



Town of Orleans
Wind Energy Committee

Report to the
Board of Selectmen

June 30, 2006

Final Submittal

Acknowledgments

This report prepared by the Town of Orleans Wind Energy Committee is the result of the effort and input from many organizations and individuals.

The citizens of Orleans, Massachusetts, through the Orleans Citizen's Forum, elected officials, town meeting votes, feasibility study funding, dedicated town staff and volunteers developed and provided ongoing support. Shared experiences were learned from neighboring towns including: Eastham, Brewster, Harwich, Yarmouth, Dennis and Falmouth. Hull, Massachusetts provided information, tours and encouragement based on the success of wind energy at the Hull Municipal Light Plant. Orleans wind energy progress was shared with communities of Western Massachusetts through the Berkshire Renewable Energy Collaborative. Community education and outreach in Orleans was provided with assistance of John Hodgkinson and Nicolas Armenti, members of the Cable TV and Telecommunications Advisory Committee. Production assistance by Jim Tviridik in coordination with Local Channel 17 Lower Cape TV was provided for broadcast of public information about renewable energy and the Orleans Wind Energy project. Thanks also to Brooks Woods, Liz Argo, Argo Video Productions, Chuck Kleekamp and Tom Wineman for their support and input.

Town of Orleans staff and professionals provided support, including: from the Planning Dept, George Meservey, Karen Sharpless, John Jannell; Finance, David Withrow; the Conservation Office, Leslie Derrick and Jenny Wood; Town Assessor Ken Hull; Town Administrator's Office, Ann LeMaitre and John Kelly; Town Clerk, Cynthia May; and the Water Department, Sue Brown, Todd Bunzick and Lou Briganti.

Barnstable County and the Cape Cod Commission provided technical, financial and legal assistance, including: a distributed generation assessment, wind resource mapping and model bylaw for land based-wind energy facilities. Barnstable County provided significant legal assistance through Jonathan Klavens, Attorney with Bernstein, Cushner and Kimmell, P.C., to the Town of Orleans for help with energy law issues, Federal, State and local regulatory issues and research of the Energy Policy Act of 2005. Jonathan Klavens and Town Counsel Michael Ford represented the Town of Orleans in project related-agreements.

The Town of Orleans Finance Committee members reviewed and made project recommendations. In addition to the Finance Committee -Wind Energy Committee liaison Vic Noerdlinger, the following members also participated in Wind Energy Committee meetings: Yoshio Inomata and Peter Monger.

Contributions from many citizens were made to the project. Paul Ammann provided technical analysis to the project. In addition, the Town hired the team of Birch Tree Capital, LLC to evaluate project economics.

Massachusetts Technology Collaborative (MTC) and their consulting team of University of Massachusetts Renewable Energy Research Lab, R.W. Beck, Global Energy Concepts, LLC and Wilmer, Cutler & Pickering and Hale and Dorr LLP provided significant financial, technical and legal assistance. The MTC consulting team members who supported the project included: Steve Weisman (formerly of MTC), Kristen Burke, Diedre Matthews, Sonya Mitchell, Richard Elrick (formerly of MTC), Jason Gifford, Matt Schemmel, Nils Bolgen, Warren Leon, Rob Pratt (formerly of MTC), Paul Cleri, Charles Vansant, Gregory Brown, Tony Rogers, Sally Wright, Kevin Smith and Mark Kalpin.

Finally, the advancement of this project was possible because of the leadership and dedication of: Ann Hodgkinson, Charles Groezinger, Kenneth McKusick, Robert Rich, John Wherry - the Board of Water Commissioners; and, Margie Fulcher, Jon Fuller, David Dunford, John P. Hinckley, Jr. and Mark Carron - the Board of Selectmen.

