnection, brake deployment
Communications	Serial link to central computer for energy monitor and maintenance dispatch (optional)
Enclosures	NEMA 1, NEMA 4 (optional)
Soft Start	Optional
ROTOR SPEED CONTROL	
Production	Blade stall increases with increased wind velocity
Normal Start up	Aerodynamic, electrical boost if necessary
Shut-down	Control system simultaneously applies dynamic brake and deploys tip brakes. Parking brake brings rotor to standstill.
Back-up Overspeed Control	Centrifugally activated tip brakes deploy
BRAKE SYSTEM CONTROL	
Fail-safe brakes automatically deploy when grid failure occurs.	
APPROXIMATE SYSTEM DESIGN WEIGHTS	
Tower	3,210 kgs (7,080 lbs)
Rotor & Drivetrain	2,420 kgs (5,340 lbs)
Weight on Foundation	5,630 kgs (12,420 lbs)
DESIGN LIFE	30 Years
DESIGN STANDARDS	Applicable Standards, AWEA, EIA and IEC
DOCUMENTATION	Installation Guide and Operation & Maintenance Manual
SCHEDULED MAINTENANCE	Semi-annual or after severe events.

NOTE 1: Atlantic Orient Corporation and its affiliates are constantly working to improve their products, therefore, product specifications are subject to change without notice.
NOTE 2: Power curves show typical power available at the controller based on a combination of measured and calculated data. Annual energy is calculated using power curves and a Rayleigh wind speed distribution. Energy production may be greater or lesser dependent upon actual wind resources and site conditions, and will vary with wind turbine maintenance, altitude, temperature, topography and the proximity to other structures including wind turbines.
NOTE 3: For design options to accommodate severe climates or unusual circumstances please contact the corporate office in Prince Edward Island, Canada.
NOTE 4: For integration into high penetration wind-diesel systems and village electrification schemes contact the corporate office in Prince Edward Island, Canada for technical support and systems design.

Revised April 2003

AOC 15/50 60 Hz	
SYSTEM:	
Type	Grid Connected
Configuration	Horizontal Axis

Rotor Diameter	15 m (49.2 ft)
Centerline Hub Height	25 m (82 ft)
PERFORMANCE PARAMETERS:	
Rated Electrical Power	50 kW @11.3 m/s (25.3 mph)
Wind Speed	@hub height 25 m (82 ft)
cut-in	4.6 m/s (10.2 mph)
shut-down (high wind)	22.4 m/s (50 mph)
peak (survival)	59.5 m/s (133 mph)
Calculated Annual Output	
@ 100 % availability	5.4 m/s (12 mph) 87,000 kWh
	6.7 m/s (15 mph) 153,000 kWh
	8.0 m/s (18 mph) 215,000 kWh
ROTOR	
Type of Hub	Fixed Pitch
Rotor Diameter	15 m (49.2 ft)
Swept Area	177 m^2 (1902 ft^2)
Number of Blades	3
Rotor Solidity	0.077
Rotor Speed @ rated wind speed	65 rpm
Location Relative to Tower	Downwind
Cone Angle	6°
Tilt Angle	0°
Rotor Tip Speed	51 m/s (114 mph) @ 60 Hz
Design Tip Speed	6.1
BLADE	
Length	7.2 m (23.7 ft)
Material	Wood/epoxy laminate
Airfoil (type)	NREL, Thick Series, modified
Twist	7° outer blade
Root Chord	457 mm (18 in) @ 4% 279 mm (11in)
Max Chord	749 mm (29.5 in) @ 39% 2925 mm (115 in)
Tip Chord	406 mm (16 in) @ 100 % 7500 mm (295 in)
Chord Taper Ratio	± 2:1
Overspeed Device	Electro-magnetic tip brake
Hub Attachment	Embedded female bolt receptors
Blade Weight	150 kg (330 lbs) approximate
GENERATOR	
Type	3 phase/4 pole asynchronous
Min. Ambient Temp.	-25°c
Frequency (Hz)	60 Hz
Voltage (V)	480, 3 phase @ 60 Hz
kW @ Rated Wind Speed	50 kW
kW @ Peak Continuous	60 kW
Speed RPM (nominal)	1800 @ 60 Hz
Winding Configuration	Ungrounded WYE
Insulation	Class F
Enclosure	Totally Enclosed Air Over (TEAO)

Frame Size	365 TC
Mounting	Direct mount to transmission
Options	Arctic low temp. shafting (-40°c)
TRANSMISSION	
Type	Planetary
Housing	Ductile iron-integrated casting
Ratio (rotor to gen. speed)	1 to 28.25 (60 Hz)
Rating, output horse power	88
Lubrication	Synthetic gear oil/non toxic
Filtration	Service filtration cartridge @ scheduled maintenance.
Heater (option)	Arctic version, electric
YAW SYSTEM	
Normal	Free, rotates 360 degrees
Optional	Yaw damping-required when known conditions frequently exceed 50° yaw rate per second.
DRIVE TRAIN TOWER INTERFACE	
Structural	Yaw bearing mounted on tower top casting
Electrical	Twist Cable
TOWER	
Type	Galvanized 3 legged, bolted lattice, self-supporting
Tower Height	24.4 m (80 ft)
Options	30.5 m (100 ft)
Tilt down	24.4 m (80 ft)
FOUNDATION	
Type	Concrete or special
Anchor Bolts	Certified ASTMA-A-193-Grade B7
CONTROL SYSTEM	
Type	PLC based
Control Inputs	Wind speed, generator shaft speed
Control Outputs	Line interconnection, brake deployment
Communications	Serial link to central computer for energy monitor and maintenance dispatch (optional)
Enclosures	NEMA 1, NEMA 4 (optional)
Soft Start	Optional
ROTOR SPEED CONTROL	
Production	Blade stall increases with increased wind velocity
Normal Start up	Aerodynamic, electrical boost if necessary
Shut-down	Control system simultaneously applies dynamic brake and deploys tip brakes. Parking brake brings rotor to standstill.
Back-up Overspeed Control	Centrifugally activated tip brakes deploy
BRAKE SYSTEM CONTROL	
Fail-safe brakes automatically deploy when grid failure occurs.	
APPROXIMATE SYSTEM DESIGN WEIGHTS	
Tower	3,210 kgs (7,080 lbs)
Rotor & Drivetrain	2,420 kgs (5,340 lbs)
Weight on Foundation	5,630 kgs (12,420 lbs)

