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WIND GENERATION ON NANTUCKET

An Interactive Qualifying Project Proposal

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WORCESTER POLYTECHNIC INSTITUTE

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Degree of Bachelor of Science

by

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ABSTRACT

This report, prepared for the Nantucket Energy Study Committee, addresses important background information which can be used to study the feasibility of implementing land-based wind turbines on Nantucket. Through interviews with key informants and archival research, the project team addressed pertinent laws, regulations, and permits; ownership and financial arrangements; and concerns regarding implementing wind turbines on Nantucket. The project provides a timeline to address laws, regulations and permits; evaluates the financials of different turbine sizing options; recommends how to mitigate concerns; and ultimately proposes how Nantucket should proceed with their land-based wind project.

AUTHORSHIP PAGE

This report was written as a collaboration of all of the group members: Diana Berlo, Jennifer Hunt, Amanda Martori, and Justin Skelly. While some sections were written primarily by one individual, each section was read and revised by all group members to ensure clarity and make sure that the views presented in the report were the views of the group as a whole.

Disclaimer

This project was completed by a team of students from WPI for a school project and for the benefit of the Nantucket Energy Study Committee. The authors of this report are not professionals or experts in the field of wind turbine implementation. The team used information gained from interviews with local experts, organizations, and turbine owners, as well as archival research to compose this report. The data used to create the various financial analysis situations was acquired from case studies and reports, and was compiled with the help of Dave Fredericks from National Grid. This financial assessment is an estimate that is based on various stated assumptions and does not necessarily depict the actual situation on Nantucket. The report also focuses on the concerns regarding land-based wind turbine implementation on Nantucket. The paper does not focus on the benefits and advantages to wind power and should not be used to weigh concerns versus benefits. The team tried to remain objective throughout the entire project and when making recommendations to the Energy Committee.

ACKNOWLEDGEMENTS

We would like to thank our advisor, Professor Michael Elmes, and Social Science Research Professor Dominic Golding for all of their help with our project. We could not have completed this project without your feedback and support.

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Nantucket has a bright future for wind power, with high wind speeds and relatively flat open terrain. We hope that the progress made by the Interactive Qualifying Project Team will provide the Energy Committee with valuable information, analysis, and recommendations needed to expedite the process of determining the feasibility of implementing wind turbines on the island.

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EXECUTIVE SUMMARY

In 2008, the average residential cost of electricity in the United States was 10.97¢/kWh, and the average cost of electricity in Massachusetts was 16.27¢/kWh (Energy Information Administration, 2008). On the Island of Nantucket, Massachusetts, electricity rates are even higher because electricity must be transported from the mainland through two submarine cables. All Nantucket rate payers, commercial and residential, are responsible for paying a cable surcharge fee, resulting in Nantucket's substantially high electricity costs: 18.978¢/kWh in the summer and 17.924¢/kWh in the winter for residents (https://www.nationalgridus.com/nantucket/index.asp, September 6, 2008). Consequently, the Nantucket Energy Study Committee was formed in order to look at options to reduce electricity costs on the island and to ultimately make Nantucket an electricity exporter. The Committee is pursuing is the possibility of generating electricity from wind power on Nantucket. As an island, Nantucket has tremendous wind resources averaging 15-19MPH (McClelland & Knipe, 2008), making wind power a viable option for electricity generation.

The Massachusetts Technology Collaborative completed a preliminary feasibility study of Nantucket's wind resource at thirteen proposed sites from 2005-2006, and from this study the Energy Committee narrowed their focus to two sites. The goal of the Wind Generation on Nantucket Interactive Qualifying Project (IQP) was to assist the project sponsor, the Nantucket Energy Study Committee, in its efforts to map out a strategy for the development of wind power on Nantucket. The team helped to obtain valuable information required for the Massachusetts Technology Collaborative to accept a site on Nantucket for a formal feasibility study. Based on priorities of the Energy Study Committee and the team's archival research of key aspects related to wind power implementation, the IQP team formulated three objectives for their project. The objectives of the IQP were to (1) identify and prioritize pertinent laws, regulations, and permits, and organize them into chronological order to approach these requirements; (2) conduct a financial analysis and investigate ownership arrangements; and (3) investigate concerns regarding wind power implementation on Nantucket, including prioritizing these concerns and suggesting mitigation strategies. After accomplishing the stated objectives, the team provided the Nantucket Energy Study Committee with results of their studies, and recommendations for progression with the implementation of turbines on the island. The project team provided the Energy Study Committee with valuable information which the Committee used to determine how to proceed with their project plans, and allowed the Energy Committee to move forward with the Massachusetts Technology Collaborative (MTC) feasibility study, a necessary step toward implementing wind power on Nantucket.

The team scheduled weekly meetings with the project sponsor, Nantucket Energy Study Committee, and the project advisor, Professor Elmes. Following the initial meeting with the Energy Study Committee, the team scheduled interviews with key informants. The team conducted a total of twenty interviews and transcribed the interviews as they were conducted. The team employed a snowball sampling technique and conducted more interviews based on suggestions by previous interviewees, and ultimately achieved triangulation as the later interviewees suggested that the team speak with individuals that they had already interviewed. The team began analyzing the data in the fourth week, compiling relevant results, analyzing those results, and seeking feedback from the sponsoring organization. After prioritizing the results for each objective, the team drew conclusions and formulated recommendations for the Energy Committee.

The background literature was used to define the range and scope of the issues related to implementation of turbines on the island. Such issues included information regarding the current (fall 2008) energy and electricity situation in the United States; current renewable energy projects throughout the country and world; ownership and financial arrangements currently in use; pertinent laws and regulations; and public concerns. The literature also helped the team draft intelligent interview questions to ask each individual interviewee. For example, a study at the Massachusetts Maritime Academy investigated the avian impact from their wind turbine and suggested that proper siting of the turbine reduces the avian impact and that in good weather conditions birds can detect turbines and deter their flight paths to avoid collision. This allowed the team to draft questions for bird experts about the effect of fog and weather conditions on birds, as well as information such as bird populations and migrations routes specific to Nantucket that would be necessary to determine proper siting of wind turbines. The team collected data from case studies in Scituate, MA, a town without a municipal light department which is currently in the process of implementing turbines, as well as Princeton, MA and Hull, MA, which each have a municipally owned electricity utility and generation plant. These studies allowed the team to gather financial statistics, issues and issue management processes, and to gauge the extent of the project.

The team acquired factual data from reports and documents obtained from the different interviewees, such as electricity consumption and component costs from National Grid Employees, turbine costs from municipalities with wind turbines, and plant and bird nest locations from the Department of Public Works and Nantucket Conservation Foundation, as well as from comments provided during the interview itself. Factual information was used to inform the Energy Committee of current laws, regulations, and permits with which they must comply, as well as what options other towns in similar situations chose, and costs that other towns incurred over the course of their turbine implementation process. The team used the data to draw conclusions and support recommendations. The team analyzed the data by grouping interviewee comments on similar topics and the team noted the range of responses, as well as conflicts and consensus of answers to compare the comments and make recommendations to the committee. For Objective 1, the team collected and grouped laws, regulations, and permits according to function group, such as zoning, aviation, and environmental. The team then prioritized the permits by the phase of the project in which the permit must be obtained, and then suggested a chronological order, based on interviewee feedback of challenging and time-consuming permits to obtain. The team used a simple payback period breakdown as well as a projection for percent returns based on initial investment in order to analyze the financial aspects of various potential project situations that may be implemented on Nantucket and to create simple visuals showing the economics for each situation. To analyze concerns related to Objective 3, the team performed a pair-wise comparison, in which each concern was compared to each other concern, in order to create a ranking of the concerns from most difficult to mitigate to easiest to mitigate.

In order to implement wind turbines on the island, the Nantucket Energy Study Committee must obey federal, state, and local laws and regulations and must file for many permits. For example, the Committee must file a Notice of Proposed Construction to the Federal Aviation Administration, and apply for the United States Fish and Wildlife Service Incidental Take Permit. The team also analyzed the current Code of the Town of Nantucket to discern which local regulations the Energy Committee should advocate for change, such as the noise and setback distance bylaws. The team used the information acquired from interviews and the Massachusetts Technology Collaborative, in order to prioritize the local, state and federal regulations and provide a chronological order for the Energy Committee.

Social issues including aesthetics and noise; the protection of avian, plant, and animal life on Nantucket; and the financial aspects of a wind turbine project are major concerns regarding a wind power project on Nantucket. Turbine projects require public outreach programs to educate the community and gain support. People have concerns regarding noise, visual impacts, and the size of turbines, though many of these concerns can be mitigated with education. Nantucket residents and bird experts alike are concerned that wind turbines will injure or kill Nantucket's precious bird population, which contains many federal and state listed endangered and threatened species including Northern Harriers and Piping Plovers, as well as ten percent of the world's population of Long-tailed Ducks. Wind turbine projects have many associated costs, including siting, purchasing, transportation, construction, permitting, and maintenance. Due to the large upfront costs, payback is very important. The team performed a simple payback period analysis under several different conditions at both proposed sites, calculated the cumulative payback over the first twenty years, and calculated the percent return for a 250kW, 660kW, and 1.5MW turbine. Transportation to specific sites on Nantucket can be exceptionally costly if turbines larger than 660kW are selected, as any larger turbine requires a helicopter to transport the blades to the sites on the island.

Weighing all concerns, the team recommends that the Energy Study Committee implement one 660kW wind turbine at the Madaket Landfill and one to three 250kW wind turbines at the Surfside Waste Water Treatment Facility. Smaller wind turbines are more likely to receive support from the community, as the smaller turbine will be less visible, quieter, and less costly. From a financial standpoint (analyzing single 250kW, 660kW, and 1.5MW turbines), a 660kW turbine at the Landfill and 250kW turbines at the Waste Water Treatment Facility are most cost-effective, providing the shortest payback period and highest percent return on the initial investment.

Several of the team's recommendations are included in Table 1 on the following page. All recommendations are discussed in the Conclusions and Recommendations section of this report.

Table 1. Recommendations for the Energy Study Committee

Objective 1: Laws, Regulations, and Permits
Review the citizen article regarding WECS, included in Appendix E, and support the changes regarding noise levels and tower access and advocate for a change in the setback distance from a property line.
Apply for Federal Aviation Administration form 7640-1 (Notification of Proposed Construction) and Massachusetts Aeronautics Commission Airspace Review in conjunction.
FAA lighting: apply for red lights, day and night, for both of the sites.
Submit an Environmental Notification Form to the Executive Office of Environmental Affairs for review.
Objective 2: Financial Analysis and Ownership Arrangements
Put the issue of starting a municipal light department on hold.
Consider joint-venture opportunities for ownership and/or funding.
Objective 3: Concerns Regarding Wind Power for Nantucket
Work with the MTC Community Wind Collaborative to organize a Wind 101 workshop. Host information and question sessions throughout the course of the wind turbine project.
Hire and individual or organization to conduct a study of the impacts the wind turbines at each the Madaket Landfill and Waste Water Treatment Facility will have on Nantucket's avian life.
Form a bird sub-committee to inform the Energy Committee of particular nights when the turbines must be shot off to prevent massive bird kills.
Conduct studies of bird, turtle, and property value impact in the vicinity of the Bartlett's Farm wind turbine.
Conduct a study of the turbine's interference with radar and to determine if the turbines will impact Air Defense and Homeland Security Radars.
Final Recommendations
Pursue the installation of 250kW wind turbines at the Surfside Waste Water Treatment Facility.
Pursue the installation of one 660kW wind turbine at the Madaket Landfill.

INTRODUCTION

Energy supply is a major issue in the United States today. Between the effects of climate change, health hazards from fuel emissions, and rising energy costs, renewable energy is receiving increasing attention from entrepreneurs, policy makers, and the public (American Wind Energy Association, 2008). Nantucket's electricity costs are among the highest in the United States because Nantucket receives electricity through submarine cables from the mainland (Energy Information Administration, 2008; National Grid, 2008). Consequently, in 2004, the Nantucket Board of Selectman formed the Energy Study Committee to look at options to reduce fuel costs in general and electricity costs in particular (Town and County of Nantucket, Massachusetts, n.d.). Given the tremendous wind resources on the island and public concerns about the environment, the Energy Committee is particularly interested in the possibility of developing substantial electricity generation from wind power.

The goal of this Interactive Qualifying Project was to assist the Nantucket Energy Study Committee in its efforts to map out a strategy for developing wind power on the island. The IQP focused on identifying pertinent laws, regulations and permits; studying ownership arrangements and performing cost analyses; and examining concerns regarding wind power for Nantucket. The project team accomplished these objectives by gathering information primarily through archival research and interviews with key informants, many of whom were found through the use of a snowball sampling technique, in order to assist the Energy Committee in a wind turbine project that will ultimately help to reduce electricity costs on Nantucket. This report addresses the background information, which provides a better understanding of key items such as costs associated with implementing wind turbines and the affects wind turbines have on a community. The following section, Methods, outlines tasks, such as conducting interviews, continuing archival research, among other things, which were accomplished while the team was on Nantucket. Next is the Results and Analysis section, which the team used to explain key pieces of data and how the data pertained to the project. Conclusions and Recommendations follow, stating the beliefs of the team members, based on the results and analysis, and suggestions that the team has for the Nantucket Energy Study Committee. Concluding this report, the team included Appendices of relevant information, and a list of resources used to create this report.

LITERATURE REVIEW

In preparation for a project dealing with alternative energy generation and particularly wind power on Nantucket, we needed to conduct a comprehensive review of the literature. This section describes the background information necessary to understand the issues and scope of the problem faced by the Wind Generation on Nantucket Interactive Qualifying Project Team. Section 1 analyzes the current energy situation in the United States, including discussion of the different forms of energy generation available, as well as costs and benefits of each. Section 2 discusses the associated costs for a wind generation project. Discussion of relevant laws and regulations follows in Section 3. Finally, discussion in Section 4 focuses on issues and problems associated with wind power projects, these include siting, public versus private utility ownership, connection to the electrical grid, impact on residents, and impact on birds.

1. Electricity Consumption and Costs: United States, Massachusetts, and Nantucket

Americans today are extremely dependent on electricity. The electricity industry is a massive industry that grows every day to meet the demands of the nation while striving to produce electricity at a low cost. In 2006, the United States consumed 3,669.963 billion kilowatt hours of electricity, with Massachusetts alone consuming 57.228 billion kilowatt-hours. At an average (2008) cost of 10.97¢/kWh in the United States, residential consumers spent $402.60 billion dollars on electricity, and Massachusetts, with an average cost of 16.27¢/kWh, residents spent $9.31 billion (Energy Information Administration, 2008). While Massachusetts has the third highest electricity costs in the continental United States, Figure 1 shows that Nantucket has even higher costs: 18.978¢/kWh in the summer and 17.924¢/kWh in the winter (https://www.nationalgridus.com/nantucket/index.asp). Annual average residential electricity rates in Nantucket are approximately 17% higher than the average Massachusetts residential rate. This is because National Grid imposes a cable surcharge to cover costs associated with transmission through submarine cables to the island, which, as Figure 2 shows, totals nearly 16% of a Nantucket resident's electricity bill. Assuming the average residential unit consumes 920 kWh of electricity each month (Energy Information Administration, 2006), a Nantucket resident pays about $25 more per month in the summer and $15 more in the winter than the average

Massachusetts resident. The high electricity rates provide a strong incentive for the Nantucket Energy Study Committee to consider other options for obtaining electricity.

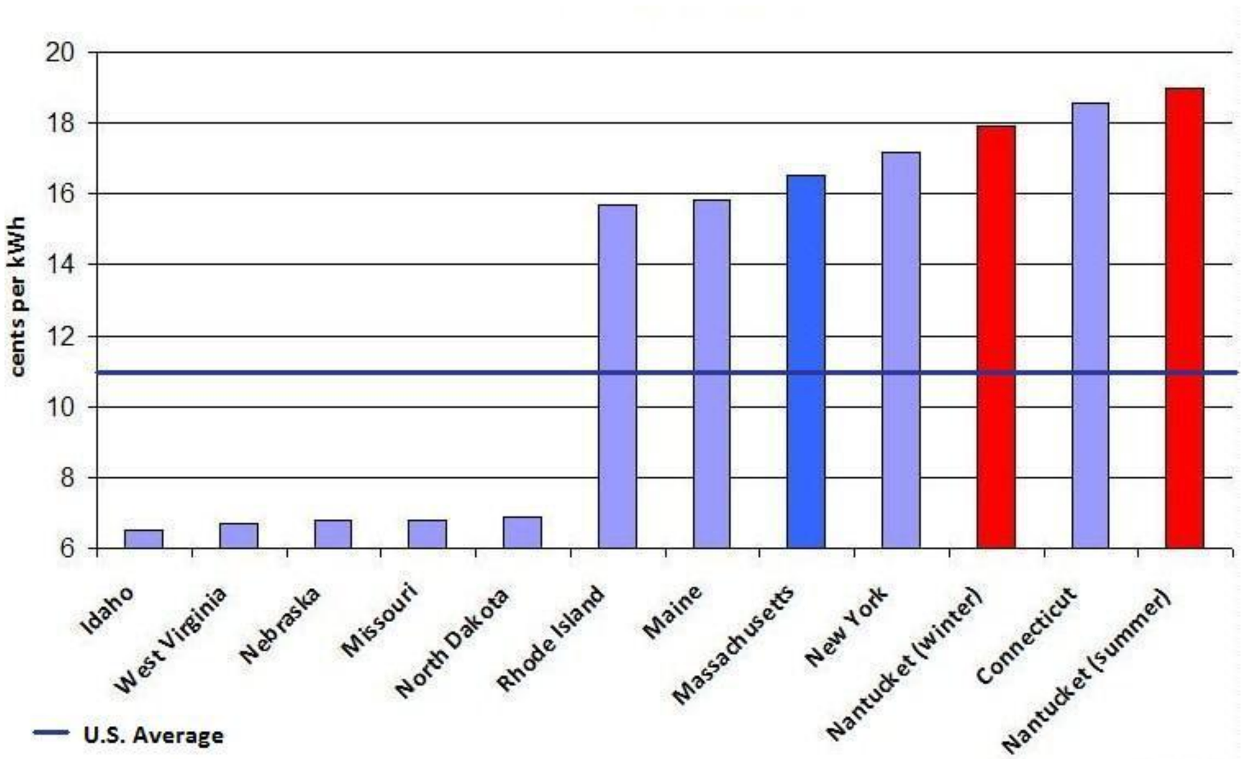


Figure 1. Average Electricity Costs: U.S., Nantucket, and Most and Least Expensive States. This graph shows the average electricity costs in the five least and most expensive states in the continental United States, and Nantucket. Adapted from http://www.eia.doe.gov, "Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State" and https://www.nationalgridus.com/nantucket/index.asp

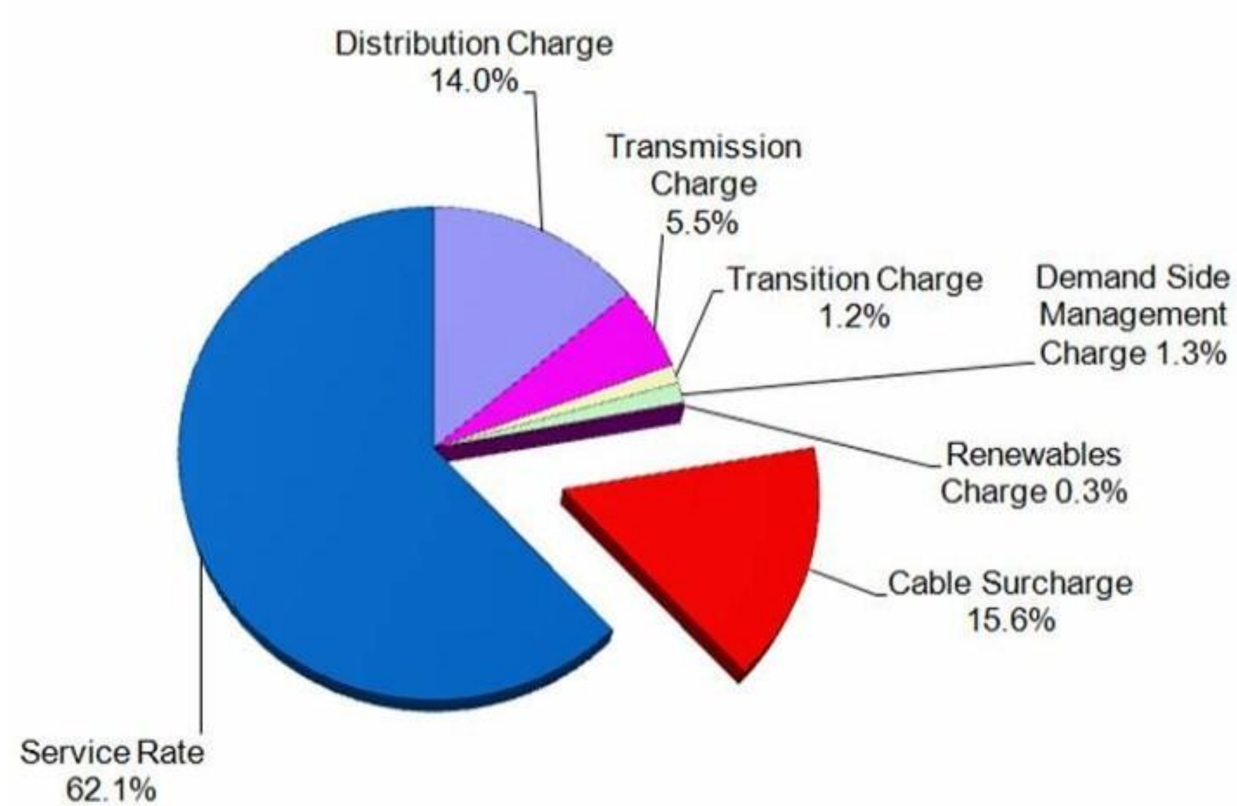


Figure 2. Breakdown of electricity charges for Nantucket residents. Adapted from https://www.nationalgridus.com/nantucket/index.asp

1.1. Fossil Fuels

Most of the electricity in the United States is generated by burning fossil fuels. As Figure 3 shows, fossil fuels accounted for 70% of all sources of electricity production in the United States, and just 9.5% of electricity consumption came from renewable resources in 2006 (http://www.eia.doe.gov/). Fossil fuels are non-renewable resources. Humans are consuming the earth's fossil fuels supply much more rapidly than fossil fuels form, depleting reserves. A combination of the rapid depletion and harmful effects of burning fossil fuels has caused an increased interest in developing renewable energy (U.S. Department of State, 2006).

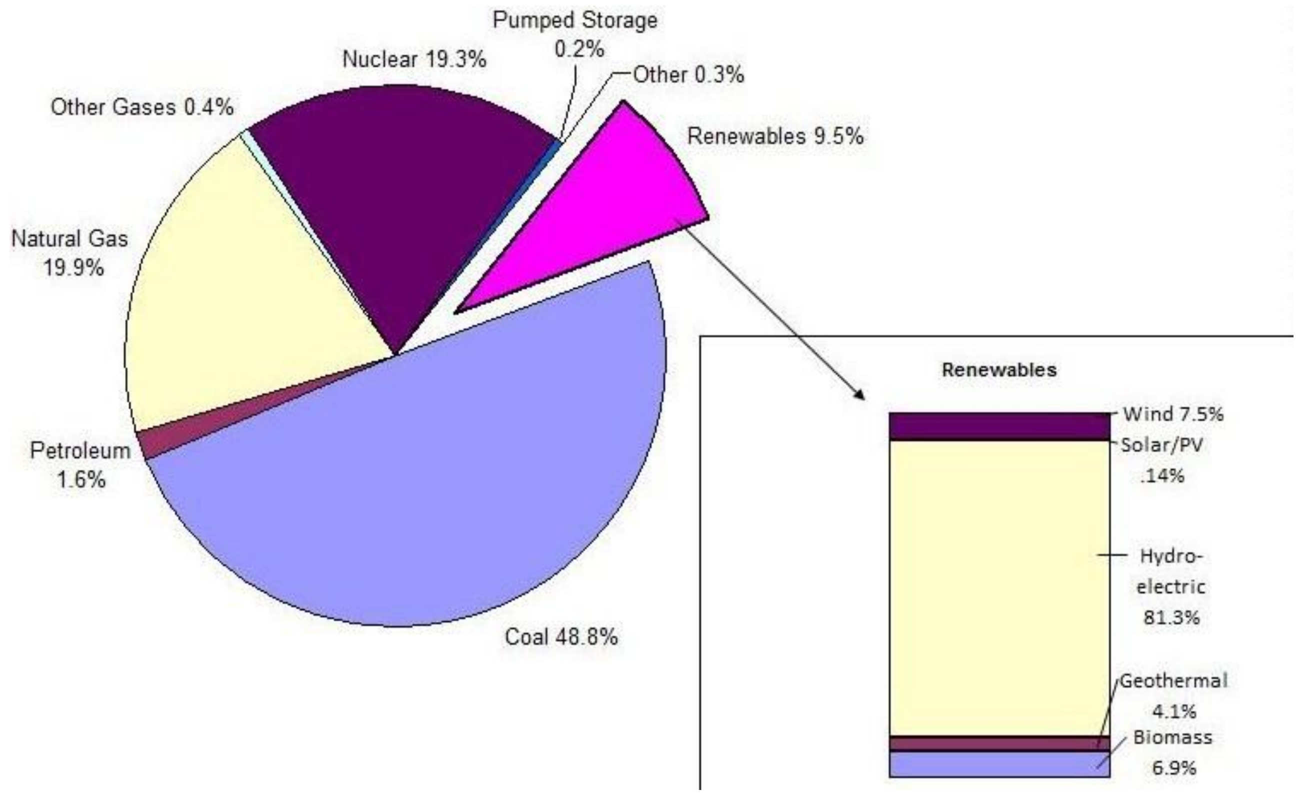


Figure 3. Fossil fuels (coal, petroleum, and natural gas) account for more than 70% of sources used to produce electricity in the United States, and wind power accounts for less than 1%. Adapted from http://www.eia.doe.gov/

Fossil fuels are burned for heating and to power steam turbines which produce electricity. The burning of fossil fuels produces large amounts of carbon dioxide and other activities associated with the mining and processing fossil fuels produces large amounts of methane. In 2004, 94% (5656.6 teragrams, or 5656.6×10^{12} grams) of all carbon dioxide emissions were a result of the burning of fossil fuels and 36% (200 teragrams of CO_2 equivalent) of methane emissions resulted from activities involving fossil fuels (U.S. Department of State, 2006). Carbon dioxide and methane are two of the dominant greenhouse gases. These emissions remain in the atmosphere and trap the sun's heat, contributing to climate change, including global warming. Global warming increases the earth's average temperature, melting ice caps and causing the ocean level to rise. Fossil fuel use also produces other pollutants, such as particulates, ozone, mercury, and benzene, a carcinogen, that can lead to health problems such as asthma, cancer, and other lung infections (Wilkinson, Smith, Beevers, Tonne and Oreszczyn, 2007, p.1180; Awosika-Olumo, Lester, and Raouf, 2005, http://www.epa.gov/).

1.2. Renewable Energy

Renewable energy sources are alternatives to fossil fuels which are continually replenished and do not create emissions. Wind power, wave power, tidal power, and solar power are examples of renewable energy sources. Renewable energy is becoming increasingly popular, growing from just 1.5% of total electricity generation in the United States in 2000 to 9.5% in 2006 (Energy Information Administration, 2007, Electricity Net Generation). Figure 3, above, shows that of the 9.5% of electricity generated from renewable resources just 7.5% is generated from wind power.

1.2.1. Wind Energy

Wind energy has many benefits, including producing no direct emissions[1] while generating electricity at a reasonable cost. The efficiency, or capacity factor, of wind turbines continually increases with improved manufacturing processes, siting techniques, and operating procedures. Since the 1980s, the cost to install turbines has decreased, as shown in Figure 4, and the cost to produce electricity from wind turbines has decreased by a factor of 20 (U.S. Department of Energy, 2008, Cost Trends). The cost to produce electricity from a wind turbine is directly related to the cost of developing the land, purchasing components, and constructing and maintaining the turbine. These costs are fixed and completely independent of fuel costs, allowing the long term electricity generation cost to be determined in the early stages of turbine implementation (American Wind Energy Association, 2007; Manwell, McGowan, Rogers, Ellis, and Wright, 2004, p.2). A combination of these factors and the increasing costs of fossil fuels, leads to the increasing cost effectiveness of wind turbines as a means of electricity generation. Wind energy is a resource that is available almost everywhere[2], and unlike most forms of electricity generation, wind power does not require water and can be used in remote locations that cannot easily or cheaply be connected to the electricity grid (Pasqualetti, 2000). While Keith et al. (2004) recognize that wind power can produce electricity without emissions; they argue that wind power does in fact have effects on climate. Turbines create increase in drag in the atmosphere as they extract energy, and this creates a very small temperature increase. While

[1] Arguably, some pollutants are emitted during the process of manufacturing and shipping parts, as well as in the maintenance of turbines and infrastructure.

[2] While wind exists almost everywhere, wind speeds determine whether turbines can effectively capture wind energy. See http://www.windpoweringamerica.gov/wind_maps.asp for more information about wind resources in the United States.

the impact that wind power has on the atmosphere is small compared to the impact of fossil fuels, this impact cannot be ignored. Despite the objections, such as noise, visual disturbance, and avian impacts (see Section 4 below), faced by many entities proposing the construction of wind turbines, researchers and scientists unanimously agree that extracting energy using wind power has substantially fewer adverse effects on the environment than does the use of fossil fuels (AWEA, n.d., Wind Energy and the Environment; Northeast Sustainable Energy Association, 2001). Thus, wind energy is a major untapped resource with great potential.

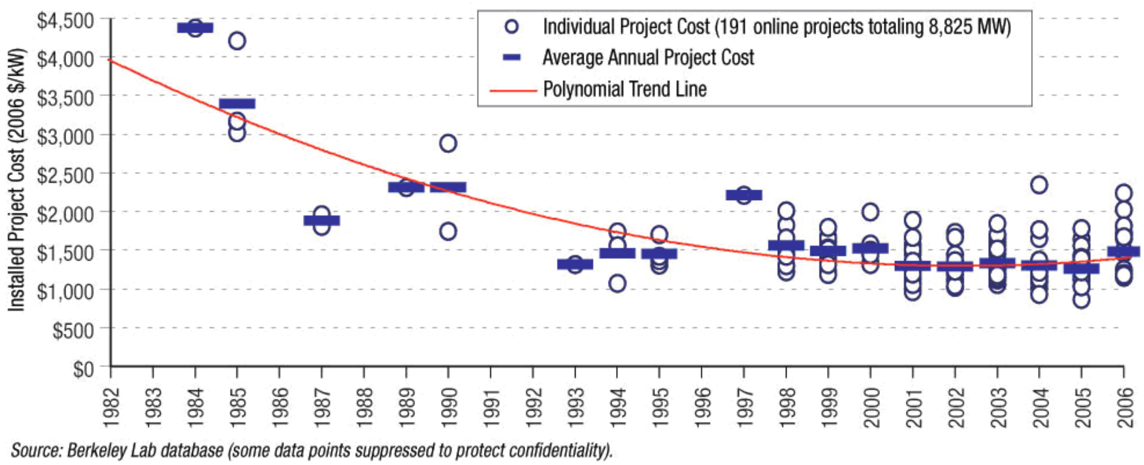


Figure 4. Installed Wind Project Costs Over Time. Since 1982, the cost to install a wind turbine has decreased by more than 50%. From U.S. Department of Energy, Energy Efficiency and Renewable Energy, *Cost trends*.

1.3. Wind Resource on Nantucket

Wind speeds are one of the critical factors that can determine the economic success of a turbine project. Areas that have wind speeds over approximately 6.5m/s or 17mph are adequate for implementing wind turbines. Below is a wind map of Massachusetts, the areas that are dark green or darker have sufficient wind resources for wind power production. The map shows that Nantucket and the waters surrounding the island are some of the most abundant wind resources in Massachusetts (RERL, 2008). Due to the abundant wind resource available on the island, investigating wind energy solutions is an obvious option.

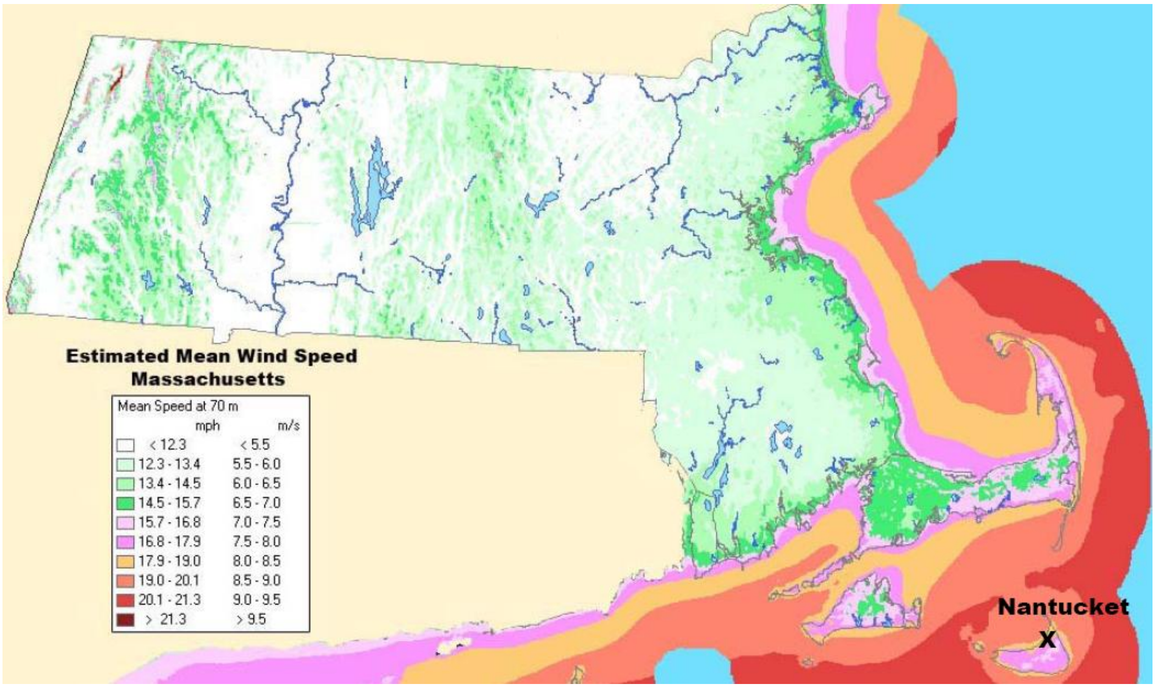


Figure 5. Massachusetts Wind Speed Map. From Wind Power in Nantucket: Siting Considerations for a Wind Turbine, *Renewable Energy Research Laboratory, University of Massachusetts at Amherst*

The wind speed map of Massachusetts (Figure 5) shows that Nantucket has some of the highest wind speeds in the state. For over a year, the Renewable Energy Research Laboratory (RERL) at the University of Massachusetts at Amherst collected and monitored wind data on the island. One of the anemometers collected wind data at a height of 70 meters which is equivalent to the height of the Vestas 1.65MW turbine, a turbine identified by the Energy Committee for potential use on Nantucket. The RERL created Figure 6; this map shows the estimated annual mean wind speeds on the island of Nantucket. It was determined that wind speeds on Nantucket average 17mph, an ideal speed for the use of wind turbines for electricity generation. The map also shows the ten sites (green stars) that were identified through the RERL technical survey as potential locations for wind turbines (RERL, 2008).

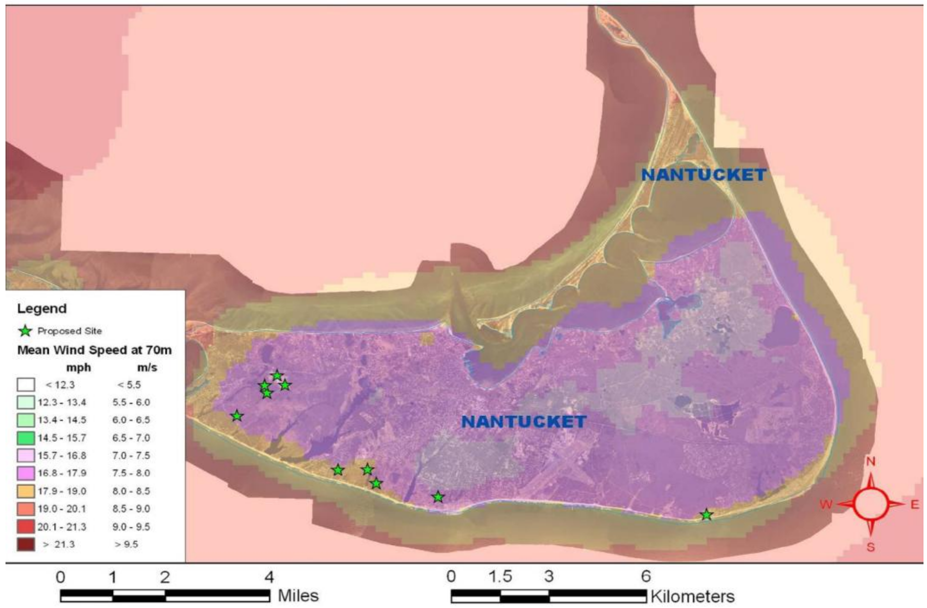


Figure 6. Nantucket Estimated Annual Mean Wind Speeds at 70 Meters and Potential Sites for Turbines. Adapted From Wind Power in Nantucket: Siting Considerations for a Wind Turbine, *Renewable Energy Research Laboratory, University of Massachusetts at Amherst*

1.4. Wind Turbines

Wind energy is an increasingly popular form of renewable energy around the world. Figure 7 shows that worldwide installed capacity has increased from 7,475 MW in 1997 to 93,849 MW in 2007 (WWEA, 2008).

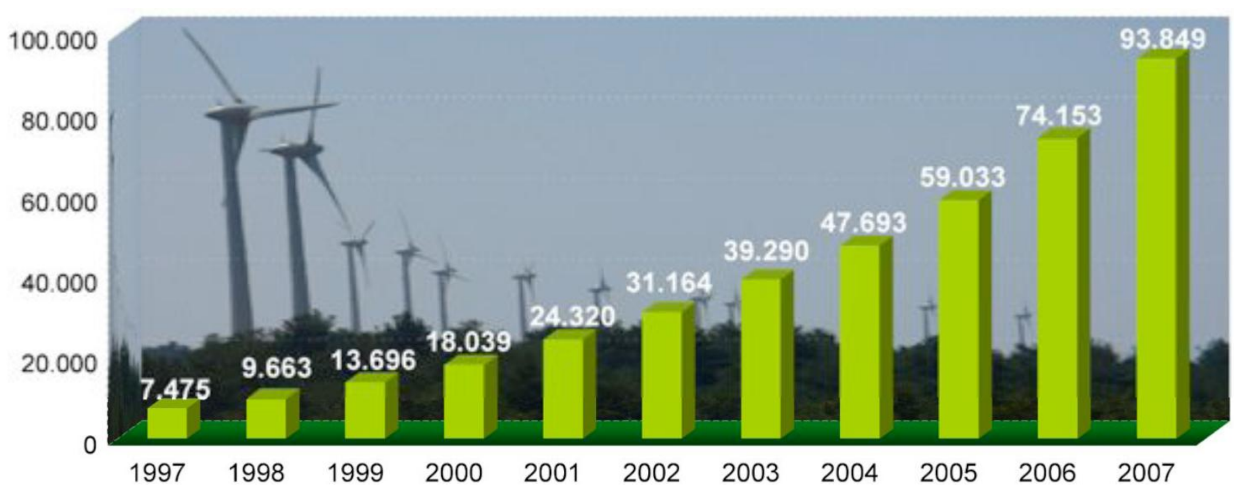


Figure 7. Worldwide Installed Wind Capacity 1997-2007. From http://www.wwindea.org/home/images/stories/pr_statistics2007_210208_red.pdf

The use of wind power is also growing in the United States which increased its wind power capacity by 45% from the beginning to the end of 2007. The United States ended up investing over $9 billion in 2007. These wind turbines are projected to generate 48 billion kilowatt-hours (kWh) in 2008, accounting for a little more than 1% of the country's electricity (AWEA 2008). Figure 4 shows that, in 2007, wind power was used in 34 states, with Texas as the U.S. leader in wind energy.

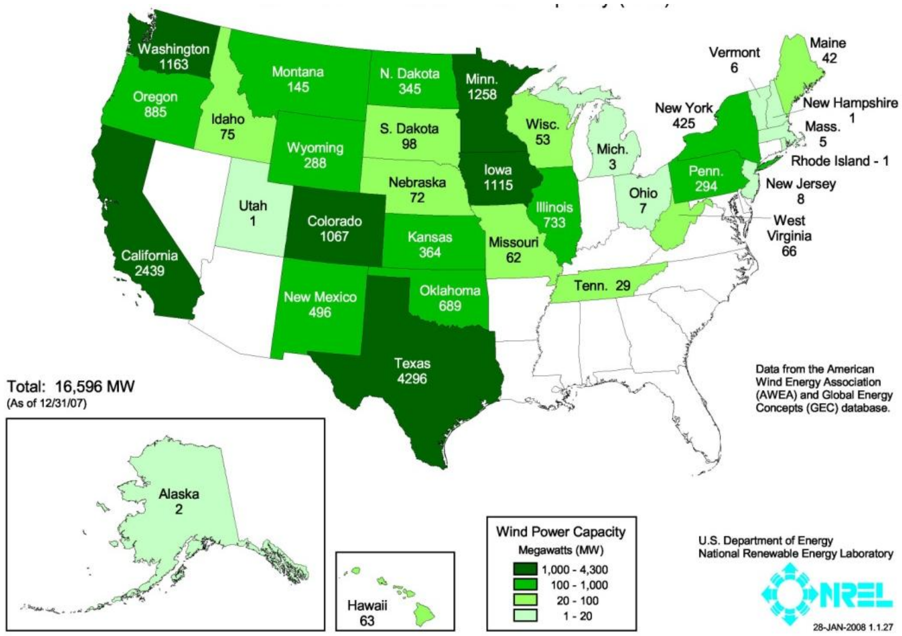


Figure 8. U.S. Wind Turbine Power Capacity Distribution, 2007. From http://www.eere.energy.gov/windandhydro/windpoweringamerica/images/windmaps/installed_capacity_2007.jpg

Wind farms and turbines come in a variety of different shapes and sizes depending on the application and amount of electricity needed for the project. However, there are three main components of wind turbines: tower, rotor and generator. Each component is responsible for a specific task that is necessary to convert the wind into electricity. The tower is the support system and mounting component for the turbine. The height of the tower affects the power production of the turbine. A rotor is used to collect and remove the kinetic energy present in the wind and convert it to mechanical energy. Rotors typically consist of two or three blades. As the size of the rotor increases, the amount of power production also increases because the rotor is able to collect more kinetic energy from the wind. Finally, the mechanical energy created by the rotor is transformed into electrical energy by the generator. The generator and gearbox are contained in a housing; those three components make up the nacelle (AWEA 2004).

1.4.1. Storage

Storage of energy is an integral part of providing uninterrupted electricity in the case of plant outages. When wind turbines are added to an electricity grid that also receives electricity from other sources, such as coal and hydroelectric plants, storage for the electricity produced by the turbine is not necessary. With current technology, it is less expensive to feed power back into the electrical grid than to use a storage system on the turbine (AWEA, Wind Power & Reliability Factsheet). Since wind speeds vary constantly, the amount of wind power produced varies comparably. For this reason, wind turbines cannot produce a steady baseload power (a guaranteed amount of power production), as do coal burning plants (AWEA, n.d., Fair Transmission). Wind turbine power is effectively used when the turbine is connected to the electrical grid, because electricity plants can maintain reliability when winds are low, and wind generators can provide electricity in the case of plant or line outages. As the average amount of electricity produced by turbines increases, power plants can reduce their baseload power production (Utility Wind Integration Group 2006, p. 3). Until Nantucket is at the point of becoming self sustaining and independent from the electricity delivered through the submarine cables, including a storage mechanism for the wind turbines would be unnecessary and costly. Thus, it is most likely that any wind turbines on the island would feed electricity back into the main electrical grid.

2. Wind Generation Project Cost

The process required to implement a wind turbine or turbines is costly. The major costs associated with wind turbines include the up-front installation costs, routine maintenance, and dismantling the turbine when it is no longer useful. Fixed costs include purchasing necessary components and paying for delivery, installation, and grid connections. Currently demand for turbine components is high and supply is limited, resulting in high component costs. There are also costs associated with permitting, studies of the land, contracting, and community outreach. General costs include maintenance and paying technicians, as well as taxes and insurance (U.S. Department of Energy 2008, Cost Trends).

Another cost of operating wind turbines is the cost of transmission to the electrical grid. Due to the constant variance of wind speeds, power produced by wind turbines varies hour to hour. Utilities require a set amount of electricity be generated hourly, and the variance caused by changing wind speeds can result in expensive penalties (AWEA 2005, Economics of Wind Energy, p. 4). Some utilities charge for generation at the turbine's peak rate (the maximum amount that a turbine can produce over a short time period) rather than the average power generation, increasing the abovementioned penalties (AWEA n.d., Fair Transmission p.4). National Grid's transmission policy includes a provision allowing for a study to be conducted if the generator is expected to run under peak load. This provision would allow the owners of wind turbines to explain the intermittent nature of wind turbines and avoid some of the penalties (ISO New England 2007, p.5415). If the owner of the turbine was also the electric utility, in the case of a public utility owning the turbine, these penalties can be avoided all together.

2.1. Ownership and Financing

Ownership of a wind turbine or wind farm has a large impact of the cost of the project. Several ownership models currently exist in the United States. Such models include ownership by municipal utilities, individuals, local investors, joint limited liability corporation (LLC) and an outside corporation. The majority of private non-utility wind power projects are owned by a group of investors, who form an LLC which allows them to receive profits (and suffer losses) while protecting the individual investors from liability (Kubert, 2004, pp. 2-4, 6).

Financing options differ based on the owner of the wind turbines. Municipal utility owned wind turbines can take advantage of the Renewable Energy Production Incentive (REPI, described below in section 2.2 Financial Assistance), have access to low-cost public financing, and are less constrained by financial return requirements. Turbines under sole ownership by an individual or business may be eligible for a production tax credit (PTC, described below in section 2.2 Financial Assistance) if the individual or business has sufficient tax liability. The individual should establish the project as a limited liability corporation (LLC) to avoid personal financial liability. Local investors can use the PTC for only the portion of each individual's passive income[3], against which the PTC can be offset. LLC/C-Corporation Joint Ownership, or an ownership between individual LLC investors and an outside corporation allows for "long term ownership and financial benefits…with less up-front capital" (Kubert, 2004, p.6) from the individuals, but they receive the benefit of PTC eligibility. After ten years, once the PTC has expired, majority ownership is "flipped" to the local investors when they purchase the interest from the major corporate investor. Some key benefits associated with each ownership option are shown below in Table 1.

Table 2. Financial advantage to various turbine ownership options

	Eligible for REPI	Eligible for PTC	low-cost financing	individual liability
Municipal ownership	Yes	No	Yes	n/a
Individual ownership	No	Yes	No	No
Local investor ownership	No	Partial	No	No
LLC/C-Corporation Joint Ownership	No	Yes	No	No

Adapted from Charles Kubert's "Community Wind Financing: A Handbook by the Environmental Law & Policy Center," 2004.

Ownership of a wind turbine project affects overall costs for the project. Utility-owned wind turbines or farms have lower overall costs because utilities receive lower interest rates and longer debt payment periods than developers (AWEA n.d., Cost). These reduced rates correspond to about 30% lower-cost financing. Financing terms that are available for wind projects are less favorable than financing other "conventional" energy sources, because wind energy is still relatively new and considered "risky" (AWEA 2005, Economics of Wind Energy, p. 3). For public utility ownership, costs will be lowest if the project is internally financed (as opposed to financing by an outside corporation) and the Renewable Energy Production Incentive is used (AWEA n.d., Cost).

Financing may change throughout the course of a wind turbine project. During the development stage, the developer generally pays for permits, contracting, site studies (including

[3] Passive income: income earned from business activities in which the individual does not participate in day-to-day activities (TaxWorld, n.d.)

evaluating the location and available wind resource) and community outreach. If the developer will not be the long term owner of the turbine, "short-term bridge financing" is used during the construction stage, but if the developer will be the long term owner, construction costs are combined with developing costs and fees, as well as equipment costs, into the permanent financing of the project (U.S. Department of Energy 2008, Cost Trends).

2.2. Financial Assistance

The Federal Government has developed tax incentive programs to encourage greater use of wind power by offsetting some of the relatively high costs associated with this nascent industry. The federal production tax credit (PTC) provides a 1.5¢/kWh inflation-adjusted tax credit for wind energy produced in the first ten years of a turbine's operation. The owner of the wind turbine receives a business tax credit for each kilowatt-hour of electricity produced. This tax credit only applies to owners who sell their electricity wholesale to a utility or electric supplier. The American Wind Energy Association and over 200 other companies and organizations lobbied for the PTC extension, and in October, 2008, the United States Congress extended the PTC one year. It is now set to expire on December 31, 2009. In the few years when the PTC extension was not approved, wind power capacity dropped by over 50% from the previous year (AWEA, Legislative Affairs). Another incentive, the Renewable Energy Production Incentive (REPI) provides "a direct payment to a public utility installing a wind plant that is equal to the PTC" (AWEA n.d., Wind Energy Costs). The money to pay the REPI comes from the federal budget that requires approval by Congress, which can be very difficult to obtain (AWEA n.d., Wind Energy Costs; Union of Concerned Scientists n.d., Production Tax Credit for Renewable Energy).

In addition to the Federal Government, some states have their own forms of assistance for renewable energy projects. Massachusetts has several types of assistance including the Massachusetts Technology Collaborative (MTC) Clean Energy Pre-Development Financing Initiative and MTC Large Onsite Renewable Initiative (LORI) Grants. The MTC Clean Energy Pre-Development Financing Initiative offers renewable energy systems in New England a maximum grant of $50,000 to support a feasibility study. The Massachusetts Technology Collaborative distributes the funds acquired from the Renewable Energy Trust Fund. These funds are acquired from a small fee imposed by the state's investor-owned electric utilities and are required by state legislature. In order to receive a LORI grant the "applicant and project site must be a customer of a Massachusetts investor-owned electric distribution utility or a municipal utility that pays into the Renewable Energy Trust." Both feasibility study grants and design and construction grants are provided by the MTC's LORI grant. The purpose of the LORI grant is to aid in the expansion of renewable energy technology in Massachusetts (DSIRE, 2007). The Community Wind Collaborative (CWC) is another form of financial assistance distributed by the MTC that "offers qualified interested communities technical assistance, wind monitoring equipment, data analysis, and competitively secured resources" (MTC, n.d.). Nantucket would be eligible for CWC funding because their wind turbine project would exceed the minimum requirement of 500kW. There are several other forms of financial assistance provided by the state of Massachusetts some of which include sales tax exemptions, matching grants for communities, production incentives and state loans (DSIRE, 2007).

3. Laws and Regulations

After a site is chosen, the individual or community that is attempting to construct turbine(s) must obtain local, state, and federal permits prior to construction of the turbine(s). There are also regulations involving the Federal Aviation Administration in regards to airspace and lighting.

