

**Princeton Wind Farm
Upgrade Project Work and Business Plan**

**Princeton Municipal Light Department
March 2006**

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Section 1: Historic Background of Existing Turbines Site

PMLD owned and operated an eight turbine wind farm at our wind farm site since 1984. The current wind farm was constructed as an alternative to PMLD purchasing power from Seabrook Nuclear Power plant. The residents of the Town of Princeton voted in favor of purchasing and developing this 16 acre site as the Town's wind farm in January 1984. The existing wind farm consists of; seven 40 kW EnerTech and one Atlantic Orient Corporation 50 kW turbine mounted on 100' steel lattice towers. Currently five of the turbines are not operational due to lightning damage and age. All of the units are at the end of their useful life and the cost to maintain and repair the existing units is not practical. The small amount of electricity they produce does not justify the high maintenance and repair costs. Our current strategy is to run the operational units to failure.

The original plan as designed in 1984 recommended approximately 500 kW of capacity on 50 Meter (164 foot) towers. PMLD did not install the recommended size and quantity of units due to the high cost, and therefore, only 320 kW of capacity was installed on much smaller towers. This decision resulted in less energy generated than the projected 10% of the Town's requirements. The wind resource at this lower height and the 50' mature tree canopy surrounding our site were also factors contributing to lower than expected amounts of renewable energy for our existing site.

The new state-of-the-art turbines we propose to install are based on entirely new wind speed analysis conducted over the past three years. New wind speed data was collected from eight new anemometers mounted at various heights on our site. The proposed tower size is significantly taller than the mature tree canopy surrounding our site. This will result in generating significantly more renewable energy for the Town of Princeton with the least number of wind turbines on our site. Our strategy is to install the least number of units that minimizes the community and environmental impact, while still generating the greatest amount of renewable energy possible for the residents of the Town of Princeton.

In December 1999, PMLD started the public process to look at the various options regarding the future of our wind farm. One of PMLD energy strategies is to provide our customers with affordable, long term fixed pricing for electricity, from environmentally sound or renewable energy supplies. One of the options discussed included upgrading the existing wind farm with the newest wind turbine technology. The elected Board of Light Commissioners representing the residents of the Town of Princeton decided that upgrading the existing site would be preferable to establishing a new wind farm site in town. Upgrading the existing 20 year site would allow us to take advantage of both the existing infrastructure already in place and the community support for the existing location.

In the time since the original equipment was installed, the wind industry has matured significantly. Equipment reliability and cost effectiveness have improved significantly. The equipment capacity or size has also increased dramatically leading to much larger turbines and towers. There is essentially no manufacturer today that produces a commercial wind turbine in the size or scale of our existing turbines. Cost effective wind energy production only occurs by investing in larger capacity systems. New wind turbines are typically sized between 660 KW to 3000 KW and are mounted on 130' to 265' towers. The larger the capacity, the more cost effective a wind farm becomes. Also, at higher heights, a given turbine will generate more electricity due to typically higher than average wind speeds.

Section 2: Project Description to Upgrade PMLD's Existing Wind Farm

PMLD, through its elected Board of Light Commissions, started considering the various alternatives to operating our existing wind farm at a public meeting held on December 18, 1999. This meeting and the resulting wind farm research and analysis lead to special town ballot vote in February 2003 by the community to approve upgrading our existing wind farm. The community overwhelmingly supports the upgrade project and as a result of this support, PMLD intends to remove the eight existing 40kW wind turbines mounted on 100' towers and replaced them with two new, 1.5MW to 1.6MW wind turbines mounted on 70 meter towers. The new wind turbines will produce approximately 40% of our Town's annual energy requirements in a cost effective manner. 100% of the electricity will remain in Town and PMLD does not plan to sell the electricity to other entities. The electricity generated will reduce our town load and therefore reduce the amount of energy PMLD purchases through wholesale contracts, PPA's, or at markets rates.

The environmental and community impact is relatively small based on the fact that PMLD already operates a wind farm on our 16 acre site over the past 20 years. This community owned small scale wind project successfully demonstrates that renewable energy plants can be sited responsibly and sized appropriately within the environment they are meant to protect. This project reaffirms our commitment to renewable energy, reduces our dependency on fossil fueled energy, and reduces our Town's energy costs while balancing the environmental and community impact.

This relatively small scale project only makes economic sense because PMLD is utilizing existing infrastructure at our wind farm site. Relocating to another site would require many more wind turbines to offset the additional infrastructure costs associated with a typical wind farm project. Any other site in Princeton would require significantly more costs related to site acquisition, electrical interconnection, site preparation, wind resource measurement, and most importantly, community acceptance. New sites would ultimately require many more turbines in order to justify the increased infrastructure costs. PMLD further believes that installing only two new units minimizes the impact to the environment while still providing a significant amount of renewable energy to the resident/ratepayers of Princeton MA.

PMLD considered the following criteria in order to determine that upgrading our existing site made the most economic and environmental sense.

Exposure to Prevailing Wind: The prevailing wind in Princeton is from the northwest. Sites with multiple turbines must be located perpendicular to the direction of the prevailing wind. Potential sites must not be downrange of higher geographical terrain located northwesterly of any potential sites. Higher terrain or natural barriers located in the northwest vicinity of potential sites will create wind turbulence which decreases energy production. The existing Wind Farm has very good exposure to the northwest prevailing winds without any natural terrain features that would cause turbulence.

Elevation: Wind speed increase substantially with higher elevations. Higher locations have a greater potential wind resource. Higher elevations also help minimize the height of the wind towers. Our existing site has an elevation of 1,504' and is one of the highest elevations around not including Wachusett Mountain (2,000') and Little Wachusett (1,565'), both already owned by the Department of Conservation and recreation.

Existing Land Use: Land that is already owned by the Town should be considered first. PMLD also considered; proximity to residential neighborhood, setback from public road, whether or not another site could be purchased or leased, and whether or not the land is owned by another governmental agency. The cost to acquire and develop new land would make this project too expensive and uneconomical. PMLD's existing Wind Farm Site already exists and is owned by the Town and controlled by PMLD; the natural terrain in the vicinity of the wind farm masks the view from much of the surrounding area; and most importantly, the residential of the Town of Princeton voted to acquire this property as a wind farm site back on 1984, before the surrounding area was acquired by the Department of Conservation and Recreation (DCR).

Road Access: The existing access road along Stage Coach Trail is suitable with minor alterations, to receive the new turbines and construction equipment. The existing access road was formerly a county road to the summit of Wachusett Mountain but now owned by the Department of Conservation and Recreation (DCR). As an alternative to the existing access road, PMLD has a legal right of way (ROW) to the wind farm site that will be developed to the event continue access along Stage Coach Trail is not allowed. This alternative is still economical and would only require the construction of a new 850' by 20' access road to our site.

Transmission Line Access: PMLD already owns and operates an adequately sized, 3-phase, 13,800V, overhead distribution lines to the existing site. The existing overhead electric line is capable of handling the new electric load without major modifications.

Significant tree clearance, line construction, and access would be required for other potential sites that are not in the vicinity of existing distribution lines. PMLD's existing electric distribution system is not adequate sized in most other locations in the Town of Princeton. Upgrading our existing electrical distribution to another site would require a significant investment by PMLD and make most other sites unfeasible.

Section 3: Summary of Options PMLD Considered

There are a number of options PMLD considered in upgrading the existing wind farm:

1. Invest the minimum amount to keep it running until failure and dismantle it. This would involve minimal investment and eliminate the wind-farm over time. This would reduce Princeton's amount of renewable energy. PMLD could then decide whether or not to retain control of the site or sell the land and right of way.
2. Upgrade the existing wind turbines with small scale (50kW – 250kW) commercial wind turbines. The projected amount of electricity generated would increase between 1-5% depending on the size and quantity of units. The economics are very poor with no annual savings, negative net present value, and would lead to higher electricity rates. New units in this scale are no longer available from many of the leading wind turbine manufacturers.
3. Upgrade the existing wind turbines with intermediate scale (500kW – 750kW) commercial wind turbines. The projected amount of electricity generated would increase between 5-20% depending on the size and quantity of units. Various cost analysis of this option illustrates a negative return on investment for this option. Intermediate sized turbines are becoming less attractive because similar sighting issues exist as compared to the large scale turbines. Since there is a negative return on investment, PMLD decided not to pursue this option.
4. Replace the existing turbines and towers with large scale units. This is option is more cost effective and would produce a larger percentage of renewable energy for the Town of Princeton. The options include turbines mounted on towers from 200' to 265'. Wind turbines in this range are sized between 1,000kW to 3,000W. These turbines become more cost effective and generate positive net present value and annual cost savings. Additionally, private partners may be willing to participate in financing the project since more energy and attributes are available to trade.

Section 4: Community Support for Upgrade Project

PMLD through its elected Board of Light Commissions started researching the wind farm alternatives in a public meeting held on December 18, 1999. This meeting led to the recommended strategy to upgrade the existing wind farm, with fewer but much larger turbines in the 1.5MW range, mounted on 213' – 230' monopole towers. The environmental and community impact is relatively small based on already operating a wind farm on our site for the past 20 years. The resident stakeholders also support this project as demonstrated in our surveys and ballot vote to approve the project as presented by PMLD.

Winter Survey Results:

A total 1,250 survey were mailed to each resident in the Town of Princeton. 726 surveys were returned which is a 58% response rate. This response rate is very high for a survey but clearly indicates the level of interest in Town for the project.

- Winter 2000 customer survey results:
 - 726 returned surveys out of 1,250, 58% response rate
 - 66% support continued investment in wind farm
 - 78% support larger more efficient units
 - 68% want PMLD to maintain environmentally sound power supply

See attached survey results

Special Town Election:

A special town ballot vote was held on February 11, 2003. The elected Board of Light Commissioners requested a ballot vote for the residents of Princeton. The results would determine the level of support for this project and the Board of Light Commissioners would honor the wishes of the voting stakeholders.

The overwhelming majority of residents voted in favor of the project. Approximately 74% of the voters supported the new wind farm project. This level of support reaffirmed the elected Board of Light Commissioners decision to support and approve the project to install two much larger units at our existing wind farm site.