Disclaimer

This report was prepared by the members of the Town of Orleans Wind Energy Committee listed below as an account of the work charged by the Board of Selectmen. Neither the Town of Orleans Wind Energy Committee, Board of Selectmen, Board of Water Commissioners, nor any person or organization acting on behalf of any of them:

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David Dunford	Board of Selectmen Liaison
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Ann Hodgkinson	Past Regular Member
John Kelly	Ex-Officio
George Meservey	Ex-Officio
Victor Noerdlinger, Jr.	Finance Committee Liaison
Richard Philbrick	Regular Member
John Wherry	Past Regular Member
Margaret "Peg" Wineman	Regular Member



Further information about this report may be obtained by contacting Town of Orleans, 19 School Rd., Orleans, MA 02653 or

www.town.orleans.ma.us or (508) 240-3700.



Horse Drawn Vehicles by the Fulcher Blacksmith shop on Court



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Introduction

The Town of Orleans Board of Selectmen, on June 5, 2003, established the Wind Energy Committee (Committee) and charged them to evaluate the economic and practical feasibility of operating a one-plus megawatt wind-powered generator on Town property, primarily to power the production of drinking water. The anticipated increase in electricity requirements of the, at the time, planned Iron & Manganese Water Treatment¹ plant was a factor in the Town decision to establish and fund this effort.

Tasks of the Wind Energy Committee

- (1) Install a test tower to evaluate the wind resource (1 year);
- (2) Evaluate and recommend appropriate equipment based on Water Department demand;
- (3) Conduct a financial analysis based on current and projected future market;
- (4) Identify demand cycles of other municipal facilities and evaluate potential to connect to wind power;
- (5) Identify necessary equipment and costs for facility connections and metering;
- (6) Recommend options and legal requirements for use or sale of excess power generated;
- (7) Explore the downstream potential for solving intermittency problems inherent in wind resource.

¹ The water treatment plant commenced full operation by the Water Department in March, 2005.

Summary Schedule Of Accomplishments

The Committee held fifty-five (55) meetings² beginning June 25, 2003 through June 21, 2006. Committee meetings explored, discussed and deliberated a broad range of issues such as watershed protection, wind turbine technologies, meteorological data, financial models, turbine specifications, environmental permitting, electric distribution franchise, electrical grid interconnection requirements, state and federal energy policy and regulations and, finally, but not the least was, to educate the Committee, town officials, and the community throughout the term of the project. Meetings were held with representatives from the Towns of Brewster, Chatham, Dennis, Eastham, Harwich, and Yarmouth, also pursuing wind energy studies, to share information and mutual experiences.

Key Wind Energy Project Milestones

- **September, 2003: Orleans becomes first MTC Community Wind Collaborative member;**
- **October, 2003: 50 meter (160-ft) high meteorological test tower installed by UMass Renewable Energy Research Lab with funding by MTC;**
- **May, 2004: Annual Town Meeting approves wind energy zoning bylaw;**
- **March, 2005: Feasibility Study Completed, identifies up to six locations suitable for wind power in the watershed;**
- **May, 2005: Annual Town Meeting approves lease of watershed for up to two (2) “1.5 megawatt class” turbines;**
- **December, 2005: MTC and Town execute Host Community Agreement defining roles and responsibilities to advance project. MTC places order to Vestas for (2) 1.65-MW turbines;**
- **May, 2006 Annual Town Meeting approved modification of alternate turbine lease location to minimize watershed impact.**

² The Wind Energy Committee estimated the total value of investment by all parties to the Orleans-MTC wind energy project through June, 2006 in the Appendix.

Summary Recommendations

The Committee recommends the Town consider the following near-term and long-term next steps to advance the wind energy project and renewable energy efforts in the future.