3.1. Permits: Local, State, and Federal

Locally, a zoning permit is required and can be obtained from the town zoning board. A town may have setback regulations that need to be considered before the project can be constructed. The project also requires a building permit that is acquired from the town building inspector. The project also needs planning board approval. An Order of Conditions, or Notice of Intent (NOI), may be required if the alteration of wetlands is to take place during any phase of the wind turbine implementation process. If applicable, the Order of Conditions can be acquired from the Town Conservation Commission (CC) (Renewable Energy Research Laboratory, n.d., p.2).

At the State level, an Environmental Notification Form (ENF) must be submitted to the Massachusetts Executive Office of Environmental Affairs (EOEA) if implementing the turbine will alter more than 25 acres of land. If more than 50 acres of land are altered, an Environmental

Impact Report (EIR) must be completed and submitted to the EOEA. The EOEA Article 97 is used to complete the ENF, or EIR, if applicable, and is relevant if protected land is needed for use or alterations at any stage in the process. Similar to the local level, a Notice of Intent (NOI) is also required at the state level to be submitted to Massachusetts Department of Environmental Protection (DEP). The same NOI is required to be submitted to the Massachusetts Natural Heritage and Endangered Species Program if any State endangered species is threatened by the project. General Access Permits and Wide Load Permits may also be required from the Massachusetts department of highways, for the transport of wind turbine related materials, or if road alterations are needed. A Project Notification Form, showing the influence the project has on historic sites, is required by the Massachusetts Historical Commission. The DEP requires that a Water Quality Certificate be submitted in accordance to the clean water act, if more than 5,000 square feet of wetlands is affected. The DEP also requires that a noise control policy be completed to ensure acceptable noise levels. To ensure the operating quality of the existing grid after the addition of wind turbines a New England Power Pool (NEPOOL) Interconnection System Impact Study is conducted by ISO New England. The Energy Facility Siting Board is involved in projects that produce more than 100 MW of electricity. The Massachusetts Aeronautics Commission should be contacted for any projects that are over 200 feet tall (Renewable Energy Research Laboratory, n.d., p.2-3).

Federally, A Notice of Proposed Construction is required by the Federal Aviation Administration, as described in section 3.2. The FAA also requires that any structure over 200 feet tall be sufficiently lighted. If the project poses harm or endangerment to a threatened or endangered species, a Habitat Conservation Plan & Incidental Take Permit must be received from the U.S. Fish and Wildlife Service. If there is discharge into wetlands, or the project creates wastewater, the U.S. Army Corps of Engineers, and the Environmental Protection Agency, respectively, must be contacted (Renewable Energy Research Laboratory, n.d., p.4).

3.2. Federal Aviation Administration Determination

Any object that extends 200 feet above ground level requires a Notice of Proposed Construction to be filed with the Federal Aviation Administration (FAA). For projects built within 20,000 feet of an airport the allowable height of the object is shorter. The FAA must issue a determination of impact for the proposed project, ensuring that the object does not negatively interfere with air traffic and radar. After filing a Notice of Proposed Construction, the FAA evaluates the potential interference by conducting a preliminary aeronautical study of the site. Based on the results of the study, the FAA issues a Determination of No Hazard to Air Navigation (DNH) or a Notice of Presumed Hazard (NPH) (Massachusetts Technology Collaborative, n.d.).

If a Determination of No Hazard is issued, the project poses no interference with airspace or radar, and construction can proceed as planned. If a Notice of Presumed Hazard is issued, the site requires an extended study to decide whether the interference is acceptable. The extended study looks at the three primary impacts to airport operation: imaginary surface penetration, operational impacts, and electromagnetic interference. An imaginary surface is the defined space around the airport and travel routes. This space is required to ensure safety in operation of the airport. Operational impacts occur when the turbines interfere with the visual flight rules or the instrument flight rules. The turbine can interfere by changing the predefined trajectory of the flight. Electromagnetic interference is caused when air traffic control receives inaccurate signals from blade movement of turbines within the range of an airports radar system. If the project is not adapted to minimize these interferences, by relocating the site or lowering the height of the turbine, a Determination of Hazard (DOH) is issued, and the project cannot continue. A DOH can be appealed to a federal court (Massachusetts Technology Collaborative, n.d.).

3.3. Green Communities Act

Massachusetts Governor Deval Patrick signed the Green Communities Act, encouraging alternative and renewable energy, in July of 2008. The act includes an array of partitions relating to energy reformation. The most pertinent to wind energy implementation is the development of a Green Communities Division (GCD) added to the Department of Energy Resources. The Act also doubles the rate of increase of funds into the Renewable Portfolio Standard. The GCD provides communities interested in renewable energy projects financial and technical assistance. The Green Communities Act requires utility companies to provide renewable energy incentives, and allows the owners of wind turbines to sell surplus electricity into the grid. Governor Patrick believes that “this legislation will reduce electric bills, promote the development of renewable energy, and stimulate the clean energy industry that is taking root here in the Commonwealth” (McDermott Newsletters, 2008).

4. Issues and Problems

Wind power is an ever-growing technology that offers an enormous amount of potential. The efficiency of wind turbines has been increasing by about 5 percent every year (Kirsner, 2003), leaving the question as to why is this form of alternative energy not used in every facet of our daily lives. While wind power may seem like an easy choice, the road to getting there is not an easy one to take. There are numerous obstacles in the way of installing and incorporating wind turbines, such as siting and ownership issues, grid connection, and public concern for various things like aesthetics, noise, and avian life.

4.1. Location and Wind Resources

Many factors need to be considered when siting individual turbines or developing a wind farm with multiple turbines. These factors include physical characteristics (wind speed, terrain), environmental factors (conservation land, avian life), and human impacts (aesthetics, noise). An analysis of the factors is done as a part of the permitting process. In regards to the mentioned laws and regulations from section 3.1, additional siting criteria must be considered. If the site consists of wetlands, a Notice of Intent must be filed. An ENF or EIR must be filed if the project is placed on 25 or 50 acres or land respectfully. There are also other considerations that are determined during the permitting process, such as if the site disrupts endangered species. These are performed before any other part of a project can even progress past the point of just being an idea. There are many different ways that investigations can be done to look into these criteria, but it is a long and usually challenging process. "Wind Turbines can be a drawn out affair and may take 2 to 3 years from first contact to construction and commissioning" (MacFarlane Generators, 2002).

Siting must begin with the most important aspect needed for a wind turbine to be successful: wind speeds. For a 1.65 MW Vestas turbine (one mentioned for consideration on Nantucket), a minimum "cut-in" wind speed of 3.5 m/s is required. If these speeds are not reached, the turbine will not operate. The "rated" wind speed (where maximum output of power is obtained) is 13 m/s (Vestas, 2008). A power curve is shown in Figure 8, illustrating how a slight alteration of wind speeds can greatly affect the turbine's power output. Wind speed is necessary for successful wind turbine installation, but just as prominent of a factor is the consistency in which the wind is present. Wind speeds need to remain somewhat constant so there is as little variation above and below the range of operational wind speeds as possible. As seen again in Figure 8, the maximum power output range is no doubt desirable, but a wind speed higher than the “cut-off” speed (approx. 20 m/s) is not productive, either, as the turbine will shut down (Vestas, 2008). Fluctuations in wind speed can put unneeded stress and even cause damage to the turbine. Nantucket’s average wind speeds fall comfortably in this range, as seen in Figure 6.

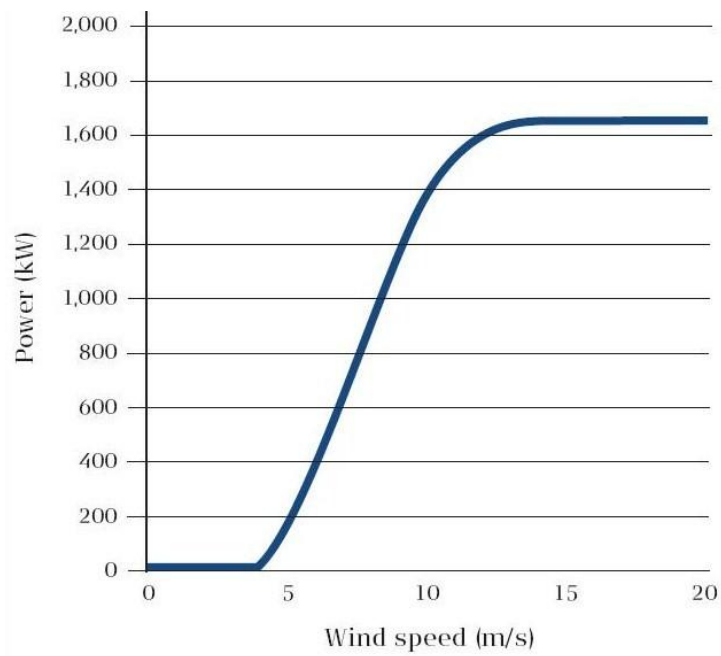


Figure 9. Power Curve for Vestas 1.65 MW Wind Turbine from http://www.vestas.com/Admin/Public/DWSDownload.aspx?File=Files%2fFiler%2fEN%2fBrochures%2fProductBrochureV821_65_UK.pdf

If proper siting techniques are not used in the evaluation of a potential wind turbine site, originally unforeseen problems may arise. One example of siting problems may be seen in Princeton, MA. The project was completed with 8 turbines erected along the side of Mount Wachusett, but the height of the towers was selected incorrectly. Wind speeds at the elevation chosen were inadequate, and according to Kalisz, Monast, Santoro, and Trow (2005), “by not anticipating the effect of large tree canopies, the site did not suit a wind farm as much as developers had anticipated.” This, paired with the fact that three of the wind turbines went out of service due to lightning strikes and all had since been outdated from their once state-of-the-art status that they held when constructed in 1984, led to the need for a change in the form of a new proposal that has been passed for 2 new larger turbines (Kirsner, 2003). The Wind Farm Upgrade Project was voted on in February 2003, and was passed with 'yes' votes totaling 605, and 'no' votes 210. "Voter approval will now enable Princeton Municipal Light Department and its development partner Community Energy, Inc. to replace the eight 40 kilowatt wind turbines currently sited on 100-foot towers at the Mount Wachusett wind farm with two new 1.5 megawatt wind turbines to be sited on 230-foot towers" (Business Editors/Energy Writers, 2003). Princeton voters made a choice by weighing the benefits of renewable energy against the visual changes that would occur to install these larger turbines; in the end, wind power won (Business Editors/Energy Writers, 2003).

The determination of a site that is adequate for wind turbine installation is a large part of whether or not a wind turbine or wind farm will succeed, and much time and effort should be put into analysis of it. Every step possible should be taken to avoid these pitfalls, therefore allowing wind power to grow and succeed at a greater level than ever.

4.1.1. Siting Examples: The Good, The Bad and The Ugly

An interesting way to combine all of these siting issues into a form easier to analyze can be seen by looking how a site in Northern California was chosen for its feasibility for turbine installation. The process involved utilizing a Geographic Information System, or GIS, to determine feasible locations. The framework was made up of a "rule-based spatial analysis to evaluate different scenarios" (Rodman & Meentemeyer, 2005). The program looked at 3 main criteria (physical, environmental, and human) collectively, with each category having a type of 'score' based on importance. To narrow down the possible sites, these three scores could be visualized onto a map to show only sites that satisfy all criteria with a high enough satisfaction rating. What was unique was that public opposition was also added to these criteria and factored in (Rodman & Meentemeyer, 2005).

One more site that illustrates just how important the siting process is in the procedure of exploring wind power is the wind farm at Altamont Pass, California. When initially sited, the area seemed ideal - large open space with no developments nearby. Wind speeds were sufficient for the turbines, but there was a lack of analysis that went in to determining the final location. "Wind turbines at the Altamont Pass Wind Resource Area (APWRA) kill more birds of prey than any other wind facility in North America, due to their location on a major bird migratory route in an area with high concentrations of raptors, including the highest density of breeding Golden Eagles in the world" (Altamont Pass Wind Resource Area, 2007). The Center for Biological Diversity has a list of changes to be made to make these turbines less harmful to the wildlife around them, but nothing has been done yet to fix this problem (Altamont Pass Wind Resource Area, 2007).

4.2. Publicly vs. Privately Owned Electrical Company

Going along the lines of financial issues like those mentioned in Section 2 of this report, a major issue when considering the construction of a wind turbine is whether or not it will be owned by a public or private electrical company. Municipally utilities are considered public because "all customer payments [are used] to provide low-cost electric service or meet other community needs" (Massachusetts Municipal Wholesale Electric Company, n.d.), whereas private, investor-owned utilities (IOUs) "are in business to earn a profit for their stockholders" (MMWEC, n.d.). This can influence the public's decision on accepting or rejecting a proposed wind turbine. People like to see direct benefits, and if they know that an "intrusion" is being put on their town's land and is not helping that town at all, it will be a lot harder to convince that person that they should accept a proposed project.

Public Electrical Companies are those that are owned by the town or city they supply. There are many advantages associated with choosing the path of a town owning its own utility, but there are also many limitations. A large benefit to having a municipal utility comes from the fact that it is more interested in providing good service to residents of the community rather than collecting a profit. Rates and services are controlled by the town itself, and if problems arise or "a customer has a complaint, he or she doesn't have to call '1-800-YOU'RE-ON-HOLD' to explain the problem to an operator in Dallas, Texas (Municipal Electric Utilities of Wisconsin, 2008). There is also an economic benefit for towns that decide to go the way of owning their utility. The local economy profits from residents' energy dollars staying within the community, and also from the fact that there will be new jobs that need to be filled in order to keep the municipality's system running.

> The city may be able to provide electric services along with all other city services to produce synergies, benefits of which could be passed on to the customer by the way of lower price. As a tax-exempt public entity, the return on equity expected by the city could be lower than that of a private entity. This low cost of capital could be translated to lower prices. In addition, since the city customers own the utility, any return on capital is ploughed back to the city budget to enhance city services and/or to reduce city taxes.
>
> [Swaminathan & Ratchye, 2000]

Aside from economic issues, the fact that municipal electric companies can adapt and strive to fit the needs of the community it serves is a very attractive facet of this type of system. Figure 10 shows the breakdown of wind power ownership by type. An independent power producer (IPP) is a private company that handles the generation and distribution of electricity, i.e. National Grid, while a publicly owned utility (POU) is that in which the utilities are handled completely by the town or municipality itself, i.e. the Princeton Municipal Light Department. Community owned is “defined here as projects using turbines over 50 kW in size and completely or partly owned by towns, schools, commercial customers, or farmers, but excluding publicly owned utilities” (US Department of Energy, 2007). As you can see from Figure 10, the proportion of publicly and community owned wind capacities is increasing.

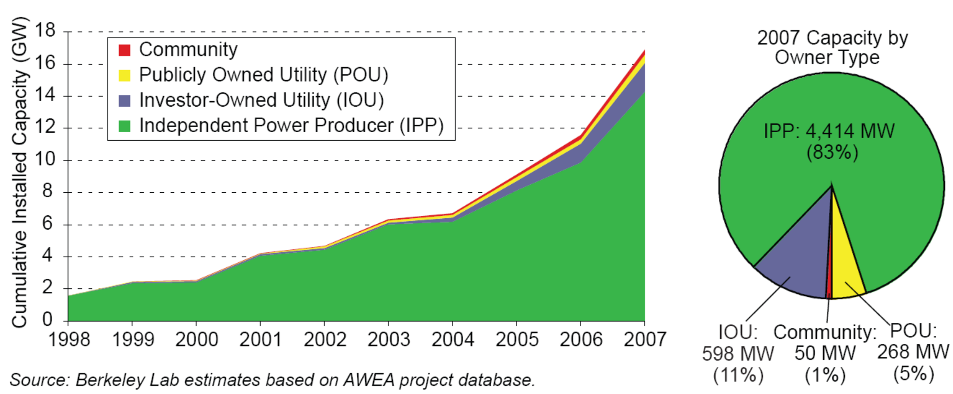


Figure 10. Cumulative and 2007 Wind Capacity Categorized by Owner Type
From http://www1.eere.energy.gov/windandhydro/pdfs/43025.pdf

Princeton, Massachusetts is a town that owns its own utility company, meaning it is a POU. The town has its own electricity company (the Princeton Municipal Light Department, or PMLD), headed by general manager Jonathan Fitch. When it came time and two new turbines were proposed to replace 8 other outdated and broken ones, the public was surprisingly receptive. “Persuading residents that a 400-foot-tall wind turbine can be a good neighbor is much easier when, as in Princeton where residents own their utility, it's directly feeding them power, not reaping revenues for a remote energy company. 'When you can actually connect a community to the electricity, then it's a much easier sell'" (Howe, 2007). This reiterates the fact that consumers want to know that they are being helped in some way, and that there is a benefit to the community as a whole.

Hull, Massachusetts is another town where having a POU played a large role in the general acceptance level of wind turbine use. Hull has its own public electricity distributor, the Hull Municipal Light Plant (HMLP), and has had a long history of turbines in the town. These two things were an advantage when it came to the issues of turbine construction and acceptance. Hull found that having a public electricity distributor (HMLP) was helpful because this organization was familiar with electricity distribution which facilitated the process of acquiring a turbine (Manwell et al., 2004, p 3-4). By the town having its own utility, not only was the turbine project more readily accepted by the residents, but people in the community actually had some sense of the process as they dealt with their own electricity issues in the past. This can equip some townspeople with the ability to foresee problems or to realize the great benefits. Others will be more readily influenced and able to accept change by being informed from their fellow residents rather than a large company only interested in making a profit.

The other side of this would be having a private utility handle the town's electricity needs. A valid reason for conducting business in this way would be to avoid the risks that come when a town relies on its own utility company. These risks include new technologies and improvements in old technologies that could "abruptly render the existing generation assets obsolete or uncompetitive in cost" (Swaminathan & Ratchye, 2000). This loss could prove to be an insurmountable challenge for a town, as it would be directly affected by something of this nature, with no outside company to rely on. This makes private companies seem like a compelling option, but again the fact that consumers will not directly see benefits and be aided in any way may overtake the risk involved.

Searsburg, Vermont is an example of a town where there electricity is run by a private, outside company, or IPP. It is a small town, where 11 turbines have been built by a company called Green Mountain Power (GMP). The turbines had been struggling in their production, and there was a desire to expand the wind farm. “As John Zimmerman, Enxco's eastern regional director, is quoted in a March 3, 2003, Boston Globe article, ‘Wind has become a serious way to make money.’ They want to add 22 (or more) new 1.5-MW towers that are 1 2/3 times taller than the current ones (requiring lights day and night and much noisier)” (Rosenbloom, 2006). There is not much public support at all for this expansion. Searsburg is a very small town, and does not see any direct benefits from this proposed expansion. “The electricity goes into the grid that supplies power throughout New England, so locals don't directly benefit from the low-cost energy” (Leaning, 2002). This can be directly correlated to the low support of an expansion of wind power.

Public and private electrical utility companies both have their advantages and disadvantages. With municipal systems, residents will feel more comfortable knowing that they are directly benefiting from any type of project that involves their town’s land, and that they are not simply “nuisances” to some larger private company looking to make a profit. Ultimately this issue comes down to a matter of the community it is being applied to, and only then can the right choice be made.

4.3. Grid Connection

The assessment of multiple wind turbine connections to a power grid is necessary to prevent unprecedented voltage fluctuations and interruptions. Large wind turbine installation into a grid can produce slow voltage variation, voltage dips, harmonics, and flicker. These issues can be managed by selecting the appropriate turbine for the location, and by adjusting the controls (Tande, 2002).

There are two different modes of operation for wind turbines, fixed and variable speed. Fixed speed turbines have an induction generator directly connected to the grid. The induction generator controls the speed of the turbines via a gearbox, and can maintain constant turbine speed in varying weather conditions. Variable speed turbines utilize pitch control, reducing fluctuation in the grid. Variable speed turbines allow the option to use the momentum from the turbines to power the generator allowing for higher energy generation over a larger range of wind speeds. The ability of variable speed turbines to generate more electricity than fixed speed turbines is one reason why the majority of new turbines are designed to operate with variable speed. There are two methods for achieving variable speed that can reduce power fluctuations in the grid. "Variable speed operation is commonly achieved either by controlling the rotor resistance of the induction generator, i.e. slip control, or by introducing a power electronic frequency converter between the generator and the grid" (Tande, 2002). The power electronic converter is combined with a generator; two options are a double-fed induction generator system and the multipole synchronous generator system, directly driven by the turbine (Tande, 2002). The type of turbine and the type of generators used can help reduce the affect of varying energy connection to a grid.

Electrical flicker is one problem that arises when connecting wind turbines to a grid. Electrical flicker is a rapid voltage change that can affect the quality of outlet power. Wind turbines contribute to flicker by starting up and by switching operations. The most feasible way to reduce the effects of flicker is to implement a mechanism that only allows a certain predetermined number or turbines to start up within a specific time interval (Tande, 2002).

A sudden reduction in voltage running through the grid, and then voltage recovery is known as a voltage dip. Wind turbine start up can also lead to a dip in the voltage of the grid. Larger dips in the grid may be caused by faults (Tande, 2002).

The assessment of the grid connection depends on the type of wind turbine, how it operates, and the manufacturer. Allowable variance in the grid is also decided by the utility owner, which may decide what turbines are allowable in a specific site.

4.4. Public Concerns

Turbine implementation becomes increasingly difficulty without the support of local residents. People are mainly concerned with visual and auditory impacts of wind turbines, but some other things to consider pertain to the dangers of falling ice, shadow flicker, and the negative effects on avian life. These factors are very important, and must be considered when planning for and siting wind turbines.

4.4.1. Aesthetics

Another problem with wind turbines, especially in the eyes of the public, is aesthetics. The Cape Wind project has encountered a great deal of opposition from both prominent political figures and the residents of Cape Cod because the wind turbines are viewed as an eye sore. On clear days the members and guests of the prestigious and exclusive Wianno Yacht Club will be able to see the wind turbines on the horizon if the proposed project moves forward (Williams & Whitcomb, 84). Cape Wind is one of the prime examples of the "Not in My Backyard" (NIMBY) opposition. NIMBY is evident in this statement by Douglas Yearly who is the head of the Alliance to Protect Nantucket Sound: "We are not against renewable energy … but we're not for it in this location" (Williams & Whitcomb, 87). The NIMBY sentiment was also a form of opposition against an upstate New York wind turbine project. Floyd Many, a resident of upstate New York echoed the NIMBY sentiment, "I will say this just once: not in my backyard. People in Delaware County think it ought to be in the Adirondacks. People in the Adirondacks think it should be in the ocean off Massachusetts. Teddy Kennedy thinks it should be somewhere else. Everyone wants alternative energy, but no one wants it where they have to look at it" (Applebome, 2007). Although Senator Edward M. Kennedy tends to favor renewable energy, he is one of the powerful political figures against the Cape Wind Project because he will be able to see the wind turbines from his Hyannis compound (Daley, 2008).

Other concerns involving the aesthetics of the Cape Wind project are focused on a decrease in property value. In this statement by Robert F. Kennedy Jr., "Everybody who lives on Cape Cod, who lives on Martha's Vineyard, who lives on Nantucket, all of them will have a diminishment of their quality of life and a diminishment of their property values." Kennedy expressed the concern of Cape Cod residents that not only will the wind turbines take away from the beauty of Nantucket Sound, but the turbines will also affect them financially (Williams & Whitcomb, 121). Former Massachusetts Governor Mitt Romney is afraid that property values will decrease and tourism will be negatively affected by the installation of a wind farm in Nantucket Sound (Daley, 2008). Whether the turbines will actually affect the worth of the houses on Cape Cod is unknown, but the concern of the residents will remain until a there is a final decision on the Cape Wind project.

4.4.2. Wind Turbine Noise

Wind turbine noise is one of the main perceived disturbances of a working turbine. There are two sources of wind turbine noise, mechanical noise and aerodynamic noise. Mechanical noise is the noise generated from the gearbox, generator, and other parts of the machine.

Mechanical noise has been shown to contain discrete tone components which are more annoying than toneless noises, but this noise annoyance can be minimized with better technology practices. Aerodynamic noise is the noise created from the movement of the blades through the air, and increases substantially with the height of the turbine (Pederson & Waye, 2004). The Renewable Energy Research Laboratory at the University of Massachusetts at Amherst discovered that "from a distance of several hundred feet, [utility scale] wind turbines can be compared to the sound level of a refrigerator." Figure 8, below, shows the Decibels of wind turbine noise in relation to other everyday sounds.

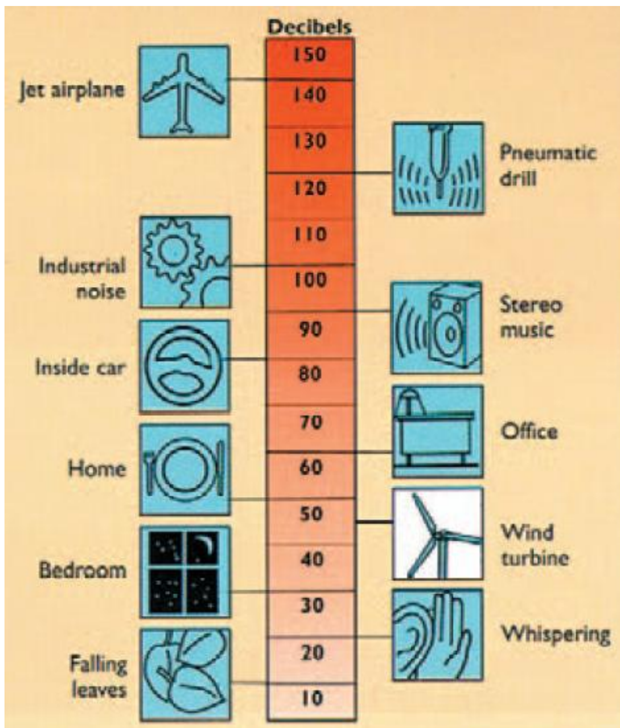


Figure11. Decibel Levels of Everyday Noises. This is the noise level of a utility scale turbine from a distance of several hundred feet. From http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_3_Impacts&Issues.pdf

As you can see, the noise produced by a wind turbine is slightly above evening bedroom noise and below both home, office and inside the car noise. While wind turbine noise depends greatly on the wind patterns and type of surrounding land, noise from turbines from a reasonable distance away is fairly quiet (*Wind Power Impacts and Issues*, n.d.).

4.4.3. Dangers of Falling Ice

Another public concern in the implementation of wind turbines becomes apparent in sites that experience a winter climate. Falling ice is considered to be a danger to the people who would be in the vicinity of operating turbines when wintry weather conditions are present. If a storm came through while the turbine was not in use, upon startup the accumulated ice would be thrown off a fair distance depending on the turbine. One such case is that of Princeton, MA. A resident and strong opponent of Princeton's new project to install 2 new wind turbines, John Mollica, has expressed his concerns about this. "'I don't want a windmill of that size in my neighborhood. We need setbacks. The windmills are up against hiking trails,' he said. 'Ice coming off the new windmills at 350 feet high will take off someone's head'" (Booth, 2006). These 'setbacks' that he mentions refer to having a zone of land around the turbine site as an added safety element. Mollica also researched and published a 29 page report which included a majority of information relating to icing, and concluded with this statement: "Ice and windmills are a perilous combination and present a hazard to anyone in the vicinity. This is collaborated by scores of international wind industry professionals and a growing national consensus" (Mollica, 2005).

On the other side of this argument, many discount the fact that snow and ice are not a factor to consider when safety questions arise in siting for a wind turbine site. The American Wind and Energy Association states the following when asked- "What about turbines throwing blades, or ice? Is wind energy dangerous to the public?":

> It has been estimated by a number of reliable sources that 50,000 Americans a year die from air pollution, of which about one-third is produced by power plants. By contrast, in 20 years of operation, the wind industry (which emits no pollutants) has recorded only one death of a member of the public--a German skydiver who parachuted off-course into an operating wind plant. Blade throws were common in the industry's early years, but are unheard of today because of better turbine design and engineering. Ice throw, while it can occur, is of little danger because setbacks typically required to minimize noise (see above) are sufficient to protect against danger to the public, and because ice buildup slows a turbine's rotation and will be sensed by a turbine's control system, causing the turbine to shut down. One European group that has investigated the ice throw question recommends a setback of 1.5 times the sum of a turbine's hub height and its rotor diameter.
>
> [American Wind Energy Association, 2008]

It is apparent that falling snow or ice is not a strong argument against the implementation of wind turbines in an area. Wind turbine icing is not a problem when proper precautions are taken. Due to the minimal impact that icing has on the overall turbine project, few studies have actually been conducted regarding this phenomenon. It would not be cost-effective in any sense to conduct such a study of a problem that is not evident. To show the point more effectively, a paper titled "Assessment of Safety Risks Arising from Wind Turbine Icing" is concluded with the statistic that "the risk of anything or anyone being hit by ice from a wind turbine is… the typical probability of (being hit by a) lightning strike" (Sagrillo, 2003).

The Blue Highlands Citizens Coalition dealt with this same concern, and is conducting continuing research on the topic. The areas proposed for their wind turbines are not in sparsely populated areas as would be desired, and much of the area is heavily used in the winter months for activities such as hiking and skiing. The coalition mentions using appropriate set back restrictions, but ultimately believes the problem can be managed in different ways. These include having heated rotor blades on the turbines so they do not collect ice or snow, and having requirements calling for turbine shutdown when conditions are classified as unsafe.

These points ultimately discount the argument concerning the dangers incurred from falling ice or snow. If it is still a large point of concern however, then it is shown that it can be handled and dealt with effectively. The outcome of dealing with this problem is site specific, but overall icing does not prove to be a major problem.

4.4.4. Shadow Flicker

Shadow flicker is the changing light intensity caused from the presence and absence of shadows created by the rotating turbine blades. Residents within close proximately to the turbines may feel dizzy or disoriented, depending on their sensitivity to flashing lights. At 1,000 feet from the turbine, shadow flicker only occurs at sunrise and sunset. If the proper setback specifications are followed, shadow flicker is minimized for those living in close vicinity to the turbine (Nielsen, 2003).

4.5. Avian Collision Fatalities

There are different factors that increase the likelihood of bird collision fatalities with wind turbines. Bird fatality rates increase as structure heights increase, and as structure visibility decreases. Lighted structures and poor weather conditions also pose a greater risk to birds. The location of the structure influences the rate of avian casualties. There is a higher probability of bird fatalities if the structure is placed in a breeding, roosting, or migratory path, especially in areas with a high percentage of collision-susceptible birds. Turbines that are placed on slopes or in canyons also pose a greater risk to birds (Barrios & Rodriguez, 2004). It is important to avoid areas of high collision risk in order to minimize avian deaths. It is also important to avoid placing wind turbines directly in endangered or threatened species' habitats or migratory paths.

Bird fatalities have become a concern at certain sites in California, especially in Altamont Pass. The possible causes for this are that the turbines are older, smaller 100-250 kW turbines that were placed in the migratory path and breeding areas of raptors, a type of bird that is highly susceptible to collisions. Newer wind turbine projects are unlikely to suffer similar problems because new wind turbine designs and more careful siting minimizes bird fatalities (Erickson, Johnson, Strickland, Young, Sernka & Good, 2001, p.7).

A study on soaring bird fatalities as a result of wind turbines was conducted from December 1993 to December 1994 at two different turbine farms in the Strait of Gibraltar. This study shows the collision fatality of the avian population in regards to older turbine technology. The Strait of Gibraltar is a major flight path of migratory birds travelling between Europe and Africa. The two specific turbines farms are the E3 and PESUR sites totaling 87 turbines, which is 34% of the turbines in the Strait. Specific sections of these farms were chosen randomly for observation. Prior to data collection, Domestic Pigeon, Kestrel, and Griffon Vulture carcasses were placed around the chosen sites. The carcasses were monitored daily to determine how many and how quickly the carcasses were removed by predators, to account for any necessary correction factors for the actual study. These preparations minimized the error in the total estimated bird fatalities (Barrios & Rodriguez, 2004).

The results of the study concluded that 70 birds collided with the turbines and the connecting power lines during this 12 month span. The majority of the bird carcasses found were Common Kestrel and Griffin Vultures. The PESUR turbine site was responsible for 68 of the 70 bird-turbine collisions. The death rate per turbine per year at the PESUR site was much larger than recorded death rates in other locations during similar studies. The E3 site was responsible for 2 of the 70 avian deaths, a death rate per turbine per year that is more consistent compared with other studies. This shows a tremendous difference between bird mortality rates at different sites, and that properly siting a wind turbine can minimize the risk to avian populations (Barrios & Rodriguez, 2004).

Another study was conducted to analyze the flight patterns and collision fatality of soaring bird populations in the Strait of Gibraltar from July 1994 to September 1995. The study was conducted at the Eolica del Estrecho Windplant which consists of 66 turbines. As a method of comparison, two neighboring ridges were also included in the study. There were 16,225 birds observed in the Windplant area. Of these 16,225 birds, 71.8% showed changes in flight direction, 28.5% showed a large change. Of these 71.8% that changed direction, it was shown through recording and direct observation that 82.41% changed direction when the turbines were running. The data shows that birds have the ability to detect turbines and change their flight paths to avoid collision, especially when turbines are functioning. Two bird carcasses were found during the study, resulting in a yearly mortality rate of 0.03 per turbine (Lucas, Janss & Ferrer, 2004).

The following study shows bird collision fatality rates in comparison to newer turbine technology. The Massachusetts Maritime Academy erected a single Vestas 660kW turbine at Taylor's Point near a highly populated nesting and foraging ground of roseate terns, a nationally endangered species, and common terns, threatened statewide. The turbine is location within 100 meters from the shoreline, a foraging habitat for a variety of bird species. The study was conducted from April to November in 2006, and the turbine was operational for a series of 3-5 randomly assigned days every week. From April to September visual surveys were used to estimate the abundance of birds in the area, and flight patterns (Vlietstra, June 2007).

Mortality surveys were conducted from April to November. Each week 1-2 observers searched the ground for carcasses within approximately a 600 by 900 foot range surrounding the base of the turbines. These searches were conducted 4-12 times each week, in the early morning and early evening. To normalize the data that was collected during the survey, scavenging surveys were conducted. The scavenging surveys included placing bird carcasses on the ground in the areas around the turbines, and recording each day until the carcass disappeared (Vlietstra, June 2007).

Based off the visual surveys, approximately 11,000 Common Terns were seen in the water near the campus, constituting 75% of the total Tern population. Approximately 254 Terns were seen within the airspace of the turbine, and were 4-5 times less abundant when the turbine was in operation compared to when the turbine was at rest. Throughout the entire surveying period, April to November, one Laughing Gull carcass, suspected of dying from collision with the turbine rotor, was found (Vlietstra, June 2007).

Depending on the siting considerations, turbines pose varying risk to bird populations. The above mentioned studies show that in fair to good weather conditions, birds can detect wind turbines and deter their flight paths to avoid collision. Newer turbine technology and knowledgeable placement of wind turbines, minimizes the avian collision risk.

5. Conclusion

The Energy Study Committee needs to know about laws and regulations, alternative financial and institutional arrangements that will affect turbine implementation on Nantucket, and advantages and disadvantages to wind turbine use. The archival research conducted to complete this Literature Review educated the team about many advantages of wind turbines as well as concerns that people have about turbines; explained various institutional and financial arrangement options; and informed them of laws and regulations with which wind turbines projects must comply. The information gained in the Literature Review as well as the research conducted on Nantucket helped the Energy Study Committee gain answers necessary for moving forward with their wind power project.

METHODOLOGY

1. Goal and Objectives

The goal of the Wind Generation on Nantucket Interactive Qualifying Project was to assist the Energy Study Committee in its efforts to map out a strategy for the development of wind power on Nantucket. The project had three major objectives: (1) to explore what laws, regulations, and permits affect the proposed development of wind farms and identify any legal changes for which Nantucket should advocate; (2) to examine financial analysis and ownership arrangements for the development of wind power on Nantucket; (3) to investigate the concerns regarding wind power for Nantucket (including potential adverse impacts, such as impacts on aesthetic and property values). By accomplishing our objectives and presenting this information to the Nantucket Energy Study Committee, we successfully achieved our goal.

2. Tasks

The team identified several tasks required to accomplish the project goal and objectives. To satisfy Objective 1, through information gained from previous research, study of Nantucket bylaws, and from key informants, the team identified applicable regulations and permits such as those related to zoning, construction, wildlife, airspace, and lighting. We created a list of these laws and regulations, and a timeline prioritizing the filing and obtaining of these permits. Other tasks relating to our first objective included researching the impact of land-based turbines on endangered species and Nantucket habitats and possible impact on marine life; determining necessary setbacks for housing from turbines; and conducting relevant interviews, as described in Section 2.2. The team examined and presented the key issues pertaining to Objective 2, such as financial analysis for wind turbine projects, and funding scenarios for various turbine sizes at each site. We created tables which calculated payback periods and long-term positive returns for various turbine sizes. The team acquired information to satisfy Objective 3 by conversing with representatives of privately and publically owned electrical facilities, as well as residents and other individuals knowledgeable about the potential sites, and the flora, fauna, and avian life. The team created a pair-wise comparison chart to evaluate and compare the concerns regarding the implementation of wind power on the island. In order to accomplish these tasks, the team continued to search for relevant literature throughout the course of the project, conducted seventeen interviews, and had email correspondents with three other key informants. More information about the Energy Study Committee can be found in Appendix A.

2.1. Sponsor Meetings

The first task after arriving on Nantucket was for the team to present their proposal to Dr. Willauer and the Energy Study Committee. This presentation allowed us to suggest our plan for completing the Interactive Qualifying Project and assisting the Energy Committee. The next task was to have a meeting with Dr. Willauer and the Energy Study Committee. The initial, informal meeting conducted on our second day of work clarified the goals and objectives of the project, and allowed the team and sponsor to discuss any questions that arose. We obtained contact information of key informants with whom the Energy Committee members suggested we meet.

The team attended the November 6th, and December 4th monthly Energy Study meetings. In addition to the Energy Committee's scheduled town meetings, the team met weekly with Dr. Willauer, members of the Nantucket Energy Study Committee, and Professor Elmes, in order to keep everyone updated on the project's progress.

2.2 Interviews

The team initially selected individuals to interview based on information from our professors, liaison, and members of the Nantucket Energy Study Committee. The team also conducted a reference or 'snowball' sample by contacting informants that were recommended by other interviewees.

We developed a preliminary interview schedule before arriving on the island, which depicts the range and depth of topics in which we needed to address in order to meet each of our three objectives. This preliminary interview schedule is included in Appendix C. We developed this schedule based on data collected for our literature review, and used it as a place to brainstorm the types of questions which we would ask the various interviewees. We created a separate list of questions for each interviewee by referencing the interview schedule and focusing on questions specific to each interviewee's area of expertise. We conducted our first interview on Friday, October 17, 2008 with Jonathan Fitch, operations manager of the Princeton Municipal Light Department. From this interview we determined that our interview schedule covered all necessary topics for interviews with municipal utility companies. The team also requested and was granted permission to contact Mr. Fitch at a later date to follow up on any information that we may have forgotten.

Based on our knowledge of each interviewee, as well as information gained during any prior correspondence, we asked questions focused around specific objectives and interviewee expertise in our interviews. Each interviewee had important knowledge and expertise from which we gained and analyzed data that was then used to draw conclusions and present them to our sponsor. Tables 2-5, below, list each individual that we interviewed, either in person, by telephone or via email, as well as the objective about which the team gained information. Table 2 includes the key informants who were particularly knowledgeable about the proposed Nantucket wind turbines project, wind turbines in general, and electrical issues associated with wind turbines on Nantucket.

Table 3. Primary Interview Topics by Key Stakeholder: Turbine and Electrical.

	Objective 1: Pertinent Laws and Regulations	Objective 2: Financial Analysis and Ownership Arrangements	Objective 3: Concerns Regarding Wind Turbines on Nantucket
Nantucket Energy Study Committee	X	X	X
Municipal Electrical Utility Managers Jonathan Fitch, Princeton, MA Richard Miller, Patrick Cannon, Hull, MA	X	X	X
Bartlett Farms John Bartlett	X		X
New England Windpower, Inc. Action for Clean Energy, Inc. Andrew Stern, WPI Graduate	X	X	X
National Grid			
Dave Fredericks	X	X	X
Dave Larson	X	X	
Mike Peterson		X	

Table 3 notes key informants involved with various Nantucket organizations which are involved with the required permitting process or have knowledge necessary for progressing with the feasibility study for turbines on Nantucket.

Table 4. Primary Interview Topics by Key Stakeholder: Pertinent Nantucket Departments.

	Objective 1: Pertinent Laws and Regulations	Objective 2: Financial Analysis and Ownership Arrangements	Objective 3: Concerns Regarding Wind Turbines on Nantucket
Nantucket Memorial Airport Al Peterson, Manager	X		X
Nantucket Historic District Commission Mark Voigt, Administrator	X		X
Nantucket Department of Public Works Jeff Willett, Director	X	X	X
Surfside Waste Water Treatment Facility Eric Schultz, Chief Operator	X		X
Nantucket Planning & Economic Development Comm. Andrew Vorce	X		
Nantucket Land Council Cormac Collier	X		X

Table 4 includes individuals knowledgeable about flora, fauna, and avian life on Nantucket as well as individuals who provided us with information about environmental impacts of wind turbines.

Table 5. Primary Interview Topics by Key Stakeholder: Environmental Concerns

	Objective 1: Pertinent Laws and Regulations	Objective 2: Financial Analysis and Ownership Arrangements	Objective 3: Concerns Regarding Wind Turbines on Nantucket
University of Massachusetts Nantucket Field Station Sarah Oktay			X
Massachusetts Audubon Society Ernie Steinauer	X		X
Maria Mitchell Association, Natural Sciences Dr. Robert Kennedy			X
Massachusetts Division of Fisheries and Wildlife Scott Melvin	X		X
Shorebird Biologist Edie Ray			X
Nantucket Conservation Foundation Karen Beattie	X		X
Linda Loring Nature Foundation Vernon Laux			X

Table 5 includes individuals and corporations contacted to gain information about transportation of turbine components to the Island of Nantucket, and through the streets on

Nantucket. This information was essential to the Energy Committee's wind turbine feasibility study.

Table 6. Primary Interview Topics by Key Stakeholder: Transportation

	Objective 1: Pertinent Laws and Regulations	Objective 2: Financial Analysis and Ownership Arrangements	Objective 3: Concerns Regarding Wind Turbines on Nantucket
Toscana Corporation Jim Palatine			X
Turbine Manufacturers Fuhrlander, General Electric			X

All interviews were conducted based on the practices described in section 2.2.1, Interview Data Collection.

Based on suggestions from members of the Energy Study Committee and Dr. Willauer, the team interviewed Eric Schultz, Chief Operator of Surfside Waste Water Treatment Facility, which is a site being considered for turbines; John Bartlett, who owns a commercial farm with a wind turbine on Nantucket; Mark Voigt, Administrator of the Historic District Commission; Andrew Vorce, Director of the Nantucket Planning and Economic Development Commission; Jeff Willett, Director of the Nantucket Department of Public Works, which owns land at the locations where turbine sites are being considered; Richard Miller, Operations Manager of the Hull Municipal Light Plant; and David Fredericks, Vice President of the National Grid division that oversees Nantucket. Additional interviewees were identified as a result of the use of the snowball sampling technique: Ernie Steinauer, head of the Massachusetts Audubon Society on Nantucket; Edie Ray, shorebird biologist for the Nantucket Conservation Foundation; Vernon Laux, Resident Naturalist and bird enthusiast; Dr. Robert Kennedy, Director of the Maria Mitchell Association Natural Sciences department; Scott Melvin from the Massachusetts Division of Fisheries and Wildlife and the United States Fish and Wildlife Service Endangered Species Program; Arthur Larson and Michael Peterson of National Grid; Jim Palatine, General Manager of Toscana Corporation; and Cormac Collier, Executive Director of the Nantucket Land Council .

The team also contacted and asked questions of several other individuals, with whom a more formal interview was deemed unnecessary due to the limited number of specific questions that we planned to ask each of these individuals. Via email, the team asked questions of Al Peterson, manager of Nantucket Memorial Airport; Sarah Oktay, from the University of Massachusetts at Boston Nantucket Field Station; and Andrew Stern, a graduate of Worcester Polytechnic Institute who is President of New England Windpower, Inc. and co-founder of Action for Clean Energy.

2.2.1 Interview Data Collection

The team created interview questions for each interview, using the interview schedule (Appendix C) as a guide, and conducted semi-structured, open-ended interviews lasting approximately 45 minutes. In advance, we sent an electronic letter to each interviewee, requesting an interview, briefly describing the project, and indicating the general topical areas that the team planned to address in the interview. For reference, a copy of the generic interview request letter can be found in Appendix B. When we were unable to find an email address with which to contact the individual, we contacted the individual by telephone and followed the same procedure as used in the email request. The team followed up with a phone call several days after the initial interview request, if the interviewee had not responded. During the interviews, when applicable, the interviewee was prompted for any reports or other documents that could be useful to the project. The team also asked for recommendations for other potential interviewees. Each interviewee was asked if the team could contact them in the future with additional questions, and finally the interviewer asked if the interviewee gave the team permission to use his or her name in the final report.

Personal interviews were conducted at the convenience of the interviewee. When a personal interview was not feasible, the team conducted a phone interview via a conference call. We sought implied consent for each interview, meaning that we read our disclaimer (see Appendix C) and verbally asked for consent to participate in the interview. We did not ask the interviewee to sign a consent form. We also asked each interviewee for consent to use an audio recorder to record the interview, and at least one member of our team took notes. Before publishing any information from the interviews in our report, we gave each interviewee a copy of the interview transcription and asked him or her to read it. This was requested to assure that we correctly portrayed all of the information given to us in the interview, to note any sections of the transcription that the interviewee wanted us to remove, and if the interviewee wanted any section to be dissociated from his or her name.

2.2.2 Interview Data Coding

After each interview, a member of the team transcribed the audio recording, focusing on information pertinent to our research and omitting unrelated information. We used the transcription as our primary data collection method, with handwritten notes used to fill in any information that was indiscernible on the recording. After conducting interviews, we analyzed the transcriptions, looking for related ideas or themes suggesting a consensus on certain topics, as well as contrasting data, varying opinions, and discontinuities.

2.3. Archival Research

After arriving on Nantucket, we conducted further archival research to obtain information that we were unable to obtain prior to our arrival on Nantucket, and to follow up on key points mentioned by the Energy Study Committee and addressed in the interviews. Building on the provisional analysis presented in the literature review, the team compiled a complete list of federal, state, and local laws, regulations, and permits required to begin the construction of a wind power project. We also reviewed minutes from Nantucket Town Board and Committee meetings in order to gain a better understanding of the dynamics of the issues relating to wind power on Nantucket.

3. Data Analysis and Presentation

After collecting all of this data, we presented and analyzed the data and from those results reached conclusions and provided recommendations. The team organized the transcription data into three different tables related to each objective. These tables were then used as an organization tool and the basis of our results section. Within each table we listed the important quotations from all of the key informants and inserted these quotations into the appropriate table and categorized each table by topic. Next to each topic, the team listed the name of the interviewee that mentioned the topic, as well as the comment that interviewee made about the topic. Each table is included in Appendix I: Results Tables.

From these results tables, the team began their presentation of the results. The team identified discontinuities and consensus based on the comments of the group of individuals that discussed each topic. Combining the information we garnered from the interviews with the information we gleaned from archival research and reasoning, the team analyzed the results, drew conclusions and formulated recommendations.

For Objective 1, the team compiled a list of laws, regulations, permits, and documents required for turbine implementation on Nantucket. Based on suggestions by our interviewees and archival research regarding what each entailed, we created a timeline for the order in which the Energy Committee should approach the permits. In order to analyze Objective 2, Financial Analysis and Ownership Arrangements, the team created cost tables for various sizes of wind turbines in differing scenarios at each the Madaket Landfill and Surfside Waste Water Treatment Facility in order to determine short and long term payoffs for each possible arrangement. We also used a sensitivity analysis to examine the effects that an unforeseen variable change may have on a project. A sensitivity analysis is a test performed to determine how "sensitive" a certain model is to changes in the data chosen. It can take into account several uncertainties that may be present when making assumptions in a model, and account for them in some way. For example, our sensitivity analysis altered the variables of capacity factor, electricity rate, and installed cost per kilowatt-hour. Regarding the analysis of concerns regarding wind turbines for Nantucket, the team's third objective, the team conducted a pair-wise comparison and listed the ranking and weight of the concerns relative to each other.

After analyzing the data for each objective, we drew conclusions and formulated recommendations, suggesting a timeline for approaching the permitting process, and methods for dealing with the opposition and concerns regarding wind turbines on Nantucket. The team presented their findings to the Nantucket Energy Study Committee and the Board of Selectmen, and distributed the report to the Energy Committee and any interviewee that requested a copy of the report.

RESULTS AND ANALYSIS

1. Objective 1: Laws, Regulations, and Permits

There are Nantucket, Massachusetts, and United States regulations that need to be complied with in order for the Nantucket Energy Study Committee to move forward with implementing wind turbines at the Madaket Landfill and the Waste Water Treatment Facility (WWTF) sites. The following figure shows an aerial view of both proposed sites.

Figure 9. Aerial Overview of Madaket Landfill and Waste Water Treatment Facility. Adapted from Town of Nantucket Web GIS, Aerial Photo 2007.

Nantucket has bylaws regarding the implementation of wind turbines, which are located in §139-21Wind Energy Conversion Systems (WECS), in the Code of the Town of Nantucket, Massachusetts. Within the WECS section there are two different classifications, residential and commercial. The Energy Committee's turbine project is most similar to the commercial classification, which is defined in the bylaws as being "designed or operated to provide energy principally to consumers located off the premises and does not meet the requirements established for a residential WECS" (Code of the Town of Nantucket, §139-21, n.d.). According to Andrew Vorce, Planning Director on Nantucket, a turbine project that is implemented by the Town of Nantucket, a municipality, is technically exempt from the WECS bylaws (A. Vorce, personal communication, November 14, 2008). A citizen article was recently drafted (November-

December 2008) to update the Nantucket Wind Energy Conversion System bylaw, and is included in Appendix E.

1.1. Turbine-Specific Zoning Regulations

Turbine-specific zoning regulations need to be taken into consideration when implementing the Energy Committee's wind turbine project. Table 6 depicts a list of local and state regulations regarding this particular topic.

Table 7. Turbine-Specific Zoning Regulations.

Agency	**Regulation / Permit**	**Project Phase**	**Required?**	**Comments**	**Level**
Planning Board	Special Permit with Major Site Plan Review	Pre-Construction	Recommended	Permitted in certain districts	Local
Planning Board	Special Permit	Pre-Construction	Recommended	Required for maximum # of towers, and maximum tower height.	Local
Planning Board	Tower Setback	Planning	Recommended	Setback distance from property line is the distance measured from the mean grade surrounding the support pad(s) to the tip of the blade.	Local
Planning Board	Guy Wire Setback	Pre-Construction	N/A	Guy wires must be at least 15 feet from the nearest property line.	Local
Planning Board	Tower Access	Pre-Construction	Recommended	Turbine must be accessible only by authorized personnel.	Local
Planning Board	Blade Color	Pre-Construction	Recommended	The blade color should be white or light gray.	Local
Planning Board	Maintenance	Operation	Recommended	A structural report needs to be submitted to the building inspector, attesting the structural integrity of the wind energy system.	Local
Planning Board	Building Permit	Pre-Construction	Yes		Local
Mass. EOEA*	EOEA Article 97 Policy, Massachusetts General Law Chapter 61	Pre-Construction	No	Change in use of existing public lands. Necessary if the project is located on conservation land. May be applicable if the project requires access / easements over conservation land.	State

*EOEA: Executive Office of Environmental Affairs
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*.