DESIGN LIFE	30 Years
DESIGN STANDARDS	Applicable Standards, AWEA, EIA and IEC
DOCUMENTATION	Installation Guide and Operation & Maintenance Manual
SCHEDULED MAINTENANCE	Semi-annual or after severe events.

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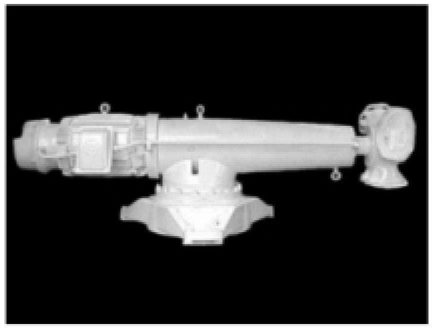
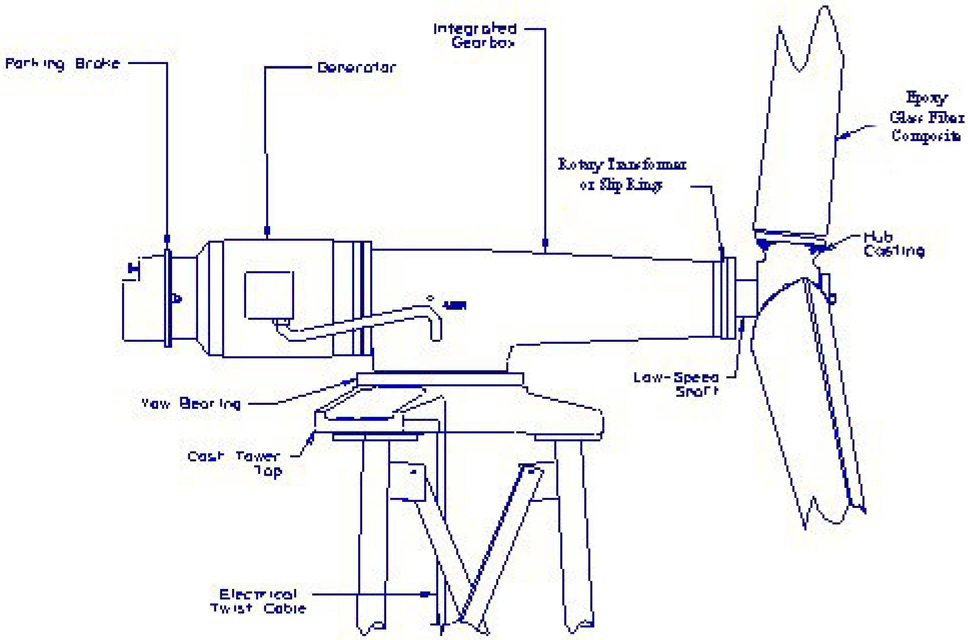
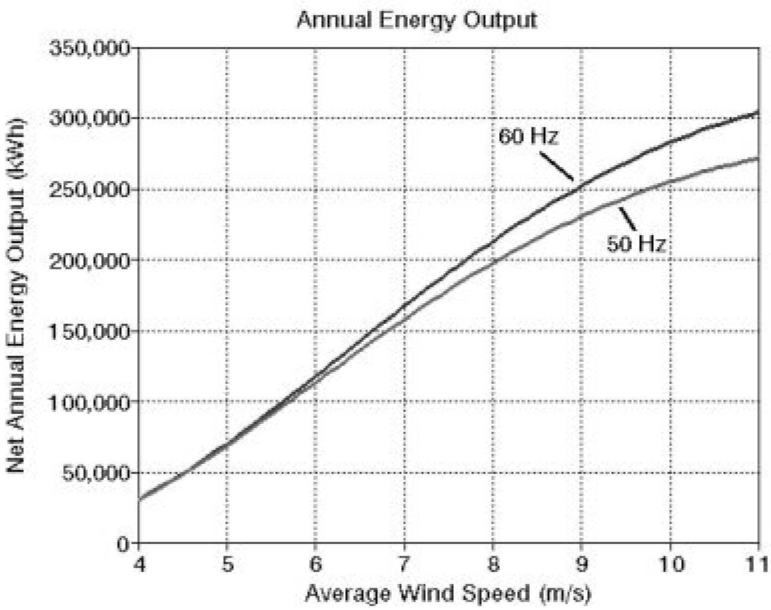
Revised April 2003