- (1) The proposed wind energy turbines and financial arrangements by MTC under a revocable license and long-term lease with the Town should be advanced to a successful installation;
- (2) The increased effort provided by the Water Department and Board of Water Commissioners should continue to advance the project as it transitions from project concept to implementation;
- (3) The Planning Director should remain a main point of contact with MTC through project implementation for project continuity;
- (4) A Project Coordinator, assigned to the Town, should be established and filled prior to MTC selecting the construction contractor to insure that Town Protective Conditions and overall communication is maintained among all parties involved through the duration of facility installation, including testing and commissioning;
- (5) The Water Department, upon completion of the proposed project, should consider additional uses of the wind generated-electricity to maximize benefit to the Town. Some additional uses could include connection of additional well pumps and future plug-hybrid electric town vehicles;
- (6) Town municipal facilities, beyond the Water Department, should consider the applicability of and appropriate use of renewable energy facilities (including wind turbines and photovoltaics) where the wind resources, “on-site” electric load and potential project economics appear to be favorable;
- (7) Consider creating at some future time, a Committee to study the intermittency issue and on-site storage of energy when the technology, costs and grants become available to explore this future opportunity;
- (8) Finally, consider the land acquisition needs that may be used to support future renewable energy facilities for the benefit of the Town.

Background

The Town of Orleans Annual Town Meeting on May 12, 2003³ established funding for a feasibility study to explore options to utilize wind generated electricity to offset the projected increased electricity costs anticipated with the operation of the new iron and manganese treatment plant. The feasibility study contemplated several facets of a wind turbine project, including installation of a test tower to measure the wind resource, evaluation of the coincidence of supply versus electricity demand of the Water Department, financial potential, and necessary equipment and contracts with NSTAR and others.

As a result of the Restructuring Act of the Electric Utility Industry⁴ passed by the state legislature and signed into law in November of 1997, the four components of electricity supply and delivery were unbundled and separately shown on monthly bills as: (1) generation, the power plants that create the electricity that is transported to homes and facilities in Massachusetts; (2) transmission, the wires and associated facilities that transport the electricity (at high voltage levels) from power plants to distribution substations; (3) distribution, the wires and associated facilities that transport the electricity (at lower voltage levels) from distribution substations to customers' facilities and homes; and (4) customer services, which covers, among other things, metering, billing, and information services. In the electric industry as it existed before restructuring, these components were bundled and provided as monopoly services by electric companies, at prices fully regulated by the Department of Telecommunications and Energy (D.T.E.).

As of March 1, 1998, the generation component became unbundled from the other components of electric service. Customers were able to purchase generation services from entities other than their traditional electric companies. The prices that these "competitive suppliers" of generation service may charge customers are determined by the competitive market; these prices are not be regulated by the D,T.E. The Restructuring Act also permitted Towns like Orleans and the other Cape and Vineyard towns to form municipal aggregation groups, specifically the Cape Light Compact was formed in 1997, to provide competitive supply on behalf of the Towns and all electric ratepayers in the Towns.