See attached election ballot question and result

Support for this project is based on the following Ratepayer/Stakeholder Benefits:

- Provides at least 20 years of renewable energy economically
- Reduce our Town's energy costs
- Diversifies the Town's sources of electricity and dependency on one bulk supplier
- Increase the amount of renewable energy utilized as a Town to 40-50%
- Reduce dependency on fossil fuels and associated pollution
- Meet the requirements of Massachusetts Renewable Portfolio Standard

Section 5: Public Process and Key Dates

- December 18, 1999 First Public meeting to discuss future of site
- January 2000 Survey mailed to every resident in Princeton
- July 2000 UMASS provides one 130' meteorological station
- May 2000 Survey results published
- January 2001 Residents in vicinity of wind farm interviewed
- January 2002 PMLD issues RFQ for partners
- March 2002 Notice of Intent Letters to DEM, Audubon, Planning, Advisory, Bldg Insp.
- April 8, 2002 1st Public Informational Hearing
- May 20, 2002 2nd Public Information Hearing
- June 29, 2002 PMLD sponsors community visit to Town of Hull
- July 24, 2002 Meeting with Stakeholder: Wachusett Mt Advisory Council
- August 22, 2002 Meeting with Stakeholder: Audubon Citizens Advisory Council
- September 3, 2002 Board of Light Commissioners public meeting to discuss stakeholder issues
- September 24, 2002 Board of Light Commissioners public meeting to discuss stakeholder issues
- October 8, 2002 Board of Light Commissioners public meeting to discuss stakeholder issues
- October 22, 2002 Board of Light Commissioners public meeting. Board approves private partnership as best choice for PMLD
- October 31, 2002 Board of Light Commissioners public meeting. Board votes unanimously to approve and construct wind farm project
- December 10, 2002 Board of Light Commissioners public meeting. Board no longer requires bond as backup plan for project
- February 11, 2003 Special Town Vote to approve new wind project. 74% of the voters approve the project!

In addition to the specific meetings above, the Board of Light Commissioners held **24 additional public meetings** with the wind farm as topic of discussion prior to the special town vote on February 11, 2003.

Over **20 articles** were published in our local newspaper, The Landmark, from December 1999 through November 2002.

See attachments:

Certified Copy of Vote related to Wind Farm Upgrade Project

Section 6: Turbine Operation

Wind turbines are relatively simple systems that generate electricity when wind conditions are between 3 and 4 m/s, the speed at which the turbine blades experience sufficient lift to begin rotating, and 25 to 30 m/s, depending on the manufacturer and model. Each wind turbine can be considered a fully self-controlled power unit. A wind turbine consists of the rotating blades fixed around the hub, a main drive shaft, a gearbox assembly, a generator, the control cabinet located inside the base of the tower, the tower, the concrete foundation and a transformer located either at the base of the turbine or pad-mounted adjacent to the tower base. The control of all energy production and ancillary equipment will be through multiple programmable logic controllers (PLC), which interface with computers at each turbine.

Wind turbines are designed to be operated in an automatic mode; however, turbines may also be manually controlled for specific situations, such as resets following turbine trips and when weather conditions prevent automatic operation. All of the wind turbines will be controlled through a remote SCADA system location at PMLD's operation center. Preventative maintenance data and fault conditions will be provided real-time to PMLD in order to control operation of the wind turbines. During after-hours, on-call personal are expected to be respond on site within 30 minutes of any conditions that require personal attention.

Wind Farm operators will make regular trips to the site in order to ensure the turbines are in operating conditions at all times, for regular unit maintenance and for overall project surveillance. The wind turbines will undergo semi-annual scheduled maintenance, which can require from one to two days per turbine. The O&M system will be implemented so only one turbine will be required to go off-line at a time for scheduled maintenance. In this manner, maintenance will result in minimal effects on the overall wind farm availability and energy generation. The scheduled maintenance will not require the use of cranes, as the crew can access the equipment from the ladder located in the tower, and can easily be handled by a two-man crew. The project will not require fencing, as most of the equipment will be installed within the towers, which will be large tubular structures, safely secured and impossible to scale. The individual transformers will be the only piece of equipment accessible and these are well secured and safe for the general public.

See attachments:

NEG Micon, Main Specification NM82 Wind Turbine, 2003

Section 7: Project Cost Estimates

Typical wind farm projects cost between \$1,600 and \$2,000 per kW of turbine capacity. For this project, a 3,000 - 3,300kW wind farm consisting of two turbines will cost between \$4,800,000 and \$6,600,000 to construct. Actual quotes were solicited and received by the project team.

Section 8: Federal and State Credits and Rebates

Renewable Portfolio Standard

The Commonwealth of Massachusetts has established a renewable portfolio standard (RPS) that investor owned power suppliers must meet. Investor owned energy providers must provide a certain amount of renewable energy to Massachusetts customers. Municipal Light plants are exempt, but it makes good sense to follow these higher standards. Our project produces renewable energy that is consumed at the point of the generation by the Town of Princeton. It also generates RPS certificates that are tradable in a separate non-energy related market similar to pollution credits. The quantity of the certificate that a site can generate is equal to the amount of energy. The value is market based, but initial discussions with potential buyers have placed the value at approximately \$.03 - \$.04 per kWh.

Renewable Energy Portfolio Incentive

Municipal Light Departments are also eligible for a Federal rebate called the renewable Energy Production Incentive (REPI). This is an annual cash rebate given to any municipal that generates new renewable energy. The program is congressionally approved on an annual basis and has been in effect for the last 10 years. The current rebate is fixed at \$.019 per kWh.

Section 9: Energy Production Estimates

PMLD proposes to install two turbines rated between 3,000-3,300kW mounted on 70 meter towers. This business model is based on the NEG 72c 70 meter tower, 72 meter rotor wind turbine. PMLD's site plan review and construction permit is based on a maximum tower height of 70 meters. PMLD may consider a 1.65MW turbine as an alternative in order to produce more electricity than the proposed 1.5MW turbines.

The most important factor in determining whether or no this project is viable, is accurately measuring and quantifying our wind resource at our site. The wind resource at our site has been measured at various heights since July 2000. PMLD was also able to use its original wind data collected between 1980 and 1983 and wind data from a nearby municipal airport to verify our site specific wind resource.

Three separate energy production estimates were prepared for various sized turbines at our site. The preferred turbine at this time is the NEG Micon NM72c 1,500kW wind turbine mounted on a 70 meter tower. PMLD's financial analysis is based on a conservative production estimate of 7,358,000 kWh annually and a capacity factor of 28%. This is also the smallest production estimate of the various wind turbines considered for this project. PMLD may utilize another manufacturer and model once final bids are received. PMLD will verify the final energy production estimate once a final bid is received and accepted. It is important to note that our construction permit is based on the installation of 70 meter towers only. PMLD can install slightly larger 1.65MW turbines, but they must be installed on 70 meter towers.

		GE 65M tower/77M rotor	GE 80M tower/77M rotor	GE 80M tower/70.5M rotor	NEG72c 70 M tower/72M rotor	NEG72c 80M tower/72M rotor	NEG82c 80M tower/82M rotor
Operating Stats	Units						
Number of Turbines	EA	2	2	2	2	2	2
Capacity per turbine	MW	1.5	1.5	1.5	1.5	1.5	1.65
Total Capacity	MW	3	3	3	3	3	3.3
Capacity factor	%	31.00%	34.00%	31.00%	28.00%	31.00%	34.40%
Annual Energy	MWH	8,147	8,935	8,147	7,358	8,147	9,944
Power Curve Guarantee	%	95%	95%	95%	95%	95%	95%
Availability Guarantee	%	95%	95%	95%	95%	95%	95%

See attached energy production analysis:

- 1. University of Massachusetts, Renewable Energy Research Laboratory, Wind Turbine Report Completed November 2002*
- 2. Wind Resource Evaluation for CEI/PMLD, Allen Becker and Richard Simon, December 11, 2002*
- 3. NEG Micon, Production Estimate, September 1, 2003*

Section 10: Financial Analysis

PMLD is undertaking this upgrade project because of our commitment to renewable energy, to reduce our bulk or wholesale electric costs, and, to maintain stable and cost effective retail electricity rates for our customers throughout Princeton. The primary benefit associated with this project is relatively low cost electricity that isn't affected by fluctuating fossil fuel costs. Given that we are using wind as the source of energy for this project, our fuel costs are zero and as long as there is wind, PMLD will generate a significant portion of its energy requirements from the wind turbines.

PMLD's wind farm will generate enough energy and capacity to significantly reduce our Town's requirements. PMLD estimates the wind farm will produce approximately 40% of the Town's energy requirements annually. The wind farm is separately metered within PMLD's service territory and there are no transmission or distribution costs associated with this project. The existing infrastructure from our original wind farm is adequate to service the new wind turbines. 100% of the energy and capacity generated will remain in the Town of Princeton and will not be sold to other entities.

The net difference between our total town load and wind generation is what PMLD will have to purchase through PPA's, energy contracts, or market rates. The long term cost forecast for energy is significantly higher than the all in \$/kWh to produce energy from our proposed wind farm project. Market and contract rates for electricity are approaching \$70/MWh to \$90/MWh delivered to our LMP (service territory). The all in cost to produce electricity through the wind turbines is approximately \$52/MWh including repayment of the bond principal, O&M, insurance, and extended warranty over the 20 year life of the project.

The total project cost of \$5,750,000 was determined by soliciting quotes from various construction firms and the wind turbine manufactures directly. Some of the costs associated with the project were determined using estimated per unit costs. Some of the project costs fluctuate widely such as transportation, steel, and Euro exchange rates. Fluctuations in these costs could impact our final cost once the project is financed.

Chart 1 itemizes the various cost components of this project. The bulk of the project cost is directly related to the purchase and delivery of wind turbines. The schedule of estimated payments and approximate timeline is also included in chart 1. Chart 2 is PMLD's financial analysis calculating the annual energy costs savings, net present value (NPV), and internal rate of return (IRR) on the project. The objective of the project is to generate electricity cheaper than what it would otherwise cost PMLD to purchase. This project achieves that objective and PMLD estimates the project will generate approximately \$200,000 in annual savings in our energy budget.

PMLD is confident that its wind farm upgrade project can produce less expensive electricity than purchasing electricity through either PPA's, contracts, or local spot markets for electricity. This difference will reduce our energy costs and result in more

stable electric rates for our customers. The net present value (NPV) of the project is positive and the IRR is 5.6%. The life of the project is 20 years which matches the operational life of new wind turbines. PMLD's financial analysis does not include the financial benefits derived from selling our renewable portfolio standards credits (RPS) and also does not include the financial benefits of receiving the REPI credit from the Federal Government (See section 8 for more information related to these benefits). Both of these financial benefits could produce an estimated \$255,000 and \$140,000 in additional project revenue per year for RPS and REPI respectively. The RPS estimate of \$255,000 is based on selling the credits at \$35/MWh. The REPI credit of \$140,000 is based on the Federal Government continuing to issue the credit at \$19/MWh.

Overall our financial analysis is based on conservative assumptions and estimates. The project cost of \$5,750,000 financed through CREB bonds over the 20 year life of the project will cost PMLD approximately \$287,500 annually in bond repayments. The combined costs related to the project annual bond principal repayment, insurance, maintenance, operations, and warranty is significantly less than what PMLD would have paid for the same amount of energy through long term contracts, PPA's, or spot markets.