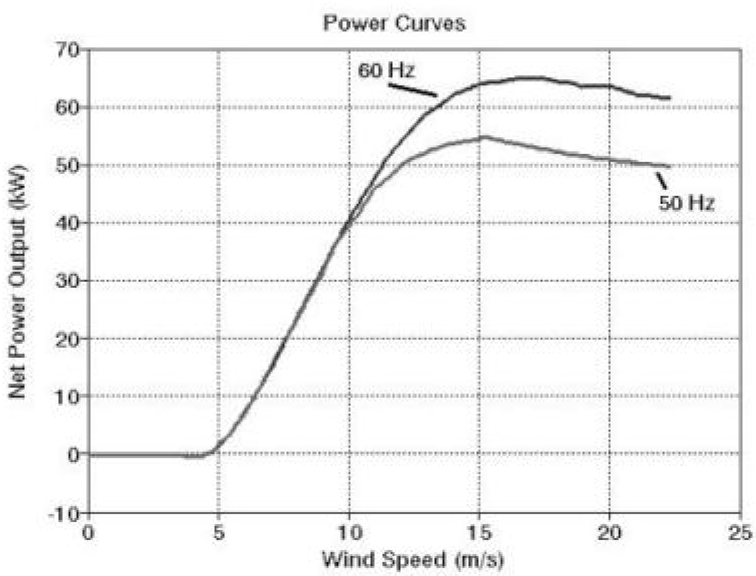
Atlantic Orient 15/50 Turbine Body




Parking Brake
Generator
Integrated Gearbox
Epoxy Glass Fiber Composite
Rotary Transformer or Slip Rings
Hub Casting
Yaw Bearing
Low-Speed Shaft
Cast Tower Top
Electrical Twist Cable

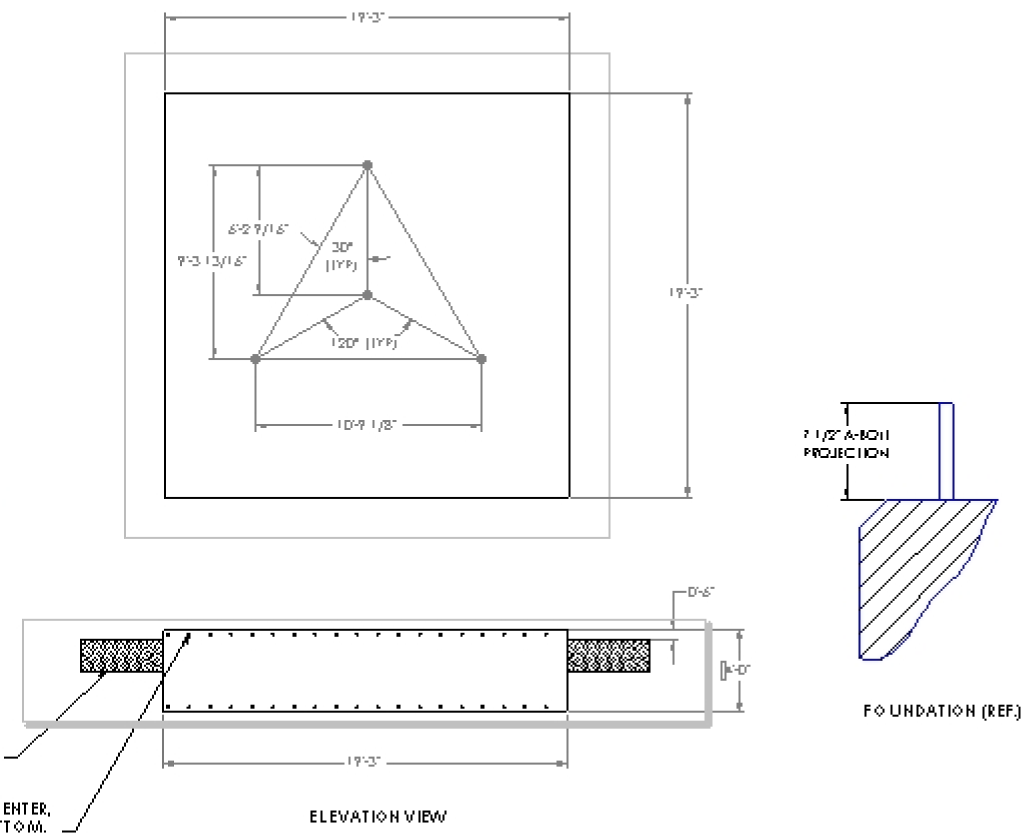
Atlantic Orient 15/50 Power Curve





NOTES:

1. ALL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 PSI AT 28 DAYS.
2. ALL REINFORCING STEEL SHALL BE DEFORMED BARS MEETING THE REQUIREMENTS OF ASTM A615, GRADE 60.
3. MINIMUM CONCRETE COVER ON REINFORCEMENT SHALL BE 3 INCHES.
4. FOR ANCHOR BOLT LOCATIONS AND INSTALLATION INSTRUCTIONS, SEE SPECIFICATIONS FOR TOWER BEING USED.
5. FOR FOUNDATIONS AND ANCHOR BOLT TOLERANCES AND FOUNDATION NOTES, SEE SPECIFICATIONS FOR TOWER BEING USED.
6. SPLICES IN REINFORCEMENT SHALL NOT BE ALLOWED. WELDING OF REINFORCING STEEL OR ANCHOR BOLTS IS NOT ALLOWED.
7. ALL CONSTRUCTION SHALL CONFORM TO LOCAL CODES AND TO THE LATEST VERSION OF ACI-318, "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE.
8. THE BASE OF THE FOUNDATION SHALL BE PLACED ON NATURAL UNDISTURBED SOIL.
9. IN THE PLAN VIEW THE AXIS OF THE TOWER SHALL BE LOCATED AT THE CENTER OF THE FOUNDATION.
10. THE CONTRACTOR SHALL CONFIRM THAT THE SOIL CONDITIONS AT THE SITE ARE AT LEAST THE EQUIVALENT OF E.I.A. "NORMAL" SOIL (4000 PSF ALLOWABLE BEARING PRESSURE) AND THAT THE DEPTH OF THE FOUNDATION IS ADEQUATE FOR MAXIMUM FROST DEPTHS AT THE SITE.



THE DRAWING ON THIS PRINT AND INFORMATION THEREWITH ARE PROPRIETARY TO ATLANTIC ORIENT CORP AND SHALL NOT BE USED IN WHOLE OR IN PART WITHOUT WRITTEN CONSENT OF ATLANTIC ORIENT CORP.

