Green Mountain Power Wind Power Project Development

U.S. Department of Energy - EPRI Wind Turbine Verification Program

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Prepared by
Global Energy Concepts, Inc.
516 Sixth Street South, Suite 200
Kirkland, Washington 98033

Principal Investigator
K. Conover

Prepared for
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

EPRI Project Manager
C. McGowin

Renewables Business Intelligence Target,
Generation Group

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ORGANIZATION(S) THAT PREPARED THIS REPORT

Global Energy Concepts, Inc.

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REPORT SUMMARY

In 1992, EPRI and the U.S. Department of Energy (DOE) initiated the Utility Wind Turbine Verification Program (TVP). The goals of the program were to help electric utility companies gain field experience with wind power; evaluate early commercial wind turbines at several U.S. sites; and transfer the experience to the wind power community. This report describes the project development experience at the 6.05 MW Green Mountain Power wind power project near Searsburg, Vermont. The lessons learned in the project will be valuable to other utilities planning wind power projects.

Background
A previous TVP report described the project development experience at the 6.6 MW wind turbine project owned by Central and South West at a site near Fort Davis, Texas (EPRI TR-107300, December 1996). The second wind project to be implemented under the TVP was the 6.05 MW wind turbine project owned by Green Mountain Power (GMP) at a site near Searsburg, Vermont. The plant consists of 11 Zond Z-40-FS wind turbines. Each turbine has a 40-meter diameter, three-bladed rotor and a constant-speed turbine-generator mounted on top of a 40-meter tubular tower. Plant construction occurred in 1996, and turbine acceptance testing was completed in June 1997.

Objectives
- To document GMP's project development approach
- To describe the experience gained and problems encountered in the project
- To transfer the lessons learned to other utilities that are planning projects

Approach
Project investigators documented the project development experience at the GMP project, from initial planning and site selection through construction, startup, and acceptance testing. This report describes the project background, site selection, land acquisition, permitting and public acceptance studies, environmental studies, turbine vendor selection, project design, engineering and construction, turbine commissioning and acceptance, project cost and schedule, operation and maintenance and performance evaluation plan, and outreach activities during the project development process.

Results

GMP has successfully developed and constructed a wind power plant in Southern Vermont that is now in operation. Issues that arose during project development included permitting and weather delays to the project schedule; contract negotiations with the equipment vendor; and start-up problems on a number of turbine components. Some of the issues were related to the lack of experience with installing wind energy projects in cold and wet conditions similar to the environment at GMP's project site. The host utility successfully used the wind project to educate the surrounding community and state and national interest groups on the benefits of renewable energy.

EPRI Perspective

An important goal of the TVP has been to transfer the experience gained in the TVP projects to other utilities, wind power developers and turbine vendors, government agencies, and others so that lessons learned can be incorporated into future projects. The GMP project development report should be very helpful in this regard, because it describes negative as well as positive experiences. The information in the report should help others avoid, or at least reduce, the impact of the problems encountered. Future reports on the TVP will describe the operating experience of the GMP and Central and South West TVP projects and operating experience of five new distributed wind generation projects selected for funding under the TVP during 1997.

TR-109061

Interest Category
Wind

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Planning
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Wind resource assessment
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Acceptance testing

ABSTRACT

The Wind Turbine Verification Program (TVP) is a collaborative effort of the US Department of Energy, the Electric Power Research Institute, and host utilities to develop, construct, and operate wind power plants.

Through their involvement as a TVP host utility, Green Mountain Power Corporation (GMP), has developed and constructed a commercial wind power plant. GMP completed construction of its new wind facility near Searsburg, Vermont, in December 1996 and the project was commissioned in June 1997. The facility is situated in a sparsely-populated, forested area on privately-owned land. The 6.05 MW plant consists of 11 Zond 550-kW Z-40-FS (full span) turbines which are expected to generate about 14 GWh of electricity a year in normal wind conditions. Zond turbines were selected by competitive solicitation. The estimated project cost is $11 million, of which EPRI and DOE are each contributing $1.75 million in TVP funds, and EPRI and GMP are each contributing $477,000 in Tailored-Collaboration funds. GMP will conduct a three-year testing and evaluation program.

This report discusses GMP's activities and experiences from the initial project conception to the commissioning of the wind turbines. It includes site selection, permitting, vendor selection, project design and construction, cost and schedule, and equipment acceptance. Some of the experience gained from the development phase of the project is common to any construction project, some is unique to developing a wind power plant, and some is related to the specific project location and GMP's research objectives. Subsequent annual reports on the GMP project are planned to document the first three years of operating experience.

ACKNOWLEDGMENTS

A number of individuals provided information and contributed to the production of this report. Valuable input on the outline and comments on draft versions were received from representatives of Green Mountain Power, Zond Systems, the Electric Power Research Institute, the US Department of Energy and the National Renewable Energy Laboratory. John Zimmerman and Martha Staskus of Vermont Environmental Research Associates were particularly helpful in providing details, clarification, and assistance with graphics.

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INTRODUCTION

1.1 Background

The Wind Turbine Verification Program (TVP) is a collaborative effort of the US Department of Energy (DOE), the Electric Power Research Institute (EPRI), and host utilities to develop, construct, and operate wind power plants. The objective of the program is to provide a bridge between the wind turbine development programs currently underway in the US and utility purchases and evaluation of commercial, utility-grade wind turbines. The TVP is intended to assist utilities in learning about wind power through first-hand experience and to build and operate enough turbines to gain statistically significant operating and maintenance data. A further objective of the TVP is to provide other utilities with information about wind technology and the project development process from the perspective of a utility owner and operator.

The TVP has been implemented in three phases. A Request for Proposal (RFP) for the first round of the TVP (TVP I) was released in 1993. It stipulated that each proposed project was to include up to 30 turbines of at least 250 kW each. The RFP also specified a minimum project size of 6 MW, the use of wind turbines incorporating the latest technology, and a US-manufacturing content of at least 50%. As a result of this solicitation, Central and South West Services (CSW) and Green Mountain Power Corporation (GMP) were chosen to host the first two TVP projects.[1] EPRI and DOE awarded funds to cover a portion of the costs associated with the selected projects based on a number of criteria that demonstrated the ability of the project to help commercialize state-of-the-art wind technology. A third utility was selected to host a project in the second phase of the program (TVP II), but negotiations were never finalized.

In 1996, an RFP for TVP III was released and the solicitation focused on distributed generation. TVP III projects must be connected to a distribution line, consist of at least two wind turbines, and be less than 5 MW in total size. Contracts for up to five TVP III projects are expected to be finalized in 1997. In addition to the TVP I and III hosts, other utility wind projects were incorporated into the TVP as "associate projects" in

[1] A separate report on the Central and South West TVP project was prepared and published in 1996: *Central and South West Wind Power Project Development*, TR-107300, Electric Power Research Institute, December 1996.

1997. These projects receive limited funding from the program but benefit from the information exchange and technical assistance. In return, the program sponsors receive performance data and other valuable information.

EPRI manages the TVP program on behalf of the funding organizations. EPRI and DOE, through its National Renewable Energy Laboratory (NREL), also provide valuable technical and management assistance to the host utilities. Additional TVP solicitations are under consideration for the future.

This report focuses on the project development experiences of one of the TVP I host utilities, Green Mountain Power Corporation. The report discusses GMP's activities and experiences from the initial project conception to the commissioning of the wind turbines. Subsequent annual reports on the GMP project are planned to document the first three years of operating experience. Reports are also planned to document the experiences of the other TVP projects.

1.2 Objectives and Scope

One of the major components of the TVP is to verify the performance of the wind turbines installed in the projects and to transfer the lessons learned to others in the utility and wind industries. Because the CSW TVP project is roughly one year ahead of the GMP project, GMP was able to benefit from CSW's early experiences and incorporate many of the lessons learned into their own decision-making processes. Both of the projects use Zond Z-40 wind turbines. The CSW Z-40 turbines have ailerons for power regulation and overspeed control, and they are mounted on tubular towers. The GMP Z-40 turbines employ full span pitch control and are mounted on tubular towers. In addition, the site characteristics, climate, rationale for participating in the TVP, and other factors are unique to each project. The purpose of this report is to document the development process of GMP's TVP wind power plant so that other utilities can benefit from this experience.

The principle objectives of the report are to summarize the approach taken by GMP to develop the project, describe any problems that were encountered in the process, and detail the accomplishments and experiences that occurred along the way. The report is intended to document GMP's rationale for decisions. However, it is not necessarily the recommended approach to developing a wind project. Another utility may choose a different approach that better suits its particular needs. Explanatory footnotes are used throughout the report to clarify and expand on those areas in which GMP's approach varies from the typical process for developing a commercial wind power plant or to offer EPRI's perspective on a topic. Additional information on wind power plant development and operation is available in other EPRI publications.[2]

1.3 Report Organization

The report is organized into 11 sections, in the approximate chronological order of the project development steps followed by GMP. Following the introduction, Section 2 provides background information including a brief description of GMP's wind project to set the context for the rest of the report, a summary of GMP's rationale for participating in the project, and a discussion of the wind monitoring activities that GMP conducted prior to its participation in the TVP program. Section 3 discusses GMP's site selection and land acquisition process for the TVP wind power plant. A brief summary of the site wind resource characteristics is included in this section. Section 4 contains a description of the permitting process, and technical, environmental, and public acceptance studies that were conducted or are planned as part of the program. Section 5 discusses the turbine vendor selection process, including a description of the bidding process, the evaluation criteria, and the contract negotiation issues. Section 6 discusses project design, engineering, and construction activities, and Section 7 summarizes the turbine acceptance and project commissioning procedures. Section 8 summarizes the costs and schedule for the project. The operation, maintenance, and performance plans are summarized in Section 9. Section 10 discusses the outreach activities that were conducted as part of the program. Section 11 contains conclusions and summarizes the experience gained from the development process.

[2] In particular, see *Planning Your First Wind Power Project, A Primer for Utilities*, TR-104398, Electric Power Research Institute, December 1994.

2

PROJECT BACKGROUND

2.1 Project Description

GMP is a small investor-owned electric utility, headquartered in South Burlington, Vermont. The utility serves about 80,000 retail customers, and its service territory is entirely within the State of Vermont. It is a winter-peaking utility with a maximum peak load of less than 350 MW. The TVP wind energy project represents about 0.5% of GMP's power supply resources.

GMP selected Zond Development Corporation and Zond Constructors Incorporated of Tehachapi, California to supply the wind turbines, electrical interconnection equipment, and construction and installation services for the project on a turnkey basis. Both of these companies are wholly-owned subsidiaries of Zond Systems Incorporated (Zond). In January 1997, Zond was acquired by Enron Corporation and it has subsequently been re-named Enron Wind Corporation.

The GMP TVP wind power plant is a 6.05 MW facility of commercial-scale wind turbines. It is currently the largest wind project in the eastern United States. The project consists of 11 model Z-40-FS 550-kW wind turbines manufactured by Zond. The turbines include a cold weather package to address the Vermont climate. The 11 turbines are installed along a ridgeline in a string stretching approximately 1.2 km (.75 mile). The turbine sites are at elevations between 823 and 884 meters (2,700 and 2,900 feet) above sea level.

The project site is located on private property in the town of Searsburg, Vermont, in Windham County. The site is in a heavily-forested section of the uplands region of the Green Mountains in southern Vermont, approximately 11 km (7 miles) north of the Massachusetts border. Figure 2-1 shows the location of the project relative to the surrounding towns and states. The topography in the vicinity is shown in Figure 2-2.

GMP awarded a contract to Zond in late 1995 to provide a turnkey project, and construction was substantially completed in December 1996. Commissioning took place in June 1997 and GMP accepted ownership of the project later that month. A project dedication ceremony was held in August 1997. Additional details on the project characteristics are provided in later sections of the report.

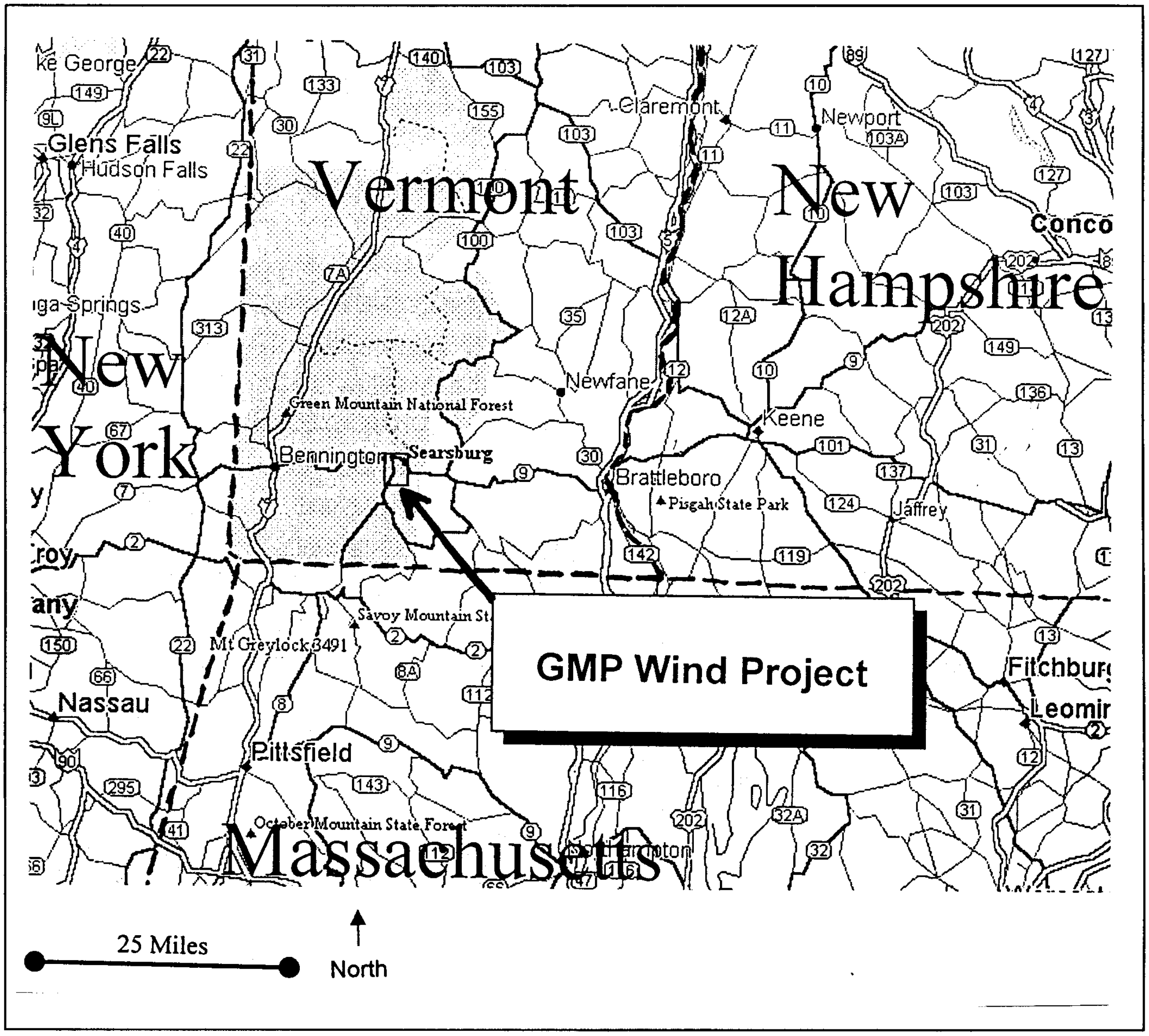

Figure 2-1
Location of GMP Project Site Relative to Surrounding Towns

2.2 Green Mountain Power's Renewable Energy Program

Like CSW, GMP has been involved with renewable energy projects, including wind power, prior to their participation in the TVP. If hydroelectric facilities' production and purchase agreements are considered, approximately 50% of GMP's generation supply is renewable energy. GMP's wind energy program was initiated close to 20 years ago when they began studying the wind power potential in or near their service territory in the late 1970s. Since that time, they have been an advocate of the utility use of wind power and maintained an active role in a number of wind energy industry organizations.

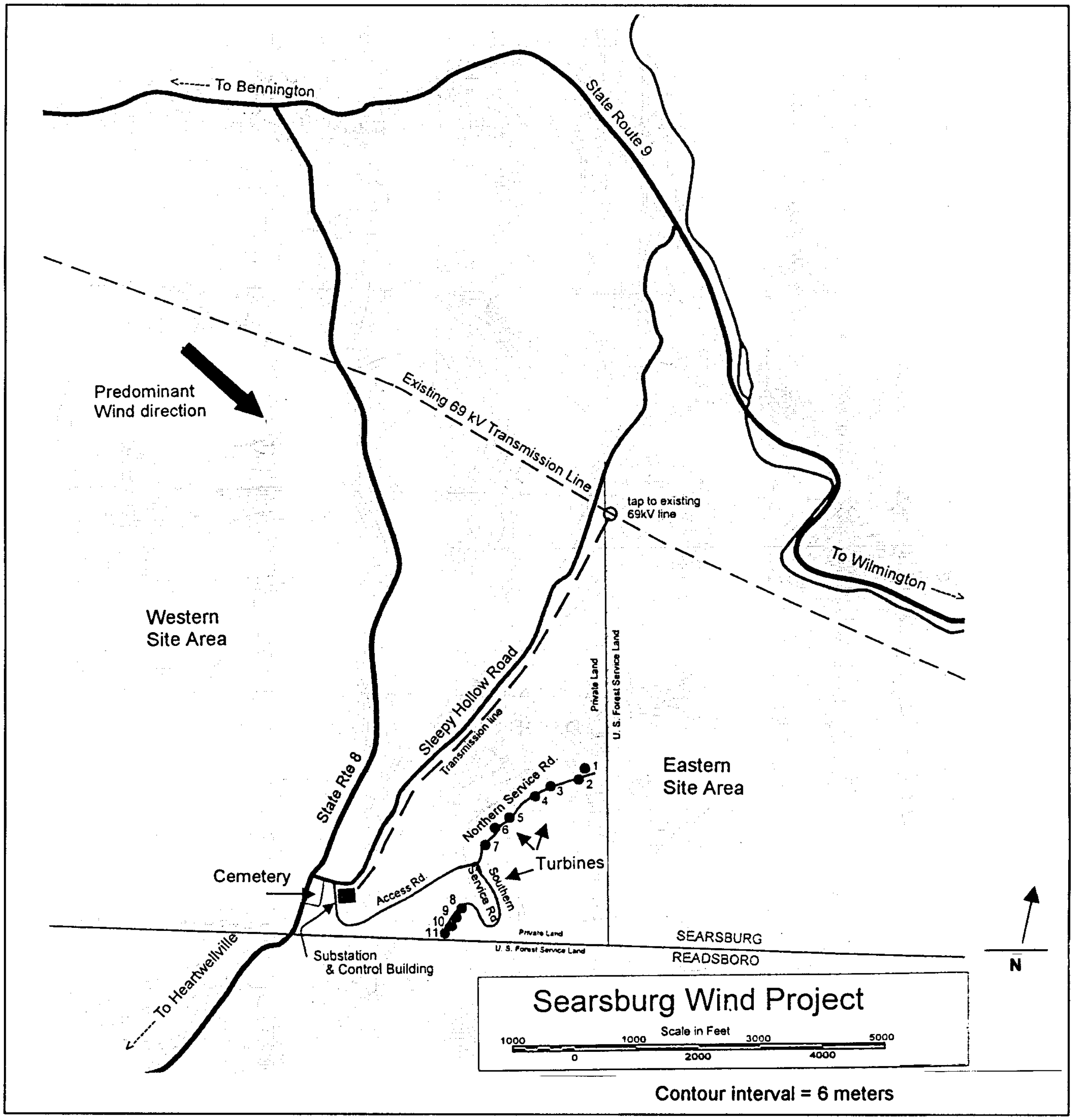

Figure 2-2
Topographic Map of GMP Project Site

GMP's first wind resource monitoring station was installed in the early 1980s. In addition, they operated two 100-kW turbines near Manchester, Vermont from 1990 to 1994 to evaluate cold climate issues and public acceptance of wind turbines. The TVP project is seen as the next important step in verifying the performance of wind power in cold regions.

An important goal of GMP's wind program is to help diversify its energy supply mix through the use of in-state renewable sources of energy. Through its monitoring program, GMP had already identified potential project sites with significant wind resources. The TVP provided an opportunity to proceed with plans to install a commercial-scale facility approximately two to three years earlier than would otherwise be economically viable. In addition, GMP is participating in the TVP project to gain hands-on knowledge about emerging wind energy technologies with the goal of identifying renewable energy alternatives that are reliable, dependable, and lower in cost than other renewable technologies.

The objectives of the EPRI-DOE and GMP TVP program are as follows:

- Determine the economic viability of wind turbines in the Vermont operating environment;
- Determine and document the performance of the wind turbines;
- Share the cost of the project so it can be considered a prudent capital investment;
- Provide a limited market for newly designed wind turbines prior to their achievement of a fully commercial status;
- Document and communicate the experiences gained in a turbine verification project to other utilities and turbine manufacturers;
- Enable the utility to maintain its leadership position in the utility use of wind power; and,
- Create a project whereby the expertise available through EPRI and NREL is readily accessible to GMP in their early use of wind power.

In response to the first TVP solicitation, GMP submitted a proposal for a 6 MW project and was awarded a contract in 1994. In addition to the EPRI-DOE TVP funding, GMP was also able to use EPRI Tailored-Collaboration funds to supplement their own contribution.[3]

2.3 Early Wind Monitoring Experience

In the early 1980s, GMP initiated a wind energy prospecting and site evaluation program. As a result of this program, wind monitoring stations were established at

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[3] As a member of EPRI, GMP was able to use approximately $477,000 in EPRI Tailored-Collaboration funds. Under this program, EPRI matches a portion of a member utility's funds for applicable projects.

seven sites identified as having wind energy development potential. In the vicinity of the current TVP project, two areas on either side of State Route 8, an "Eastern Site Area" and a "Western Site Area," were initially identified as promising, and the first measurement tower was installed in this vicinity in the fall of 1981. This station, located on the top of a hill in the Western Site Area, served as the long-term reference station for the site area. Although this station was de-activated between 1984 and 1987, there are still more than 13 years of data available in the vicinity of the TVP project site. Since 1981, GMP has operated 13 other measurement towers for shorter periods in the area. One of the measurement towers to the immediate south of the TVP project area now serves as the long-term reference for the site.

To assist them with their resource assessment activities, GMP contracted with consultants experienced in wind energy meteorology. In the 1980s, there was little experience with wind resource assessment outside of California. In climates similar to Vermont, or in heavily forested areas, the practical experience with wind resource assessment techniques was even more limited. As a result, GMP and their consultants developed several innovative studies to assess their wind resource and gain information about the impact of the environment on wind turbine operation.

One example of this approach is the partnership GMP formed with NRG Systems (NRG), a Vermont meteorological equipment manufacturer, to develop and test heated measurement sensors. GMP was concerned about the impact of icing not only on wind turbines but also on the wind measurement sensors. On three of their measurement towers, GMP installed heated anemometers as well as conventional sensors to compare the data from the heated and non-heated instruments. Subsequent analyses were conducted to determine the effects of icing on wind speed and direction measurements. The heated sensors, developed as part of this project, are now commercially available through NRG. Several years later NRG partnered with GMP again to test their new cellular data loggers on GMP's sites.

GMP also developed a unique financial agreement with NRG for data collection. Rather than purchase the monitoring equipment and collect the data themselves, GMP contracted with NRG to purchase only the data from their monitoring stations. This idea stemmed, in part, from GMP's concerns about the equipment becoming obsolete over the lifetime of the monitoring program. Under the agreement, GMP pays NRG to install, remove, or relocate equipment, but NRG retains ownership of the equipment and assumes responsibility for the cost to maintain and replace components. Thus, the burden for data recovery is shifted from GMP to NRG because NRG is only paid for the data it delivers. As a result of this agreement, NRG chose to use redundant sensors and redundant data loggers on the GMP monitoring stations. Both NRG and GMP have found this approach, and their agreement, to be satisfactory.

As part of another study, GMP obtained permission from the US Forest Service to remove the trees in a 10-acre area surrounding one of its monitoring stations. A full year of data were collected prior to the tree removal and a second year of data were collected after the tree clearing. Additional sensors were added to the tower to measure parameters at four heights. Data analyses, including shear and turbulence studies, were conducted on the two data sets to determine the impact of the trees on the wind resource characteristics. The study concluded that the tree removal did not significantly increase the wind speed; therefore, clearing did not provide a benefit for wind energy development.[4]

Overall, the logistics of installation, data collection, and maintenance of monitoring stations are complicated in Vermont because of the dense vegetation and the cold climate. To install a monitoring station in the Green Mountains, some clearing is generally required for the tower base and the guy wire anchors. Guy wire placement requires careful planning, and the guy wires are typically different lengths due to the topography. At the Searsburg sites, access during the winter months to collect data or perform maintenance was only by foot or snowmobile. The development of cellular data loggers was beneficial for data collection. However, maintenance of the loggers continues to be challenging.

In 1990, GMP installed two 100-kW US Windpower wind turbines on Mount Equinox in southwestern Vermont. The turbines were operated through three successive winters in a severe climate that included extreme cold temperatures and significant icing events. GMP conducted a number of performance analyses on this project including quantifying the effects of icing on wind turbine performance and the variability of icing with respect to elevation above sea level.

[4] This conclusion is specific to this site. In other wooded areas, the height of the trees, the ridge shape and slope, meteorological conditions, and other factors may indicate that tree removal will have a different impact.