Under the Nantucket Wind Energy Conversion System bylaws, and as shown in Table 6, above, the maximum number of towers and the maximum height of the towers are determined by a special permit. The above mentioned citizen article removes the specifications in the bylaws regarding tower access, guy wires, and blade color. This citizen article also eliminates regulating the turbine tower height by special permit. The process for obtaining a special permit is defined in the bylaw as "the granting of a special permit for a commercial WECS shall be conditional upon a finding by the special permit granting authority that the proposal is in the public interest and provides substantial benefit to the community, the burden of proof which shall rest with the applicant" (Code of the Town of Nantucket, §139-21, n.d.). In Nantucket, the Planning Board is the special permit granting authority. In order to grant a special permit, the Planning Board requires a super majority vote, meaning four out of five members of the board must vote in favor of permitting the project (A. Vorce, personal communication, November 14, 2008).

The process of obtaining a special permit begins with an advertising period. Prior to a public hearing, a notice is sent to any abutter, defined as "someone who has direct boundary, shares boundary with the property, is directly across the street from the property or is an abutter to somebody with direct access…Generally anyone within 300 feet has standing" (A. Vorce, personal communication, November 14, 2008). Figure 10 shows the parcels at the two proposed turbine sites, and the ownership of the surrounding properties.

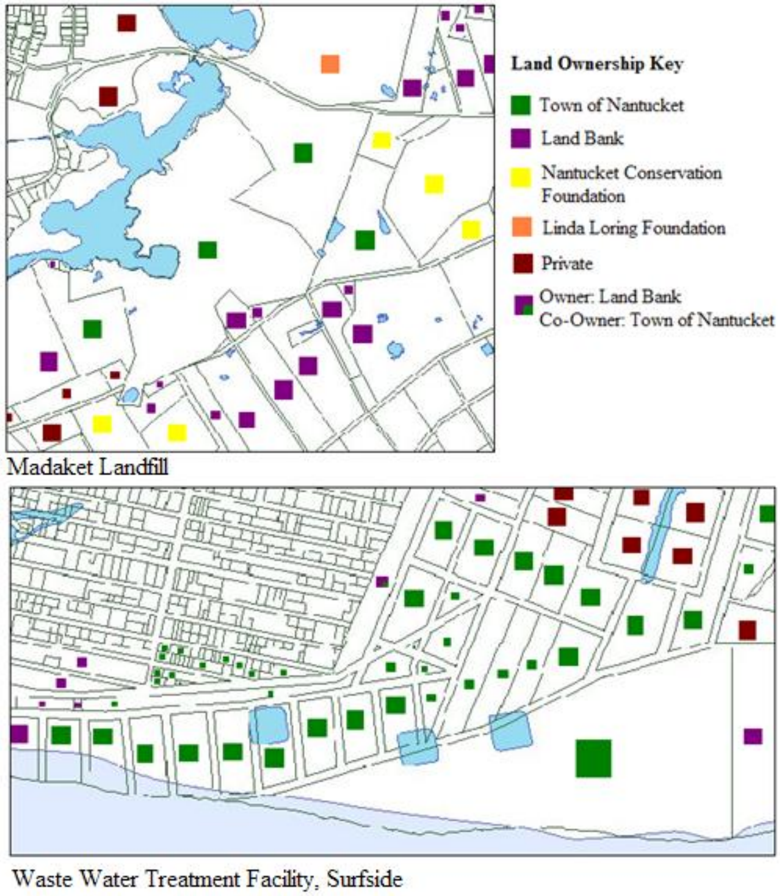


Figure 10. Parcel Ownership at Landfill and Waste Water Treatment Facility. Adapted from Town of Nantucket Web GIS, Parcels and Water Bodies 2007.

A notice regarding the project must also be posted in the local newspaper for two weeks. Next, the Planning Board holds a public hearing. The board listens to the testimony of any abutter who wishes to speak regarding the project. After hearing enough testimony, the Board deliberates publically, and the testimonial period ends unless the Board motions to reopen discussion. The Planning Board has 120 days to issue a decision unless an extension is granted, which must be agreed upon by the applicant and the board. The Planning Board's decision is then filed with the town clerk, and a 20 day appeal period begins (A. Vorce, personal communication, November 14, 2008).

According to the Nantucket Commercial WECS, wind energy conversion systems are allowed in LUG-1, LUG-2, LUG-3, and RC-2 zoning districts with a special permit and a major site plan review. Figure 11 shows the zoning districts at the Madaket Landfill and Waste Water Treatment Facility. As seen in this figure, both locations are in LUG-2 zones.

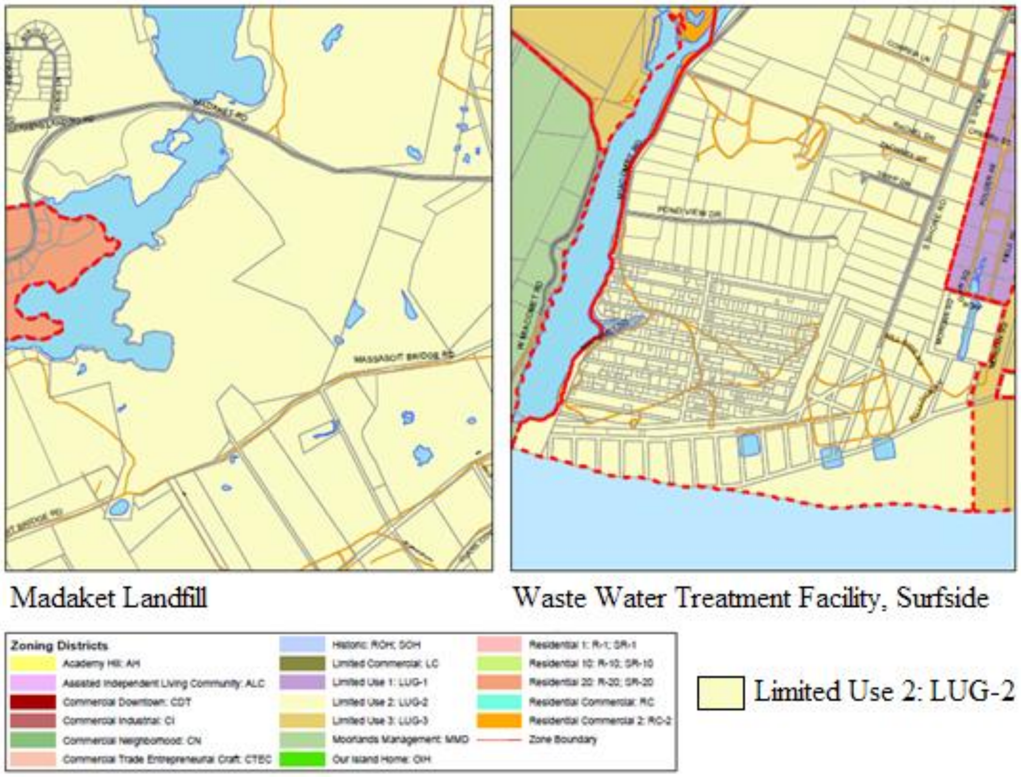


Figure 11. Zoning districts at the two proposed turbine sites. Adapted from Town of Nantucket Web GIS, Parcels and Zones 2007

The above mentioned citizen article updates the zones where wind power systems are permitted in. The updated zones do not impact the Energy Committee's current turbine project.

In order to gain a special permit regarding turbine placement in the allowed zoning districts, a major site plan review is necessary. The major site plan review process is explained in §139-23 Site Plan Review (SPR) of the Code of the Town of Nantucket. The major site plan review authority is the Planning Board and the minor site plan review authority is the Zoning Enforcement Officer. A major site plan review requires a super majority vote of the board, and a minor site plan review requires a simple majority (A. Vorce, personal communication, November 14, 2008). The necessary requirements for both a major and minor site plan review are defined in §139-23F. The site plan is prepared by a professional land surveyor, registered architect, landscape architect, or designer, as appropriate (Code of the Town of Nantucket, 2008, §139-23F). The plan includes but is not limited to: the project information, such as the project name and location, a map of the location and the surrounding properties, specifications regarding existing structures, easements, and rights-of-way.

A site plan approved in conformance with §139-23 of the Code of the Town of Nantucket is necessary for a building, or any construction permit to be issued. As shown in Table 6, above, a building permit must be obtained for any wind energy conversion system prior to construction of the project. Application for a building permit requires a plot plan, a Certificate of Appropriateness, and an Order of Conditions. When applying for a building permit construction of the project must proceed within 6 months of the permit issuance date unless an extension of time is granted, or the permit will be labeled abandoned (Code of the Town of Nantucket, 2008, §139-26).

The Nantucket Wind Energy Conversion System bylaw also defines the allowed set back distance of a turbine from any property line as the distance from the base of the turbine to the tip of the blade when fully extended. The Massachusetts model bylaw regarding wind turbines states that the turbine must be at least 100 feet from the property line, unless the property is owned by the same landowner as the initial turbine site (Massachusetts Division of Energy Resources & Massachusetts Executive Office of Environmental Affairs, n.d.).

The Nantucket WECS bylaw describes a setback distance for property lines, but does not specify a setback distance from structures, such as housing. The Energy Study Committee was interested in determining the proximity of the sewer beds to the new DPW housing, and if it was possible to add a section into the DPW housing lease regarding siting a turbine in close proximity to the housing. According to Eric Shultz, the DPW housing is rental housing for current employees of the Waste Water Treatment Facility and the town sewer department (E. Schultz, personal communication, November 7, 2008). Regarding the addition of potential wind energy into the DPW housing lease, Jeff Willet stated that, “We have not included at this point anything in the lease regarding the potential for wind generation. These buildings will probably be occupied by the end of December [2008]. I don’t know that we’re going to have an opportunity to include something in that lease before then” (J. Willett, personal communication, November 16, 2008). It is unlikely that the potential of a turbine at the site can be added to the DPW housing lease.

1.2. Noise Regulations

The University of Massachusetts at Amherst Renewable Energy Research Laboratory (RERL) report suggests to "site wind turbines at least three times the blade-tip height from residences. Distances from mixed-use areas may be shorter" (McClelland & Knipe, 2008). This is a recommended distance to minimize the effect of noise level disturbances on residents around the turbine site. Table 7 shows the regulations regarding noise level restrictions that apply to a community wind project.

Table 8. Noise Regulations

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
Mass. DEP*	Noise Control Policy Compliance (310 CMR 7.10)	Operation	Yes	Policy discourages a broadband noise level greater than 10 dB (A) above ambient, or pure tone noise.	State
Planning Board	Noise control	Operation	Yes	Regulations the allowable noise levels with an operational windmill. Decibel level readings are measured at the closest property line.	Local

*DEP: Department of Environmental Protection
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

Massachusetts state law on Community Sound Level Criteria states that "a source of sound will be considered to be in compliance with the DEP noise regulation 310 CMR 7.10(1) if the source does not: 1. Increase the broadband sound level by more than 10 dB(A) above ambient, or 2. Produce a pure tone condition" (Air & Noise Compliance, n.d.). Nantucket's local zoning bylaw §139-21F states the maximum levels of noise permitted while a turbine is in operation. Table 8 shows Nantucket's current WECS bylaws concerning allowed noise levels. Depending on the turbine size, these strict noise regulations could pose a problem to the Energy Committee when implementing the turbines at both sites.

Table 9. Nantucket Wind Energy Conversion System Allowed Noise Levels

Ambient Reading Without Windmill (decibels)	Maximum Permitted Reading with Windmill Operating (decibels)
45	55.4
50	56.2
55	61
60	61.2
65	65.4

Adapted from the Code of the Town of Nantucket, MA, 2008, §139-21F

According to §139-21 F, the levels depicted are to be measured at the nearest property line to the wind turbine, and are on a type A weighing scale for decibel determination. If an abutter files a complaint regarding the noise levels, the Planning Board is required to designate an agent to perform both ambient and maximum allowed decibel measurements at the site. The Planning Board reviews the decibel measurement data submitted by the agent. An appropriate service fee is charged to the complainant, unless the maximum decibel readings have been violated in which case the owner of the wind energy conversion system is responsible for paying the service fee. "If maximum readings are exceeded, the installation shall be considered a public nuisance in violation of § 139-20A of this chapter. The violation shall be corrected within 90 days from the date of notification, and if the noise violation cannot be remedied, the WECS shall be removed or relocated" (Code of the Town of Nantucket, 2008, §139-21). The citizen article, if approved, removes the noise regulation from the current Nantucket WECS bylaws.

1.3. Historic District Regulations

The Energy Committee is required to send the Massachusetts Historic Commission a Project Notification Form, as shown in Table 9.

Table 10. Historic District Regulations

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
MHC*	Project Notification Form	Planning	Yes	Identify potential project impacts on sensitive archeological / historic sites. Courtesy Notification	State
Nantucket HDC**	Certificate of Appropriateness	Planning	Yes		Local

*MHC: Massachusetts Historic Commission
**HDC: Historic District Commission
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

The Energy Committee is also required to obtain a Certificate of Appropriateness from the Nantucket Historic District Commission. In order to obtain a Certificate of Appropriateness, the Energy Committee must fill out a three part triplicate application that can be obtained from the Historic District Commission office building. The application requires a site plan, drawings, specifications, and information regarding surrounding infrastructure. The HDC also views the site to decide the visual impact that the project will have on the island. HDC approval can be acquired in as few as 60 days (M. Voigt, personal communication, November 7, 2008). Obtaining a Certificate of Appropriateness from the Nantucket Historic District Commission (HDC) is a relatively easy process, as long as the project does not directly impact any historic buildings. John Bartlett, who is currently (December 2008) in the process of installing a wind turbine on his farm, told the team that applying for HDC approval “was the first thing that I did, which I thought was going to be the hardest thing was actually the easiest thing. I had HDC approval in May of 2007 for this project” (J. Bartlett, personal communication, November 3, 2008).

1.4. Water and Wetland Regulations

There are a number of regulations regarding water and wetlands that might apply when dealing with implementing wind turbines. Table 10 shows descriptions regarding each of these various local, state, and federal regulations.

Table 11. Water and Wetland Regulations

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
Mass. DEP[1]	Notice of Intent (NOI)	Pre-Construction	TBD	Wetlands alteration. Same form that is required by the local Conservation Commission	State
USEPA[2]	National Pollution Discharge Elimination System (NPDES): Storm Water Notice of Intent	Pre-Construction	TBD / Unlikely	Discharge of storm water from construction sites disturbing > 1 acre. Needed if waste water is to be generated during construction, or ground water to be affected. Note that unlike most forms of electricity generation, wind turbines do not use water for power production.	Federal
USACOE[3]	Section 404 Nationwide Permit	Construction	TBD / Unlikely	Required if discharge of dredge or fill material into US waters, including jurisdictional.	Federal
USACOE[3]	Section 10 Nationwide Permit	Construction	No	Required for construction in navigable waters of the US.	Federal
NCC[4]	Order of Conditions	Pre-Construction	Yes	Pursuant to the State Wetland Protection Act if at least a portion of the property is subject to the Wetland Protection Act.	Local

[1]DEP: Department of Environmental Protection
[2]USEPA: United States Environmental Protection Agency
[3]USACOE: United States Army Corps of Engineers
[4]NCC: Nantucket Conservation Commission
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

The Energy Committee must obtain an Order of Conditions, which is issued by the Nantucket Conservation Commission. The Committee must file an Order of Conditions if they feel that a portion of the property is subject to the Wetland Protection Act (Code of the Town of Nantucket, 2008, §139-21). Figure 13 shows both the Landfill and the Waste Water Treatment Facility sites in respect to the neighboring wetlands, which are depicted in green.

Madaket Landfill

Waste Water Treatment Facility, Surfside

Figure 12. Location of wetlands at the Landfill and Waste Water Plant sites. Adapted from Town of Nantucket Web GIS, Parcels and Wetlands 2007.

The Landfill site is in particularly close proximity to a large number of wetlands. The Massachusetts Department of Environmental Protection (DEP) requires a Notice of Intent for any wetland alteration. This form is the same as the Order of Conditions form (RERL, n.d., *Wind Power: Permitting in Your Community*).

The United States Environmental Protection Agency requires a National Pollution Discharge Elimination System: Storm Water Notice of Intent (NOI). This NOI is necessary if any wastewater is generated during construction. It is unlikely that the Energy Committee’s project will require this NOI because turbines do not use water power for production. The United States Army Corps of Engineers (USACOE) oversees Section 404, and Section 10 Nationwide permits. The Energy Committee’s land based turbine project will not require a Section 10 Nationwide permit, which is only required for construction in navigable U.S. waters. It is unlikely that the Committee’s turbine project will require a Section 404 permit, which is necessary for the discharge of dredge or fill into U.S. waters (RERL, n.d., *Wind Power: Permitting in Your Community*).

1.5. Other Environmental Regulations

There are state and federal regulations regarding other environmental regulations in addition to water and wetland use. These regulations are included in Table 11, below.

Table 12. Environmental Regulations

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
USFWS[1]	Habitat Conservation Plan & Incidental Take Permit to comply with Endangered species act	Planning	TBD	Necessary if any federally listed endangered or threatened species will be harmed. Protects the project from conducting illegal activities in regards to the Endangered Species Act.	Federal
USFWS[1]	Migratory Bird Treaty Act Compliance	Construction	TBD	Migratory bird impacts. May be required, at the discretion of USFWS, based on other federal agency involvement. Forbids the "take" of migratory birds	Federal
Mass. NHESP[2]	Conservation and Management Permit	Construction	Yes	Required for any take of a state endangered species	State
Mass. NHESP[2]	MESA[4] Notice of Intent	Construction	Yes	Notice of Intent to comply with Mass. Endangered Species Act. Required if project falls within an "Estimated Habitat" of rare wildlife.	State
EOEA[3]	MEPA[5] Determination: Environmental Notification Form (ENF) or expanded form	Pre-Construction	Maybe	Must be filed if more than 25 acres will be directly altered or certain other criteria met. MTC may choose to file even if the threshold is not met.	State
Mass. EOEA[3]	MEPA[5] Review: Environmental Impact Report (EIR)	Pre-Construction	Unlikely	Unlikely to apply to community-scale projects. Based on the review of the ENF by the Secretary of Environmental Affairs. Automatically required if more than 50 acres of land will be directly altered or other thresholds met.	State

[1]USFWS: United States Fish and Wildlife Service
[2]NHESP: Natural Heritage and Endangered Species Program
[3]EOEA: Executive Office of Environmental Affairs
[4]MESA: Massachusetts Endangered Species Act
[5]MEPA: Massachusetts Environmental Protection Agency
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

The United States Fish and Wildlife Service (USFWS) requires the creation of a Habitat Conservation Plan in order to evaluate whether the project will have any impact on surrounding federally listed endangered or threatened species. An incidental take permit is required if, as a result of the construction of the project, it is predicted that any federally listed species will be harmed. The USFWS may also require compliance of the Migratory Bird Treaty Act, which forbids causing death to migratory bird species. The Massachusetts Natural Heritage and Endangered Species Program (NHESP) is the regulating agency for projects that impact state listed endangered or threatened species. The NHESP requires a Conservation and Management Permit be obtained if any state listed species are killed. The entire island of Nantucket is a priority habitat of rare species. The Energy Study Committee will most likely need to file a Notice of Intent with the Massachusetts NHESP (RERL, n.d., *Wind Power: Permitting in Your Community*). For further information on endangered and threatened species on Nantucket refer to Sections 3.1 and 3.2 of the Results and Analysis.

For any project that directly alters 25 acres of land or more an Environmental Notification Form (ENF) must be submitted to the Massachusetts Executive Office of Environmental Affairs (EOEA). The Massachusetts Technology Collaborative may choose to file an ENF or expanded form if less land is altered. As a result of filing the ENF, the EOEA may require that an Environmental Impact Report (EIR) be filed. An EIR is also required if the project directly alters 50 acres of land or more. It is unlikely that an EIR will be required of the Energy Committee's current turbine project (RERL, n.d., *Wind Power: Permitting in Your Community*).

1.6. Interconnection and Transportation Regulations

There are State and Federal regulations that might apply to the Energy Committee's turbine project regarding interconnection into the grid, and transportation of turbine components, and construction materials and resources.

As shown in Table 12, if a wind project generates more than 100 MW of electricity, the Energy Facility Siting Board (EFSB) must approve the transmission line. The EFSB might also review a project if the project involves the addition of a new transmission line that is over 1 mile long, or over 69 kilovolts. It is unlikely that the EFSB will have jurisdiction over the Energy Study Committee's turbine project. An Interconnection System Impact Study will need to be conducted for ISO New England and National Grid. The System Impact Study reviews the impact of the new generating facility on the existing grid. The study will determine if the transmission system requires any additional electrical components (RERL, n.d., *Wind Power: Permitting in Your Community*).

Table 13. Interconnection Regulations

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
EFSB*	Transmission line approval	Operation	TBD / Unlikely	EFSB is primarily concerned with plants of 100 MW or more. EFSB may have jurisdiction over a community wind project if a new transmission line is: 1. Over 1 mile long, or 2. Over 69 kilovolts	State
ISO New England as well as National Grid	NEPOOL Interconnection System Impact Study	Pre-Construction	Yes	Interconnection system impact and facility study. The impact of the new generating capacity on the existing grid is studied. The Facility Study then determines what, if any, additional electrical components are required for the transmission system.	State

*EFSB: Energy Facility Siting Board
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

During the transportation of turbine components and construction materials the project might require a general access, or wide load permit. A general access permit is required if any road alterations are necessary. A wide load permit might be required to transport components and construction materials by truck. These permits can be acquired from the Massachusetts Department of Highways (MDOH) (RERL, n.d., *Wind Power: Permitting in Your Community*). See Table 13, below, for a summary of transportation-related permits. For more information regarding the transportation of wind turbines to Nantucket and the specific sites, see 3.10 of the Results and Analysis Section.

Table 14. Transportation Regulations

Regulatory Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
MDOH*	General Access Permit	Construction	TBD	Needed if road alterations to state roads are required.	State
MDOH*	Wide load	Construction	TBD	Possibly needed for transportation of turbine components, construction materials and equipment.	State

*MDOH: Massachusetts Department of Highways
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

1.7. Aviation Regulations

The following table, Table 14, shows any regulations the committee will have to take into consideration involving aviation review requirements.

Table 15. Aviation Requirements

Agency	Regulation / Permit	Project Phase	Required?	Comments	Level
FAA[1]	Notice of Proposed Construction or Alteration, 7460-1 "Part 77 review"	Pre-construction	Yes	This form is submitted for all construction projects of structures exceeding 200 feet or within 20,000 feet of an airport. http://forms.faa.gov/forms/faa7460-1.pdf	Federal
FAA[1]	Lighting	Construction	Yes	FAA requires that any structure over 200 feet above ground be lit.	Federal
MAC[2]	Airspace Review	Pre-Construction	Yes	MAC should be notified (courtesy notification) of projects over 200 feet tall to review the potential aviation impacts involving structures greater than 200 feet in height. The airspace review can be submitted from MAC's website.	State

[1]FAA: Federal Aviation Administration
[2]MAC: Massachusetts Aeronautics Commission
Adapted from RERL, n.d., *Wind Power: Permitting in Your Community*

According to the Federal Aviation Administration (FAA), a Notice of Proposed Construction or Alteration is required for any project that is within 20,000 feet of an airport, or has a tower-height of more than 200 feet above ground. The Federal Aviation Administration also requires that an object over 200 feet be lighted.

The Energy Committee received an Airspace Obstruction Report in November of 2008 for the Madaket Landfill and Waste Water Treatment Facility sites. The WWTF is located 1.51 nautical miles or 9,175 feet away from the Nantucket Memorial Airport Runway 6. The report restricts the tower height at the Waste Water Treatment Facility site to a maximum allowed height of 178 feet, because of the close proximity. The report also states that a Notice of Proposed Construction must be submitted to the FAA for any proposed structure on the WWTF site that is more than 119 feet above ground level (Aviation Systems Inc., Waste Water Treatment Facility, 2008). The Madaket Landfill site is located 4.56 nautical miles or 28,301 feet from the Nantucket Memorial Airport (Aviation Systems Inc., DPW Solid Waste Facility, 2008). The Energy Committee's proposed turbine project at the Landfill involves structures that are greater than 200 feet measured from the base to the blade tip, requiring that a Notice of Proposed Construction be submitted to the FAA. The Airspace Obstruction Report concludes that any project at the Madaket Landfill that does not exceed 397 feet should obtain routine approval (Aviation Systems Inc., DPW Solid Waste Facility, 2008). The proposed turbine project at the Landfill does not exceed this height limitation, therefore there should be no turbine height restrictions regarding aviation at the Landfill site. The Massachusetts Aeronautics Commission should also be notified of turbine projects that exceed 200 feet in order to conduct an airspace review to determine any potential impacts.

The Notice of Proposed Construction must be submitted to the FAA at least 30 days prior to the first of either the date of proposed construction, or the construction permit application filing date. The airspace review can be submitted to the Massachusetts Aeronautics Commission in the same time period. The Massachusetts Renewable Energy Research Laboratory recommends that, "If any of the sites are considered for a wind turbine project, then early filing of the FAA 7460-1 form is recommended" (McClelland & Knipe, 2008). According to the RERL report, it takes approximately three months to receive a first response. "We recommend that these filings, or a detailed analysis of airspace issues, be undertaken as soon as possible if a site is seriously being considered for a wind turbine" (McClelland & Knipe, 2008). According to Jonathan Fitch, "FAA permitting is a very easy process, and you can get a determination pretty quickly" (Jonathan Fitch, personal communication, October 17, 2008).

The Federal Aviation Administration requires any project that exceeds 200 feet above ground be lighted. Lighting the turbine is a federal requirement, and this takes precedence over any local bylaws regarding lighting such as the dark sky initiative (T. Broderick, personal communication, November 14, 2008). The RERL report states that "All utility-scale wind power installations are lit" (McClelland & Knipe, 2008). This means that any prospective turbine 660kW or larger requires lighting. According to Richard Miller regarding FAA lighting,

> One thing you want to do if possible is try to get FAA to approve you for red only light, day and night... if the red shield doesn't come down over the white light and it's on all night, it can affect the cycle and takes 24 hours to correct itself and I get 1,000 phone calls...about the white strobe at night..... If you can do that, you'll save the people you are working for a lot of aggravation down the road.

[R. Miller, personal communication, November 10, 2008]

1.8. Green Communities Act: Net-metering

Section 78 of the Green Communities Act refers to net-metering. Net-metering is defined as the "process of measuring the difference between electricity delivered by a distribution company and electricity generated by a Class I, Class II, Class III or neighborhood net-metering facility and fed back to the distribution company" (The Commonwealth of Massachusetts, 2008). Section 78 defines three different net-metering classes. Class I is defined as a "plant or equipment that is used to produce, manufacture or otherwise generate electricity and that is not a transmission facility and that has a design capacity of 60 kilowatts or less" (The Commonwealth of Massachusetts, 2008). Class II is defined as a wind net-metering facility that generates more than 60kW of electricity and less than 1MW. Class III is defined as a facility that generates more than 1MW of electricity and less than 2MW (The Commonwealth of Massachusetts, 2008).

There are also three different classes of metering credits that follow along with the three different net metering facility classes. With regards to wind power generation, Class I and II are the same, and Class III differs slightly. A net-metering credit is defined as:

> A credit equal to the excess kilowatt-hours by time of use billing period, if applicable, multiplied by the sum of the distribution company's (i) default service kilowatt-hour charge in the ISO -NE load zone where the customer is located; (ii) distribution kilowatt-hour charge; (iii) transmission kilowatt-hour charge; and (iv) transition kilowatt-hour charge; provided, however, that this shall not include the demand side management and renewable energy kilowatt-hour charges set forth in sections 19 and 20 of chapter 25.
>
> [The Commonwealth of Massachusetts, 2008]

The net-metering credits allow the implementers of turbines that are characterized as a Class I, II, or III net-metering facility to receive the full value of the electricity that is generated, as opposed to the wholesale rate of electricity, a small portion of the full value.

The Energy Committee will have to follow the regulations, and acquire the permits that are described in this section in order to progress with the implementation of wind turbine on Nantucket. These results will be used to make recommendations to the Energy Committee, regarding the Committee's next steps in the project.

2. Objective 2: Financial Analysis and Ownership Arrangements

2.1. Ownership Arrangements

Breaking down Objective 2 into its main components, the issue of whether or not Nantucket should establish a municipal light department arose. In looking at this issue, the team approached several towns with their own municipal utility companies and interviewed two municipal utility managers. Jonathan Fitch, of the Princeton Municipal Light Department (PMLD), and Richard Miller and Patrick Cannon of the Hull Municipal Light Plant were valuable sources of information regarding this issue. Both towns came to the consensus that a town with a municipally owned utility company benefits more than any other utility company ownerships, and would also benefit the most from any implementation of wind turbines.

The first topic that the team noticed as a common theme amongst the interviewees was their pride in the fact that being a municipal light department gave them the ability to provide lower than market rates of electricity to the customers they serve. Jon Fitch made the following remark that echoes this sentiment: "We usually compare ourselves to National Grid, Unitel, Boston Edison. And they're much bigger than most muni[cipal light department]s but we tend to have much lower rates because of our non-profit status, and we report directly to the rate payers, not shareholders" (J. Fitch, personal communication, October 17, 2008). From this, it is also apparent that another distinct advantage is that as a municipal utility, electricity distributors are on a more personal level with the citizens that they support. Richard Miller confirmed reduced rates as an advantage when he stated, "Look at our rates, they are almost half of National Grid['s rates]" (R. Miller, personal communication, November 10, 2008). To put it in perspective, Patrick Cannon put all of these statements in terms we could visualize easily: "We are about 12cents a kWh and any of the investor owned are about 19[¢/kWh]. We are doing extremely well rate-wise" (P. Cannon, personal communication, November 10, 2008).

The chance to provide reduced electricity rates to customers is of course an advantage, but Jon Fitch mentioned to us that the biggest advantage of a municipality may be the fact that they are able to provide longer term stabilization for the costs of electricity (J. Fitch, personal communication, October 17, 2008). Not only can municipal light departments provide reduced rates, but when producing wind power, they can also ensure that these rates do not fluctuate widely as market rates sometimes do. Apparent from the interviews was the fact that people involved in municipal light departments feel strongly that this is the best infrastructure a town can have in terms of benefits to the community. These results however, were taken from two towns that have had municipal light departments for many years (Princeton- about 100 years, Hull- since 1894). Based on these comments, we decided to explore the options for the island of Nantucket to establish its own municipal electric utility.

We interviewed three National Grid employees (Dave Fredericks, Dave Larson, and M. Peterson) to discuss the feasibility of Nantucket changing to a municipally owned utility company from its current arrangement as a customer of National Grid. Once again we noticed a common theme among all three interviewees that suggested that this topic was more difficult than previously thought. When asked about the possibility of Nantucket becoming its own utility company, Dave Fredericks told us:

> The fact that the committee asked you to layout what are the pros and cons of a municipal utility being formed and taking over our system…if you guys were getting your graduate degree and already had your law degree that might be a realistic paper to write… that may be more than you guys can handle… there are big law firms that make their living debating the pros and cons of municipal ownership. I couldn't even begin to help you, and I think I'm one of the last people that has a general view on some of that.
>
> [D. Fredericks, personal communication, November 11, 2008]

He went on to reinforce this statement by adding, "I don't know that you can get into this in a report unless you're a lawyer and really very crafty..." (D. Fredericks, personal communication, November 11, 2008). To see if this was simply an opinion, or was biased in any way, we asked the same thing of Dave Larson in our phone interview with him. "I don't think you should include anything right there, that's more of a law school thing" (D. Larson, personal communication, November 14, 2008).

These results indicated the subject was complex, but we were still interested in gaining some insight into the topic. The team then asked what impact and scale such an undertaking would incur, and we were provided with some unique insights. Mike Peterson informed us of something the team had not previously thought of:

> On Nantucket National Grid pays the town of Nantucket a personal property tax on all of our facilities. If the town of Nantucket were ever to pursue the concept

> of becoming a municipal light company, all of that tax income that they are dependent on by the town to operate town facilities… would go away.
>
> [M. Peterson, personal communication, November 14, 2008]

This could end up having a significant effect on tax revenues depending on what the property taxes actually are. The team asked Mr. Peterson a last question, concerning what he thought the actual possibility of this occurring would be, and we were left with this statement:

> With infinite time and infinite money anything is possible.....you're definitely talking about a lot of money to buy the infrastructure, I mean you're talking all the utility poles, all the wires, the transformers and everything else. It might easily be in the hundreds of millions of dollars if the town wanted to pursue that.
>
> [M. Peterson, personal communication, November 14, 2008]

Jon Fitch echoed this theme in our interview with him as well: "[Nantucket would] have to buy the electrical distribution system out, and that's a big endeavor" (J. Fitch, personal communication, October 17, 2008). A last opinion was gained when we asked Patrick Cannon of Hull what he thought about the chance for a town to make the switch to a municipally owned utility company.

> There hasn't been one to our knowledge constituted in many many years [in Massachusetts] for whatever reason, maybe the infrastructure or original buy….. No one has stepped up to the plate. Many have discussed it but for one reason or another they haven't gotten all the way.
>
> [P. Cannon, personal communication, November 10, 2008]

We realized that 3 of our key informants on this issue were National Grid employees, who may or may not have answered with slightly biased responses concerning the issue of a town buying out National Grid's infrastructure. That is why the team also interviewed 2 towns who are on the opposite side of this and have their own municipal light department, and their responses were very similar on these issues. This led us to believe that we had gained the perspective needed to fully understand what this type of project would require.

Moving away from the issue of the establishment of a municipal light company, as suggested by the consensus of our interviews, the team looked into the possible ownership options for wind turbines using the current status of Nantucket as a customer of National Grid.

Dave Fredericks informed the team that there are three different possibilities for ownership that could be considered.

> One is completely owned by the municipal. The second is owned by a third-party - that is, they would find a generation company: Solar Turbines, American Wind, someone - and set up a relationship. They would make the land available and so on, and the good wind regime of Nantucket and support a location and letting a third party own it. The last is a municipal/private party ownership or collaborative if you will, where it's possible because of the unique financial characteristics of the island, that they could get a joint venture either with public or private money. That's very practical out here as a possibility.
>
> [D. Fredericks, personal communication, November 11, 2008]

This gave the team a broad overview of what options Nantucket has in terms of ownership. We gained more information from looking at the Scituate Feasibility Study, where some pros and cons of town-owned and privately-owned situations were laid out.

> There are risks and benefits to both kinds of ownership. The two benefits of private-ownership are that the town bears no responsibility for the cost and maintenance of the turbine, while locking in a long term energy rate that is expected to be lower than current (and potentially escalating) market rates for electricity. The town will also benefit from leasing payments received for the WWTP turbine site. The benefit of town-ownership is that the town may completely offset some portion of town electricity costs, which is estimated to create greater economic value to the town than private ownership. However, along with gaining a greater portion of the benefits, town-ownership requires assuming a greater portion of the risks, including financing and maintaining the turbine.
>
> [KEMA, Inc., 2008]

In an interview with Jeff Willett, Director of the Nantucket Department of Public Works, the team asked if he saw the town as being able to own the turbines, and being able to be accountable for the responsibilities that come with ownership. His response to this was as follows:

> What I would hope would happen…[would be to have] some sort of arrangement with an owner/operator where the town would derive some benefit [from the turbines] whether it be from lease of the property, cut of the profits…I don't think the town wants to be in a position where it is owner of these things and responsible for maintenance.
>
> [J. Willett, personal communication, November 16, 2008]

The team acquired a good sense of municipal utility companies as well as some insight into the issue of ownership of wind turbines from these interviews. The next major aspect to be explored for our 2nd objective was the financial side of a wind turbine project.

2.2. Financial Arrangements and Considerations

Looking at the broad topic of wind turbine financials, it breaks down into two main aspects: the economics that the specific usage of the turbine creates, and the initial monetary investment and other issues necessary to purchase and install turbines. Starting with the first issue, when asking Dave Fredericks what the ideal setup would be for Nantucket when it installs wind turbines, we were told that size is critical in determining the economics of a project. We learned that there are two different options when it comes to the usage of the electricity produced from a turbine on Nantucket: one would be net-metering the electricity (making only enough for a specific site to use), while the other would be to pay National Grid to use the distribution system and sell the electricity back to the market (D. Fredericks, personal communication, November 11, 2008). Both methods can technically be involved, in the case that the turbine produces more electricity than the site can use in its net-metering. In this situation the excess energy gets sold back to the grid. Both of these situations have unique advantages and disadvantages.

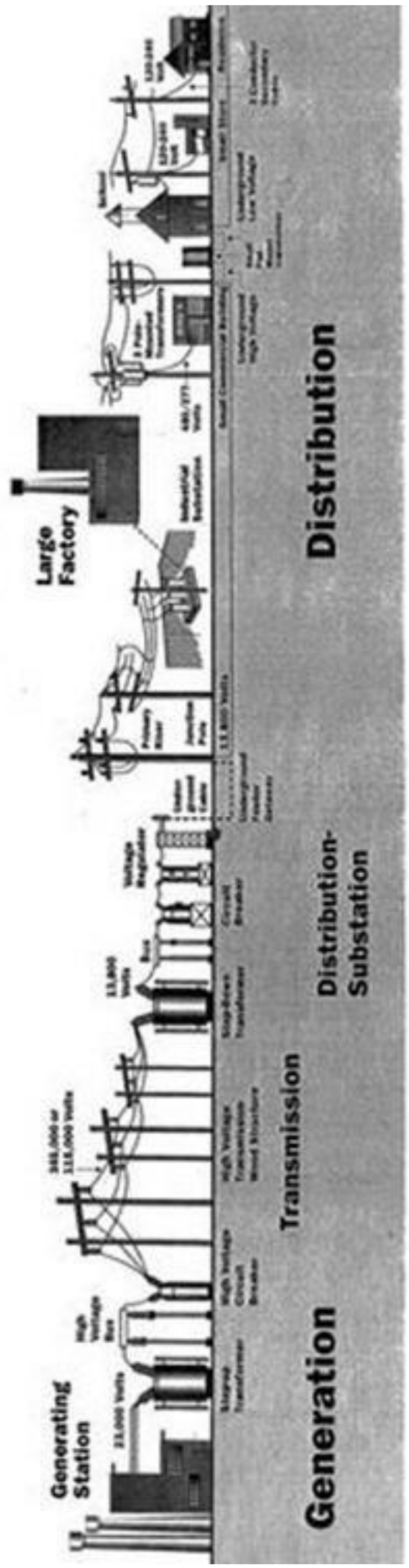


Figure 13. Setup of Standard Electrical Infrastructure. Obtained from D. Fredericks, November 11, 2008.

Figure 13 gives an overview of the standard electrical distribution system. Electricity is produced at the first location or the "generating station." This electricity is then stepped up in voltage to be transmitted over high-tension lines ("transmission"), eventually being stepped back down several times (at the "distribution substation") to convert the electricity back down to a voltage usable for a business or house. In a net-metering situation, the turbine could be considered to be on the customer side of the meter (farthest to the right in the figure), and essentially "rolls back" the meter and directly offsets the electricity usage at the site at which the turbine is implemented. If the turbine produces more electricity than the site consumes, this excess energy is then sold back into the grid but, as will be explained, the value of the energy sold will be much less in terms of dollar figures. The other setup would be with the wind turbine(s) taking the place of the generating station or power plant.

The net-metering setup would be ideal for a small-scale turbine project. The ideal situation would be for the turbine to produce approximately the same amount of electricity required by a given facility, causing a complete offset in the electricity bills. John Bartlett, owner of Bartlett Farms and owner of a soon-to-be operating 250 kW wind turbine, also informed us that using all of the energy produced as opposed to selling it back to the grid is much more beneficial from an economic standpoint, as the value of the energy is higher when used as opposed to when it is sold back at the wholesale rate (J. Bartlett, personal communication, November 3, 2008). This idea was present in Scituate's Wind Feasibility Study as well. One of the suggestions presented to the town was that "Electricity production from a wind turbine should coincide as much as possible with electricity usage at the WWTP" (KEMA, Inc., 2008). Dave Fredericks offered us an example to better illustrate this idea:

> [for a facility using 350kW per day,] On a peak day the first 350 kW is free, I've offset my bill completely. [On an] average day, [I have] more than offset my bill completely. So the pro of this is, up to the use of the building, I sell the power at 16 cents plus the tax credit of 2 cents, or 18 cents/kW. So I can completely eliminate my bill and I can make 2 cents in tax credit. If I size [the turbine] perfectly, the wind blows every time I need electricity, and the utility is really there for backup when it is not a windy day where they're selling you electricity, the rest of the time you've offset your electric bill.
>
> [D. Fredericks, personal communication, November 11, 2008]

As is evident from this quote, an advantage to net-metering is the maximization of economics, at least in the short term. A benefit that comes in addition to net-metering and producing only enough electricity for a specific site is the fact that it is a more small scale approach. This means that you minimize the social and environmental impacts a larger project might provoke, while still receiving substantial benefits from the project. Dave Fredericks put this well when he said, I "promise you, the bigger the turbine, the better the long-term financial outcome will be, except that the social and the human factor can change the permitting" (D. Fredericks, personal communication, November 11, 2008).

Negatives of a net-metering setup were apparent as well. "So the downside to being on this side, if you will, [with] a customer-owned or net-metering, if I go much bigger than my use, I have a lot of people to pay to get it to market so the value of the extra [electricity] is less [than the electricity used onsite]" (D. Fredericks, personal communication, November 11, 2008). Any excess electricity has a much lower value than the electricity being used onsite. Unless an organization plans to make selling back to the grid the primary goal (with a larger energy output from multiple turbines), it is not cost-effective to go over your usage only slightly as you may not get the return you had hoped for. This makes it apparent that if the decision is to use a net-metering approach, sizing is an important issue to be considered. Another downside to net-metering has to do with who actually benefits from this setup (this is an example given to us about a turbine being placed at a school): "You've done all this work. The school will benefit, maybe a little of this will get pushed back into the system, but you've really limited who gets to benefit from this particular application" (D. Fredericks, personal communication, November 11, 2008). A final overview of a net-metering situation was given to the team:

> If I put it on this side of the meter and I size it correctly, what I am really doing is deferring my total cost of power, which for Nantucket is about 16 cents per kilowatt...If I go beyond what I need, I can sell it to the market, but because I'm on this side of the meter I now pay losses through the meter and I pay a piece of it, I have to push it all the way through the distribution system and pay another piece, all to get the excess to the market. So by the time I am done with my 5-9 cents, a large portion of it has been eaten.
>
> [D. Fredericks, personal communication, November 11, 2008]

We asked Mr. Fredericks an additional question pertaining to the cost of connecting the wind turbines in a net-meter situation. He offered this response: "the interconnect cost could easily be a few hundred thousand dollars" (D. Fredericks, personal Communication, November 11, 2008).

A net-metering setup with wind turbines is just one option that was discovered by the team. The other would be to use National Grid's distribution system and sell the electricity produced. For this second method of using the power produced from wind turbines, the turbine itself would be tied into "the distribution system and feed directly to the distribution system" (D. Fredericks, personal communication, November 11, 2008). Mr. Fredericks mentioned that this method is a lot more effective for large wind farms, and added that, "If I am big enough to play, the right place is the market" (D. Fredericks, personal communication, November 11, 2008). The reason that this setup is more cost-effective for larger numbers of turbines and more electricity production comes from the fact that to do this, Nantucket would have to pay a fee to National Grid. If the output of the turbines is greater, the profit made by selling this amount of excess electricity overcomes this fee much quicker than if a lesser amount was produced. If selling back was the intended plan, then it will be more beneficial to have a greater amount of electricity produced by turbines, making the payback period longer, but with the long term profits amounting to a greater value. The payment mentioned would cover the renting of some space on their lines that would be necessary to get it back to the market. When asked about the actual monetary value of this 'fee', we were told "… you're probably looking at a penny a kilowatt" (Dave Fredericks, personal communication, November 11, 2008). This value of a penny per kilowatt did not provide a good overview to the team, so we obtained some information on the entire scope of the situation of selling back to the market:

> If I sell here, I get the market minus the "handling fees" from National Grid… the market is going to pay me 5-8 cents, and… this is all offset by some tax credits - about 2 cents a kilowatt. So the real value of this if you add in the tax credit… you're going to end up with something between 6 and 9 cents a kilowatt on this side.
>
> [D. Fredericks, personal communication, November 11, 2008]

This was confirmed when Dave Larson also told us, "If they sold as a qualifying facility to the market via National Grid they would get the wholesale prices plus any capacity payments. It's roughly 7 or 8 cents,…when all is said and done on that, per kWh" (D. Larson, personal communication, November 14, 2008).

Dave Fredericks added to this one more piece of information that the team had not previously thought of regarding the possibility of Nantucket selling electricity produced from their turbines back to the market. He mentioned that this is a viable option for the island, but with higher numbers or even larger turbines there is the possibility that there will be a need to upgrade the infrastructure at the sites.

> …if you size it to be tied to… a school or another major municipal project… you want to size it in such that there is not a lot of excess power being sold to the market because of both the risk that you really have to spend some big money upgrading the equipment at that location which changes to economics…
> [D. Fredericks, personal communication, November 11, 2008]

Even if the turbines were put in without the intention of selling back power, there would be costs involved, as Dave Larson stated, "Even fairly easy implementation of sizable wind turbines will cost probably $20,000-$30,000 for facility upgrades" (Dave Larson, personal communication, November 14, 2008). Mr. Larson offered a last piece of information when he mentioned that, "You can get one turbine on a net transformer pretty easily, beyond that you're going to need to start adding transformers and maybe upgrading some of the underground cable, etc." (D. Larson, personal communication, November 14, 2008). Dave Fredericks confirmed this for us when the team asked him the amount of electricity that each of the two sites could handle without requiring an upgrade of electrical equipment. He went on to say of the equipment at the Waste Water Treatment Facility,

> It's a lot of underground. It's kind of unusual to have this tying into a system that is primarily underground…..it's fairly limited, about 1 MW is about all we could carry on that, so we might even have to upgrade the overhead section….. depending on how the substation is set up and what the minimum loads are on the feeders...if there's a chance that there will be reverse power at the substation you might have to add quite a bit of protection equipment back there.
> [D. Larson, personal communication, November 14, 2008]

He also noted that installing one turbine at the site would not require an upgrade or any additional costs. This problem of having to update the electrical equipment can turn what seems like a simple method of using wind turbines into something much more complex.

The team knew that in order for any electricity Nantucket wished to sell to get back to the market, it would be necessary for it to travel through the submarine cables. In the interview with Dave Fredericks, the team asked whether or not electricity could ever travel both ways through the cables. He offered a pretty useful explanation in regards to this:

> If someone was to ask us to do that, that is a very complicated study that they would have to pay to do. It is technically feasible; there would be costs because there is complex relaying that would have to be changed. And the issue is not the cables, the issue is the transmission system and the market we are tying to - there are a lot of really complicated things going on on it - and you might find that pushing power back into the system could force changes all the way to New York City or Boston because of how it all kind of ties together and works.
>
> [D. Fredericks, personal communication, November 11, 2008]

Regarding costs to pursue the idea of exporting electricity off Nantucket, including a study and actually making necessary changes, Mr. Fredericks explained that, "I would say it's an extremely complex system, it can be addressed, but the study itself is probably in the $50,000-$100,000 range. And the [resulting] changes could far exceed [the cost of] the study" (D. Fredericks, personal communication, November 11, 2008).

The financing of a wind turbine project is a tremendous undertaking that had to be looked into next. For information on this we approached informants that had some experience in the matter. Jon Fitch offered a few suggestions on how to gain the funds necessary address the situation on Nantucket. His first suggestion was to borrow money as a town through bonds. When talking of his recent financing issues with the town of Princeton, MA he explained,

> I could have either gone out as a town and borrowed through bonds as if we were building a school and back them up from PMLD's electric rates. We would take a town vote, but getting a bond vote in a small town is very difficult.....Asking for bond funding for wind turbines is very risky because it takes 2/3 voter approval, but that is an option for Nantucket - they can go through the town process of voting on borrowing money for a project like this and getting the money.
>
> [J. Fitch, personal communication, October 17, 2008]

Another suggestion from Mr. Fitch was to do some sort of co-op with a private organization to help with the financing. "Early on we were able to find private corporations that wanted to develop the wind farm with us as a joint project - they would finance it and own and operate it, we would get a share of the output and benefits, and both our names would be on the project. You could try to do something like that as well" (J. Fitch, personal communication, October 17, 2008). This arrangement was something that Dave Fredericks mentioned was possible as well. A last suggestion he offered was to look into what the Massachusetts Technology Collaborative (MTC) has to offer to aid a town in such projects like this. "Nantucket can get money through

MTC. MTC has some funding available for projects like this in towns served by IOU's [investor-owned utilities]" (J. Fitch, personal communication, October 17, 2008).

The team gained valuable insights into the financial aspects of a wind turbine project from other sources as well. Cormac Collier, executive director of the Nantucket Land Council, suggested that funding could be a fatal flaw:

> It's expensive. It's a huge and expensive endeavor to get this going. The other fatal flaw unfortunately might be money and the lack of funds to do it. It's really going to be on the committee or other people to come up with the grants with if not all of it, at least a sizeable chunk of it. Unfortunately that's just the way it is. Town meetings are really not supporting a lot of expenditures at this point.
> [C. Collier, personal communication, November 19, 2008]

This is an interesting concern that certainly would need to be addressed. Another concern comes from Mike Peterson, and pertains to the issue of maintenance of any turbines installed. "Maintenance is something that you always have to be cognizant of because these things do need attention….. What happens if the thing goes offline? These things are considerations that have to be at least mentioned in your study because they cost money" (M. Peterson, personal communication, November 14, 2008). Keeping with the trend of financials being a large factor in the success of a project of this magnitude, there was a recent article in the *Connecticut Post* newspaper dealing with this. It concerned the development of wind power in the state of New York. The article stated that "The nationwide financial crisis has put the brakes on a wind farm in northern New York… another developer has aborted possible projects in eastern and central New York…" (Hill, 2008). The article goes on to inform the reader that there are still new projects being planned for the state, "But the last few tumultuous months have been tough for the industry nationwide and New York in particular" (Hill, 2008).

2.3. Financial Analysis

As seen from all of the team's interviews, ownership and financing options are very crucial aspects to any wind turbine project. These are two aspects that will require thorough analysis to determine what is best for each specific situation, as each is unique in its own way. Using the two sites that the Nantucket Energy Study Committee is considering, the Surfside Waste Water Treatment Facility and the Madaket Landfill, we performed a cost analysis. Comments made by interviewees about financials aided in making assumptions used in the analysis. For each site, we considered 3 situations with different single turbine sizes: 1) 1.5 MW, 2) 660 kW, 3) 250 kW. Each of these three turbine sizes were then run through various scenarios in our sensitivity analysis. It is also to be stressed that these scenarios relate to a single turbine project only.