Atlantic Orient Corporation

A WIND ENERGY SYSTEMS COMPANY

DRAWN

AOC 15/50 Typical Purchase Order

AOC 15/50 Wind Turbine

- AOC 15/50 WTG [ ] 60 Hz, [ ] 50 Hz - standard 80 ft galvanized tower
- Tower Safety Climbing Cable and harness
- Anchor Bolts and template for standard concrete foundation (12 bolts per turbine, see note 1)

Tower Options

- 100 ft. Tower Option
- 80 ft. Tilt Down Tower Option

Resistive Soft Start Equipment

- Watts transducer and current transformer
- SCADA data interface
- 9 Bay controller for SCADA Interface
- Digital Display for System Monitoring
- Stainless Steel Control Enclosures (Required for exposed marine or tropical moist environment)
- NEMA 4 Control Enclosures -Control Box, Dynamic Brake Box (Required for Controls not in a weatherized shelter)
- Tropical Package for generator
- Modified Cold Weather Package Category 1
  - Transmission and Parking Brake Heater - Enclosure Heater and insulation - Low Temperature Lubrication
- Severe Cold Weather Package Category 2 (<-40° C)
  - Transmission and Parking Brake Heater -Enclosure Heater and insulation - Low Temperature Lubrication - Arctic Turbine Shaft

Design, Service, Support, and Freight

- Design Utility Interface per person per day
- Export Packing Turbine
- Travel to site
- AOC site support at project site per person per day
- List of recommended on-site Spare Parts for one or two turbines per site or Service Center
- Service and Maintenance Kit
- Documentation package
- Special engineering

NOTE 1: Non standard foundation configurations may require special anchor bolts.
NOTE 2: Freight, fees, import duties, and taxes are the responsibility of the buyer.
NOTE 3: All travel, Per Diem, and incidental expenses are for the account of the buyer.
NOTE 4: Support structure or mounting hardware and connectors for control boxes are the responsibility of the buyer.
NOTE 5: Recommended for weak grid or high penetration wind diesel systems.

AOC 15/50 Planning Checklist

The following information is intended as a set of checklists to assist our customers in addressing the relevant details of an installation in logical sequences. Although most items apply to both large and small projects not every item will apply to every project. To insure thorough planning it is very important that the customer understand why a particular detail is or is not appropriate to the installation.

By reviewing the entire list at various stages of the project, the customer should be able to ensure that he/she has not overlooked any of the details necessary to complete a project

Site Construction at Kotzebue Electric Association

Siting Factors

Site selection may have a significant effect on annual energy production. It is typically worth the additional time and effort to locate the proper site to maximize energy production and maintain the wind turbine expected life. The following siting factors should be considered:

- Wind Resource Characteristics
- Average wind speed
- Makeup of average (frequency and duration of power producing winds)
- Prevailing wind direction (s)
- Turbulence
- Peak windspeed

- Height and location of obstructions
- Distance from utility service point
- Local restrictions relative to height, proximity to boundaries, etc.
- Tower height
- Proximity of wind turbines to each other
- Site accessibility and its effect on construction and maintenance costs.

Utility Factors

The AOC 15/50 includes an induction generator which requires the interfacing electrical system to provide generator excitation. Each Turbine includes a fixed set of power factor correction capacitors located within the dynamic brake capacitor box. The turbine installation must consider specific factors regarding the interfacing utility network to provide for a safe and efficient installation. The following utility related factors should be considered:

- Buy back rates, contract options, green pricing, and net billing
- Available line capacity (in kVA)
- Available fault current
- Voltage and phase configuration of the primary circuit and the local utility line
- Distance to nearest substation
- Size and winding configuration of the step down transformer required at the site (in kVA)
- Line protection required
- Cogeneration standards for small power producers
- Interconnection hardware and wiring standards
- System operation requirements:
- Voltage regulation
- Power factor
- Protective devices
- Utility/Wind turbine interface responsibilities
- To properly interface with the utility network the customer needs to identify any and all power factor correction capacitors or unique loads connected to the utility system.
- To assist AOC in designing your interface , AOC needs the attached "Required Customer Power Grid Information" sheet to be completed.

Permit and Approval

Many wind turbine locations will require some of the permits and approvals identified herein. It is important to determine which permits / approvals apply to your particular site.

- Issued by:
  - Municipality or local council
  - Country
  - State or Province
  - Federal (FAA, FCC, etc.)
  - Commission (energy, conservation, historic, etc.)
  - Utility
- Type:
  - Construction
  - Foundation Engineering
  - Electrical
  - Interconnection
  - Zoning
  - Communication Interference
  - Aviation Interference
  - Enviromental Impact
- Inspections required for above

Plans and Drawings

Suggested items to have on hand or to prepare for efficient and proper site development and for the submittal, if necessary, for various approvals:

- Plot plan
- Site layout
- Tower foundation drawing
- Tower assembly drawing
- Site wiring layout
- Control house interior wiring (if applicable) diagram
- Control house physical layout (if applicable)
- Utility interface - single line drawing
- Utility interface - three line drawing
- Wind turbine generator to control box wiring schematic
- Wind turbine generator wiring diagram

Construction Planning Considerations

To minimize time and cost, the following items should be considered in the planning process:

- Subcontractor roles and responsibilities
- Cable trenches (type, length and depth)
- Control enclosure design
- Site specific weather extremes
- Tower foundation type
- Foundation forming details
- Site accessibility and road conditions
- Crane availability and cost
- Concrete availability and cost
- Backhoe availability and cost
- Concrete Reinforcing Bar availability and cost
- Labor skills and related costs
- Soil Characteristics
  - Soil stability
  - Depth to water table
  - Depth to significant frost
  - Allowable bearing capacities
- Blasting needs
- Tripod or backhoe for tower assembly
- Availability of hand tools
- Concrete working tools
- Anchor bolt template and verification of proper placement
- Fencing materials and security