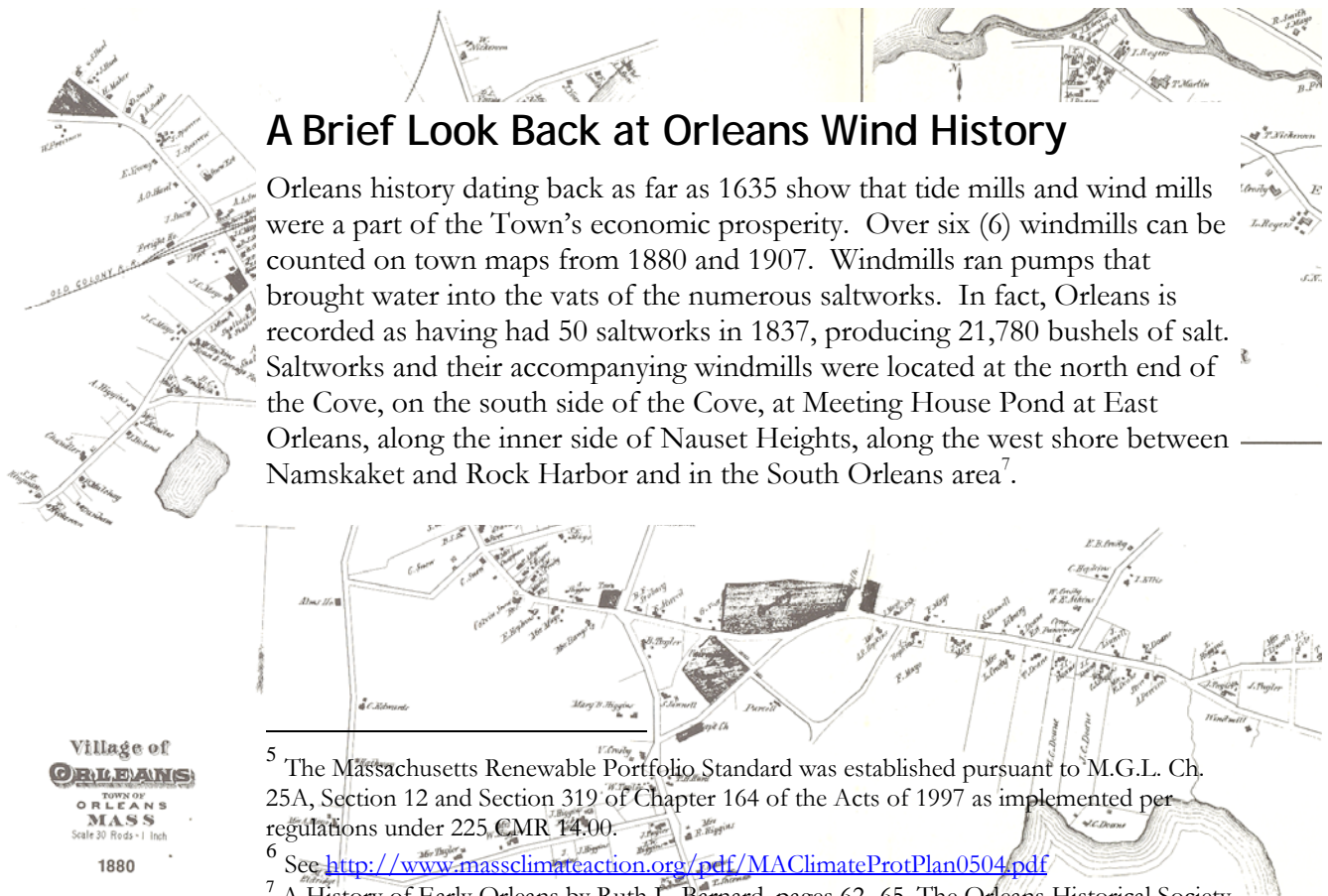
³ Town of Orleans Annual Town Meeting held on May 12, 2003, Article 5 Wind Power Feasibility Study/Management Plan.

⁴ Massachusetts Chapter 164 of the Acts of 1997.

In addition, the Restructuring Act established the Renewable Portfolio Standard (RPS)⁵ to ensure the use of and development of electricity that is generated from renewable sources in the future. The minimum RPS standard is the percentage of electricity sales from new renewable generation attributes (also referred to as Renewable Energy Certificates or RECs) sold to Massachusetts End-Use Customers by a Retail Electricity Supplier. This minimum RPS standard began at 1% in 2003, and increases by 0.5% each year until it reaches 4% in 2009. Currently, in 2006, the RPS minimum standard is 2.5%.

The introduction of a “competitive marketplace” through the Restructuring Act and the combination of unbundled generation and RECs provide two revenue streams for renewable energy projects, like the Orleans-MTC wind energy project.

The environmental benefits are, in part, reflected in the value of RECs but also provide locational benefits to the host community. The Commonwealth of Massachusetts Climate Protection Plan (Spring, 2004) specifically references Community Wind projects with support by the Governor and DEP⁶. The Appendix provides further information about environmental benefits of wind.



A Brief Look Back at Orleans Wind History

Orleans history dating back as far as 1635 show that tide mills and wind mills were a part of the Town’s economic prosperity. Over six (6) windmills can be counted on town maps from 1880 and 1907. Windmills ran pumps that brought water into the vats of the numerous saltworks. In fact, Orleans is recorded as having had 50 saltworks in 1837, producing 21,780 bushels of salt. Saltworks and their accompanying windmills were located at the north end of the Cove, on the south side of the Cove, at Meeting House Pond at East Orleans, along the inner side of Nauset Heights, along the west shore between Namskaket and Rock Harbor and in the South Orleans area⁷.