Table 16. Cost Analysis for 250 kW Wind Turbine at Madaket Landfill Site Under Given Conditions.

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	225,443	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	216,705	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Adapted from RERL, 2006.

Table 15 is an example of the analysis performed for our first step in performing a cost analysis. The table used has been modified from the Renewable Energy Research Laboratory's document on how to calculate a simple payback period. The assumptions we utilized in our calculations are lettered according to the row to which each applies, and will be described briefly here. Assumption A explains that we obtained the value for capacity factor from an estimate made by the RERL in their Wind Site Analysis of Nantucket from May of 2008. Assumption B states that our availability percentage was gained through a personal communication with Richard Miller. Annual peak kWh usage information at the sites (F) was obtained from communications with Mike Peterson. For our analysis purposes, Assumption H explains that we altered the retail electricity prices between 16 cents, 18 cents, and 22 cents. This in turn alters the wholesale price of the electricity, as we used an arbitrary value of 25% of the retail price as Dave Fredericks indicated was most often the case (J). Assumption L establishes the value used for the Massachusetts Tax Credit, which we found on the State of Massachusetts website. Assumption M explains that we obtained the value for the Federal Tax Credit from the RERL example on payback periods.

Assumption P corresponds to the 'Estimated Annual Revenue' value, and indicates that since National Grid uses a monthly billing system this may not be precise. One month could be quite windy as opposed to another where there is limited if any wind. This would alter the 'Estimated annual income' as well (row T). Assumption R explains that we obtained the maintenance cost rate from Hull's existing 1.8 MW turbine, and were also told by Dave Fredericks that this value we obtained is an industry standard. Assumption U addresses the value of 'installed cost per kW.' Projects at Princeton, MA and Hull, MA were averaged to determine this, and we added 20% to this value to account for additional costs associated with Nantucket being such a unique location for construction projects. For cases with a 250 kW turbine, the team used estimates from communications with Dave Fredericks relating to John Bartlett's recently purchased 250 kW project. Finally, we made a last assumption to state that transportation issues to Nantucket were not included in this analysis, and that a larger project may incur more costs.

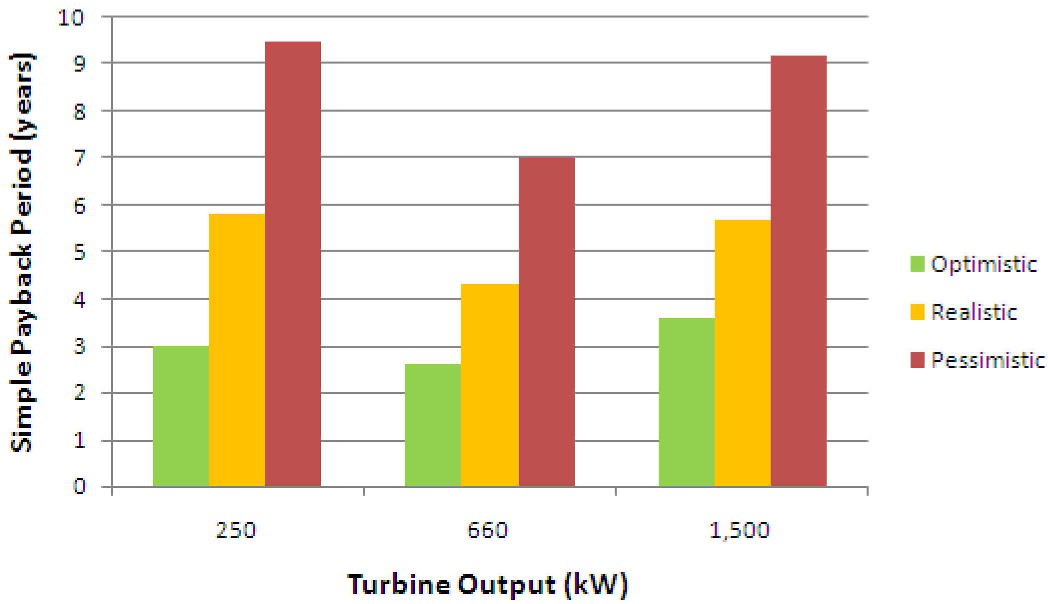
We will now explain the process our economic analysis followed in terms of the table used. The column in green text explains where each value is obtained and how it is calculated.

First, a value for capacity factor is entered into row A. One then inputs the power of the turbine into row B, and the availability, or time the turbine can be expected to be up and running in row C. These three values are multiplied along with a conversion in D to get the result of 'Annual Energy Production" in E. By then entering the 'Annual peak kWh' that will be used at the site in row F, one can determine how much of the electricity produced from the turbine will be used on-site in row G. Then, taking into account the retail and wholesale values of electricity, the overall value of the energy can be determined by using the information of how much power will be used on site as opposed to sold back to the grid at a lesser value. This 'Energy value' is shown in row K.

Continuing on, in rows L and M the state and federal tax credits are factored in, and then added together with the previously determined 'Energy value' to obtain a 'Revenue Rate (per kWh)' in row N, which is basically the dollar amount that will be made for every kWh produced by the turbine. This rate is then multiplied by row E, 'Annual Energy Production,' to determine an 'Estimated Annual Revenue' in row P. In row R, the 'Maintenance and insurance' rate is introduced, and then multiplied by the 'Annual Energy Production' of row E to determine 'Annual costs' for a project in row S. The result of subtracting these 'Annual costs' in row S from 'Estimated Annual Revenue' in row P and, is an 'Estimated annual income' in Row T. An 'Estimated installed cost/kW is entered in row U, and then multiplied by the power of the turbine from row B to produce an 'Estimated installed cost' in row V. This value of installed cost in V is then divided by the 'Estimated annual income' in row T to determine a simple payback period, in years, which is shown in row W and highlighted in green.

2.3.1 Methodology of Analysis

When we tested out our different situations, or 'sensitivities,' we altered certain values used in our calculations. The first value we were interested in changing was the capacity factor in row A, and we did so between 42% and 25%. This was to give a view of a 'what-if' scenario if the turbine did not perform as well as predicted. The next value that was changed was the retail electricity price. We used values of 16 cents per kWh, 18 cents per kWh, and 22 cents per kWh to show the various changes that may occur in payback with changing energy prices. The last variable we altered in our analysis was the cost per kilowatt for a turbine project (row U). We used the value that was obtained from averaging costs for the Princeton, MA and Hull, MA projects that we researched, with the 20% value added. This was then tested at a value 50% higher, to account for any unforeseen costs associated with permitting, transportation, etc. issues that arise in the course of a wind turbine project. With all of these variables being tested against each other in every combination that was possible, we obtained 72 total unique scenarios. Our next task was to sort through this tremendous amount of data and to get it into a form that is easily understandable but still provides an overview of the sizing issues that come with a wind turbine project. Three different scenarios were chosen for each of the 3 turbine sizes at each of the two sites, and were titled "Optimistic," "Realistic," and "Pessimistic." These scenarios are depicted in Figure 14.



Optimistic:	capacity factor	=	42%
	retail cost of electricity	=	$0.22 per kWh
	wholesale cost of electricity	=	$0.055 per kWh
	installed cost per kW	=	$2208 per kWh

Realistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.18 per kWh
	wholesale cost of electricity	=	$0.045 per kWh
	installed cost per kW	=	$2208 per kWh

Pessimistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.16 per kWh
	wholesale cost of electricity	=	$0.04 per kWh
	installed cost per kW	=	$3312 per kWh

Notes: - installed cost per kW for 250 kW turbine is either $3000 or $4500

Figure 14. Simple Payback Sensitivity Analysis at Madaket Landfill Site

Figure 14 gives an example of the next step taken with the data we had from our initial 72 cost breakdowns. The "Optimistic" situation for a wind turbine project, at least in terms of the variables we were able to test, would be with a capacity factor of 42%, a retail cost of electricity of 22 cents with a corresponding wholesale cost of 5.5 cents, and an installed cost per kW of $2208. The "Realistic" situation for a wind turbine project would be one with a capacity factor of 25%, a retail cost of electricity of 18 cents with a corresponding wholesale cost of 4.5 cents, and an installed cost per kW of $2208. The “Pessimistic” situation would be one with a capacity factor of 25%, a retail cost of electricity of 16 cents with a corresponding wholesale cost of 4 cents, and an installed cost per kW of $3312. The only factor that may be necessary for further explanation is the electricity prices and their effect on the period of payback. Wind generation actually becomes more cost-effective with higher electricity prices, as the value of the electricity net-metered and sold is tied directly to this value. Another note to be made is that for the 250 kW situations, different prices were used, as the cost per kW for a smaller turbine are generally higher. Values of $3000 per kWh and $4500 per kWh were used. This concept is show in Figure 15.

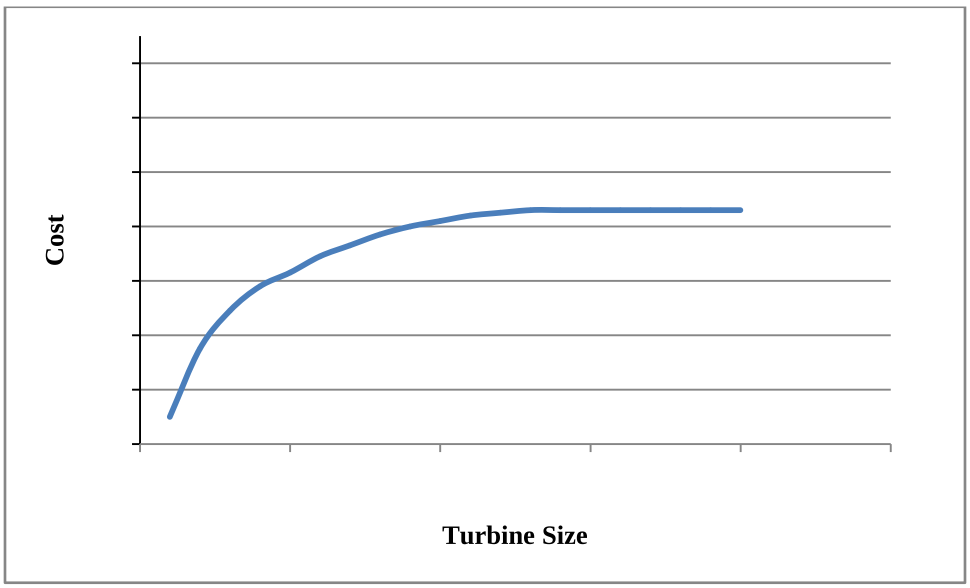


Figure 15. Visual of cost per kW relative to turbine size. Created from D. Fredericks, personal communication, November 11, 2008.

This figure above is used to visualize the concept that with a smaller turbine the price paid per kW of its output is more than would be paid per kilowatt on a larger turbine. As turbines get larger, this increase in price paid per kilowatt slows and then eventually becomes constant. The point where it begins to decrease quite rapidly (the ‘knee’ of the curve) is around 1 MW (D. Fredericks, personal communication, November 11, 2008).

Back to Figure 14, while displaying the three different scenarios selected for each turbine size, the figure also gives a contrasting view between the different sizes. Not only are a ‘best-case,’ ‘realistic-case,’ and a ‘worst-case’ scenario presented for one turbine size, but all are displayed against each other so that it may help in understanding the different scales of a wind turbine project. This analysis was performed at both prospective sites. This was one method for the team to compile their data and give a good comparison of sizing based upon the simple payback periods of the turbines. We realized that this one statistic does not, by itself, give the whole picture of all that must be considered when sizing a wind turbine project. The next method was to actually forecast what the returns would be on these different scale projects using the different scenarios.

Table 17. Twenty Year Projection with Cumulative Returns by Year and Percent Returns Overall for Various Turbine Sizes at the Madaket Landfill Site.

Madaket Landfill

Positive Return by year (cumulative)	(under Realistic conditions) Turbine Size 250 kW	660 kW	1.5 MW
0	-$750,000.00	-$1,457,280.00	-$3,312,000.00
1	-$621,009.00	-$1,116,744.00	-$2,729,855.00
2	-$492,018.00	-$776,208.00	-$2,147,710.00
3	-$363,027.00	-$435,672.00	-$1,565,565.00
4	-$234,036.00	-$95,136.00	-$983,420.00
5	-$105,045.00	$245,400.00	-$401,275.00
6	$23,946.00	$585,936.00	$180,870.00
7	$152,937.00	$926,472.00	$763,015.00
8	$281,928.00	$1,267,008.00	$1,345,160.00
9	$410,919.00	$1,607,544.00	$1,927,305.00
10	$539,910.00	$1,948,080.00	$2,509,450.00
11	$668,901.00	$2,288,616.00	$3,091,595.00
12	$797,892.00	$2,629,152.00	$3,673,740.00
13	$926,883.00	$2,969,688.00	$4,255,885.00
14	$1,055,874.00	$3,310,224.00	$4,838,030.00
15	$1,184,865.00	$3,650,760.00	$5,420,175.00
16	$1,313,856.00	$3,991,296.00	$6,002,320.00
17	$1,442,847.00	$4,331,832.00	$6,584,465.00
18	$1,571,838.00	$4,672,368.00	$7,166,610.00
19	$1,700,829.00	$5,012,904.00	$7,748,755.00
20	$1,829,820.00	$5,353,440.00	$8,330,900.00
% return based on initial investment	59.01%	72.78%	60.24%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Using some of the values that were gained in the initial cost analysis in Table 15, we were able to project the cumulative return of various situations over a twenty year period (the approximate effective lifetime of a modern wind turbine), as shown in Table16. The initial cost of investment was entered into year '0', with the estimated annual income from row T in Table 15 continuously added to it over the span of twenty years. Red values indicate the initial investment made, while orange indicates the first full year of a positive return, and green being the final return after all 20 years. With this taking place over a long period of time, many assumptions were used in projecting these values. They will be explained briefly in the order presented on the table.

The first assumption made in this forecast is the fact that the price of energy is held constant over a 20 year period, something that is not likely to be the case. Also, in the values that come after the 10 year mark, the Federal Tax Credit is still applied. This is something that expires after the first 10 years of a project's life. The potential for decreased efficiencies and increased spending on maintenance due to a project's age are also not considered in this analysis. If a larger size turbine is implemented, the initial cost may be higher due to the potential need to upgrade the electrical infrastructure to handle the increased load at a site. Finally, this model does not incorporate any interests or net-present values into its calculations.

A final calculation was done from Table 16 to give one more picture comparing the different sizes of wind turbines at the proposed sites. We decided that the percent return on investment would be a good way to step back and get a good picture of what size turbine is truly the most beneficial at a site. This was done by taking the final cumulative return of the project after 20 years and then subtracting the initial investment from this. This value is then divided by the final cumulative return after 20 years to get to a percentage for each. A higher percentage would in turn mean a higher cost-effectiveness in terms of what was invested into a project and then what was gained from this investment. This is a good way to assess the differences between the various size turbines that could be implemented. The entirety of our cost analyses can be found in Appendices J, K, and L.

There are many more factors involved with determining the size of a project, but this financial analysis will be very useful to the team when it makes its conclusions and recommendations to the Nantucket Energy Study Committee.

3. Objective 3: Concerns Regarding Wind Power for Nantucket

Many people on Nantucket perceived concerns regarding the use of wind power on the Island. Concerns varied from the effect that the turbines will have on avian life, flora, fauna, and humans to the effective use of the town's facilities. However, interviewees also saw opportunities to the use of wind power on the Island. This section focuses on potential concerns of implementing land-based wind turbines on Nantucket, as interviews were centered on the potential problems that the Energy Committee may face as they move forward in their studies of the possibility of implementing turbines. This data will help the Energy Committee anticipate and try to mitigate these concerns.

3.1. Concerns: Avian Life

Nantucket's avian population is a very important part of the island. In order to address the concerns about potential harm to avian life, the team interviewed six individuals who were very knowledgeable of avian life and Nantucket's bird population in particular. All six expressed concerns about potential avian deaths at both the Madaket Landfill and Waste Water Treatment Facility sites. Particular concern was noted by all six individuals for Short Eared Owls and Northern Harriers, both rare species. Ornithologist Dr. Robert Kennedy noted that these species, "us[e] that [Waste Water Treatment] Facility for foraging and very close by nesting," (R. Kennedy, personal communication, November 4, 2008) and shorebird biologist Edie Ray noted that they "might be attracted to hunt near [the Landfill] because there's available food" (E. Ray, personal communication, November 19, 2008). Four of those six individuals mentioned concerns about Ospreys, including that "Ospreys…nest on poles" (E. Steinauer, personal communication, November 3, 2008) and nest adjacent to the Landfill site, and wind turbines are essentially poles with blades. Three individuals noted that the federally-listed endangered species, the Piping Plover was a concern at the Waste Water Treatment Facility, as "Plovers could be feeding right on the beach there in the dunes" (S. Melvin, personal communication, November 12, 2008) immediately adjacent to the sewer beds. Concern for Long- tailed Ducks was noted by four individuals, because "a tenth of the world's Long-tailed Ducks [live in the area and]…hundreds of thousands of these birds fly over [Nantucket] every day" (E. Steinauer, personal communication, November 3, 2008). Two people expressed concerns for migratory song birds, which travel in large groups and could be killed by turbines in massive quantities in the right weather conditions. One individual noted concerns over the impacts of turbines on the federally listed Roseate Tern, and two noted concerns for the state listed Least Tern. Dr. Kennedy noted concern for both Bald Eagles, which “can show up there [at the landfill],” (R. Kennedy, personal communication, November 4, 2008) if they do come to the island, and for seagulls. Ernie Steinauer was concerned that Peregrine Falcons may be affected by turbines on Nantucket as they migrate through the area. Four individuals expressed increased concerns for birds during foggy weather, as “there are certain nights in the fall where it’s foggy and the lights are on, and all the birds are crashing” (V. Laux, personal communication, November 13, 2008). All six individuals noted that turbines operating during bird migrations on foggy nights may be especially lethal. Songbird migrations during the fall months are a concern on Nantucket, because birds migrate south along the east coast of the United States. In the spring, the migration is over the middle part of the United States and therefore is not a concern for Nantucket (V. Laux, personal communication, December 11, 2008). Table 17, below, summarizes concerns noted for avian life on Nantucket.

Table 18. Concerns for Avian Life.

Species	Concern at landfill	concern at Surfside facility	migratory concern	MA State Status	Federal Status	number of individuals expressing concern
Northern Harrier	X	X		T		6
Short Eared Owl	X	X	X	E		6
Osprey	X					4
Long Tail Duck	X	X	X			4
Piping Plover		X		T	T	3
Least tern	X	X		SC		3
Roseate Tern		X	X	E	E	2
migratory songbirds			X			2
Bald Eagle	X			E		1
Peregrine Falcon			X	E		1
sea gulls	X					1

* E = endangered, T = threatened, SC = special concern
State and Federal Status obtained from Massachusetts Division of Fisheries and Wildlife, 2008.

While concern exists for the life of all birds on Nantucket, the Roseate Tern and Piping plover are of extreme concern, because they are federally listed as endangered and threatened, respectively. Those two birds as well as the five others which are listed as endangered, threatened, or of special concern in Massachusetts are also of particular concern, and must be dealt with according to federal laws (Endangered Species Act, Migratory Bird Treaty Act) and state laws (Massachusetts Department of Fish and Game Natural Heritage and Endangered Species Program, Massachusetts Wetlands Protection Act, Massachusetts Endangered Species Act).

One bird of chief interest, as noted above, is the Northern Harrier. The map shown in Figure 17, below, was provided by Karen Beattie of the Nantucket Conservation Foundation.

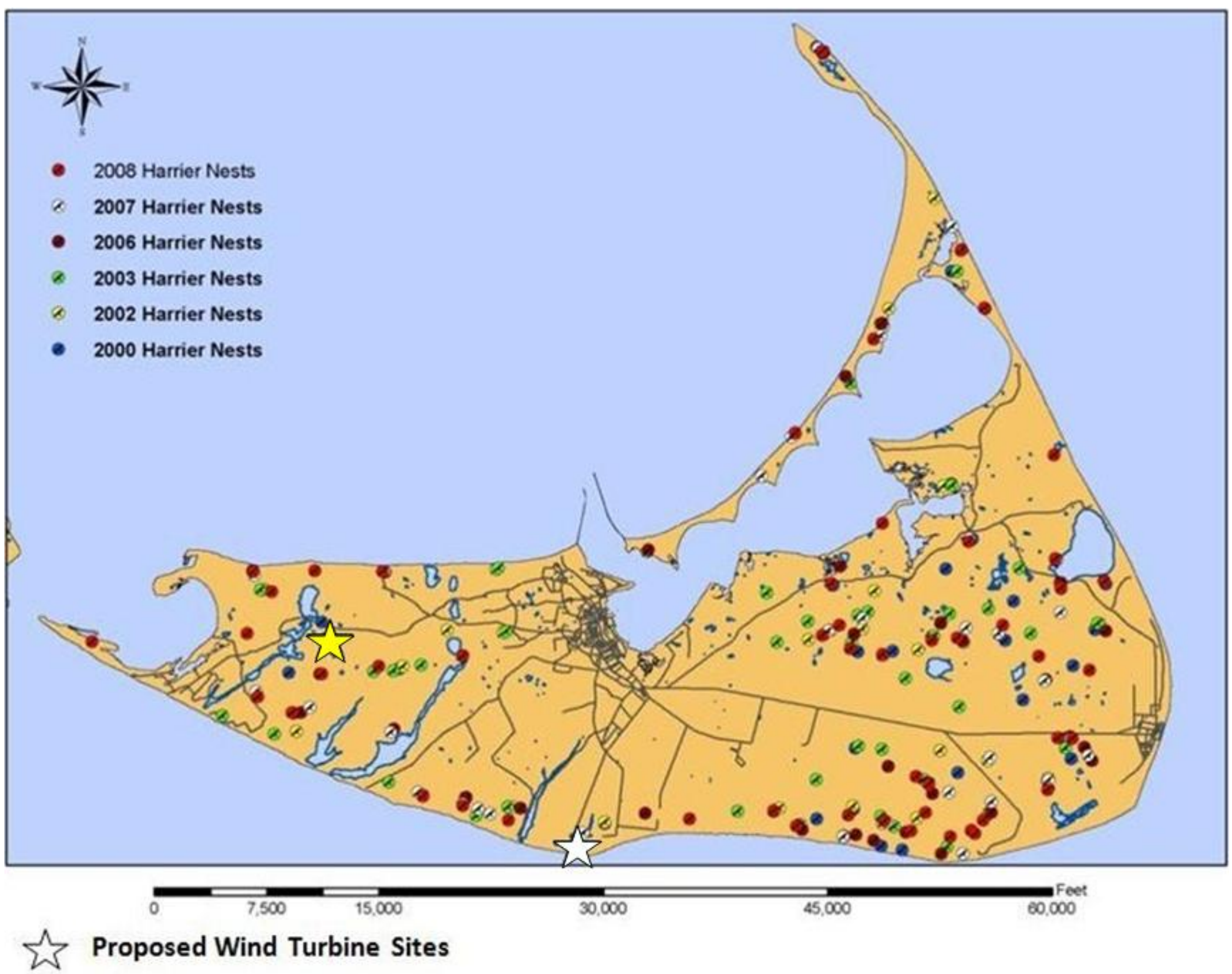


Figure 16. Locations of Northern Harrier Nests and Proposed Turbine Sites on Nantucket. Adapted from Bowen, 2008.

The map depicts the location of Northern Harrier nests over the past eight years, from 2000 to 2008. By comparing the map of the hawks' nest locations and the locations of the Madaket

Landfill and Surfside Waste Water Treatment Facility, one can see that the Landfill site (marked with a yellow star) has had no Harrier nests in the immediate vicinity since 2000, and the nest near the Landfill site was on Long Pond, not actually on the Landfill site. However, the Surfside Waste Water Treatment Facility (marked with a white star) had a Northern Harrier nesting pair in 2007, and the nest appears to be on the Facility land, very near the sewer beds. This map supports Dr. Kennedy's comment that Northern Harriers nest very near the Surfside Facility.

In addition to the effect the turbines might have on hunting and nesting birds, the effect that turbines may have on migrating birds is one of the most prevalent and important concerns on the island of Nantucket. Vernon Laux, bird expert for the Linda Loring Nature Foundation, suggested that the Energy Committee assign authority to shut down the wind turbines on particularly risky nights. Otherwise,

> There would be a few nights in the fall [when]…there would be massive kills...a few nights when the right wind conditions…a northwest wind [anywhere from 10-30 mph], and fog coming in the morning. You could go down [to the turbine] in the morning and there would be thousands of dead birds, and I don't think anyone wants that.
>
> [V. Laux, personal communication, November 13, 2008]

However, these nights could be predicted after sunset using online tracking websites and assessment of the wind and weather conditions. Edie Ray, a shorebird biologist, agreed with Vern Laux, "We were talking about shutting down in certain times where we know there are tweedy birds, passerines, passing through; we can predict that by using radar and some weather information" (E. Ray, personal communication, November 19, 2008). Both Edie Ray and Vern Laux said that Long-tailed ducks can also be tracked because some of them have implanted radio transmitters and can be tracked via certain websites. This link from the Patuxent Wildlife Research Center includes information about tracking the Long-tailed Ducks and shows GIS maps of Long-tailed Duck locations: http://www.pwrc.usgs.gov/resshow/perry/scoters/Nantucket_Telemetry/Seaduck_Nantucket_Telemetry_DNA_LTDU.htm. The National Ocean and Atmospheric Administration maintains a NEXRAD (Next Generation Radar) weather radar network which can be used to track real-time bird migrations (V. Laux, personal communication, November 17, 2008). Vern Laux and Edie Ray are willing to start a bird advisory sub-committee to the Energy Study Committee that monitors the bird migrations and informs the Committee of times when the turbines need to be shut off.

3.2 Concerns: Plant, Animal, and Marine Life

Siting of the turbines so that they have the least affect on the plant and animal species in the area was another concern of many of the interviewees. Edie Ray, a shorebird biologist, said "Populations of animals and things are cyclic…sometimes it's there and sometimes it's not. So I think an investment of time to really plan [siting of the turbines] carefully is the most important thing" (E. Ray, personal communication, November 19, 2008). No archival research exists regarding the transmittal of vibrations from turbines to the ground, nor did any interviewees have knowledge about this. However, the lack of information does not mean that vibrations are not a problem; there may not have been any studies conducted in the area of turbine vibrations. Edie Ray suggested how to address the potential issue of vibrations from the turbine and the effect they would have on certain turtles. "Do some geology work out there and find out what kind of soils are out there and do [the soils] transmit sound? It'd be easy enough to do. Put some probes in" (E. Ray, personal communication, November 19, 2008) the ground.

Land-based wind turbines in Nantucket could potentially disturb rare plant species. Four of the twenty individuals interviewed had some knowledge of plants, and all four expressed concerns about the impact that constructing wind turbines on Nantucket may have on these plant species. "All turbine sites should be thoroughly surveyed for rare plants. Steps should be taken to minimize impacts to rare plants and unavoidable impacts should be mitigated" (E. Steinauer, personal communication, November 3, 2008). Since protected land and areas with rare species are mapped, this should not be particularly challenging. A study was conducted by ENSR, an environmental consulting and engineering firm, to identify the rare plant species located at the Surfside Waste Water Treatment Facility prior to the construction of the new sewer beds. Figure18 below is a combination of the ENSR map of the rare species locations (ENSR, 2008) and the locations of the new sewer beds, both maps can be found individually in Appendix F.

Figure 17. Rare Plant Locations at Waste Water Treatment Facility. Adapted from ENSR, 2008 and Photo of Construction Plans by Diana Berlo, see Appendix F.

Figure 18 shows that the rare plants that may be affected in the sewer beds are bushy rockrose, coastal plain blue-eyed grass and little lady's tresses. Based on the ENSR study, the only identified locations that may contain rare plants are sewer beds # 10, 13, 14 and 15.

Of the six individuals with knowledge of birds, three expressed concerns about bats. Although Nantucket's "bat populations are significantly low" (R. Kennedy, personal communication, November 4, 2008), "wind turbines are spectacularly bad for bats" (V. Laux, personal communication, November 13, 2008). Several journal articles and studies address the issue of bats and wind turbines. One useful article, "Barotrauma is a significant cause of bat fatalities at wind turbines," by Erin F. Baerwald, Genevieve H. D'Amours, Brandon J. Klug and Robert M.R. Barclay, appeared in *Current Biology* in Volume 18, Issue 16, on 26 August 2008. Another valuable resource is Bats and Wind Energy Cooperative, whose website (http://www.batsandwind.org/) contains information about recent studies of the impact of wind turbines on bats. Further research may be conducted if the concern for bats is deemed important enough.

One member of the Energy Study Committee expressed concern about potential harm to marine life caused by land-based wind turbines. None of the interviewees provided any information about studies of the effect of land based turbines on marine life. "Some might say vibration could transmit" (P. Cannon, personal communication, November 10, 2008) to the ocean. Hull Wind 1, shown below in figure 19, is located immediately adjacent to the ocean. Andrew Stern knows of no impacts on marine life and does not "know if there have been any studies done because this [turbine] is on land" (A. Stern, personal communication, November 21, 2008).

Figure 18. Hull Wind 1. Hull has had no reported incidences of wind turbines disrupting marine life. From Hull Wind, 2006.

The team obtained no information from interviewees or through archival research regarding the effects of land-based wind turbines on marine life. This concern could be mitigated by continuing to study this topic until conclusive evidence is found. However, this lack of information about the effect of wind turbines on marine life suggests that marine life has not been seriously affected by other land-based turbines, and likely will not be an issue on Nantucket.

3.3 Concerns: Environmental

Environmental concerns are a major apprehension on the island of Nantucket. Ernie Steinauer of the Massachusetts Audubon Society said, "Another concern I'd have as a big picture item would be land management. Especially the grass and heathlands need to be fairly regularly and intensely managed with say brush cutting or prescribed fire" (E. Steinauer, personal communication, November 3, 2008). The project team was unable to find any information or research on the impacts of fires around the base of turbines, so the Energy Committee may need to investigate this further if it is deemed a major concern.

One resident of Nantucket expressed concern regarding the effect of oil or lubricant leakage into the sewer beds and the ground water. Sarah Oktay, a chemical oceanographer, addressed this concern:

> The amount of lubricants and oil used in the operation of most current brands of wind turbines are relatively minor and most systems have redundant ways of retaining oil (double walled containers, etc.). The turbines would not represent any significant threat to groundwater or drinking water supplies on the island if sited appropriately in regards to state and local wetland protection laws (not within 100 feet of wetlands and in areas where the depth to groundwater is at least 6 feet). Their location near a sewer bed or treatment facility poses no unique concerns.
>
> [S. Oktay, personal communication, November 20, 2008]

If this issue was of major concern, Sarah Oktay also said,

> In scenarios where wind power replaces either oil tanks (above and below ground) or propane tanks, the amount of oil and lubricants that could be potentially released into the environment would be reduced. In addition, pressure and leak sensors are typically installed on all newer equipment, from pipelines to oil tanks. If concerns were significant for interaction of leaked material into the groundwater, a filtration mechanism similar to a 'wash down' facility used at boat yards could be sited underneath a turbine to catch and treat any leaks.
>
> [S. Oktay, personal communication, November 20, 2008]

We believe that the risk of pollution from wind turbines is so minimal that it does not pose a risk to the environment of Nantucket.

3.4 Concerns: Social

Social concerns include aesthetic issues, noise which may irritate workers, gaining public support and public outreach. Aesthetic issues defined as the attitude and perception of the visual impact from wind turbines pose a significant risk to gaining public support and the completion of the project. Dave Fredericks said,

> I believe this word sustainability is key. I believe this [social issue] is key, I believe human is key. I think those three things [sustainability, social and human]

> are more important than the economics and the financial. Environmental is always important. And I'll tell you why, my belief only. We're at the brink of trying to make this work, and the reason it has not been working has not been economic or environmental or financial. It's all been perception of the human being; it's all been social concern.
>
> [D. Fredericks, personal communication, November 11, 2008]

These social concerns relate to the acceptance of technology and wind as a viable energy option, and aesthetics. Aesthetic views are personal opinions which are not easily swayed. Jeff Willet, Director of the Nantucket Department of Public Works (DPW) commented that:

> For [the workers who live in the housing near the sewer beds] the height isn't an issue, but it's going to be a huge issue politically and sociologically to overcome. If you just invested 15 or 20 million dollars into your dream cottage on Nantucket the last thing you want is a 200 foot tower in your backyard. I think will be one of the big issues. They're very supportive until the NIMBY, Not in My Back Yard.
>
> [J. Willett, personal communication, November 16, 2008]

People come to Nantucket to be away from mainland, and the last thing many people may want is a huge wind turbine blocking their scenic view. In contrast, one resident said, "I live on the east side, if one was out there I'd think it was pretty cool, I mean not next door but maybe two doors down" (C. Collier, personal communication, November 19, 2008). Although there are some residents that are accepting of the technology and the visual impact, aesthetic issues related to implementing wind turbines on the island are a major problem that must be addressed.

Noise is a perceived issue associated with wind turbines on Nantucket, because turbine noise could bother workers at the facilities as well as nearby neighbors. As Jeff Willett, Director of the Nantucket Department of Public Works, stated, "We do have people who work around these locations" (J. Willett, personal communication, November 16, 2008) who may be bothered by the noise of the turbines. The noise level of Hull's 660kW Vestas V-47 "is about 50dB" (A. Stern, personal communication, November 21, 2008) and a member of this IQP team noted that the noise of the turbine becomes background noise within minutes of being introduced to the sound. Though only one individual expressed concern about noise, according to several case studies it is a common concern which must be addressed.

Comments and advice about dealing with opposition and gaining public support was stated by a few of the interviewees. In response to a question about dealing with opposition, Jonathon Fitch said, "The biggest thing is to answer the questions. And no matter what question they came up with, you have got to answer honestly and sincerely. No matter how trivial or how crazy it may be, you have to always provide an honest answer- address the question head on" (J. Fitch, personal communication, October 17, 2008). Patrick Cannon of the Hull Light Department said, "At that time there were people that had come out with a lot of research about they thought the turbines could do such as throwing ice balls, killing birds, noise, and strobe effect. So we addressed their concerns as best that we could" (P. Cannon, personal communication, November 10, 2008), explaining how the Hull Municipal Light Board in Hull, MA dealt with opposition to their turbines. Jonathan Fitch also said that the best way to gain public support is, "to show the community hard benefits,…not just the fact that you got a wind turbine in your backyard. The community should try to figure out a way to get some direct benefit from the energy" (J. Fitch, personal communication, October 17, 2008).

Several of the interviewees also stressed the importance of public outreach. Jonathon Fitch, head of the Princeton Municipal Light Department said, "Start early!" (J. Fitch, personal communication, October 17, 2008). Dave Fredericks of National Grid also agreed with Mr. Fitch about the importance of public outreach. Though Dave Fredericks was not involved with community outreach for a wind power project, this was very important for the success of the project that ultimately resulted in National Grid laying submarine cables from the mainland to Nantucket. Mr. Fredericks said

> ...you need a social/public outreach program, because you need their support. And it starts with public input, starts with educating all of the key players. You win this by not surprising the key players. We [National Grid] did something, it's how I got successful, and we call it the Technical Advisory Group.....What I'm doing is bringing in the smartest people in town with all of the issues that I need to address and putting them in a room and closing the door and saying 'what are the issues?' without saying that to them. Guess what they do? They help me define. I may find the best place to put this is the sewer plant. But the environmental group is going to say that you're in the last bit of eel grass protecting the last dune on Nantucket.
>
> [D. Fredericks, personal communication, November 11, 2008]

Cormac Collier, Director of the Nantucket Land Council also talked about public outreach:

> They really have to do diligence with the neighbors on scenic impacts. I like the look of turbines myself. But I understand, although I don't agree with, people

> who don't like them on the landscape. So you have to respect that and do diligence with educating the neighbors about that.
>
> [C. Collier, personal communication, November 19, 2008]

Patrick Cannon of Hull, MA addressed the public outreach issue,

> We probably started to put the word out initially in newspapers and community meetings…about 2 years prior to installation. Probably 6 months prior to installation we sent out a stuffer in our bills, a questionnaire asking how [the residents] feel about additional wind turbines at Hull.
>
> [P. Cannon, personal communication, November 10, 2008]

These key informants realize the importance of public input and that their involvement is essential to having an approved and successful project.

3.5 Concern: Safety

Members of the Energy Committee and interviewees expressed concerns about safety, including ice throw and electrical failure. Two of three individuals interviewed with knowledge of owning and maintaining turbines said that turbine manufacturers offer both "a winter and marine package…so it's a concern but [cold weather and sea spray are] manageable" (A. Stern, personal communication, November 21, 2008). Jonathan Fitch said that, "the ice ball issue can be addressed easily because [turbine manufacturers] do make a cold weather package which we [Princeton] did buy for the turbines that keeps them from icing up" (J. Fitch, personal communication, October 17, 2008), and Andrew Stern also said that "the winter package…keeps a pretty constant temperature and humidity" (A. Stern, personal communication, November 21, 2008) inside the machine to protect the electronics. The issues of ice throw and electrical failure due to cold conditions can both be easily resolved by simply purchasing a cold weather or winter package for any wind turbine constructed in a cold climate.

3.6 Concerns: Financial

Financial issues were addressed in Results and Analysis of Objective 2, however a serious concern is financial risks. Both a Nantucket resident and light department manager expressed that "the biggest thing is [financial] risk" (J. Fitch, personal communication, October 17, 2008). "I think the economics of it is potentially the…fatal flaw" (C. Collier, personal communication, November 19, 2008). Unless a donor or grants are found to pay for the entirety of a wind power project, all Nantucket taxpayers will be impacted if the town decides to construct turbines. John Fitch addressed a financing concern of the Princeton project and an option for Nantucket,

> I could have either gone out as a town and borrowed through bonds as if we were building a school and back them up from PMLD's electric rates. We would take a town vote, but getting a bond vote in a small town is very difficult.....Asking for bond funding for wind turbines is very risky because it takes 2/3 voter approval, but that is an option for Nantucket- they can go through the town process of voting on borrowing money for a project like this and getting the money.
> [J. Fitch, personal communication, October 17, 2008]

If the town of Nantucket plans to borrow money through bonds, since it requires voter approval, if voter's turn this down, that source of funding is no longer an option. The biggest financial risk involves the massive amount of investment you have to put into the project and potentially not receive the payback you would expect from the project. If the turbines do not produce the amount of power that was predicted, the payback will not be as high as originally expected and is inherent in the financial risk. Unforeseen maintenance issues could cause financial concerns as well. The cost associated with transporting the turbine components to the island is also a financial concern. The infrastructure upgrades that might be required to distribute the power, especially if the town opted for large turbines, are another financial concern.

Municipal light department managers addressed the issue of decreased property values. Both managers interviewed said that it was "not an issue" (J. Fitch, personal communication, October 17, 2008), and Jonathan Fitch supported this statement with ECONorthwest's *Economic Impacts of Wind Power in Kittitas County Final Report*, and the Renewable Energy Policy Project's *The Effect of Wind development of Local Property Values*. Since property values were not affected in Princeton, an affluent Massachusetts town, nor in Hull, and national reports suggest no negative impact on property values in the vicinity of wind turbines, the risk of decreased property values is minimal. However, Nantucket is a vacation destination, and many residences are summer homes. As discussed in Results and Analysis Section 3.4, Social Concerns, due to Nantucket's unique designation as a vacation destination with a high density of luxury homes, the fear of decreased property values could be a reality on the island of Nantucket.

3.7 Concerns: Maintenance

A few of the interviewees also commented or expressed concern about maintenance of the wind turbines. When Eric Shultz was asked if he thought there would be an issue with maintaining the turbines in the sewer beds, he replied, "They are on land, you can drive to them. I don't see any problem with that" (E. Schultz, personal communication, November 7, 2008). Figure 20, below, shows one of the Surfside Waste Water Treatment Facility's sewer beds. Also, since the use of the beds is rotated every one to two days, scheduled maintenance in particular could be arranged around the day that the bed is in use.

Figure 19. Sewer Bed at the Nantucket Waste Water Treatment Facility. Photo Courtesy of Diana Berlo

Edie Ray, a shorebird biologist and Nantucket resident expressed concern about turbine maintenance, asking, "What kind of a track record do the various companies...have with maintenance? Can parts be here immediately? Is there going to be a technician here to deal with it right now?" (E. Ray, personal communication, November 19, 2008). The operations manager of the Hull Light Plant, Richard Miller, addressed this concern by explaining the maintenance of Hull Wind 1 and 2. "[We have] 2 PDMs per year where Vestas comes and maintains the turbines. As a rule, we have a warranty and service agreement and get 24 hour service. If [a turbine is] down they are here within 24-48hrs. They take care of it right away" (R. Miller, personal communication, November 10, 2008). In response to someone's concern about potentially damage to the turbine when it stops spinning either due to malfunction or manually stopping the turbine, Andrew Stern, President of New England Windpower, Inc. and co-founder of Action for Clean Energy, who works closely with the turbines in Hull, MA, said, “I am not aware of any problems [due to breaking or having the blades not spinning]. It’s just the way the machine operates, so I don’t know of any problems” (A. Stern, Personal Communication, November 21, 2008). Overall, shutting down a wind turbine is not a problem. Mr. Stern said, “[shutting down] is automated, once the winds die down or go to a low enough speed. But also there’s a stop button inside that you can manually stop and stuff like that…I don’t think it’s ever been manually stopped. For maintenance they shut it down” (A. Stern, personal communication, November 21, 2008).

As mentioned in the safety concern of Results and Analysis Section 3.5, turbine manufacturers offer a marine package, which helps to protect the machines from damage due to salt spray. Andrew Stern said that “it’s a concern but it’s manageable. [Hull Wind 1] has been out here for 7 years times 365 [days]. You’re going to get wear and tear…..But [Hull has had] no real major problems as far as sea spray” (A. Stern, personal communication, November 21, 2008). This potential problem associated with installing wind turbines near the ocean can be lessened by taking advantage of the marine package offered by the turbine’s manufacturer.

3.8 Concerns: Land Use and Interference with Existing Operations on the Island

The Director of the Nantucket Department of Public Works expressed concern that “wind…has the potential of conflicting with designated use” (J. Willett, personal communication, November 16, 2008) of facility land, and that improper placement may “impact the design of the facility” (J. Willett, personal communication, November 16, 2008). In the long term, this poses a risk to the island, as there is currently (December 2008) only one landfill and one waste water treatment facility on the small island. “We need to really understand how this [turbine project] will impact the future use of the site for solid waste disposal. That’s a critical concern because there is no other alternative to solid waste on the island and we cannot significantly impact or reduce our solid waste capability” (J. Willett, personal communication, November 16, 2008). A similar potential issue exists at the Waste Water Treatment Facility. As Eric Schultz explained, “Our discharge permit of 3.5 MGD(million gallons per day) is based upon the fact that we have 15 one acre sand infiltration beds equaling 675,000 square feet. So it would impact it a little bit...reducing by 3000 square feet the amount of land available for effluent percolation" (E. Schultz, personal communication, November 7, 2008). Disturbances or designated use of land at either facility could impact the entire island.

Land-based wind turbines on Nantucket pose the potential issue of interfering with electrical systems, airport landing and takeoff patterns, and radar. "A wind turbine can potentially disrupt electromagnetic signals used in a long range of telecommunication, navigation and radar services" (URS Australia Pty. Ltd., 2004). All three pose potential issues related to the effective use of the Surfside Waste Water Treatment Facility and Nantucket Memorial Airport.

Jeff Willett of the DPW noted that,

> Maybe these concerns aren't justified; however the control mechanisms at the Surfside Waste Water Treatment Facility are technologically advanced, [with] a lot of computer systems, systems which are sending signals back and forth. I don't know how well insulated these generating facilities are and whether there may be some electrical interference. We can't have any electrical interference at this facility. Somehow either the generators must be shielded to prevent that or the equipment shielded. So I'm concerned about that.
>
> [J. Willett, personal communication, November 16, 2008]

Potential electrical interference with electromagnetic signals depends on the composition and design of the rotor blades, characteristics of the signal receiver, and the siting of the turbine in relation to the signal transmitter and receiver (International Finance Corporation, 2007). According to the Australian Wind Energy Association, although it is possible for a wind turbine or wind turbine generator to affect telecommunications systems or produce interfering electromagnetic waves,

> In general the effects of wind turbine generators on electromagnetic waves will be relatively limited. The tower and blades are slim and curved and consequently will disperse rather than obstruct or reflect waves…However, the location, size and design of turbines may be important depending on the location and nature of the telecommunication facility.
>
> [Australian Wind Energy Association, 2004]

While older wind turbine models may have experienced electrical interference as a result of metallic blades, "The use of fiberglass/epoxy or plastic blades (i.e. those with no metallic content) in modern wind turbine generators reduces the likelihood of interference caused by the blades however the risk is not completely eliminated" (Australian Wind Energy Association, 2004). Even though there is a slight possibility that electrical and electromagnetic signal interference could occur, research indicates that, "a means of mitigation, avoidance or remedy can be found to minimize or eliminate the interference through a combination of special technical solutions and appropriate turbine siting" (Australian Wind Energy Association, 2004).

Since "Nantucket Airport is the second busiest airport in Massachusetts" (Delahunt, 2006), air space review is a concern for the Energy Study Committee. The Massachusetts Technology Collaborative hired Aviation Systems Inc. to conduct a "Far Part 77 Airspace Obstruction Report" of the Landfill and Surfside Waste Water Treatment Facility, and determined that the maximum height of a structure at the Madaket landfill is 397 feet, and at the Waste Water Treatment Facility is 178 feet. (Aviations Systems Inc., 2008) If the heights do not exceed the maximum height determined by the Aviations Systems Inc., Al Peterson, the airport's manager, said, "There should be no problems with air traffic interference at landfill or wastewater sites" (A. Peterson, personal communication, November 7, 2008). However, potential radar interference was also mentioned, and Mr. Peterson said this interference is possible at the Waste Water site as, "FAA ASR-9 radar is located in the southeast corner of the airport" (A. Peterson, personal communication, November 7, 2008). According to the "Far Part 77 Airspace Obstruction Report" for the Waste Water Treatment Facility,

> Development is unlikely to impact Air Defense and Homeland Security radars. Further radar impact is not necessary. Minimal to no impact to Weather Surveillance Radar-1988 Doppler (WSR-88D) weather radar operations. Further radar impact study is not necessary.
>
> [Aviation Systems Inc. 08-N-0448.040, 3]

In regards to the landfill site, Aviation Systems Inc determined:

> Impact to Air Defense and Homeland Security radars is likely. The project is in the yellow area on the FAA Radar Tool. Further radar impact study may be advisable. Minimal to no impact to Weather Surveillance Radar-1988 Doppler (WSR-88D) weather radar operations. Further radar impact study is not necessary.
>
> [Aviation Systems Inc. 08-N-0448.035, 3]

3.9 Concerns: Small Scale Purchasing of Wind Turbines (Excluding Costs)

Three of our interviews were with individuals who purchased wind turbines for their business or town. Jonathon Fitch, Richard Miller and John Bartlett have all purchased turbines and provided some insight on the different manufacturers and how they selected their turbines. The manger of the Princeton Municipal Light Department, Jonathon Fitch said, "You'll learn as you go through the process that some turbine companies won't sell to your site...There are many great turbines out there - they have power production guarantees, warranties, and are very well-made - some don't have thousands of turbines installed but they have hundreds of turbines" (J. Fitch, personal communication, October 17, 2008). Mr. Fitch was suggesting that since Nantucket is looking at a smaller number of turbines, it is likely that the larger companies will not be interested in selling to Nantucket, but there are other manufacturers that are not as well known that also sell high quality. About the selection of the Hull wind turbines, Patrick Cannon of Hull, Massachusetts said, "We put it out for an RFP (Request for Proposal). Got 3 or 4 bids. The only two that I recall were, GE gave us a bid for 1.5MW machine and Vestas for the 1.8MW on Hull Wind 2" (P. Cannon, personal communication, November 10, 2008). John Bartlett of Bartlett Farms on Nantucket also commented about his final decision regarding the selection of his wind turbine stating that Wind Energy Solutions was used, but he recommended selecting the manufacturer based on each turbine's output. Another important comment regarding the purchasing of wind turbines by Jonathon Fitch was, "the demand for these turbines today is extremely high worldwide. So if you make an order for any turbine at any size turbine that's popular today, you're going to wait 2 years" (J. Fitch, personal communication, October 17, 2008).

3.10 Concerns: Transportation

In order to address the Massachusetts Technology Collaborative concern about transportation of the wind turbine components to the island (MTC, Personal Communication, November 14, 2008), the project team compiled the shipping specifications of the components of both a 1.5MW and 600kW wind turbine and asked several transportation experts about issues regarding the transportation of the components to the island, through town and to the individual sites. As an example of the shipping specifications of the different turbine components, the team contacted and received information directly from Fuhrländer, a turbine manufacturer. The heaviest and longest components are highlighted in red. As Table 18 shows, the nacelle of the Fuhrländer 1.5MW turbine is the heaviest component and the rotor blade is the longest component.

Table 19. Fuhrländer 1.5MW Turbine Components

FL-1500/70	pcs	length mm	length feet	width mm	width feet	height mm	Height Feet	Weight kg	Weight ton
Nacelle	1	7600	25	3700	12.2	3900	12.8	63000	**69.5**
Hub	1	4700	15.4	4060	13.3	3300	10.8	18000	19.85
Hub cover	1	3000	9.85	3000	9.85	1150	3.8	500	0.55
Nacelle cover palette	1	10100	33.2	2500	8.2	1900	6.2	2000	2.2
Parts wooden box	1	2250	7.4	1600	5.25	1350	4.4	1000	1.1
Rotor blade LM 34.00	3	34000	111.6	2270	7.5	2620	8.6	6000	6.6
FL-1500/77									
Rotor blade LM37.3	3	37300	**122.4**	2270	7.5	2620	8.6	6300	7

Adapted from Fuhrländer Shipping Information, 2008

The specifications of the Fuhrländer 1.5MW tower sections are also listed below, with the longest and heaviest components highlighted in red.

Table 20. Fuhrländer 1.5MW Tower Sections

FL-1500 Tower 80m	length m	Length Feet	diameter bottom mm	diameter bottom Feet	diameter top mm	diameter top feet	weight kg	weight ton
Section 1	23,9	**78.4**	3364	11	2666	8.75	27950	30.8
Section 2	18,00	59.1	3890	12.8	3364	11	32310	35.6
Section 3	14,00	46	4300	14.1	3890	12.8	32940	36.3
Section 4	11,00	36.1	4300	14.1	4300	14.1	33460	36.9
Section 5	11,10	36.4	4300	14.1	4300	14.1	36160	**39.9**

Adapted from Fuhrländer Shipping Information, 2008

The shipping specifications for the Fuhrländer 600kW turbine are also listed below, with the longest and heaviest components highlighted in red.