Electrical planning considerations

Your local wiring inspector should review the design of the electrical installation prior to commencing work at the site. The following items should be considered in the design / installation of the electrical system :

- Wire sizes, length, and type as described in Section 1.7 and Appendix B
- Conduit type and size
- Service entrance hardware
- Revenue meter specifications
- Protective hardware required by the interfacing utility
- Distribution panel(s) with properly sized circuit protection
- Single phase power for control house lights and receptacles
- Step down transformer characteristics

- Control house interior wireways
- Control house junction box (es)
- Multiple unit control for wind power stations
- Twist cable termination box
- Foundation / conduit interfaces

Anenometer Booms
Photo courtesy KEA

WARNING:

THE INSTALLATION OF A LARGE SIZE WIND TURBINE GENERATOR (SUCH AS THE AOC 15/50) REQUIRES SPECIALIZED SKILLS, EQUIPMENT AND EXPERIENCE. INFORMATION SUPPLIED BY ATLANTIC ORIENT CORPORATION AND ITS SUPPLIERS ASSUMES THAT PERSONNEL WILL HAVE THE REQUIRED SKILLS, EXPERIENCE, AND EQUIPMENT TO INSTALL AND/OR MAINTAIN ALL PRODUCTS. NO ONE SHOULD ATTEMPT TO CLIMB TOWERS, OPERATE, OR MAINTAIN WIND TURBINES WITHOUT THE NECESSARY SKILLS, EXPERIENCE, TOOLS, AND SAFETY EQUIPMENT.

ATLANTIC ORIENT CORPORATION ASSUMES NO DIRECT OR CONSEQUENTIAL LIABILITY IF FAULTY OR DANGEROUS INSTALLATION OR MAINTENANCE PRACTICES ARE USED. THERE ARE TRAINED AND EXPERIENCED PERSONNEL AVAILABLE TO ASSIST IN INSTALLATION, OPERATION, MAINTENANCE, AND TROUBLE SHOOTING. CONTACT ATLANTIC ORIENT CORPORATION OR ITS AUTHORIZED REPRESENTATIVE IF CONSULTATION OR ASSISTANCE IS REQUIRED.

ATLANTIC ORIENT CORPORATION AND ITS SUPPLIERS RECOMMEND RESTRICTED ACCESS, ANTI-CLIMB SECTIONS, OR FENCES FOR ALL TOWERS TO PREVENT UNAUTHORIZED PERSONS FROM CLIMBING THE TOWER. APPROPRIATE WARNING SIGNS SHOULD ALSO BE PLACED ON THE TOWER.

TOWERS SHOULD NOT BE INSTALLED NEAR UNPROTECTED POWER LINES. ALL ELECTRIC WIRES AND CABLES SHOULD BE CONSIDERED DANGEROUS.

For best performance, all wind turbine installations should be thoroughly inspected by qualified personnel within 60 days after completion, at least semi-annually, and after any major windstorm, earthquake or other severe event.

The inspection and service intervals identified by Atlantic Orient Corporation must be followed for any Atlantic Orient warranty to remain valid.

EMCOR Energy & Technologies

Appendix F
Bergey Manufacturer Data

Bergey Turbines are Tornado-Tuff
Designed, Built, and Proven in America's Tornado Alley

Exclusive 5 Year Warranty

BWC EXCEL
10KW CLASS WIND TURBINE

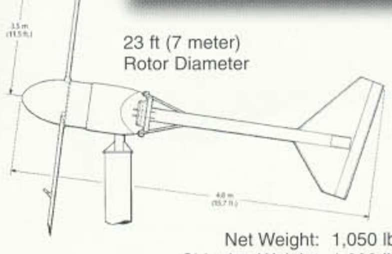
- 5-YEAR WARRANTY
- AMERICA'S BEST SELLING RESIDENTIAL SYSTEM
- CERTIFIED BY CALIFORNIA ENERGY COMMISSION
- SIMPLE DESIGN - 3 MOVING PARTS
- PATENTED POWERFLEX® ROTOR SYSTEM
- AUTOFURL® AUTOMATIC STORM PROTECTION
- DIRECT-DRIVE PM ALTERNATOR
- NO SCHEDULED MAINTENANCE REQUIRED
- HEAVY-DUTY CONSTRUCTION
- DESIGNED FOR 30+ YEARS
- POLYURETHANE AIRCRAFT-QUALITY PAINT
- PROVEN, OVER 50 MILLION OPERATIONAL HOURS

The Bergey BWC Excel is a rugged and reliable small wind turbine that has been proven in hundreds of installations around the world. It comes from the world's leading manufacturer of small wind turbines and is backed by the longest warranty in the industry. Whether you want to reduce the electric bills at your home or power a critical load far from the power grid, the BWC Excel will deliver years of "worry-free" power.

Excel–S: Grid-Intertie Applications (10kW)
Excel–R: Battery Charging Applications (7.5kW)
Excel–PD: Pumping Applications (10kW)

Excel–S GridTek 10 Power Processor (AC output)

Excel–R OptiCharge Voltage Regulator (DC output)



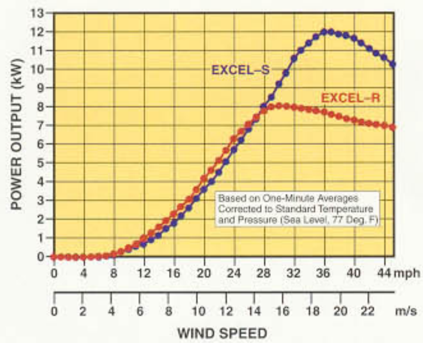
23 ft (7 meter) Rotor Diameter

Net Weight: 1,050 lbs
Shipping Weight: 1,200 lbs

THE ONLY MOVING PARTS ARE THE PARTS YOU SEE MOVING

PERFORMANCE

Start-up Wind Speed...7.5 mph
Cut-In Wind Speed...8 mph
Rated Wind Speed...31 mph
Rated Rotor Speed...310 RPM
Furling Wind Speed...36 mph
Max. Design Wind Speed...125 mph
(with Extra-Stiff Blades...150 mph)