Chart 1, Project Cost Summary

Total Project Cost Summary	Unit Cost	
Capital	\$	\$5,206,000
O&M + Unscheduled Maint	\$ PV 10	\$425,678
Warranty	\$ PV 10	\$70,000
Total		\$5,701,678
Operating Stats		
Number of Turbines	EA	2
Capacity per turbine	MW	1.50
Total Capacity	MW	3.0
Capacity factor	%	28.0%
Annual Energy	MWH	8,420
Power Curve Guarantee	%	95%
Availability Guarantee	%	95%
Per Unit Cost for Project		
Turbine Price	\$/T	\$2,100,000
Turbine unit price	\$/kW	\$1,273
Freight per turbine	\$/T	\$175,000
Transformer	\$/MW	\$20,000
Foundations	\$/T	\$160,000
Erection	\$/T	\$120,000
Turbine Cost Summary		
Total Turbine Price	\$	\$4,200,000
SCADA	\$	incl in Turbine
VAR (capacitors)	\$	\$25,000
Commissioning	\$	incl in Turbine
Freight	\$	\$350,000
Cold Weather package	\$10k/T	incl in Turbine
Lighting	\$5k/T	\$5,000
Total		\$4,580,000
Construction Cost Summary		
Foundations	\$	\$320,000
Erection	\$	\$240,000
Step up transformer	\$	\$66,000
Capital Summary		
Turbines	\$	\$4,580,000
Erection	\$	\$320,000
Step up transformer		\$66,000
Foundations	\$	\$240,000
Total Capital Cost		\$5,206,000

Operating Cost

O&M	\$/T/year	\$20,000
Unscheduled Maint	\$/T/year	\$5,000
Annual O&M	\$	\$40,000
Unscheduled Maint	\$	\$10,000
PV Annual O&M	PV 10 20 years	\$340,543
PV Unscheduled Maint	PV 10 20 years	\$85,136
Warranty years 1-2	\$/T/year + 2.5% CPI	incl in Turbine
Warranty years 3-5	\$/T/year + 2.5% CPI	\$35,000
Warranty years 3-5	\$/year	\$70,000

Payment/Construction Schedule

Down payment	%	20%
	\$	\$1,150,000
	Schedule	0 months
Shipping, delivery, and erection of turbines	%	60%
	\$	\$3,450,000
	Schedule	6-12 months
Site construction	%	15%
	\$	\$862,500
	Schedule	3 months
Commissioning	%	5%
	\$	\$287,500
	Schedule	1 month

Section 11: Environmental Benefits

The environmental benefits can be calculated using various methods. Our wind generators can offset or eliminate the need for fossil fueled power plants. Carbon dioxide emissions from power plants are the leading cause of greenhouse gases. A similar sized power plant fueled by coal, oil, or natural gas emits approximately thousands of pounds of CO₂, NO_x, and SO₂ annually.

The wind farm contributes to the reduction of this pollution by eliminating our dependency of fossil fueled power plants. Since carbon dioxide is absorbed by trees, our wind farm can absorb as much as 2,300 acres of forest. Another analogy used, is to equate the energy generated by the wind farm to the amount generated by a barrel of oil. PMLD's wind farm can generate the same amount of energy annually as 4,700 barrels of oil.

PMLD's Wind Farm will offset emissions (pollution) from other regional sources of electricity. If we do not install our wind farm and generate approximately 9,000,000 kWh of renewable energy annually, the same amount of energy generated from oil, coal or natural gas would create the following estimated emissions:

Princeton's Wind Farm will offset emissions by:

- **11.6 million lbs of Carbon Dioxide**
- **18,000 lbs of Nitrogen Oxides**
- **50,400 lbs of Sulfur Dioxide**

Carbon dioxide is the primary gas involved in global warming. Rising global temperatures are expected to raise the sea level, change precipitation and alter other climate conditions

Based on 1,293 lbs CO₂ per MWH generated

Nitrogen oxides contribute to the formation of smog, acid rain and toxic chemicals by reacting with other compounds in the air. NO_x emissions also contribute to the deterioration of water quality by increasing nitrogen loading.

Based on 2.0 lbs NO_x per MWH generated

Sulfur dioxide contributes to respiratory illness and aggravates existing heart and lung disease; damages trees, crops, stone and other materials; increases acidity in soils, lakes and other bodies of water; and increases visibility impairment. Sulfur dioxides form particulates that can be transported over long distances and deposited far from the point of origin.

Based on 5.6 lbs SO₂ per MWH generated

Data Source for Emissions Calculated: U.S. Environmental Protection Agency, Emissions & Generation Resource Integrated Database <http://www.epa.gov/cleanenergy/egrid/pdfs/state.pdf>

Section 12: Access Road Choices

Our Primary choice for access to the site is Stage Coach Trail. Site Plan Review focused on the re-development of Stage Coach Trail. As an alternative, PMLD could develop its legal right-of-way in the event continued access along Stage Coach Trail is not possible.

Department of Conservation and Recreation (DCR) Access Road: PMLD currently utilizes an existing access (See attached Locus Map of site in this section) road called Stage Coach Trail. This 1,700' trail is a discontinued "county road" that was used to reach the summit of Mount Wachusett back in the late 1800's. This access road is owned and controlled by DCR. PMLD has had an informal agreement to utilize the road as an alternative to developing our legal right of way (Alternative Access Road) on Westminster Road since 1984. Since the existing access road is already developed, it makes more environmental sense to continue using the existing access road and not develop a second access road to the site along our legal right-of-way.

The existing access road needs minor improvement in order to deliver the turbine equipment to the site during the construction phase of this project. The improvements will include grading and compaction of the access road so that the heavy equipment can be delivered. Once the project is complete, access to the site will occur 1-2 days per month. During the winter months access will be limited and the access road will not be plowed or utilized by vehicles, except in an emergency. PMLD's maintenance personnel will hike up the trail in order to check operations during the winter months. PMLD's computer control system (SCADA) will monitor the turbines 24 hours a day and notify PMLD staff in the event of a problem with the site.

The minor alterations to the existing access road include regarding with pervious gravel material, compacting the gravel, repairing existing drainage facilities, and removing trees along the edge of Stage Coach Trail. All of the minor alterations and repair are necessary in order to deliver the turbine tower, blades, and generator to the site. The entrance into our 16 acre site at the top of the access road also requires modifications during construction. This is necessary for the longer pieces of equipment such as the turbine blades. The blades will be delivered in one piece approximately 131' long. The turning radius is therefore fairly wide. The turning radius requires us to temporarily remove the stone walls along our site boundaries. PMLD will temporarily remove approximately 30' of rock wall where Stage Coach Trail makes a left into PMLD's property. All of the stones walls will be reconstructed and returned to their original location once construction is complete. A relatively small number of trees will be removed along the side of the access road and at the entrance into PMLD's property, in order to facilitate the turning radius and delivery of equipment. PMLD will replace the same number and species of trees in any location DEM requests in order to mitigate the environmental impact.

- 10 trees greater than 2' in diameter along ROW
- 15 trees between 1'-2' in diameter along ROW
- 10 trees between 4" – 1' in diameter along ROW
- 20 trees less 4" in diameter along ROW at entrance to our 16 acre site

After construction, the access road and entrance to our site will be returned to its original condition. Access to the site for preventative and corrective maintenance will be managed accordingly:

- Summer Access: Once per month, primarily using 4x4 pickups and material handling trucks. PMLD can schedule these preventative maintenance visits in order to minimize impact to hikers and other users of the trails and reservation.
- Winter Access: The access road will not be plowed during the winter. Access will be limited to PMLD staff walking to the site in order to perform preventive maintenance and safety inspections.

PMLD's Right of Way: If DCR does not allow PMLD to continue using the existing access road, PMLD will utilize its alternative easement access (See location on attached Locus Map) and construct an access road along its legal right of way (ROW) off Westminster Road. The legal ROW is approximately 850' long by 40' and is included as an easement over DCR property. PMLD would remove a large number of trees along the ROW (See table below) in order to develop a suitable access road to our site. A large number of additional trees would also be removed on PMLD's property as well, in order to get from the end of the ROW to PMLD's turbines.

- 2 public shade trees greater than 2' in diameter at entrance to ROW
- 5 trees greater than 2' in diameter along ROW
- 26 trees between 1'-2' in diameter along ROW
- 40 trees between 4" - 1' in diameter along ROW
- 75-100 trees less 4" in diameter along ROW

The access road would require stripping the tree stumps and loam, cutting a passable grade, filling with suitable rock tailings, and finishing with compactable gravel fill. The cost to complete this work is included in the project budget.

Distribution Line Access: PMLD installed 224' of overhead electrical distribution line (See attached Locus Map for location of existing electrical line) from Westminster Road, over DCR property, to the southern corner of our 16 acre site in 1984. The overhead distribution line feeds our existing wind farm and is designed adequately to support the new wind turbines without modification. PMLD will request DCR to formalize our existing 20 year agreement with a 224' by 10' aerial easement over DCR property in order to maintain the existing electrical distribution lines to our property.

Section 13: Location and Construction Plans for Turbines

Multiple turbines are typically sited in rows perpendicular to the prevailing winds. Our site experiences a north-west prevailing wind. In order to prevent turbulence from one turbine to another, the turbines are typically spaced at least three blade diameters apart. In our case, only two units will be installed so spacing is not a serious concern.

The turbines will be located entirely on PMLD property and no part of the turbine or blades will protrude over our property boundaries. Unit 1 will be located in the northeast corner of our property. Unit 2 will be located in the southwest corner of the property. The units will be spaced approximately 800' apart.

Construction plans have been completed and submitted to the Town of Princeton, Building Inspector for permitting. PMLD received a building permit on November 14, 2005.

See attachments:

- 1. Locus Map with Turbine Coordinates***
- 2. Construction plans for proposed turbines***

Section 14: Foundations

PMLD's proposed wind farm has 0 – 5 feet of soil overburden on bedrock. Based on observation during our site inspection, the bedrock is of a high quality favorable for rock anchor foundations. These foundations will, however, require significant drilling and anchoring. As a result we estimate that the overall cost of the foundations will be significantly higher than the more traditional “inverted T” or “P&H Cylinder” foundations used for wind turbine foundations in more homogeneous soils. PMLD will use standard engineering practices in the design and construction of the foundations.

A typical spread footing foundation for units of this size is approximately 45' x 45' x 7'. Most of the spread footing is covered with compacted common fill and only a 14-16' diameter foundation pedestal is visible above finished grade. Due to the sloping terrain at our site, some portion of the spread footing foundation will be exposed depending on the slope of the terrain. In cases where the terrain slopes are steep, rip rap retaining walls will be constructed to reduce the amount of fill required and minimize erosion.

Section 15: Land Survey, Soil Borings, and Testing

An updated site survey was completed for this project. The survey includes PMLD's property boundaries, topography, and the proposed locations of the turbines, crane pads, turbine lay down and staging areas, and the electrical infrastructure. In addition to the survey, soil/rock borings and geotechnical analysis will be performed once construction begins. Other ground and site work includes; concrete tests for the foundations and soil conductivity tests for the design of grounding mats.

Section 16: Electrical Design and Connection to PMLD's Distribution Facilities

Our electrical design includes pad-mount transformers, protective relays, fused load-break switches, surge arrestors, PT's, CT's, and HV metering. For our design, we propose (2) 1500kVA oil-filled, fan cooled Y-Y transformers manufactured by Siemens. Although larger transformers could be substituted for this project, as always the tradeoff is between efficiency and cost. Based on the wind regime at the Princeton wind farm, larger and more costly transformers may be warranted upon further economic analysis. The feeder from the first turbine will enter a live-front panel on the second transformer (turbine closest to PMLD's interconnection line), in a daisy-chain configuration. A separate section is provided for metering. PMLD will supply our own CT's and PT's for HV side metering.