Table 21. Fuhrländer 600kW Turbine Components

Component	Packing	Length m	Length ft	Width m	width Ft	Height m	Height ft	Weight mton	weight Ton
Nacelle		6.055	20	3.05	10	3.55	11.65	27	**29.8**
Rotor hub	Hub-dummy	3.6	11.8	3.05	10	3	9.85	7	7.72
Rotor blade (x3)	If required	26	**85.3**	1.8	5.9	2.6	8.5	2.3	2.54
Other	20 ft OT container	6.5	21.3	2.4	7.9	2.5	8.2	5.3	5.85

Adapted from Fuhrländer Transport dimensions Export Wind turbine FL 600, 50m HH, 2008

Jeff Willet, director of the Nantucket Department of Public Works, stated, in regards to the transportation of the components to the island and site,

> That could be a real problem, but I have no idea about the size of the components. You'll have to make special arrangements, bring things by barges and get bigger trucks. Length and weight are a real consideration. It could be a fatal flaw, but it all depends on how much will there is to get these things constructed. It could be done but it's very expensive.
>
> [J. Willett, personal communication, November 16, 2008]

The project team brought the tables (above) to an interview with Jim Palatine of Toscana Corporation to discuss the transportation issues. The largest and heaviest components were used to determine if delivering the components to the island and to the individual sites is possible. When we asked Jim Palatine if it was possible to transport the 122 foot rotor blade of the Fuhrländer 1.5MW turbine to the island he replied, "We [Toscana Corporation] have a 110 foot barge and even if it hangs off that's fine. You'll be fine" (J. Palatine, personal communication, November 17, 2008), stating that their barges can get a 122 foot rotor blade to the island. Thus the smaller components of the 660kW turbine can also be transported to the island. In conclusion, Toscana Corporation has a 110 foot barge rated at 100 tons that would be able to transport any of the turbine components listed above {Fuhrländer 1.5 MW: max. length 122 feet (rotor), max weight 70 tons (nacelle)}.

Therefore the issue is not going to be transporting the turbine components to the island but rather transporting them to the individual sites. Jim Palatine echoed this sentiment, "Your problem is not going to be getting it to the shores. It's going to be getting it through town" (J.

Palatine, personal communication, November 17, 2008). When the project team asked Jonathan Fitch about the issue of transporting the turbines to the sites he said,

> You do have to take into consideration how to get the components to your site. The turbine pieces are very heavy; the blades are very long, meaning they are going to have a turn radius that is very long and wide.....Nantucket might have an issue given that it is an island, but this stuff is coming out of port. Hull did it, and Hull has very similar circumstances and almost the same address as Nantucket, so Nantucket shouldn't have an issue. The components might have to be barged out there, and a crane would have to be barged out there, but that's do-able. But you'd have to take that into consideration, you can tell the turbine manufacturer who is typically responsible for getting it to the site. Sometimes they are not, but you can build it into the price and say 'You get it to me.' And then the crane guy is going to need to know where to go, you'll need a massive crane out there. Our access road had to be modified to accommodate the turn radius.
>
> [J. Fitch, personal communication, October 17, 2008]

The issues regarding getting the turbine through town were also addressed with Jim Palatine and other employees of Toscana Corporation. Mr. Palatine said that the Fuhrländer 1.5MW turbine's 122 foot blade cannot get through town. One option identified by Toscana Corporation is to barge the large component to Madaket and use a helicopter to pick the component off the barge and bring it to the site, "it'd be expensive but doable" (J. Palatine, personal communication, November 17, 2008). The helicopters, which can handle the large components, recommended by Toscana Corporation were the Sikorsky Sky Crane or Carson S-61. However, when the team asked Mr. Palatine if it would be possible to transport the 600kW turbines largest component of 85 foot could be driven through town he replied, "Yes. We could put a dolly in the back and it steers" (J. Palatine, personal communication, November 17, 2008). But any component larger than the 85 foot blade of the 600kW turbine would not be able to make it through town because of all the tight turns. In order to assemble the turbine, a large crane could be barged to Nantucket and assembled on site, or the helicopter could be used to assemble the turbine. The LeFlore crane that is currently on the island is not capable of lifting the 1.5 MW turbine's 70 ton nacelle to the top of the tower. The roads should be able to handle the weight of the trucks and turbine components. Certain bridges may need caution, but Madaket Bridge over Long Pond Creek will probably be the only one that will be used, and it should be strong enough. In conclusion, the transportation of the components to the island or to the individual sites is possible and can be eliminated as a fatal flaw but will be very expensive.

3.11 Analysis and Summary

Though there are a number of potential concerns and perceived issues, many of these may be mitigated. Each of the concerns previously mentioned in Sections 3.1-3.9 represents a concern of one or more individuals regarding the implementation of land-based wind turbines on Nantucket. The primary concern of our sponsor was to find the perceived concerns with regard to wind power on Nantucket and our interview questions were designed to do this. No interviewee was asked what potential benefits he or she saw for the implementation of wind turbines on the island. However while discussing the concerns and potential issues to implementing wind turbines on the island, a few interviewees mentioned some of the opportunities of such a project, which will be discussed in the Conclusions and Recommendations section that follows in the next chapter.

A pair-wise comparison was used to evaluate the concerns regarding wind turbine implementation. According to Dym & Little, pair-wise comparison is:

> …A relatively simple device in which we list the objectives as both rows and columns in a matrix or chart and then compare them on a pair-by-pair basis, proceeding in a row-by-row fashion. The pair-wise comparison is useful for rank ordering objectives early in the design process. It is also helpful for choosing among competing attributes or requirements…..to rank order design objectives in terms of their perceived relative importance.
>
> [Dym & Little, 28, 40]

A pair-wise comparison is a technique that is most frequently used in the design process to rank objectives, but it can also be used to compare competing attributes such as components or characteristics of a project (Dym & Little, 2004). In this case, the team used a pair-wise comparison to evaluate the list of perceived concerns in order to determine the ranking of what the team believes to be the factors that need to be addressed by the Energy Study Committee. The list of concerns was acquired through archival research, interviews with key informants on the island of Nantucket and our knowledge of existing wind turbine projects. Table 21, below, shows the team's pair-wise comparison of the concerns regarding the implementation of wind power on Nantucket.

Table 22. Pair-wise Comparison of Concerns Regarding Wind Power on Nantucket

Concerns	avian	bats	turtles/vibrations	flora	marine life disturbance	winter issues (ice/electrical failure)	small scale turbine purchasing	financial	decreased property values	salt spray	transportation	Social issues (aesthetics, public outreach)	DPW land use	electrical interference (Surfside only)	air traffic interference	radar interference	maintenance	land management	oil leakage from turbine	Totals
avian	X	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	16
bats	0	X	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	5
turtles/vibrations	0	1	X	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	6
flora	0	1	1	X	1	1	1	0	0	1	0	0	0	0	1	0	0	1	1	9
marine life	0	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
winter issues (ice/electrical failure)	0	0	0	0	1	X	0	0	0	0	0	0	0	0	0	0	0	0	1	2
small scale turbine purchasing	0	1	1	0	1	1	X	0	0	0	0	0	0	0	1	0	0	0	1	6
financial	1	1	1	1	1	1	1	X	1	1	1	0	1	1	1	1	1	1	1	17
decreased property values	0	1	1	1	1	1	1	0	X	1	0	0	0	1	1	0	0	1	1	11
salt spray	0	0	0	0	1	1	1	0	0	X	0	0	0	0	0	0	0	0	1	4
transportation	0	1	1	1	1	1	1	0	1	1	X	0	0	0	1	0	0	1	1	11
Social issues (aesthetics, public outreach)	1	1	1	1	1	1	1	1	1	1	1	X	1	1	1	1	1	1	1	18
DPW land use	0	1	1	1	1	1	1	0	1	1	1	0	X	1	1	1	1	1	1	15
electrical interference (Surfside only)	0	1	1	1	1	1	1	0	0	1	1	0	0	X	1	0	1	1	1	12
air traffic interference	0	0	0	0	1	1	0	0	0	1	0	0	0	0	X	0	0	0	1	4
radar interference	0	1	1	1	1	1	1	0	1	1	1	0	0	1	1	X	1	1	1	14
maintenance	0	1	1	1	1	1	1	0	1	1	1	0	0	0	1	0	X	1	1	12
land management	0	1	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	X	1	7
oil leakage from turbine	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	X	1

*Transportation and small scale turbine purchasing does not include cost but financial includes all costs.

This chart was created by listing the concerns on both the horizontal and vertical axes. Each concern was compared to every other concern by assigning a "1" if the concern on the left column was determined to be a greater concern than the concern on the top row. If the potential or perceived risk on the top row was deemed greater, a "0" was assigned (Dym & Little, 2004). For example, in the "birds" row, the cell at the intersection of "birds" and "bats" has a "1" because birds were deemed a greater concern than bats. After each concern was compared to all others, the sum of each row was noted. This gives a ranking of the importance of each concern.

In order to determine the percent risk, the following equation was used:

$$\left(\frac{Total\ Points\ for\ Each\ Concern}{Total\ Points\ from\ Entire\ Pairwise\ Comparison\ Chart}\right) * 100 = \%\ Risk$$

For example, the percent concern for birds is $\left(\frac{16}{170}\right) * 100 = 9.41\%$.

The rank organizes the analyzed concerns in order of importance. The percent concern is the weight of concern compared to all of the other concerns that we identified; the total of the percent concern of all concern is 100% (Dym & Little, 2004). Table 22 lists the identified potential concerns in ranked order, with weights.

Table 23. Ranked and Weighted Concerns

Concerns	Total from Table *	% Concern
Human Factors (aesthetics, public outreach)	18	10.59
Financial	17	10.00
Avian	16	9.41
DPW Land Use	15	8.82
Radar Interference	14	8.24
Maintenance	12	7.06
Electrical Interference (Surfside Only)	12	7.06
Transportation	11	6.47
Decreased Property Values	11	6.47
Flora	9	5.29
Land Management	7	4.12
Small Scale Turbine Purchasing	6	3.53
Turtles/Vibrations	6	3.53
Bats	5	2.94
Salt Spray	4	2.35
Air Traffic Interference	4	2.35
Winter Issues (Ice/Electrical Failure)	2	1.18
Oil Leakage from Turbine	1	0.59
Marine Life	0	0.00
Total	170	100

* The ‘transportation’ and ‘small scale turbine purchasing concern do not include costs; all costs are included in the ‘financial’ concern.

The weighted percents allow the reader to easily see which factors pose the greatest concern regarding the implementation of wind turbines on Nantucket, and therefore should be addressed first. The highest perceived-concern items are social issues, financial issues, and birds. The lowest perceived-concern issues are marine life, oil leakage from turbines, and safety from physical contact. Social issues, including aesthetic concerns and public outreach, were ranked as most difficult to overcome because mitigation requires a lot of effort.

Financial issues are also a high concern, because any turbine project is expensive, even with donations. Even if the full cost of purchasing a wind turbine is covered by a donor, other costs such as, construction, public outreach activities, and maintenance must be considered. Also, if the expected power output from the turbine and expected payback are not achieved this will alter the financial benefits of the turbine project. Avian life is an important concern because Nantucket as a large bird population, including several protected species, with many birdwatchers and conservation organizations on the island.

Marine life concerns are ranked lowest compared to all other identified concerns because the team was unable to turn up any information about land based wind turbines impacting marine life. Oil leakage was ranked very low because this concern was mentioned by only one individual, and the chemical oceanographer said that this was essentially not an issue and would probably require no mitigation. Even if the minimal amount of oil leakage was determined to be an issue, filtration systems can be installed to collect all leakage. Winter issues, including ice throw and cold weather electrical failure ranked low in comparison to other concerns because both issues can be easily mitigated by purchasing the cold weather (also referred to as 'winter') package from the turbine manufacturer. Air traffic interference is ranked low in comparison to the other concerns because Aviation Systems Inc. submitted reports for both the Madaket Landfill and Surfside Waste Water Treatment Facility which state the estimated maximum heights for structures at each facility. The team believes that the information is credible, as the company that conducted the review was hired by the Massachusetts Technology Collaborative.

The purpose of this analysis was to provide information about the greatest concerns and issues that should be addressed regarding wind turbine development on Nantucket, so that the team could draw conclusions and make recommendations about mitigating these concerns.

Inevitably the team's opinions as well as the opinions of interviewees are present in this pair-wise comparison. Results of future studies of these concerns will change the outcome of this pair-wise comparison. For example, if further studies determine that transportation both to the island and to the specific sites is not an issue, the pair-wise comparison can be repeated. If transportation is deemed less of a concern, it will end up a lower rank, showing that it no longer requires as much attention as human factors and financial issues. This pair-wise comparison can be repeated at any time as more information is gained, repeating the process noted above. Also, if concerns are determined not to be an issue, they can be removed from the chart.

As the main focus of this objective was to determine the concerns and opposition that the Nantucket Energy Study Committee may face, the team did not seek information about potential opportunities that that wind power may offer to Nantucket. Therefore, the number of identified concerns is large but the purpose of this objective was to determine the concerns and issues that the Energy Committee needs to be aware of and address, and this by no means signifies that concerns outweigh the potential opportunities. If a comparison of potential opportunities versus concerns is desired, further data collection will be necessary. Data must be collected to determine what other potential opportunities exist for the implementation of wind turbines on the island, and studies must be done in order to determine which concerns can be mitigated.

CONCLUSIONS AND RECOMMENDATIONS

1. Objective 1: Laws, Regulations, and Permits

The following section describes the conclusions and recommendations that the team reached in regards to the laws, regulations, and permits needed to implement land-based turbines on Nantucket.

1.1. Recommended Order to Apply for Permits

There are Local and State permits that the Energy Committee will have to acquire in order to implement wind turbines. The majority of Federal permits only apply to a turbine project if the project is on Federal land, or uses Federal grants. The only Federal permits that apply to the Energy Committee's turbine project are the Federal Aviation Administration (FAA) Notification of Proposed Construction, and the United States Fish and Wildlife Service Incidental Take Permit.

Table 23 lists the order that the team recommends the Energy Study Committee approach the permitting process. It includes the Local, State, and Federal permits that the Nantucket Energy Study Committee will need to acquire to implement wind turbines at the Madaket Landfill and Waste Water Treatment Facility sites. These permits are required for a typical wind turbine project, and focused on wind turbine implementation on Nantucket. Every turbine project is unique and other requirements might be necessary for the Energy Committee's project. The table orders the permits into the three phases: planning, pre-construction, and construction. Within each phase the permits are listed first in ranking order based upon priority; federal permits are the highest priority followed by state and then local, and then the permits are listed in ranking order based on time; more time consuming permits are ranked higher then permits that take less time, on average. The permits that can be completed in conjunction with each other are included together in the table, and are separated by a dotted line. Regulations and permits that do not apply to the Energy Committee's proposed turbine project are not included in the timeline, but are included in the tables in the Results and Analysis section, which are ordered based upon function groups (Turbine-Specific Zoning, Noise, Historic District, Water and Wetland, Other Environmental, Interconnection and Transportation, and Aviation).

Table 24. Proposed Permit Application Order

Agency	Permit	Project Phase	Required?	Level	Notes
USFWS	Habitat Conservation Plan & Incidental Take Permit	Planning	Yes	Federal	The Energy Committee must confirm with the USFWS that the project does not impact threatened and endangered species. If the project will impact these species and Incidental Take Permit may be required.
FAA	Notice of Proposed Construction or Alteration, 7640-1 "Part 77 review"	Planning	Yes	Federal	
MAC	Airspace Review	Planning	Yes	State	
MHC	Project Notification Form	Planning	Yes	State	
Nantucket HDC	Certificate of Appropriateness	Planning	Yes	Local	
Mass. DEP	Notice of Intent (NOI)	Pre-Construction	TBD	State	
NCC	Order of Conditions	Pre-Construction	Yes	Local	
Mass. EOEA	MEPA Determination: Environmental Notification Form (ENF) or expanded form	Pre-Construction	TBD	State	
ISO New England as well as National Grid	NEPOOL Interconnection System Impact Study	Pre-Construction	Yes	State	
Planning Board	Special Permit with Major Site Plan Review	Pre-Construction	Recommended	Local	Regarding allowed zoning locations of turbines.
Planning Board	Special Permit	Pre-Construction	Recommended	Local	# of turbines/tower height
Planning Board	Building Permit	Pre-Construction	Yes	Local	
Mass. NHESP	MESA Notice of Intent NOI	Construction	Yes	State	
Mass. NHESP	Conservation and Management Permit	Construction	Yes	State	

Adapted from Renewable Energy Research Laboratory, n.d., Wind Power: *Permitting in Your Community*

Considering the permits that are included in the table above, certain permits take longer than others to receive. For each permit, the length of the permitting process is dependent on the specific turbine project.

1.2. Updating Nantucket's WECS Bylaws §139-21

The Nantucket wind energy conversion system (WECS) bylaw describes the regulations regarding implementing residential and commercial wind turbine projects. The WECS bylaws include zoning, building, number of turbines, and turbine size permits. The bylaws also regulate turbine blade color, noise, maintenance, and the required setback distance from the nearest property line. Under the bylaws, the Energy Study Committee must obtain an Order of Conditions, issued by the Nantucket Conservation Commission, and an Order of Appropriateness, issued by the Nantucket Historic District Commission (HDC). Based from John Bartlett's actions regarding his turbine project, and Andrew Vorce's suggestions, the IQP team recommends that the Nantucket Energy Study Committee comply with as many of the local bylaws as possible, without placing the project completion in jeopardy, in order to reduce local opposition towards the project.

The current (December, 2008) version of the Nantucket wind energy conversion system bylaws, §139-21, is outdated and many sections need updating. For example, modern turbines do not require guy lines, yet the bylaws require that guy lines be sited at least 15 feet from the nearest property line. Most of the outdated sections, similar to the guy line phrase, will not affect the Energy Committee's current wind turbine project. The WECS contains sections, such as noise and the setback distance from property lines, that are stricter than the Massachusetts State laws and the model bylaws regarding wind energy systems, which might prolong the permitting process for the Committee's project.

The current Nantucket WECS bylaw setback distance is much stricter than the Massachusetts model bylaw. Depending on the scale of the Energy Committee's project, the amount of usable land at the Waste Water Treatment Facility and the Landfill is limited by the strict setback regulations. The usable land at the Landfill site is especially important in regards to the Committee's hopes for future expansion, and since Nantucket is an island, land is a very valuable resource. The IQP team recommends that the Energy Committee update the current (2008) wind energy conversion system bylaw regarding turbine setback distance to reflect the

Massachusetts model bylaws suggested setback distance of 100 feet. The IQP team also recommends that the Committee clarify the language of the setback restriction to prevent discrepancies, by including a phrase stating that the setback restrictions are not applicable to an abutting parcel with the same ownership.

Nantucket's current wind energy conversion system bylaw regarding noise restricts the amount of noise a wind conversion system can generate with respect to the current ambient noise at the site. These regulations are much stricter than the Massachusetts regulations regarding noise. Using this information, and the actions of another Massachusetts town that is in the process of implementing wind turbines, the IQP team recommends that the Energy Committee update the bylaw to match the State regulations. By updating the Nantucket WECS bylaws to match the state law regarding sound, the new noise regulation would be less restrictive at all ambient levels. The team also recommends that the Energy Committee, as part of or in addition to the Massachusetts Technology Collaborative (MTC) feasibility study, conduct a noise study at both the Landfill and Waste Water Treatment Facility sites. This study should record the ambient noise at the sites during daily operation and rest.

There is an effort to update the current (as of December 2008) WECS bylaws. As part of this effort, a citizen article was drafted and is included in Appendix E. The IQP team recommends that the Energy Committee review this citizen article. The article updates the language, and inserts new wording into the residential and commercial sections of the WECS. The article does not change the current setback restrictions, but removes the entire noise section from the bylaws allowing noise regulations to be regulated by the state law. The team recommends that the Energy Committee take into consideration the updates made in the citizen article, the probability the citizen article will pass, and the team's recommended changes to the WECS, in order to make the best decision for the progression of the project. The team recommends that the Committee work with the author of the citizen article, or that the Committee draft their own proposed changes to the WECS bylaw. For more information on the citizen article, contact Andrew Vorce, Director of the Nantucket Planning Board.

1.3. Other Local Regulations

The Nantucket WECS bylaws require that an Order of Conditions and an Order of Appropriateness be obtained for a wind turbine project. An Order of Conditions is submitted to the Nantucket Conservation Commission, and is required if construction at the prospective wind turbine site would disturb wetlands. The entire island of Nantucket is classified as a Historic District. As a result of this classification, the Energy Committee must obtain an Order of Appropriateness from the Nantucket Historic District (HDC) to ensure that the project does not negatively impact the integrity of the town.

The Massachusetts Historical Commission requires documents that are satisfied by applying for the Order of Appropriateness with the Nantucket Historic District. The process to apply for an Order of Appropriateness at the Landfill and Waste Water Treatment Sites can be completed in as little as 60 days, and should be relatively easy to gain approval. Both sites are modern use sites, and are not historical landmarks on Nantucket. The HDC has already approved permits for turbines in various locations on the island.

The IQP team recommends sending the Project Notification Form to the Massachusetts Historic Commission during the planning process, after site plans have been created, but prior to any construction or purchasing. After notifying the Massachusetts Historical Commission of the project, the Energy Committee should work with the Nantucket Historic District Commission and submit an application for an Order of Appropriateness. The turbine project is classified as “other” on the majority of the application form. Working with both MA Historical and the HDC in conjunction is the most efficient way to satisfy these requirements.

The Energy Study Committee must obtain an Order of Conditions from the Nantucket Conservation Commission. This is also referred to as a Notice of Intent, which is required by the Massachusetts Department of Environmental Protection. According to GIS maps (Figure 13 of the Results and Analysis Section), there are minimal wetlands at the Waste Water Treatment Facility, and it is unlikely that the Committee will be required to obtain an Order of Conditions at that site. The GIS map shows that the majority of the land surrounding the Landfill and adjoining property is composed of wetlands. The IQP team recommends working with the Nantucket Conservation Commission in order to determine if the property at the Landfill is subject to the Wetland Protection Act. The team also recommends that the Committee apply for an Order of Conditions with the Nantucket Conservation Commission in respect to the Landfill site.

1.4. Federal Regulations

The Federal Aviation Administration (FAA) requires a Notice of Proposed Construction be submitted for any turbine project at the Waste Water Treatment Facility, and for any turbine project over 200 feet at the Landfill. As part of the review process, the FAA considers the proximity of the turbine project to the closest airports, and evaluates the potential impact to radar systems. The FAA then issues a Determination of No Hazard, or notification that an extended study must be conducted. This process can be tedious and time consuming, especially if the FAA requires an extended study. The IQP team recommends that the Energy Study Committee apply for an FAA Notice of Proposed Construction form 7640-1 as soon as feasibly possible. The team also recommends that the Committee submit the Airspace Review to Massachusetts Aeronautics Commission in conjunction with the FAA Notice of Proposed Construction. Any turbine project at the Landfill less than 397 feet in height should receive routine approval from the FAA.

The FAA also requires that a 250kW turbine project at the Waste Water Treatment Facility, and any 660kW or larger turbine project at the Landfill, be lighted. The color of the light is irrelevant, but social issues arise from mechanical failures of multicolored lighting. For this reason, when filing the application, the Energy Committee should apply for “red lights and paint” under section 7: Marking/Painting and/or Lighting Preferred of the 7460-1 form.

If receiving a federal grant, a new set of regulations apply to the project that would otherwise be inapplicable. In order to satisfy these requirements, the Energy Committee may end up spending almost as much money as the grant is worth. The IQP team recommends, unless as a last resort, that the Energy Committee does not apply for Federal Funds.

1.5. Green Communities Act

The Green Communities Act defines three different net-metering classes, and credits that can be obtained for each class. The largest allowed electricity production that qualifies for net-metering under the Green Communities Act is a Class III net-metering facility which generates 1-2 MW of electricity. Net-metering allows the producer of the electricity to receive credits for the entire product. Under current legislation Facilities that generate more than 2MW of electricity do not receive net-metering credits through the Green Communities Act. These facilities receive a percentage of the full value of the electricity generated by selling the excess product into the grid. As long as 2MW of electricity or less is produced at each site, the full amount of electricity produced can be net-metered and therefore is worth the market value. Any excess of this 2MW limit must be sold back to the grid, and the value of this electricity is the wholesale rate. The wholesale rate is approximately ¼ of the market value. If the amount of electricity produced exceeds the amount which can be net-metered, the return on investment of the turbine decreases.

The following recommendations, regarding the turbine size and number at each site, are based exclusively on the aviation restrictions and the information regarding net-metering under the Green Communities Act. These recommendations do not take into consideration the maximum loads at each the Waste Water Treatment Facility and the Landfill site, nor do they consider transportation costs, financial analysis, social issues, or any other aspect of a turbine implementation project. The Airspace Obstruction Report restricts the size of any turbine installed at the Waste Water Treatment Facility to a maximum turbine size of 250kW. The IQP team recommends that the Energy Committee choose to install up to eight 250kW turbines, with a total energy production of 2MW. The IQP team recommends that the Energy Committee install up to three 660kW turbines at the Landfill site, for a total energy production of 1.98MW. These sizes and numbers may change when considering all other factors involved in a wind turbine project.

2. Objective 2: Ownership and Financial Arrangements

Using the results and analysis the team obtained for Objective 2, the team compiled a series of conclusions and recommendations. These recommendations are presented in the order that the issues were brought up in the corresponding Results and Analysis section for Objective 2. The various ownership and financial arrangements are each in their own way very complex and offer unique advantages and disadvantages.

2.1. Establishment of Municipal Utility Company

With regard to the financial arrangements of wind energy on Nantucket, the team first investigated the feasibility of establishing a municipal light department. From our analysis, the team concluded that municipal utilities do offer some unique benefits that investor owned utilities (IOU's) simply cannot provide, such as lower electricity rates and the ability of a town itself to set the electricity rates.

Although the team did not identify many negative aspects of a municipal electric utility, there are negative aspects to a town *starting* a municipal utility. Establishing a municipal utility is a massive endeavor which requires legal study. The team concludes that having a municipal light department is beneficial, but changing from an investor owned utility to a municipal utility is an extremely complex issue and beyond the scope of this project. Therefore, the team recommends that this issue be put on hold in relation to the other areas of Nantucket's wind energy project, and that the town should consult with a legal expert if it wishes to further pursue becoming a municipal electric utility.

2.2. Possible Ownership Options

A second aspect that the team addressed was the issue of ownership options for a turbine project on Nantucket. The team discovered three primary arrangements for the ownership of wind turbines. In one situation, the town completely owns the turbine(s). The second possibility is to have a private source or company own the project. The last arrangement is a combination of the two, a joint venture between the town and a private source.

The team concludes that the issue of ownership is a unique and complex subject. We would like to stress that we did not perform financial analysis to weigh the various ownership arrangements. In addition, nothing in our research led us to believe that one ownership arrangement is substantially more beneficial than another, as each possesses its own benefits and risks. The team also notes that the next step to be completed, the Massachusetts Technology Collaborative's (MTC) Feasibility Study, will address this issue and lay out different scenarios with all three situations taken into account. Nantucket's choice of an ownership arrangement is dependent on whether or not an individual has interest in owning or co-owning wind turbines on the island. Due to this variable, the team recommends that the issue of ownership arrangements be addressed when the MTC conducts their study. Another suggestion is for the Energy Committee to seek residents who are particularly strong advocates for wind power projects, and interested parties that may aid this project financially through a donation or joint venture. Joint ventures may be a valuable opportunity for a project on Nantucket given the affluence on the island.

2.3. Financing Options

Some of the issues surrounding financing tie into the previous section regarding ownership situations. The team found different options for acquiring funds required for a project of this magnitude. The town could borrow money through bonds, but this requires a town vote and may not pass. While the town may be able to secure funds in this way, it is not guaranteed and therefore the town should not rely on bonds to fund the project unless the project passes the town vote. As mentioned in the previous section, another option is to form a joint venture with a private corporation. This would reduce the amount of money that the town must pay for the project. Grants from the MTC and various other organizations are available for wind power projects such as the one that the Nantucket Energy Study Committee is pursuing. Also, the MTC's Wind Feasibility Study will contain a section titled "MTC Standard Financial Offer" which explains the financial support that the MTC is willing to offer the Nantucket wind turbine project. The MTC Feasibility Study will give an overview of funding that is available for wind turbine projects.

The team also realizes that current economic trends have been a hindrance for some other turbine projects. The only potential "fatal flaw" of a land-based wind turbine project on Nantucket is the cost of a wind turbine project, which includes siting, purchasing, transporting, constructing, and maintaining a wind turbine, as well as warranties, interest rates, electrical upgrades, and public outreach programs (a full list of costs is included in Appendix G). The wind turbine project, if not funded by outside sources, will impact all Nantucket taxpayers. Due to the current economic situation and high cost of a wind turbine project, the team recommends that the Energy Committee secure outside funding for the turbine projects. If the Energy Committee decides to borrow funds through bonds, the team recommends that the Energy Committee look into Nantucket's process and voter approval requirement. Lastly, the team recommends that the Energy Committee create an accurate and specific cost breakdown (turbine cost, interest rate, etc.) for their projects.

The team concludes that acquiring private funds and donations would greatly assist in the success of a wind turbine project on Nantucket. As the issue of financing is also very complex, the team recommends that the Energy Committee investigate obtaining private funds and donations. After the MTC completes its study, the Energy Committee will be able to determine what size wind turbines to purchase, and how many. This information is critical for determining the scale of financing that will be required. At that point, financing must be analyzed more closely.

2.4. Turbine Electricity Usage Options

The team has concluded that the sizing of a turbine project is crucial in determining how the electricity produced from a turbine will be used. Nantucket has two options regarding electricity usage: net-metering and selling to the grid. A smaller-scale project is ideal for a net-metering situation. If the majority of the energy that is produced by the turbine is used on site, the value of the energy is maximized, and, under ideal conditions, can fully offset the electricity bill of a specific site. Although this situation's benefits would not be apparent in a decrease of citizen's electricity bills, it would benefit two town-owned sites by offsetting their electricity bills completely, which in turn would benefit town taxpayers by decreasing taxes. If the Energy Committee plans to sell the generated electricity back to the grid, a larger-scale project is more cost-effective in the long term.

2.5. Sizing of Project Based Solely on Economics

Choosing the size of a wind turbine project based purely on economics is mostly a straight-forward proposition. As presented in Results and Analysis for Objective 2, a cost breakdown led the team to draw conclusions. The main tool used in forming conclusions was the 20 year forecast of cumulative positive returns, along with the percent return on investment that was calculated from the 20 year forecast (see Results and Analysis Section 2.3.1 Figure 16). The findings from these calculations led us to conclude that there is a unique situation at each the Madaket Landfill and Surfside Waste Water Treatment Facility sites. The difference in results of the financial analysis at each site is due to the fact that the Madaket Landfill and Surfside Waste Water Treatment Facility sites have different annual electricity usages. The Landfill is a much larger power consumer, having almost three times the annual demand of the Waste Water Treatment Facility (1,700,000 kWh to 600,000 kWh respectively). This value alters the amount of electricity used on-site as well as the amount sold back to the grid, therefore affecting the overall value of the energy produced. We realized that this sole value could greatly affect the economics of different size turbines at their respective sites, and therefore performed separate financial analyses at each site. The financial analysis considered single wind turbines only, not multiple-turbine farms.

From our analysis of the Landfill site, we conclude that the 660 kW wind turbine, under all three sets of conditions tested, received the highest percent return based on initial investment. Under the conditions our analysis allowed us to test, a 660kW wind turbine would be most cost-effective for a project at the Madaket Landfill. Considering the data analysis for the Surfside Waste Water Treatment Facility site, a 250 kW turbine, also under all three scenarios focused on, would be the most cost-effective. Considering financial analysis only at these two prospective sites, the Committee should select a 660 kW model for the Landfill, and a 250 kW model for the Waste Water Treatment Facility. Assuming that Dave Larson's estimate that the maximum power that could be produced at each site without upgrading the electrical infrastructure is 1MW, the team recommends installing a single 660kW turbine at the Landfill and one to three 250kW turbines at the Waste Water Treatment Facility.

3. Objective 3: Concerns Regarding Wind Power for Nantucket

Though studies are needed to assess these concerns, it is possible that the benefits to Nantucket outweigh the risks. Also, data was collected in a manner that biased results to include a greater breadth and depth of potential concerns than opportunities.

3.1. Social

The project team determined that social concerns will be the most difficult concerns to overcome. Social concerns include aesthetic and noise concerns, as well as public outreach, gaining public support, and perceived impact on property values. The main reason why aesthetics is an issue in any community is because the average person does not have a great knowledge of wind turbines. Only a small percent of the population has actually been up close to a wind turbine. People do not know how large or loud turbines are, or if they really do cause shadow flicker, or throw ice in the winter. Most aesthetic issues can be mitigated by education. The Massachusetts Technology Collaborative Community Wind Collaborative's Wind 101 workshop would be a very helpful program to help The Nantucket Energy Study Committee begin educating Nantucket residents. The Energy Committee should continue information and question session throughout the course of the wind turbine project. Another element of education includes photographs with wind turbines superimposed on the landscape, to show the visual impact that the turbines will have from various locations on the island. The wind turbine at Bartlett's Farm should be running by early 2009. This 250kW wind turbine will be very helpful to the Energy Study Committee, as it will introduce the residents of Nantucket to horizontal axis, monopole wind turbine. The team recommends that the Energy Study Committee organize visits to the Bartlett Farm wind turbine, so that Nantucket residents can get close to the turbine to hear how noisy it actually is, and to see for themselves what visual impact this turbine has from different places on Nantucket.

The noise of wind turbines at the Madaket Landfill and Waste Water Treatment Facilities is not likely to cause discomfort to either facility's workers. Even at the base of a wind turbine, the noise is a steady sound that is not particularly loud. The project team recommends that the Energy Committee hire a professional to conduct noise level tests at each facility, both within facility boundaries where people work, as well as at the property line nearest to the site of the proposed turbines. A citizen article which changes the Nantucket Bylaws has been proposed for vote at the April, 2009 Annual Town Meeting. This change removes the noise section of the WECS bylaw, therefore making the Massachusetts state law (s) the only noise law with which the wind turbines must comply. The team recommends that the Energy Study Committee support this citizen article, because the Massachusetts wind turbine noise law is much more lenient than the current Nantucket bylaw.

Public outreach is very important to the success of a wind turbine project. Steps for success include beginning public outreach early in the project, supporting involvement by community members, requesting assistance from advisory groups, and honestly answering all questions. These methods have led to success in energy projects on Nantucket, in Princeton, MA and in Hull, MA. The team recommends that the Energy Study Committee take the advice of local experts (such as ornithologists, Planning Board members, Historic District Commission members, etc.) by discussing their ideas for the wind turbine project on Nantucket as soon as possible, holding information and question sessions, and giving straight, factual answers to all questions that arise.

3.2. Property Values

Through archival research and case studies the team identified the affect of wind turbines on property values as a potential concern. From our interview with Jonathon Fitch, the head of the Princeton Municipal Light Department, we received copies of two national studies related to the effect that wind turbines have on property values. *The Effect of Wind Development on Local Property Values* was a study conducted by the Renewable Energy Policy Project (REPP) that analyzed national property sale data from communities with wind turbine projects. (Beck et al., 2003) Another nationwide study that addressed the issue of wind turbine projects on property values was *The Economic Impacts of A Proposed Wind Power Plant in Kittitas County, WA: An Evaluation of Potential Impacts on Property Values, Tax Revenues, and the Local Economy*. (ECONorthwest, 2002) The REPP report analyzed over 25,000 property sales from ten different communities around the United States in order to determine the effect that wind turbines had on property values. In the REPP report, properties within a five mile range of the wind turbine were considered in the view zone and analyzed further (Beck et al., 2003). Both studies resulted in the conclusion that wind turbine projects do not negatively affect property values.

While two Massachusetts towns and two national studies concluded that wind turbines do not negatively impact nearby property values, the team believes Nantucket is different from the towns studied, as it is a vacation destination with a high density of luxury homes. People are concerned that property values will decline because of aesthetic concerns. The team does not believe that there will be much if any impact in property values near the Madaket Landfill, because that area already has the negative visual impact of a 467 foot communications tower, and the large mound making up the landfill. Wind turbines at the Surfside Waste Water Treatment Facility also should not have a negative impact on property values. The turbines can be no taller than 178 feet, due to the proximity to the airport, and therefore the turbines will be visible from a smaller portion of the island.

The team suggests that a study be conducted of the impact on property values and interests in buying a home in proximity to the Bartlett's Farm wind turbine. Although this type of study may take several years, it may help to address resident concerns and prevent problems with future wind turbine projects on the island.

3.3. Birds

Avian life is a major concern for many birders and residents of Nantucket. Turbines must be very carefully sited in order to reduce the impact that they will have on birds in the area.

Though many individuals were concerned for the well-being of birds in the proximity of the proposed turbines, none believed that the risk of avian fatalities was a fatal flaw for the proposed project. With careful siting and a thorough study of avian life in the area surrounding the proposed sites at the Madaket Landfill and Surfside Waste Water Treatment Facility, the Energy Committee may be able to implement wind turbines without grave effects on the birds of Nantucket.

Avian life is very important to residents of Nantucket, and turbines pose a great potential risk to the birds. Based on results from the six interviews with birders, case studies found through archival research, and concerns expressed by various informal conversations between team members and people on Nantucket, the team is confident that further study of avian life at the Madaket Landfill and Surfside Waste Water Treatment Facility will be necessary. Fall migrations pose the risk of large-scale deaths to songbirds during poor weather conditions, but spring migrations are not a concern because these birds do not migrate along the east coast of the United States in the spring. Despite the small number of individuals interviewed, protecting the birds of Nantucket was very important to enough individuals and organizations on Nantucket that the concern for avian life as a result of wind turbine implementation on the island cannot be ignored. Bird experts on the Island will not be satisfied unless a thorough study is conducted, and concludes that birds will not be seriously affected by the wind turbines.

The team recommends that the Energy Study Committee hires an individual or organization to do a thorough bird study of the two proposed wind turbine sites. The study should focus on federal and state endangered and threatened species as well as species of specific concern (See Table 17 in Results and Analysis Section 3.1 Concerns: Avian Life), as state and federal laws require that turbines do not have a significant impact on endangered and threatened species. The study should include Long-tailed Ducks, because a large percentage of world's population migrates over the island of Nantucket twice a day during the winter.

The Energy Study Committee should appoint a sub-committee which tracks songbird migrations in September and October to identify nights that are particularly likely to results in massive bird deaths (specific situations are explained in Results and Analysis section 3.1 Concerns: Avian Life).

It may be helpful for the Energy Committee to hire an organization or local ornithologist to study the effect that the wind turbine at Bartlett Farm has on avian life. This horizontal axis monopole turbine should ideally begin functioning in January, 2009. Avian deaths can be monitored, and results may be extrapolated to predict the effect that turbines at the Madaket Landfill and possibly the Waste Water Treatment Facility may have on birds.

As the feasibility study for land based wind turbines on Nantucket progresses, the Energy Committee should make their proposed plans and results of their studies easily accessible to the public. In order to mitigate concerns for avian life (and other concerns as well), the public needs to have access to all possible information.

3.4. Improper Land Use

The issue of improper use of town land is a valid concern. As the town currently (December 2008) has only one facility with limited land available for each solid waste disposal and waste water treatment, the land that those facilities have is very valuable. The concern for land use does not have immediate ramifications, but in future years the island could encounter serious problems if the facilities need to expand by increasing the size of the landfill or building additional sewer beds but do not have the land on which to build. Before the project can progress, The Energy Committee must determine whether or not the construction of wind turbines adjacent to the landfill or in the sewer beds will negatively impact the Madaket Landfill or Waste Water Treatment Facility.

In order to determine the magnitude of the concern of facility land use, the team recommends that the Nantucket Energy Study Committee discuss the concern regarding use of DPW land with Jeff Willett, Director of the Nantucket Department of Public Works (DPW). This is required to determine if implementation of wind turbines on DPW owned land may negatively impact the proper functioning of the facilities. The Energy Study Committee should also speak with individuals from the Planning Board to gather information about long term land use on Nantucket. This is a top priority, as availability of land use should be determined before conducting a full feasibility study.

3.5. Interference

Air traffic interference will not be a problem for wind turbines at the Madaket Landfill, but height restrictions limit the height for turbines at the Surfside Waste Water Treatment Facility. Since both 1.5MW and 660kW turbines are shorter than the maximum allowable height of 397 feet at the Madaket Landfill, the Energy Study Committee does not need to consider air space restrictions as part of their determination of which size wind turbine to use at this site. The maximum allowable height for a wind turbine at the Surfside Facility is 178 feet, therefore only 250kW turbines are possible at this site. (Aviations Systems Inc., 2008)

Radar interference may be an issue at the both the Madaket Landfill and Surfside Waste Water Treatment Facility. After a Notice of Proposed Construction is submitted to the FAA, the FAA will conduct a study of possible radar interference at the site, so other than applying to the FAA, federally required before a wind turbine can be built. As advised by the Aviation Review Inc. report on the Madaket Landfill sites, the team recommends that the Energy Committee conduct a study to further determine if the turbines will impact Air Defense and Homeland Security Radars (Aviation Systems Inc., 2008).

Although archival research identified that Jeff Willett's concern of electrical interference at the Waste Water Treatment facility is justified, the concern remains an unlikely and easily mitigated issue. Electrical interference should not be an issue at the landfill site. With proper siting and the use of a modern turbine at the Waste Water Treatment Facility, electrical interference is only a minor concern. The team recommends that the committee implement very careful and meticulous techniques when siting the turbine at the Waste Water Treatment Facility in order to ensure minimal affects on the telecommunications system at the site. After the turbine is constructed, the team recommends monitoring the turbine's affect on the telecommunications system to determine if any impacts occurred. If there are any impacts on the system, an amplifier or directional antenna can be installed to Waste Water Treatment Facility infrastructure to alter the signal and reduce the level of interference (International Finance Corporation, 2007).

3.6. Maintenance

Access to wind turbines for maintenance at both the Landfill and Surfside Waste Water Treatment Facility is not an issue. Even with wind turbines located in the sewer beds, access is not a problem as long as that specific sewer bed is not being used on the specific day of maintenance. Since waste is deposited into one sewer bed per day, with 15 sewer beds, maintenance can be scheduled around the use of the bed with the turbine, and sewer bed use can be altered based on necessary unscheduled maintenance. No further action is necessary regarding the concern of sewer bed access.

Wind turbines are designed to shut down in very high or very low winds, and for maintenance. No harm comes from the stopping of the rotor. Shutdown for insufficient or exceptionally strong winds is automatic, and the turbine also has a manual 'off' switch to turn off the turbine (for maintenance, or during major bird migrations). Since turbines are designed to be stopped for various situations, stopping is not a risk and the Energy Study Committee does not need to action regarding this concern.

Some turbine manufacturers offer warranties that cover maintenance, both routine inspections of the machine and in the case of problems, for a set number of years. Despite Nantucket's remote location, with a maintenance warranty the turbine manufacturer is required to send a maintenance personnel to the turbine site, so timely repair will not be an issue as long as the Energy Committee purchases the maintenance warranty for each turbine constructed on Nantucket. Since Nantucket is a small municipality and not likely to have any turbine maintenance experts on the island, the team recommends that the Energy Committee to research maintenance warranties offered by various manufacturers, and purchase the maintenance warranty with their turbine(s).

3.7. Transportation

Transportation of both the 660kW turbine and 1.5MW turbine to the island of Nantucket is possible. The turbine components need to be delivered to the island by tug and barge. Transporting the components to the site depends on the size of the turbine. The components of the 660kW turbine can be driven through town and to the site, whereas the 1.5MW turbine components are too large to maneuver through town. A helicopter is necessary to transport the

1.5MW turbine components from the barge to the site. The need for a helicopter greatly increases the transportation costs.

Based on the shipping estimates and interview with Jim Palatine of Toscana Corporation, the team determined that transportation both to the island and to the specific sites is not a fatal flaw, as long as there are sufficient funding sources. The team recommends that the Energy Committee select the 660kW turbine rather than the 1.5MW turbine because the transportation cost will be much lower since the smaller turbine can be transported by barge and through town without requiring the use of a helicopter. Toscana Corporation can transport the turbine components to the island using their tug and barge, and can also transport the 660kW through town. A police detail will be required to transport the 660kW turbine components through town, as well as shutting down of some roads. However, if the Energy Committee does select the 1.5MW turbine, the team recommends looking into Carson Helicopters S-61 or the Sikorsky Sky Crane.

3.8. Plants

Nantucket is also home to several species of endangered flora, which live in close proximity to the two proposed sites. Turbines must be sited in locations that neither displace nor require construction of access roads that disturb these endangered plants. At the landfill site, the team recommends that a study similar to the ENSR Pre-Construction Conditions of the Surfside Waste Water Treatment Facility (ENSR, 2008) be conducted to determine the impact that the construction project will have on the rare plants in the area at or surrounding the landfill.

3.9. Purchasing

Currently, the worldwide demand for wind turbines is extremely high. The Energy Committee should be aware that the lead time on the popular manufacturer is about 2 years. Since the Energy Committee is planning on a constructing a small wind farm, the team recommends contacting manufacturers like Fuhrländer because due to worldwide turbine demand the larger manufacturers like Vestas and GE are unlikely to be interested in a small wind farm project.

3.10. Land management

The team did not discover any research that discusses whether or not prescribed fires around a turbine could pose a concern. The team recommends that, if residents raise a concern about this or prescribed fires are needed directly near the locations of any of the turbines, the Energy Committee contacts the manufacturer of the turbines and ask for more information.

3.11. Bats

Nantucket has a very low bat population. Bats are very bad at avoiding wind turbines, and often are affected with barotrauma when they fly close to the turbine blades. The team suggests that the Energy Study Committee be aware of the danger that wind turbines pose to bats, but do not take further action unless residents raise the issue.

3.12. Turbine Vibrations and Turtles

Vibrations have been known to affect a particular type of turtle. However, no archival research or interviews resulted in any information about wind turbine vibrations transmitting to the ground. We cannot conclude that the lack of evidence supports the idea that turbines do not transmit vibrations to the ground. The team recommends that the Energy Committee use Bartlett's Farm wind turbine to conduct a study to determine the amount of vibration caused by the turbine, and if that turbine affects turtles in the area. The information from the Bartlett's Farm turbine can be extrapolated to determine the estimated impact at the Landfill and Waste Water Treatment Facility sites.

3.13. Cold Weather Issues (Ice Throw & Electrical Failure) and Salt Spray

Turbine manufacturers offer both a marine package and a cold weather package which can be purchased for the turbines. To protect the turbines from salt spray, and to protect equipment and prevent blades from icing and freezing during winter weather, the team suggests that the Energy Study Committee purchase both the cold weather package and marine package for all turbines.

3.14. Oil Leakage

Oil leakage will not result in negative impacts to the Landfill, Waste Water Treatment Facility, or surrounding land, and the volume of lubricant that can leak from each turbine is minimal. Unless environmental groups or managers at either facility demand action to prevent any oil or lubrication from the wind turbine from entering the ground, the Energy Committee does not need to take any further action regarding this issue. If a knowledgeable individual demands protection from any leakage, the team recommends that the Energy Study Committee has a filtration system installed beneath the turbine.

3.15. Marine Life

Marine life will not be impacted by the implementation of land-based wind turbines. The Energy Study Committee need not take any further action regarding this concern.

3.16. Opportunities

Wind turbines on Nantucket offer opportunities such as providing renewable, green energy and stabilized electricity rates. Using renewable energy is a good thing, because "even if it's a no profit gain, you are potentially reducing carbon and not burning fuel out there" (C. Collier, personal communication, November 19, 2008). Since wind turbines require no fuel, "wind turbines will help stabilize [electricity] rates due to natural gas fuel price fluctuations" (J. Fitch, personal communication, October 17, 2008). These statements are supported by information found through archival research, validating these points. The team concludes that wind turbines will provide benefits to Nantucket by providing green energy and stabilizing electricity rates.

Based on the views of several interviewees as well as the team's knowledge of the facility, the Madaket Landfill is an excellent site at which to conduct a feasibility study for the siting of wind turbines. Vernon Laux, a birder, believes that "on Nantucket there's really no [good place to put turbines]; the dump is really the only logical place" (V. Laux, personal communication, November 13, 2008). Cormac Collier of the Nantucket Land Council thinks the Landfill location "is pretty ideal because it's a dump…..It's in disturbed area and you don't have to clear any vegetation. You are not going to have the impact on plants" (C. Collier, personal communication, November 19, 2008). Ernie Steinauer, a plant specialist, noted that "the dump would really be the place the landfill because there's so much building around there" (E. Steinauer, personal communication, November 3, 2008). Mark Voigt, the Nantucket historic district commissioner commented, "Do you think there is anything historic about them? Is there anything that needs to be protected? It's a dump" (M. Voigt, personal communication, November 7, 2008).

As the land has already been cleared for the facility, the Landfill location requires no further disruption of habitats on Nantucket, however endangered bird and plant species do live in close proximity to the land. The area has been built up, making it a less desirable location for birds to inhabit. As the facility was designed to accomplish a necessary requirement for modern life, it is not a historic area and therefore obtaining the necessary permit from the Nantucket Historic District Commission is not likely to be a problem. Support by interviewees with such a broad range of expertise, combined with the Renewable Energy Research Laboratory's wind data and the Nantucket Energy Study Committee's selection of the site for further consideration causes the team to believe that this site is ideal to be considered for a feasibility study.

4. Final Conclusions and Recommendations

Nantucket, an island 30 miles off the coast of Massachusetts, is a unique place that is quite different from the locations that the team analyzed in various case studies. Due to Nantucket's unique situation, it is rather difficult to predict exactly how the process of turbine implementation at this location will progress.

All of the financial analysis in this report considers single turbines only. Without precise knowledge of the number and size of wind turbines for Nantucket's wind farm, these calculations are impossible. Since the team has no financial analysis for multiple-turbine wind farms, we cannot make a recommendation for single turbines versus a wind farm at each location. Therefore, our recommendations were made based on analysis of 250kW, 660kW, and 1.5MW wind turbines.

A maximum of 1 MW of electricity can be produced at each site without upgrading equipment. Due to the extensive costs associated with upgrading equipment, we are not recommending any turbine arrangements that produce an excess of 1 MW at either site.

Based on analyses from all three objectives, the team drew conclusions about turbine size selection. As the maximum height that may be approved by the Federal Aviation Administration is 178 feet at the Surfside Waste Water Treatment Facility, the largest turbine that remains under this height limitation is the 250kW. Also, a 250kW wind turbine has already been approved on Nantucket, at Bartlett's Farm. Therefore, this size turbine is feasible on the island. The team recommends that the Nantucket Energy Study Committee consider 250kW wind turbines at the Waste Water Treatment Facility. The Bartlett's Farm wind turbine should be used to the benefit of the Nantucket Energy Study Committee's project in any way possible. Bird and animal impact studies may be conducted at this site, and the site can be used as an example to the Nantucket community to educate people about wind turbines.