3

SITE SELECTION AND LAND ACQUISITION

3.1 Site Selection for the TVP Wind Power Plant

GMP's site selection process began with its Wind Turbine Site Prospecting and Evaluation Program, which was designed and initiated in the late 1970s. The objective of the program was to locate the best potential wind sites in, or near, GMP's service territory. Several previous investigations indicated that the windiest areas in New England's interior were at the highest elevation sites. As a starting point for their prospecting study, GMP identified several hundred sites in Vermont with an elevation above 1,500 feet, and then applied a screening process to prioritize and/or eliminate sites from further consideration based on the following set of evaluation criteria:[5]

- The environmental impacts of developing the site;
- Compatibility of wind energy development with existing land-use;
- Location within a reasonable distance to existing access roads & transmission lines; and,
- Exposure to winds from all directions.

The screening process reduced the number of original high-elevation sites from several hundred to less than ten. Monitoring equipment was subsequently installed at seven of these sites to characterize each site's wind resource. Long term data from nearby National Weather Service stations and airports were used to further define the area's climatology and determine the long-term representativeness of the data from the new monitoring sites. Based on the wind data and an additional examination of each site's suitability for a wind energy project, the following four candidate sites were identified as having the best potential for development:

- A ridge to the north of Bolton Ski Area in Bolton, Vermont;

[5] Additional factors that are often considered in the site selection process include potential for expansion, match of wind patterns with demand requirements, suitability of physical site characteristics for construction and operation, public acceptance, and others.

- A ridge between Haystack Mountain and Mt. Snow in Wilmington and Dover, Vermont;
- A series of high points on either side of State Route 8 in Searsburg and Readsboro, Vermont (the Eastern and Western Site Area); and,
- A ridge straddling the Vermont/Massachusetts border in Stamford, Vermont and Florida, Massachusetts.

The Searsburg/Readsboro sites were ultimately selected as the most promising for early wind energy development because of a lower potential for land-use conflict than at the other sites. In addition, GMP considered input from local citizens, public interest groups, and regional authorities. The area's moderate elevation relative to other candidate sites also contributed to its selection. At between 823 and 884 meters (2,700 and 2,900 feet) above sea level, the Searsburg/Readsboro sites exhibited a strong wind resource without the heavy icing and potentially damaging winds found at higher elevation sites in the Northeast.

Although GMP's general methodology and approach to selecting a site are commonly employed in the wind industry, the challenges posed by the physical environment in Vermont and the timing of the work are particularly unique. The site selection work was initiated in the early days of the US wind industry. At that time, and even today, there is little experience with developing wind projects in areas with such dense forest, extreme temperatures, and icing frequency. GMP, other utilities, and the wind energy community in general will use the project experience gained at this site to make decisions regarding future implementation of wind energy projects in similar environments.

3.2 Land Acquisition Process

GMP originally considered building its wind power plant on a combination of private and federal lands in the Eastern Site Area. The US Forest Service (USFS) administrates the federal lands in this region and the use of this land requires a Special Use Permit. GMP initially applied for the permit in 1993. However, the review of their application was delayed due to limited staff resources within the USFS. In 1994, to help expedite the review process, GMP agreed to pay for a consultant to assist the USFS with its workload.

Shortly after the consultant was hired, the process was again halted due to an unrelated dispute regarding the proposed use of a neighboring land parcel. The conflict revolved around the USFS's proposal for timber management in the Lamb Brook section of the Green Mountain Forest. The USFS land that was part of GMP's proposed project site was outside of, but adjacent to, the Lamb Brook area. For political reasons, the USFS decided that they wanted to resolve the timbering issue before considering the wind project.

Although the USFS was working with the interested parties to settle the conflict in the Lamb Brook area, the delay continued for several months and worst-case projections for a resolution were estimated to be another year or two. Because more than a year had already passed from the date of the original submission to the USFS, GMP began to evaluate other options for locating the project. In conjunction with their meteorological consultants, GMP developed an alternative layout for the project at the Searsburg site that included only the private land in the area. The Western Site Area was also considered; however, additional meteorological investigation and other factors indicated that the private-land alternative in the Eastern Site Area was the most favorable option. This approach would benefit from using the same transmission line plans, substation location, and access roads as the original project layout. The revised layout was also deemed to have fewer visual impacts.

The TVP project was ultimately constructed on privately-owned land in the northern part of the Eastern Site Area. The ridgeline is heavily forested and has a northeast to southwest orientation. The nearest year-round resident is more than a mile away and there are no residences within four miles downwind of the site. Since the project includes no federal land, the only permit that was necessary was a Certificate of Public Good from the Vermont Public Service Board. The permitting process is discussed in a later section of the report.

GMP estimates that the larger tract of land adjacent to the project site could be developed to a maximum capacity of between 20 and 25 MW of wind power based on commercially available turbine sizes. Any future expansion of the wind power plant will require the use of federal lands.

3.3 Land Lease

For the privately-owned parcels, the land acquisition and lease negotiation process was relatively easy. The land ultimately used for the project is owned by a single landowner. In the 1980s, during the early stages of their monitoring program, GMP executed a lease option for the parcels of interest and the landowner had no significant objections to the project development plans. The terms of the lease were negotiated and finalized in the spring of 1996.

The lease gives GMP the right to use a defined, 70-acre section of the property for wind generation purposes for 99 years, with a renewal option. The lease rate includes both a fixed and variable component. On a quarterly basis, GMP pays the landowner a specific amount per acre, which escalates each year with inflation. In addition, on an annual basis, GMP pays the landowner a variable amount based on the prior year's energy output from the project. GMP has the right to terminate the lease at any time. Based on the estimated output from the project, the current cost of the lease is approximately $4,000 per year.[6]

Several of the terms and conditions that GMP incorporated into their land lease were the direct result of experiences CSW had with the land owner at their project site. For example, after he signed the lease, the landowner of the CSW site indicated that he was concerned about the amount of traffic on the site access road. GMP added specific language to their lease to address potential site access issues, particularly for tour buses and heavy equipment.

The land required for the transmission line, substation, and access road is owned by the same landowner. For these parcels, GMP compensates the landowner based on the acreage.

3.4 Site-Specific Wind Resource Assessment

GMP operated several wind monitoring stations in the Eastern Site Area during various times between 1981 and 1989. Additional stations were also installed in the Western Site Area. Although the original monitoring towers were 100 feet or less, taller towers were later installed at heights of 105 and 120 feet to obtain data at higher levels above the tree line. Data were collected at two measurement heights on each tower.

In 1993, when the TVP award was announced, GMP was still operating only the long-term reference station in the Western Site Area. Following the announcement, GMP activated five monitoring stations in the Eastern Site Area, four of which were installed at different locations than those used in the earlier measurement program. As part of their micro-siting activity, GMP also installed monitoring stations at two additional locations in the summer of 1995 to collect short-term data to optimize the project layout and identify specific turbine locations. Figure 3-1 shows the location of GMP's monitoring stations.

Micro-siting wind measurement activity was discontinued in November 1995 at some of the measurement towers along the ridge where the turbines are now located. Those towers were located along the proposed project service road and their continuing operation would have interfered with construction. GMP and its meteorologist concluded that sufficient data had been collected by this time to characterize the wind

[6] Although there are examples of land purchases for wind energy projects, land leasing is the most common land acquisition approach in the US. A combination of a fixed payment, either an up-front fee or a continuing per acre amount, and a variable payment based on energy is also common. An independent power producer typically bases the variable portion of the lease on a percentage of gross revenues.

resource. Measurements continued over the winter months at two towers that are outside the immediate project area.

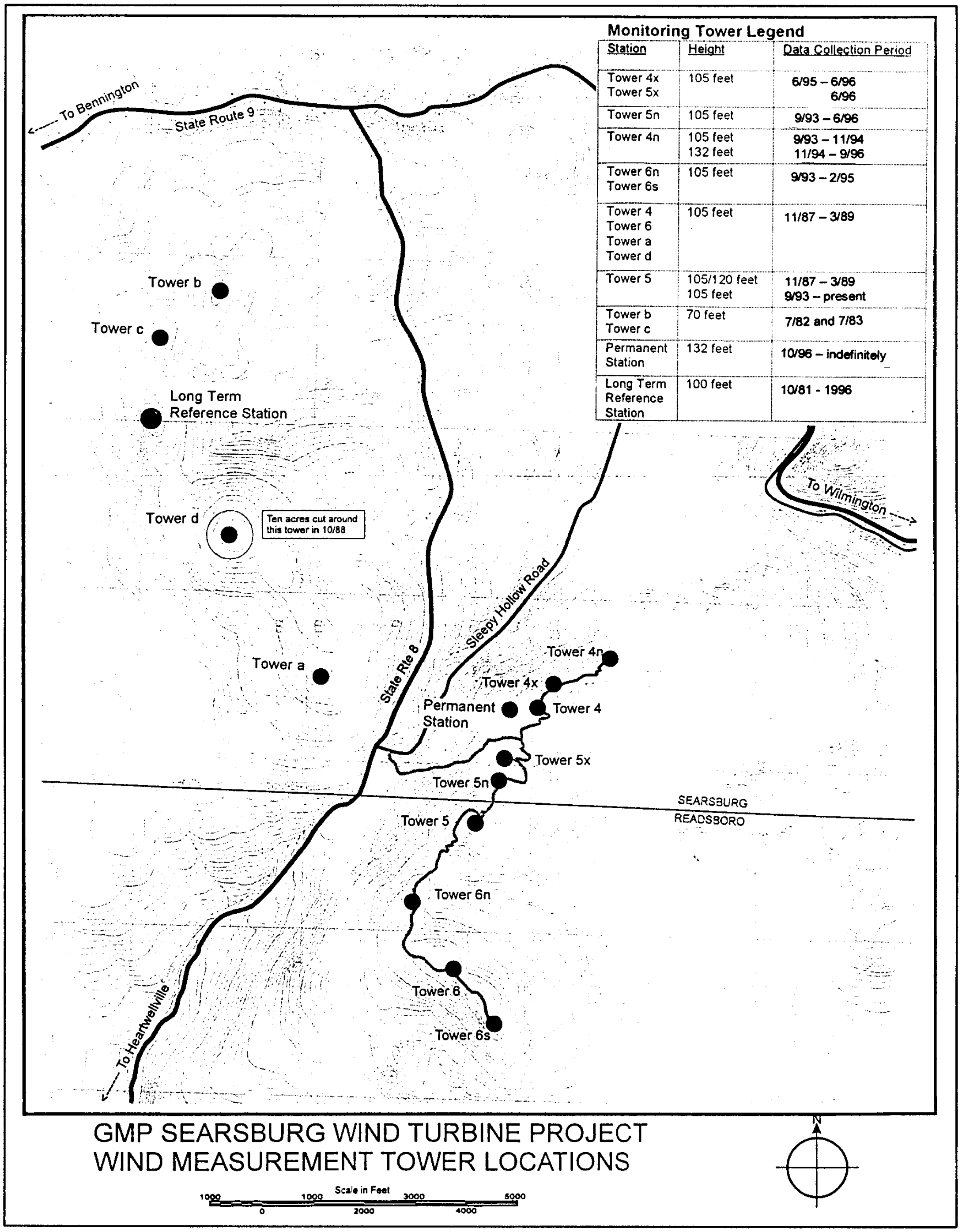

Figure 3-1
Location of GMP's Monitoring Stations

In October 1996, GMP installed a permanent 40-meter monitoring tower, 2.5 rotor diameters upwind of one of the turbine sites, to use for evaluating project performance. GMP, Zond, EPRI, NREL, and other consultants worked together to locate this tower in the most appropriate location for power curve verification measurements in accordance with available standards.[7] This station will continue to operate for the life of the project.

Altogether, data from eight different measurement stations along the 4.03 km (2.5 mile) ridge in the Eastern Site Area were used to assess the wind resource at potential turbine sites in the last four years. Most of these stations are located in the final development area on the privately-owned land.

Wind speed measurements from the various monitoring stations show the site to have an annual average wind speed ranging from 7.15-8.49 m/s (16-19 mph) at the 40-meter hub height of the Z-40-FS turbine. Figure 3-2 shows the monthly pattern of the wind resource at a representative monitoring station. As shown in the figure, the highest winds occur in the winter, matching GMP's load peaks.

Figure 3-3 shows the diurnal pattern of the wind resource in the project area. The highest winds typically occur in the evening and early morning hours. During the winter months, the peak load in the Searsburg area occurs between 6 PM and midnight.

A representative wind rose for the site is shown in Figure 3-4. The predominant wind direction is from the northwest, roughly perpendicular to the orientation of the ridgeline.

[7] For power performance verification purposes, IEC Draft Standard 1400-12 recommends placement of the meteorological tower between 2 and 4 rotor diameters upwind of the turbine. AWEA Standard 1.1-1988 recommends placement between 1.5 and 6 rotor diameters upwind. At the GMP site, the topography upwind of Turbine #6 offered the only viable location for the placement of the permanent meteorological tower.

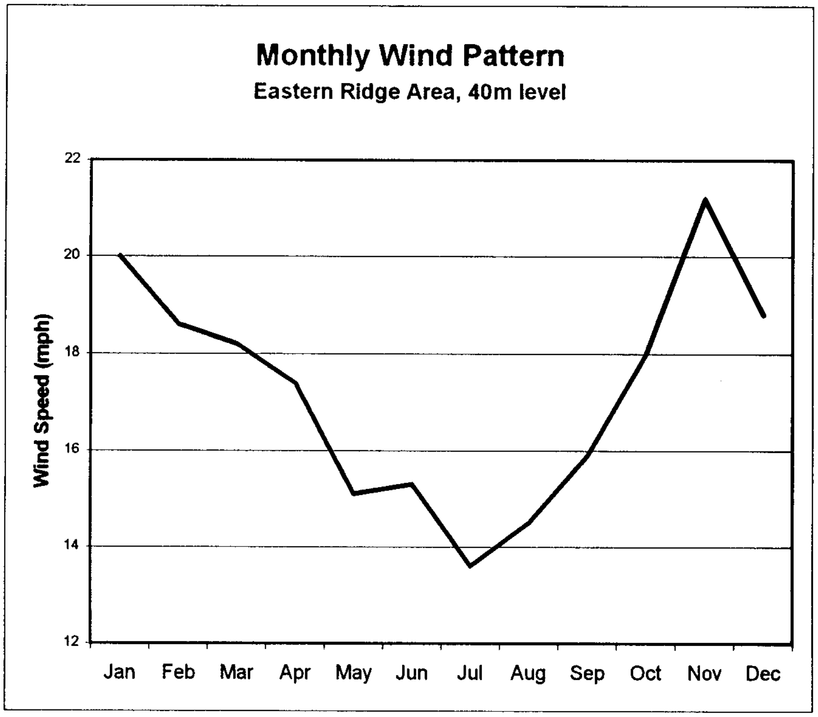

Figure 3-2
Monthly Pattern of Wind Resource at GMP Project Site

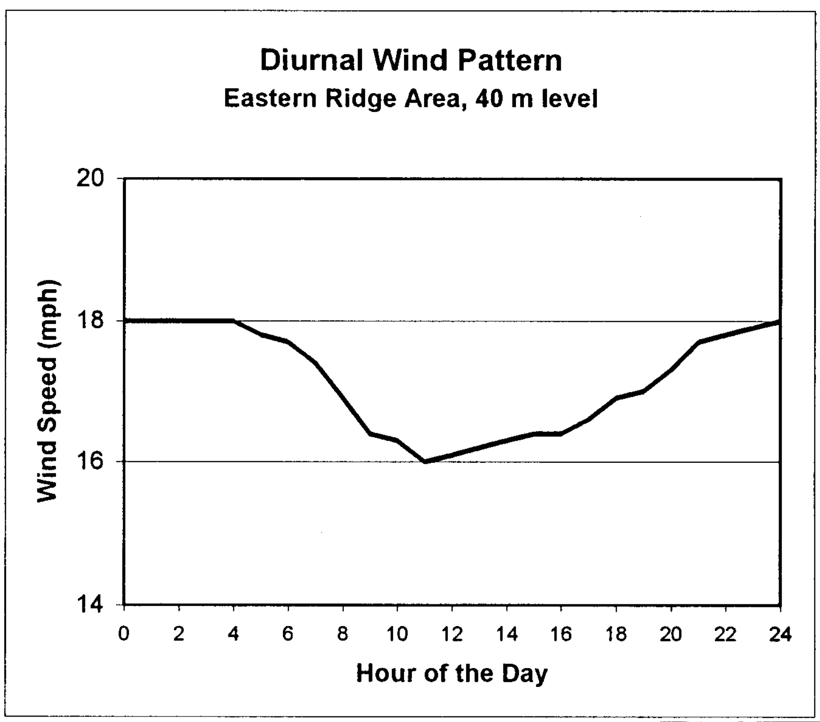

Figure 3-3
Diurnal Pattern of Wind Resource at GMP Project Site

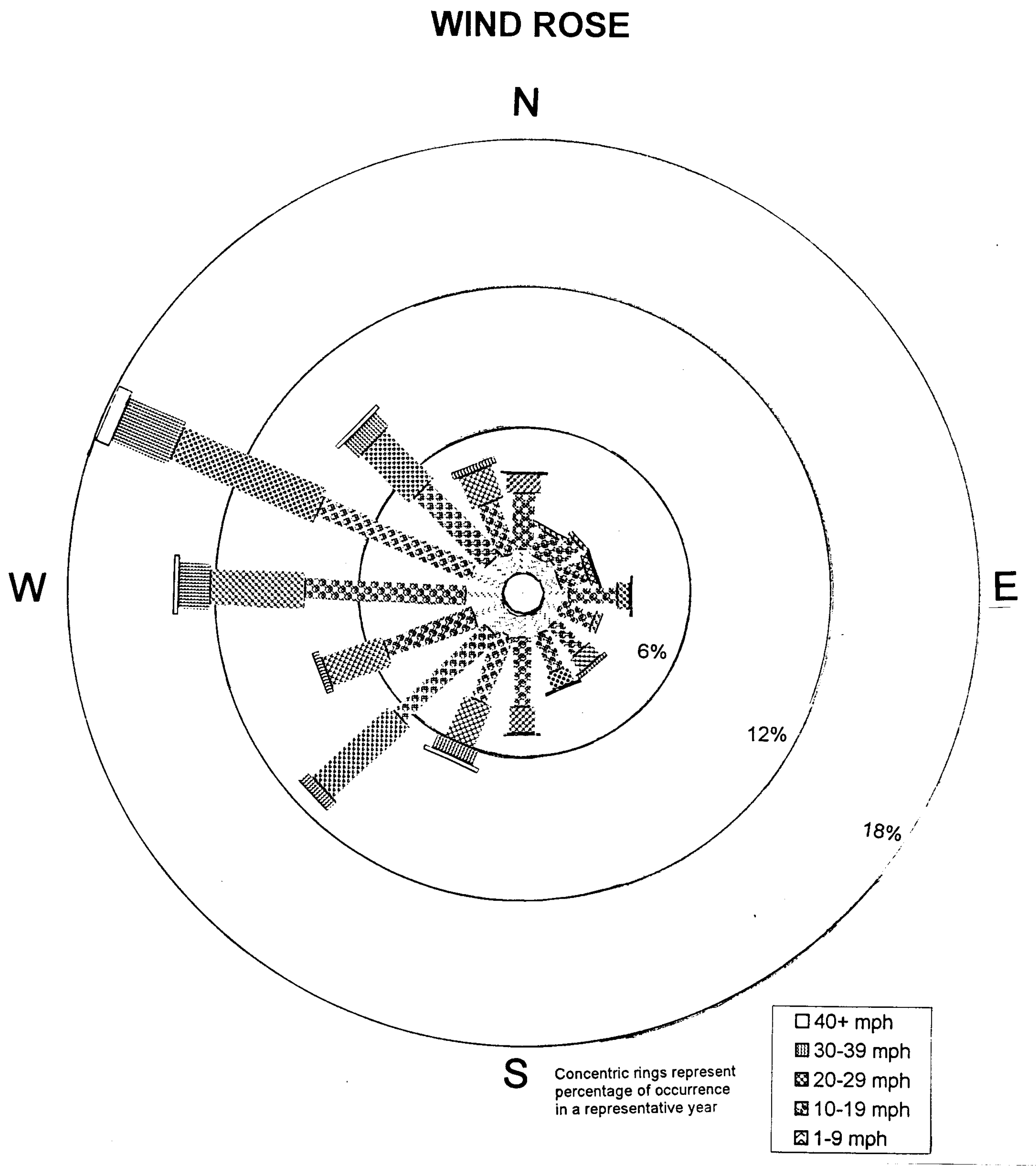

Figure 3-4
Representative Wind Rose for GMP Project Site

4

PERMITTING AND ENVIRONMENTAL STUDIES

4.1 Permitting Requirements

GMP is subject to the regulatory jurisdiction of the State of Vermont Public Service Board. Pursuant to 30 V.S.A Section 248, GMP was required to obtain a Certificate of Public Good for the construction and operation of their 6.05 MW wind power plant and the associated transmission line extensions. The petition for the certificate was filed with the Vermont Public Service Board on May 5, 1995.[8]

Compliance with the applicable Public Service Board regulation (30 V.S.A. Section 248) requires that proposed construction:

- Will not unduly interfere with the orderly development of the region after due consideration is given to the recommendations of the municipal and regional planning commissions, the municipal legislative bodies, and the land conservation measures contained in the municipal plans;

- Will meet the need for present and future demand for service that could not otherwise be provided in a more cost-effective manner through energy conservation and load-management measures;

- Will not adversely affect system stability and reliability;

- Will result in an economic benefit to the State and its residents;

- Will not have an undue adverse effect on aesthetics, historic sites, air and water purity, the natural environment and the public health and safety, with due consideration to the criteria of [10 V.S.A. Section 1424a(d), and Section 6086(a) (1)-(8), and (9) (k)]:

    The project does not affect any Outstanding Water Resources;

[8] Docket No. 5823, Petition of Green Mountain Power Corporation for a Certificate of Public Good for Authority to Construct a 6 MW Wind Generation Facility and Associated Line Extensions in Searsburg, Vermont.

- — The project will not result in undue water or air pollution;
- — The project has sufficient water available for its needs and it will not cause an unreasonable burden on an existing water supply;
- — The project will not cause unreasonable soil erosion or a reduction in the capacity of the land to hold water such that a dangerous or unhealthy condition would exist;
- — The project will not cause unreasonable congestion or unsafe conditions with respect to use of highways, waterways, railways, airports, airways, and other means of transportation, existing or proposed;
- — The project will not provide any burden on the ability of a municipality to provide educational services;
- — The project will not place an unreasonable burden on the ability of the local governments to provide municipal or governmental services;
- — The project will not have an undue adverse effect on the scenic or natural beauty of the area, aesthetics, historic sites, rare and irreplaceable natural areas or wildlife habitat and endangered species;
- — The project will not destroy or significantly imperil necessary wildlife or endangered species habitat;
- — The project will not unnecessarily or unreasonably endanger the public investment in the Green Mountain National Forest or interfere with the function, efficiency, or safety of, or the public's use or enjoyment of, or access to the Green Mountain National Forest; and,
- — The project does not affect nor is it located on any segment of the waters of the state that have been designated as outstanding resource waters by the Water Resources Board.

- Is in compliance with the electric energy plan of the Department of Public Service under 30 V.S.A. Section 202;
- Will not have an undue adverse effect upon, and is not located on, any segment of the waters of the State that has been designated as outstanding resource waters by the Water Resources Board; and,
- Can be served economically by existing or planned transmission facilities without undue adverse effect on Vermont utilities or customers.

In response to the state permitting requirements, GMP researched a number of potential issues associated with the project development and expended a considerable amount of effort to support the review process. This work included the environmental studies, economic and technical analyses, supporting evidence and documentation, responding to interrogatories, site inspections, public hearings, and a "Technical Hearing." The Technical Hearing had a quasi-judicial format in which expert witnesses presented testimony and were cross-examined by other parties to the proceedings. As a result of this process, and in direct contrast with CSW's experience, GMP provided extensive detail on all aspects of the project development to the Public Service Board and the information was recorded in the public domain.[9]

In November 1995, the parties to the certification review process submitted briefs. The Vermont Department of Public Service and the Agency of Natural Resources filed letters supporting GMP's brief. One group, the Green Mountain Forest Watch, filed a brief opposing the approval of the project. The basis of their opposition was that the site was adjacent to a wilderness area. A few landowners voiced objections to the project on aesthetic grounds. The approval was issued by the Public Service Board in April 1996.

The following sections outline the approach and major findings of several studies conducted by GMP to support the permitting process. Some of the work was planned and initiated prior to the permitting application, either as part of their site selection work, to support other activities associated with the wind project, or as general research to support their on-going planning processes. In some cases, the studies are continuing and only initial results are available at this time.[10]

4.2 Avian Impacts

GMP used several consultants to conduct avian studies in the vicinity of the project site over a period of several years. Dr. Paul Kerlinger and Nancy Martin, independent consultants, and David Capen from the University of Vermont, took inventories of bird activity and conducted other work to assess the potential impacts of the proposed wind project on various bird populations in the vicinity of the project. Because previous studies indicated that raptors are particularly susceptible to wind turbine impacts, an inventory of raptors was conducted in the vicinity of the project during their migrating seasons in the fall of 1993 and the fall of 1994. A study of the spring time songbird migration was conducted in May 1995 and June 1996.

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[9] Although CSW performed various technical, environmental, and public acceptance studies to determine the potential impact of their project, no local, state, or federal permits were required.
[10] Study results will be reported in subsequent reports on the operation of the GMP TVP project.

It was determined that no extraordinary concentrations of breeding birds occur at this site, that the breeding community is typical of much of southern Vermont forests, and that none of the breeding birds found on the site are endangered or threatened. It was also concluded that no significant impacts to songbird populations were expected to occur. With respect to migrating raptors, the studies summarized that it was unlikely that the proposed wind turbine project at Searsburg would have an undue adverse impact on these birds, based on the following factors:

- Few hawks migrate through or near the Searsburg site;
- Those birds that migrate through the site area generally do so at heights above the proposed turbine blades;
- Birds migrating or flying near wind turbines usually avoid the towers and blades;
- By using tubular rather than lattice towers, raptors and other birds cannot perch on the towers and thus will not be attracted to the site; and,
- By encouraging the growth of shrubby vegetation and small trees, and avoiding grassy fields, the area will not attract hawks as a hunting site.