We have specified metering with a pulsed output so that power output can be monitored by the utility via a modem connection. Approximately 1000 feet separate the two proposed wind turbines. The second turbine is then another 200 feet from PMLD's 13.8kV line. PMLD specified 350MCM feeder cable for each phase between the turbines. In a separate conduit, an interface cable will be installed to enable each turbine to be tripped off in the event of a ground fault on the turbine side of each transformer. Finally, a third conduit will house the fiber optic lines for turbine communication.

PMLD assumes that straightforward trenching will be possible to a depth of 4-5'. Should this not be the case, we assume that any ledge removal will be billed as a change order on a cubic yard basis. In areas where the minimum 36-inch cover is not achievable, PMLD may be required to artificially elevating the ground cover above the feeder trenches.

Metering

Metering the production of energy will be provided in a separate section of the pad-mount transformer enclosure at the turbine adjacent to PMLD's 13.8kV interconnection. The proposed meter will include a pulsed output port so that the utility may dial up and monitor wind farm production remotely. Our electrical one-line diagram includes a ground fault trip interlock on the meter's current transformer. With this arrangement, both turbines can be tripped off-line in the event PMLD experiences an outage on the utility's side of the meter.

Interconnection to Electrical Distribution System

Interconnection of the wind farm to PMLD's electric grid will consist of an existing, 3 phase Hendrix bundle 13.8kV overhead feeder. Six existing utility poles connect the wind site electrically to PMLD's electrical distribution system. Underground feeders to each turbine will be installed from the last existing utility pole on PMLD's property. PMLD will isolate the wind farm from its distribution system with a pole-mounted, fused disconnect with a ground level operating handle.

Supervisory Control and Data Acquisition (SCADA)

A variety of SCADA alternatives are available for the proposed Princeton wind farm. The small size of this project does not warrant a server-based communication system typically found in large wind farms. PMLD has identified SCADA packages "Windman Express SCADA system" and "VisuPro system" as potential SCADA systems for this project.

Section 17: Crane Access, Delivery, and Installation Pads

The existing access road at the proposed wind farm will require minimal upgrades. The removal of several trees adjacent to the roadway will be required, and a topcoat of crushed graded gravel may be necessary. During our initial site assessment we noted that the radius of curvature at the entrance to PMLD's property is inadequate. Consequently, our proposal includes a design for the necessary civil work at this location. This work will require the removal of several trees, the relocation of several stone walls, and re-grading of the area. The stone walls and grading will be reconstructed and returned to its current condition after construction is complete.

A 300-ton Manitowoc 2250 crane will be required for installation of the turbines. This crane is transported via fifteen tractor-trailer trucks and assembled on-site. In its unassembled form, only a 12-14-foot roadway is required for access of the crane assembly. Once constructed, however, this crane will require a 26-foot roadway in order to move from one turbine installation site to the next. Once PMLD's land is cleared and grubbed, and the existing wind turbines and infrastructure are removed from the site, we anticipate that the crane will be able to travel between the two turbine locations without requiring full demobilization.

The installation layout and construction of staging areas on our 16 acre site is significant. If the rotors are pre-assembled on the ground (the most desired and economical method), almost an acre of space will be required at each turbine site. Because the existing topography at both of the proposed turbine sites is irregular, fill material will be required. The slope of the layout area at the turbine sites need to be relatively flat for turbine assembly. Additional cut and fill may be necessary at our site.

Section 18: Turbine Shipping and Delivery

Mass-Highway must be contacted to coordinate route access and clearance along highways and Town roads leading to our site. The turbines are typically shipped on 8-10 semi-trailer sized trucks. The tower is delivered in three pieces, each blade is delivered separately, and the generator, hub, transformers, and associated equipment are delivered on 2-4 trucks. The table below details the sizes and weights of each component. The turbine blades are the most critical piece since they are made out of lightweight fiberglass and are delivered in one piece.

Tower Sections	Weight	Length	Diameter (base)	Diameter (top)
Embedded Section	7 tons	8'	14'	14'
Base	37 tons	58'	14'	14'
Middle	28 tons	65'	14'	14'
Top	27 tons	99'	14'	8'
	Weight	Length	Width	Height
Generator	51 tons	25'	10'	12'

	Weight	Length	Diameter
Blades	7.5 tons	131'	10.5'

The turbine blades are shipped individually and are approximately 131' long. Minor alterations are necessary along Stage Coach Trail in order to deliver the turbine pieces. These improvements include minor grading and compaction of the access road. The entrance into our 16 acre site at the top of the access road also requires modifications during construction. This is necessary for the long blades to make the wide turning radius from Stage Coach Trail into the site. This turning radius requires PMLD to temporarily remove the stone walls along our site boundaries.

PMLD will temporarily remove approximately 25-30' of rock wall where Stage Coach Trail makes a left into our site. Once construction is complete, PMLD will reconstruct the stones walls to their original condition. Approximately 12-20 trees will be removed in this corner as well in order to facilitate the turning radius and delivery of equipment. PMLD will replace the same number and species of trees in any location DEM requests in order to minimize the environmental impact.

See attachment:

NEG Micon, Weight, Dimensions & Transport Guidelines, NM82, 2003

Section 19: Site Structures and Buildings

Temporary Facilities

No new storage facilities will be required at the wind farm site for this project. PMLD plans to use the existing storage shed and electrical service at the wind farm during the installation of the new turbines. PMLD will decommission and remove the existing transformers and storage shed at the conclusion of the project.

Meteorological Towers

PMLD replaced the existing 78' and 130' meteorological towers installed in 1982 and 1999 with two new temporary 40m (130') and 50m (165') towers. The new meteorological towers will record and verify wind speed, direction, and temperature at 20m, 35m, 40m, and 50m.

Wind data has been collected in 15 minute increments since 2000. The current wind resource data-logger emails data via cell phone from the site to PMLD. PMLD may require one 50m meteorological tower to remain for one additional year after construction is complete in order to verify the power production guarantee.

Existing Turbines and Towers

The existing turbines and towers will be disassembled and lowered to the ground by PMLD's developer. PMLD will transport and store the old units at its operations building on Worcester Road. PMLD will sell the old towers and wind turbines.

Section 20: Local, State, and Federal Permitting

PMLD successfully completed all of the necessary environmental reviews and permitting requirements for this important community project and was issued a building permit in November 2005. Pre-construction studies and activities completed to date include:

1. Town of Princeton, **Special Town Ballot Vote** in support of project **completed February 2003**. Majority of residents voted in favor of project. Project received 605 of the 818 total votes or 74% supported the infrastructure improvements to their 20 year old wind farm.
2. **Expanded Environmental Notification Form (EENF) completed and submitted** to EOEPA for MEPA review in March 2004. This report covers impacts related to vegetation, cultural resources, recreational use of reservation, air navigation, noise, visual, security, and public safety.
3. **MEPA Review and Certificate issued April 23, 2004**. PMLD received favorable MEPA review from the Secretary of the Executive Office of Environmental Affairs (EOEA). The certificate states “that the potential environmental impacts identified in the EENF for the project do not warrant further MEPA review” and further states “the project advances the Commonwealth’s management goals for protected parklands and furthers a number of Commonwealth objectives related to air quality and sustainable development”.
4. **Special Use Permit** issued on October 5, 2005 by DCR to PMLD to utilize Stage Coach Trail as access road.
5. **Historic and Cultural Resource Survey**, completed August 2004
6. **Alternatives Analysis** in response to Historic and Cultural Resource Survey, completed November 2004
7. **Intensive Archeological Survey**, completed September 2005. Study found no significant archeological resources and recommends no further studies.
8. **Massachusetts Historic Commission (MHC)** letter dated October 28, 2005. Agrees with Intensive Archeological Survey, completed September 2005. MHC agrees to PAL recommendation of no further historic studies.
9. **Noise Study, Photo Simulation, Shadow Analysis, and Wind Data Analysis**, completed May 2002 by Renewable Energy Research Laboratory. Determined that wind turbine sounds are generally quite, well masked, and virtually inaudible at greater distances than 200 meters.
10. **Preliminary Acoustic Noise Impact Assessment**, completed May 2002 by PB Power. The new turbines will generate 40dba at 1800’. 40dba is the noise level of a quiet urban residential neighborhood.

11. **Wind Resource Evaluation**, completed December 2002
12. **National Heritage and Endangered Species Program determination** of no rare plants or animals or exemplary natural communities in the area of our site, completed June 2002
13. **FAA Determination of No Hazard to Air Navigation**, completed July 2002
14. **Bird Risk Study**, completed September 2002 by Dr. Paul Kerlinger. He concluded that risk associated with repowering is likely to be low and not significant and not a potential threat to avian populations.
15. **Shadow Flicker Modeling and Results**, Completed by Wind Engineers, Inc. May 2004. This study was conducted at Harrington Farm as they are the closest business/resident to the wind farm. There will be no shadow flicker in the summertime. There is shadow flicker in the morning only. Shadow flicker will occur for a total of 12-16 hours during the year between the hours of 7:00am and 9:00am. Study also includes Mollica property and indicates that very similar amounts of shadow flicker may occur. These worst case scenarios are based on the assumption that there are obstructions such as trees obstructing the shadow flicker. Both properties are surrounded by a mature tree line.
16. **Solar Shadow Analysis**, Completed by PB Power May 2004. Similar results as noted in 15 above
17. **Solar Flicker Analysis**, Completed by Renewable Energy Research Laboratory, May 2004. Similar results as noted in 15 above.
18. **Site Plan Review**, Town of Princeton Planning Board, completed May 2004
19. **Notice of Intent for Storm Water Discharges, NPDES General Permit** issued by EPA on June 24, 2004
20. **Construction Permit** issued October 2004 by the Town of Princeton to PMLD and CEI to construct wind turbines.
21. **Annual Town Meeting (Home Rule) vote to approve Article 97 easement transfer.** This vote allows the Town of Princeton to exchange its easement to the wind site for easement over Stage Coach Trail for access to wind farm. Unanimously approved at annual town meeting held on May 10, 2005.
22. **Annual Town Meeting vote to approve Zoning By-Law changes.** The zoning by-law changes were approved by the residents of Princeton at annual Town Meeting in May 2005. New zoning by-laws specifically allow wind turbines and municipal use of wind turbines.
23. **Article 97/Senate Bill 40:** PMLD requests legislative support for Senate Bill 40. DCR and PMLD mutually developed the Article 97 legislation that allows DCR to grant an easement over Stage Coach Trail in exchange for a greater amount of land owned and controlled by the PMLD and the Town of Princeton. This legislation was sponsored by Senate Chandler and Representative Evangelidis. The bill was favorably reviewed by the Joint Committee on Bonding, Capital Expenditures, and State Assets. The bill was review and released by the Senate Ways & Means Committee. The Senate voted and

passed the bill on February 2, 2005. The House Committee on Steering, Policy, and Schedule will review the bill and vote on it as its next formal session (within 30 days).