The team recommends that the Energy Study Committee further investigate installing a 660kW wind turbine at the Madaket Landfill site. According to the sensitivity analysis, a 660kW turbine has a greater long-term payoff than a 250kW turbine, and has either the same payback period or only a slightly longer payback period than a 250kW turbine, depending on the specific situation. A 660kW turbine has many benefits over a 1.5MW turbine. The cost of transporting a 1.5MW turbine to the specific sites on Nantucket is much greater than transporting smaller turbines, because a helicopter is needed to transport the blades of the 1.5MW turbine. This cost was not included in the financial analysis because we do not have data on the cost of using a helicopter. Mitigations to many concerns, such as human factors, including aesthetics and noise, and concerns for plants and animals, are simpler for smaller turbines (such as a 660kW versus a 1.5MW) because the turbine is physically smaller, smaller blades vibrate less and therefore are quieter, and smaller turbines have a smaller base, requiring less space. A 660kW wind turbine has many benefits over both the smaller 250kW turbines and larger 1.5MW turbine.

All of the decreases in potential concerns associated with a 250kW or 660kW compared to a 1.5MW turbine are compounded by the fact that gaining the funding for this type of project would be much easier, and chances for the project to be completely financed from a donation or joint venture would be much higher. Public acceptance can be assumed to be much higher as well for a project of a smaller scale.

Implementing wind turbines on Nantucket could benefit the island in many ways. Wind turbines would provide the town with energy from a 'clean' source. Beginning with a successful smaller-scale project is a great way to introduce the island to wind power, and may be less controversial than trying to implement a large wind farm. Ideally, public support of a larger-scale wind farm will increase after Nantucket residents can see the benefits of wind power for themselves.

APPENDIX A: NANTUCKET ENERGY STUDY COMMITTEE

Nantucket has exceptionally high energy costs. National Grid imposes a cable surcharge on all customers, to cover the cost of constructing and maintaining the submarine cables that deliver electricity to Nantucket from the mainland. Figure 1, below, shows the high electricity costs on the island, compared to the United States average cost, and the five states with the most and least expensive average electricity costs in the continental United States. According to the National Grid website, the cost of electricity per kWh on Nantucket is 18.978¢/kWh in the summer and 17.924¢/kWh in the winter, compared to the Massachusetts average of 16.27¢/kWh. This amounts to a 17% increase in cost in the summer and 10% increase in cost in the winter for Nantucket residents over the average Massachusetts resident. For commercial customers, the cost on Nantucket is 35% higher in the summer and 33% higher in the winter than for the rest of Massachusetts (https://www.nationalgridus.com/nantucket/index.asp). For the average United States household consuming 920 kWh of electricity each month (Energy Information Administration, 2006), a Nantucket resident pays about $25 more per month in the summer and $15 more in the winter than the average Massachusetts resident.

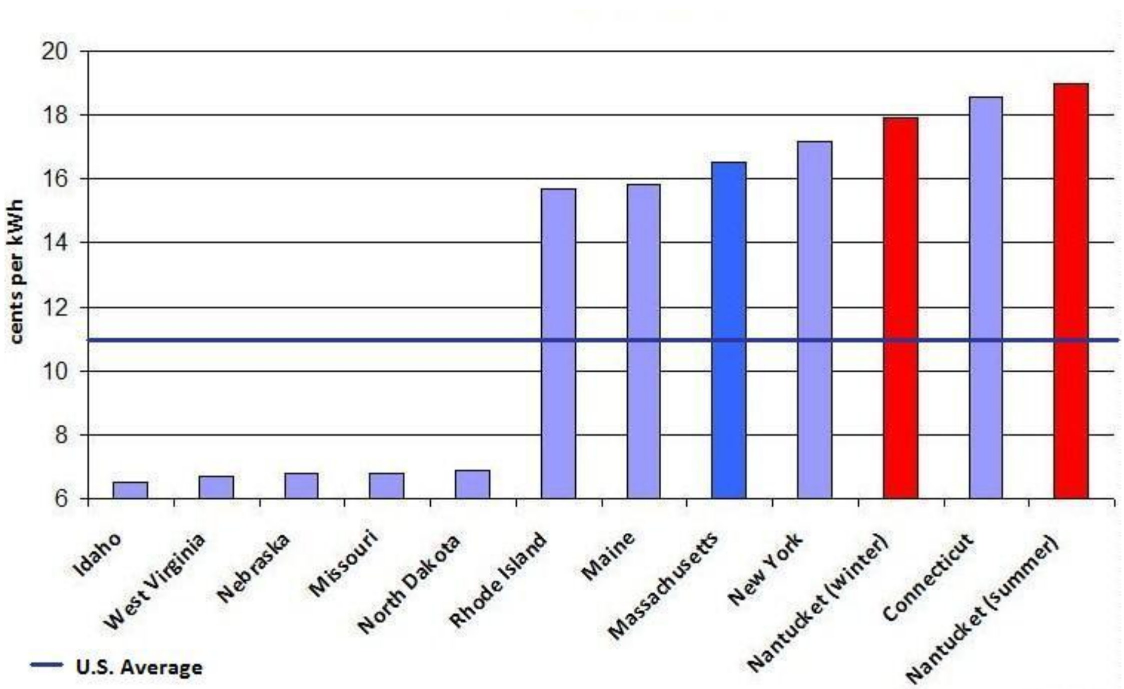


Figure 12. Average Electricity Costs in the Five Least and Most Expensive States in the Continental United States, and Nantucket. Adapted from http://www.eia.doe.gov / "Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State" and https://www.nationalgridus.com/nantucket/index.asp

Concerned residents recognized that the town's energy costs were very high, and at the town meeting in 2004 Barbara Gookin started the Energy Study Committee with a town vote (B. Gookin, Personal Communication, November 6, 2008). The purpose of Nantucket's Energy Study Committee is to inform the Board of Selectmen of issues affecting Nantucket electricity users, recommend policy amendments, explore options for energy production on Nantucket, and "serve as a resource for information on renewable and sustainable energy technologies, energy conservation and any energy related issues with relevance to Nantucket Island" (Town and County of Nantucket, Massachusetts, n.d.). The Energy Study Committee hopes to reduce electricity costs on the island, and has the ultimate goal of energy independence for Nantucket. In order to accomplish this goal, the Committee negotiates with energy suppliers "to secure below market electricity rates" (Town and County of Nantucket, Massachusetts, n.d.) for Nantucket residents and businesses, and is investigating energy generation options for the island.

The Energy Study Committee, or simply the Energy Committee, is an appointed Committee, with individual members appointed by the Nantucket Board of Selectmen. Each member of the Committee serves three year terms. The Committee has the authority to propose town articles, but does not have signing authority (B. Gookin, Personal Communication, November 6, 2008). The Energy Committee meets monthly, on the first Thursday of every month.

Nantucket's Energy Study Committee currently (November, 2008) has five members, Chairman Barbara Gookin, Carl Borchert, Mike Burns, Anne Kuszpa, and Sandra Welsh. Dr. Whiting Willauer was officially appointed by the Board of Selectmen as a liaison to the Energy Committee (W. Willauer, Personal Communication, November 6, 2008). The individual members of the Energy Study Committee each bring valuable traits to the Committee. Barbara Gookin moved to Nantucket full time eighteen years ago. Ms. Gookin currently owns her own advertising agency, and does graphic design and photography (B. Gookin, Personal Communication, November 6, 2008). Carl Borchert has lived on Nantucket for the last 31 years and currently works for the Steamship Authority. The Energy Committee is Mr. Borchert's first experience with local politics. For six and one half years, Mr. Borchert has been actively involved in the Cape Wind Energy Project as a proponent. Mr. Borchert's area of interest lies in offshore wind energy (C. Borchert, Personal Communication, November, 6 2008). From childhood, Sandra Welsh was a summer resident of Nantucket, and she has been living on the island full time for the last decade. Ms. Welsh's interest in tidal energy was sparked by the Chesapeake Bay study and the tidal model that was built at Kent Island (S. Welsh, Personal Communication, November 6, 2008). Dr. Whiting Willauer was a summer visitor of Nantucket and came to the island full-time 10 years ago. Dr. Willauer was previously the Chairman of the Board of Selectman, and is currently actively involved in town politics and many of the islands committees. Dr. Willauer brings scientific and political knowledge to the Energy Committee.

The Committee initially worked on the possibility of starting a municipal aggregate. This would give Nantucket power to shop for electricity contracts as the entire island, and use National Grid as a distributor. This would allow Nantucket to capture the renewable energy surcharge of approximately $300,000 a year (B. Gookin, Personal Communication, November 6, 2008). The Energy Committee is currently considering all forms of renewable energy in order to accomplish its above stated goals, but is focusing its attention on wind power. Due to its location, Nantucket has high winds. Figure 2 shows that the average wind speeds on Nantucket are approximately 15-19MPH (McClelland & Knipe, 2008). High wind speeds make Nantucket a desirable site for wind turbines. As Nantucket is surrounded by the ocean, tidal power and wave power are also potentially feasible forms of renewable energy for Nantucket. The current focus of the Committee is to consider wind turbines based on the island to produce electricity (Brace, 2008, Land-Based Sites). The Committee sees the value of wind power, which produces electricity at lower cost than conventional methods of electricity generation while protecting the environment by producing electricity with no direct emissions. Carl Borchert of the Energy Study Committee said of the project:

> I have worked on off-shore wind power for four years and I have traveled and researched clean renewable energy extensively during that time. My objective on the Energy Committee would be to secure a 25 to 35 percent reduction of residential and commercial electric rates for every ratepayer on Nantucket through negotiated power contracts with power suppliers.
> [Lancaster, June 13, 2007]

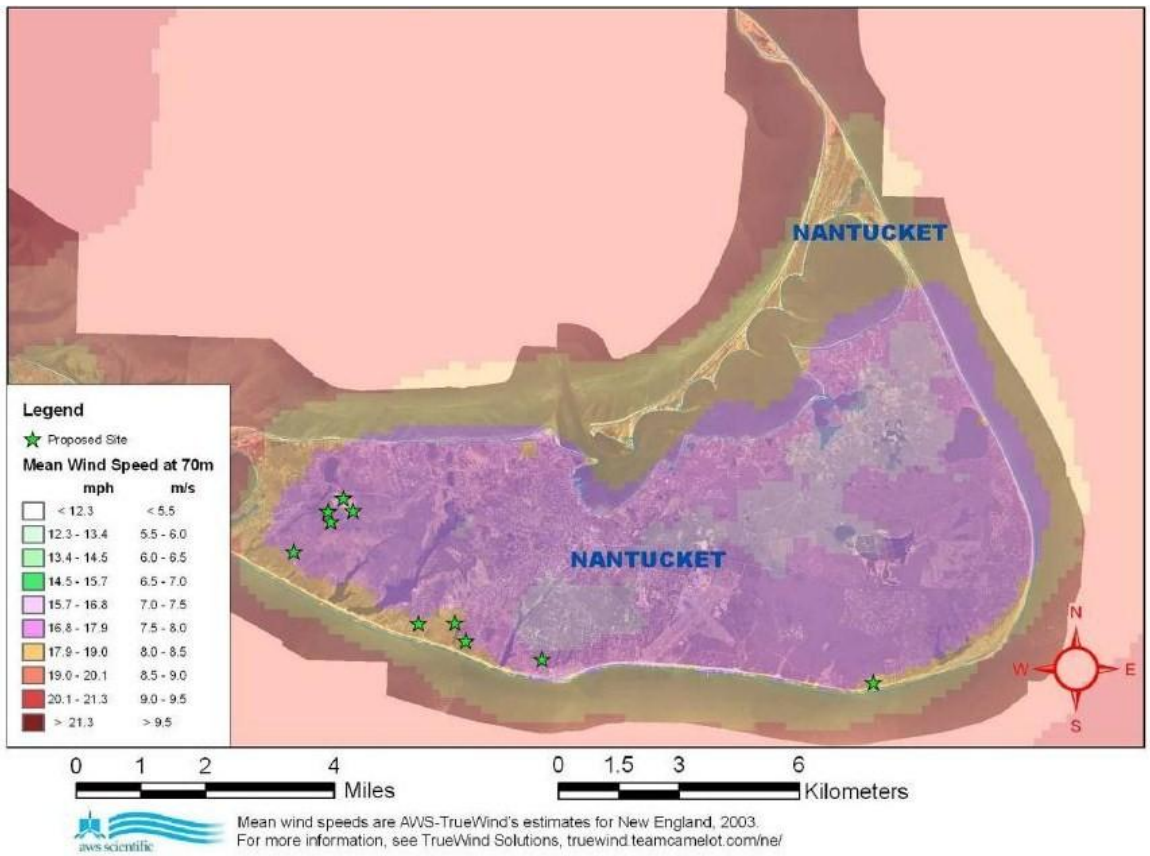


Figure 13. Nantucket Wind Speed Map. Estimated Annual Wind Speeds at 70 meters. From McClelland & Knipe, 2008.

The Energy Committee met with several experts in the field of energy generation in an effort to map out the alternative strategies that the island might consider. One particular organization was National Grid, who currently supplies Nantucket's electricity. Dave Fredericks from National Grid is willing to assist the Committee with their endeavor of reducing Nantucket's electricity costs. Other contacts include Richard Miller from the Hull Municipal Light Plant in Hull, MA; and Chris Amory, who is knowledgeable about turbine production and function, and has offered advice regarding Nantucket's use of this technology (W. Willauer, Personal Communication, Summer 2008). The University of Massachusetts at Amherst Renewable Energy Research Laboratory conducted a technical survey at ten sites for potential wind turbine construction on the island of Nantucket. Wind data was collected over the course of 15 months from a meteorological tower set up at the DPW landfill site (McClelland & Knipe, 2008). Based on this study, the Board of Selectmen approved the Energy Study Committee's initial siting plan to take necessary steps toward implementing turbines at two locations on Nantucket. (W. Willauer, Personal Communication, September 21, 2008). The proposed plan was to investigate "install[ing] four to six turbines with a size range of 660 KW to 1.5 MW in the landfill/Massasoit area, as well as… install[ing] 2-3 smaller (250 KW- 660 KW) [turbines] at the Waste Water Treatment Facility (WWTF)" (Nantucket Energy Study Committee, September 15, 2008).

The long term goal of the Committee is to recommend renewable energy sources that can produce enough electricity on Nantucket to power the entire island, and to use the current submarine cables to export energy back to the mainland. Nantucket hopes to use renewable energy to become self sustaining regarding energy, reducing the island's dependence on the mainland (W. Willauer, Personal Communication, Summer 2008). Nantucket's Energy Study Committee is looking at the big picture of what must be done to solve the energy problems of the small island community. The focus of our project was to examine the advantages and disadvantages of wind power for Nantucket and advantages and disadvantages of financial and institutional arrangements for development of wind power and ownership of wind turbines. Our project identified and evaluated the relevant information necessary to assist the Committee in its decision making.

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APPENDIX B: INTERVIEW REQUEST

This is a generic interview request letter. We will modify and personalize the letter for each individual that it is sent to.

Dear (interviewee name),

We are students working on a school project for Worcester Polytechnic Institute (WPI). Our project investigates different options related to the implementation of wind power on Nantucket. We hope that our studies will help our sponsor, the Nantucket Energy Study Committee.

We understand that you have unique insights about the use of wind turbines on Nantucket and would like an opportunity to speak with you about your opinions on this important issue. We know that you are involved in (include the key areas of expertise specific to the interviewee.) (Recommending Party) recommended that we contact you.

If we do not hear back from you, then we will contact you by phone in order to arrange a convenient time for the interview. If you would like to contact us, our team email address is nantucketwind@wpi.edu.

Thank you for taking the time to help our project. We look forward to meeting you.

Wind Generation on Nantucket IQP Team

Diana Berlo
Jennifer Hunt
Amanda Martori
Justin Skelly

APPENDIX C: INTERVIEW QUESTIONS

This section includes the disclaimer that we present to each interviewee, to comply with ethics standards. Our initial interview schedule follows. This interview schedule resulted from an initial brainstorm of questions that we may want to ask our various interviewees. Appendices C1a – C20a include the questions that we prepared for each interview. Appendices C1b – C20b include the actual questions that we asked interviewees, based on the interviewee's responses.

Disclaimer: We are a student project team from Worcester Polytechnic Institute (WPI). We hope that our project will benefit our sponsor, the Nantucket Energy Study Committee, and will aid in their efforts to assess the possibility of putting wind turbines on the island. We would like to conduct an interview with you lasting less than 45 minutes. All the information we gain from this interview will be used solely for assisting the team with this project. Any information or quotations we use from this interview in our final report will remain anonymous and you will not be described in any way that is recognizable to the reader, unless you give us permission to use your name. We will provide you with any quotations we intend to use so you can review them before our report is published. Our final report will become a public document that is accessible both online and in print from the WPI Gordon Library, and will be given to the Nantucket Energy Study Committee. Would you like us to send you a copy of the final report? (Yes / No). {if yes: We will send you an electronic copy via email.} We would like to ask you several questions regarding your involvement with [wind power/endangered species/Nantucket bylaw permits/etc.]. If there is any question you do not wish to answer you may skip it, and you can end the interview at any time. You can also change your mind about the use of your name, or any information you provide us with, at any time. Will you allow us to interview you? (*If affirmative response, thank the individual*). Do you mind if the interview is recorded?

General Topics

- Interviewee background information
  - Tell us briefly about your background regarding wind energy?
    - How long have you worked for ________________?
  - Tell us how you became interested in wind energy?
  - Can you tell me a little about your job and what it entails?
  - Can you tell us about some of the specific projects you have worked on?
  - Could you give us some information about the various costs associated with wind turbine projects?
    - Component (manufacturer, power output)
    - Transportation
    - Interest rate
    - Construction/Installation
    - Siting, feasibility study
    - Public outreach

Objective 1: Laws and regulations affecting the proposed development of wind farms

- What are your concerns about existing legislative and regulatory arrangements?
  - What does or does not work?

    - How could these arrangements be improved?
    - What new legislation/regulation would be helpful?
- Was there any legislature or regulations that hindered the progression of the project?
    - FAA
    - EIR
    - ENF
    - Lighting
    - Noise setbacks
    - Distance from residences

Objective 2: Advantages and disadvantages of alternative institutional and financial arrangements

- Public (Municipal)
    - Could you tell us about the process of dealing with turbine manufacturers?
        - How you chose the manufacturer that you bought the turbines from?
        - What kind of questions did you ask them/ what topics were of main concern?
    - Could you tell us about some of the funding options that you considered?
    - How did you determine the ownership of the turbines?
        - Municipal utility, private utility, individuals…

    - What were the different financing alternatives that you considered at the beginning of the project?
        - What were the advantages and disadvantages of these options?
        - What financing option did you end up choosing? Why?
        - Did the project apply for any grants? If so, which ones?
    - As your town owns its utility company, what do you see to be the advantages of this? Disadvantages?

    - Advantages
        - Decreased electricity cost
        - Eligible for REPI
    - Disadvantages
        - Not eligible for the PTC or LORI grant
- Private (i.e. National Grid)
        - As your town is provided electricity through a private company, what do you see to be the advantages of this? Disadvantages?
    - Advantages
        - Eligible for PTC
    - Disadvantages
        - No direct benefit to people affected by the wind turbine

Objective 3: Advantages and disadvantages of wind power on Nantucket

- What do you see as some of the benefits that have resulted from your town's implementation of wind turbines?
    - Disadvantages?
- Advantages
    - Decreased electricity costs

    - Environmental benefits/pollution reduction
        - Do you believe wind power is the best choice as an alternative to fossil fuels? Why?
    - New revenue sources
    - Reduce the cost of heating
- Disadvantages
    - Visual impact
        - What is your opinion of wind turbines in terms of aesthetic issues?
        - What was your opinion of wind turbines when you first found out your town was implementing wind turbines?
        - Now that the wind turbines have been installed, what is your opinion?
    - Decreased property values?
        - Do you have any information about how property values have changed since the installation of wind turbines?
        - Do you know anyone who might be able to help us with this question?
    - Ice
    - Noise
    - Birds
    - Initial cost
    - Intermittence and variability of power output
    - No effective utility-scale mechanism for storing off-peak wind power
    - 20 year life cycle
    - Lightning Strikes
    - Flashing from sun reflections

APPENDIX C1: QUESTIONS FOR J. FITCH

C1a. Prepared Question, J. Fitch

Interview with Jonathan Fitch, operations manager of the Princeton Municipal Light Department, Princeton, MA

October 17, 2008. 10-10:45 am

Tell us briefly about your background regarding wind energy?
    How long have you worked for the Princeton Municipal Light Department?

Tell us how you became interested in wind energy?

Can you tell me a little about your job and what it entails?

Can you tell us about some of the specific projects you have worked on?

We know that your town is in the process of constructing two new turbines. What have been some of the major obstacles in the siting process?

    How did you overcome them?

Could you give us some information about the various costs associated with your wind turbine project?

What did you do for public outreach and community involvement

    How early in the project was the community involved?

        Did you do surveys to get public feedback?

        Can we get the results from these surveys?

Was there much opposition to the wind turbine project in Princeton?

    How was this dealt with?

What do you see as some of the benefits that have resulted from your town's implementation of wind turbines? Disadvantages?
    Do you have any information about how property values have changed since the installation of wind turbines?
    Do you know anyone who might be able to help us with this question?

Could you tell us about the process of dealing with turbine manufacturers?
    How you chose the manufacturer that you bought the turbines from?
    What kind of questions did you ask them/ what topics were of main concern?

Could you tell us about some of the funding options that you considered?

How did you determine the ownership of the turbines?

What were the different financing alternatives that you considered at the beginning of the project?

What were the advantages and disadvantages of these options?

What financing option did you end up choosing? Why?

Did the project apply for any grants? If so, which ones?

As your town owns its utility company, what do you see to be the advantages of this? Disadvantages?

What are your concerns about existing legislative and regulatory arrangements?

What does or does not work?
How could these arrangements be improved?
What new legislation/regulation would be helpful?

Was there any legislature or regulations that hindered the progression of the project?

C1b. Actual Questions, J. Fitch

Can you tell us about your history with energy and wind power?

When did you begin the community involvement when you started thinking about new turbines? Was it pretty much you want new turbines and then immediately the next day [started community outreach]?

So the biggest benefits, it seems like, are the decrease of rates from the average price that would have been paid if not municipal. Were there other big things?

What disadvantages do residents think come with this project?

It looks like here you have the costs for once a turbine is operational. Do you have any information about what the costs were for like buying the turbines, construction, and all of that?

Was there a lot of opposition to the project or was it mostly just some citizens saying they have some concerns about this…[spitting out the ideas that Mr. Fitch talked about before].

How did you deal with those people who were fighting the project?

One thing we have found is a lot of people complaining that they think that turbines will decrease property values in the area [near turbines]. Do you know anything about that in [Princeton]?

Can you tell us about some of the different financing options that you were considering for this project, and what you decided on?

Were there any loans that you took out or any other forms of financing that helped on top of that?

So you said that the permitting process was dragged on because of the USDA grant. Do you think it would have been a lot faster if you hadn't gone for that grant, just like the basic permits for [the turbine]?

Were there any laws or regulations (municipal or state) that you would want to change to get the turbines implemented or to make the process easier?

In the whole process of siting and talking to the town and all of that, when did you buy the turbines? How far into it did you actually decide 'we're going to go through with this'?

Was that pretty much after you got past all of the permits and the regulations?

So it's still about another year or two before you'll get the turbines?

Was it difficult to get the turbines delivered for construction?

Can you tell us a little bit about the process of choosing a turbine and the company that you were going to buy from?

So you chose based on who would sell to you and then of that group the best ones?

As far as getting turbine components to this site, have you had to change roads, newly paved roads (for example - need big turning radius for trucks)?

Did you have any major setbacks in the process of just getting everything moving along? Was there anything that really just had you at a standstill?

In terms of setbacks [keeping people away from the turbines], were you concerned with hikers? Do you plan on maybe fencing off areas? Are there any restrictions with that aspect?

APPENDIX C2: QUESTIONS FOR J.BARTLETT

C2a. Prepared Questions, J. Bartlett

Interview with John Bartlett, Bartlett Farms, Nantucket, Massachusetts

November 3, 2008. 10-10:45 am

Why did you choose to install a turbine on your property?

Is it installed yet or have you just obtained permits thus far?

(If it is not installed) When do you think it will be [installed]?

What model turbine are you/do you plan on using? How did you come to the conclusion of using this model? How did you choose [between models and manufacturers]?

(Provide Bartlett with a list of laws and regulations)

Are there other laws and regulations that you had to comply with that we did not include?

What steps in the permitting process were particularly difficult to overcome?

Were there any permits that were particularly time consuming to acquire or to fill out?

Specifically regarding compliance with Nantucket Bylaws, were any permits particularly difficult or time-consuming to obtain? Do you have any suggestions about which permits or documents to complete first?

Do you know of any opponents on the island who might be against this proposed project?

Did you run into any opposition with your residential-size turbine?

Have you had any experiences or encounters with the Save Our Sound group? (if yes) Do you think they will be in favor of land-based turbines?

May we contact you if we have further questions? What would be the best form of contact to get a hold of you should this need arise?

We will send you a transcript of this interview by email to make sure we took your thoughts in the way you meant them and did not take them out of context.

C2b. Actual Questions, J. Bartlett

We hear that you are looking into installing a wind turbine on your property, or have you already installed it?

So you have gone through the laws and permitting and all that?

Why did you choose to install a turbine on your property?

How much of [of the electricity that Bartlett Farms consumes] do you think the turbines are going to provide for you?

So more than half of your electricity will be provided from the turbine?

What manufacturer is this?

Do you know if they sell just to individuals or would they sell to the town of Nantucket Energy Committee?

I know you talked a little bit about the sizes [of the turbines] and how you selected them, but was there any process [you used to choose] when different manufacturers had similar [turbines]?

[Going back to] the laws and regulations that we talked about a little earlier - we found an extensive list of federal, state and local laws, particularly local ones. If you don't mind looking over the local ones, we are wondering if there are any local permits that you went through that we're missing or ones that were particularly difficult or time consuming [to obtain]. (hands Mr. Bartlett a list of laws)

So you kind of don't really fit into either? [residential or commercial, referring to Nantucket bylaws]

But you did go through Nantucket Historic District Commission?

You were talking about transporting the turbine components through the town. Do you think you will encounter any problems with the turbine you have selected?

You mentioned bird studies. Did you hire someone to study the birds in the area?

Was it Bob Kennedy [who did your bird study]?

You were talking about all the work with the Department of the Interior, was that a long process? Would that be something the Energy Committee would want to start now? [went through DOI to comply with regulations regarding Nantucket's designation as a National Historic Landmark]

Other than the USDA process which the Energy Committee would not have to go through, was there anything else that was difficult or long to complete?

Did you come across any opposition to you putting a turbine on your land?

APPENDIX C3: QUESTIONS FOR E. STEINAUER

C3a. Prepared Questions, E. Steinauer

Interview with Ernie Steinauer, Massachusetts Audubon Society, Nantucket, Massachusetts

November 3, 2008. 7-7:30 pm

How long have you been working on Nantucket?

The Massachusetts Division of Fisheries and Wildlife Natural Heritage & Endangered Species Program (NHESP) has designated the entire island of Nantucket as a priority habitat of rare species. Do you know what this entails regarding construction on the land?

Do you have any prior knowledge of wind turbines? Particularly, the impact that the construction has on wildlife and habitats in the area.

The construction of turbines requires clearing a relatively large area, constructing access roads, and digging and pouring a foundation. The construction would probably be similar to constructing the existing tower. Do you have any concerns about affects on endangered species with the construction of wind turbines? With the operation of them?

Are the specific sites chosen (Waste Water Treatment Plant, Landfill site) in areas of migratory paths and/or will they have an effect on other flora and fauna? (Osprey, Long-tailed Duck)

Knowing that the Energy Study Committee will need to conduct a study of avian life, is there any person or organization you would specifically suggest?

Would you happen to know if there are effects on marine life from land-based turbines? If not would you happen to know anyone who could help us with this concern?

C3b. Actual Questions, E. Steinauer

How long have you been living on Nantucket?

And you've been with the Audubon Society the whole time?

Did you work with the Audubon Society before you got here [to Nantucket]?

What kind of work did you do there [at the Audubon Society]?

We found out that the entire island is a Priority Habitat of Rare Species. Do you know what this means?

Do you have any idea what it [priority habitat of rare species] means [with regard to] new construction projects?

Do you have any prior knowledge of wind turbines or have you heard anything about the Energy Committee's [proposed project with wind turbines]?

You don't have to answer this, but if you don't mind saying, what are your views on turbines on the island?

Do you have any concerns about the effects [on plants, animals, and birds] of a possible construction project of wind turbines [on Nantucket]?

Do you know anyone on the island who studies bats and knows a lot about them?

One more question, someone had mentioned concern about land based turbines on marine life, do you know anyone who studies marine life in the area who might know something about this?

APPENDIX C4: QUESTIONS FOR R. KENNEDY

C4a. Prepared Questions, R. Kennedy

Interview with Dr. Robert Kennedy, Director of natural Sciences, Maria Mitchell Association, Nantucket, MA

November 4, 2008. 1:30-2:10 pm

Can you tell us a little about you educational background, as well as you credentials and experiences with birds?

How long have you been studying birds?

How long have you been working on Nantucket?

Can you tell us about your work with the MMA?

Do you know anything about wind turbines? Can you tell us briefly what you know about them and what your opinions are?

What do you know about the Nantucket Energy Study Committee's proposed turbine project?

The sites that the Energy Committee is investigating are at the Landfill and the Waste Water Treatment Facility. Do you think that this project will have a negative effect on the birds of Nantucket? Particularly on endangered bird species?

Is there a particular time of year when migrations occur? For example, in Princeton, MA, there is a 2 week period when many hawks migrate through the area. The turbines will be turned off during this migration period. Would something like this be helpful on Nantucket? Or are you more concerned with daily migrations?

Many people were opposed to turbines in the Nantucket Sound due to the potential hazardous effects on birds. Do you think land based turbines will have similar effects on birds as people feared the Cape Wind project would?

Any structure over 200 feet must me lighted. Do you know anything about the effect of lighted towers on birds? Do you have any suggestion on how to minimize the effects on birds? Such as color of the light or tower, etc.

When we interviewed John Bartlett, he said that you conducted a formal study for him to help with his USDA application.

- What exactly does this type of bird study entail?

- What kind of things are you looking for?

- Does this type of survey require putting up a tower or anything like that?

Do you know if a record exists of bird deaths at various towers on the island?

Do you know anything about bats on Nantucket?

- Do you know anyone who may be able to help us find information about bats on Nantucket? Ernie Steinauer said that you may know how we can contact the following:
    - Edie Ray – how to contact her?
    - Danielle or Kelly from the Conservation Commission

C4b. Actual Questions, R. Kennedy

Can you tell us a little bit about your educational background and any experience you have with birds?

How long have you been working on Nantucket?

Can you tell us a little bit about your work with the Maria Mitchell Association?

Do you know anything about wind turbines or the Nantucket Energy Study Committee's ideas for possibly using wind turbines on the island?

We were wondering if you think that doing a construction project and having turbine in those two locations (Waste Water Treatment plant and Landfill) would have a negative effect on the birds of Nantucket?

Do you have any information about the birds that are in those areas [Waste Water and Landfill sites]? Also, we know there are migrations and we weren't sure if they were mostly daily migrations or annual migrations that just happened one time during the year?

We know that any structure over 200ft has to be lighted [FAA regulation] and we have some information that the lighting can affect birds especially in foggy conditions. Do you know anything about birds and if they are attracted to lighted objects or special conditions where they would be?

We'll look into this more, but do you know if birds are attracted to certain colors?

We also know that when they were looking into the Nantucket Sound wind turbines, there were a lot of concerns with potential bird deaths in those areas. Do you think it would be a similar effect with a land based turbine because in the open ocean it would be potentially worse or better?

We interviewed John Bartlett from Bartlett Farms and he said that you conducted a formal study for him for helped him with his USDA application. We were just wondering what kind of things you look for in that bird study and what kind of things you did [for that study].

How did you determine this [minimal effect on Piping Plovers], was it just [determined by] looking at the area?

Do you know if there is any record of bird deaths at the various towers, [such as the] communications tower at the land fill and other locations?

Is the problem with the birds hitting the towers the guy wires or is it them hitting the tower itself?

Have you done anything looking in those areas [around towers on Nantucket]?

Do you know anything about bats on Nantucket or anybody who might know [about bats]?

Do you know anything about how they [bats] may be affected if they can see things like towers? We've heard different things about with their echolocation and the motion of the turbine, do you know anything about this?

So [bats are] not nearly as much of a concern as the bird populations?

We talked to Ernie Steinauer and he mentioned that we contact Edie Ray. Do you know how we could contact her?

Ernie Steinauer also mentioned that Danielle or Kelly from the Conservation Commission may know something about bats. Do you know who either of them is or if they may know something?

APPENDIX C5: QUESTIONS FOR M. VOIGT

C5a. Prepared Questions, M. Voigt

Interview with Mark Voigt, Nantucket Historic District Commission Administrator, Conducted at 37 Washington Street, Nantucket, Massachusetts

November 7, 2008. 10-10:50 am

How long have you lived on Nantucket?

How long have you been working for the Nantucket Historic District Commission?

Could you describe tell us about the type of work that you do for the Commission?

Do you know anything about the Nantucket Energy Study Committee's proposed wind turbine project?

- Can you briefly tell us what you know about the project, and any opinions that you have regarding the proposed project?

While on a tour with the Nantucket Historical Association, we were told that all of Nantucket is a historic district.

What constitutes a historic district? Why is *all* of Nantucket a historic district?

We know that in order for a wind turbine project to be constructed, the Energy Committee needs to acquire a certificate of appropriateness, issued by the HDC. What do you know about this process? What will the Energy Committee need to do in order to apply for this? (when?)

- Are there any other requirements for new construction projects on land that is considered a historic district? Could you tell us about these requirements?
- Do you foresee any of these requirements as being a problem for the Energy Committee's implementation of turbines on the Waste Water Treatment Plant and Landfill sites?

Do you know anything about the required process for complying with the Massachusetts Historic Commission regulations? (such as a project notification form, or any other requirements that they may have)

Do you know if there were any problems with permitting for the communications towers, such as the one at the landfill?

C5b. Actual Questions, M. Voigt

How long have you lived on Nantucket?

How long have you been working for the Nantucket Historic District?

Did you do similar things when you were in Florida, or did you have a different type of job there?

Can you tell us a little bit about the type of work you do here on Nantucket?

Do you know anything about the Nantucket Energy Study Committee's proposed wind turbine project?

When we went on a tour with the Nantucket Historical Association, they told us that all of Nantucket is a Historic District. Could you tell us what constitutes a Historic District and why all of Nantucket is one?

We know that in order for a wind turbine project to be constructed the Energy Study Committee or whatever organization is trying to build it needs to acquire a certificate of appropriateness issued by the Historic District Commission. What can you tell us about this process? What will the Energy Study Committee have to do in order to move on with the permitting process?

I found one form online, but had trouble accessing it. Is there one form or are there several different applications that need to be completed for a project such as a wind turbine?

Do you see any major problems in terms of the HDC and putting turbines at those sites [Waste Water Treatment Facility or Landfill]?

Do you know anything about the required process for complying with the Massachusetts Historic Commission, or even the federal part?

So would you say it would be advisable to start at the local level and then once they get a permit from you, move to the state?

About how long does it take to go through the Nantucket Historic District Commission process, from when you apply until you receive a response?

Skipping back to a previous question about the various state and federal organizations that would have to be gone through for the Historic District, do you know anyone at those organizations who may be helpful to us? Or is pretty much everything readily available (the applications and such)?

That one existing tower at the landfill site, were there any siting issues with that? I was wondering if there were any problems with that, as the turbines will be a much lesser height.

Do we get the application through you in person?

APPENDIX C6: QUESTIONS FOR E. SCHULTZ

C6a. Prepared Questions, E. Schultz

Interview with Eric Schultz, Chief Operator, Surfside Waste Water Treatment Department, Nantucket, Massachusetts

November 7, 2008. 1-1:20 pm

We know you are involved with the Energy Study Committee and have suggested some areas for turbine implementation.

We have a few questions that we would like to ask you about the site.

Do you see the displacement of liquid in the sewer beds as a result of the turbines being a problem?

How do you plan on anchoring the turbines in the sewer bed?

To you foresee problems with maintaining the turbines, due to their location?

Do you have any concerns, or know anything about oil or lubrication from the turbines leaking into the sewage?

Do you know of any people or organizations that may have some information on this?

Could we possibly show us the locations where the turbines might be located?

Changing topics,

How close is the employee housing to the turbines?

Is all of the employee housing leased?

Do you see any problem with the lease if it mentioned that they would be in close proximity to the turbine?

May we contact you if we have further questions? What would be the best form of contact to get a hold of you should this need arise?

We will send you a transcript of this interview to make sure we took your thoughts in the way you meant them and did not take them out of context. May we have your e-mail address? (as this is the easiest way for us to get out transcription to you.)

C6b. Actual Questions, E. Schultz

How long have you lived on Nantucket?

How long have you been working at the Surfside Waste Water Treatment Plant?

What does your work here entail?

We know you have been involved with the Energy Study Committee and have suggested some areas for them to possibly put turbines. We have questions that we would like to ask you about some of the sites.

What exactly are the sewer beds?

Do you see the displacement of any of the sand/sewage in these areas from the turbines as being a problem?

How do you plan on anchoring the turbines, or do you have any plans for how you would anchor the turbines?

So you just know that they [turbines] could go in the sewer beds?

Do you foresee any problems with maintenance of the turbines due to their locations? Accessibility concerns?

We were told there is going to be employee housing somewhat close to the sewer beds (the proposed turbine site). Do you know a distance from [the housing to] the nearest sewer bed?

Is this housing going to be leased or would any be [privately] owned?

One of the Nantucket bylaws states that the turbine must be at least 1000 feet from the nearest property line, but all of this is town land correct?

So the nearest property line is going to be significantly farther away?

I know the Energy Committee said you suggested locations, where these specific or just the sewer beds in general?

Is there a problem with the proximity of the turbines affecting the lease?

We had a question about the writing of the lease that would have to be signed, and could it mention it is close to the turbines? But if that is a town question we will go to them.

Do you know anyone in the town who may specifically know about that?

APPENDIX C7: QUESTIONS FOR R. MILLER & P. CANNON

C7a. Prepared Questions, R. Miller & P. Cannon

Telephone interview with Richard Miller and Patrick Cannon, Hull Municipal Light Plant, Hull, Massachusetts

November 10, 2008. 9-9:35 am

Could you please tell us briefly about your background regarding wind energy?
    How long have you worked for the Hull Municipal Light Plant?

Tell us how you became interested in wind energy?

Can you tell me a little about your job and what it entails? (if not answered above)

Can you tell us about some of the specific projects you have worked on?

We know that your town has new turbines. What were some of the major obstacles in the siting process? How did you overcome them?

(if not answered in last question) Was there much opposition to the wind turbine project in Hull?

    How did you deal with this?

What did you do for public outreach and community involvement?

    How early in the project was the community involved?

        Did you do surveys to get public feedback?

            Can we get the results from these surveys?

What do you see as some of the benefits that have resulted from your town's implementation of wind turbines? Disadvantages?
    One concern we have heard about is a potential decreased property values within sight of the turbines. Do you have any information about how property values have changed since the installation of wind turbines, if at all?

As your town owns its utility company, what do you see to be the advantages of this? Disadvantages?

How did you determine the ownership of the turbines?
Could you give us some information about the various costs associated with your wind turbine project? If you have any documents that you could send us, it would be very helpful.

What were the different financing and funding alternatives that you considered at the beginning of the project?

What were the advantages and disadvantages of these options?

What financing option did you end up choosing? Why?

Did the project apply for any grants? If so, which ones?

Could you tell us about the process of dealing with turbine manufacturers?

How you chose the manufacturer that you bought the turbines from?

What kind of questions did you ask them/ what topics were of main concern?

What are your concerns about existing legislative and regulatory arrangements?

What does or does not work?

How could these arrangements be improved?

What new legislation/regulation would be helpful?

Was there any legislature or regulations that hindered the progression of the project?

What do you/the HMLP do during turbine downtime?

Do you have any information about the potential effects that your land-based turbines may have on marine life?

- Did you have any studies conducted in Hull?

How did you address the concerns about the effect of turbines on migratory and nesting avian life?

Do you have endangered flora, fauna, or avian life in the areas affected by the turbines?

- What particular permits or studies were needed, relating to endangered species?

We know Hull, and especially the turbine located at the High School, is relatively close to Logan Airport in Boston. Did you encounter any difficulties when dealing with the FAA to get permission to construct the turbines? Do you have any advice for us regarding FAA or any other airport-related permits?

C7b. Actual Questions, R. Miller and P. Cannon

Could you please tell us briefly about your background regarding wind energy?
Can you tell us a little bit about what your job entails?

We know that the town [Hull] has two turbines. Can you tell us about any of the major obstacles you had with siting the turbines? If you had any, can you tell us how you overcame them?

In terms of public outreach and community involvement, how early did you let the public know that you were looking into wind turbines and how did you get them on board?

Would we be able to get a copy of the [public interest] survey results?

What do you see as some of the benefits that have resulted from the town's implementation of wind turbines?

As far as disadvantages, one that we have heard a lot about is the potential for decreased property values. Do you have any information about how the turbines may have changed any of the property values around Hull?

One of the questions Nantucket is having is maybe eventually having a municipal light department. As Hull has a municipal light department, what are the distinct advantages of this?

Being a municipal utility, do you see any disadvantages to this?

Can you give us any information about various costs associated with wind turbine projects? For example, costs, delivery, installation, altering roads etc.

Back to the financial part of this...What were any of your major funding or financial sources you considered at the beginning of the project, in terms of grants etc.?

So you did not apply for any grants or any of that?

What was the process you used for dealing with the turbine manufacturers and how did you choose the manufacturer and model?

Were there any regulations or legislature along the way that hindered the project?

In terms of the FAA regulations, some of the sites that Nantucket is looking at are close to the airport. Do advice on handling FAA regulations?

Do you have average number of [turbine] down time per year?

This [maintenance] agreement with Vestas, is it standard or specially written into a contract?

With these turbines being close to ocean, was there any information about the potential affects they might on marine life?

We spoke already about birds, who did you go through to conduct that study?

APPENDIX C8: QUESTIONS FOR D. FREDERICKS

C8a. Prepared Questions, D. Fredericks

Interview with David Fredericks, Vice President, National Grid New England South, conducted at 2 Windy Way, Nantucket, Massachusetts
November 11, 2008. 2- pm

Can you tell us about what you do with National Grid, and particularly your involvement with Nantucket?

Have you had any involvement with turbine projects through National Grid?

- What types of projects? (Residential, Commercial)
- Where were the projects located? (Rural or Urban/Suburban areas)
- Did the residents of the nearby town benefit from the turbines? (i.e. rate decrease)
- What type of complaints did National Grid hear about?

What are the options that Nantucket has when connecting to the grid?

- Is National Grid required to connect turbines to the grid?
- What is involved in connecting renewable energy generators to the grid?
- What options/deals do individuals or towns have in regards to hooking up renewable energy?
- What benefits would residents have?

Is Nantucket able to send power back to the mainland?

- Can electricity be sent to the Candle Street substation and voltage be increased to send electricity to mainland?
- What type of additional equipment is needed for this?
- What are the costs associated with acquiring this additional equipment?

What is the maximum electricity that can be produced at each the Landfill site and Waste Water Treatment site without requiring additional equipment?

- If more electricity is produced at these sites, what type of additional equipment is needed for this?
- What are the costs associated with acquiring this additional equipment?

If Nantucket chose to become its own municipal electrical utility again, what steps would need to be taken to transition from National Grid ownership to public utility ownership? (i.e. purchasing or leasing equipment, such as the submarine cables)

Regarding the Green Communities Act, do you know what the current regulations are regarding net metering? Is there a maximum amount of electricity that can be net metered? Can power from a turbine go to more than one meter, or is all power exceeding the amount used by one meter sold back to the grid?

C8b. Actual Questions, D. Fredericks

Can you tell us what you do with National Grid now?

What particularly do you do with Nantucket?

Have you had any experience with wind turbine projects through National Grid?

Did you see anything from the feasibility studies in terms of benefits and disadvantages to wind turbine implementation?

And what was the report called?

What are the options that Nantucket has for connecting to the grid?

Do you have an estimate on that [what Nantucket would need to pay National Grid to use the distribution system]?

So is it pretty much impossible to setup a new municipal light department?

Based on what you were saying about the school example and it being most cost-effective is if the school uses all of the electricity produced and you don't sell [any] back?

Do you know what the numbers for peak usage and daily usage at the 2 sites are?

Do you know what the maximum amount of electricity that could be produced at the Landfill and Waste Water sites without having to add/upgrade equipment?

Can electricity travel in both directions through the cables?

Do you have any idea of the costs of the equipment for that?

Going back to the electricity that could be produced at the sites, do have any idea how expensive the equipment would be if an upgrade was needed?

If Nantucket was not its own electrical utility, would wind turbines still be feasible?

Do you know what the different ownership options would be as far as if Nantucket wanted turbines. Would National Grid want to own them, or would it be fine for the town to own them?

As far as net-metering goes, do you first off know that there is more than one meter at each site?

Do you know if you used net metering if you could use it on more than one meter?

APPENDIX C9: QUESTIONS FOR S. MELVIN

C9a. Prepared Questions, S. Melvin

Telephone interview conducted with Scott Melvin, United States Fish and Wildlife Endangered Species Program

November 12, 2008, 3-3:30 pm

Can you tell us a little about your educational background, as well as your credentials and experiences with endangered species and birds?

How long have you been studying birds and endangered species?

How long have you been working for the Massachusetts Division of Fisheries and Wildlife National Heritage and Endangered Species Program?

Can you tell us a little bit about your work with the National Heritage and Endangered Species Program?

Do you have any prior knowledge of wind turbines? Can you tell us briefly what you know about them and what your opinions and concerns are?

Do you know anything about the endangered species or birds on Nantucket?

Many people were opposed to turbines in the Nantucket Sound due to the potential hazardous effects on birds. Do you think land based turbines will have similar effects on birds as people feared the Cape Wind project would?

The two possible sites that the Nantucket Energy Committee has identified are the Landfill and Waste Water Treatment Facility. (If he doesn't know the locations of the sites, the Waste Water Treatment Facility is near Surfside and close to Miacomet Pond; the landfill is kind of near Long Pond and some wetlands) Do you foresee any fatal flaws with these sites regarding endangered species or birds?

Since the Waste Water Treatment Facility is near the shore, we've been told that Piping Plovers and least terns could be affected at this site and may possibly feed at the sewer beds. Can you tell us a little bit about these birds and the concerns you might have with these birds and wind turbines at this site?

At the sewer beds, we've also been told that Short-eared Owls and Northern Harriers use that area for foraging and close by nesting, do you think wind turbines would have an effect on these species?

According to Bob Kennedy, the possibility of Piping Plovers and least terns feeding at the sewer beds hasn't been studied on Nantucket and a study would need to be done. Do you know what a study like this would entail? Do you have any recommendations for the Energy Committee for someone who could conduct this study?

The other site is the landfill or dump, and adjacent to the dump are nesting Ospreys. Other migratory birds use Long Pond and the wetlands attract shorebirds; do you think these would be of concern as well?

Do you have any concerns or know about any endangered species at any of these sites?

Do you have any concerns about the effects [on plants, animals, and birds] of a possible construction project of wind turbines on Nantucket?

Any structure over 200 feet must me lighted. Do you know anything about the effect of lighted towers on birds? We've been told that red lights are better for reasons unrelated to birds; would red lights be harmful to birds? Do you have any suggestion on how to minimize the effects on birds? Such as color of the light or tower, etc.

Concerns have been mentioned about fog and birds, can you tell us about this?

Someone has mentioned concern about the effect of land based turbines on marine life, do you know if this is an issue?

Can you tell us about the work you've done on Nantucket and the study for the Cape Wind project?

Are there any other concerns or issues that you think the Energy Committee would need to investigate?

C9b. Actual Question, S. Melvin

Can you tell us a little bit about your educational background, and your credentials and experiences with endangered species and birds?

How long have you been studying birds and endangered species?

Can you tell us a little about the work you do with the Natural Heritage and Endangered Species Program?

Do you have any prior knowledge of wind turbines?

Can you tell us what your opinions and concerns are with wind turbines?

Do you know anything about the endangered species and birds on Nantucket?

We know that many people were opposed to turbines in Nantucket Sound due to hazardous effects on birds. Do you think land based turbines - they're looking at 4-6 turbines at the Landfill site and 2-3 turbines at the Waste Water site - do you think these will have similar affects on birds as people feared the Cape Wind Project would?

The two possible sites are the Landfill site and Waste Water Treatment Facility. Do you foresee any fatal flaws with these sites regarding endangered species and birds?

We've been told by a few other people that Piping Plovers and Least Terns could be affected at the Waste Water Treatment Facility, and might potentially feed at the sewer beds. Can you tell us a little about these birds and the concerns you might have with them and the turbines at this site?

We've also been told that Short-eared Owls and Northern Harriers use the area for foraging and close by nesting. Do you think that turbines could have an effect on these species?

Bob Kennedy told us about the possibility of Piping Plovers and Least Terns feeding at the sewer beds, which hasn't been studied on Nantucket, so a study would need to be completed. Do you know what a study like this would entail or have any recommendations for the committee for someone who could conduct the study?

Would this be something that Mass Wildlife could study or would someone else be needed?

At the landfill site, adjacent to the dump, are nesting Ospreys. We were told that they are attracted to poles. Do you think that they could be a concern with turbines as well?

Do you have any concerns of any endangered species other than birds at either of the sites?

Do you have any concerns on plants, animals or birds that the possible construction project in regards to the foundation or access roads etc.?

Any structure over 200ft must be lighted. Do you know anything about the effect of lighted towers on birds?

Red lights are better for reasons unrelated to birds, for residents and such. Do you know if red lights are particularly harmful to birds?

Do you have any suggestion to minimize these affects on birds, such as color of the light or the tower?

Other concerns have been with fog and birds; can you tell us how fog can affect birds?

Do any of the sites appear to be in any migratory bird paths that might be a concern?

We talked to the head of the Princeton Municipal Light Department, they are putting up two turbines and had a few prior turbines, and he told us in October during a two week period they have a big path of migratory birds so their plan is to shut the turbines down during that two week period. When we were talking to some of the birders at the Energy Study Committee meeting last Thursday, they mentioned that there's some time in the fall when the migrations can be predicted. Do you know anything about this and does this happen during other times of the year?

Can you tell us about what you did to come up with the Cape Wind data, like what is used to determine how the birds will be affected by the turbines?

You said that Mass Fish and Wildlife would have to conduct a study before constructing turbines on Nantucket, would this be similar to the study done for Cape Wind?

Are there any other concerns or issues that you think the Energy Committee would need to investigate?

Someone from the Maria Mitchell Association had mentioned concern that land based turbines and their vibrations could affect marine life. Do you know if this is a concern?

APPENDIX C10: QUESTIONS FOR V. LAUX

C10a. Prepared Questions, V. Laux

Interview conducted with Vernon Laux, Linda Loring Nature Foundation, Nantucket, MA

November 13, 2008. 1:30-2: pm

Can you tell us a little about your background, as well as your credentials and experiences with endangered species and birds?

How long have you been studying birds?

How long have you been living on Nantucket?

How long have you been working for the Linda Loring Foundation?

Can you tell us a little bit about your work with the Linda Loring Foundation?