⁵ The Massachusetts Renewable Portfolio Standard was established pursuant to M.G.L. Ch. 25A, Section 12 and Section 319 of Chapter 164 of the Acts of 1997 as implemented per regulations under 225 CMR 14.00.

⁶ See <http://www.massclimateaction.org/pdf/MAClimateProtPlan0504.pdf>

⁷ A History of Early Orleans by Ruth L. Barnard. pages 62 -65, The Orleans Historical Society, 1975.

Discussion of Tasks

Task 1. Install a test tower to evaluate the wind resource (1 year);

On October 17, 2003, the 50 meter (about 160 ft) high meteorological test tower installation was completed and data collection started. The installation including data analysis was provided by University of Massachusetts Renewable Energy Research Lab under contract to the Massachusetts Technology Collaborative. Town Water Department staff assisted through use of feasibility funds authorized at town meeting to provide site clearing and chipping. Over the next twenty months, town staff swapped the memory chip located at the met tower base, on a monthly basis and sent it to UMass RERL staff for analysis. Quarterly, yearly and final reports⁸ were prepared and were reviewed and included as a basis for the feasibility study. During the period of measurement, October 2003 – August 2005, the mean recorded wind speed at 50 m (164.0 ft) was 5.77 m/s (12.9 mph); the prevailing wind direction at 40 m (131.2 ft) was SW.

Task 2. Evaluate and recommend appropriate equipment based on Water Department demand;

Task 3. Conduct a financial analysis based on current and projected future market;

Task 4. Identify demand cycles of other municipal facilities and evaluate potential to connect to wind power;

Task 5. Identify necessary equipment and costs for facility connections and metering;

Task 6. Recommend options and legal requirements for use or sale of excess power generated;

The completion of Tasks 2 through 6 were accomplished primarily through the Feasibility Study⁹. The Committee provided input to the scope, analysis and report produced by this study.

⁸ http://ceere.org/repl/publications/resource_data/Orleans/Reports/Orleans_Final_Report.pdf

⁹ The Wind Energy Feasibility Study was completed by the consulting team of R.W. Beck, Inc and Global Energy Concepts, LLC, under contract to the MTC. The study considered multiple wind energy plant concepts, analyzed wind data from UMass RERL, performed a feasibility

In addition, the Committee recommended and the Town contracted with the independent consulting team of Birch Tree Capital LLC to provide a better understanding of wind energy project economics and assist in financial negotiations with MTC.

The wind energy project, as currently proposed, is through a grant by MTC as part of the Low Income Energy Affordability Network whereby MTC will design, procure equipment, install, own and operate the facility under a long term lease with the Town. In addition, the MTC will provide the following financial benefits to the Town including:

- Orleans will receive an annual PILOT (Payment in Lieu of Taxes) to be initially set at \$64,000. After each three years of operation, the PILOT will be increased by 7%. (In other words, in year 4 it becomes \$68,480, in year 7 it becomes \$73,274, and so forth.).
- Orleans will have the right to use up to 170,000 free kilowatt-hours of electricity annually for the water treatment facility or other onsite facilities; and
- Orleans will have the right to purchase additional electricity, in addition to the free 170,000 kWh of electricity, for onsite use at the greater of (a) 5 cents less than the price Orleans is paying for retail electricity at the time it uses the turbine's output, or (b) the wind turbines' wholesale sale price at the time Orleans uses the turbine's output.