POINT, CLICK, LEARN, ANALYZE & BUY WISELY:
WWW.BERGEY.COM

Predicted Monthly Energy Production

Wind Speeds Taken at Top of Tower

Average Wind Speed	8 mph	9 mph	10 mph	11 mph	12 mph	13 mph	14 mph
Excel–S (AC kWh)	240	370	520	700	900	1,130	1,370
Excel–R (DC kWh)	340	500	680	880	1,090	1,320	1,550

Wind Speeds Taken at 10 meters (per standard wind resource maps)

Average Wind Speed		8 mph	9 mph	10 mph	11 mph	12 mph	13 mph	14 mph
60 ft. Tower	Excel–S	330	480	670	870	1,110	1,350	1,610
	Excel–R	440	620	830	1,050	1,280	1,510	1,740
80 ft. Tower	Excel–S	430	620	840	1,100	1,370	1,670	1,960
	Excel–R	560	780	1,030	1,290	1,550	1,820	2,060
100 ft. Tower	Excel–S	490	700	950	1,220	1,510	1,820	2,130
	Excel–R	630	870	1,140	1,410	1,680	1,950	2,200
120 ft. Tower	Excel–S	550	780	1,050	1,340	1,650	1,970	2,280
	Excel–R	700	960	1,240	1,530	1,800	2,070	2,320

Assumptions: Inland Site, Rayliegh Distribution, Shear Exponent = 0.18, Altitude = 1,000 ft.
Note: Battery charge regulation (batteries full) will reduce actual Excel–R performance.
Your Performance May Vary.

BERGEY WINDPOWER

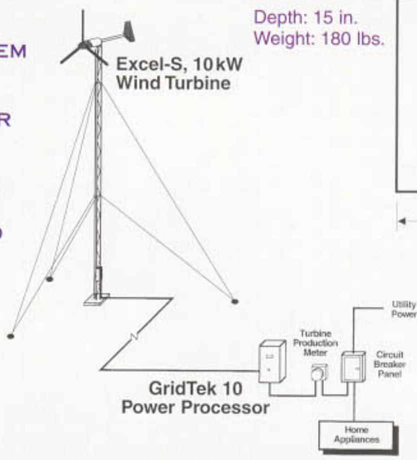
SIMPLICITY • RELIABILITY • PERFORMANCE

2001 PRIESTLEY AVE.
NORMAN, OK 73069
T: 405–364–4212
F: 405–364–2078
SALES@BERGEY.COM
WWW.BERGEY.COM

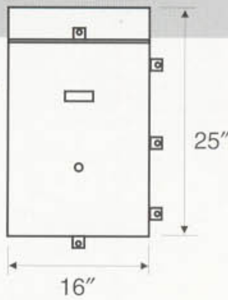
Electronics for the BWC Excel Wind Turbine

GridTek 10

- Power Processor for the Excel-S Grid-Intertie System
- 240 VAC Output, 60 Hz or 50 Hz, 220 VAC
- No Batteries, Excess Power is sold to the Power Company
- Fully Automatic Operation
- Advanced Digital Design
- Displays Output Power and Turbine Speed
- 5-Year Warranty
- UL Listed
- CEC Certified



Depth: 15 in.
Weight: 180 lbs.



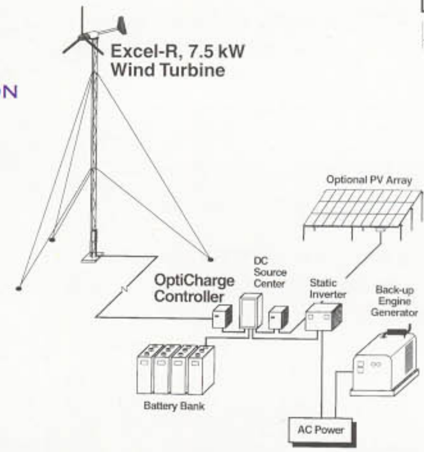
INSTALL INDOORS

48 V unit, with optional E-Meter

OptiCharge 10

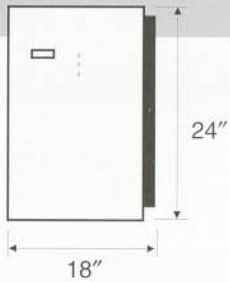
- Rectifier and Regulator for the Excel-R Battery Charging System
- 24, 48, 120, or 240 VDC Outputs
- Solid-State, Passive Cooling (except 24 V unit)
- OptiCharge, Constant Voltage Charging, for Longer Battery Life
- Fully Automatic Operation
- Displays Battery Voltage and Charging Status
- Optional Integrated DC Power Center
- 5-Year Warranty

240 V unit

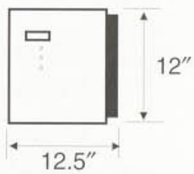


24 or 48 V Unit

Depth: 9 in.
Weight: 50 lbs.



120 or 240 V Unit

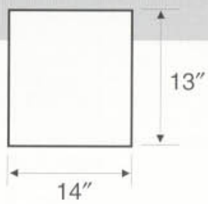


Depth: 7 in.
Weight: 15 lbs.