The two possible sites that the Nantucket Energy Committee has identified are the Landfill and Waste Water Treatment Facility.

What birds in particular nest/forage/migrate through the Landfill site/the Waste Water Treatment facility?

Do you have any documented information on specific flight patterns of different migratory birds? Or do you know where we may find it such as an online resource?

Do you have any information on how many frequent the site? For example how many nesting pairs of Harriers are on Nantucket? How many within a radius of the site?

Are you concerned about any of these species? Do any of the sites bring up any red flags?

Do you have any concerns about the effects [on plants, animals, and birds] of a possible construction project of wind turbines on Nantucket?

Do you know if there is any record of bird deaths at the various towers, such as communications tower at the land fill?

Concerns have been mentioned about fog and birds, can you tell us about this?

Some questions regarding the specific migration dates when the turbines would have to be shut off. When/Why/For How Long? / In what Conditions?

Can you tell us what your opinion and concerns are with land based wind turbines on the island?

Many people were opposed to turbines in the Nantucket Sound due to the potential hazardous effects on birds. Do you think land based turbines will have similar effects on birds as people feared the Cape Wind project would?

Any structure over 200 feet must me lighted. Do you know anything about the effect of lighted towers on birds? We've been told that red lights are better for reasons unrelated to birds; would red lights be harmful to birds? Do you have any suggestion on how to minimize the effects on birds? Such as color of the light or tower, etc.

C10b. Actual Questions, V. Laux

Tell us a little bit about your background as well as your credentials and experiences with birds.

Massachusetts is what we really care about.

Well, hopefully [the turbines] won't be too big.

The turbines shouldn't even be half the height of that tower you're looking at.

You answered that, and several other ones. I just want to double check and see if I have the right answer, so you've been working for the Linda Loring foundation since you got here, 14 months ago?

Can you tell us what kind of work you do for the Linda Loring Foundation?

Since you were at the Energy Study Committee meeting last week, I assume you know that they identified the Landfill and Waste Water Treatment Facility as possible sites for wind turbines, which they are investigating now. Are there any birds, in particular, that nest or forage or migrate through those areas that you think might be of particular concern?

Are any of the locations that they are talking about, the Waste Water Treatment Facility or the Landfill, are they similar to the Bartlett's farm area? Do you think they would be able to do studies on the turbine there, to give reasonable results for what may happen [at the proposed sites]?

The Energy Committee is very interested in having that [a sub-committee to determine when to shut down turbines (on nights likely to kill many birds)].

Yes, that is their goal, too. They want the clean energy but they also want to make sure that they don't destroy anything here.

I know you have been talking a lot about tracking the birds, websites and things like that. Are there any documents or anywhere we could find photographs of the paths they take?

Those are Long-tailed Ducks?

Do you know how high they [Long-tailed Ducks] normally fly, or is it not normal?

Are they the size of a mallard duck?

I know you talked about a number of Harrier pairs [nesting on Nantucket]. Do you have any information about the other types of birds and the numbers that are on the island? For example, the Short-eared Owl?

Are you concerned with any of the smaller song birds? I've heard people bring up the migrations of those [birds].

I think you have probably mentioned this already, but either of the two sites we talking about, did any of them raise any red flags of reasons we absolutely can't have a turbine there?

Do you have any concerns on the effects that the actual construction of the turbine will have along with the disturbed land during the short time that they are actually building them on the birds or even plants and animals if you know about those.

Do you know if there is any record of bird deaths at the various towers, such as the communication tower out there?

You've talked a little bit about the effect that fog has on birds, can you tell us a little bit about exactly what happens with birds flying in fog?

Would a blinking light be better than a steady light?

Do you know anything about different colors that might be more likely to attract the birds?

Such as the blinking red light at the tower there, do you know if that would be any worse than the lighthouse, or just because it's smaller maybe not?

You were talking about possibly shutting off the turbines, or definitely shutting them off during those big migrations?

You already described the conditions.

Do you know how many days in advance you would be able to predict this? Or would it be that day?

You would be able to tell when they leave Canada, so it wouldn't be like they are going to be here in ten minutes, there would be a little bit of time [to shut the turbines off]?

We've got this a little bit, but can you tell us what your opinion is with wind turbines on the island?

Do you like the idea of wind turbines? Or do you flat-out not like them but you are just accepting it because you feel it's inevitable?

Do you know anything about bats on the island?

Comparing the considered project of 4-6 wind turbines on the island to Nantucket Sound, do you think that the land[-based] turbines will have similar effects on birds that people feared from Cape Wind or do you think it will be a much smaller magnitude?

APPENDIX C11: QUESTIONS FOR A. VORCE

C11a: Prepared Questions, A. Vorce

Interview with Andrew Vorce, Nantucket Planning and Economic Development Commission

November 14, 2008. 10-10:30 am

How long have you lived on Nantucket?

How long have you worked for the Nantucket Planning and Economic Development Commission?

Can you tell us about the type of work you do for the Planning Commission?

The Nantucket Energy Study Committee is doing a feasibility study for possibly implementing wind turbines. We are doing research considering possible sites at the Landfill and Waste Water Treatment Facility. Do you see any fatal flaws with any of these areas as sites for turbines?

What permits are necessary for a major construction project, such as the construction of one or more land based wind turbines?

- What is the process involved with getting these permits?
- What special approval is necessary?

Would the Energy Committee need to get a commercial permit for the turbines? Or some other special permit?

What will the Planning Board's role be in the land based turbine project?

What process would the Energy Committee need to go through in order to use town land for the wind turbines?

C11b: Actual Questions, A. Vorce

How long have you lived on Nantucket?

How long have you worked for the Nantucket Planning and Economic Development Commission?

Can you tell us about the kind of work you do here?

We know you know a little bit about the Energy Study Committee and their feasibility study for wind turbines. The two possible sites are the Landfill and the Waste Water Treatment Facility. Do you see any fatal flaws with those sites as areas for turbines?

We've seen in the WECS by-laws (the set of permits). Can you just tell us about what some of the permits they would need [to construct a turbine] with regard to your office?

So you could do more with a special permit?

Is [that wind tower] the one that used to have many small blades, it was a truss type structure?

They [proposed turbine sites] are sufficiently far away from [the airport], it would just be the height of the turbines that could possibly be affected, but the distances are ok. I'll look into that more.

What exactly would that [major site plan review] entail?

So what if you made it [requirement for permit] a minor site review? Would that be a lot less stress?

Can you tell us a little bit about the process of getting the special permits, for things such as the height and the number of towers?

As far as lighting, we heard something about a by-law: the dark sky initiative...[Can you tell us what that is?]

One thing we were considering with lighting for reasons of just public interest is having a red light all the time, and we weren't sure if [the dark sky initiative] had anything to do with if there were any rules in this about the color of the light. I know we'll have to work with the FAA as well. Do you know if there are any big issues with the towers, with the existing lights they have on those if they needed to go through any hoops?

Do you know anything about the process that the Energy Committee would need to go through in order to use the town land for the turbines?

Does color apply in any of the Dark Sky [initiative bylaws]?

Obviously with turbines, FAA wants it lighted so that can be pointing up so that the airplanes can see it, so it overrides the by-laws?

Follow-up question, December 2, 2008. (e-mail)

In the Nantucket bylaws, § 139-21 B, regarding commercial WECS, the Code of Nantucket states "(7)Tower access. The tower shall be made inaccessible to unauthorized personnel." Is the intent of this law that a fence must be built around the wind turbine so that people cannot get close to the tower, or does it mean that the door to enter the tower is locked at all times so that no one can get into the tower?

APPENDIX C12: QUESTIONS FOR D. LARSON & M. Peterson

C12a: Prepared Questions, D. Larson & M. Peterson

Telephone interview with Dave Larson and Mike Peterson, National Grid

November 14, 2008. 1-1: pm

What is the current rate of electricity on Nantucket, for each residents and municipal buildings?

Could you tell us what the electricity consumption is at each the Landfill, and Surfside Waste Water Treatment Facility?

What is the maximum electricity that could be produced at each site without upgrading the equipment?

What would be the cost of upgrading the equipment? (if asked the desired electricity generated: approximately 6-9MW at the landfill, 1.3-2MW at the Waste Water Treatment Facility)

Do you know the approximate cost per kW of selling electricity back to the market? And the cost of using Nantucket's distribution system?

Can you tell us about some of the options that the Energy Study Committee has for interconnecting the wind generations to the grid? Which do you think would be most beneficial form an economic standpoint?

If the town net meters electricity generated from the wind turbines, can they provide electricity to more than one meter, or must all excess over the consumption of one meter be sold back to the market?

If Nantucket decides to try to become a municipal electrical utility, how much would it cost the town to buy or lease the equipment from National Grid?

C12b: Actual Questions, D. Larson & M. Peterson

Do you know what the current rate of electricity is on Nantucket for residents as well as municipal buildings?

Would you be able to tell us anything about the exact electricity consumption at either the landfill or the surfside Waste Water Treatment Facility?

We are not but through the Energy Study Committee that we are working for, they are all involved with the town somehow. Everybody pretty much knows everybody around here, so it wouldn't be a problem to get in touch with her at all.

What is the maximum electricity that could be produced at each site without updating the existing equipment there? As far as like peak loads go without having to update any of the equipment.

Ok, so it really depends on what the existing infrastructure. You don't know what that is offhand?

If the existing infrastructure would not be able to support the exporting of any extra power produced what would be the scale of upgrading one of the sites, for instance the landfill? I know there won't be any hard numbers, just in general, what would be the scale?

Going back to selling the electricity back into the market or back to National Grid to distribute, do you know what the approximate cost per kWh that they would receive by selling this back?

If the town net metered electricity from the wind turbines and provided electricity more than the site used, could this be transferred to other meters on the site or must all of the excess be sold back to the market?

So if we were talking four to six 1.5MW turbines, this would take multiple additional transformers?

So for that site, say they were going to do two to three 660kW. Do you see that needing any additional?

I just wanted to ask a question. Did you mention that when you normally interconnect turbines it's not through underground cables?

Could you tell us about any other options for interconnecting the wind turbines to the grid or what you think would be the most beneficial from an economic standpoint for the committee?

The last thing that we really have to ask, is something that hasn't happened in Massachusetts in a number of years but whether or not if Nantucket decided to become its own municipal electricity again, what would the scale or the cost of the equipment be if it is even possible?

From talking with them it just seems that those towns are more accepting when a wind turbine project is going to start because they know that they are going to reap directly because they are in charge of setting their prices?

APPENDIX C13: QUESTIONS FOR J. WILLETT

C13a. Prepared Questions, J. Willett

Interview conducted with Jeff Willett, Director, Nantucket Department of Public Works, Nantucket, MA

November 17, 2008, 9-9:40 am

How long have you lived on Nantucket?

How long have you worked for the Department of Public Works?

Can you tell us about the work you do for the DPW?

I am assuming you know about the Energy Study's work, and their plans to study the feasibility of implementing wind turbines at the landfill and Waste Water Treatment Facility sites.

- Do you have any problems with turbines being potentially constructed on DPW land? Do you support their work studying these areas?
- Do you have any concerns with turbines being constructed near the recycling facilities at the landfill?
- Would you want to be in charge of the turbines, or would you prefer someone else be responsible for overseeing them?

Do you know anything about the employee housing at the Waste Water Treatment Facility? Do you know who is in charge of this housing and the lease? (Would it be possible to write into the lease that the housing is near wind turbines?)

C13b. Actual Questions, J. Willett

How long have you lived on Nantucket?

Have you been with the Department of Public Works the whole time?

Can you tell us about the work you do for the Department of Public Works?

We assume you know a little bit about the Energy Study Committee's work and their plans looking at a couple of different sites that are actually both on Department of Public Work's land at the Landfill and Waste Water Treatment Facility. Do you have any concern with the turbines potentially being constructed on DPW land?

At the Waste Water Treatment Facility, they are considering putting the turbines in the beds, so that would displace about 3000 square feet [per turbine].

You mentioned that they discovered several rare species at the Waste Water site. Do you have any documents or know where we can get the documents that talk about the species that they discovered there?

Do you have concerns with turbines possibly being constructed near the recycling facility other than the land space?

Do you know anything about the employee housing at the Waste Water Treatment Facility?

Do you know who's in charge of the lease for that housing?

Would that person happen to be you?

One thing we were considering based on the possible locations of the turbines, would it be possible to write into the lease that the houses are located "x" number of feet from the wind turbines?

Since it is the worker's living in the housing, will they have to renew the lease and sign a new one every year?

If the turbines ended up being on DPW land as they were proposed, how would you feel about being in charge of them or would you want someone else to be in charge of them?

Some of the turbine components can be very large, and come in sections that are considerably large. Do you think it would be an issue transporting the components from the center of town to the two sites?

One of the concerns that they have been having with moving forward with the feasibility study is they are afraid that a fatal flaw is not being able to transport the components to the island because they are too big and heavy.

Do you know the size of the digester?

APPENDIX C14: QUESTIONS FOR J. PALATINE

C14a. Prepared Questions, J. Palatine

Interview with Jim Palatine, Toscana Corporation, Nantucket, MA

November 17, 2008. 3- pm

What kind of work does Toscana Corporation do here on Nantucket?

The Nantucket Energy Committee is researching the feasibility of implementing land based wind turbines on Nantucket. Before they can continue with the feasibility study, they must determine that there are not any "fatal flaws," and the ability to transport the turbines to the sites is a major concern. The Energy Committee is considering 4-6 1.5MW turbines at the landfill, and 2-3 660kW turbines at the Surfside Waste Water Treatment Facility. The Energy Committee must determine if it will be possible to transport the wind turbine components to the Island and through the town to the desired locations.

What is the length of the largest object that you have transported on your barge?

What is the weight of the heaviest object that you have transported on your barge?

What is the length of the largest object that you have transported on trucks across the Island?

What is the weight of the heaviest object that you have transported on trucks across the island?

The largest component (rotor blade) of a 1.5MW turbine is **122.4** feet long, **7.5** feet wide, **8.6** feet tall and weighs **7** tons. Does your company have a barge able to transport this from the mainland? Trucks able to transport it through town?

The heaviest component (nacelle) of a 1.5MW turbine weights **69.5** tons, and has dimensions **25'l x 12.2'w x 12.8'h**. Does your company have a barge able to transport this from the mainland? Trucks able to transport it through town?

If no to either of the last questions,

The largest component of a 660kW turbine is **85.3** feet long, **5.9** feet wide, **8.5** feet tall and weighs **2.54** tons. Does your company have a barge able to transport this from the mainland? Trucks able to transport it through town?

The heaviest component of a 660kW turbine weights **29.8** tons, and has dimensions **20'l x 10'w x 11.7'h**. Does your company have a barge able to transport this from the mainland? Trucks able to transport it through town?

Was your company involved in transportation of components for the Waste Water Treatment Facility?

What are the maximum dimensions and weights that your barges can transport?

What are the maximum dimensions and weights that your trucks can transport?

What is the maximum height at which your crane can operate?

Are you familiar with the location of the Landfill and Waste Water Treatment sites?

- Do you have concerns with transporting heavy and/or long objects to these locations?

Do you mind if we contact you in the future with further questions?

May we use your name in our report?

C14b. Actual Questions, J. Palatine

What kind of work does Toscana Corporation do here on Nantucket?

Do you do trucking at all?

Based on your knowledge of construction, do you have any problems with either of those sites [landfill or Waste Water Treatment Facility]?

What is the length of the largest object you have transported on the barge?

How heavy would be the heaviest you've ever carried?

What's the heaviest you can carry [on land]?

How long of an object can you transport [on your trucks]?

But your trucks aren't like that [extended bed]?

Do you know anyone on the island who does [have a telescoping truck]?

How much weight can they [helicopters] carry?

With the 85 ft long piece for the smaller turbine, do you think that would also be a problem getting through town or do you think that's doable?

Did you say that you think the barge would be able to get the 122ft piece across [the Sound to Nantucket]?

So he thinks that 85ft is doable for [being transported through] the town?

The heaviest component we have is almost 70 tons and that is not a problem on the barge? It's only 25'x13'x13'.

So I think we've hit most of the big things, the last question is do you have a crane?

Was your company involved in the transportation components for the Waste Water Treatment Facility?

Do you know how large or heavy those components were?

Do you know if there are any not real strong roads or anything like that?

No. I don't think so. I mean of course you have the Madaket Bridge over Long Pond Creek down
One more thing, where do your barges typically unload? Do you go in through Steamboat Wharf?

When they construct the foundation and everything for the turbine, would [Toscana] be able to do such a large project like that?

APPENDIX C15: QUESTIONS FOR C. COLLIER

C15a. Prepared Questions, C. Collier

Interview with Cormac Collier, Nantucket Land Council, Nantucket, MA

November 19, 2008. 10-10:30 am

How long have you lived on the island?

How long have you worked for the Nantucket Land Council?

- (If not answered)- how long have you been in the position of executive director?

What does your work here entail?

The Nantucket Energy Study Committee is looking at the Landfill and Surfside Waste Water Treatment Facility areas as sites to do preliminary feasibility studies for wind power.

What would the process be for acquiring town land for use in a project such as this?

We were told that you are very knowledgeable on sand plain grasslands; can you tell us a little of what you know?

- Where they are specifically located? (any documents showing this?)
- Restrictions concerning them?

If a construction project were to be undertaken near such areas, what kind of limitations would these grasslands put on it?

-Are there any ways to get around these problems?

Do you foresee any fatal flaws in a wind turbine project at either the Landfill or Surfside Waste Water Treatment Plant?

C15b. Actual Questions, C. Collier

How long have you lived on Nantucket?

How long have you been working for the Nantucket Land Council?

How long have you been in the Executive Director position?

What does your work here entail?

The Energy Committee is looking at two sites right now for their feasibility studies, the landfill and the Surfside Waste Water Treatment Facility. What would be the process for acquiring town land for use in a project such as this? Do you do anything with that or just the conservation type land?

So there's no town owned land that is conservation land that you know of?

Do you know if there is conservation land in close proximity to the landfill or Waste Water Treatment Facility?

If the construction was contained to the area [in the sewer beds], it wouldn't affect the conservation land around it?

Does Mass Heritage do the actual study or do you have to contact someone else?

We were told that you are very knowledgeable about sand plain grasslands and that there is sand plain grassland in those locations.

Do you know if there are any restrictions as far as how close you can have constructions to [sand plain grassland]?

[The turbines at the Waste Water Treatment Facility would be placed] in the sewer beds.

As far as construction, as long as they [construction vehicles] stay on the roads and away from the little side roads it should be all right?

Do you see any fatal flaws with a wind turbine project in either of these areas [Landfill or Waste Water Treatment Facility]?

That's all our questions. Do you have anything else that came to mind that you'd like to tell us about?

APPENDIX C16: QUESTIONS FOR E. RAY

C16a. Prepared Questions, E. Ray

Interview with Edie Ray, Shorebird Biologist, Nantucket, MA

November 18, 2008. 1- pm

Can you tell us a little about your background, as well as the work you do on Nantucket?

How long have you been studying birds?

How long have you been living on Nantucket?

Can you tell us what your opinion and concerns are with land based wind turbines on the island?

Someone has mentioned concern about the effect of land based turbines on marine life, do you know if this is an issue?

The two possible sites that the Nantucket Energy Committee has identified are the Landfill and Waste Water Treatment Facility.

What birds in particular nest/forage/migrate through the Landfill site/the Waste Water Treatment facility?

Are you concerned about any of these species?

Do any of the sites bring up any red flags?

Any structure over 200 feet must be lighted. Do you know anything about the effect of lighted towers on birds? We've been told that red lights are better for reasons unrelated to birds; would red lights be harmful to birds? Do you have any suggestion on how to minimize the effects on birds? Such as color of the light or tower, etc.

Do you know if there is any record of bird deaths at the various towers, such as the communications tower at the land fill?

Do you have any documented information on specific flight patterns of different migratory birds?

Concerns have been mentioned about fog and birds, can you tell us about this?

Are there any other concerns or issues that you think the Energy Committee would need to investigate?

C16b. Actual Questions, E. Ray

Can you tell us a little bit about your background on Nantucket, as well as the work that you do here?

How long have you been studying birds? Maybe moving from just watching to be more involved in their habits and things like that.

Do you think you can tell us anything about what your opinions and concerns are with land based turbines on the island?

Someone mentioned a concern about land based turbines on marine life, from vibrations and stuff, do you know if this would be an issue?

One of the other concerns was with a certain turtle on the island that is sensitive to vibrations.

The two possible sites, as you know, are the landfill and Waste Water Treatment Facility. Are there any birds in particular that nest, forage or migrate through either of the sites that would be of particular concern?

What other red flags do you see with this project?

Any structure over 200ft has to be lighted per FAA. Do you know anything about lights attracting birds or anything like that?

Is there a particular color [light] that they [birds] are attracted to?

Do you know if there's any record of bird deaths or anything at any of the various towers on the island that already exists?

Do you have any documented information or do you know if it's possible to gain anything on specific flight patterns of the various birds?

Can you tell us a little bit about birds and fog?

Are there any other concerns or issues that you think the Energy Committee would need to investigate or think about in their travels?

APPENDIX C17: ACTUAL QUESTIONS, A. STERN

The following questions were asked during a tour of Hull Wind 1. The team did not prepare formal questions for this interview.

At what speed does this machine [Hull Wind 1] shut off?

Does the breaking cause any damage to it [the turbine]? I have heard concerns about the lubrication not working so well when it is started up again.

On Nantucket they are very concerned about salt spray. They had turbines in the ‘80’s and they were damaged by this. Are there any problems with [salt spray]?

There is concern about the effects that the vibrations have on marine life by turbines being close to the water. Do you know if there were any studies done here [in Hull], or if that wasn’t a concern here?

When the turbine shuts down for whatever reason, about how long does it take before it’s back up and running?

Do you know if they have had much for problems when they’ve had to manually stop [the turbine] for whatever reason?

Vestas does the twice a year maintenance on it?

Vestas provides this [maintenance] for whatever fee?

APPENDIX C18: E-MAIL QUESTIONS FOR A. PETERSON

E-mail correspondence with Al Peterson, Manager, Nantucket Memorial Airport, Nantucket, MA

Do you know the height of the existing tower at the landfill site?

Are there height restrictions that come with different proximities to the airport? Can you explain any or tell us where we can find documents or information on these?

Two sites have been chosen as proposed sites for the project. One is at the landfill site which is more than 5 miles from the airport (turbines of about 260ft.). The second is at the Surfside Waste Water Treatment Plant which is within 2 miles of the airport (turbines of less than 200ft.). Would either of the two proposed sites be of any concern?

Do you foresee any problems the Committee may have in getting approval for such a project?

Follow-up Questions:

Do you know the heights of the various communications towers on the Island? If not, do you know who or what organization may have these records?

What is the height of the fence surrounding the airport?

Could you give us information about landing and takeoff paths over Nantucket? If not, do you know who may be able to provide us with this information? Or is it confidential?

We are aware of the law requiring any structure over 200 feet to be lighted. Do you know if airports/pilots/FAA require or prefer steady or blinking lights?

The lights on the turbines in Hull, MA (very near Logan International Airport) are white during the day and red at night. Is the color of the lights very important for aircraft? Do you see any disadvantages of having a red light during both the day and night?

May we use your name in our report or would you like your answers to remain anonymous?

APPENDIX C19: E-MAIL QUESTIONS FOR K. BEATTIE

The Nantucket Energy Study Committee is doing a feasibility study for possibly implementing wind turbines. We are doing research considering possible sites at the Landfill and the Waste Water treatment facility.

Do you know of any flora, fauna, or avian life that relies on any of these areas for nesting, hunting, etc? Do any of these areas have any "fatal flaws" making them very dangerous for plant, animal, or bird life?

Do you have any information about nesting birds on Nantucket? In particular we are interested in the number of nesting Harrier pairs, and any other endangered birds on Nantucket.

- Do you have any documents showing where these nesting pairs are located?

Could you provide us with copies of any documents showing the flight patterns of birds over the Island of Nantucket?

Any additional documents of information that you think may be helpful to us would be greatly appreciated.

APPENDIX C20: E-MAIL QUESTIONS FOR S. OKTAY

One proposed site for turbines is in the sewer fields at the Surfside Waste Water Treatment Plant, and the other is at the Landfill.

Do you know if leakage of things such as lubricants and oil from turbines would be a concern if they went into the sewer beds? Or any other ramifications leakage at the two proposed sites may have on ground water, or other water sources?

APPENDIX D: INTERVIEW TRANSCRIPTIONS

APPENDIX D1: INTERVIEW TRANSCRIPTION, J. FITCH

Interview with Jonathan Fitch, Operations Manager of the Princeton Municipal Light Department

October 17, 2008. 10-10:45 am

Can you tell us about your history with energy and wind power?

My background is electrical engineering. I graduated from Northeastern for my undergraduate [degree], and I have an MBA from WPI. My whole life, and my whole career actually I've been working in some kind of electrical engineering, energy-type field, mainly in the private industry, and then the last 10 years has been here at the municipal utility company which is a public utility, so owned by all the rate payers in town.

Princeton itself has been around since 1911, so about a hundred years of being in operation as a small electrical utility company for the ratepayers of Princeton. And we only serve Princeton's geographical location. 01541 zip code is my service territory. It's a local government monopoly and we operate as a not-for-profit electric utility. I report to a board elected by the residents of Princeton and they basically hire and fire me, set rates, set policy, and then I implement it and pretty much run the utility company. That is basically how Princeton works.

For background there are about 41 municipal light plants in Massachusetts of the 350 or so communities across the state. There's not a lot of muni's, but from what there are of us, we think that we do a better job than investor utility companies (IOU's). We usually compare ourselves to National Grid, Unitel, Boston Edison. And they're much bigger than most muni's but we tend to have much lower rates because of our non-profit status, and we report directly to the rate payers, not shareholders.

That's the history of PMLD. PMLD needs to supply the energy for the town and we buy energy through energy markets and contracts. We have been doing this since 1911. The electricity we purchase gets re-sold and distributed to our customers. Back in 1980, Princeton's residents and the board that the manager at that time reported to, were given an opportunity to buy energy through Seabrook Nuclear Power Plant. The residents actually said "no, we don't want a nuclear component to our energy portfolio; we must do something else." The resident/ratepayers said to the board, "Take that money and invest it in something else." So in 1984, they invested about $550,000 in a wind farm, and since 1984 we've had 8 turbines operating, as a small-scale wind farm. And that was all because the community said we don't want a nuclear component to our energy portfolio.

And at that time, wind power was expensive. To operate a wind turbine like that, it was more costly, it was actually more expensive than market energy at the time. It was a 1^{st} generation wind technology, so it hadn't been around all that long. People really didn't know what it did, how noisy it was, how fast the blades turned back then. It just wasn't a proven technology. In 1998, 1999 I was hired, and I quickly surveyed the wind farm and said, "alright, it's at the end of its useful life, its almost 20 years old [at that point in time] and we got to do something about it."

I could get the old units running, but it costs money, and so back in 1999 I told the board that we should think about what we are going to do with the site, and in between 1999 and about 2003, we came up with a plan to replace them, and do something new with the latest, greatest wind technology. Today's technology is much more viable, much more cost-effective. So we scheduled a town vote to decide the fate of the wind farm and PMLD went through the entire public process for that vote. PMLD also did started the permitting process and quickly found out that we had some legal challenges. We're finally under construction today. We should have our turbines operational by next spring or early summer depending on the delivery date, because the demand for these turbines today is extremely high worldwide. So if you make an order for any turbine at any size turbine that's popular today, you're going to wait 2 years.

There is a "grey market" where you can find a developer who has turbines and is held up in court and needs to sell a couple turbines on the side because he can't install them yet. Generally speaking if you have a big site and you're going to import turbines, it's a good year or so to wait for the turbines to even get delivered to you. So that's kind of a history to it.

(explains the Princeton documents he gave us)

(suggests we do survey on Nantucket like they did) If you don't get the community support for one of them in their backyard, you might as well pack up and leave. My own 2 cents is that if you need to show the community hard benefits as well, not just the fact that you got a wind turbine in your backyard. The community should try to figure out a way to get some direct benefit from the energy (i.e. Low rates, free energy, etc)

Is yours electric distribution system [Nantucket] going to be owned by the town? {We tell him that that is one of the questions we have to investigate…} They'd have to buy the electrical distribution system out, and that's a big endeavor. Luckily for Nantucket it's an island in itself. There's only one point of connection, it's probably a submarine cable, and everything on the island is what's there is there. So the town would have to pay the IOU today's value of whatever is there, that's a big endeavor. Nantucket seems probably like a pretty wealthy town, maybe they could buy it, but they'd be paying top-dollar for that asset.

There is new legislation that just passed that allows communities to do this a little bit easier than it used to be. Lexington started it, so look at some of the MA general laws related to Lexington and municipalization of utility plants. Nantucket can do that, or Nantucket as a community itself could put the turbines up and not even own the distribution system. National Grid **has** to connect it, there's nothing to prevent them, or let them say no to Nantucket. So Nantucket as a town can buy the turbines, and then not have the investment in a utility system, or fight that battle later on.

Community support is hard to achieve. Giving the community direct benefits is key to getting support. Because you can't tell someone "Hey I'm going to put a turbine in your backyard and I'm going to do great things for the world" that's one thing, but if you say "I'm going to drop your rates 10% or I'm going to provide all of the electricity for all of the street lights in town and your ball fields", those things people really put their arms around.

And us here, in Princeton we own the utility company, we are the utility company, so for us to say we are going to put turbines up, the people know they are getting a direct benefit, their rates are directly impacted. In our location, it was easy to sell that to the community, so that's why you see really good numbers on our customer surveys.

What I try and show everybody is that it it's a very long, public process to get to this point. We've heard people yell at us, scream at us, praise us, and then finally we got a vote that said yes, do it.

When did you begin the community involvement when you started thinking about new turbines - was it pretty much you want new turbines and then immediately the next day [to started community outreach]?

December 18th, 1999- 1st public meeting to discuss the future of the site. It was a Saturday morning, we said to the community ratepayers come to the meeting, we are going to discuss what to do with the old site. We went through all of these meetings, which led to a Feb. 11th, 2003 special town vote- we actually put a ballot out there to the community and asked the people vote. 74% of the voters approved of the project so we said, "Well, let's do it… I'm going to find the money and we will put it up."

So the biggest benefits it seems like are the decrease of rates from the average price that would have been paid if not municipal. Were there other big things?

I would also go as far to say "rate stabilization", because rates for us tend to fluctuate depending on our contracts and the market. With wind power, the fuel is zero. Most power plans today in MA demand natural gas, but natural gas prices fluctuate tremendously. Our wind turbines will help stabilize our rates due to natural gas fuel price fluctuations.

So when you look at the financials of our project, I don't know if you're going to get to financials, but… (gives us financial breakdown sheet, and explains it)… If I can get column K lower than A, I know I have a very viable project. And the savings are in column L, and so if I have many more positive values than it's a good investment. I could sell the renewable credits (REC's) which are attributed to a project like this, it's another revenue stream separate from electricity. PMLD signed a very good REC deal for 5 years…

If I can beat the cost of market energy and generate myself at a cheaper cost, or even the same cost, it's a good project. So right now I've actually told the community that it's going to be at or near what they pay otherwise, so almost a net-zero with today's rates. But long term it's going to be a fixed, stabilized cost of electricity.

What disadvantages do residents think come with this project?

The biggest thing is risk, the financial risk of committing this much money, $7 million, to a project that may fail. Because the first set of turbines we bought in 84' didn't operate as planned. They certainly did not generate as much energy as they were told back then. And I agree, it wasn't a very good investment. They knew going into it, it wasn't going to be a positive investment to begin with, but certainly the turbines didn't generate 10% of the energy as predicted and only produced about 2%. The costs therefore were higher, but they were already going to be higher, they knew that. The project wasn't just for savings, they didn't want nuclear power. But that was left in everyone's minds now, "PMLD didn't make money on the first site of turbines", so that was a hard one to get over.

The other disadvantage was related to aesthetics. Every other issue was used to throw up roadblocks to the project because some people just didn't want to come out and say "I don't like the look of it", which is a valid stance, you don't have to like the look of it, but opponents would throw out; noise, bird kill, epilepsy from the flicker, shadow flicker itself, etc. There were all kinds of things thrown out there by concerned customers. But I really think it boiled down to aesthetics as one of the biggest concerns or disadvantages. In summary the aesthetics and the financial risks of doing it ourselves were key concerns.

It looks like here you have the costs for once a turbine is operational. Do you have any information about what the costs were for like buying the turbines, construction, and all of that?

(Gives us another form)

Was there a lot of opposition to the project or was it mostly just some citizens saying they have some concerns about this, spitting out the ideas that you were talking about before.

Very small number. I think the number of local residents that were willing to stand up and say their piece in public and be very active against it was maybe 5. But certainly there are more people against it than that- a lot of folks didn't take an active role in going against it. As noted by our [survey], we had a 74% approval rate from the town vote, so that means 26% of the people didn't approve. Of them only a very small handful of them actually fought the project.

How did you deal with those people who were fighting the project?

The biggest thing is to answer the questions. And no matter what question they came up with, you have got to answer honestly and sincerely. No matter how trivial or how crazy it may be, you have to always provide an honest answer- address the question head on. Noise, bird kill, all of the other things like safety, ice throw, those things tend to grab headlines. So we have to face them, and have experts to back us up. Because me just saying that there's not going to be any bird kill, isn't valid. I can say that in 24 years of operating the existing wind farm we haven't had any bird kill that we've seen, but who's going to believe me? Nobody. But when I hire *Dr. Paul Kerlinger* who wrote various books on *How Hawks Migrate*, works for the Audubon in Cape May, New Jersey, and has written almost all of the most referenced literature on migrating raptors people listened. When I hired him to come here and tell the community that there's not going to be an issue with eagles or hawks, or any other raptor that migrates through the area in October, people tend to listen. Except for the folks that don't want to hear that because he's my hired hand, and so you have to address that aspect- he has nothing gain from his statements and analysis in this other than the fact that he is an expert.

No project is perfect, you have to recognize this and know what the concerns are, what the problems are, and deal with them and address them, and try to mitigate them. One thing on the bird kill, since some people still had a concern, and the main a concern was during the October migration period for raptors, I agreed to turnoff the turbines under the right conditions in October where it might lead to more risk of bird kill.

One thing we have found is a lot of people complaining that they think that turbines will decrease property values in the area. Do you know anything about that in this area?

Not at all. There are many studies (says he will send us some that were done nationwide- *if we email him*)… Certainly Princeton is very high end, and even with our old turbines, I don't think there has ever been a concern with property values, and this is about as high end as it gets in terms of Nantucket. Not an issue.

Can you tell us about some of the different financing options that you were considering for this project? And what you decided on?

There's all types of options out there, even in today's economy. The total cost is $7.3 million. I could have either gone out as a town and borrowed through bonds as if we were building a school and back them up from PMLD's electric rates. We would take a town vote, but getting a bond vote in a small town is very difficult. As an example you see town votes for schools and fire trucks go every which way. Asking for bond funding for wind turbines is very risky because it takes 2/3 voter approval, but that is an option for Nantucket- they can go thru the town process of voting on borrowing money for a project like this and getting the money.

We decided to finance the project through a "wind cooperative" with MMWEC. MMWEC is a joint public action agency (Mass Municipal Wholesale Electric Company). PMLD buy all of our energy through MMWEC and they represent us in different areas of the energy business. They're a public agency that can borrow for us without the town vote. We decided to form a co-op, and borrow on our own without going through the town, and that was a much better process, because I didn't need to get another town vote for the project. Additionally PMLD's borrowing wouldn't impact the town's borrowing for other things like schools, fire trucks, etc. And that's the route we took.

Early on we were able to find private corporations that wanted to develop the wind farm with us as a joint project- they would finance it and own and operate it, we would get a share of the output and benefits, and both our names would be on the project. You could try to do something like that as well.

Unfortunately on smaller projects a lot of those bigger private companies won't do them because they want the most bang for their buck. Most private developers are looking for the wind sites with 10,20,30, or more turbines nowadays, so they might not want to do a small project . But it's still an option.

Nantucket can get money through MTC (Mass. Technology Collaborative). MTC has some funding available for projects like this in town's served by IOU's.

Were there any loans that you took out or any other forms of financing that helped on top of that?

Yes. PMLD received a grant from the USDA, as we are a rural community. PMLD received $470,000. It was a very [labored] long process to go through in order to get this grant. I think I spent $300,000 in environmental studies to get $470,000. So it was almost a waste of time and money to be honest with you. So keep that in mind when you look at grants- if you see a grant for $500,000, consider the cost of getting it- what are the criteria and demands the organization will ask of you in order to get the grant money . I didn't know half of this stuff until we got started, and then after awhile I was telling the grantee "Hey, keep your money, I don't need it" because I am spending too much to get it. You're allowing the permitting process to drag on, and drag on for years, in order to get to the point where they say "Alright we will give you the money".

You can get that type of money, the USDA still has grant programs available today, so Nantucket should look at that. They might have a tough time given they're not very rural, but they may not be considered a rural community.

(concerning MTC) They have pre-development money, so feasibility studies- they could probably get a feasibility study of their wind resource for free.

(discussing how Nantucket went through the UMass Amherst RERL)

So you said that the permitting process was dragged on because of the USDA grant. Do you think it would have been a lot faster if you hadn't gone for that grant, just like the basic permits for it?

If you go after federal funding, federal grants, you trigger a different set of permitting standards that you would otherwise not have to go through at the state level. So if you go through just your own financing, you only trigger state and local permitting, unless you're somehow impacting federal territory. This would trigger federal permitting guidelines. If you get federal funding, then you trigger some things that are unique, that for us led to the MA Historic Commission getting involved because we needed to go through that process for federal funds, and that was painful. For instance, we had already done all of our permitting on the site, since I was getting federal funds MA Historic said "Oh, now this triggers this set of Department of Interior standards and your wind farm can't impact historic sites." So we had to do an analysis of all the historic sites around us for miles, figure out which sites were directly impacted by the visual aspect of our turbine, and then it actually led to an archeological dig on the site, because they thought that it was a pre-contact site during the French-Indian war. If I knew that going into it, I probably wouldn't have asked for the grant.

Were there any laws or regulations (municipal or state) that you would want to change to get the turbines implemented or to make the process easier?

State wise, no, there's nothing. Locally, there are only bylaws, but variances can always be requested. There's are ways to deal with local zoning by-laws but it's a slow and painful process. You should go to Nantucket's planning board and get their zoning bylaws and find out if there is anything in there that regulates wind farms. I think that's the only thing you have to worry about, and then maybe FAA permitting, which is not really a big issue. FAA permitting is a very easy process (explains how we can even do it by putting the coordinates down on the FAA website and see what happens)- and you can get a determination pretty quickly, and they may need more information as well.

In the whole process of siting and talking to the town and all of that, when did you buy the turbines? How far into it did you actually decide we're going to go through with this?

We signed a turbine contract in October 2007 and put the down payment of $1.3 million on the turbines.

Was that pretty much after you got past all of the permits and the regulations?

It wasn't until the last second, after everything was said and done and I knew I had a buildable project, and I was able to find a bank that would finance it in the form a co-op to do it, so I didn't have to go through town financing. And once I had the money in hand, I was able to buy the turbines and get the construction started. Basically in October 2007 we had project with turbines ordered and construction underway.

So it's still about another year or two before you'll get the turbines?

No, about a half a year. Next summer.

Was it difficult to get the turbines delivered for construction?

It took half a year to get Fuhrlander , a German wind turbine supplier to commit to the order PMLD basically paid them 100% of the money for the turbines upfront, and they are taking forever to get the turbines delivered. PMLD had to have $4.5 million in the form of a deposit and letter of credit to hand over to Fuhrlander to get the order confirmed. You can't just sign a form saying I want to order turbines and I'll pay you when you install them, most turbine suppliers want 100% of the financing upfront. I had to hand them a down payment check of $1.3 million in October 2007 and give them a letter of credit from the bank saying that we promise to pay the rest of the funds over a fixed schedule. Financing is key to get the turbine ordered because you're going to need to put a good 25-30% upfront from your financing source, whether it's from your own cash or from the bank your doing a loan through.

After all that, delivery still takes two years. But, that's the industry, and with today's worldwide demand for turbines that's what happens, you got to deal with it, and that's because it's a seller's market- there's just such a demand for these things that they can almost dictate the terms and conditions.

Can you tell us a little bit about the process of choosing a turbine and the company that you were going to buy from?

What you want to do, and what we did, is find out who the top turbines are, who has the best turbines in the world? You can quickly figure out there are a few top-tier turbines- Vestas, GE… Those are generally thought of as the top 2. Then there is a second tier of suppliers like Fuhrlander, Mitsubishi, Gamesa, Clipper, VRRB, and a few others. You can quickly rank them and determine who you want to deal with? Some may tell you whether or not they are even going to want to talk to you in the first place, because some like GE won't talk to you if you're not building a hundred-turbine site. They will tell you right up front, no thanks. Vestas may do it, they have been supplying smaller turbine sites , but even Vestas might not supply a small site. Most of the turbine suppliers are very selective- they won't do sites if they don't think it will benefit them in the long run either. You'll learn as you go through the process that some turbine companies won't sell to your site, they are very selective about where there turbines are located and as a result you might be forced to go with some other turbine manufacturer . There are many great turbines out there- they have power production guarantees, warranties, and are very well-made- some don't have thousands of turbines installed but they have hundreds of turbines

So you chose based on who would sell to you and then of that group the best ones?

Who had the best delivery date and performance were the key factors for PMLD. We went to Fuhrlander actually visited them, and we liked dealing with a smaller company, because we felt like we would get better attention, so we chose Fuhrlander.

As far as getting turbine components to this site, have you had to change roads, newly paved roads (for example- need big turning radius for trucks)?

Yes and no. We're pretty confident with the delivery to Princeton and our access road to the site. It shouldn't be much of an issue. You do have to take into consideration how to get the components to your site. The turbine pieces are very heavy; the blades are very long, meaning they are going to have a turn radius that is very long and wide. We had a trucking firm do a survey of the route from most of the ports around us, mainly the port of Boston, there was really no other way of getting here. But once in town, the tight turns and stuff like that can be dealt with, but we're the local utility - any wires both telephone and power- I'm cutting down right in front of the truck, right then and there. Any dips in the road I have to deal with, I'll have the highway department right behind me with sand and fill and we will just fill in the lower areas and figure it out. We have that flexibility because of our utility company. Nantucket might have an issue given that it is an island, but this stuff is coming out of port. Hull did it, and Hull has very similar circumstances and almost the same address as Nantucket, so Nantucket shouldn't have an issue. The components might have to be barged out there, and a crane would have to be barged out there, but that's do-able. But you'd have to take that into consideration, you can tell the turbine manufacturer who is typically responsible for getting it to the site. Sometime they are not, but you can build it into the price and say "You get it to me". And then the crane guy is going to need to know where to go, you'll need a massive crane out there. Our access road had to be modified to accommodate the turn radius. (shows us map of alteration of access road)

Did you have any major setbacks in the process of just getting everything moving along? Was there anything that really just had you at a standstill?

Yes, the lawsuits in land court based upon our local construction permit. I was given a construction permit to build it right away. Our local permitting agency didn't have any problem with zoning bylaws or anything like that. The building permit was pretty simple to achieve, but once the permit was issued it was challenged

(talks about siting and distances and spacing)

In terms of setbacks [keeping people away from the turbines], were you concerned with hikers? Do you plan on maybe fencing off areas? Are there any restrictions with that aspect?

I try to answer that by saying- "Is there any setbacks or danger from the Prudential building falling down?" I don't think so, so I'll take that chance. How many buildings have fallen down? A lot more than turbines. In 24 years of operation we haven't had any issues with setbacks, hikers, fences, or other restrictions.

If it was to fall, they typically fall in conditions where not too many people would be around, and you're going to know what those conditions are and you're going to be there to warn people, rope it off, do something about it, shut the turbines down.

APPENDIX D2: INTERVIEW TRANSCRIPTION, J. BARTLETT

Interview with John Bartlett, Bartlett Farms, Nantucket, MA

November 3, 2008. 10-10:45 am

We hear that you are looking into installing a wind turbine on your property, or have you already installed it?

I am in the process of installing a wind turbine.

So you have gone through the laws and permitting and all that?

I have local approval from the historic district commission which is the HDC. I applied for and received a building permit. I applied for and received funding from the USDA. I have also applied for and received funding from the MTC.

Why did you choose to install a turbine on your property?

We had some wind turbines here on the farm in the mid to late 80s. They were Enertech, not sure of the exact model. There were a total of 8 of them. Initially they ranged in the kilowatts; anywhere from 5 to the last ones were 40s. That was a partnership that we had entered into with I think they were called the Nantucket Wind Power Company. The farm just leased the property to them so we didn't have any ownership or rights in the power that was generated. So we had some experience with wind turbines. Those were taken down in the early 90s. The company kind of disbanded, some of the tax credits went away, and they were based out of Norwich, VT so they didn't really have an on island presence for maintenance or anything like that. We had always thought about keeping those or trying to put something up again but it was a little too difficult to try and take over those machines from that company so we just decided to let the company disband the turbines and take the infrastructure away.

So I started thinking about trying to reinstitute some sort of clean power for the farm in late 2005. So I started doing searches for different manufacturers. I came across several different things and decided to use the modeling to determine the payback on different kilowatts. Also looked into trying to determine how some of the net metering worked because that ultimately depends on how quick the payback is, can you use all the power you are generating versus selling the power wholesale back to the grid which is much less beneficial from a profit standpoint. You can basically avoid almost all the costs with the power you generate and use versus any excess power which you then have to sell back to the grid at substantially less. In my case, my average is a little over 17 cents, I haven't checked since the rates have gone up again, and my resale price back to National Grid would have been 7 cents or less. So it would be at least 10 cents less for every kilowatt that I had in excess that I needed to sell back to National Grid.

The Green Communities Act was recently passed in either late July or early August, they are still trying to work out some of the technical issues so I'm not 100% sure how that's going to work. But basically under 60kW you used to be able to net meter and anything over 60kW they stopped it at month end and whatever excess you generated you got a check for that. I think they have increased that by up to a MW, maybe even 2 MW, I'm not really sure. They have 3 classes, a class I, II and III. There are some discrepancies but now what they are allowing some of the wind producers to do if you have other meters you can designate those meters for excess production. So if I was producing 10,000kW in a month and I only used 8,000 kW, I could take the extra 2,000kW and apply it to another meter so that rather than selling it back wholesale I could get the retail. Although you still have to contribute to the Renewable Energy Trust Fund and I'm not sure if there are other transmission charges, but it would still be more like 14 or 15 cents as opposed to the 7 cents [wholesale]. The payback will be a lot better now than it was even when I started but there are some questions as to whether or not you can take more than one meter. I have 15 meters on the farm so theoretically if I had one that only used 1,500 kW using my previous example I'd still have another 500 kW that I could apply to another meter. I don't know if they're going to let you go down your chain of meters or if you can just only do it with one. That's what they are trying to work out. There are a bunch of interested parties and they have some court cases that are taking place and ongoing as to determine how they are going to lay the groundwork. Municipalities are different, there are different light compacts. Everyone wants to have a benefit and have it benefit them. The payback will be a lot more beneficial to the producer as opposed to National Grid.

How much of your electricity do you think the turbines are going to provide for you?

The windmill is modeled to produce about 500,000kW. It's connected to the transformer on this building and that's how it has to work in the existing regulations. Plug it into the transformer and that transformer feeds your electrical source and then there's a meter. This building uses around 360,000kW and my total farm electrical use is around 700,000kW. It will definitely satisfy the electrical demand of this building and I'll have excess. It depends on how much of that excess that I can stick on other meters. I have one that uses about 180,000kW and another that uses around 90,000kW and I have a bunch of other smaller ones.

So more than half of your electricity will be provided from the turbine?

Yes. That went into the decision of how you size the turbine. The company I went with only offers 3 turbines. They have a 3kW, 80kW and 250kW. Do I put up two 80kW turbines or do I want a 250kW one? In the end I decided that it would be cheaper to put up one larger one and hope that I grow in my demand or the net metering laws change.

What manufacturer is this?

WES is the name of the manufacturer. It's Wind Energy Solutions.

Do you know if they sell just to individuals or would they sell to the town of Nantucket Energy Committee?

They wouldn't sell to a home owner. But they would definitely sell to the town of Nantucket Energy Committee.

I know you talked a little bit about the sizes [of the turbines] and how you selected them, but was there any process [you used to choose] when different manufacturers had similar ones?

I looked at some of the Vestas. I looked at Furhlander. Furhlander has one up on 93 at the electrical union right off of 93 on the way into Boston. My turbine is going to be similar, that's on a 30 meter tower and the one that I'm going to put up is on a 30 meter tower. It's a WES 250kW, a two bladed design.

So basically my selection process was to look at different manufacturers. There's not really a lot when you get right down to it. I looked at Bergie, and Bergie only has really small turbines, they have a 1kW, 1.5kW, 10kW, in the process of developing a 50kW one but they haven't worked all the kinks out yet and it's not commercially available. Furhlander had the 100kW and 250kW. The general contractor that I am using on this project does the maintenance on the Furhlander outside of Boston and he said they have a lot of maintenance problems with it, so that kind of eliminated my consideration of that machine. I don't want to have the maintenance type issues with it. I was thinking about getting the 250 from them [Furhlander] but they had production limits on it as far as they wanted to make 12 of them so unless I was going to take 12 of them they weren't going to put one into production for me. Because on the municipal side of the generation everyone is going to the larger turbines 1.5MW etc, everything is more on the bigger side. For the medium size market there are not really a lot of turbines out there. For people who are doing more onsite generation as opposed to wind farm or commercial build utility scale generation, there are not really a lot of choices. There's Vestas, Furhlander and WES.

WES seemed like they had a few of these machines out there so I'm hoping for the best as far as is it going to work, is it going to be reliable. They just started Dutch Company and they have a North American office just north of Buffalo and recently put one up on Port Huron near Canada on a farm out there. I took a trip out there to see the turbine and talk to the guy who owns it. He'd had it up for a year and hadn't had any problems with it.

Otherwise I was going to have to do a small wind farm of turbines and I wasn't really interested in that from the standpoint of the space it would take up and the additional infrastructure, the cost.

[Going back to] the laws and regulations that we talked about a little earlier - we found an extensive list of federal, state and local laws, particularly local ones. If you don't mind looking over the local ones, we are wondering if there are any local permits that you went through that we're missing or ones that were particularly difficult or time consuming [to obtain]. (hands Mr. Bartlett a list of laws)

With some of these I'm not a square peg in a square hole because of my agricultural distinction. I am technically exempt from some of these laws Chapter 3, Section 40A of the MA general laws. I did comply with all of the Nantucket bylaws. Agriculture has some exemptions from zoning, not really the building codes but some of the zoning issues. I did follow the setbacks, but I did not get a special permit. Technically with the WECS bylaw by right if you are less than 60ft residential or less than 80ft commercial, which I don't really, classify myself as a residential producer or really a commercial producer because commercial producer to me would be a utility scale production. I'm a commercial business but I'm not a commercial energy producer. I am producing energy for my own business but I'm not necessarily making money selling power which to me is the distinction between a residential and commercial enterprise.