This public ownership financial arrangement evolved over the course of the Committee work. Two (2) prior transactional models were considered including a private ownership deal and a shared public/private model, but each were rejected due to financial and other challenges. A significant economic impact occurred to the project when MTC received proposals in November, 2005 to their RFP for turbine procurement that was greater than the project estimate by more than \$1 million¹⁰.

assessment, identified predevelopment tasks, specific site preparation work, project economics, technical data needed to prepare anticipated permits and approvals and considered on-site electric loads as well as electrical interconnection to the grid and other municipal loads. The study also included photo simulations, preliminary environmental impacts and reported conclusions and observations regarding the feasibility of the proposed project. See full report at <http://www.town.orleans.ma.us/pdf/committees/wind/finalreport.pdf>

¹⁰ MTC received a responsive bid from Vestas for their V82 1.65-MW turbine. GE turbines were not available until 2008. This high demand for turbines was created by the increased global market for wind turbines and specifically in the United States since the extension of the

Higher turbine pricing is currently being experienced due to significant global demand for wind turbines, higher energy costs and increases in raw materials (such as steel and copper). In fact, the total installed cost was \$1.48 million for the Vestas 660-kW turbine installed at the Massachusetts Maritime Academy in May, 2006. This results in a \$2,242/kW installed cost, significantly higher than MTC's Community Wind Collaborative early estimates. For comparison, the proposed (2) turbine Vestas V82 MTC-Orleans Project would total 3.3 MW of installed capacity at an estimated \$7 million would result in a \$2,121/kW installed cost.¹¹

All parties to this effort recognized that this is a "pioneering project" where significant exploration and alternative analysis was required to chart a course that had not been followed before.

Three critical elements of a successful municipal land based-wind project are:

- 1. a good wind resource;**
- 2. favorable turbine costs, and;**
- 3. significant on-site use.**

Task 7. Explore the downstream potential for solving intermittency problems inherent in wind resource.

This final task of the Committee Charge is forward thinking and recognizes the tremendous opportunity that wind energy can provide to displace the traditional electricity supply in the future. As identified in the Feasibility Study and confirmed through detailed discussions with the Water Department, the "on-site" use of wind generated power for the water treatment plant and related facilities will not always be matched with the power from wind. There will be times when wind produced-energy will exceed the "on-site" needs and sold through power purchase arrangements to benefit the Town and the Region. However, if there were an ability to store some or all of this excess power it could be used when the wind was not blowing or to serve increased electrical energy needs. References to future hydrogen storage facilities are included in the Appendix.

production tax credits for renewable energy projects was approved in the Energy Policy Act of 2005 in August of 2005.

¹¹ The Town of Orleans May, 2003 Town Meeting article that commenced the wind energy feasibility study, and the Town Capital Plan, contemplated a 1.5-MW turbine at a total cost of \$1.5-million at a very low and unrealistic installed cost at \$1,000/kW.

List of References and Photo Credits

- UMASS RERL (wind data and reports)
http://www.ccere.org/rerl/rerl_resourcedata.html
- MTC Clean Energy (Wind Fact Sheets)
<http://www.mtpc.org/renewableenergy/cleanenergy>
- Cape Cod Commission (Wind Energy Bylaw)
<http://www.capecodcommission.org/windenergy/>
- Town of Orleans
<http://www.town.orleans.ma.us/>
- Photo Page 2 – South Orleans Mill: Souvenir Booklet, American Revolution Bicentennial 1776-1976, Orleans Bicentennial Commission, 1975. Pg. 43.
- Photo Page 3 – Jonathan Young Windmill, Orleans: Cochran, Betsy. Flotsam and Jetsam, Eelman’s Press, Ithaca, NY, 2003.
- Photo Page 3 – Fulcher Blacksmith Shop on County Road in Orleans Center: Souvenir Booklet, American Revolution Bicentennial 1776-1976, Orleans Bicentennial Commission, 1975. Pg. 26.
- Photo Page 3 – Massachusetts Maritime Academy Vestas 660 Turbine installed Spring, 2006. <http://www.maritime.edu/>
- Photo Page 3 – Wind Farm (location unknown): Cochran, Betsy. Flotsam and Jetsam, Eelman’s Press, Ithaca, NY, 2003.
- 1880 Map Village of Orleans: Barnard, Ruth L. A History of Early Orleans. The Orleans Historical Society, Orleans, Massachusetts, 1975.