24. **Second Site Plan Review**, Town of Princeton Planning Board, completed September 2005.
25. **Building Permit issued by Town of Princeton.** Issued November 14, 2005 and based on new zoning by-laws and second site plan review completed September 2005.
26. **DTE filing for a comprehensive zoning by-law exemption.** Filed February 2006.

Section 21: Land Use Before and After Construction

The Town of Princeton, through its light department (PMLD), owns and operates the 16 acre wind farm site off Westminster Road. PMLD has complete control and maintenance of the land since it was purchased with electric ratepayer revenues in 1984. The site includes an 850' x 40' right of way off Westminster Road. As an alternative to developing this ROW, The Department of Conservation and Recreation (DCR) allowed PMLD access through its right of way along Stage Coach Trail since 1984 in order to minimize the environmental impact of an additional access road to the same site.

A site plan will be created detailing all topographic details, cut and fill, and grade change. Upon completion of the installation, topsoil will be reapplied over all of the cleared areas, and the site will be vegetated.

PMLD will request both DCR and MA Audubon to recommend what state the cleared portion of the 16 acre is returned to, when construction is completed. The site could be allowed to return to its natural state (forest) or the site could be maintained as open-space with periodic brush cutting and mowing. Maintaining the site as open-space will ensure more accurate post avian studies.

PMLD will not install exterior lighting on the site except for the FAA required lighting on top of each tower.

The gravel access road will be maintained to allow access to the site. PMLD and outsourced preventative maintenance workers will visit the site approximately two days per month during the spring, summer and fall. PMLD will not access the site by vehicle during the winter months unless there is an emergency. The turbine equipment will be monitored remotely by PMLD's SCADA system and site access will be minimal during the winter months.

The existing improved gravel access road on our 16 acre site will remain after construction is complete. The access road will end with enough room for vehicles to turn around. No dedicated parking spaces will be constructed or are necessary.

Trail Access during Construction

PMLD will coordinate construction activities in order to minimize impact on visitors and hikers to the reservation. Although the construction schedule anticipates 36 weeks of construction to complete the project, only small portions of the that time will involve heavy use and activity on Stage Coach Trail. Grading and compacting the road will take approximately 3-4 weeks, delivery and pouring the cement will take approximately 1 week, and delivery of the turbine and tower will take approximately 1 week. All other work will take place on PMLD's site and only require vehicle access along Stage Coach Trail. PMLD will work with DCR to coordinate the timing of construction, trail access, and alternative access to the reservation trail system during construction.

Section 22: Project Schedule

PMLD developed a 36-week project schedule outlining all of the major design and construction tasks. This schedule accounts for all long lead items, a likely ground breaking project start date, and includes “adverse weather” days. Given that the physical turbine erection will take place during the relatively calm summer months, we have included only minimal “adverse weather days” for this task. Moreover, we have assumed that the crane being used for the installation will not require a complete demobilization and remobilization when moving between the two turbine sites. Our preliminary project schedule is broken down into various tasks. Long lead time equipment and significant tasks include:

- Wind turbines have a 6-12 month lead-time
- Transformers and various switchgear items have between 10-14 week lead time
- Site preparation and access road work takes 1-2 months
- Drilling and pad construction takes 1-2 months
- The foundation must cure for at least 30 days before concrete testing and consequent turbine installation
- The turbines are installed by crane in 2-3 weeks
- Turbine Commissioning is completed within 1 week

Earliest Ground Breaking: The long lead-times required for the wind turbines provide project flexibility, as the design and construction tasks can be completed well within a 3-6 month timeframe. This allows us to complete all site work well before turbine delivery is anticipated. Heavy snowfall will impede the mobilization of erection equipment at the site and therefore turbine erection must be coordinated in the spring, summer or fall months.

Schedule Logic and Staffing: The proposed project schedule below presents a preliminary map of the various construction phases leading up to the installation of the turbines. We believe there is great flexibility with regard to paralleling some construction tasks, although space limitations may limit the productivity of multiple crews at times. Once the site is cleared and grubbed, foundation preparations can take place concurrently with trenching for the feeders and final site grading and compacting. We propose this to ensure that any necessary ledge removal is completed before the foundations are installed or the turbines are erected. The Manitowoc 2250 requires 15 tractor trailer trucks and a crew of six for assembly. PMLD plans to mobilize a turbine erection crew consisting of two crane operators (for both the 300-ton crane and the assist crane), a crane oiler, and a rigger. The erection crew will include the installer’s field manager, two turbine erection technicians, and an installation supervisor from the turbine manufacturer. Once the turbines are installed and the transformers and switchgear are in place, a commissioning crew consisting of turbine technicians and a turbine manufacturer’s supervisor will complete final hookup and commissioning. Once on-line, the turbine manufacturer’s supervisor will provide two full days of training for PMLD.

Section 23: Design and Installation Assumptions

PMLD has made the following assumptions in the development of our price quotes for this project:

- PMLD will prepare and submit all necessary and applicable permits pertaining to this project.
- Wind turbine foundations are based on the assumption that the bedrock at the proposed sites is suitable for a “typical” design. Ultimately, the results of a site-specific geotechnical analysis will dictate the final foundation designs and consequent costs.
- Gravel/fill material is available at a nearby gravel pit.
- Excavation to a depth of 4-5 feet. We have tentatively assumed that excavations for trenching and foundations will not require ledge removal. Should ledge removal be required, the installation contractor will be required to do the necessary drilling, blasting, and removal.
- Sales or usage tax has NOT been included in our price quotes. Applicable import duties are included in the price of the turbines.
- Electrical service will be required during the installation of the proposed wind turbines. The existing transformer at PMLD’s wind site will remain operative during the project, and that supplementary portable electric generators will not be required.
- During the installation of the turbines, PMLD assumes that the 300-ton Manitowoc crane will require only one day of mobilization/demobilization between the two turbine sites.
- Although PMLD has requested turnkey quotes, we may complete some of the installation tasks associated with this project in order to reduce costs. All price quotes developed herein reflect complete turnkey services.
- Some of the tasks in this scope of work will be completed with 12-hour workdays. PMLD assumes that there will be no problems associated with access or construction during these extended workdays.
- Loss of use (business interruption insurance) is not included in this proposal but will be required once the units are in operation.
- Transportation estimates provided by wind turbine manufacturers vary significantly. Actual freight costs may differ at the time of shipping and will be reflected in final project price.

Section 24: Wind Turbine Erection Methods

PMLD proposes to use a 300-ton Manitowoc 2250 Series C crane with a luffing jib to erect the wind turbines. The installation contractor must have relationships with several crane services in the Massachusetts region that can provide cranes of this size. A sample wind turbine assembly layout is included in appendix 2. The erection sequence will be carried out in standard format: tower sections and nacelle being placed, then followed by the complete rotor assembly (the rotor will require all open area at the lift site during its assembly). All weather and safety precautions will be taken. The secondary (small) crane will be used to support this erection sequence.

Section 25: Preventative Maintenance and Turbine Operation

Preventative Maintenance

The project cost will include a 2-3 year maintenance agreement with the manufacturer. The units will be maintained by the manufacturer according to their recommended schedule. PMLD's staff will accompany the manufacturer during every PM visit during the first 2-3 years in order to learn the manufacturer's PM process. PMLD will assume PM in year four if the manufacturer certifies our staff proficient and honors the extended manufacturer warranty.

Manufacturer's Warranty

The project cost will include a 2-year manufacturer's warranty. PMLD will purchase an additional 3-year manufacturer's warranty to cover the equipment through years 3-5.

Construction Insurance

PMLD will require the installation contractor to purchase full insurance coverage for this project including liability, site, and equipment breakage for the construction period.

Corrective Maintenance Insurance

PMLD will purchase property insurance to cover all major corrective maintenance and catastrophic equipment failures including lightning, mechanical failure, tower collapse, etc. The insurance policy will include power replacement coverage as well, to ensure that PMLD does not incur any costs for replacement power in the event the turbines are off-line due to corrective maintenance or catastrophic equipment failure.

Hazardous Materials

No hazardous materials will be stored on site. PMLD will install oil-filled transformers for this project. The insulating oil is non-hazardous "mineral oil". Each transformer pad will include emergency oil overflow reservoirs. As the proposed wind turbines are induction machines, they require a significant volume of gearbox oil. Standard preventative practices will be employed to ensure that this oil does not enter the environment during the installation and operation of the turbines. The transformers and gearboxes will be inspected monthly during preventative maintenance visits to ensure containment of oil based insulation and lubricating fluids.

Spares and Special Tools

All turbine manufacturers will provide a detailed list of recommended spare items. The manufacturer will determine the most appropriate spares inventory for this project. PMLD will contact other municipal and private wind farms to coordinate a spare parts inventory list.

Life Span and Decommissioning

The life span of a wind turbine is about 20 years and occasionally up to 30 years. At this stage, the turbines can either be replaced or removed. Turbines can be removed as quickly as they are erected (about one per day). The foundations and underground cabling can be removed from the site, but it is generally recommended that foundations are simply covered over, and that tracks and cabling be allowed to remain. The scrap value of the turbines will generally cover a proportion of the cost of decommissioning. The Board of Light Commissioners will decide what to do with the turbines at the end of their useful life.

Section 26: Operational Issues

Potential Sources of Pollution

Wind energy is an extremely clean electricity source. No airborne or other pollutants are emitted during the operation of the wind turbines. Wind turbines do require the use of hydraulic and/or gearbox oil. Transformers are oil-cooled using non-hazardous mineral oil. Any potential oil leak would be contained inside the turbine tower or transformer pedestal and would be prevented from reaching the surrounding environment by enclosed basins capable of retaining 110% of the oil holding capacity. Also, the transformer will be installed on an impermeable concrete slab, with a lip designed to contain any oil spill.

No harmful waste or pollutant will be discharged into the environment during the construction time period. All normal precautionary measures and standard construction practices will be implemented to minimize disturbance to the site, control runoff and sedimentation, noise levels, dust emissions, to avoid oil or fuel spills, and to collect waste. As a precautionary measure, the project will allow only construction and craning equipment in good repair on site. Furthermore, emergency response spill kits will be maintained on site in the event of the loss of containment of hazardous fluids.

Noise levels are expected to increase during the construction period. Road graders, construction equipment, cranes and increased traffic will be the major sources of noise, which will result in minor inconveniences for local residents and hikers.

Potential Cause of Resource Conflicts

Recreational land use around the construction site is expected to be temporarily affected during construction only. As such, no resource use conflict is expected between the wind power project and recreational use of the neighboring reservation. Other land uses in the area are limited and no particular resource conflict is expected with the implementation and operation of the wind turbines.

Construction Period Mitigation Measures

In order to minimize the amount of environmental impact the project could generate, certain mitigation measures will be implemented.