GMP specified the use of tubular towers in their bidding documents to eliminate the opportunity for birds to perch, as well as to provide protection from the weather for maintenance activities during the winter months. In addition, the transmission line design incorporated single pole construction to reduce the chance for electrocution of birds with large wingspans.

The State of Vermont applied for, and was awarded, a DOE Sustainable Technology Energy Partnerships (STEP) grant to continue the avian studies in 1997. NREL is administering the grant and providing technical assistance. State wildlife officials are leading the work and GMP will participate as a partner in the continuing effort. As part of the work, a control site has been identified near the long-term monitoring site in the Western Site Area. Surveys will be taken in both the control area and the project site area, and the results will be compared to evaluate how operation of the wind power plant affects avian populations and behavior. Results of this study will be included in subsequent project operation reports.

4.3 Wildlife Impacts

Multiple Resource Management (MRM), of Leicester, Vermont, conducted an analysis of the impacts of the project on wildlife other than avian species. This GMP study was coordinated with the Vermont State Department of Fish and Wildlife who had recently collected data on wildlife in the region. Of particular interest in the study was the impact of the project on the black bear population because there are critical habitat areas for black bear near the site. MRM determined that the critical bear habitat nearest the project area was protected from significant impact by substantial separation distances combined with dense forest vegetation. As a result, potential visual or noise disturbances to this habitat were judged to be minimal. In addition, human activity on the site was expected to be small after the construction was completed, reducing potential long-term disturbances. Minimizing the clearing and allowing the vegetation to grow back along the transmission line route and access road will further reduce the potential for impacts on wildlife movements in the area.

MRM's study concluded that no critical wildlife habitat was found that would be directly impacted by the project, and any indirect impacts were mitigated "to the point of insignificance." As a condition of the permit, GMP agreed to monitor bear movement by looking for corridors where bears travel between habitats and documenting the effect of the turbines on their movements. This task was accomplished, in part, by constructing "bear fences" in the project area to track the movement of the bears from one side of the project to the other. The fence consists of barbed wire strung between fence posts at a height slightly lower than the height of a bear's shoulder. The bears can navigate under the wire; however, as the wire slides across the bear's back it catches a tuft of the animal's fur. The fence is inspected on a regular basis for shags of bear fur on the wire.

During the construction period, there were indicators that the bears continued to move through the project site, despite the activity. Figure 4-1 shows the location of the identified bear habitat, bear fences and observed bear shags. A second bear fence, closer to the turbines, was installed on the project in the summer of 1996, and information on bear shags on this fence are not available at this time. GMP is continuing to monitor bear movement in the post-construction period of the project.

4.4 Impacts on Areas of Archeological, Cultural, and Historical Significance

GMP commissioned the Cultural Group at Louis Berger and Associates (LBA) of Halsted, New Jersey to conduct a study of archeological, cultural, and historical areas of significance in the vicinity of the project site. In the first phase of their study, LBA identified a high probability that cultural resources may be found in the project area. The second phase of the LBA study, developed in conjunction with the Vermont Division of Historic Preservation, included selective excavation work to determine whether the project would impact the identified resources. Of particular concern were ruins of the Crosier homestead, which bordered the site, and the Fairington Cemetery (also known as the Crosier Cemetery), located near the junction of the site access road and the existing town road (shown on Figure 2-2). The Crosier family founded the first settlement near Searsburg and occupied the homestead in the early 1800s.

The final report was completed in early December 1995 and filed with the Public Service Board shortly thereafter. The study concluded that no significant historic or cultural resources would be disturbed by the project. The study recommended that

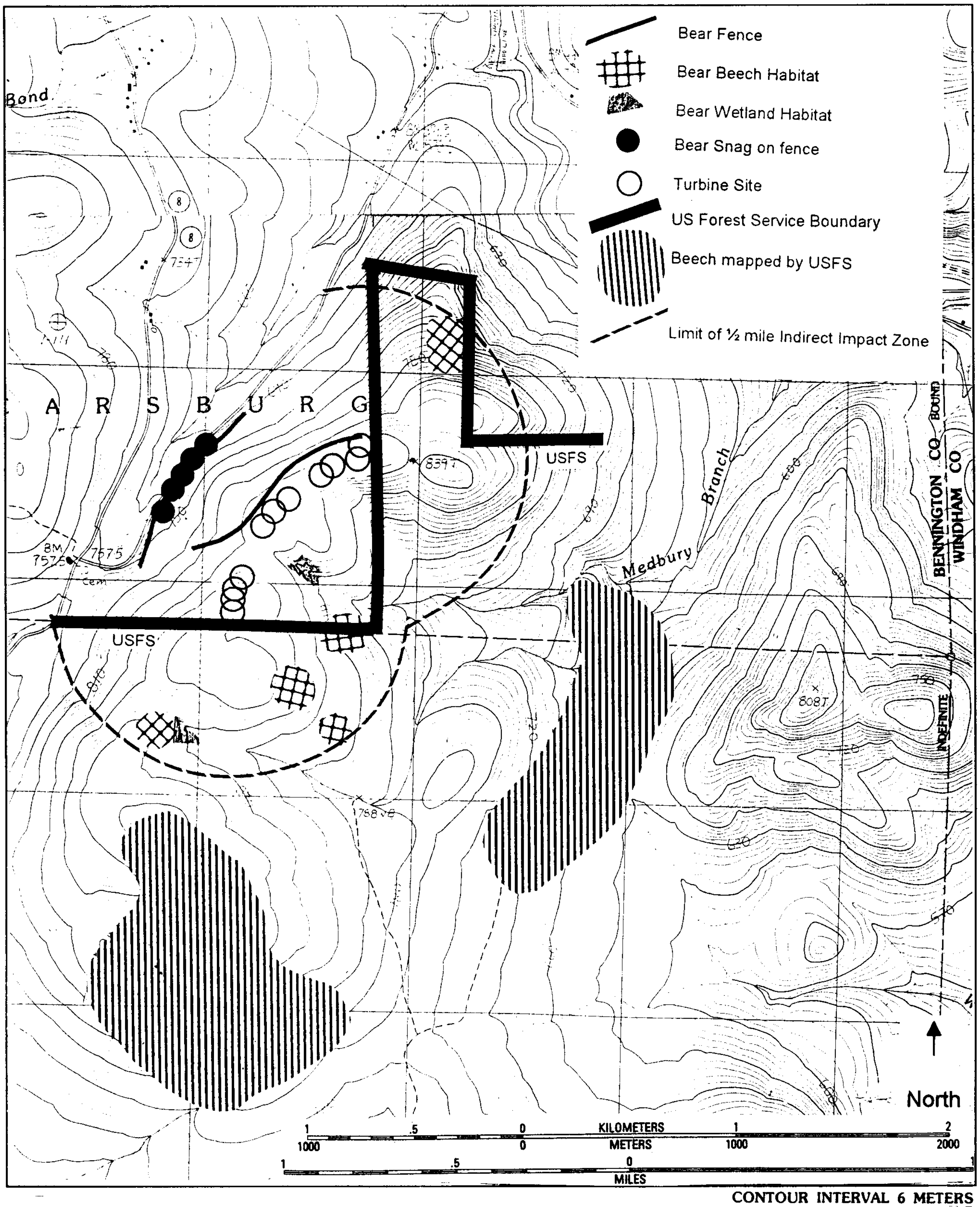

Figure 4-1
Location of Bear Habitat and Bear Fence

temporary fencing be erected around the cemetery to prevent disturbance during construction. The work included over 200 "shovel tests" and the excavation of several trenches throughout the project site areas that would be disturbed by the development. Although several artifacts were recovered and analyzed, none were found to have significant historical or cultural value.

4.5 Visual and Aesthetic Impacts

GMP retained Cavendish Partnership and T.J. Boyle & Associates, both of Vermont, to assess the potential effects of the proposed wind power facility, including the access road, transmission line, and substation, on the visual resources of the area. The consultants' work included the following:

- conducting a visual inventory of the surroundings;
- identifying potential viewpoints;
- characterizing the viewing public in terms of approximate number of viewers, types of viewers and viewer perceptions; and
- conducting an evaluation of the visual impact of the proposed facility to determine if the project would create an undue visual impact on the scenic and natural beauty of the area.

A series of computer-generated representations were developed showing the view of the wind project from the most prominent viewpoints in the area. Figure 4-2 shows examples of the computer generated graphics from two viewpoints. GMP subsequently used these graphics for a variety of public meetings and other events.

The analyses concluded that the project will not be seen from sensitive areas such as population centers, scenic corridors, major recreation areas, wilderness areas, or historic sites. While the project was found to have an adverse impact upon the scenic and natural beauty of the area, the impact was not judged to be "unduly adverse" by the consultants, thereby complying with 30 V.S.A. Section 248.

To further reduce the visibility of the project, GMP specified that the towers be painted a neutral color to minimize contrast with the background under average lighting conditions. Minimizing the tree clearing also reduced the visual impacts of the project. Three neighboring landowners objected to the project based on its visual impact. GMP met individually with these residents to discuss their concerns and took these comments into consideration when deciding what steps to take to reduce visual impacts.

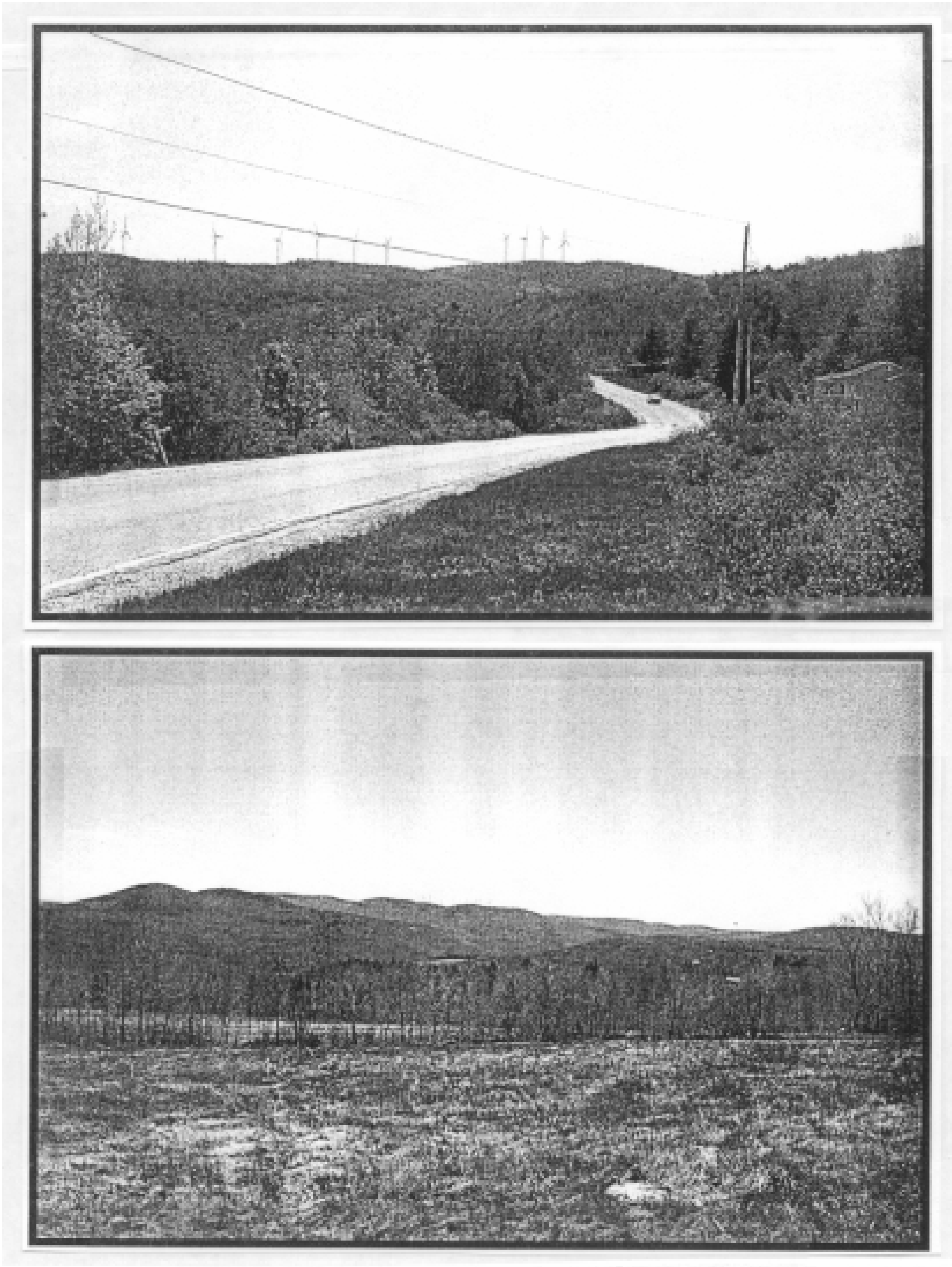

Figure 4-2
Computer Simulated Views of Project Site

4.6 Noise Impacts

Resource Systems Group, Inc. (RSG), from White River Junction,Vermont, conducted a study for GMP to determine the potential noise impact of the proposed wind project on the surrounding area. The work included an evaluation of potential noise impacts from both construction activities and the operation of the wind turbines. In addition to the noise impact on nearby residents, RSG also evaluated the noise impact at critical wildlife habitat areas in the vicinity.

Neither Searsburg nor Readsboro have ordinances restricting noise levels. As a point of reference, the Town of Colchester, Vermont has zoning regulations that require that noise levels shall not exceed 70 dBa in residential areas and 75 dBa on “developed land.” The Town of Georgia, Vermont has a performance standard which permits noise levels to 70 dBa at the property line. The US Federal Highway Administration, Department of Housing and Urban Development, and Environmental Protection Agency also have standards or guidelines for noise levels.

To obtain baseline data, RSG measured background noise levels during the evening and early morning hours in early spring at the nearest residences and at wildlife habitat areas identified by GMP’s wildlife biologists. The measurement period was chosen because it represents times when background noises are likely to be lowest. In early spring, deciduous trees have little or no leaves and thus the area tends to be quieter. Because the measurement period was during a light wind period, adjustments were made to the data to reflect conditions during higher winds when the turbines would actually be operating.

The background data were compared to modeling results of projected noise emissions from the proposed project. The model used measured noise levels for the Zond Z-40-FS wind turbines and assumed 12 turbines would be used in the project. The model also considered the effects of the forest, topography, and wind speed and wind direction data. In all cases, the assumptions used in the study were conservative. For example, the project contains only 11 turbines, rather than the 12 turbines assumed in the model.

Table 4-1 provides the projected noise levels at three nearby residences and three critical wildlife habitat locations. Figure 4-3 is a noise contour map that was developed in the study. The modeled noise levels are near or below current ambient levels at critical wildlife habitats and nearby residences. The results indicate that noise should not be noticeable during most periods of the day and night. One exception is House 3 where some noise from the turbines may be noticeable during very quiet times and light winds. Inside the house, the noise should not be noticeable at all, even with the windows open.

Table 4-1
Calculated Noise Levels at Critical Wildlife Habitat Locations and Nearby Residences
(Leq = "equivalent" noise level)

Receptor	Background Noise (Leq)	Noise from Turbine (dB(A))	Total Noise (Leq)
House 1	50.6	37.3	50.8
House 2	50.6 est	35.4	50.7
House 3	35.0 est	31.3	36.5
Bear Habitat 1	34.2	35.2	37.7
Bear Habitat 2	35.0	11.3	35.0
Bear Habitat 3	37.9	30.9	38.7

RSG's findings indicate that the loudest noise will be associated with the drilling and blasting of ledge during the construction of the project. Obviously, this impact was judged to be temporary and all construction activities were expected to occur between 7 am and 7 pm. RSG concluded that the wind energy project will not create any undue adverse noise impact on critical wildlife habitat or neighboring residences.

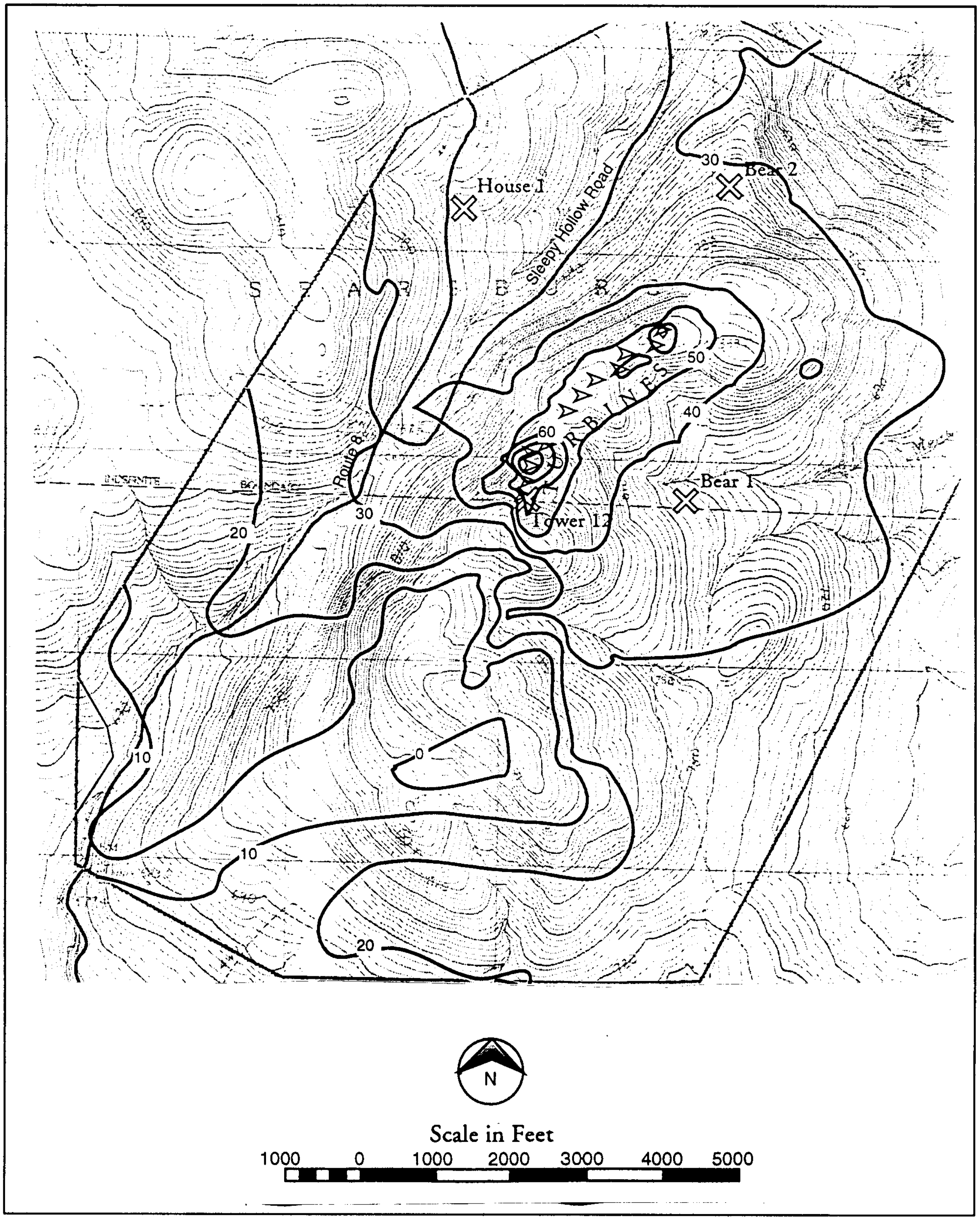

Figure 4-3
Critical Receptor Locations at Wildlife Habitat and Nearby Residences and 10 dB(A) Noise Contours From Turbines

4.7 Tree Removal

The permitting documents include a cautionary note about tree removal and stipulations that the clearing activities associated with the project be kept to a minimum. The requirements of the re-vegetation plan for the site and the treatment of the access road with respect to clearing are specifically detailed. The documents stipulate that plants should be allowed to grow up along the road and under the transmission line following the construction period. This recommendation was supported by mitigation strategies that were suggested in some of GMP's other work, including the studies on the visual impact and wildlife habitat.

The permitting stipulations on tree removal were consistent with GMP's stated intent to minimize the clearing at the site. As previously mentioned, GMP had conducted a study at one of their monitoring towers to determine the effect of tree removal on the wind speeds at the likely hub-heights of commercial wind turbines. The results of this study indicated that increases in wind speed from tree clearing would be modest at best. Therefore, there was no need to clear-cut areas of the project site other than for construction and access purposes. Based on the size of the turbine rotor, the assembly and installation methods, and site topography, GMP and Zond determined that the clearing around each turbine could be minimized to an area with a diameter of between 100-150 ft. Additional tree clearing was required for the access roads, the transmission corridor, and the substation.

4.8 Societal Acceptance Study

Clinton Solutions of Fayetteville, New York is conducting a societal acceptance study for GMP. A pre-construction societal acceptance survey was mailed to residents of Searsburg and the surrounding towns, which will be followed by a post-construction survey when the wind plant is operational. The responses were grouped and analyzed by several categories: the full sample was analyzed to determine general support for the project; the responses of seasonal residents were compared to the responses of year-round residents; and, Searsburg respondents were compared to respondents from surrounding towns. The majority of the respondents expressed support for the project. Seasonal residents were generally less supportive than year-round residents.

GMP was particularly conscious about involving local community leaders and environmental groups early in the site selection process. In general, they got favorable response on their plans. When a local resident expressed some concerns, GMP met with the resident individually. In addition, they continued to update the local planning commission as to their on-going plans and any changes in their schedule.

4.9 Other Permitting Submissions

GMP also submitted information on a number of topics for which the project had a limited impact, such as increases in vehicular traffic, demand on local services, and potential for water contamination. More detailed information was submitted on economic analyses, utility integration studies, erosion prevention plans, and transmission line routing to support their permitting application. When significant, this information is discussed in other sections of the report.

5

TURBINE VENDOR SELECTION

5.1 Preliminary Vendor Qualifications

In February 1994, GMP sent a *Request for Information* to more than 20 domestic and foreign wind turbine suppliers. The objective of this request was to notify prospective bidders of GMP's interest in wind projects, obtain cost and other information to use in their economic models, and familiarize themselves with the status and characteristics of various wind turbines that are under development or currently available. They received an excellent response to their request and scheduled meetings with a number of vendors to obtain additional information about available products.

As a host utility in the TVP, GMP was responsible for selecting the wind turbines and other equipment to be purchased for the project based on guidelines provided by EPRI and DOE. The TVP grant included stipulations that the wind turbines installed in the project are:

1. New in design, but not yet fully proven in the commercial market; and,

2. In the economic interest of the United States, as evidenced by the manufacturers' investment in US research, engineering, and manufacturing of the product.

The first criterion was a requirement for participation in the TVP program. The second was a condition required for the $1.75 million DOE portion of the TVP funding. Turbines that did not meet the second criteria were still eligible to be bid on the project; however, such bids were at an economic disadvantage because GMP planned to consider the loss of DOE funds in the bid evaluation process when they calculated their cost of energy.

In order to determine the eligibility of specific turbines according to the criteria, GMP issued a *Solicitation of Interest in Receiving the Request for Proposals* and a *Determination of Wind Turbine Eligibility Form* prior to releasing the bid documents. The one-page eligibility form was designed to solicit specific information on turbine models so that GMP could inform vendors of their qualification to bid before they expended effort on a full proposal. EPRI and DOE provided assistance in making these pre-qualification determinations. Nine vendors submitted the form for one or more of their turbine models. Eleven turbine models met the criteria for newness of design and 12 met the criteria for US content. The eligibility form is included in Appendix A.

5.2 Development and Content of the RFP

To develop their bid package, GMP reviewed other utility wind procurement documents, including CSW's, and solicited comments from EPRI, DOE, NREL, and others. A formal Request for Proposal (RFP) was issued on May 1, 1995, with a proposal due date of June 7.

GMP's procurement strategy was to encourage turbine suppliers to submit proposals for a turnkey project including final design and engineering work, the supply and installation of the wind turbines and related infrastructure equipment, and all necessary balance of station construction. GMP does not have power plant construction capabilities, and since most of the turbine suppliers also developed projects, they thought a turnkey project would be the most efficient and cost-effective method to complete the work. However, the RFP also allowed bidders to submit proposals for just the wind turbines and their installation.

Because GMP had little prior experience in operating and maintaining a wind facility of this type, the RFP indicated GMP's desire to enter into a contractual arrangement for operation and maintenance (O&M) services. Bidders were also requested to include proposals for financing the project with their submission.

The RFP was divided into three parts:

1. INFORMATION: This section provided general information on the scope and schedule of the work; location and description of the site; and data describing the physical environment and climate. In the RFP, wind resource data were limited to a representative wind speed and direction distribution, extreme measured gust, and general information on wind shear and turbulence intensity.[11] Only a general description of the soil conditions was available in the document.[12]

2. SCOPE OF WORK AND SPECIFICATIONS: This section included the technical specifications for the wind turbines and other equipment, and a description of the services to be provided. The scope of work was divided between the turbine and

[11] GMP included a clause in their contract with EPRI so that they would not have to release details of their wind data collected prior to signing the TVP contract.

[12] Information on the soil conditions is necessary to determine the foundation and electrical grounding grid designs. When available, this type of information is generally included in a bid document to allow the bidders to accurately determine their foundation and grounding costs.

the balance of plant requirements. Information on the design specifications and drawings of GMP's preliminary project design work was included in an appendix.