Glossary of Terms¹²

Anemometer – A device to measure the wind speed.

Average wind speed – The mean wind speed over a specified period of time.

Blades – The aerodynamic surface that catches the wind.

Brake – Various systems used to stop the rotor from turning.

Cut-in wind speed – The wind speed at which a wind turbine begins to generate electricity.

Cut-out wind speed – The wind speed at which a wind turbine ceases to generate electricity.

Density – Mass per unit volume.

Grid – The utility transmission and distribution system. The network that connects electricity generators to electricity end-users.

Inverter – A device that converts direct current (DC) to alternating current (AC).

kW – Kilowatt, a measure of power for electrical current (1000 watts).

kWh – Kilowatt-hour, a measure of energy equal to the use of one kilowatt in one hour.

MW – Megawatt, a measure of power (1,000,000 watts).

Nacelle – The body of a propeller-type wind turbine, containing the gearbox, generator, blade hub, and other accessory parts.

O&M Costs – Operation and maintenance costs.

Power Coefficient – The ratio of the power extracted by a wind turbine to the power available in the wind stream.

¹² Selected terms from U.S. Department of Energy, Wind Energy Program
<http://www.eren.doe.gov/wind/>

Power Curve – A chart showing a wind turbine’s power output across a range of wind speeds.

Rated output capacity – The output power of a wind machine operating at the rated wind speed.

Rated wind speed – The lowest wind speed at which the rated output power of a wind turbine is produced.

Rotor – The rotating part of a wind turbine, including either the blades and blade assembly or the rotating portion of a generator.

Rotor diameter – The diameter of the circle swept by the rotor.

Rotor speed – The revolutions per minute of the wind turbine rotor.

Start-up wind speed – The wind speed at which a wind turbine rotor will begin to spin. See also cut-in wind speed.

Swept area – The area swept by the turbine rotor, $A = \pi R^2$, where R is the radius of the rotor.

Turbulence – The changes in wind speed and direction, frequently caused by obstacles.

Wind farm – A group of wind turbines, often owned and operated by one entity. Also known as a wind power plant.

Yaw – The movement of the tower top that allows the turbine to stay into the wind.

Appendices

Estimated Investment through June, 2006 in Orleans-MTC Wind Energy Project

Town of Orleans payments	\$9,716 ¹³
Barnstable County legal services	\$40,000
Town of Orleans in-kind support	\$33,750 ¹⁴
MTC contracted services ¹⁵	\$400,000
MTC in-kind support	<u>\$40,000¹⁶</u>
Estimated Total	<u>\$523,466</u>

Wind Energy Environmental Benefits¹⁷

A single 750-kilowatt wind turbine, operated for one year at a site with Class 4 wind speeds (winds averaging 12.5 – 13.4 mph), can be expected to displace a total of 2,697,175 pounds of carbon dioxide, 14,172 pounds of sulfur dioxide, and 8,688 pounds of nitrogen oxides, based on the U.S. average utility generation fuel mix.. The proposed Orleans-MTC wind turbines, with a total capacity of 3.3-megawatts, could provide nearly four times the environmental benefits described above.

¹³ Orleans funds from May, 2003 Town Meeting authorization toward site prep for met tower, hearing notices and independent financial analysis.

¹⁴ Estimated In-Kind project support by Town of Orleans includes: 55 committee meetings (5 members at \$50/hr) and town staff (4 hrs/wk over 100 weeks at \$50/hr).

¹⁵ MTC contracted services include engineering, legal and professional services.

¹⁶ Estimated In-Kind project support by MTC assumes staff (8 hrs/wk over 100 weeks at \$50/hr).

¹⁷ Wind Energy Fact Sheet, <http://www.awea.org>

Additional Appendices

The hydrogen storage and fuel cell information, due to large file size, is available by calling the Town of Orleans Planning Office at (508) 240-3700 Ext. 435.