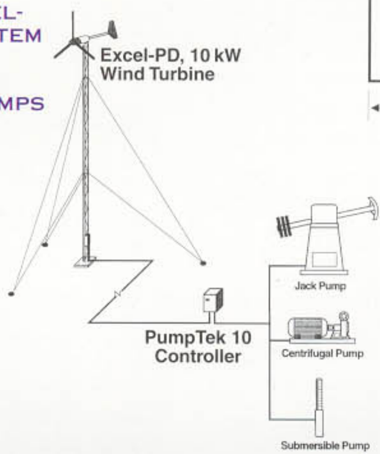
INSTALL INDOORS

PumpTek 10

- Pump Controller for the Excel-PD Wind-Electric Pumping System
- New Improved Design
- Solid-State, No Battery
- For Standard 240 VAC 3-Ph Pumps
- Fully Automatic Operation
- Dry Pump Shutdown
- Outdoor Rated Enclosure
- 5-Year Warranty



Depth: 9 in.
Weight: 25 lbs.



INSTALL INDOORS OR OUTDOORS

Dealer

BARK
BARK

WILD SANCTUARY

CLICKCLICKCLIK

RRRRRRRRRRRRRR

12 July 2001

Michael L. S. Bergey
Bergey Windpower Co., Inc.
2001 Priestley Ave.
Norman, OK 73069

RE: Wind Turbine Noise Output Evaluation

Dear Mr. Bergey:

Per your request, on the afternoon of 9 July 2001, accompanied by John Stalcup, your representative in Glen Ellen, California, we traveled to a Bergey installation located in Solano County at Ledgewood Creek Vineyard to measure the sound pressure level generated by the Bergey Model BWC Excel 10kW Class Wind Turbine.

The wind during the time of measurement was gusting between 19 and 24 mph generally from a SE direction. It was mutually decided once on site to sample at distances of 20, 50, 100, 150, and 200 feet, respectively. The temperature was in the mid-70s with mostly clear skies. The sound pressure meter was a calibrated Rion Integrating Sound Level Meter, Model NL-06, Ser. # 00892560, featuring a NH 19, 1/2 inch capsule and windscreen. The meter was set to measure dBA sound pressure levels (SPL) each 200ms over a period of 20 seconds time with the average expressed in the chart below. We measured only from a downwind position since the SPL upwind and to the sides was measurably less. As the measurement was made in a vineyard at ground level, the SPL generated by the BWC Wind Turbine was often masked by the rustling of nearby grape leaves and vines, which by this time of year had fully matured (with the exception of the grapes).

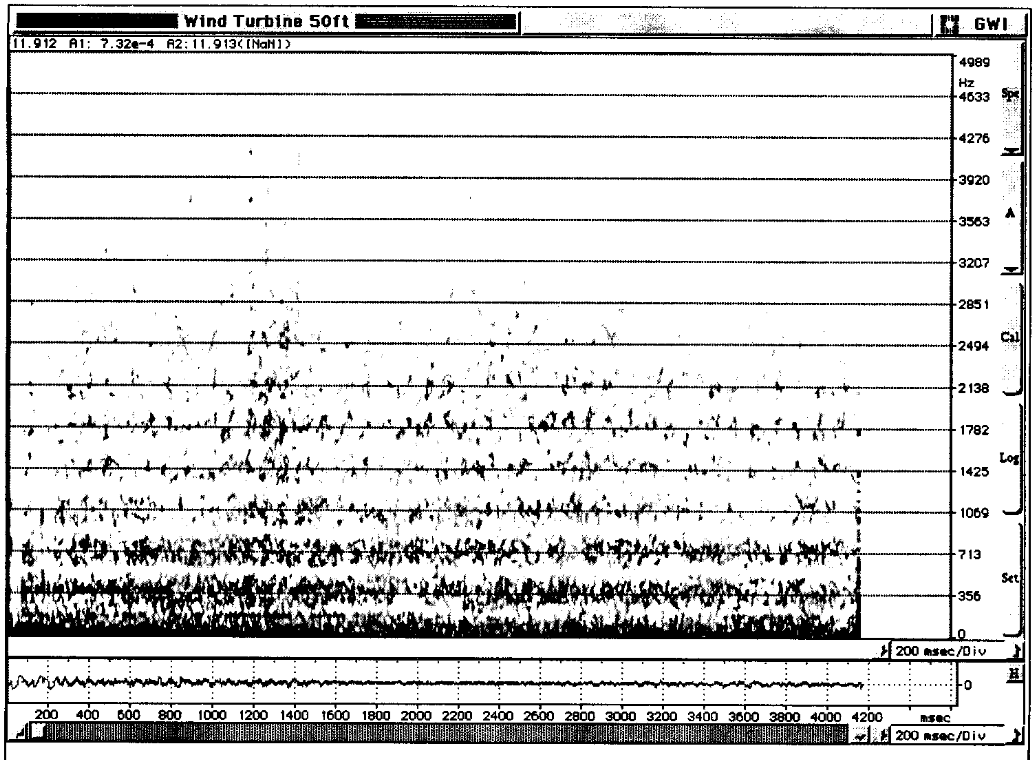
012 HENNO ROAD GLEN ELLEN CALIFORNIA 95442 TEL 707 996 6677 FAX 707 996 0280

We also attempted to record the samples using an M-S system consisting of a Sennheiser MKH 30 and a MKH 40 pair of mics, with Aerco pre-amp and a Sony PCM M1 DAT (digital audio tape) recorder. Despite the usual high wind effect attenuation precautions we took, this operation was not generally successful because of the unusually high gusts obviating collection of consistently useful data during this test. We were, however, able to obtain brief moments of sound spectrum data that might be helpful and are included with this evaluation report.

The following SPL measurements were made in relationship to the tower:

Distance	Wind Turbine "on"	Wind Turbine "off"
20 ft.	**50.1dBA**	**45.7dBA**
50 ft.	**49.3dBA**	**45.8dBA**
100 ft.	**46.9dBA**	**48.1dBA**
150 ft.	**44.2dBA**	**44.4dBA**
200 ft.	**44.1dBA**	**44.3dBA**

Sound spectrum data (below) reflects a sample of recorded sound taken at 50 feet. As the spectrogram shows, the sound output generated by the turbine during wind gusts of between 19 and 24 mph is similar in character to that of ocean waves, a stream, and wind effect in tall grasses or blowing through trees densely foliated with leaves and is a common element in acoustics not generally known to cause discomfort or stress in any culture.