- Prevention of non-native vegetation species from colonizing the area (dispersed by machinery and workers) by ensuring the machinery is clean
- Timing of construction: undertaken to minimize impact on the soils and vegetation
- Use existing roads as much as possible
- Avoid ecologically sensitive areas
- Should any objects of archaeological value be found during construction, work should stop temporarily to allow a qualified archaeologist to assess the importance of the finding and devise a suitable mitigation plan, including buffers to protect the site.
- Minimize the amount of vegetation removed from the site.
- Avoid construction during avian nesting seasons
- Silt controls to monitor the amount of silt created by the access roads. These measures will be included in a detailed environmental protection plan (EPP) that will be developed and submitted to the Department of Environment prior to the onset of the project construction activities.

Emergency Access and Parking

The access road on PMLD's site will act as parking for the site and can accommodate the turning radius of operation and emergency vehicles.

Site Lighting

No site lighting will be installed except for the FAA require tower light (See Section 27)

Drainage and Storm Water

The access road will be designed using pervious gravel and materials. No special drainage is required because the road is pervious (See construction documents for more details). The access road will be design to accommodate and properly discharge storm water and snow melt.

Security of Site

Turbines are monopole structures with lockable porthole type doors. Turbines are climbed from within the tower using OSHA approved lad safe system. The monopole cannot be climbed on the outside. The door to each turbine is locked at all times and access through the door is monitored through the SCADA system monitored at PMLD's operation center.

Access Road Gate

The access road to the site will be gated and locked at all times. Only authorized employees and contractors will be allowed to utilize the access road. Keys to the gate will be maintained at PMLD, Wachusett Mountain Visitor Center, Princeton Police Department, and the Princeton Fire Department.

Site Fencing

The site will remain open and unfenced. The towers and transformers will be locked and appropriate signage will indicate the potential damage to equipment and personnel if the devices are tampering with.

Site Perimeter Signage

PMLD will install signage around the perimeter of the site to inform the public the site is the Town of Princeton's Wind Farm. The signage will also inform the public that the site is a renewable energy generation facility; it will also provide a phone number, monitored 24 hours a day, for emergencies and questions. The perimeter sign dimension will be approximately 12' x 24' mounted on steel posts.

Energy Kiosk and Display

PMLD will also install an Energy Kiosk at the entrance to our Wind Farm to provide the public with information describing; what the Wind Farm is, why it was constructed, the annual energy produced, safety concerns, and emergency phone numbers. The kiosk will be located on PMLD's property at the corner of the access road and the 16 acre site. The 3' x 5' display will be constructed to match similar displays within the Wachusett Mountain Reservation.

Section 27: Visual Impact

Most forms of electricity generation have drawbacks. For example, the air pollution and greenhouse gases resulting from oil, coal, or natural gas generated electricity can't be seen, but is serious in terms of impact on human health and on the environment. With wind power, what you see is what you get. Wind farms are clean, and very visible.

The installation of a two, 70 meter tall wind turbines in a rural and mostly wooded location will certainly be visible from various locations. Even our existing eight 100' wind turbines are visible from various locations in the area. The wind turbines are sited in the environment they are meant to protect. The turbines are well masked by the nature tree canopy and the natural rolling topography surrounding the site. The tubular towers and the aerodynamic blades have been designed with smooth lines that tend to have greater aesthetic value than our older lattice tower type wind turbines. They are considered attractive industrial structures.

Improvements in technology have also lowered the speed of the turbines. Our exiting existing turbines spin at approximately 70 rpm's, while the new, but much larger turbines spin at only 17-20 rpm's. This slow speed reduces noise and creates a more aesthetically pleasing site.

Photo simulations were created by the Renewable Energy Research Laboratory at the University of Massachusetts. PMLD floated two balloons at the 70m hub height in order to create a reference point for some of the photo simulations.

See attached photo simulations of wind farm from various locations

1. Photo simulation from Scenic Overlook Ledges to Wind Farm
2. Photo simulation from Wachusett Mountain summit to Wind Farm
3. Photo simulation from Brown Hill to Wind Farm
4. Photo simulation from 106 Thompson Road to Wind Farm
5. Photo simulation from 67 Westminster Road to Wind Farm
6. Photo simulation from 178 Westminster Road to Wind Farm
7. Photo simulation from 191 Westminster to Wind Farm
8. Photo simulation between 178 and 191 Westminster to Wind Farm

Flicker Shadow

The rotation of the wind turbine blades during periods with low sun angles and bright sun, such as early morning, may result in a flickering, or shadow. This effect is typically limited to the time the sun is directly behind the turbines. Since the closest private property is 2,400' away from the wind farm, it is unlike any flicker shadow will occur. Shadow flicker typically occurs when the observer or property is much closer to the turbines and inline with the turbines and sun.

See attachment:

Solar Shadow Effects, PB Power, May 2004

Section 28: FAA Required Warning Lights

FAA Advisory Circular AC 70/7460-1K states that warning lights should be installed on wind turbine structures. In order to comply with the FAA Advisory, PMLD selected the least intrusive lighting system available, which will minimize the impact to the environment (birds) and surrounding community. PMLD will install a medium intensity white strobe light for night and day use. The strobe light will be programmed to strobe for the longest period of time allowed. The flash rate will be approximately 40 flashes per minute during the day and 20 flashes per minute during the night. The slow flash rates allow the lamp to completely darken. This technique has proven to be less distracting to communities and avian life. PMLD will also utilize fixtures that have the lowest amount of stray light and shielding to prevent light pollution below the horizon of the generator enclosure on top of the tower.

The lights will be located on top of the generator enclosure, which tends to mask the light from shining directly down. The FAA allows cone shields to prevent the light from directing downward. PMLD will ensure the lights are installed in a position on top of the generator enclosure with cone shields in order to prevent stray light from impacting the community and environment.

FAA publishes strict guidelines on the amount of stray light that can emit below the horizon. In fact, the amount of stray light below the horizon cannot exceed 75 candelas, the approximate light intensity of a 60W light bulb. Most manufacturers design strobe lights so that stray light does not exceed 25 candelas or 1/3 the amount of the standard. When the time comes to specify the strobe lights, PMLD will ensure we utilize the manufacturer with the lowest stray light as compared to the FAA standard.

The FAA has determined that our wind farm does not exceed obstruction standards and would not be a hazard to air navigation.

See attached:

“FAA, Determination of No Hazard to Air Navigation” dated July 25, 2002

Section 29: Noise

Modern wind turbines create very little noise above the natural background noise typically caused by wind. The noise level from the turbines proposed at our site is significantly less than the noise level of the existing units. In order to provide a perspective of sound levels, consider the fact that normal conversation is approximately 60dbs. The noise level in a bedroom at night is approximately 30dbs. The sound from a new wind turbine can be equated to trees rustling in the wind or ocean waves breaking. The small amount of sound at close distances is not intrusive but is considered background noise, similar to wind and ocean sounds or even a refrigerator humming.

During quiet non-windy days and nights, the units will not operate and there is no noise. Generally speaking as the wind approaches the speeds necessary for the turbines to work, you will hear more wind and background related noise than anything else. Since the closest private property is approximately 2,200' from the turbines, our noise studies, completed by UMASS Renewable Energy Research Laboratory and PB Power, indicate that **without** taking into consideration wind related background noise and forest or topographic barriers that tend to mask noise, the level of noise at 2,200' will be 36 db(A). This noise level is slightly louder than whispering. Based on our studies and including normal wind related background noise, there will be little or no noise, 2,200' (670m) away from the turbine. (See attached noise studies)

It's important to reiterate that the existing (8) turbines generate significantly more noise than the proposed units. Technology improvements and slower blade rotation significantly reduces the noise levels of newer turbines. Based on studies (See figure 1) completed by the National Renewable Energy Laboratory (AIAA-2004-1185), the existing units generate noise levels ranging from 60-65 db(A), at approximately 122' (Measured using hub height plus 1/2 the blade diameter) away from the turbine at ground level.

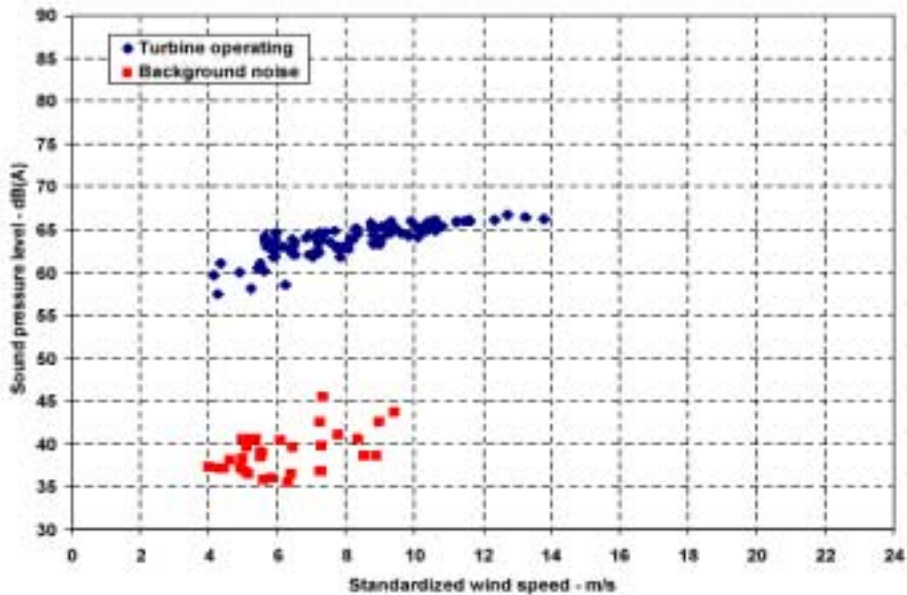
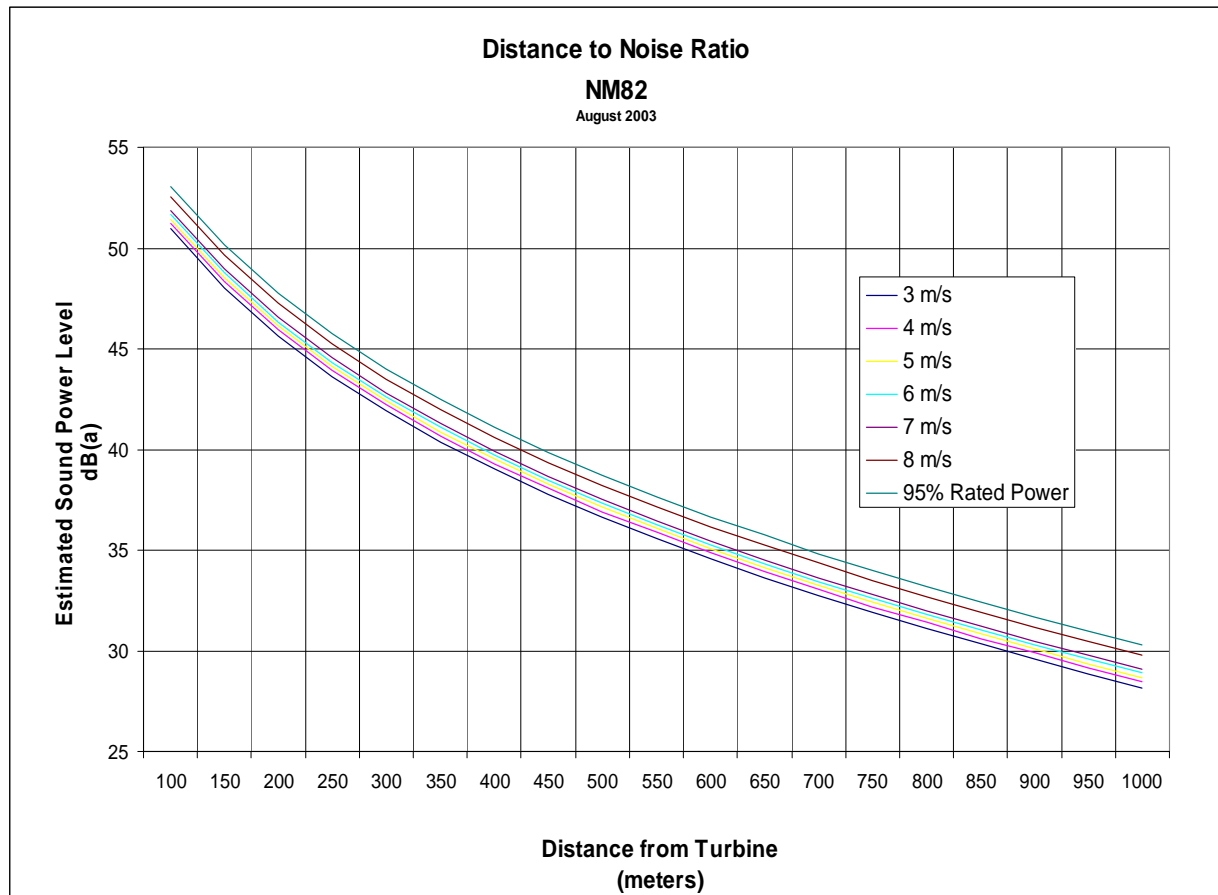