3. SUBMITTAL AND EVALUATION CRITERIA: This section included the proposal preparation instructions, the evaluation criteria, and the bid submission format. GMP asked the bidders to submit their proposals in three parts: technical proposal, cost proposal, and financial proposal. Standardized forms were included for the cost information.

GMP's consulting engineers developed the technical specifications for the electrical interconnection equipment and access roads. For the wind-energy-related items, including the turbines, control system, testing, commissioning, training, and maintenance, GMP obtained assistance from EPRI, DOE, CSW and other consultants to develop technical specifications. The desired role and responsibilities of the winning bidder in terms of the final design, financing, construction, performance, testing, acceptance, warranty and documentation were outlined to the greatest extent possible.

The exact terms and conditions of the warranty were left to the bidder to propose. However, GMP specified minimum conditions of 95% availability, 95% of energy projections based on a guaranteed power curve, and a term of three years. A power curve adjusted for the site elevation and average temperature was requested as part of the bid submission.[13] They also requested costs for extensions of the warranty to five years or more. Noise limits and measurement techniques were also specified.

For O&M services, GMP requested a cost proposal to tie at least 50% of the annual maintenance payments to the achieved energy production of the project for a three year period. This was done as an incentive to respond to downtime events in a timely manner and plan preventive maintenance during low wind periods.

GMP listed the following general evaluation criteria in the RFP:

- Technical Capability of the Bidder
- Technical Merit of the Proposal
- Quality of the Warranties
- Ability to Meet Schedule
- Financial Capability of Bidder
- Cost Competitiveness and Realism
- Financing Terms and Conditions

[13]Turbine sale information typically includes a power curve for standard atmosphere, sea-level conditions. Since the energy in the wind is directly proportional to the air density, it is important to have a power curve representative of the site elevation and temperature.

They specifically did not include a weighted scoring system because they had found such systems to be too restrictive in past bid evaluations.

GMP's RFP was fairly short and straightforward. Compared to a typical utility RFP for other types of generating equipment, there was a minimal amount of information provided or requested in the document.[14] GMP considered incorporating additional specifications, but they were concerned about limiting their flexibility to negotiate on items later. In addition, GMP required the winning bidder to provide detailed specifications for the electrical and civil work to GMP, subject to GMP approval, so it was not necessary to specify this type of information in the RFP.

5.3 Bid Evaluation

In response to their RFP, GMP received three bids for the project. All of the bids were for turnkey projects.

GMP organized its RFP to facilitate the evaluation process by asking for information in a specific manner and by defining the response format. For the CSW project, the bid evaluation process was cumbersome, and GMP drew on this experience in developing their own approach. CSW indicated that their RFP was too general and therefore, the content and detail of the bids they received was variable and inconsistent. As a result, CSW had a difficult time in conducting their bid evaluations and made multiple requests to the bidders for additional information.

To conduct the evaluations, GMP developed a series of tables to assist them in organizing and comparing the information in the bids. Their approach included summarizing similar information from the proposals into four tables to allow easy, direct comparisons. These tables included the following information in a side-by-side format:

- Specific characteristics of the proposed turbines to allow for quick access to pertinent information without going through the bulky proposals.
- Observations regarding the bidders' responsiveness to the RFP as illustrated by the completeness and clarity of the responses, the level of detail and documentation included, and the quality of the information provided.
- A breakdown of costs, including a cost-of-energy calculation.

[14] Because a wind turbine model is a fixed configuration, it is generally not necessary or appropriate to include detailed design or component-level requirements for the equipment other than the inclusion of optional "packages" that may be available for some turbines to address concerns such as cold weather or corrosive environments.

- A description of services offered, including specific terms, conditions, and exceptions.

This comparison provided a qualitative evaluation that incorporated the use of engineering judgment more than quantitative scoring systems. GMP put significant emphasis on the ability of the bidder to work in Vermont and the ability of the bidder to work with GMP in developing a long-term relationship.

A committee of GMP employees and consultants reviewed the proposals. EPRI and DOE also contributed to the review process. GMP found it necessary to request only limited additional information from the bidders, and their evaluation was completed relatively quickly. In early July 1995, Zond was selected as the winning bidder and a press release was issued on July 26, 1995 to announce the award.

5.4 Contract Negotiation and Issues

Although GMP met with Zond to sign a letter of intent and begin informal discussions following the award announcement, serious contract negotiations did not begin until October 1995. GMP used the services of outside counsel to facilitate the contract negotiation process. Zond also provided GMP with copies of contract documents they had available from past projects.

GMP chose to split the scope of work into three contracts: a Turbine Purchase Agreement that covers the equipment purchase; a Construction Agreement that covers the design work, installation, and construction; and an Operation and Maintenance (O&M) Agreement that covers Zond's role and responsibilities after commissioning. Their efforts were initially focused on completing the Turbine Purchase Agreement and the Construction Agreement. The goal was to complete these agreements before the permit for the project was issued. The permit review occurred concurrently with the contract negotiation. It was also important to order the turbines as soon as possible so that delivery and installation could be completed in accordance with the construction schedule.

One of the more time-critical elements included in the agreements was the final design and engineering of the project. Some aspects of this work and the final drawings were required to complete the permit documentation; other portions of the work were critical so that orders for long-lead time equipment could be placed in a timely manner. Zond agreed to begin work on the final design before the agreement was completed so as not to delay the project development and permitting review any further.

The contract negotiations focused on details that either were not requested in the RFP, were not fully described in Zond's proposal, or required modifications prior to contract signing. For example, the payment terms were a point of negotiation, in part because they were not specifically defined in either the RFP or Zond's proposal. GMP thought that the bulk of the payment for a turnkey project should be made when the project was commissioned and turned over to the utility. Zond wanted progress payments as significant construction milestones were achieved, and as turbines were shipped. GMP viewed progress payments as shifting a significant amount of the risk from Zond to GMP. Although they reached a compromise that included small progress payments during the construction period and a larger payment at acceptance and turnover, GMP believes they carried more risk than they originally intended.[15]

The contract negotiation was also affected by the operating experience at the CSW TVP project. For example, Zond and GMP were both familiar with, and concerned about, the lightning damage experienced at the CSW site. As a result, the responsibility for the grounding grid design and any subsequent damage due to lightning events was a sensitive contract issue to both GMP and Zond. The soil resistivity at the GMP project site was expected to be poor. Although the frequency and magnitude of the lightning events in Vermont are less than in Texas, the duration of the lightning season is potentially longer.

GMP had already designed a grounding system for the substation with an objective of obtaining a ground resistance of approximately two ohms, but no grounding work had been done for the turbines. Zond ultimately assumed responsibility for designing the grounding and lightning protection system on the turbines, and GMP retained the right to review and approve the design prior to construction. Damage due to lightning events was negotiated as an exclusion to the warranty, so any damage due to lightning events is the responsibility of the project owner. Until commissioning and acceptance by GMP, Zond is the project owner.

GMP was particularly interested in negotiating modifications to Zond's proposed cold weather package and incorporating these specifications into the contract. The cold weather measures incorporated into the turbine are discussed in more detail in the next section.

The schedule was also an important negotiation point. Both parties agreed to a work plan that included completing the substantial construction tasks by mid-October 1996 to allow for some contingency time before the onset of winter. GMP included substantial penalties in the contract for not completing the construction work on schedule. Although Zond was confident that they could meet the schedule, GMP had more experience, and a better appreciation for the potential difficulties of construction in the Green Mountain environment. Any delays in the schedule due to force majeure events were treated as extensions to the schedule and not subject to the penalties.

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[15] It is common for an equipment supplier to require partial payments at milestones such as placement of the order, shipping from the factory or arrival at the site, and completion of acceptance tests.

Although Zond originally proposed 12 wind turbines, GMP decided to reduce the project size to 11 turbines for several reasons. First, eleven turbines reduced the overall cost of the project. In addition, GMP was considering the re-location of the project to private land, and 11 turbines allowed more flexibility in the development of a project layout on a smaller land parcel.

The equipment purchase and construction contracts were signed on April 18, 1996, following the approval by the Vermont Public Service Board on April 1, 1996. GMP was reluctant to sign the contracts until the permit was obtained, therefore the delay in obtaining the permit resulted in the delay of the contract signing. The contracts were not finalized, however, until shortly before this time due to delays in the completion of Zond's final design and engineering plans, and the final cost determination. In addition, the weather and the timing of the construction season probably indirectly contributed to the delay. Because it was clear that construction would not begin until the spring, there was a noticeable lack of urgency among the project participants until the construction period became imminent. GMP worked extensively with both Zond and the Public Service Board to ensure that the tasks progressed; however, neither the contract nor the permit were completed until the last minute.

The final Turbine Purchase and Construction Agreements include the turbine manufacture, project design, construction, and installation. The scope of Zond's services includes the final design and engineering work for all aspects of the project; the procurement and construction of all the electrical interconnection equipment; construction of the access roads, turbine foundations, control buildings, and control equipment; the Zond SCADA system; and, supply and installation of the turbines.

The contract specifies 11 Z-40-FS turbines, each rated at 550 kW, for a total rated capacity of 6.05 MW. This is the first commercial installation of the Z-40-FS model. The major difference between these turbines and the Z-40 turbines installed at the CSW site is the use of full-span blade pitch for power regulation and overspeed control, rather than the aileron control employed by the CSW model. Also, tubular towers are used in Vermont and truss towers are used in Texas. Prior to construction of the GMP wind plant, one prototype of the Z-40-FS was field-tested at Zond's facilities in Tehachapi. The turbine is shown in Figure 5-1 along with the weights and dimensions for the major components. A complete description of the Z-40-FS wind turbine is included in Appendix B.

Although GMP intended to keep the procurement contracts as simple as possible, they found that the level of detail expanded substantially during the contract negotiation. A number of issues, including the development of the final design and engineering plans, cold weather modifications to the turbines, and others, required significantly more explanation and detail than originally anticipated.

After commissioning, Zond will operate and perform the maintenance work for the plant under a three-year contract during which it will also train GMP personnel. Zond will also provide a five-year warranty for the wind turbine equipment. The contractual arrangements for these items will be included in the O&M Agreement, which, at this time, has not been finalized. GMP and Zond agree on the basic content of the O&M Agreement. However, preliminary discussions indicate that the specific details will require substantial negotiation. GMP and Zond have continued to work together in good faith with the understanding that they will be able to reach acceptable terms for both parties.

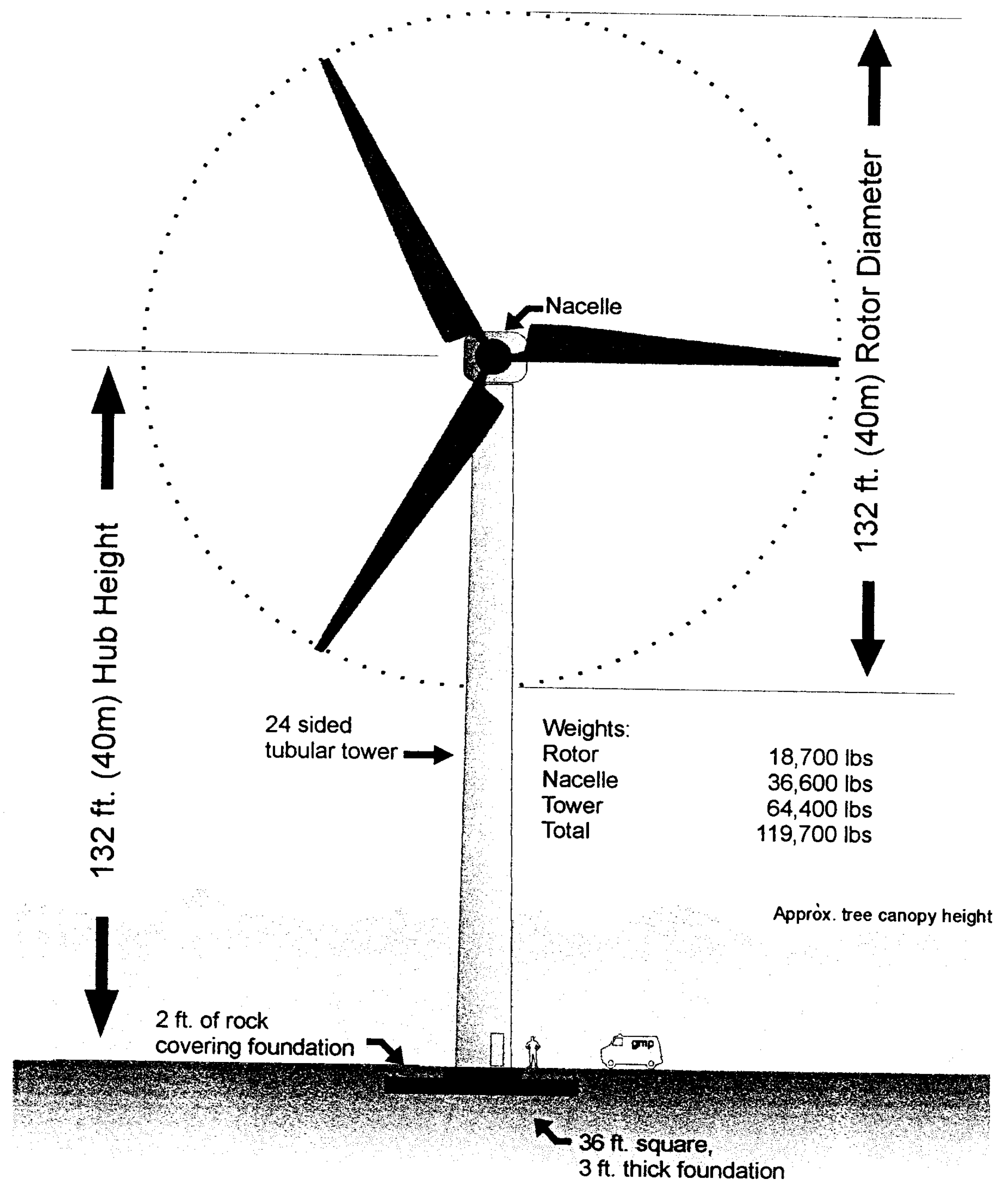

Figure 5-1
Weights and Dimensions for Zond Z-P40-FS Wind Turbine

5.5 Cold Weather Considerations

In the process of developing the wind turbine specifications to be included in the contract, and prior to placing an order for turbines, GMP conducted some research on cold weather applications and decided to further clarify the cold weather specifications for the turbines. The Searsburg site's annual low temperature is typically about minus 30 degrees F. Over the life of the Searsburg project, the minimum temperature will likely be in the range of minus 35 to minus 40 degrees F.

Considering these temperature extremes, Zond's original specifications were considered to be sufficient for the environmental conditions. However, GMP noted some exceptions during the contract negotiations, and worked with Zond to incorporate modifications to the cold-weather measures into the Turbine Purchase Agreement. For example:

- Zond's control system was specified to operate as low as minus 25 degrees C (minus 13 degrees F). In response to GMP's inquiries, Zond indicated that they would provide thermostatically controlled heaters in the controller enclosure to allow operation of the turbine in extremely cold temperatures. The heaters operate independently from the controller electronics and are designed to keep the interior of the cabinet above a minimum established set point. Heaters were also included in the variable pitch controller enclosure, gearbox, hydraulic unit, and generator windings.

- GMP was concerned about the tower steel specified in Zond's proposal. NREL and GMP conducted a literature search on cold weather applications and provided this information to Zond. Zond agreed to use a special grade of ASTM No. A36 steel with a toughness consistent with use in the low temperature climate that was anticipated.

- GMP also wanted to specify the use of black blades for the project to absorb solar energy and reduce the persistence of icing accumulation in the winter. Zond resisted this suggestion because they were concerned that black blades would get too hot in the summer and could potentially warp. Also, they had no experience with black blades and did not include any additional cost for this process in their bid price. GMP conducted their own research and solicited NREL's assistance in discussing options with Zond. They also provided Zond with historical information on maximum and minimum low temperatures and icing occurrences. Zond subsequently performed finite element analyses and determined that the expected increase in the temperatures of black blades in the summer months would be acceptable. The black color of the blades that were eventually installed at the site is provided by the color of the gelcoat of the fiberglass rather than a coating of paint. GMP also encouraged Zond to investigate the use of StaClean, a Teflon-based, ice-phobic coating that was applied to the blades of GMP's Mt. Equinox turbines. Zond also found this suggestion to be acceptable, and StaClean was applied to the blades to minimize icing impacts.

GMP also specified use of low-temperature-tolerant seals and lubricants, such as the gearbox oil and hydraulic fluids, in the contract. They also required heated anemometers and vanes on the turbine nacelles, as well as the meteorological tower. Other features of the turbine that are well suited to the cold environment include the full span, variable-pitch blades and the tubular tower. Like the ailerons at CSW, the full-span pitch rotor is designed for power regulation and overspeed control, but may be better suited than ailerons to operate reliably in icing conditions. The 40-meter (132 foot) freestanding tubular tower provides access to the nacelle by an internal ladder, thereby protecting workers from inclement weather.

GMP and Zond are currently investigating modifications to the Zond Supervisory Control and Data Acquisition (SCADA) system to assist the project operators in identifying potentially dangerous icing conditions. The proposed modifications would allow a turbine to poll the performance of its neighbors to confirm if its own performance is within an acceptable range. If incorporated, this feature could provide indications of other potential problems, as well as the presence of icing conditions.

GMP's cold weather experience and first-hand knowledge of the harsh climate drove their research activities and literature search for information on other applications with cold weather and icing problems. They also talked to cold weather research organizations, ski resort operators, and other Vermont industries about their experiences with rotating machinery in winter conditions.

GMP's experience with this issue illustrates the value in taking advantage of the expertise available on both sides of a negotiation to reach the best possible conclusion for the project. GMP is also likely to incorporate different wording into their future RFP's and contract documents to reflect their knowledge and experience. For example, there could be a potentially significant difference between the phrase "turbines will operate in the specified environment" and the phrase "turbines are designed to operate under the following conditions." The operating experience of the turbines will also contribute heavily to the wording of any future documents.

5.6 Project Ownership and Financing

GMP could not take full advantage of the federal production tax credit for wind energy projects[16] in a timely manner so they investigated a number of alternative ownership

[16] The Federal Production Tax Credit (PTC) was established as part of the Energy Policy and Conservation Act of 1992, commonly called Epact, and is available for a ten year period to wind energy projects installed and operating

options that would make more efficient use of the tax benefits that were available to the project. GMP was committed to retain a minimum of 25% ownership interest in the project but were open to a range of potential partnership or leasing possibilities. During this period, they determined that resolution of this issue was not a priority given their existing time constraints. They also concluded that it may be easier to generate more interest in various ownership structures once the project was constructed and operating.

As part of the contract negotiation, a work plan for pursuing a third-party financing partner was drafted by Zond and GMP. The basic financing structure was discussed with EPRI to ensure there were no conflicts with the TVP funding. The proposal was also discussed with GMP's Chief Financial Officer to gain his concurrence, and with a tax attorney to insure its consistency with income tax regulations.

Zond and GMP jointly solicited proposals from seven regional lenders to provide the construction and long-term debt financing for the project. GMP expected that Zond could obtain construction financing for the entire project and GMP could defer their purchase of the project until it was substantially completed. Proposals for the construction financing were reviewed by GMP's Finance Department and found to be more expensive than anticipated. In addition, most of the proposals required GMP to guarantee repayment of amounts borrowed, even if the project was not completed. This condition had the effect of shifting a portion of the construction risk to GMP and significantly diminished the advantages of financing through Zond. Traditional project financing approaches may not have imposed such conditions; however, GMP believed that it could finance the project at costs lower than traditional project finance levels. The trade-off for the reduced financing costs was the recourse to GMP. Nonetheless, GMP decided to finance the construction of the project with their internal funds rather than accept any of the construction financing offers. At the same time, they continued to negotiate with Zond on the contract terms to further mitigate the increased exposure to construction risk that resulted from this financing method.

The long-term debt financing proposals were more in line with GMP's expectation. However, plans to pursue this financing were put on hold pending the completion of the GMP-Zond agreements and an assessment of GMP's expected federal income tax status that is underway by their Finance Department.

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prior to July 1999. The PTC is equivalent to approximately 1.5 cents/kWh, adjusted annually for inflation.

6

PROJECT DESIGN, ENGINEERING AND CONSTRUCTION

6.1 Project Design

GMP had already completed a significant amount of the project layout work before Zond's involvement in the project. During the process of relocating the turbines to private land, GMP and their consultants developed preliminary layouts and associated energy estimates to ensure that there was sufficient private land available and that they were not making a significant compromise on energy production by eliminating the use of USFS land. In 1994, GMP completed topographic maps with five-foot contour intervals of the entire project area, including the transmission corridor and access road.

The project layout was also affected by recommendations from the visual and wildlife consultants. In particular, the consultants recommended changes in the location of the substation and transmission line. GMP worked with the consultants to develop a list of mutually acceptable changes to the siting plan that would further reduce the visual and wildlife impacts of the interconnection facilities. These recommendations were provided to Zond to be incorporated in their final design work.

Following the award announcement, Zond contracted with a New England civil engineering firm to do the field survey work required for the preparation of the final civil design and engineering. Several modifications were made to the designs as a result of their initial site visits. As part of the review process, it was necessary to submit each set of modifications to the Public Service Board. After the Public Service Board's Technical Hearing, several additional issues were raised including a request to further define the method and facilities that would be used to handle visitors at the site, facilities necessary for the operation and maintenance functions, and the final size and orientation of the substation.

Zond and GMP engineers worked together to address the areas of uncertainty, complete the design and engineering work, and address the permitting requirements. Zond conducted additional field work that included a more detailed topographical survey in the vicinity of the substation and percolation tests. Geological borings were made at selected locations along the ridge to collect data on the soil conditions and rock structure to facilitate the preparation of the foundation designs. These tests confirmed the poor soil resistivity at the site. Final project design drawings showing the location of all major project features were prepared and submitted to the Public Service Board in January 1996. Figure 6-1 shows the final site plan for the project.

6.2 Transmission Line Studies

A stability and reliability study was conducted for GMP by Vermont Electric Power Company (VELCO) under the direction of GMP's Engineering Department. VELCO is owned by several of the electric utilities in Vermont. It is engaged in the transmission of electric power within Vermont and performs the statewide transmission planning and coordination work for Vermont's electrical transmission system. GMP also contracted with GE Power Systems, of Schenectady, New York, to conduct load flow and transient stability analyses based on the characteristics and output of the Zond Z-40-FS turbines. GE obtained databases from both GMP and New England Power Company which were modified to represent 1997 conditions. Their report concluded that the wind generation facility would have no adverse impact on the local system's load flow and transient stability performance. On the contrary, the study concluded that the project would have a beneficial effect by reducing the loading on the existing 69 kV line and slightly improving the voltage performance at the two nearby 69 kV substations.

GMP also conducted a transmission line routing study to determine the best connection point to the existing 69 kV transmission line. The study, which was one of the submissions to the Public Service Board, was completed in 1994. A subsequent analysis by GMP's engineering consultants, Dufresne-Henry, was performed to evaluate the feasibility and cost implications of a number of alternative locations for the transmission lines, substation, and access road. Their recommendations took into account the possibility of expanding the project in the future.

The final location of the transmission line and substation was determined by response to visual concerns. The 69 kV transmission line was moved from a route directly along the side of the road to a parallel route set further back from the road out of view. The purpose of the relocation was to allow for a buffer of trees between the road and the transmission line to reduce the visual impact of the line. Similarly, the substation was reduced slightly in size and re-positioned to address visual concerns.

6.3 Performance Projections

GMP's meteorological consultant prepared a revised estimate of the energy output for the project based on the site adjusted power curve for the Z-40-FS turbine, wind data from the on-site met towers, and the final siting configuration for the 11 turbines. The revised estimate of the net annual output for the 6.05 MW plant is 14.36 million kWh.

This estimate assumes 6% annual energy loss for icing, 5-6% annual energy loss for wake interference, and 9% for other energy losses related to the control system, line losses, and downtime.

6.4 Engineering and Construction Responsibilities

Although the project is discussed as a turnkey project, GMP had already completed much of the necessary engineering and development work and made substantial progress on the project design prior to Zond's involvement. After the contract signing, GMP intended for Zond to take over the engineering and design work for the project completely.

Transferring the final design and engineering work to Zond was more difficult than GMP anticipated. Besides having limited experience with the climate, Zond did not have the long-term involvement and the associated wealth of knowledge that GMP had accumulated over years of evaluation work on the site and surrounding environment. GMP also has extensive electrical system design capabilities. Because of these and other factors, GMP expended more effort after the award than they anticipated by working with Zond on completing the final design and engineering to their satisfaction.

As the general contractor, Zond prepared the final drawings and bid documents for the subcontracted work which included the land clearing, substation installation, and power collection line work. A significant number of local subcontractors were used for various phases of the project. Despite the remote location of the project, Zond was pleased with the availability of equipment and services in the area.

GMP engineers assisted Zond in preparing the substation and transmission line specifications that were included in the package sent to potential subcontractors. GMP negotiated a clause in the contract with Zond to ensure these items were completed to GMP's satisfaction. During the bid process, GMP worked with Zond to answer many of the subcontractors' technical questions.

In addition to their designated Project Managers, GMP contracted with a former employee, an experienced Construction Manager, to coordinate and oversee the construction activities. He submitted weekly reports to GMP's Project Managers and other interested parties which described the progress made during the week, any potential problems that arose, the implications on the schedule, and general comments about the construction activities. GMP gained significantly more experience by participating in the construction process in this way than they would have gained in a strictly turnkey project.

Zond provided monthly construction reports to GMP that included information similar to the weekly reports. Zond's reports also included photographs of the construction progress and notations about any events that had contract implications. For example, days were noted in the reports in which poor weather conditions affected the work because schedule penalties incorporated into the contract excluded weather delays. Both sets of reports were valuable to GMP because they offered different perspectives.