Bergey Wind Turbine spectrogram recorded 7/9/01 at Ledgewood Creek Vineyard from a distance of 50 feet downwind. This 8 second sample (time on the "x" axis/frequency to 5kHz on the "y" axis) demonstrates acoustic characteristics common to natural sounds such as waves, leaves and grasses rustling as a result of wind, and stream sounds.

Conclusion. At distances of 20 and 50 feet, respectively, the level of noise generated by the rotating blades of the turbine, was never in excess of 5dBA greater than the ambient noise (with the turbine shut down). As far as we could detect, there was no measurable noise from the turbine, itself, at any distance. From measurements in excess of 100 feet, the ambient sound of grape leaves tended to be louder in every case than the sound of the turbine blades.

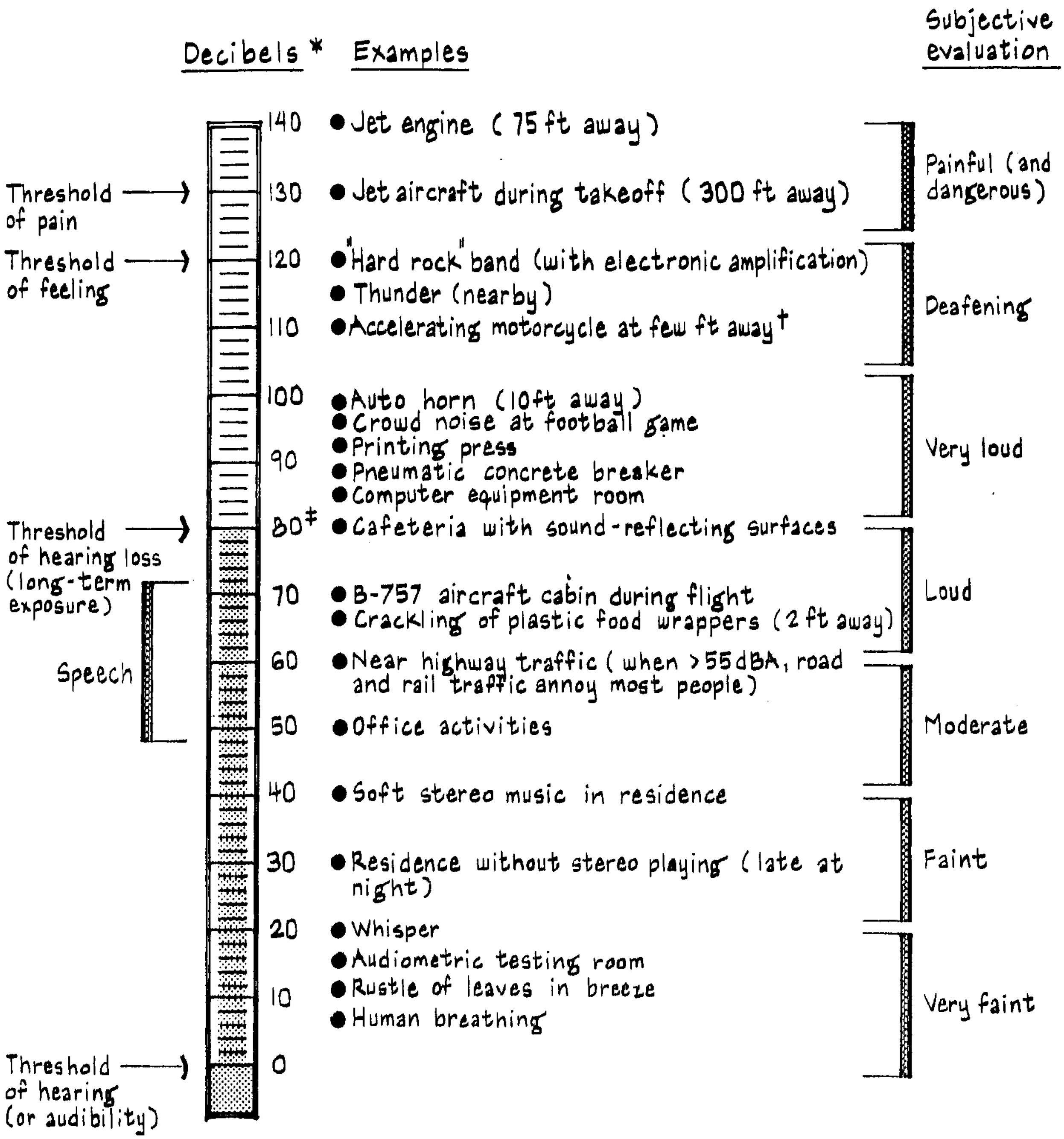
The nature of the sound generated by the blades was the same class of *white* or *pitched* noise commonly experienced by humans in the natural world. No sound type emanating from the wind turbine at any level was present that would be considered objectionable within the classes of industrial sound commonly thought of as such.

Very truly yours,

Bernard L. Krause, Ph.D.
President
Wild Sanctuary, Inc.
BLK/er
CC: John Stalcup - AirSource

COMMON SOUNDS IN DECIBELS

Some common, easily recognized sounds are listed below in order of increasing sound levels in decibels. The sound levels shown for occupied rooms are only example activity levels and do *not* represent criteria for design. Note also that thresholds vary among individuals.



*dBA are weighted values measured by a sound level meter. See page 31 for details of electronic weighting networks which modify the sensitivity of meters.

†50 ft from a motorcycle can equal the noise level at less than 2000 ft from a jet aircraft.

‡Continuous exposure to sound energy above 80 dBA can be hazardous to health and can cause hearing loss for some persons.