Figure 7. 1-minute-average sound pressure level for Atlantic Orient Corporation AOC 15/50

Figure 1, Noise characteristics of existing PMLD turbines compared to typical background noise

Based on the manufacturers noise curve (See figure 2) for a NM82 wind turbine, the noise generated from the proposed units will be approximately 50-55 db(A), 364' away from the base of the turbine. Noise levels will diminish with distance from the turbines and at approximately 1,968' (600m) the noises of the turbines is completely masked by natural background noise.



1. Figure 2, NEG Micon NM82 Sound Power Level characteristics, August 2003

Acoustic emission measurements conform to applicable elements of **IEC 61400-11 "Acoustic Emissions Measurements."** The purpose of this measurement standard is to document the acoustic emission characteristics of the wind turbine type.

This standard was developed to provide a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustic emissions by Wind Turbine Generator Systems (WTGS).

See attached noise studies:

1. *Acoustic Noise Impact Assessment, PB Power, May 28, 2002*
2. *University of Massachusetts, Renewable Energy Research Laboratory, Wind Turbine Report Completed November 2002. Located in Section 9 of this report.*

Section 30: Avian Impact

Bird fatalities at wind generation sites are very low. Studies at existing sites indicate only 2.19 bird deaths per turbine per year (NWCC). Migrating birds, like hawks, tend to fly above 500 feet. PMLD hired avian expert, Dr. Paul Kerlinger of “Curry & Kerlinger” to analyze potential avian impact at our site (See attached Bird Risk report by Paul Kerlinger, September 2002). Dr. Kerlinger was the former Audubon Director of the Cape May Bird Observatory in New Jersey and authored “How Birds Migrate (1995) and Flight Strategies of Migrating Hawks (1989). Dr. Kerlinger’s visit and analysis indicates that avian risk from our project is likely to be low and not significant. In perspective, more birds die annually from the following:

- 100 million annually flying into glass windows
- 100 million from house cats (Source: American Bird Conservancy)
- 50-100 million from automobiles and trucks
- 4-10 million from guyed communications towers over 500’

From the total number of turbines installed in the United States, only 10,000 – 40,000 avian fatalities per year are expected. However, because our site is in a known migration path, PMLD will perform a post avian study during the first 2-3 years of operation. PMLD will request DEM and MA Audubon’s assistance in selecting and approving the post avian study methodology.

PMLD’s property is approximately one mile away from the summit of Mount Wachusett. Since there is a large number of migrating Hawks during a specific time of the year (typically October), PMLD will provide the hawk watch community our emergency contact numbers in order to alert PMLD when conditions occur that increase the risk of avian fatalities. These events may include low visibility, fog, and specific weather events. In these events, PMLD will stop the turbines in order to minimize the risk to migrating birds.

Bird Collisions

Earlier turbine tower designs used latticed towers, which were frequently used by raptors as perching locations allowing for a clear view of open land (Kerlinger, 2001). Studies have shown a predominance of bird strikes during take-off, as the birds were carried by the draft into the rotor of downwind-operated turbines. Today's wind turbines are essentially upwind machines (i.e. the rotor is upwind from the tower), commonly mounted on tubular towers, where raptors have no opportunity to perch. Furthermore, large turbines have reduced rotational speeds (17 to 24 rpm), which decreases the chances of bird collisions.

Also, recent reviews of avian impact studies conducted at wind power facilities in Europe and in the United States reveal that bird turbine interactions resulting in bird fatalities represent extremely minor occurrences. Nowhere in Europe (even in Tarifa, Spain and coastal Netherlands) and in all but one location in the United States (Altamont Pass, CA) have these impacts been judged to be significant or to cause avian population problems or impact rare or threatened species (Kerlinger, 2001).

Finally, the numbers of fatalities reported at wind plants has been extremely small, especially when compared to other sources of human induced mortality as indicated in the table above (Kerlinger, 2001).

Mitigation and Monitoring Measures

PMLD will implement mitigation measures to ensure minimal environmental and avian impact:

- Tubular towers will be installed to reduce the possibility of birds perching on the towers. (Tubular towers also improve the aesthetics of the wind farm)
- The electrical distribution lines connecting the wind turbines to PMLD distribution system will be installed underground. This prevents avian perch points and improves aesthetics.
- Any equipment brought to the site during the construction period will be in good repair, to prevent oil, grease, or other hazardous spills.
- Grass will be planted on disturbed areas after construction

PMLD is committed to developing and implementing a post study on the effects of the Wind Farm Project on migrating birds in the area. The highest probability of bird strikes is during the spring and fall bird migration periods. Critical migration periods (spring and fall) will be identified and these periods will be the focus of monitoring avian fatalities associated with the wind farm. This program will determine the level of wind turbine bird mortality during migration.

In developing the post study, the PMLD will ensure there are clear and achievable objectives and hypotheses, temporal and spatial controls, and practical methodologies. PMLD will also consult with regulatory authorities and stakeholders to discuss aspects of this study prior its implementation. The study's results will help quantify bird mortality during migration periods. Results of the study will be used to design, implement and eventually evaluate mitigation strategies that may be required to address the bird mortality issue.

See attached:

Bird Risk Report from Dr. Kerlinger dated September 10, 2002

Study Plan for Post-Construction Monitoring, dated February 8, 2003

Section 31: Icing

The new units are designed to withstand low temperatures, wind, and icing conditions. Icing events that result in significant ice accretion are not common at our location. Only 3-5 ice events per year are expected at the Princeton site. There are two types of ice that can form on wind turbines: glaze and rime (Manwell 2000). Meteorologists classify transparent and homogeneous ice similar to ice cubes, which forms on vertical and horizontal surfaces, as *glaze*. Its amorphous, dense structure clings tenaciously to any surface on which it forms. In contrast, milky and crystalline ice is termed *rime*. Rime lacks the transparency of glaze, is less dense, and does not cling as tenaciously as glaze.

Given our site elevation is only 1,500' glaze ice is more common than rime ice. However small the number of ice events is, some small amount of ice will accumulate on either the existing towers and turbines and the new ones. This same ice also accretes on the trees surrounding our site, on our overhead utility lines along our roads, and on the mature tree canopy that covers Stage Coach Trail adjacent to the wind site. Typically, significant ice events last only 24-48 hours before melting off the existing turbines and trees. The risk of a hiker being hit by dropping ice is less than from the tree

Given the shape, size, and diameter of the new tower, ice build-up is less of a risk with the new units as compared to the existing towers. The new tower will be a non-guyed 8'-14' diameter monopole tower. The large diameter and surface area decreases the likelihood of ice accretion as compared to our existing lattice style towers small diameter blades. The new units also rotate slower at only 20 rpm as compared to 70 rpm by the existing units. The slower blade speed and reduced number of turbines from the existing eight to only two, also reduces the risk of ice accretion and ice throw.

PMLD will install sensors that monitor ice accretion, which will shut down the turbines during significant ice events. This safety feature is not present on our existing turbines. The turbine control system (SCADA) will send an alert to PMLD's 24-hour dispatch. Once the turbines are shut down and the warning sent, PMLD's staff must visibly check the site for ice accretion. The turbines will not be restarted until the ice melts away or is removed by jogging the turbine blades (Jogging is a quick start and stop operation that flex's the fiberglass turbine blades enough to cause the ice to break off and fall to the ground).

During weather conditions that may lead icing, PMLD will supervise the wind turbine site more closely. The turbine SCADA system will monitor the site 24 hours a day. The controls of the turbine will automatically perform the following functions in order to shut down the units and minimize the risk of ice throw during an ice event.

- **Power curve:** Ice accretion on the blades has a big influence on the lift force and therefore on the power curve of the wind turbine generator (WTG). The power curve is programmed into the control system and is always compared with the actual power output. When the mean (average) of the power is continuously out of the power curve for 2 minutes, it is an indication that ice has accumulated on the blades and the WTG will be stopped automatically. The turbine stays off until it is reset manually by an operator who must physically visit the site to determine if icing is present. If icing is present the operator will jog the turbine to shed the ice or keep the turbine off until the ice melts away naturally.

- **Vibration Sensors:** Additional loads resulting from iced blades cause vibrations which are monitored by the control system. When the vibrations exceed the adjusted limits, the turbines will be stopped. The turbine will stay off until it is reset manually again, after an operator physically visits to determine the cause of the vibration.
- **Ice sensors:** The ice sensor is installed on the roof of the nacelle (generator enclosure). Ice sensors measure the temperature and the relative air humidity of the environment. If certain values are measured which indicate ice, the turbine is stopped by the control system. The meteorological values are determined from national weather institutes. The turbine can only be restarted manually after an operator physically visits the site to ensure the unit is clear of ice and it is safe to restart the unit.

In all these cases an autonomous restart of the turbine is impossible and ice throw is avoided and minimized. Shut down and restart of the turbine are recorded in the alarm list of the control system and can be provided to anyone requesting the information to prove the reliability of our system. Signage will be fixed on the turbine and site perimeter to warn passing pedestrians of the risk.