The weekly reports also kept GMP apprised of events as they were occurring so that any issues could be addressed in a timely manner.[17]

Although GMP did not manage the construction activities, the project management responsibilities for the overall development of the project were much greater than experienced in a typical turnkey project. GMP was responsible for the permitting, associated studies, public relations, construction oversight, and TVP participation.

6.5 Construction Process

Construction activities began in May 1996 with the installation of the on-site office, a temporary phone line, and a buffer zone and protection fence around the cemetery and old homestead foundation. As is typical during this season, site conditions were still wet and muddy so it was not yet possible to begin any significant civil work.

The unusually wet conditions continued through June and posed a number of problems for the clearing and construction crews. The resulting mud made it nearly impossible to move large equipment that was used for site clearing and chipping. The construction reports include numerous incidences when efforts were re-directed or work stoppages occurred because heavy equipment was stuck in the mud, often blocking access to other sections of the site. Weather records indicate that the spring of 1996 was wetter than normal.

It was necessary to clear certain areas of the site before other construction activities could be initiated. As a result of the wet conditions, the bulk of the tree clearing was delayed until June and was not completed until July. For clearing the trees, Zond worked with a local contractor that sheared and chipped the trees. A portion of the wood chips were shipped to Burlington, Vermont and used for fuel in a wood-fueled power plant. An area equivalent to approximately 35 acres of the 280-acre parcel were cleared for the project.

The access road to the site was constructed in July and August. The road alignment was designed to minimize the slope and number of turns as well as the amount of cut and fill that was required. The road is approximately 13 meters (40 feet) wide and 11,300 meters (3,700 feet) in length. It has a grade ranging from 2% to 14%, and the

[17]CSW and TVP also strongly recommend a full-time presence at the site during construction activities and a weekly progress review to identify opportunities for proactive measures.

finished surface of the road consists of gravel and crushed gravel. Figure 6-2 shows the access road at the site under construction.

Figure 6-1
Access Road at Site Under Construction

Although the actual construction of the on-site roads was fairly routine, particular care was taken to avoid potential soil erosion problems. For example, stone-lined swales were constructed along the uphill side of the road in areas with steep slopes. During construction, hay bales and other temporary measures were used to minimize erosion in disturbed areas. The affected ground was seeded and mulched as soon as possible after disturbance. A gate was installed to control vehicle access where the site road intersects with the existing town road. A permanent 20 by 50 foot parking area, designed to hold five vehicles, was constructed near the substation.

A pad-mounted transformer near the base of each turbine electrically interconnects the turbines to a 12 kV circuit paralleling the service road that runs along the ridgeline. For turbines 1 through 7, the 12 kV circuit is underground. For turbines 8 through 11, the 12 kV circuit is overhead beside the road, but underground in the vicinity of the turbines. This line is connected to an overhead 12 kV line that runs along the access road from the ridgeline to the substation at the base of the hill. The substation transforms the voltage from 12 kV to 69 kV. Two 50 kVAR power factor correction capacitor banks are located in each turbine and 3.6 MVAR of capacitors are located at the 12 kV collection bus. A one-line diagram for the project is shown in Figure 6-3.

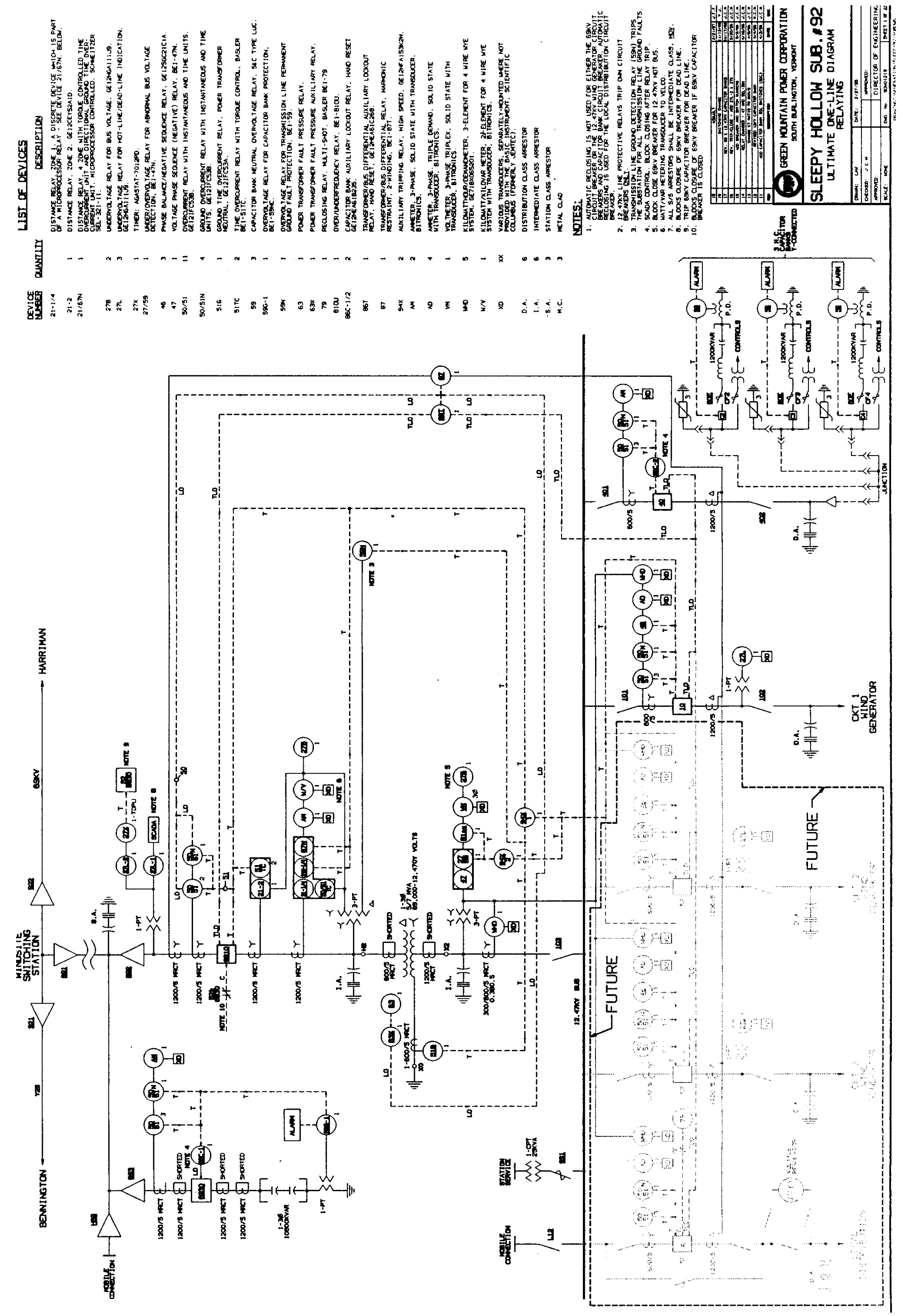

Figure 6-2
One-line Electrical Drawing for Power Collection System at GMP Project Site

From the substation, a new 69 kV transmission line runs 2.42 km (1.5 miles) in a parallel path along an existing road. This new line is interconnected to an existing 69 kV line owned by New England Power Company.

GMP originally specified overhead lines for the entire project because of the rockiness of the soil. Zond recommended underground lines in the vicinity of the turbines and proposed this approach during the final electrical design work. The underground lines also reduce potential avian interaction with the transmission lines, are less affected by environmental factors such as icing and lightning, allow for much easier movement of cranes and large turbine parts, and improve the safety and aesthetic characteristics of the site.

New England Power Company built the line tap connection from the new 69 kV transmission line to their existing 69 kV transmission line. GMP installed the fiber optics utility communication line that runs alongside the transmission line and installed the safety and relay equipment in the substation control building.

Zond was responsible for the design and installation of the turbine foundations. Foundation diameters and depths were selected by Zond based on allowable soil/rock geotechnical design criteria and applied loads. Each foundation is a reinforced concrete slab. The foundations have a base that is 36 feet square, three feet thick, and a pedestal that is 15 feet square, three feet thick, for a total of approximately 200 cubic yards of concrete. Despite early delays in clearing as a result of the wet weather in June, the foundations were complete in August on schedule.

The control building for the project was constructed adjacent to the substation inside the entrance gate. The 48.77 by 97.54 meter (16 by 32 foot) building is a single story, windowless structure that houses various control and protection equipment for the electrical facilities. The central computer for the control and monitoring system is also located in the building. One of the drawbacks to the building design is that the on-site technician can not see the turbines from inside the building.

6.6 Equipment Delivery and Installation

Coordination of the equipment delivery was particularly important at the GMP site due to the tight construction schedule, limited storage area on or near the site, and the confining cleared space near each turbine site. In addition, because the assembly and erection of the equipment was one of the final tasks and occurred in the fall, the days were shorter and there were increasing concerns about the weather as winter approached. A 165-ton crane, the largest mobile crane in Vermont, was used for installation of the turbines and towers. The first turbine was installed in late September and last turbine was lifted into place in early November. The heavy construction equipment was removed from the site just days before a snowstorm left almost a foot of snow on the mountain.

The turbine installation at the GMP site was more difficult than usual because the amount of cleared space was intentionally small, and the dense forest around the clearings eliminated any possibility to negotiate beyond the cleared area, even for a few feet. For example, the space around each turbine foundation was not large enough to lay down the tower sections, and so these were unloaded and placed along the service road. While the roads were wide enough for the tower sections, they were not wide enough to allow construction equipment to pass around the tower sections.

Transportation issues also required close attention. For the GMP project, the blades and turbines were supplied from California and the towers were supplied from Minnesota. These components are awkward to ship and sometimes difficult to route through small communities. For the GMP project, the fabrication of the towers was the critical path item that drove the equipment delivery schedule. Obviously, the arrival of a nacelle or blades for a turbine is not particularly useful if the tower has been delayed. Zond's experience was evident in this area and demonstrated by their carefully planned manufacturing, shipping, and installation schedule.

Because the schedule was particularly important, GMP, like CSW, hired an independent expediter to track the progress of major manufacturing and assembly tasks. "Manufacturing" of most wind turbines consists of assembling components supplied by various subvendors. Both utilities found the use of an expediter to be important because delays in the completion or delivery of one component to the assembly shop can set back the shipping date for the entire turbine.

Construction activities were substantially completed by early December 1996, within a few days of the scheduled completion date. The substation was energized on December 17, 1996. Figures 6-4 through 6-7 show construction activities on GMP's project site. Construction of the entire facility was completed in under 8 months.

Figure 6-3
Foundation Construction at the GMP Project Site

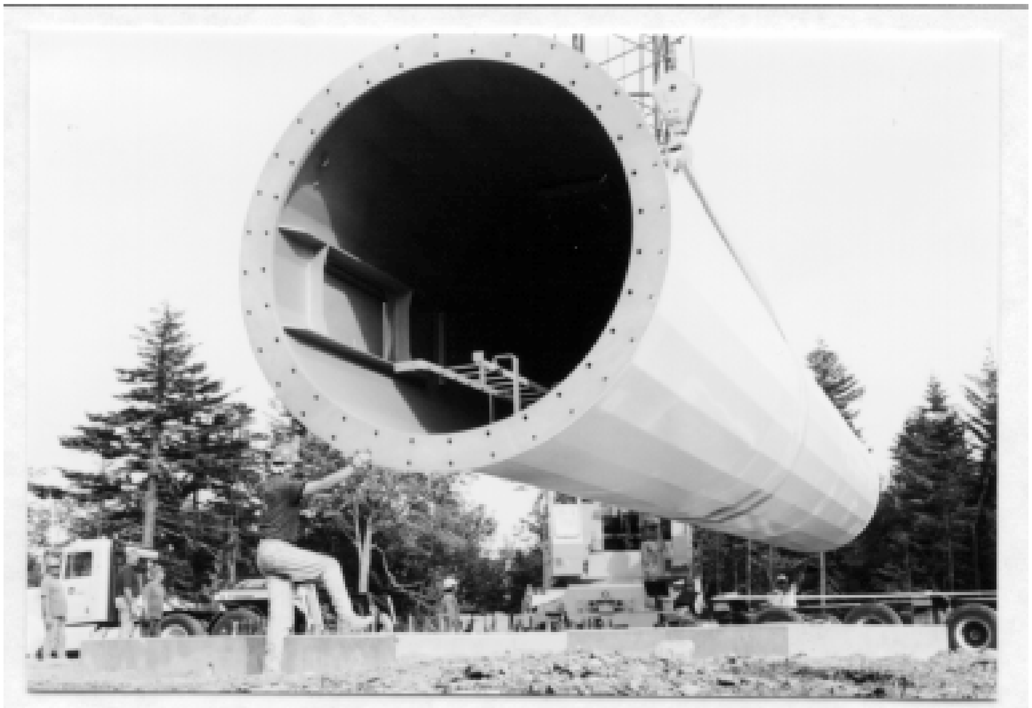

Figure 6-4
Off Loading a Bottom Tower Section at the Site

Figure 6-5
Installation of a Top Tower Section

Figure 6-6
Lifting the Rotor Assembly for Attachment to the Nacelle. Note the limited area for lay-down purposes.

7

TURBINE TESTING AND ACCEPTANCE

GMP required that Zond conduct or confirm a number of tests prior to project turnover in order to ensure the manufacturing quality of the wind turbines, verify the performance characteristics, and determine that the project was appropriately constructed and installed according to applicable standards. Figure 7-1 shows a summary of the turbine testing activities.

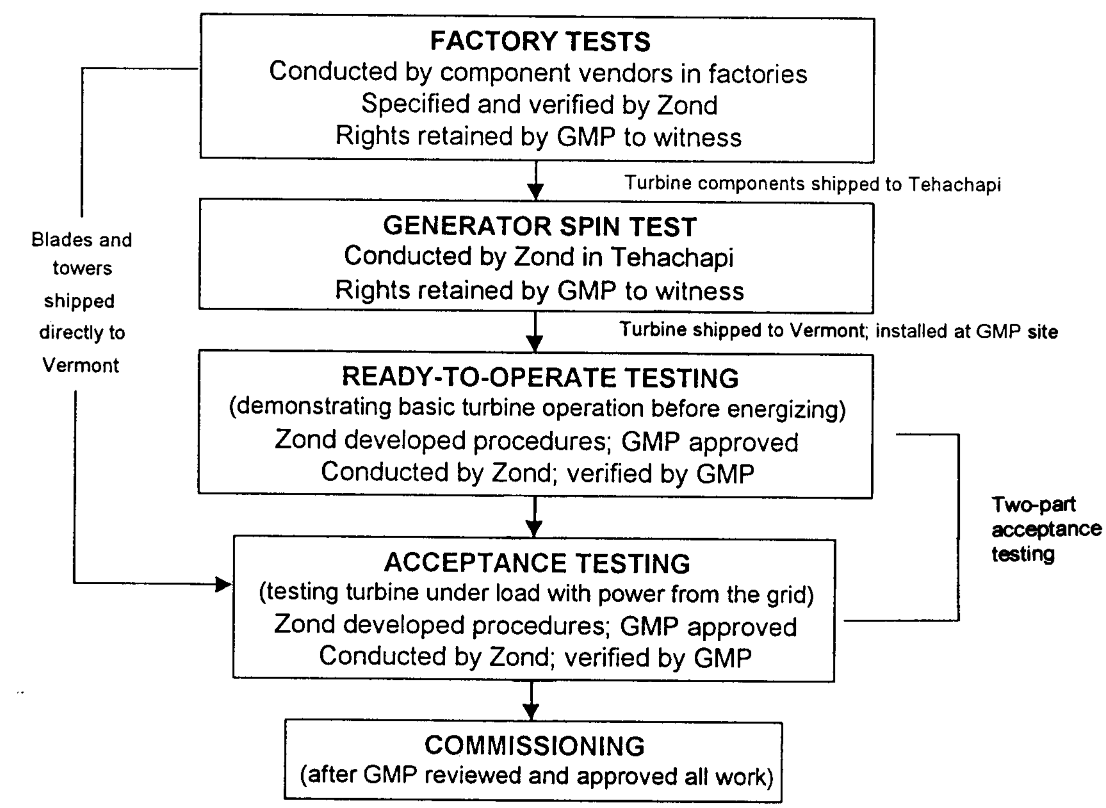

Figure 7-1
Wind Turbine Testing Activities

To supplement their own expertise, GMP hired an independent engineer with wind turbine knowledge to assist them with the turbine-related tests and inspections. The engineer was expected to:

- Assist in the development of procedures for the on-site testing activities;
- Monitor a representative sample of the tests completed on-site and verify that the turbines are assembled according to specification, the safety and control systems properly function, and the turbines are ready to operate in automatic, unattended mode;
- Assist in verifying that the turbines meet their power curve; and,
- Review the factory test data, quality control procedures, and any other documentation provided by Zond.

7.1 Pre-shipment Inspections

Under the terms of the Turbine Purchase Agreement, Zond was responsible for ensuring that their fabricators and suppliers performed component tests for function and capability prior to shipment. GMP reserved the right to witness any or all of these factory tests, and they required Zond to notify them in advance of the date and location for spin-testing of a representative turbine. GMP also retained the right to inspect and observe the testing on major components such as the gearbox, generator and blades.[18] GMP visited the facilities of some of Zond's suppliers, including the blade and gearbox manufacturers, and made multiple trips to inspect the activities at Zond's manufacturing facility in Tehachapi. In addition, their expediter visited other subvendor facilities. A GMP representative also witnessed the acceptance tests conducted on Zond turbines at the CSW site.

Zond has a contractual obligation to provide GMP with all certifications, specifications, and test results for sub-assemblies and major equipment, if requested.

7.2 Approach to Acceptance Testing

During the contract negotiation, GMP and Zond agreed to conduct acceptance testing for the project in two steps. The first step, designated a Ready-to-Operate (RTO) test, was intended to demonstrate the basic operation of a turbine after its installation prior to being connected to the grid. The second step, or final acceptance, included further testing of the turbines under load and the acceptance of the other work included in Zond's contract.

[18] TVP recommends witnessing factory tests, visiting the major component suppliers, and monitoring other testing activities to the extent practical.

The decision to use a two-part process was driven by several factors. The original project schedule included a time gap between the turbine installation and the energizing of the electrical system due to the schedule for New England Power Company's interconnection work. Because of the increasing possibility of weather constraints during that part of the year, Zond suggested that some of the testing activities be started during this period if a portable generator was available for powering up the control circuits, hydraulic pump, and yaw motor. Also, because GMP intended to retain a large percentage of the purchase price until after the project was completed, Zond was concerned about any potential delays in completing the testing. As a result, GMP and Zond negotiated to provide for a significant progress payment after successful completion of the RTO tests and a smaller payment at final acceptance and turnover.

Another consideration was that both parties wanted to avoid the project acceptance complications experienced at the CSW site, where the project operated for more than nine months before it was turned over to, and accepted by, CSW. Project acceptance at the CSW site was initially delayed until CSW and Zond resolved some outstanding issues. Although it seemed reasonable to operate the CSW project during this time, the roles and responsibilities of the project participants were unclear in the interim, and new issues developed that extended the discussions and further delayed the final turnover.

The general concept of the two-part acceptance testing (see Figure 7-1) was included in the Turbine Purchase Agreement, and Zond agreed to develop updated, detailed acceptance test procedures prior to the testing.[19] As a fallback position, both parties agreed to use the CSW acceptance test procedure to the extent that it could be applied to the full-span pitch turbine. However, the CSW turbines do not include any of the cold weather features of GMP's turbines or the two-step acceptance approach. As a result, the usefulness of the CSW document was less than desired, and Zond eventually developed a GMP-specific procedure for each test.

The RTO procedure was designed to confirm proper field installation of the turbines and demonstrate basic machine functionality in a step-by-step manner. To conduct the test, correct electrical connections are confirmed and the function of the Emergency Stop circuit is verified. The rotor is turned, and the brakes are inspected and adjusted as necessary during the rotation. The brakes are then burnished (a wearing-in process) by commanding repeated stops.

To complete the final commissioning of the turbines, the Acceptance Test Procedure (ATP) was designed to verify all operational and fault monitoring functions before

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[19]TVP recommends that the buyer require the turbine vendor to provide the acceptance test procedures at least 30 days before the turbines are shipped.

placing the turbines in service. The ATP is conducted once the pad-mounted transformers are energized. This test includes powering the turbines off the utility line, simulating all previously untested faults, demonstrating the power regulation, and confirming the overall operation in accordance with the design parameters.

The acceptance procedures for the other work associated with the project were much more standard. The roads were accepted based on compaction tests and an inspection to confirm they were completed according to the specifications. The electrical interconnection facilities and collection circuit were accepted after GMP's engineering department verified that the installation and operation was in accordance with the specifications, and that New England Power Company was satisfied with the connection.

7.3 Testing Experience

A portable 25 kV generator was transported to the site since the utility interconnection was not available, and the RTO tests were started on the turbines in early November 1996. During the RTO test on the sixth turbine, the gears slipped on an intermediate shaft in the gearbox during the brake burnishing procedure. Zond initially speculated that the damage was caused by a combination of factors including the lack of grid power available to the turbines, no previous operation of the gearbox under load, cold temperatures, and freezing moisture. Subsequent investigation indicated that the brake was applied more quickly than intended because of a missing throttling orifice in the brake hydraulic system.

Zond and GMP inspected the five other turbines that had undergone this test and found evidence of markings on the intermediate pinions and gears in each turbine. Zond replaced the turbine that experienced the gear slippage, and an inspection plan was developed for the other five turbines to determine if the damage was sufficient to require repair.

Zond modified the RTO procedures by making the hard braking tests part of the ATP and eliminating the brake-burnishing task in the field. The brakes on future turbines will be burnished in the factory. The missing hydraulic component was installed in all the turbines and modified RTO tests were completed by the end of 1996.

When the testing resumed in early 1997, Zond technicians discovered approximately nine broken blade bolts on several turbines. As a result, Zond replaced over 2,600 bolts on the site with bolts of a different grade. They eventually determined that the failures were due to a quality control and materials problem at the supplier. Completion of the task at each turbine took a two-man crew more than three days. The machine is designed with sufficient space so that the bolts can be replaced from inside the hub;

therefore, the bolt replacement did not require a crane. Following the replacements, there have been no subsequent problems with the bolts.

When the ATP was finally re-initiated, an additional problem was encountered. Zond technicians discovered fretting corrosion in a gearbox while investigating a thumping sound. The damage was likely caused by the slight back and forth movement of the rotor while it was in a locked position over the previous several months when the turbines were not operated or even rotated. The slight movement was believed to be sufficient to have squeezed out the lubrication between the teeth of the gears allowing moisture inside the gearbox to condense on the bare metal surfaces and cause corrosion.

The damage from fretting corrosion was significant enough to warrant replacement of all the gearboxes at the GMP site. Zond removed each turbine and shipped it to Tehachapi, where the gearbox was replaced and other slight modifications were incorporated. Each nacelle was shipped back to the site and re-installed on its original tower. Zond also modified its shipping and operating procedures, and changed the specified lubricants as additional protective measures. The entire process took several months. Manufacturing of the new gears was the critical path item in the schedule.

Zond addressed the problems promptly and effectively. Although the events caused a significant delay, there was little cost to GMP, and Zond repeatedly demonstrated its commitment to the project through its responsiveness and diligence.

Condensation was a fundamental contributor to the fretting corrosion and a number of other problems at the site. Although cold temperatures and icing had been anticipated, the quantity of moisture that can condense and accumulate inside the nacelle, and the resulting impact on the turbines, may not have been adequately considered. In December 1996, at the end of the construction period, it was actually warmer than normal and the technicians reported condensation and occurrences of "rain" inside the nacelles. The inability of the turbines to operate because they were locked in place also contributed to the problem. The turbines are warmer when generating energy and their rotation disperses the lubricants.

An unfortunate side effect of these problems was the low morale of the on-site technicians, most of which were from California. The project was originally scheduled to be completed before Thanksgiving. In addition to disrupting holiday plans, many of the technicians spent long days working throughout the harshest of the winter months in Vermont. Both GMP and Zond were concerned about the impact of morale on worker safety, efficiency, and productivity.

Since the turbines were not shipped back to California until replacement gearboxes were available, GMP and Zond agreed that the machines in the field be placed in a semi-operational mode until they were removed from their towers. In this "virtual operating" mode, the rotors were unlocked and allowed to rotate, oil was circulated through the gearbox to lubricate the gears, and the turbines were allowed to yaw with changing wind direction. To prevent the turbines from coming on line, the controller limited the generator speed to 800 rpm. The virtual operation of the turbines also had a side benefit in that the rotating blades may have been more visually pleasing to the local townspeople.

GMP continued their cold weather research effort during this period by working with the Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire, talking with wind plant operators in Canada and Europe, and consulting with drive train experts in the ski industry.

In addition to concern for its customer and its product, there were additional incentives for Zond to place the facility in service as soon as was practical. This is a high-profile project in the utility industry and the visibility of the project meant that the delay in the schedule would be apparent to many individuals and organizations who were following the project's progress. To address the inevitable questions and prevent unsubstantiated rumors, GMP took a proactive stance and issued a briefing on the situation to describe the cause and duration of the expected delay. They also described the acceptance test events in detail in their project newsletter,[20] which was distributed to town leaders, some local citizens, state agencies, environmental groups and other interested parties.

7.5 Final Acceptance and Commissioning

The first turbine was returned to the site in mid-May 1997 and the acceptance testing for the project was completed in late June. It took a crew of three men approximately 1.5 days to complete the ATP on each turbine. GMP representatives and their independent engineer reviewed the acceptance test documentation provided by Zond and conducted a physical inspection of the turbines as the tests were completed.

When the final turbine was placed in service, there were still a number of minor outstanding items, such as documentation requirements and the submission of as-built drawings, which had not been completed in accordance with the terms of the contract. In addition, Zond's SCADA system was not yet fully operational. GMP considered the majority of these items to be fairly small and they had confidence in their long-term relationship with Zond, so they were willing to move forward with the commissioning despite the status of these events.

[20] *Wind Power News, A Newsletter for Green Mountain Power's Wind Program Activities*, Volume 3, Issue 1, March 1997.

GMP commissioned the project immediately following the completion of the acceptance tests and they assumed ownership on July 1, 1997. In this case, "commissioning" indicated that GMP accepted all work performed by Zond including the construction and installation of the turbines, electrical interconnection facilities and access road. The commissioning date also marks the turnover in ownership from Zond to GMP.

8

PROJECT COST AND SCHEDULE

8.1 Project Cost

The total cost of the GMP project was approximately $11 million. This cost represents an installed cost of approximately $1800/kW based on the 6.05 MW project size. This cost is higher than would be expected from a large commercial wind power plant for a number of reasons. First, the size of the project is relatively small and there is little opportunity in either the capital or operating costs to take advantage of any economies of scale or quantity discounts. The costs associated with permitting the project were also particularly high. For a larger project, these costs would likely have been the same, but the impact of the permitting costs would have been significantly less on a $/kW basis. Also, there is a learning curve associated with developing a first project, and GMP's and Zond's costs reflect this learning curve as well as the research nature of the project. Some of the work that was completed and included in the project development costs will benefit the parties, and others, in wind projects in the future.

The costs are also higher in Vermont than they would be in some other locations due to the physical site conditions and the local environment. With CSW, some pre-construction activities conducted at the GMP site such as tree removal and extensive permitting were not required. The GMP turbines were also more expensive than the CSW turbines because of the additional cold weather features and the tubular towers.

The actual project cost was higher than initially expected. This is attributable primarily to project management costs that were approximately 40% more than estimated, change orders, and the costs incurred by GMP in assisting Zond in the design and engineering of the electrical interconnection facilities. Table 8-1 shows the projected cost estimate for the project. The site selection work and a significant amount of the wind resource assessment work is listed as "Cost Prior to 8/1/93." As previously discussed, the construction costs contribute a larger fraction of the total cost than in a typical wind project.

Considering DOE and EPRI's financial contribution, GMP estimated their net installed cost to be $1010/kW. The actual cost was closer to $1100/kW. These net costs allow for the $477,000 contributed by EPRI Tailored Collaboration funding. They also include the costs of the early wind resource and site selection work. GMP's portion of the project costs are included in their ratebase.

Table 8-1
GMP Project Cost Estimate, May 1995

COST CATEGORY				% of Project Cost
A. PROJECT MANAGEMENT			$253,868	3%
B. PERMITTING			$240,521	3%
C. WIND RESOURCE ASSESSMENT			$107,872	1%
D. DESIGN AND ENGINEERING				
Management		$35,856		
Preliminary Design		$99,007		
Final Design – Turbine, Project Site		$93,488		
Final Design – Turbine Sites		$51,344		
Job Inspection		$36,569		
Contingency		$56,082		
Subtotal Design and Engineering			$372,346	4%
E. EQUIPMENT PROCUREMENT				
Management		$9,184		
Construction Contract Administration		$17,391		
Services		$32,057		
Equipment – Turbines	$3,773,520			
Equipment – Substation Tran	$192,785			
Subtotal		$3,966,305		
Subtotal Equipment Procurement			$4,024,937	42%
F. CONSTRUCTION				
Management		$46,110		
Site – roads, civil work		$417,669		
Turbines – installation		$2,316,929		
Support Facilities		$190,330		
Electrical – High Voltage				
Transmission Line	$132,246			
Substation	$541,926			
Relay and Metering	$12,852			
SCADA	$63,379			
Subtotal		$750,403		
Electrical – Low Voltage				
Collection System	$230,638			
Site Transformers	$207,443			
Subtotal		$438,081		
Contingency		$445,689		
Subtotal Construction			$4,605,211	48%
TOTAL INSTALLED PROJECT COST			$9,604,755	100%
Cost Prior to 8/1/93			$480,000	
EPRI-DOE TVP Contribution			($3,500,000)	
EPRI Tailored-Collaboration Contribution			($477,000)	
GMP NET INSTALLED COST, $			$6,107,755	
GMP NET INSTALLED COST, $/KW			$1,010	

The estimated cost of energy for the project exceeds the projected avoided cost for several years. GMP considers the long-term economics to be acceptable and believes they will benefit from the non-economic research results of the project. Their decision to proceed with the project was also based on the opportunity to take advantage of the significant technical and financial assistance that was available from the TVP and the chance to mitigate future risk by gaining experience with a small project.

Because GMP is part of the New England Power Pool (NEPOOL), they investigated the capacity credit of the project based on NEPOOL guidelines. The capacity credit does not significantly affect the economics of the project due to the fact that the region currently has excess capacity and capacity values are low. However, GMP determined that wind projects would receive a modest capacity credit under the NEPOOL accreditation method.

8.2 Project Schedule

The actual pre-construction and construction schedules for the project are shown in Figures 8-1 and 8-2. Although there was some variation between the actual schedule and the dates assumed in the original work plan developed for the contract, construction was substantially completed within a few days of the planned completion date. GMP had included significant schedule penalties in the contract, but none of these were imposed.

GMP's project schedule is not necessarily typical for a project of this type. The time interval allowed for the bidders to prepare their proposals and GMP's own evaluation schedule were fairly short for a number of reasons. GMP's intentions to develop the project were well known in the wind industry due to their information solicitations, their outreach activities, and the TVP publicity. Because of permitting delays, there was a significant amount of time for potential bidders to familiarize themselves with the project concept and site conditions. In addition, GMP had already completed or was intending to complete a number of the time consuming development tasks such as wind resource assessment and permitting.

The schedule was also driven by the fact that the construction season at these elevations is limited to about six months during the summer and fall seasons. This is a relatively short construction time for a project of this type. Slight schedule slips could result in almost a yearlong delay if the construction season was missed.

Zond used a more detailed milestone schedule to monitor and control progress of activities over the duration of their involvement in the project. This schedule was updated regularly and included in the monthly construction reports they submitted to GMP. The poor weather at the beginning of the construction period added slightly to

Zond's overall costs even though they considered some delays as part of their contingency.

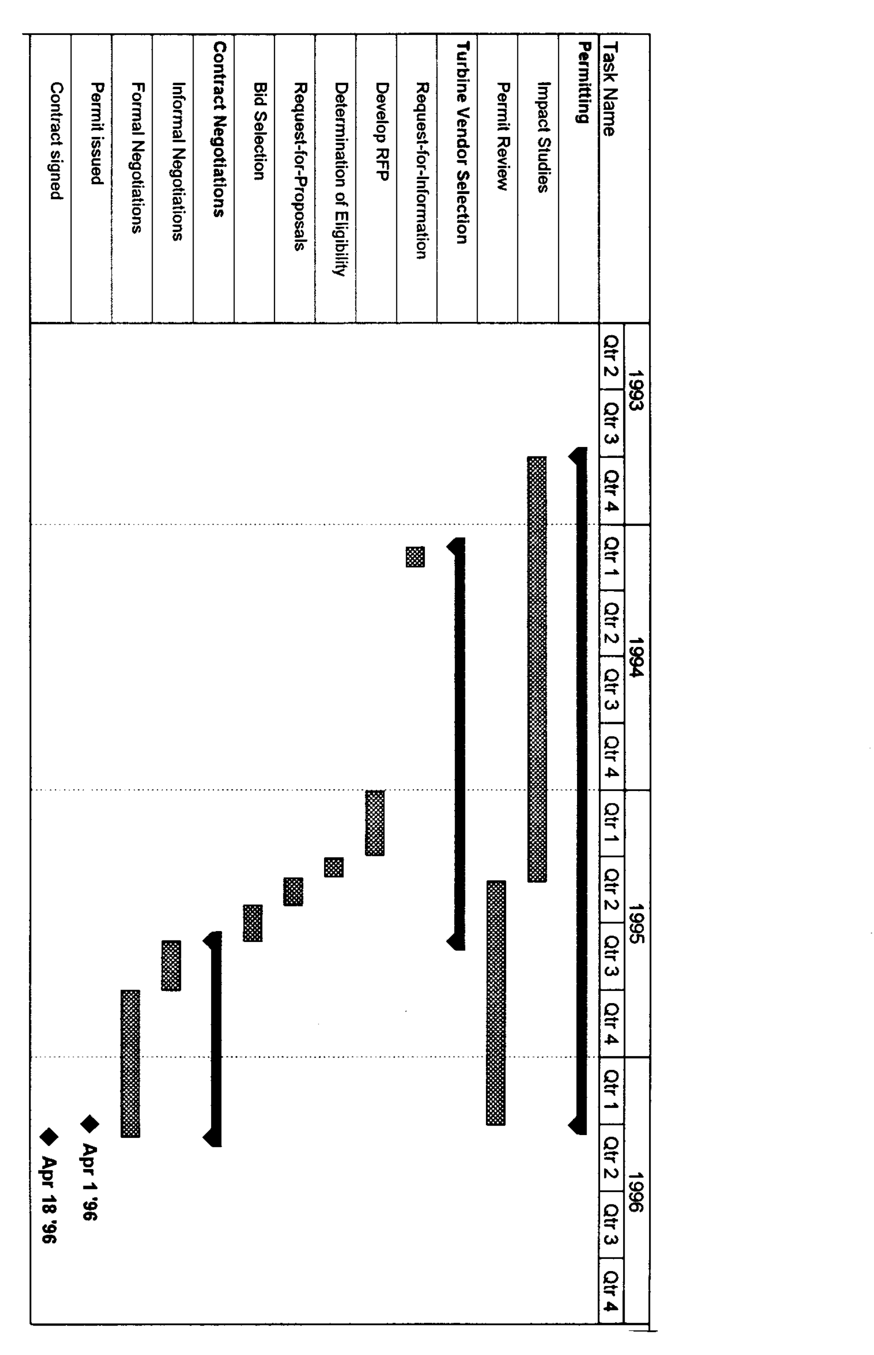


Figure 8-1
Project Schedule for Permitting and Contracting Tasks

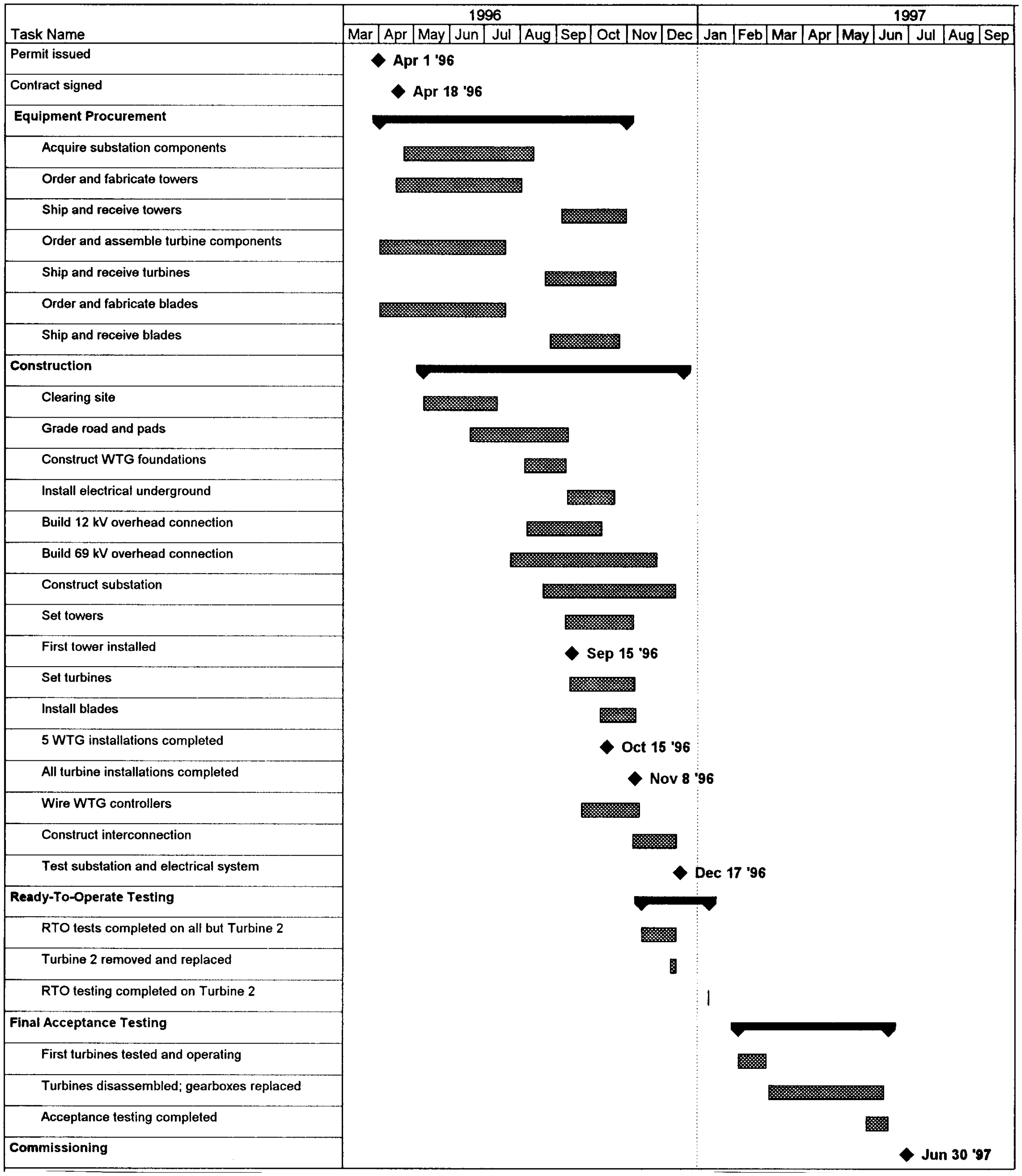


Figure 8-2
Project Schedule for Procurement, Construction, and Testing Tasks

9

OPERATION, MAINTENANCE AND PERFORMANCE EVALUATION PLAN

This section presents GMP's plans and rationale for operating, maintaining, and evaluating the performance of their wind power plant. The actual operating, maintenance, and performance experience will be described in subsequent reports on this project.

9.1 O&M Plan

GMP originally planned to operate the plant themselves by using a half-time person. After reviewing the vendors' responses from their Request for Information, they modified their plan to a full-time person for the first two years coupled with a part-time person to assist with maintenance activities that required turbine climbing. Then, during the development of the RFP, they decided to request O&M services from the vendor for an initial three-year period during which GMP personnel would receive training and be phased into the O&M activities.

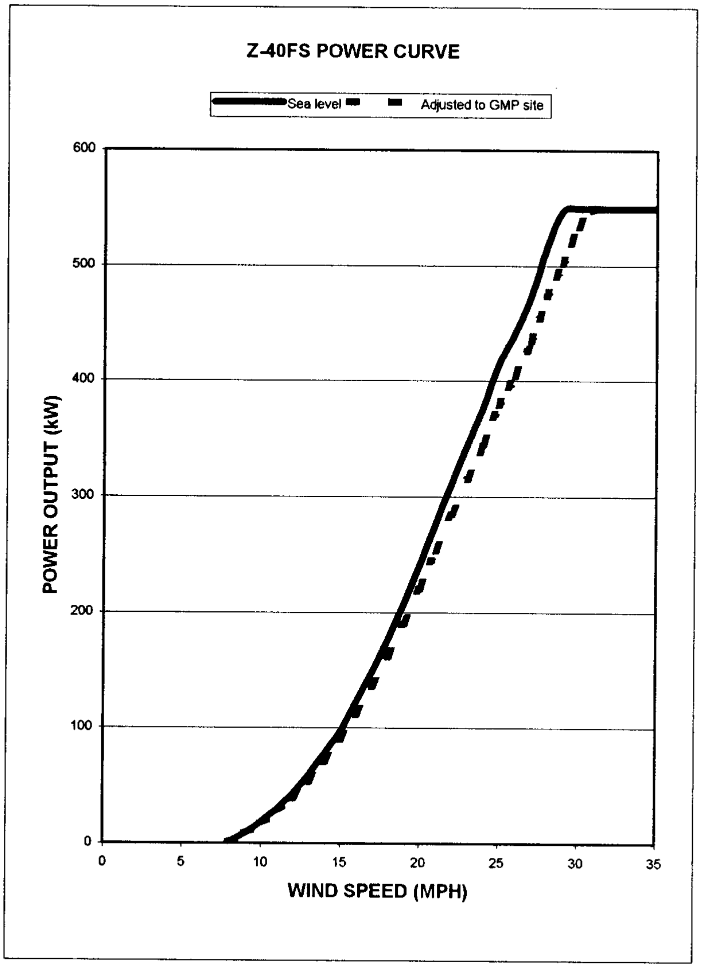
Consistent with this final decision, Zond assumed responsibility for the O&M of the plant following commissioning. A Zond employee was brought in as the site manager and Zond intends for a second, local Zond technician to work with the site manager. GMP is considering sharing the cost of the second technician with Zond.

9.2 Training

The Turbine Purchase Agreement specified that Zond will train up to two technicians selected by GMP in the operation, maintenance, and repair of the turbines at Zond facilities in Tehachapi, California. The training will be approximately two weeks in length and will be scheduled at GMP's discretion. Although the contract states that the training will occur in Tehachapi, it may be more appropriate to cover some aspects of the course at GMP's project site. The content of the course will also be impacted by the final staffing agreements between Zond and GMP, particularly if a GMP employee begins working at the site and receives on-the-job experience.

9.3 Performance Warranties

Zond provided a five-year warranty with their equipment, which began on the commissioning date of the project. The power output for each individual turbine is warranted to exceed 95% of the theoretical energy based on the actual wind speed distribution and the guaranteed power curve. Figure 9-1 shows a sea level power curve for the Z-40-FS wind turbine and the warranted power curve, adjusted to GMP's site conditions.



Wind Speed	Z-40FS Power Output	Z-40FS Power Output
mph	Sea level	Adjusted to GMP site
8	1.34	1.23
9	9.06	8.30
10	18.17	16.65
11	29.24	26.79
12	42.65	39.07
13	58.53	53.62
14	77.03	70.56
15	96.20	89.96
16	121.85	111.61
17	147.92	135.50
18	176.42	161.61
19	207.46	190.04
20	241.01	220.77
21	277.01	253.84
22	311.06	284.94
23	344.48	315.56
24	376.58	344.94
25	413.99	379.22
26	440.60	403.78
27	473.66	433.88
28	516.92	473.51
29	548.35	502.30
30	550.00	535.00
31	550.00	550.00
32	550.00	550.00
33	550.00	550.00
34	550.00	550.00
35-85	550.00	550.00

Figure 9-1
Z-40-FS Warranted and Sea Level Power Curves

GMP did not originally include a permanent meteorological (met) tower in the project plans for power curve measurement. Zond wanted to reduce the performance guarantee unless a met tower was installed at a location appropriate for data collection in accordance with the American Wind Energy Association (AWEA) performance measurement standards.[21] The importance of this issue became clear only after GMP had submitted their permit documentation and they were reluctant to submit an amendment to the package for fear of derailing the review process. As a result, a temporary tower which did not require a permit was installed at an agreed upon location until permits could be obtained for a permanent structure.

The methodology for power curve verification has been discussed extensively between GMP, Zond, and other TVP participants. This topic received considerable attention because of the difficulties CSW experienced in conducting power curve measurements at their project site. A more comprehensive standard for power performance measurements is currently under development by the International Electrotechnical Commission (IEC).[22] The TVP sponsors are exploring the possibility of conducting the power curve performance testing for the host utilities, in accordance with the IEC standards, on all the TVP sites to ensure a consistent methodology and the documentation of test results.

The permanent met tower was located to permit power curve measurements on GMP's Turbine #6. There were limited opportunities to site the met tower in an appropriate location due to the topography of the site. The power curve will not be measured until at least three months after the commissioning date to allow for resolution of any start-up problems.

In areas of complex terrain, such as the GMP site, the IEC standard recommends that a "site correlation" be developed between the met tower and the turbine site. The correlation can then be used to estimate the wind at the rotor hub based on observed met tower data. GMP took two approaches to developing a site correlation between the met tower and Turbine #6. First, they mounted an anemometer on a boom and installed it off the back of the turbine nacelle pointed in the direction of the met tower (upwind). With the yaw locked in that direction, data from the stinger anemometer were collected and compared to concurrent data from the met tower. GMP also installed an anemometer on the top of the turbine tower during the period when the nacelle was removed for the gearbox replacement. Zond altered the turbine re-installation schedule to allow the maximum amount of data to be collected from this sensor. The availability of these data sets will allow GMP to analyze the variation between the different site correlation approaches, and the results could potentially provide valuable insight on power performance testing to the wind industry community.

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[21] *Standard Performance Testing of Wind Energy Systems* – 1.1 American Wind Energy Association, 1988.
[22] IEC draft standard 1400-12, *Wind Turbine Performance Testing*, May 1996.

GMP's performance warranty includes provisions requiring Zond to pay for any shortfalls in energy production that result from power curve deficiencies based on a specified payment rate. However, the warranty covers only a five-year period. If the turbines do not achieve their power curve, there is no clause in the contract to address long-term compensation.[23] In hindsight, GMP believes that this issue should have been specified in their RFP and purchase agreement.

9.4 Availability.

The availability warranty is included in the O&M Agreement which has not yet been finalized. The terms of this warranty are one of the most significant negotiation points in finalizing this contract. GMP anticipates that the turbines will be warranted to have a 90% availability. This level is slightly lower than a typical warranty for a wind energy project but does not include exclusions for potential access problems during the winter. The calculation methodology is still under discussion. Additional comments on availability are included in the SCADA discussion below.

9.5 Other Guarantees

The output of the wind power project is warranted to meet the power quality requirements of IEEE 519 at the interconnection point with New England Power Company's line. The individual components provided by Zond are also warranted to perform their intended functions and be free of defects in design, materials, and workmanship. For many of the individual turbine components, Zond's warranty is backed up by their suppliers' warranties.

9.6 SCADA System Considerations

The GMP project includes a Zond Supervisory Control and Data Acquisition (SCADA) system which collects and stores information from each individual turbine, as well as from the permanent met tower. Met data is recorded from both heated and non-heated sensors at the 40-meter level. The data recorded by the system can be accessed, viewed, and downloaded remotely by modem. This information includes operating hours, power output, cumulative energy production, and a variety of other sensor readings. The GMP SCADA system is identical to the one used by CSW.

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[23] Some contracts and/or performance warranties specify reparation requirements or compensation in the event of a power curve deficiency. For example, the vendor could be required to make modifications to the turbines to increase their output, or in extreme cases, even add additional turbines to the project to bring it up to expected production levels.

For on-going performance evaluation and warranty calculation purposes, the capabilities and limitations of the SCADA system are important to GMP and the TVP sponsors. One of the primary objectives of the TVP is to obtain and disseminate data on the performance characteristics of the wind projects included in the program. Based on the experience at the CSW site, GMP and TVP have requested several modifications to the SCADA software. Of particular interest to the program is an additional measure of availability that considers all downtime events experienced by the turbines, regardless of their cause or the manner in which the downtime was initiated.[24] The goal is to develop a consistent definition and calculation methodology for availability reporting that is used by all TVP projects.

GMP installed an independent data logger at the permanent met station to provide redundancy to the wind data recorded by the SCADA system. This logger will ensure that wind data are recorded during periods in which the SCADA system is unable to function.

9.7 Performance Evaluation Plans

GMP plans to evaluate the performance of the project in conjunction with Zond, and with assistance from their consultants. EPRI required a number of parameters to be monitored for three years after start-up of the wind power plant. For individual turbines, the following parameters will be monitored and reported:

- Hourly energy output;
- Hourly average wind speed, wind direction, turbulence intensity, and temperature from a representative meteorological tower;
- Scheduled outage hours;
- Unscheduled outage hours;
- Unit capacity factor;
- Availability factor;
- Summary of scheduled and unscheduled maintenance performed; and
- Power curves showing actual compared to theoretical.

The following data and analyses will be provided for the sum of the machines included in the project:

- Hourly energy output;
- Hourly average wind speed (from a meteorological tower);
- Plant capacity factor;
- Equivalent forced outage rate;

[24] The TVP definition of availability takes into account all downtime hours experienced by a turbine. The remaining available hours are divided by the total hours in the period to obtain TVP availability.

- Summary of major scheduled and unscheduled maintenance performed;
- Summary of operation cost;
- Summary of maintenance cost;

- Calculated O&M cost per kWh; and
- Overall TVP power curves showing actual versus theoretical.

9.8 Other Factors

Since commissioning, Zond has assumed responsibility for the O&M activities, despite the fact that the O&M contract has not yet been finalized. For both parties, the time constraints and priority of other project tasks has been used as the reason for the delay in finalizing the agreement. A side benefit of the delay is that Zond and GMP gained experience during the 1996-1997 winter months prior to finishing the contract.

10

PROJECT OUTREACH ACTIVITIES

One of the objectives of the TVP is to disseminate information and provide outreach activities to other utilities and members of the wind industry. GMP also has a corporate objective of providing outreach activities to the local community, state and regional entities, and personnel within their own company.

GMP participates in TVP meetings with EPRI and NREL three to four times a year to discuss the status of the project and recent experience with other TVP utility and program management participants. These meetings also provide a forum for the sponsors to provide guidance and technical assistance to the program participants. The TVP also conducts periodic outreach workshops open to utility personnel and other interested parties to provide information on the technology and its operation. The first TVP outreach workshop was held in Fort Davis, Texas in September 1995 as part of the CSW dedication program. The second workshop was held in Wilmington, Vermont in September 1996.[25] The agenda for the workshop is included in Appendix C. One of the highlights of the Vermont workshop was a visit to the GMP site to observe the construction and turbine installation in progress.