Section 32: Massachusetts Historic Commission

Massachusetts Historic Commission's (MHC) conducted a site review of the wind farm project, on September 16, 2003. PMLD and MHC visited the various historic properties and districts in Princeton as inventoried by MHC and included on the National Register.

The topography of Princeton and mature tree canopies generally hide the new turbines from the majority of these sites. PMLD developed various topographic profiles in order to determine that the new wind farm is not visible from many of the historic locations. Where they are visible, PMLD plans to mitigate with appropriate signage and displays, explaining the wind farm and its associated environmental benefits.

Overall PMLD believes there is no adverse impact on these locations. PMLD has operated a wind farm in this location for almost 20 years and we are replacing eight turbines with only two new units. The two new turbines are significantly larger but they will not impact the view-shed any more than the original units. In fact, the new units operate at a slower, more graceful speed, and the monopole towers tend to be more attractive than our existing lattice style towers.

Attached are the various topographic profiles of each site we visited or discussed. The profiles clearly illustrate whether or not the wind farm is visible from the various historic locations.

MA Inventoried Locations	Is Wind Farm Visible?
Bullock Ski Lodge	No
DCR Visitors Center	No
DCR Superintendent's House	No
Scenic Overlook Ledges	Yes
Wachusett Mountain Summit	Yes
Edward Goodnow House	No

Nation Register Locations

Princeton Center Historic Center	No
Fernside	No

The existing wind turbines, installed in 1984, are also visible from some of the MHC inventoried locations in Princeton. Since the wind farm may be visible from at two of the inventoried locations, PMLD proposes the following mitigation strategies at three Department of Conservation and Recreation (DCR) locations.

DCR Superintendents House

This property is currently closed and visitors do not utilize the facility. The facility is scheduled to be renovated by DCR in the future, as an educational center for the Wachusett Mountain Reservation. Given the terrain and mature tree canopy at this location, the turbines will not be visible from the rear of this property.

Even though the units are not visible from this location, PMLD proposes to install a renewable energy education display/kiosk. The educational material in the kiosk would provide information to the public about Princeton's wind farm, renewable energy generation, and energy efficient products. This type of static display would also explain the environmental benefits of wind turbines and how they are sited within the environment they are meant to protect. PMLD would

also be available to conduct educational seminars related to wind energy, for groups and individuals visiting the visitor's center.

Scenic Overlook Ledges

This is the only location that will have a direct view of the two new turbines. This location is along the up-road to the summit of Wachusett Mountain. PMLD is not sure if this location is an inventoried historic site, but since it provides a great view of the existing and proposed wind turbines, we developed an accurate photo simulation from this location. The attached photo simulation clearly illustrates the existing and proposed turbines. The old turbines, which have been visible since 1984, will be removed once construction begins.

PMLD believes there is no adverse impact to this location since we are replacing the eight turbines with two new units. The two new turbines are significantly larger but they will not impact the view-shed any more than the original units. In fact, the new units operate at a slower, more graceful speed, and the monopole towers tend to be more attractive than our existing lattice style towers.

PMLD proposes to install a renewable energy education display/kiosk at this location with DCR approval. A kiosk or static display would explain the renewable energy project and environmental benefits of the wind turbines visible from this location.

Wachusett Mountain Summit

There are approximately 13 historic properties inventoried by MHC at the summit of Wachusett Mountain. None of these inventoried locations have a direct view of the existing or proposed wind farm. Most of the historic viewing locations at the summit point in an easterly direction away from the wind farm. The new turbines will be visible from the summit in a southwesterly direction from the junction of Harrington Trail and the fire tower. The wind farm is approximately 1 mile away.

PMLD was able to accurately create a photo simulation of the new wind turbines from one location on the summit of Wachusett Mountain. The new wind turbines will be visible from the summit looking in a southwesterly direction at the junction of Harrington Trail and the base of the existing fire/communication tower on the summit. The wind farm is approximately 1 mile away from this location. As you can see from the photo simulation, the wind turbines are attractive and not overbearing in proportion to the view shed.

Since the wind turbines are visible from this location, PMLD proposes to install a renewable energy education display/kiosk. A kiosk or static display would explain to visitors to the summit, the Town of Princeton's renewable energy project and the associated environmental benefits of the wind turbines visible from this location.

Topographic Profiles

In addition to the photo simulations found in Section 26, PMLD created the following profiles of the topography between each historic property and the wind farm. Each topographic profile confirms whether or not the wind farm is visible from the various historic locations in Princeton.

1. Topographic Profile from Bullock Ski Lodge to Wind Farm
2. Topographic Profile from DCR Visitors Center to Wind Farm
3. Topographic Profile from DCR Superintendent's House to Wind Farm
4. Topographic Profile from Scenic Overlook Ledges to Wind Farm

5. Topographic Profile from Wachusett Mountain Summit to Wind Farm
6. Topographic Profile from Edward Goodnow House to Wind Farm
7. Topographic Profile from Princeton Center Historic Center to Wind Farm
8. Topographic Profile from Fernside to Wind Farm
9. Topographic Profile from East Princeton Historic District to Wind Farm

As illustrated in topographic profile 4 and 5, the wind turbines will be visible at two historic locations in Princeton. However, it is important to note that the existing turbines are visible from these historic locations as well. PMLD believes there is no additional impact from installing the two new turbines at our existing wind farm. Photo simulations of the wind farm from these locations are found in Section 26.

As noted earlier, PMLD proposes to install energy kiosks at these locations in order to help mitigate the visual impact of Princeton's Wind Farm.

Section 33: Benefits to the General Public and Wachusett Mountain State Reservation

PMLD prefers to utilize the existing access road along Stage Coach Trail. The existing access road is owned and controlled by the Department of Conservation and Recreation (DCR). When the original wind was installed in 1984, DCR allowed PMLD to utilize Stage Coach Trail as an alternative to PMLD developing a second road to the same site along PMLD's legal right of way. PMLD will request DCR to grant access along Stage Coach Trail through the MEPA process. PMLD will file an ENF describing the two options for access to the site. If DCR allows PMLD continued access along Stage Coach Trail, PMLD will begin the legal process of exchanging its legal right-of-way with a new right-of-way along Stage Coach Trail.

PMLD believes the following benefits justify continued access along Stage Coach Trail and the eventual exchange of legal right-of-ways.

PMLD's Right of Way (ROW) will not be developed: PMLD will not develop its legal ROW and remove approximately 1 acre of mature trees through DCR's property. In exchange, DCR would allow PMLD to continue using the existing access road PMLD has utilized for the last 19 years. The condition of the existing access road is adequate, needing only minor improvements such as gravel and compaction. There is significantly more environmental impact to the reservation, if PMLD constructs its legal right of way to the wind farm.

PMLD will give DCR, 5-8 acres of land not developed at the Wind Farm: DCR's Harrington Trail currently follows a path through the Town of Princeton's 16 acre Wind Farm. PMLD will request the Town of Princeton to give DCR, ownership and control, of the land surrounding that portion of Harrington Trail on Town owned property. PMLD would also request the Town of Princeton to give DCR, ownership and control of any unused portion of the Wind Farm so that it could not be developed in the future. This could potentially add approximately 5-8 acres of land to the reservation at no cost to DCR.

Electric Service to Mountain Road Visitors Center: PMLD will design and install an underground electrical service to the new Mountain Road Visitors center. The design and installation will include approximately 300' of conduct, underground conductors, and connection to PMLD's electrical distribution system at no cost to DCR.

Renewable Energy Static Display and Kiosk: PMLD will provide and install renewable energy education kiosks at the new visitor's center or existing visitors facility on Mountain Road valued at approximately \$3,000. The material would include information related to renewable energy production and energy efficiency. PMLD will also provide and install a static display on Stage Coach Trail and on the summit of Wachusett Mountain to highlight information related to the wind farm for hikers and visitors to the reservation.

Solar Energy Demonstration Project: PMLD will provide and install a 300W, solar panel system, to demonstrate the latest technology in solar energy technology at the existing or new visitor's center on Mountain Road. This solar energy demonstration project would reduce the Wachusett Mountain Visitors Center's actual energy consumption, save money, and act as a renewable energy educational tool for the public. Solar panels and renewable energy displays would also demonstrate DCR's commitment to both protecting the natural environment and utilizing renewable energy.

Overhead Electrical Service to Mountain Summit: The overhead electric service to the summit of Wachusett Mountain is approximately fifty years old and includes 50 utility poles and over one mile of electrical conductors. DCR, as the owner, is responsible for all preventative and corrective maintenance to this electric service. PMLD has performed preventative and corrective maintenance on this electric service at no cost to DCR over the last 10 years. The annual costs are approximately \$5,000 - \$15,000 depending on how much damage is caused by weather related events. PMLD will continue to provide preventative and corrective maintenance at no cost to DCR and assist DCR is designing a new electric service to the summit.

New Access Road to Summit: PMLD understands that a new access road will be constructed to the summit of Wachusett Mountain. This project should incorporate a new underground electrical service to the summit, to replace DCR's existing overhead electric service mentioned above. PMLD will design and connect the new underground service for DCR at no cost. The approximate value of these services is \$20,000 - \$25,000.

Renewable Energy: As a customer of PMLD, the Wachusett Mountain Visitors Center will receive a large percentage of its electricity from renewable resources. The new wind farm and existing hydroelectric power supplies would increase the percentage of renewable energy delivered to the Wachusett Mountain Visitors Center to approximately 40% at no additional cost or premium. DCR could take advantage of this fact and actively market its commitment to protecting the environment by utilizing a significant amount of reliable and cost effective renewable energy.

Educational Seminars and Tours: PMLD will continue to provide personnel and material resources to help educate visitors to the reservation about wind energy and its associated environmental benefits. Since 1984, PMLD has conducted various educational seminars about renewable energy for students, teachers, and reservation visitors. PMLD has also participated in nature hikes with DCR staff to educate visitors about renewable energy as they hike to the summit Wachusett Mountain. PMLD believes that our new wind farm will draw more visitors to the reservation and lead to a greater awareness of renewable energy and its place in our environment.

Road Improvements to Stage Coach Trail: PMLD will maintain the access road at no cost to DCR and will repair the culverts at the beginning of Stage Coach Trail. PMLD's maintenance will include culverts, water dams, and periodic grading of the access road to ensure the road is maintained in an esthetically pleasing manner.

Signage: PMLD will provide and install appropriate signage around the wind farm to instruct visitors as to the various safety considerations while hiking through and around the area of the wind farm.

Stage Coach Trail Parking Area: In order to improve access to the reservation and enhance vehicle/pedestrian safety, PMLD proposes to install a parking area on DCR owned land at the Intersection of Stage Coach Trail and Westminster Road. A new, crushed stone parking area could accommodate up to 10 vehicles. Vehicles must currently park along the side of Westminster Road, because of the lack of any dedicated visitor parking spaces for visitors to the reservation.