GMP has made presentations on their experience at industry conferences and they are active in a number of wind energy interest groups, including the National Wind Coordinating Committee, the Utility Wind Interest Group, and the American Wind Energy Association (AWEA). GMP is also currently represented on AWEA's Board of Directors, and they have actively sought and obtained the support of Vermont's congressional delegation for a number of federal wind energy incentives.

GMP developed a newsletter, *Wind Power News*, to report on their wind program activities. The first issue was published in September 1992 and GMP has continued to issue newsletters on a periodic basis since that time. The newsletter is distributed to state and local government agencies, environmental groups, local citizens, GMP employees, industry members, and other interested parties. Newsletters have focused on permitting and environmental studies, construction activities and project complications as project development and construction was completed.

[25] Presentation materials and other information from the workshop are available from EPRI .

Because Searsburg and the neighboring communities are fairly small, the development of the project was big local news. GMP involved members of the local communities at an early stage in the project development. They solicited input and kept the government officials informed of their progress to the greatest extent possible. They believe that public perception is easily affected by the attitude and actions of the project participants.

In early September 1996, the arrival of components over a period of several weeks made an unusual parade through the local community. Figure 10-1 shows a tower section being transported through the town of Wilmington. These and other events received a significant amount of local press.

Figure 10-1
A Bottom Tower Section Moving Through the Town of Wilmington, Vermont

As the first commercial wind project in the Northeast, the project had its share of regional and national attention as well. In addition to the numerous published articles, GMP used a photograph of the project in one of its regional newspaper ads.

In general, GMP has been applauded for its effort by the local press. In a September 26, 1996 editorial in the Deerfield Valley News, GMP was praised for making every effort to include the state and local community, and show sensitivity to the environment. The editorial stressed the efforts to minimize the facility’s impact by burying cables, painting the towers to reduce their visibility, hiding the transmission lines with a buffer of trees, and cutting a narrow swath for the access road. It also mentioned the extensive use of local contractors, and summarized by labeling GMP as a good corporate neighbor.

GMP constructed a roadside interpretive sign and public parking area for the project. The kiosk-type exhibit is sited nearby but away from the substation and access road area to avoid disturbing the cemetery. GMP also installed the cemetery fence with input from Searsburg town officials to ensure protection of the cemetery. The objective is to provide a place for local citizens and tourists to pull off the road to view the turbines and learn about wind technology and its potential without harming historical town property. Figures 10-2 and 10-3 show the roadside exhibit and cemetery fence with the turbines in the background.

As information about the development of the project spread, a number of people hiked up to the site for unofficial visits. To address the potential safety problems, GMP hired a local resident to offer guided tours on the weekends. Hundreds of elementary and high school age children visited the facility throughout the fall construction season. Tours are currently conducted by appointment only.

GMP coordinated a series of outreach activities over a weekend in mid-August 1997 to celebrate the project's completion and operation. The project was formally dedicated on August 15, 1997. The by-invitation-only dedication ceremony was attended by about 120 people. Both of Vermont's US Senators attended the ceremony and expressed their support for wind energy.

The Governor of Vermont declared August 16, 1997 as Wind Energy Day. As part of a local fair on this day, GMP sponsored wind energy exhibits, crafts, and games. Approximately 1,000 people from across the northeast participated in public tours of the site offered by GMP as part of the festivities. Tour guides for this event were specially trained local high school students and teachers interested in being involved in the project. The dedication ceremony program and brochures produced by GMP for public dissemination during the dedication weekend are included in Appendix C.

To start off the dedication weekend, GMP employees staged a run covering 176 miles from their headquarters in South Burlington to the project site. GMP's CEO ran the first leg of the 3-day relay and GMP's Public Relations Director ran the last leg up the access road to the project. A wooden wind turbine model was passed from runner to runner.

Figure 10-2
Roadside Interpretive Sign and Parking Area

Figure 10-3
Cemetery Near Project Site

11

CONCLUSIONS

Through its involvement in the TVP, GMP has successfully developed, constructed, and is now operating a wind power plant in Searsburg, Vermont. Like the CSW project, some of the experience gained from the development phase is common to any construction project, some is unique to developing a wind power plant, and some is related to the specific Vermont location.

Overall, Zond and GMP worked together to successfully overcome some environmental challenges and complete the construction of the project within a tight scheduling window. Each party demonstrated a commitment to make the project a success and the experiences are within the realm of expectations for a project of this type.

The TVP projects are intended to have a strong research content to them and to provide an opportunity for both the utilities and the vendors to gain experience with new technology. The type of start-up problems experienced with the turbines at the GMP site are more likely to occur in this framework than in a commercial project, and the TVP provides the vendors with an opportunity to identify and resolve potential technical problems prior to large-scale deployment of new technology.

In addition to providing a market for unproven wind turbines, the program aims to gather operational data from a range of environments. As such, it was expected that the majority of the problems that arose during the development of GMP's wind power plant would be directly related to the harsh climate and the physical conditions at the site. GMP and Zond are furthering TVP goals by gaining knowledge and understanding of what is required for a successful wind project in cold and wet mountainous environments.

The environment at GMP's Vermont project site offers a striking contrast to CSW's warm and dry West Texas site. Nonetheless, the project development experience was at times similar. Both projects were successfully constructed on schedule despite strict time constraints. Both projects were also impacted by uncertainties associated with turbine warranties and turnover, the lack of established procedures, and incomplete documentation. Both utilities, however, have expressed interest in being involved in additional wind projects in the future.

GMP's permitting requirements and experience were much more stringent than CSW's. Permitting and land acquisition for the GMP site played a major role in dictating the project schedule as well as the project design. The level of effort expended on the project permitting was much greater at the GMP site than has typically been experienced at other wind project locations in the United States.

GMP and CSW also took different approaches to developing the project. GMP and Zond have both indicated a preference for a turnkey approach to the project construction. CSW assumed responsibility for the majority of the civil work on their project site. Because of their experience with electrical system and substation design, GMP may separate the project responsibilities at the low voltage side of the substation for future projects, rather than include the substation in the vendor's scope of work.

Despite the turnkey contract with Zond, it was necessary for GMP to have considerable responsibility in the overall development of the project. They were fully responsible for the site selection, land acquisition, resource assessment, environmental studies, and permitting. They also made significant contributions to the electrical system design and specification, and they have gained valuable experience through their construction oversight activities, on-going studies, and planned role in the project O&M. Their longtime interest in wind energy and the knowledge gained from previous wind projects was demonstrated during the development of the Searsburg project in areas such as their wind resource assessment activities, their approach to public relations and their technical suggestions for cold weather modifications.

As with CSW, additional consideration of acceptance test procedures, warranty calculations, and performance evaluations would have been beneficial at an earlier stage. Neither GMP nor Zond intend to divide the equipment testing into Ready-to-Operate and Acceptance Test procedures for future projects.

Because both parties were focused on completing the installation and testing activities, the operation and maintenance plans were a low priority. As a result, the O&M Agreement has not been completed despite the fact that the project is operating and Zond has a full-time employee on site. Start-up problems with the SCADA system, also a low priority, has limited the ability to conduct performance evaluation tasks at the site. Although both GMP and Zond are now directing attention at these tasks, their delayed implementation may make the process more time consuming and problematic than necessary. In addition, TVP will lose valuable operational data during the first months of operation.

GMP has been extremely effective in their community outreach activities. Although their wind power plant is relatively small, GMP has used the experience gained through the project development to educate the surrounding community, state and national interest groups, and their own staff on the challenges and benefits of renewable energy. These efforts should be a positive influence on the acceptance and implementation of future wind energy projects in the region.

The TVP is continuing to make progress towards the goal of providing a bridge from turbine development programs to commercial purchases of wind turbines. Utilities and turbine manufacturers are obtaining valuable experience in wind power plant development, operation and maintenance, and technology transfer. The lessons learned through the TVP in the GMP and CSW projects will be passed on to other projects in which EPRI and DOE have a management role and to the rest of the wind and utility industry through continuing outreach activities.

A

WIND TURBINE ELIGIBILITY DETERMINATION FORM

Wind Turbine Eligibility Determination Form

Instructions: Please supply all the requested information. Only forms with complete information will be considered. If more than one turbine is to be considered, a separate form should be completed for each turbine. Completed forms should be telefaxed to John Zimmerman at (802) 244-1857 by **8:00 pm (EST), April 14, 1995**. GMP will notify prospective proposers of their turbine's eligibility with or before the release of the Request for Proposals. **All questions must be telefaxed to the above number.**

Turbine Supplier/Developer Name: ____________________

Street Address: ____________________

City: __________, State:__________, Postal Zip Code:________, Country: ________

Contact Person : ______________, Voice: __________, Fax: __________

Turbine Manufacturer's Name (if different from above): ____________________

Affiliation with Supplier/Developer (if applicable): ____________________

Turbine Model to Considered **for use in the GMP Project**: ____________________

Generator Nameplate Rating (KW): ______________Rotor Diameter (meters): __________

Information requested for new design determination of the <u>above turbine</u>:

1. The date that the first prototype was put into operation? __________
2. How many of these turbines are committed to be in commercial operation by May 1, 1995?__________
3. What model turbine or prototype turbine was the immediate predecessor to this turbine? __________
4. What rotor sizes have been used with the drive train used in this turbine? __________
5. How many turbines of this model are expected in operation by the end of 1995? __________
6. How many of the above turbines are now in operation in cold winter climates like Vermont? __________
   (if yes, please specify the locations of where these are installed on a separate sheet)
7. Describe the improvements to predecessor designs that are incorporated into this turbine?
   (attach <u>ONE</u> separate sheet)

Information requested to determine the <u>above turbine's</u> eligibility for supplemental funding from the U.S. Department of Energy:

1. What percent of the funds spent to develop the prototype(s) were spent in the U.S.? __________
2. Where were the prototypes of this turbine tested? __________
3. Do you intend to manufacture the turbine in the United States? __________
4. What percentage of the total cost of the components and their assembly (exclusive of the foundations) will be attributable to parts manufactured in the United States? __________

Certification above information is complete and correct:

Signature of Authorized Representative ____________________

Title ____________________

Date ____________________

----------- ANNOUNCEMENT -----------
GREEN MOUNTAIN POWER CORPORATION

SOLICITATION OF INTEREST IN RECEIVING THE REQUEST FOR PROPOSALS
and
DETERMINATION OF WIND TURBINE ELIGIBILITY
for a
WIND-POWERED ELECTRIC GENERATING FACILITY
TO BE CONSTRUCTED IN
SEARSBURG, VERMONT, USA

Green Mountain Power Corporation (GMP), a small investor-owned electric utility with its service territory in Vermont, USA, will be soliciting wind turbine manufacturers and wind farm developers to submit proposals to design, construct, maintain and arrange financing for a 6 megawatt wind turbine project. The project is to be on line in Searsburg, Vermont in the fall of 1996. The Request for Proposals will be released in late April, 1995.

Proposals will be requested for either or both of two scenarios:

Type I Proposal consists of a turn-key project encompassing the purchase and installation of the turbines along with the balance of plant, and providing operation and maintenance, warranties, and financing services.

Type II Proposal consists of a turn-key project encompassing the purchase and installation of the turbines (only) and providing operation and maintenance, warranties, and financing services.

ELIGIBLE TURBINES: GMP is receiving supplemental funding from the Electric Power Research Institute (EPRI) and the U.S. Department of Energy (DOE) for this project as part of the UTILITY WIND TURBINE VERIFICATION PROGRAM (TVP). Objectives of the EPRI-DOE involvement in this program include the installation of wind turbines that:

1) are new in design, but not yet fully proven in the commercial market, and

2) are in the economic interest of the United States as evidenced by the manufacturer's investment in U.S. research, engineering and manufacturing required to produce those products.

Turbines that do not meet criterion #1 will not be eligible for use in this project. Turbines that do not meet criterion #2 can be used, but will result in a loss of $1.75 million in supplemental DOE funding and therefore could be at an economic disadvantage as GMP will consider the expected cost of energy from the facility in its proposal evaluation process.

Organizations that would like to receive the Request for Proposals for this project and a determination of their turbine's eligibility in each of the above criteria should complete the attached form and send it via **Telefax by 8:00 pm EST April 14, 1995** to:

John L. Zimmerman, Project Manager
Green Mountain Power Corporation
FAX 802-244-1857

This announcement is not a request for proposal. Telephone inquiries will not be accepted.

B

TECHNICAL SPECIFICATIONS OF Z-40-FS WIND TURBINE

TECHNICAL SPECIFICATIONS

1. **Rotor**

Number of blades. 3

Diameter. . . . . 40.0 m/131.2 ft

Swept area. . . . . .1257 m2/13,526 sq ft

Hub Height. . . . . 40.65 m/133.37 sq ft

Nominal rotational speed. . . . . 29.5 rpm

Rotational direction. . . . . Clockwise, looking downwind

Nominal tip speed. . . . . 60.7 m/s /135.8 mps

Orientation. . . . . Upwind

Power regulation. . . . . Variable Pitch

Overspeed control. . . . . Full span aerodynamic braking

Rotor shaft tilt angle. . . . . 4.0 degrees

Cone angle. . . . . None

Weight (Includes blades, hub, and bearings). . 9,222kg/20,335 lb

2. Blades

Model. . . . . ZOND 40.0 M FS

Length (root to tip) . . . . 19.47 m/63.87 ft

Type. . . . . Full span

Material. . . . . Fiberglass

Pitch. . . . . Full span controlled

3. Hub

Type. . . . . Rigid

Material. . . . . Cast ductile iron

Protection. . . . . Sandblasted & multi-layer coated

4. Pitch System

Pitch bearings. . . . . 4 point contact

Actuation. . . . . Hydraulic

Linkage. . . . . Rod through mainshaft, spider, & bell cranks

5. Drivetrain

Type. . . . . Integrated gearbox

Gearbox. . . . . 2 stage with parallel shafts

Ratio. . . . . 1:33.95 (50 Hz), 1:40.65 (60 Hz)

Input speed. . . . . 29.5 rpm

Output speed. . . . . 1,000 rpm (50 Hz), or 1,200 rpm (60 Hz)

Nominal power. . . . . 550 kW

Shaft covers. . . . . Maintenance-free labyrinth seals

Lubrication. . . . . Mechanical oil pressure pump

Oil sump. . . . . 174.1 liters/46.0 gal

6. Gear Housing

Material. . . . . Cast ductile iron

Protection. . . . . Sandblasted & multi-layer coated

7. Drivetrain Bearings

Type, rotor shaft. . . . . Spherical roller & straight cylindrical roller bearings

Type, other shafts. . . . . Double conical & cylindrical roller bearings

8. Gear Lubrication Pump

Type. . . . . Gear pump

9. Operating Brake

Type. . . . . Multiple disk/fail-safe/dual torque

Number of disk. . . . . 4 disks

Location. . . . . Highspeed shaft, upwind side of gearbox

Failsafe. . . . . Spring actuated, hydraulic pressure release

10. Yaw System

Type. . . . . Electrical yaw gear units

Slewing ring. . . . . Internal gear teeth

Damping system. . . . . Frictional

11. Yaw Gears and Motors

Type. . . . . Planetary drives

Yaw rate. . . . . 0.73°/s

Motor types. . . . . Asynchronous, 4-pole, 1500 rpm

Voltage/frequency. . . . . 3 x 690 V AC/50 Hz, or
4 x 480 V AC/60 Hz

12. Hydraulic Power Unit

Oil pump capacity. . . . . 11.7 ltr/min/3.1 gal/min

Oil capacity. . . . . 75 ltr/20 gal

Motor type. . . . . Asynchronous, 4-pole, 1,500
rpm/50 Hz, or Asynchronous,
4-pole, 1,800 rpm/60 Hz

Voltage/frequency. . . . . 3 x 690 V AC/50 Hz, or
4 x 480 V AC/60 Hz

13. Generator

Type. . . . . Asynchronous, 6-pole (Two
3-phase "Y" windings)

Insulation Class. . . . . "F"

Nominal output. . . . . 550 kW at class "B"

Full load current. . . . . 485 A at 550 kW (50 Hz), or
701 A at 550 kW (60 Hz)

No load current. . . . . 159 A

Voltage. . . . . 690 V AC ± 10% (50 Hz), or
480 V AC ± 10% (60 Hz)

Frequency. . . . . 50 Hz or 60 Hz

Nominal speed. . . . . 1,000 rpm (50 Hz), or 1,200 rpm (60 Hz)

kVAr no load. . . . . 297 kVAr

Power factor @ full load/w/ capacitor banks. . 0.86/0.95

Life of bearings. . . . . 300,000 hours

14. Wind Turbine Control System

Type. . . . . Distributed multi-microcontroller; Zond Winteligence mode DCS 6932 and VPC 6932

Master Processor. . . . . 17 MHZ, 32 bit

Soft start. . . . . Solid state SCR control; no bypass contactor

SCADA Interface. . . . . RS-422 serial line output for remote communications

Line current protection. Fast magnetic circuit breaker for overall controller and generator protection; subsystems protected by circuit breakers

Environmental Protection. . . . . Overall enclosure NEMA 4 rated; electronic enclosures rated NEMA 1, 2, 13, 3R, 4, 4X, 12 and 13; electronic and electrical control system rated at -25°C to + 70°C (-13°F to +158°F), 100% humidity and condensing atmosphere

Transient over voltage protection. . . . . High power MOVs

Power factor correction. Capacitor banks

15. Tower, Tubular

Type. . . . . Tapered tubular

Tower, height. . . . . 39.2 meters (129 feet) or 50 meters (164 feet)

Matieral. . . . . Certified steel

Protection. . . . . .Sandblasted and Multi-layer coated

Bolts. . . . . ISO 8.8 hot-dip galvanized

Access to the tower. . . . . .Through lockable door

Access to nacelle cabin. .Internal ladder and access to cabin

Foundation connection. .Anchor studs sunk into concrete pad

16. Performance

Start-up wind speed. . . . . 3.6 m/s/8.0 mph

Cut-in wind speed. . . . . 4.0 m/s/9.0 mph

Cut-out wind speed. . . . . 29.1 m/s/65.0 mph

Rated wind speed. . . . . .13.0 m/s/29.0 mph

Rated power. . . . . 550 kW

17. Certification

Certifying Agency. . . . . Germanischer Lloyd

Standard. . . . . IEC, Class I

Design Life. . . . . 30 Years

18. Cold Weather Package Features for the Z-40-FS Turbines at GMP’s Searsburg Project

The package was designed so that the turbines could operate at temperatures as low as -40 degrees C (-40 degrees F)

Blade Surface

- Black color and ice-phobic coating

Heaters for

- Operator Interface Terminal

- Controllers

- Gearbox oil

- Hydraulic oil

- Generator windings

- Anemometer and wind vane

Material changes

- Tower steel

- Drivetrain castings

- Signal cables

- Bolt and washer steel-drivetrain and blades

- Nacelle hatch pin

- Drivetrain castings

- Crimp-on watertight terminals in SCADA pedestals

Lubricant changes

- Gearbox lubricant - low viscosity, synthetic oil and increased oil capacity

- Hydraulic lubricant - low viscosity, synthetic oil

Miscellaneous changes

- Generator ventilation door with counter-balance

- Plated brake pistons

- Yaw deck manhole covers

Software changes

- Algorithm to reduce the maximum output at temperatures below -20 degrees C

- Periodic operation of systems to keep surfaces lubricated, ready to go

- Heater control algorithms

- Oil filter bypass when excessive pressure drop occurs

C

OUTREACH MATERIALS

Enclosed in Appendix C are the following documents:

1. TVP Workshop Agenda - September 19-20, 1997
2. *Harnessing the Power of the Wind*, GMP Public Information Brochure
3. Governor's Declaration of August 16, 1997 as Wind Energy Day
4. Dedication Ceremony Program
5. Wind Energy Day Brochure

EPRI-DOE

Wind Turbine Verification Program Outreach Workshop

Agenda

September 19, 1996

8:00 Welcome, Introductions, Agenda

8:15 TVP Perspectives in today's market place

8:35 CSW Project Description and Status
- Wind power/renewables development perspectives?
- Project description and timeline
- Current status and planned activities

9:00 GMP Project Description and Status
- Site prospecting program & measurements '80s
- Equinox test station early 90s
- Wind power development perspectives
- Procurement & construction approach
- Current status and planned activities

9:30 Discussion

9:45 Break

10:00 CSW TVP Experience and Lessons Learned
- Resource Assessment
- Environmental Studies
- Sound, lightning, etc.
- Procurement & construction
- Acceptance testing and turnover process

10:45 GMP TVP Experience and Lessons Learned
- Resource Assessment
- Procurement & construction
- Vermont environmental considerations
  - Cold weather issues
- Acceptance testing and turnover process -- plans

11:15 Vendor's Perspective
- Technology Status
- Lessons learned at CSW
- Progress at GMP
  - Construction Photos
  - Monthly Construction Report etc.
- Methods to improve procurement/contracting

11:45 Review, questions and discussion

12:00 Lunch

1:00 Public Acceptance -- CSW
- Pre and Post Societal Acceptance Study
- Deliberative Polling

1:25 Public Acceptance -- GMP
- General description of these type of studies
- Study design and objectives
- Methods
- Tabulations of first survey
- Plans -- follow-on study

1:50 Discussion, Q & A

2:00 Vermont Environmental Considerations Continued
- GMP studies
  - Aesthetics
  - Avian
  - Wildlife
  - Sound

2:45 Discussion, Q & A

3:00 Break

3:15 Wind Forecasting

3:25 NEPOOL Capacity Accreditation

3:45 CSW Operating and Maintenance
- Experience and lessons learned (grounding, lightning)
- Performance to date

4:15 GMP Operating and Maintenance
- Plans

4:20 Discussions and Wrap-up

4:25 Tour Plans

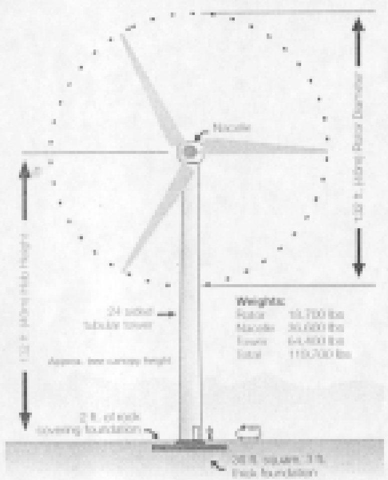
4:35 Adjourn

Friday, September 20, 1996

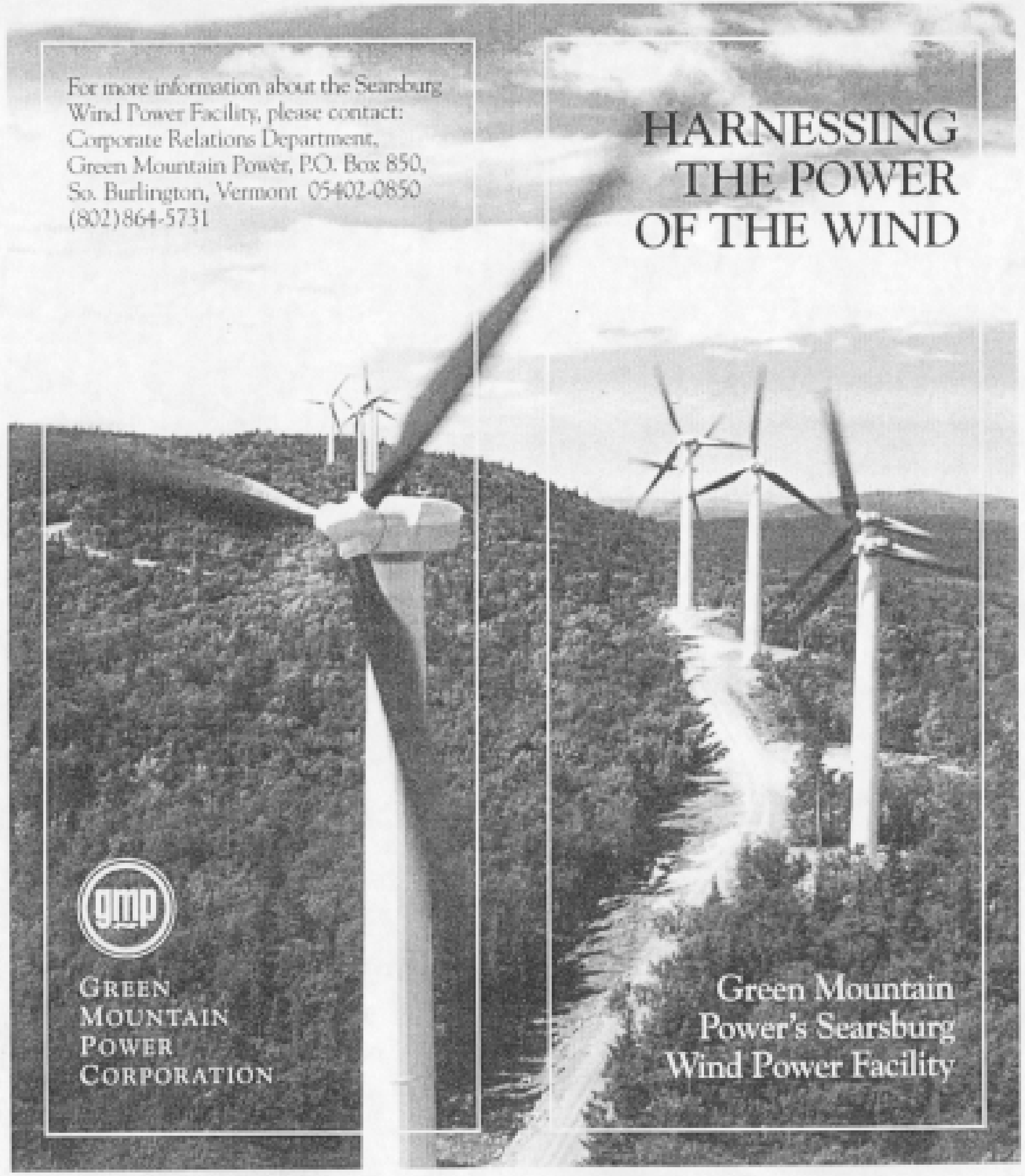
9:00-12:00 Site visit leaving from the White House Inn

The nacelle provides a weather protected, enclosed and spacious environment for field personnel to perform service and maintenance work.

Searsburg Wind Power Facility Statistics



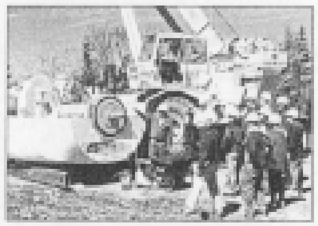
Installed capacity	6 megawatts
Turbine type	Zond Z-40FS
Number of turbines	11
Equivalent horsepower	8,113 horsepower
Name plate rating of each turbine	550 kilowatts
Interconnection voltage	69 kilovolts
Cleared land area required	35 acres
Estimated annual energy production	14,000,000 kWh
Equivalent households	2,000+ households
Equivalent oil saved	23,400 barrels/year
Estimated total plant cost	$11 million
Funding from EPRI & DOE	$4.0 million
Projected levelized cost/kWh	5.8 to 6.2¢/kWh



Until Green Mountain Power built its wind power facility in Searsburg, Vermont, advanced wind generation in the U.S. was largely limited to moderate climates. When completed in 1997, this became the largest wind power facility east of the Mississippi. GMP's six-megawatt plant not only provides emission-free, renewable energy for over 2,000 Vermont homes, it serves as an educational resource for the power industry to learn about wind generation in cold climates and environmentally sensitive regions.

Why Searsburg

GMP began "prospecting" for good wind turbine sites in the late 1970s. Knowing that higher elevations have better wind, but are more environmentally sensitive, the challenge from the start was to find a windy site that would be environmentally acceptable and still be economically feasible. After screening hundreds of potential sites in Vermont and Massachusetts, GMP selected the Searsburg site because of its strong and persistent winds and its proximity to existing access roads and transmission lines. In addition, the area was away from population centers, yet was not in an area of unique environmental concern.



Research

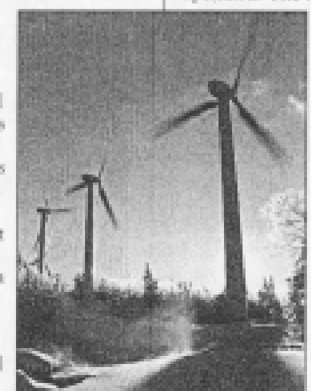
The Searsburg project was conceived by GMP and subsequently made feasible when the project was selected by the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) for participation in the Utility Wind Turbine Verification Program. The challenge of the Vermont environment, coupled with GMP's commitment to and experience with wind generation, fit well with the program's objectives of utility involvement in wind power, and the evaluation and commercialization of advanced wind turbines.

Generating energy from wind in Vermont's environment poses a unique set of challenges. Learning how to meet these challenges is an important research goal at this facility. Lessons learned will provide valuable information for environmental and energy planners in determining to what extent we will be able to use wind to meet the region's electrical needs. The research will focus on the performance of wind turbines in cold, northern climates, the level of public acceptance of wind energy facilities and their potential effects on birds and wildlife.

In recognition of the research value of this project, the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) agreed to fund approximately one-third of the cost.

Winter's influence

Vermont is well known for its beautiful, and very cold winters. Unlike most states, Vermonters use more electricity in the winter than in any other season. But the winter weather also brings strong and persistent winds, and the ability to generate more wind-powered electricity at the time it is most needed. This gives wind in Vermont an economic boost that it does not enjoy everywhere. In part because of that and the research funding, the cost per kilowatthour of energy generated at Searsburg will be comparable to alternative sources over the 25-year life of the plant. The plant reduces the need to burn fossil fuels in other parts of New England, reducing air emissions by approximately 22 million pounds a year.



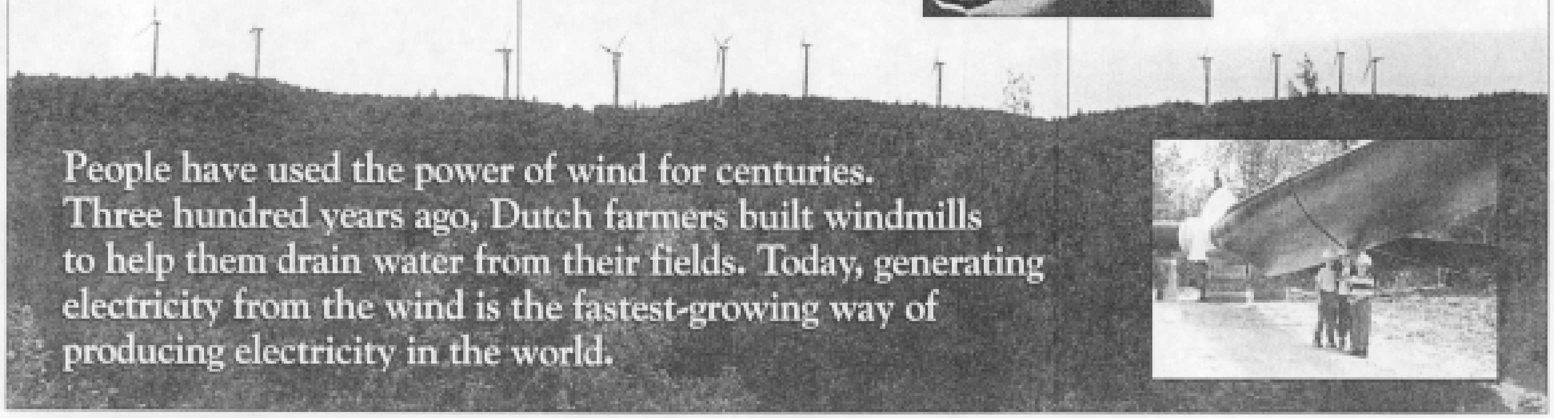
The 11 turbines used in this project were manufactured by Zond Energy Systems of Tehachapi, California, the largest and most successful wind turbine supplier in this country. Their design incorporate several features that allow them to perform better in cold climates. For example, the rotor blades are black to absorb solar energy on sunny winter days, warming them enough to shed ice. The gearboxes use synthetic lubricants and heaters to assure operation in cold temperatures.

Operating characteristics

Each turbine is controlled by a computer in the base of the tower, which in turn is connected to a central control computer at the base of the mountain. Remote control and monitoring of the turbines permits efficient operation. The turbines respond to changing wind and weather conditions automatically, moving to face into the wind, or, to prevent damage in winds over 65 miles per hour, moving the blades parallel with the wind to stop the rotors aerodynamically.

Thanks to our neighbors

The people of Searsburg and the surrounding communities are to be commended for recognizing the truly unique value this opportunity presents. We thank them for their input and participation in this project. We are grateful to be welcomed into their community.



STATE OF VERMONT

EXECUTIVE DEPARTMENT

A PROCLAMATION

WHEREAS, wind power is one of the most cost-effective ways of generating clean energy; and

WHEREAS, Vermont scientists, engineers and environmentalists have made important contributions to the development of wind power in our harsh northern climate; and

WHEREAS, development of alternative energy sources will help us preserve our natural environment and offer consumers more choice in the marketplace; and

WHEREAS, Vermont now hosts the largest commercial wind generating station in the eastern United States with Green Mountain Power's Searsburg Windpower Facility.

NOW, THEREFORE, I, Howard Dean, Governor do hereby proclaim August 16, 1997 as

WIND ENERGY DAY

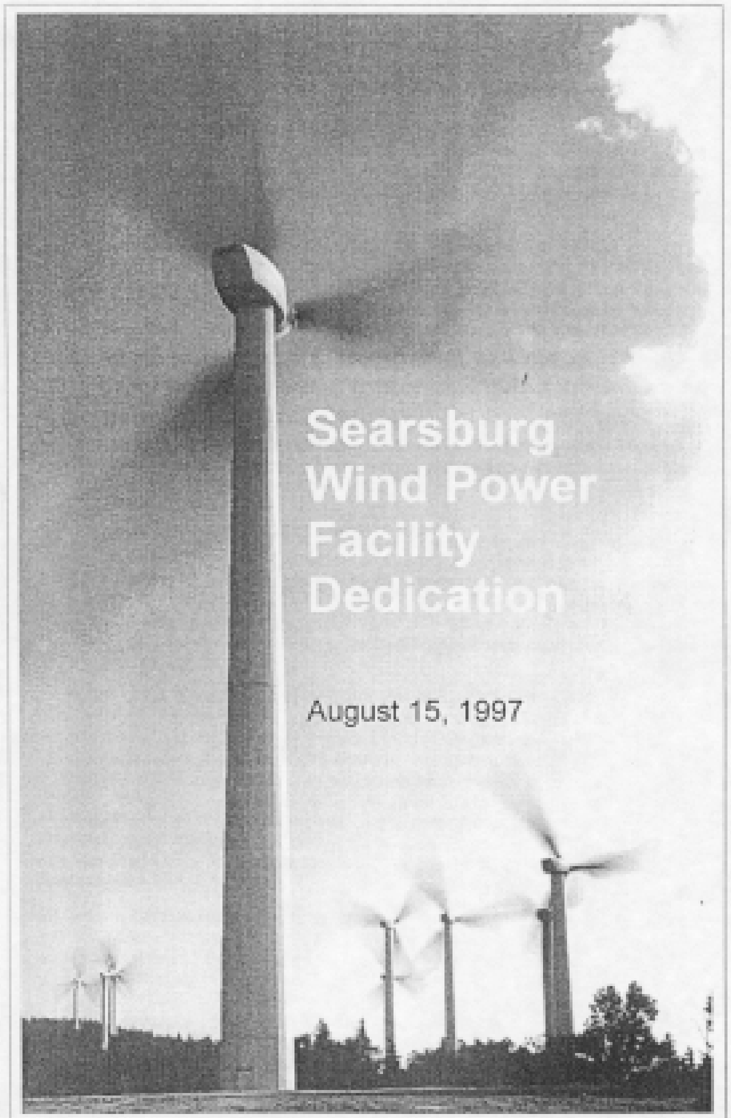
in Vermont

Given under my hand and the Great Seal of the State of Vermont this 11th day of August, A.D., 1997

Howard Dean, M.D.
Governor

By the Governor:

Kate O'Connor
Secretary of Civil and Military Affairs


Searsburg
Wind Power
Facility
Dedication
August 15, 1997

We would like to express our appreciation to the people of Searsburg and the surrounding communities for their input and participation in this project. We are grateful to be welcomed into their community.

Green Mountain Power Corporation

We would also like to acknowledge the efforts of the following people and organizations and others whose work and support helped make this project possible.

NRG Systems, Inc.,	Hinesburg, VT	Wind Measurement Equipment
Zond Contractors, Inc.,	Tehachapi, CA	General Contractor
Ron Nierenberg,	San Anselmo, CA	Meteorologist
Bemis Line Construction,	Jacksonville, VT	12 & 69 kV Line Construction
Power System Development,	Canton, OH	
Hill Engineering,	Dalton, MA	
Eilers Construction,	Readsboro, VT	Access Road & Foundations
R.L. Ruprecht Construction,	Wilmington, VT	
W.E. Dailey, Inc.,	Shaftsbury, VT	
Contractors Crane Service,	Morrisville, VT	Tower Erection
Iron Man Welding,	Bennington, VT	
John W. Tiffany,	North Bennington, VT	Land Clearing
Trees Unlimited,	Pownal, VT	
Dick Joyce,	Wilmington, VT	Surveying
P.A. Bergman Associates,	Haverhill, MA	
Soils Engineering,	Charlestown, NH	Geologist
Specialized Utility Contracting,	Monkton, VT	Substation
Stewart's Nursery, Inc.,	Turners Falls, MA	Landscaping
One-Step Home Care, Inc.,	West Dover, VT	
Nancy Martin,	Guiderland, NY,	Avian Studies
Dr. David Capen,	University of Vermont	
Dr. Paul Kerlinger,	New York, NY	
Cavendish Partnership,	Cavendish, VT	Visual Analysis
T.J. Boyle & Associates,	Burlington, VT	
Resource Systems Group,	White River Jct., VT	Sound Analysis
Louis Berger & Associates,	Halsted, NJ	Archeological Studies
Clinton Solutions,	Fayetteville, NY	Societal Acceptance Studies
Multiple Resource Management,	Leicester, VT	Wildlife Analysis

Dedication

Morning Gathering **11:00am – 12:00pm**

Welcome

John Saintcross, Director
Resource Portfolio Management
Green Mountain Power Corporation

A Promising Future for Renewable Energy in the Retail Market

Douglas G. Hyde, President
Green Mountain Energy Resources

EPRI's Utility Wind Power Mission

Clark W. Gellings, Vice President of Customer Systems and President and Chief Executive Officer epri/CSG of the Electric Power Research Institute

U.S. Department of Energy's Renewable Energy Mission

Dan W. Reicher, Senior Policy Advisor to the United States Secretary of Energy

Renewable Sources of Energy and Utility Restructuring

Richard Sedano, Commissioner
Vermont Department of Public Service

The U.S. Renewable Energy Policy and Support of Research Projects like Green Mountain Power's

Richard H. Truly, Director
National Renewable Energy Laboratory

Luncheon Buffet **11:45am – 12:45pm**

Program

Transition to Wind Power Site **12:45pm – 1:45pm**

Ribbon Cutting Ceremony **1:45pm – 2:30pm**

Searsburg Project Description

John Zimmerman, Co-Project Manager
Wind Power Program
Green Mountain Power Corporation/VERA

Renewable/Wind Energy and Deregulation including Vermont's Leadership Role

Senator Patrick J. Leahy, United States Senator

Wind Energy in the Global Economy

Senator James M. Jeffords, United States Senator

GMP's Wind Development History and Challenges Facing the National Wind Industry

A. Norman Terreri, Past Vice President
and Chief Operating Officer
Green Mountain Power Corporation

U.S. and International Market Growth and How GMP's Project Helped Prepare Zond

Ken C. Karas, Chairman and Chief Executive
Officer Zond Energy Systems

Ribbon Cutting Ceremony

Douglas G. Hyde & A. Norman Terreri

Return to Haystack Golf Club **2:30pm – 4:00pm**

Speaker Biographies

Mr. Clark W. Gellings joined the Electric Power Research Institute in 1982 as a Program Manager and subsequently served as a Senior Program director and as a Director before assuming his current position in 1992. He is a registered Professional Engineer, a Fellow in the Institute of Electrical and Electronic Engineers (IEEE), a Fellow in the Illuminating Engineering Society (IES), a Vice President of the US National Committee of CIGRE, and is active in a number of other organizations. He has degrees in Electrical Engineering, Mechanical Engineering, and Management Science.

Mr. Douglas G. Hyde resigned a few days ago from his position as President and Chief Executive Officer of Green Mountain Power Corporation in order to become the chief executive of Green Mountain Energy Resources (GMER). In his new position Mr. Hyde will lead GMER in the creation of a retail brand of electricity and natural gas that will be sold to consumers who care about the environment in competitive markets across the nation. The company is owned by a subsidiary of Green Mountain Power and by an affiliate of the Wyly Family of Dallas, Texas. Mr. Hyde had a twenty-year career at GMP and was a key figure in the company's commitment to the development of wind energy that led, ultimately, to the construction of the Searsburg Wind Power Facility.

Senator James M. Jeffords has long supported wind and renewable energy initiatives during his tenure in Congress. His support has been instrumental in promoting the use of wind energy and the design of legislation to reduce the country's oil consumption. Senator Jeffords was awarded Wind Energy Senator of the Year in 1995 by the American Wind Energy Association. Most recently, during the 105th Congress, he introduced national utility deregulation legislation mandating that energy suppliers maintain a certain percentage of wind and solar power in their portfolios beginning in the year 2000.

Mr. Kenneth C. Karas is Chairman and CEO of Enron Wind Corp. and its wind turbine manufacturing subsidiary, Zond Energy Systems. He is also Vice Chairman of Enron Renewable Energy Corp., a subsidiary of Enron Corporation. Under Mr. Karas' leadership over the past 14 years, Zond has become the largest operator of wind power plants in the world and supplier of utility-scale wind turbines in this country. Mr. Karas is a past president and board member of the American Wind Energy Association.

Senator Patrick J. Leahy is a long time supporter of efforts to decrease fossil fuel dependence by developing alternative energy sources, such as wind, solar and biomass. On the Senate Appropriations Committee, Senator Leahy has fought for strong research and development budgets promoting renewable energy, helping bring about lower-cost renewable energy sources, such as GMP's new wind farm in Searsburg. As the country considers electric utility deregulation, Senator Leahy believes Congress should further promote renewable energy as good policy for environmental, economic and national security reasons.

Mr. Dan W. Reicher presently serves as Senior Advisor to the Secretary of Energy. Recently, President Clinton announced his intent to nominate Mr. Reicher as Assistant Secretary for Energy Efficiency and Renewable Energy at DOE. From 1993 to 1997, Dan served as Chief of Staff and Deputy Chief of Staff to then Secretary Hazel O'Leary. Prior to joining the Administration, Mr. Reicher was senior attorney for the Natural Resources Defense Council. He received his B.A. from Dartmouth College and his J.D. from Stanford University. He has also studied at the Kennedy School of Government at Harvard University.

For over a decade **Mr. John Saintcross,** as Director of Resource Portfolio Management for Green Mountain Power Corp. has led the development and optimization of the power supply portfolio; including trading activities, and regional power pooling operations. He also oversees the design and execution of risk management procedures, research into emerging power supply technologies such as wind, biomass and distributed generation and he counsels others in the design of innovative integrated resource planning approaches. He is managing the development of the Company's Searsburg Wind Power Station, is a member of the Board of the Utility Wind Interest Group and a member of the National Wind Coordinating Committee. He received his Bachelor of Science degree in Nuclear Engineering from the State University of New York at Buffalo in 1977.

Mr. Richard Sedano of Montpelier has been Commissioner of the Vermont Department of Public Service since 1991. He previously held engineering positions with the DPS and with the Philadelphia Electric Company. Mr. Sedano holds degrees from Drexel University in Philadelphia, Pennsylvania (M.S. Engineering Management); Brown University in Providence, Rhode Island (Sc.B. Engineering); and Stuyvesant High School in New York, New York.

Currently, Mr. Sedano is Secretary of the National Association of State Energy Officials, a member of the Task Force on Reliability for the U.S. Secretary of Energy Advisory Board, Chair of the Vermont State Nuclear Advisory Panel, member of the New England Conference of Public Utility Commissioners, a member and former chair of the Power Planning Committee of the New England Governors' Conference, a member of the Energy Working Group of the Coalition of Northeastern Governors, a director of the Northeast Alternative Vehicle Coalition, and founding chair of EVermont, a public-private consortium promoting the development of electric vehicles.

Mr. A. Norman Terreri recently retired from his position as Executive Vice President and Chief Operating Officer after 12 years of service with GMP. He continues to work with GMP as a consultant. During his tenure, he directed the company's wind power program and was the first utility executive to serve as President of the American Wind Energy Association and today remains active as a member of the AWEA Board of Directors. Mr. Terreri has been active in obtaining support for wind energy through the Edison Electric Institute, Electric Power Research Institute and government agencies.

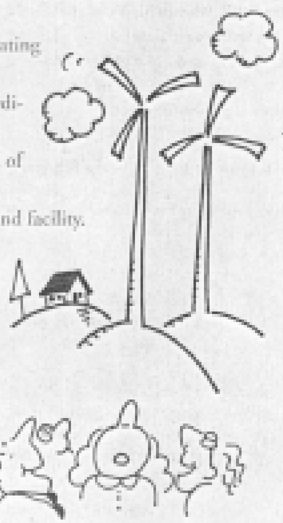
During his career as a naval aviator, test pilot, and astronaut, **VADM Richard H. Truly** logged over 7,500 flight hours and made over 300 carrier landings. As an astronaut, his career included positions in the Air Force's Manned Orbiting Laboratory program and NASA's Apollo, Skylab, Apollo-Soyuz and Space Shuttle programs. He piloted *Columbia*, the first space shuttle to be reflown into space and commanded *Challenger* on the first night launch/landing shuttle mission. He was the first commander of the Naval Space Command during 1983-86, and returned to NASA to lead the investigation of the *Challenger* accident and the recovery of the Shuttle program. Admiral Truly served as the NASA's eight Administrator from 1989-1992 and was Vice President of the Georgia Institute of Technology and Director of the Georgia Tech Research Institute from 1992-1997.

Mr. John L. Zimmerman is the Principal of Vermont Environmental Research Associates; Inc. a firm specializing in siting and economic feasibility studies, wind resource assessment and project management. He has been instrumental in the evolution and development of GMP's wind program since its formation in the late 1970s. In addition to his work with the Searsburg Wind Power Facility, he also serves as financial and technical consultant to Mountain Energy, Inc., a wholly owned subsidiary of GMP that invests in non-utility power projects and other ventures. Mr. Zimmerman holds a Bachelor of Administration degree in Environmental Administration from Johnson State College, and a Masters of Business Administration degree from the University of Vermont.

GREEN MOUNTAIN POWER

A Century of Good Choices for Vermonters

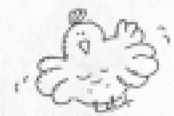
Green Mountain Power is proud to bring the largest wind-generating facility in the East to Vermont. Located in Searsburg, these 11 magnificent wind turbines are nearly 200 feet tall. They provide a valuable benefit to Vermont—the wind as clean and renewable energy. Significant amounts of electricity generated by the wind turbines will meet the needs of 2,000 Vermont homes. Please join us in celebrating the dedication of the wind facility.



Sponsored by WNCS The point Radio

25 Green Mountain Drive
South Burlington, VT 05403

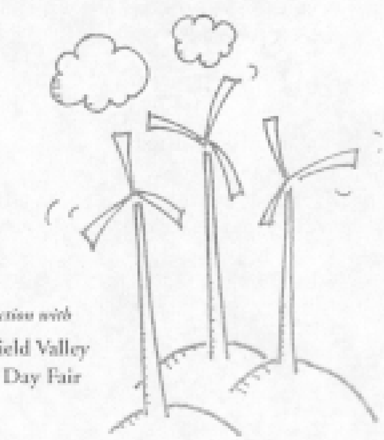
Join the
Celebration
WITH
Green Mountain Power



Wind Energy Day

Saturday, August 16, 1997
10:00am-5:00pm

at the School Street Fairgrounds,
Wilmington, Vermont



in conjunction with
the Deerfield Valley
Farmers' Day Fair

Wind Energy Day
Festivities For the Whole Family!

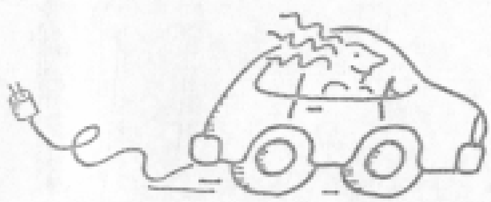
Tour the eleven spectacular wind turbines!

Submit your entry in the "Name the Wind Turbine" contest.

Kids can learn to build model airplanes, model wind turbines, & wind propellers!

Join the excitement of Bill Shontz (formerly of Rose & Shontz) world renowned singer, story teller & performer.

Enjoy the lively sound of a Country Rock Band.

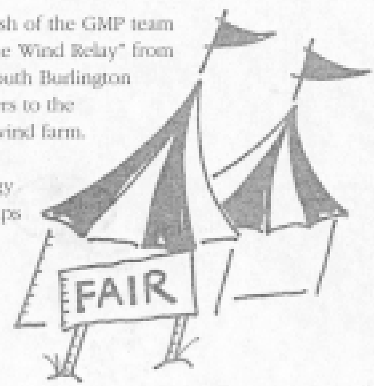


Take a ride in an EVermont Electric Vehicle!

Explore the environmental activities from the Green Mountain Club and Vermont Institute of Natural Sciences.

See the finish of the GMP team "Run For the Wind Relay" from the GMP South Burlington Headquarters to the Searsburg wind farm.

Learn energy efficiency tips for your home.



Enjoy the Traditional Fair Festivities
At the Deerfield Farmers' Day Fair
Thursday, August 14th
through Sunday, August 17th

Horse Show, Horse Pulls, Livestock Judging, Arm Wrestling, Junior Logger Contest, Children's Old Fashioned Games, and much more!

See the exhibits of local renewable energy organizations:

- **Solar Works, Inc.:** Designs and installs solar hot water, photovoltaic and wind systems. Provides engineering and training services as far a field as Capetown and Calcutta.
- **NRG Systems:** Located in Hinesburg, VT, is a manufacturer of wind measuring equipment for the wind energy industry, provides consulting services to utilities and independent power companies.
- **Wind Stream Power Systems:** Designer and manufacturer of wind turbines and complete remote power systems that use water power and solar electric. Sells equipment system engineering and site-energy assessment services world-wide.
- **Northern Power Systems:** For twenty-five years, this Waitsfield, VT company has designed, manufactured, installed, and serviced wind and solar systems around the world – including a recent wind turbine installation at the South Pole.

And if you can't join us at the fair, you can still:

✔ Submit your entry to name the wind turbine contest.

✔ Send a donation to the Green Mountain Club and Vermont Institute of Natural Science or to a renewable energy development in the Northeast.

✔ Send for a free copy of "Green Living"-an environmental publication of news and tips!

For more information call:
Dorothy Schnure,
Manager of Corporate Communications
802-660-5672