So you kind of don't really fit into either? [residential or commercial, referring to Nantucket Bylaws]

Right. So because of my agricultural exemption, even though I am over 80ft I didn't have to apply for a special permit and go through the special permit process in the Nantucket code. I didn't have to have public hearings or other type of things because of my agricultural exemptions. Although I did follow as best that I could the setbacks, the noise specs are within what the manufacture says the machine is going to make so from that standpoint I'm different from say someone making a Nantucket Wind Power Company to sell power back into the local grid.

As part of the special permit process, they have to determine a community benefit to having it.

But you did go through Nantucket Historic District Commission?

That was the first thing that I did, which I thought was going to be the hardest thing was actually the easiest thing. I had HDC approval in May of 2007 for this project.

I did go through FAA review. I went through Mass Aeronautics Commission (MAC) review. I had to do a lot of things for my USDA application that I wouldn't necessarily have to do if I was just going to put it up as an agricultural producer, but needed to do in order to receive the funding. Since I applied for and accepted USDA fund that was an extensive application. I needed to send notification to U.S Fish and Wildlife. I had to do a bird study for them to identify any species that may be impacted or whatever by the turbine and their concurrence was that it would not. I also had to send notification to the local Indian Affairs Council which is the Wampanoag Tribe. I also had to send notification to the MA Historic Commission. I had to notify the Dept. of the Interior because of Nantucket's distinction as a national historic landmark, the whole island is a national historic landmark and as a result of this I had to perform an historic architecture study which included a balloon test. The float a balloon up to simulate the height of the turbine and go around and take pictures to determine an area of potential affect, and they look within that area of potential affect which the visual affect on the historic sites, structures and view sheds. They finally concurred that it was not going to have a negative impact. I also had to do an archeological assessment to make sure there were no Native American artifacts or remains on the turbine site, part of the USDA application.

I didn't do anything with the storm water notice of intent or plain water act. I eliminated some of these because weren't in a protected watershed or flood district. These were all things I had to identify for the USDA. I had to provide soil maps, flood maps, documentation that I wasn't in a protected area or wetlands. I didn't do anything with the Environmental Affairs office because I am not disturbing that much land. I didn't do anything with National Heritage. I did go through MHC.

I have applied for an interconnection permit from National Grid.

There's nothing else that I had to comply with that you haven't listed here except for the MAC.

I was purposely less than 200ft. I did look at one point at putting up a 40 meter tower, but the manufacturer only had a 30 meter tower and a 50 meter tower. I was concerned with the 50 meter tower because of the size of the structure itself and the additional difficulties in getting such a large piece of equipment through the center of town. A day after filing paperwork with MTC and FAA found out the manufactured does offer 40 meter tower but would have had to go back and change everything. The higher you go, the more wind and pay back information would be different. I applied to USDA twice, got denied the first time. I decided to go with the 30 meter tower. Some of the other reasons didn't want to have to light it and over 200 ft have to light it. Part of the reason they started making the 40 meter tower was because it just fits in under 200 ft FAA regulation and there are all kinds of studies looking do the lights attract birds.

You were talking about transporting the turbine components through the town. Do you think you will encounter any problems with the turbine you have selected?

The biggest section now is 10 meters, so it will all fit on the standard truck so it won't be a problem. For the 50 meter tower, it came in two 25 meter sections, so it would have been two 82ft and 9ft in diameter. People told me that it was possible to get that through town but again I didn't want to get it stuck and encounter unforeseen expense involved. I'm a business owner and don't have the resources that a municipality would have to do some of that stuff.

You mentioned bird studies. Did you hire someone to study the birds in the area?

I was fortunate in that there's a local guy here who works for the Maria Mitchell Association that I have known who comes to look at birds on the farm. So I approached him and he has extensive credentials, he's done stuff for National Geographic and he has a Ph. D. They [MMA] have done studies locally on everything, the only bird that was potentially a problem was the Piping Plover and since that's a shore bird it was determined that it was outside [not near the turbine].

Was it Bob Kennedy?

Yes.

You were talking about all the work with the Department of the Interior, was that a long process? Would that be something the Energy Committee would want to start now? [went through DOI to comply with regulations regarding Nantucket's designation as a National Historic Landmark]

It depends if they are going to take Federal funds. If they are not going to take Federal funds, then they would not need to.

Federal law always supersedes. They can come and such the turbine down at any time. Not very likely but could happen.

Other than the USDA process which the Energy Committee would not have to go through, was there anything else that was difficult or long to complete?

If they are going after Federal funding. MTC did not have a lot of specific requirements. The feasibility study is a lot different than getting a design and construction grant. The MTC grant was really easy as far as requirements. It would behoove the Energy Committee to do a lot of these things anyways because in the end people will use them to try to stop the project, as far as birds or conservation issues; they are going to have to address all those anyways.

Did you come across any opposition to you putting a turbine on your land?

Not really. There were a couple of neighbors that were concerned and not that happy with it. But I'd say 98-99% of the comments were positive but again as you said this is on my property. People might not really like it but it's on my property. We are fairly remote as far as location and at 200 acres we are a large landowner.

I tried to site it as far away as I could from residential development and still make the project so it would work economically for me. I'm not trying to make a statement for green power so much as I'm trying to do something that will benefit me personally and be green. It's nice to be green, but I'm doing it for the economic reasons as well.

Do you mind if we contact you in the future if we have any more questions?

No. I would rather you email me.

We will send you a transcript of the quotes we plan to use. If you'd like we can send you a copy of the transcription of this as well, so you can make sure nothing got interpreted wrongly. Also would you like us to send you a copy of the final report?

Sure.

Is electronic, email, ok?

Yes that's fine.

That will be middle of December when we are finishing our final report.

They are going to start shipping pieces hopefully this week. We are hoping to get the foundation in the ground before Thanksgiving. I don't think I'll have it operational by the end of the year at this point but early sometime in January.

Once its operational people can decide what they think for themselves. It's kind of like one of those things, some people don't like airplane noise, some don't like motorcycles. So it doesn't really matter how loud it is, it's a subjective thing. There will be a seasonal component. You do have the ability to shut them down. Most of the wind noise issues are on the lower end when the wind isn't blowing as loud. The ambient noise and background noise of the wind when it's blowing drowns out the noise of the blades and generator itself.

[He can email us a site plan, some electronic information on the turbine itself.] I'll send you a few things and if you have other things that you want, let me know and I'll see if I have it.

After the recorder was turned off, Mr. Bartlett suggested that we contact Andrew Vorce of the Nantucket Planning and Economic Development Commission

APPENDIX D3: INTERVIEW TRANSCRIPTION, E. STEINAUER

Interview with Ernie Steinauer, Massachusetts Audubon Society, Nantucket, MA

November 3, 2008, 7-7:30PM

How long have you been living on Nantucket?

About 10 ½ years

And you've been with the Audubon Society the whole time?

Yes.

Did you work with the Audubon Society before you got here?

No, I was a graduate student at the University of Oklahoma. I was actually a visiting professor.

What kind of work did you do there?

Plant Ecology. I'm actually a Plant Ecologist not an ornithologist or avian specialist, but working with MA Audubon I do work a lot with birds and I work with birds with some of the other people on the island.

We found out that the entire island is a Priority Habitat of Rare Species. Do you know what this means?

Yes. It's not quite the entire island but its most of the island.

Do you have any idea what it means [with regard to] new construction projects?

What it means from my understanding is new construction in that habitat which is most of the island and it's a state ranking that comes out of MA Heritage. A new project that goes into that habitat it has to file with I don't know if it's MEPA or directly to Heritage and they have to sign off on the project.

Do you have any prior knowledge of wind turbines or have you heard anything about the Energy Committee's [proposed project with wind turbines]?

I did a site review for the Energy Committee probably wasn't quite a year ago but close to a year ago. They gave me a list of 13 sites to go survey and make any kind of recommendations I might have from a rare species perspective and rare habitats.

You don't have to answer this, but if you don't mind saying, what are your views on turbines on the island?

I think alternative energy is a really good idea. I would certainly withhold judgment on any particular project or site. I know there was an article in front of town meeting last time requiring the town to put solar panels on all of their buildings and I think that's a crazy idea because some buildings in town are in the shade. I guess my first thought would be to pick whatever they can to save the most energy, use the least kilowatts for our dollar and do that first. They could probably turn off light bulbs and there's probably a ton of money in very simple things that they are not doing before they spend a ton of money on these higher tech solutions. Later they are going to get to those [high tech solutions] too but in the mean time they could be turning off a lot of light bulbs.

I mean I've cut my energy by probably 30-40% and I already thought that I was doing everything possible and I wasn't. It's not that hard.

Do you have any concerns about the effects [on plants, animals, and birds] of a possible construction project of wind turbines [on Nantucket]?

Yes certainly. Well from a plant perspective some of the sites they had to go look at a bunch of town owned property that the town owns. Several of those parcels are in really high priority habitat as far as the plant communities that were there. The government doesn't rank plant communities but the Nature Conservancy does. We have Sandplain Grasslands and Coastal Heathlands that are ranked by the Nature Conservancy as globally endangered and globally threatened so that's an extremely high ranking. We have a very rare plant community. Our Scrub Oak Barons - even though we've got a lot of them - countrywide or New England wide are pretty uncommon and are very important for hosting a lot of rare species. So some of the sites in my mind should just be totally off limits just based on the plant communities and those communities tend to have state listed rare plant species. There are state ranking and federal ranking. All of our state ranked plants are not federally ranked they're common somewhere else. Nantucket is a strange place because of the climates. We have a lot of plants here that are at the very edge of the range especially from the south or they're disjunct and may not be found in any kind of abundance until you get down to New Jersey or something like that. We are in the same climate zone as Washington, D.C. as far as gardening and stuff. So we have a lot of weird stuff for Massachusetts here. There are a lot of those plants that they would not want to impact. All turbine sites should be thoroughly surveyed for rare plants. Steps should be taken to minimize impacts to rare plants and unavoidable impacts should be mitigated.

Another concern I'd have as a big picture item would be land management. Especially the grass and heathlands need to be fairly regularly and intensely managed with say brush cutting or prescribed fire or things like that. I don't know the answer to this but could be do a prescribed fire around one of the turbines, you probably could if you were careful but that'd be a question.

So we've got a lot of rare plants but we've also got quite a few rare birds. Now most of them are coastal and we do have some federally ranked birds Piping Plovers and Least Terns. But we also have Roseate Terns which are federally endangered and they migrate through here. They don't nest here but they migrate through. Those things are mostly on the coast but I know one of their sites that I looked at was just behind the town sewer beds at Surfside. I don't think that particular beach is the right kind of beach for those birds. But those are the real priority birds. We also have two birds that would be problems down at the Surfside area Northern Harriers, a type of hawk, and Short-eared Owls. Nantucket is really that last stronghold in the Northeast for Northern Harriers, at least locally they are very important. Short-eared Owls are getting very uncommon so they would be very important. As far as rare birds those are probably the biggies. We may get other migrants, lot of peregrines and things that don't necessary live here but are here during migration. You should talk to Bob or Vern Locks, they would know more about the migratory issues.

Another bird that I would be concerned about would be Ospreys because they nest on poles, and are just big birds. The other big concern about birds out here is fog. In the daylight from what I understand they're pretty good at missing objects but at night lighting is really important. You'd want to get the best information about lighting because at night those lights really mess with birds. During migration, birds fly at night often so that's a concern. Fog is a problem. We have big storms. All those things are problems with birds and they just want to make sure with their siting that they take some of that stuff into account. It'd be interesting to see what people say, but I'd think the dump would really be the place the landfill because there's so much building around there, I'm not really that concerned with seagulls and Canada geese but people definitely are. The other thing we have, I don't know how tall they're talking but we do get lots of sea ducks here in the winter. We are a major sea duck wintering grounds, they're typically lower and tend to hang out in the water, and don't cross land a lot although I know we do get some in the ponds. Surfside plant is really pretty close to Miacomet Pond so that again could be a concern. The Long-tailed Ducks, we have a tenth of the world's Long-tailed Ducks here and if you get a chance they migrate back and forth, hundreds of thousands of these birds fly over every day. They spend their nights in the sound and in the days they fly out to the shoals in the south and west of the island. The times I've seen them most is late afternoon, so that's pretty cool. The whole bird issue in general is just really important that they keep the general bird mortality in mind. One of the issues with these things is it's so easy to find the bird mortality by a wind turbine. MA Audubon went through a huge discussion about this concerning Cape Wind and we did a lot of work with Cape Wind looking at birds in the sound. The question that kept coming up is you don't know how many birds a coal fired power plant kills, you'll never know because they're spread over hundreds of thousands of miles potentially. You'll just never know, it's kind of unfair to wind turbines because you'll see them right there. I would guess that cats still remain a much bigger problems to birds on this island than a couple of wind turbines ever will, and cars and communications towers which are not designed with birds in mind at all.

Do you know anyone on the island who studies bats and knows a lot about them?

No. Probably Bob [Kennedy] or Vernon [Laux] might know the most. There's a guy, he's not on Nantucket but is one of our Audubon people up at Wellfleet his name is Mark Faherty, and he's been looking at bats up there because they were going to put a turbine on the sanctuary up there. I can give you his phone number if you want it (774-288-9465). He's been doing some work with bats, he's got some kind of a high frequency recorder that he puts out and he can record calls, so he can sense his bats by call, listening to them fly by and it's directional so he can sort of take a space and see how many bats fly through that space. So he probably knows more about the bats in the general region. He came out here to trap last spring and he didn't really find much but it was terrible weather so I don't know how many bats we have. You might talk to Darcy. She at least has an interest in bats and was around with Mark.

They found that bats have not got the ability to miss the turbines nearly as well birds, especially these big turbines. The birds can see the big blades but bats with their echolocation are not as effective at picking up something like that, I don't know if it's a range issue or what it is but they're not as effective and from what I understand and they seem to be finding that bat mortality is a bigger problem relative to the number of bats around than bird mortality relative to the number of birds around.

I don't know who out here knows a much about bats. There was somebody over at the Conservation Foundation, I can't remember if it was Danielle or Kelly but Darcy would know.

One more question, someone had mentioned concern about land based turbines on marine life, do you know anyone who studies marine life in the area who might know something about this?

Wow that's an interesting question. The only person that comes to mind is Edie Ray. I don't know who she's working for this winter. In the summer she's works for the Conservation Foundation. Bob Kennedy I'm sure would know how to get a hold of Edie. She's really a bird specialist but she's big in the Marine Mammal Stranding Team, she probably would have a lot of info on birds in general. She's one of the big birders out here. Deb Miller, lives on Hummock Pond Rd., I think; she heads up the Stranding Team and they are very concerned about marine mammals so if anybody would know they would know.

The last thing is, do you mind if we contact you in the future if we have any more questions?

No, not at all.

Is email the best form of contact?

Yes. I check that every day.

We'll send you a copy of the transcription in a few days when we have that, and will mark off the things you don't want us to quote you on and you can let us know if anything changes with what you don't want us to quote you with.

APPENDIX D4: INTERVIEW TRANSCRIPTION, R. KENNEDY

Interview with Dr. Robert Kennedy, Maria Mitchell Association, Nantucket, MA

November 4, 2008, 1:30PM-2:10PM

Can you tell us a little bit about your educational background and any experience you have with birds?

I've got a BA and MA from the College of William and Mary in biology. I did my Master's Degree on the Ospreys of the Chesapeake Bay. I have a Ph.D. from Louisiana State University and did my Ph.D. dissertation on the birds of the Atchafalaya River Basin. I've been studying birds since 1968, 40 years. I've published probably over a hundred articles on birds, several books on birds. My greatest specialty in the field of ornithology is on Philippine birds which I studied for about 8 years.

How long have you been working on Nantucket?

7 ½ years.

Can you tell us a little bit about your work with the MMA?

I am the Director of Natural Sciences. I oversee the aquarium, natural science museum, natural history programming for adults and children. I oversee all of the research activities dealing with natural science with Nantucket including the Nantucket Biodiversity Initiative which I am chair of and that is a consortium of Nantucket conservation groups.

Do you know anything about wind turbines or the Nantucket Energy Study Committee's ideas for possibly using wind turbines on the island?

Actually I don't.

(Explain a little bit about the project)

We were wondering if you think that doing a construction project and having turbine in those two locations (Waste Water Treatment plant and Landfill) would have a negative effect on the birds of Nantucket?

(Explain the size and number of the potential turbines and construction)

Do you have any information about the birds that are in those areas (Waste Water and Landfill sites)? Also we know there are migrations and we weren't sure if they were mostly daily migrations or annual migrations that just happened one time during the year?

Well at the sewer beds, I'm not sure what their status is I'd have to look up what their status is, but Short-eared Owls and Northern Harriers, which are special concern in the state of Massachusetts, use those areas extensively. I've actually got data on those species using the sewer beds. So you have Short-eared Owls and Northern Harriers using that facility for foraging and very close by nesting. Not the Short-eared Owl but the Northern Harrier. You also have Least Terns who are very close to and will be flying back and forth along the shoreline, Least Terns and possibly even Piping Plovers because that is basically right on the beach there. You could have migratory shore birds feeding within the sewer beds. This hasn't been studied here on Nantucket but in many places of the world shorebirds are attracted to the sewer beds. So there are species of special concern that they would have to deal with. Both of those species could possibly be affected by wind turbines. I'm not saying that they would be but should be looked into.

At the dump, the dump is also a magnet for birds. There are lots of gulls, with as many gulls that occur around there, there is potential for bird strikes, especially under foggy conditions. It's also a place where if we get Bald Eagles on the island, they can show up there, so they are another species of special concern. Adjacent to the dump there are nesting Ospreys. Least Terns do utilize Long Pond for foraging. You've got migratory water fowl concentrated in Long Pond. There are even some sites with low wetlands that have also attracted some pretty important migratory birds. So both sites are pretty much magnets for shorebirds.

We know that any structure over 200ft has to be lighted and we have some information that the lighting can affect birds especially in foggy conditions. Do you know anything about birds and if they are attracted to lighted objects or special conditions where they would be?

There's probably extensive literature on that because skyscrapers are sites where large numbers of birds collide during migration. Radio towers that have guy wires that extend to the sides of them, there have been millions of birds killed. Look up the McCormick center in Chicago, you can Google that "Bird strikes, McCormick Center" and see if there's anything as far as birds attracted to lights. McCormick Center picked up a thousand dead birds a day.

We'll look into this more, but do you know if birds are attracted to certain colors?

I've never really studied or looked into it. I've collected birds from underneath these structures.

We also know that when they were looking into the Nantucket Sound wind turbines, there were a lot of concerns with potential bird deaths in those areas. Do you think it would be a similar effect with a land based turbine because in the open ocean it would be potentially worse or better?

The species that we have on island is of concern for me with the offshore wind turbines is the Long-tailed Duck. Within the waters of Nantucket and Nantucket Sound, this area has a concentration of maybe close to a million birds which would represent kind of guestimating about 10% of the world population. When they move from place to place in the afternoon they often fly at heights of about 200-300 feet. When they do that they could be flying at those heights over land too. Generally they go south of the island and in the afternoon they fly from east to west along the south shore and when they reach Madaket they cut either between the islands or over Smiths Point. But they traditionally fly at heights that would interact with a wind turbine at 300 ft. It could be at any time. I've seen them fly over here but generally they do fly to the west of this.

We interviewed John Bartlett from Bartlett Farms and he said that you conducted a formal study for him for helped him with his USDA application. We were just wondering what kind of things you look for in that bird study and what kind of things you did.

For John Bartlett, the permitting process was concerned with Piping Plovers. My review of his site and location was that it would be negligible or no impact on Piping Plovers.

How did you determine this, was it just looking at the area?

It was the distance from the water. Piping Plovers generally tend to stay on or near the beach and his site was I forget the distance but could be as much as a mile but probably not that far. Whereas the sewer beds are right on the water, so that's why I draw distinction between the two.

There are also feeding zones that the Piping Plovers might fly into in the sewer beds. So my conclusion with his site that it would have no impact.

Do you know if there is any record of bird deaths at the various towers, communications tower at the land fill and a few other locations?

Not that I am aware of. There have been some strikes on the power lines, Ospreys in particular and recovered.

Is the problem with the birds hitting the towers the guy wires or is it them hitting the tower itself?

It's the guy wires and to some degree the towers but I think the guy wires are the biggest problem because the birds are flying and they don't see them.

Have you done anything looking in those areas?

No. I don't think anybody has ever done that here. We aren't a significant migration route.

Do you know anything about bats on Nantucket or anybody who might know?

I know a little bit about them.

Do you know anything about how they [bats] may be affected if they can see things like towers? We've heard different things about with their echolocation and the motion of the turbine, do you know anything about this?

No but I can tell you that our bat populations are significantly low.

So it's not nearly as much of a concern as the bird populations?

No. I'm a naturalist and I look at things like that. I would notice them if I saw them. To be honest with you I've probably only seen ten bats in 8 ½ years on the island. I think that there is very very low density on this island.

We talked to Ernie Steinauer and he mentioned that we contact Edie Ray. Do you know how we could contact her?

She does know a lot about birds. She's going be looking at it from a little different point of view so I think it would be appropriate to talk to her. Go to the Inquirer and Mirror under the calendar and look up the Sunday Bird Walks and her telephone number is in that. I'd rather you do that then say 'I got it from Bob Kennedy.'

Ernie Steinauer also mentioned that Danielle or Kelly from the Conservation Commission may know something about bats. Do you know who either of them is or if they may know something?

Yes I know both of them. I don't think that either of them are studying or know much about bats. Danielle is more of a wildlife biologist and most of their work is focused on plant related things and turtles. Their supervisor's name is Karen Beattie and you could call Karen and she would know if they have any knowledge.

We've had two visiting bat biologists out on the island. The 1st one basically decided that there wasn't any significant population of bats to come out and do a study on. The 2nd one has been out here a couple times. He comes out with a bat listening device and just picked up a couple bats. Unless for some reason there are more insects or something around the landfill or the lights at night, I've never been poking around there are night because it's closed but that's probably a good thought. If they wanted to do studies on that, that's something that Maria Mitchell could do. You can ask Darcy about the bat guys, she's actually helped him out and is interested in bats too.

Do you mind if we contact you in the future if we have any more questions?

No.

Email is the best form of contact?

If you want a quick response, you better call me. If you want perhaps a delayed response, then email. You are welcome to call my cell phone.

(Gave us business cards)

APPENDIX D5: INTERVIEW TRANSCRIPTION, M. VOIGT

Interview with Mark Voigt, Administrator, Nantucket Historic District Commission, Nantucket, Massachusetts

November 7, 2008. 10-10:50 am

How long have you lived on Nantucket?

This will be my 9th year, I moved here in October of 2000.

How long have you been working for the Nantucket Historic District?

Same, this is the job I took from Florida, coming here.

Did you do similar things when you were in Florida, or did you have a different type of job there?

Yeah, I was a city planner for the city of St. Petersburg. My responsibilities were community redevelopment agency reviews, I could go into that later if you want, and the historical preservation reviews, and preparation for our historic preservation commission. And neighborhood design review, which was another component of what we did in the planning office.

Can you tell us a little bit about the type of work you do here on Nantucket?

Well I'm the administrator for the Historic District Commission, which basically is I'm the official person as a representative for the HDC, we have a volunteer group of commissioners, but I run the office and get the staff to assist them in their technical part of reviewing and making decisions on projects. And we handle basically everything else- the issues, the education, the setup, everything else that involves their mission to protect historic structures.

Do you know anything about the Nantucket Energy Study Committee's proposed wind turbine project?

Very little. I didn't know that they were doing it. I know the Energy Committee exists. We've actually talked about this concept, and I didn't know the Energy Committee was looking at this. But we've talked about the same concept because we've been bombarded since as soon as gas hit the price that it hit that affected everyone. All of a sudden we started getting criticism before there were any questions ever asked, that we were being too strict and weren't allowing people to do solar, and we found out that these people had never even asked. Which is typical. As a matter of fact, we've said apply, because they wanted basically for us to just clear a path and say "go for it, there are really no issues involved if you want to do alternative energy sources you should be able to have carte blanche and not have to go through any review." And we're sitting there going "wait a minute, this isn't our issue, our mandate is a special act of legislature to protect historic structures. We are lenient, we are members of the community. And you could do the same thing if someone came and said "I am handicapped and therefore you should let me do whatever I want." It's sort of that same type of "No, I understand you are handicapped, but we want to understand the issues and we want to be able to do what we can. But we aren't going to let you tear down a building or modify it to the extent to the point where it becomes non-historic anymore due to your handicapped nature." It's a tough thing, we don't like doing that but again we are not proficient in everything else under the sun, we are proficient with historic buildings. And there are guidelines through the Secretary of Interior that actually you should probably refer to if you haven't already, for historic building that speak to your subject of solar collecting systems.

When we went on a tour with the Nantucket Historical Association, they told us that all of Nantucket is a Historic District. Could you tell us what constitutes a Historic District and why all of Nantucket is one?

Ok, so what constitutes a Historic District? What constitutes it would be all the contributing and individual significant historic buildings within it. Nantucket originally started - first of all it's the oldest in Massachusetts, it was the first one - secondly, it initially started and only covered what was called the core districts of Nantucket Town and [Sia]sconset Village. In the '70's there was a development out in Madaket called Tristram's Landing, and in the '70's the architecture at that time was pretty inventive I would say, or let's put it this way - it was a departure from traditional. If you wanted to design something traditional you probably wouldn't get the job. So everybody was excited about modern architecture, and modern architecture in some definitions was not doing anything that had been done before. So, take this square window. Now if you proposed that on a modern architecture building, it couldn't be square. If you wanted to be a modern architect it had to be triangular, had to be round, had to be oval, had to be anything but square or rectangular. So if you go out to Tristram's Landing, you will see the buildings, the triangular windows and things like that. This was a real problem, so the same impedance that started the commission in the first place back in the 1950's was what was called a motel on Main Street, a flat-roof building. Well, flat-roof buildings weren't part of the traditional architecture of Nantucket, so therefore neither were the modern architectural styles that were being built out in Madaket. Even though it wasn't a historic district, it caused concern to the point where people didn't want to put up with it, and so they just said "you know what, we've had enough, we are going to extend it to the entire island and the associated islands of Tuckernuck and Muskeget."

We know that in order for a wind turbine project to be constructed the Energy Study Committee or whatever organization is trying to build it needs to acquire a certificate of appropriateness issued by the Historic District Commission. What can you tell us about this process? What will the Energy Study Committee have to do in order to move on with the permitting process?

Well, it is in our definitions where we have jurisdiction over any exterior architectural features, or structure. And so the definition of a "structure", and there can be very many depending on your orientation of whether you want us to review something or you don't. Essentially it comes down to an assembly of materials, some manmade some natural, but assembled by man essentially. So if it was a natural feature, places like "Sky Bridge" or whatever, a natural rock formation that water has eroded it - this is a structure, but is not manmade. Ours is anything else that man had to deal with that is a structure. We cover fences, walls, signs, all of these less significant features like that, including obviously buildings. So they would need to apply for any exterior architectural features they would want to install, which most of these things obviously are outside.

I found one form online, but had trouble accessing it. Is there one form or are there several different applications that need to be completed for a project such as a wind turbine?

It would be one application. It would be very similar to what's happened with cellular towers, this is very similar to that respect. Communities were outraged and tried to ban them, which is constitutionally illegal, you have to zone and say how they have to fit in. So you won't see any in town because that is our core district, but you will see them throughout the island. And what they have done is they've disguised them as flagpoles, in town they have put them in church steeples - those are the highest points in the town - so it gives the churches, which have struggled, some added income, and perfect place to put it because they had these steeples which were hardly used much and actually had housing to put these cellular transmitters in them. So it actually worked in a very good sense that way. There are some throughout the island, you will see communications towers throughout the island, they are big and bulky and essentially people just don't like those eventually. And that's why I like it - you put reasonable people together and you say "you know what, there's a better way." And you'll come out with a solution, like you all just reacted to. It was a much better decision to put them in a church steeple, and provide some income to those who have struggled, and never really see something industrial.

So there is beautiful architecture that is now supported by some industrial architecture we don't want to see. So that's what the windmill issue is, and our respects is that windmills were all over the island, that was the early form of power in colonial America, and other places as well. So windmills are not foreign to Nantucket. What they look like now is sort of like that architecture I was talking about- they are still building houses but they are building them in a different way. So how does that affect our district? Well, you know, we can't go back and say "ok, this windmill needs to have the wooden ribs to it and the big stone foundation and all of this other stuff." So we've actually approved a few windmills- there's a can windmill over on Ester's Island. I think that's been preferable to some of the others at this point. There has been one approved at Bartlett's Farm, which is quite large. And then we have an old one. It's kind of funny because it's sort of a joke and people go to it to say why you wouldn't want to do a windmill because it's never worked right, it's always had problems, it's just always been there as an albatross. It only has a couple blades on it now; it's one of those iconic looking stick towers with 50 blades on it. Now it only has a few blades and doesn't move.

So for us, and there's been a couple others that actually have the 3 blades, and I don't think people are generally against it, I think we are concerned in the overall energy issue. And that is we spend huge amounts of time as a group of design professionals, preservationists, local community members, and so forth, trying to protect the look of the town Nantucket. Some perceive that as aesthetic, I perceive it as trying to retain its historicity. And in that respect, it is similar to well yeah we can pave Main Street and make it really smooth, but people would kill you if you did that and I'd probably be one of them right there trying to do it. And it's that type of thing - if it was costing us a lot more money because of it, we would probably say this isn't useful anymore.

The thing about Nantucket is [that] it is a living, working town first, and a historic district really second, or in conjunction. Maybe they are tweakable in that respect. And in a lot of ways we pride ourselves in that we are not a museum, we aren't a Williamsburg, we haven't been recreated in that respect- it's been continuous throughout. The people who live here like the traditional ways, and can still be modern people- still have their cell phones, their cars, their smart cars.

So we can deal with solar-collecting systems, we can deal with alternative energy systems, and there is a code- the WECS [bylaws]. That needs to be updated; we haven't had any applications until this past year. It wasn't worth it, as much as we all like it or don't like it, gas is cheaper, and is still cheaper. Even as it declines, but even where it was it was still cheaper. And how do you deal with that? I mean it's all nice to be green and all of these other things, but it's a fundamental dilemma, I think it's a discipline. It's like learning the right things to do, you don't really want to do some of these things, but everybody tells you that's the best thing to do. It's a cultural thing I think as much as anything else. I mean, if anyone tries to tell you the payback is relatively quick, I think they are fooling themselves. That payback is long-term. That's fine, we need a plan for long-term, but we need to recognize that's the way it's going to be. Our thing is that we would love to see this explored on town land because I think it is much more efficient, reading the things we read. Oil companies and electric companies that we talk about now, fundamentally their business module is changing, they are going to be power companies. And how they get their power they aren't going to care, as long as there are customers and they want alternative energy. You see on the ratepayer bills now "[Do] you want green energy? We can provide green energy."

From what I understand there is a gentleman you may want to talk to who works at the Sewer Treatment plant out in 'Sconset, his name is Robert… The reason I mention his name is because he actually did a study on alternative energy for the state, and what he found out just briefly is that there is a trust fund in the state and is funded to about $52 million, and is to help people, homeowners to install the systems. And the other thing is they are supposed to take this money and invest it into alternative energy, but the problem is that the electric companies are supposed to have it and buy alternative energy, but they have to do it in MA and there are not enough places to buy alternative energy, so they have nowhere to spend their money.

So now the wind farm, I'm sure we will talk about that, the wind farm out in Nantucket Sound- of course that's a big political issue as much as anything else - no one, and this is where I would like to start out, no one is against clean, dependable, efficient energy. No one is against that, no one is against that if that is what wind power means, which essentially I think it does. But how you do it to generate it is the real issue for that particular site, and everybody says they are calling it "NIMBY". And it's not NIMBYism, if it is well I would say "who else is going to talk about it other than people whose front yard it is." If it was really in the front yard of your house would you allow that? Or would you say why can't you do it in the backyard? So that's a real political ploy, they've used all of these negative things for how people to react to something to then say- "You're against clean energy." Obviously you can tell I'm not convinced about the project. I don't have a problem with windmills. My concern is that Nantucket has always defined itself as being isolated - you cannot see the continental US from Nantucket - and now you will be start to see that 'creep', which is what we call it, the creeping over of the mainland to Nantucket. And the big reason people come here is for the isolation. I mean we are not fooling anyone, we know where it is, we know you take a boat to get there, but you can't get there by car, and to me that is one more step that deteriorates Nantucket's image which happens to include historic preservation. So it's not detrimental to say "oh, there're windmills." I think it's detrimental to place windmills so we can see them from our shore, I don't think it's bad on the island, as a matter of fact I think it's good.

(explains the preliminary RERL study that was done and tells him the 2 sites focused on)

Do you see any major problems in terms of the HDC and putting turbines at those sites (WWTF, Landfill)?

Nope. As a matter of fact one of the windmills we just approved is nearby the sewer bed, and it's actually some pretty valuable property just across South Shore Rd. and is on a private lot-called Morgan Square I think, you may check that out if you're interested. I still think they are going forward with it.

We suggested this idea because my wife runs the bookstore that just moved from Main Street to over here on the corner of Washington Street. They are there just while they are re-doing the building. They are asking to put solar PV-collectors on the rear of the building, and we said no. Part of the reason we said no for PV was because there was also an alternative energy source that's basically like a reverse-radiant heat, where you usually heat the water and put it in the floors, this puts it in your roof. And you run the pipe in your roof, so you just add that much more depth in the roof, and you run these pipes in your roof and put regular shingles on top. Then the heat transfer goes into those pipes and then you run that to wherever you need it. So you are just using a different way to collect the heat. On historic buildings we want to be very careful on them, and we didn't think the gain was worth the detrimental factor. So one of our suggestions was that the money would more well spent if they do a "pay in lieu" program, which is something that is not lost on the zoning people. They do programs like this in cities like pay in lieu of parking. So instead of providing parking on a really in-town site that is a very strict on area they will say "to develop a parking space, you need 15 parking spaces but you only have enough room for 7, but we don't want you to stop your project because that is community development. But what we will do is say that the town will create a trust fund that you pay into, say $2000 a parking space, and you put that money into that trust fund, and the town at some point will acquire a piece of land outside of the town to create satellite parking, so that ultimately you will be able to balance that equation." So you don't let people off scott-free. So instead of putting all of this on top of your building which might cost $25,000, you can pay $10,000 or some equivalent even less than that to develop something on another piece of property that is less visible, less impactful to historic structures, and therefore more efficient. That's a program we would be happy with, I mean we wouldn't be directly involved, but it solves our problem. I think it's really, again, when we were talking about coming up with a better solution, it makes more sense to put these things together.

There was an interesting article in NPR from the Spring/early Summer. It basically said that the current electrical usage in the United States could be generated with the equivalent of a 100 square mile solar array. So that's the first time someone was able to define and wrap their mind around how much do we use. Would everyone putting their own on their house do this? I don't know. So we can't put it all in one place so you're going to have to disperse this 100 square mile thing. So what's the first thing you do? Break it down- 50 states, now its 2 square miles per state. Now you're going "wow, that's nothing." Then you break it down- 351 towns and cities in MA, 2 square miles into that? I mean we can generate this in no time. But I don't think we are going to do it on every house. And that's what it's going to take. Our architecture is going to change, won't change much for us here because fundamentally our architecture needs to stay the same for our purposes, for the historic district. But other towns, buildings will now become generating plants. But they will become more expensive in one way, but it is long-term and I think the equation will ultimately change into something where that building doesn't have to have any utility costs. Utility costs are getting almost as much as a mortgage or close to it, and do you know what the biggest cost of utility is? Distribution. It's the largest increase besides the fuel factor because it costs so much to acquire the lines and everything. You can tell I've been thinking about it.

Do you know anything about the required process for complying with the MA Historic Commission, or even the federal part?

Well, federal would be a couple of different things. The federal 106 process… if you receive federal funds, the federal government can't exempt itself from local rules and regulations when it comes to historic preservation. It's part of the Historic Preservation Act. It's a section, they call it 106 because it is easy to remember. So essentially what you had was all of these federal agencies that were going around- some community schools don't need full building permits, and they think they were exempt from all of these other things. No they're not. It's reasonable, as you would think, we don't make these rules so then all of a sudden people can exempt themselves. Federal agencies, the Coast Guard- when they want to do a project down here, they start the process a little differently. They have to tell us all of the things they are going to do and then we get a chance to look at it, and if we have any issues then that's how we respond. [It is] different from our local system which was just developed for Nantucket. A lot of them default to it, and just say, 'why not do both.' So they will apply to us anyway, so we issue them that certificate. Then they can go back and say, look we complied. So federal and state agencies are not exempt. If they receive any public monies, and so the states adopted that as well. So MA Historical, what they would do since it is in a historic district, you would have to notify them, they would ask what it was going to look like and the things it would involve, and they will sit there and tell you to talk to your local historic district. If you get your approval from us and say you have already gotten approved by the local district, these are the approved plans, and then they will look at it and say well will this have a detrimental effect on the historic district. That's what they look for, and that is the same thing that is going on with the Section 106 process in the Cape Wind Project, and essentially that is what it is all about.

So would you say it would be advisable to start at the local level and then once they get a permit from you, move to the state?

I would do it parallel. I think you should do both at the same time. Start it with MA Historical and the first thing they will tell you is you need to get all of these different things, and you can opt out of some of these things if you just come to us to do the local review, and they will give you a couple other pieces. But essentially they just don't want the locals to go "why didn't you stand up for us", the state. Here are the rules and you just totally let this go. If they have approval from the local agency, they will be relieved. They don't have to worry about that, now we just need to meet a few more criteria that we have as a state agency. So it makes sense.

About how long does it take to go through the Nantucket Historic District Commission process, from when you apply until you receive a response?

Well it varies, and is incumbent on the applicant as much as anything. We have applications and our guidelines are to the point where we have a 192 page guidebook, and that's for residential, so this project will be different than that. We have first time, only time applicants, who will read the directions and put their information together and they will come to one meeting and they will be approved. So we know it can be done. And as a matter of fact, that's pretty much typical for first time and only time applicants because they don't know anything so they read everything. It's the ones who know everything that don't read anything. This project I think they would probably first off, provided all of the paperwork comes together correctly and was sufficient to meet the minimum submission requirements, then our process- and we have a mandate that we need to meet within 11 days after we receive the information, so we have meetings every week. They are split up between old and new, because what happens is with that 11 days, it is more than a week, so we can't really meet every week because that would be too soon, because we also have notification requirements that prevent us from meeting every day. So every 2 weeks essentially, although we meet every week, we start out on new business - so this past Tuesday let's say that was new business - we said okay your windmill looks fine but we want to explore other options and we want to go view it. Okay, what do we do? Give us some more information and the commissioner is going to go out and view it. We have to have that information in by Friday, for you to go - this is optional - optional for you to have it to us on Friday, so you can come up at the very next meeting. So you can get 2 meetings within two weeks. No other agency in the state, probably the federal government, will move as fast as we move on these issues, potentially. Now if you want to delay, that's fine. That's just the earliest you can come back. You want to wait another 2 weeks then you're on a 2-week cycle, you become old business. New business - first time we hear it; old business - from then on. And then old business is every 2 weeks because we have that new business meeting in between. But most historic commissions - I don't know of another commission that meets more often than we do - we meet about 48 times a year, we meet every Tuesday except for a few holidays. And so that's unusual.

(explains how most other towns do it)

To answer your question the process varies, but I would say if you were trying to get a decision, we have to decide in 60 days. If you don't want us to go longer on any particular aspect of it, we have to make a decision in 60 days. So if you want it to end at a certain time, you can say "I don't want this to go more than 60 days." We will always allow you as much time as possible if you want to explore other opportunities and keep coming back to us, it's really only for people that really want to get technical or legal with us. We can extend that. But if you don't want that extended, and you want a decision, then we have to do it in 60 days. Generally on this project I would guesstimate if we had all of the information and we had to make a few minor changes or something, I would say it would probably be a month.

Skipping back to a previous question about the various state and federal organizations that would have to be gone through for the Historic District, do you know anyone at those organizations who may be helpful to us? Or is pretty much everything readily available, like the applications and such?

I haven't had any contact with the state about these, so I can't really tell you anybody. But MA Historical, I just don't even know if they have anybody that is really concentrating on these. They're going to be much more adept at the issues because they are dealing with Cape Wind, so it's not as though they are not fluent. And they have been widdled down staff-wise so I'm pretty confident they haven't hired anybody to deal with these issues. And the local agencies would have had to change their local guidelines.

That one existing tower at the landfill site, were there any siting issues with that? I was wondering if there were any problems with that as the turbines will be a much lesser height?

You go out to the dump and you look at the buildings that are there. Do you think there is anything historic about them? Is there anything that needs to be protected? It's a dump. And I didn't expect you to understand all of the things, but to try and make a connection here- as a living, working town we understand that not all of it can be- a historic dump. So that's the perfect place for it. The sewer beds- these are things to make the rest of the island work- I mean we can't have a historic sewer treatment plant, I don't know what that means. We have just approved a water tower, and this may be something that would be helpful. There is a new water tower that is going to go up mid-island, out Polpis Road and between Old South Road essentially. And it's going to be huge. And you know, you will see it from the water, it's in the forest so it's not too visible from there, but it is a modern water tower. There is nothing old about it. So there are just some things that there is no other ways to do it. The Steamship, although the building we like them to look traditional, the boats have continuously changed over time. And there are things all over the place that change around us, but it is the architecture that we protect. So this is not strictly architecture, it can involves architectural elements, but is an industrial type of thing in one way; they can be very elegant, so it includes a lot of different things, but it is a technology thing. But you're certainly not going to hurt anything at the dump or the sewer beds. And I don't think it's just restricted to those areas, it could be other places. I don't think we are opposed to windmills, as long as you don't plunk it down in the middle of a historic building and say I have to have it hear because the zoning says.

You know what the zoning says that is ridiculous? As high as the windmill is, that's the distance it needs to be away from the property line. So basically it says it needs to be right in the middle of your lot. And what's usually in the middle of your lot? Your house. That's what's crazy about it. And it's because of the fear that they will fall down. Well when have you ever known that any windmill has ever fallen down? So that's about as useful as saying well your house is going to fall down so it needs to be away from that. I've actually seen houses fall down. So I don't think it's accurate. So I think that for the dump it's a perfect location. I think that the sewer beds are as well. We've talked about that as well- they could do photovoltaic in conjunction with windmills. They should look and explore every possibility. We just got from Rensselaer Polytech, they just did a super-nano film or something like that. Our guideline used to be that we would want it on the rear of the building or something like that, and it has to be at a certain angle, but now this thing doesn't have to be at any angle, it just has to be exposed to the outside. So there are will be lots of changes. My philosophy is in the next 5 years we are going to see, if oil stays where it is now that it dropped I think it's going to kill a lot of these programs that were going to get off the ground. But essentially I think what we are going to have [is that] our houses are going to be modified, they are going to become these somewhat generating plants, pseudo-wise. Much more efficient but we are still going to cling to traditional things because we are human beings and they have worked for us. We still want houses to look like that, not an industrial plant.

Do[es the Energy Committee] get the application through you in person?

You have to contact us to get it because it is a three-part triplicate application. We have computerized it, it's just that we haven't found an effective way to use that application, because what we do is create three originals. And they have to be signed by the commissioners. This is too difficult through the computer. We just are not there yet. I will give you the application. Also, its setup for houses, so you are going to be 'other' on almost everything. And we are going to look at the spec sheets, so you are going to provide information anyways. We want to see drawings, specifications, a site plan, where it's located and all the other stuff around it. And again they will want to view it to see what the impact is going to be visually- how big is the base and all of these other things. I think it would be simple. I think they would be fine with it.

I think we are a progressive commission, a flagship district, as we have had to deal with issues way before most other people have, and we have had to deal with issues so much more in depth than other commissions. And because we are continuously on that pedestal and have to keep our balance, I think that we are pretty well-suited to deal with these issues.

(goes on to discussion of how wind power will change and how power companies will try to control it if we become dependent on it, and how hopefully laws will come out to make it easier and more cost-effective)

(discussed Duke Energy and their solar panel program- putting them on buildings for free)

APPENDIX D6: INTERVIEW TRANSCRIPTION, E. SCHULTZ

Interview with Eric Schultz, Chief Operator, Nantucket Waste Water Treatment Department, Nantucket, Massachusetts

November 7, 2008. 1-1:20 pm

How long have you lived on Nantucket?

Oh boy, well, my family started summering here in 1954. I lived here from 72' to 76' then came back in 88' and have been here since then.

How long have you been working at the Surfside waste water treatment plant?

Since 1990.

What does your work here entail?

I'm the chief operator. It's a supervisory; I have a crew of 6 people including myself. I handle the state report, I am responsible for the product that goes out and answering to the state and to my boss, Jeff Willet, who is director of the Department of Public Works.

We know you have been involved with the Energy Study Committee and have suggested some areas for them to possibly put turbines. We have questions that we would like to ask you about some of the sites.

What exactly are the sewer beds?

They are 1-acre sand infiltration beds. They actually sit about 8 feet below our ground level, and they are about 8 feet or so above the water table. And the effluent from the plant goes to them, and I rotate them daily or every other day. And the effluent from the treatment plant just percolates into the groundwater.

Do you see the displacement of any of the sand/sewage in these areas from the turbines as being a problem?

Well somebody called me and quoted me that they were saying the concrete structure would take up about 3,000 square feet of space, which doesn't bother me too much. Our discharge permit of 3.5 MGD(million gallons per day) is based upon the fact that we have 15 one acre sand infiltration beds equaling 675,000 square feet. So it would impact it a little bit, I mean your reducing by 3000 square feet the amount of land available for effluent percolation, so yes it would have some impact but I don't foresee a major problem. Also, I don't see us ever achieving 3.5 MGDs in our lifetime.

How do you plan on anchoring the turbines, or do you have any plans for how you would anchor the turbines?

No, that's not my department.

So you just know that they could go in the sewer beds?

I don't see why not. That's for a structural engineer.

Do you foresee any problems with maintenance of the turbines due to their locations? Accessibility concerns?

I don't think so. They are on land, you can drive to them. I don't see any problem with that.

(asks to see sewer beds)

We were told there is going to be employee housing somewhat close to the sewer beds (the proposed turbine site). Do you know a distance from the nearest sewer bed?

(takes out a map to show us) So, about 250 feet. Now that is according to this drawing, and I think that from looking at this, that is probably pretty close to what it is. (confirms this is to **corner** of closest bed)

It might be a little less, I think they had to relocate these a little bit.

Is this housing going to be leased or would any be owned?

No, nothing will be owned. These houses are for employees who are within the sewer enterprise fund - a specific fund that is paid for by the sewer users - so that would include people who work for the waste water facility and people who work for the town sewer department. And it is really just about 10 people that can apply for these. And obviously you have to work for the DPW, and if you leave the DPW you have to leave the house.

One of the Nantucket bylaws states that the turbine must be at least 1000 feet from the nearest property line, but all of this is town land correct?

Yes, this is all owned by the town of Nantucket.

So the nearest property line is going to be significantly farther away?

(shows us on map the closest house) So the nearest turbine is 1000 feet from that house, I'm not sure where the property line is, but it's probably around there. So you would probably not be able to use these 3 beds (the 3 corner ones closest to house).

I know the Energy Committee said you suggested locations, where these specific or just the sewer beds in general?

No I didn't. I don't know how much of a blade-span the turbine has, but if it were anything under 100 feet I could see a turbine in each one of the beds. But the people that were out here about 3 months ago or so, they started to think about every other bed or something. But that is up to somebody else's knowledge.

Is there a problem with the proximity of the turbines affecting the lease?

Well I don't know about that, I would think that is with the town. But I don't know how it is going to be worked out.

We had a question about the writing of the lease that would have to be signed, and could it mention it is close to the turbines? But if that is a town question we will go to them.

I think so, yes.

Do you know anyone in the town who may specifically know about that?

I'm trying to think about who from the town came out here that day. Have you spoken with Carl Borchert? He may have better memory as to whether or not there was another person from the town who was represented.

Do you mind if we contact you in the future for further questions?

No, not at all.

Asks for map of sewer beds. (takes picture of map for files)

Do you mind if we use your name in our report?

Could I read it first? Send it by email.

APPENDIX D7: INTERVIEW TRANSCRIPTION, R. MILLER & P. CANNON

Telephone interview with Richard Miller and Patrick Cannon, Hull Municipal Light Plant, Hull, Massachusetts

November 10, 2008. 9-9:35 am

Miller [introduced himself and Patrick Cannon, who interviewed with him]: Only been in this position for a year or so, so a lot of these questions pre-date me. So Pat can answer most of these questions more succinctly than I can.

Could you please tell us briefly about your background regarding wind energy?

Miller: Background in power. I'm a lineman and I've progressed through the industry Vice President of probably largest power line contractor in New England. Living in town and having started my career here, when this job opened up I applied for it and got it as the leader to finish out my career. I was interested in wind when I got here, and that's the reason I came here.

Pat Cannon: I'm an electrical contractor by trade and I've been on light board since 1993. As time progressed to about 1998-99 when we first started looking into wind, it was at the request of a rate payer. He's the one that got us interested and how we should go about it, he came to our light board meetings where we discussed if this was a worthy cause to investigate. We got to this point and we've learned as we go along what the benefits of wind are.

Can you tell us a little bit about what your job entails?
Miller: I'm the Operations manager of light plant, keep lights on. I keep the turbines spinning when possible. I make sure the financial ends are done correctly, we purchase from MMWEC, Massachusetts Municipal Electrical Wholesale Electric Company.

Cannon: Like I said before I'm an electrical contractor by trade. I own my own business and I'm also the local wire inspector for the town. So that keeps me pretty busy. It's basically an elected position for me to be on the light board.

We know that the town has two turbines. Can you tell us about any of the major obstacles you had with siting the turbines? If you had any, can you tell us how you overcame them?

Cannon: Back in 98-99 when we started investigating for Hull 1, there had originally been close to where Hull Wind 1 was an old turbine there since the early 80s which overtime around the mid 90s was in disrepair and it became to the point where it could no longer be used. It was not owned by the light department, it was owned by the school dept. It was a very small generator that was dismantled. A couple years later when we were looking for a location to build, it was pretty much a no brainer that it was a good spot on town owned property in an area of town is considered and called "Wind Mill Point." The name dates back to the 1800's because the fishing industry used to have a turbine down there to draw in salt water and dry it out and use the salt for salting down the fish, so that's how it originally got its name as "Windmill Point."

Once we got far enough along in our investigation how we were going to proceed with wind, we started to have some community meetings particularly down in that neighborhood because it's near high school. We had a pretty good crowd and in that crowd of I'm going to guess about 75 people, there was only one dissenter from that neighborhood. So Hull Wind 1 went up fairly easily, not too much problem from anybody.

Then when we got to Hull Wind 2, now people knew what a turbine looks like and things like that, we were originally going to put Hull Wind 2 down at same neighborhood. At the time that neighborhood was going through renovation projects and the streets and parking lots, boat ramps, Coast Guard station, so there was a lot of activity in the town there, and they felt enough was enough. So we started to look at other parts of town and identified some other areas. We ended up down at landfill, had several community meetings. At that time there were people that had come out with a lot of research about they thought the turbines could do such as throwing ice balls, killing birds, noise, and strobe effect. So we addressed their concerns as best that we could. The ice ball issue can be addressed easily because they do make a cold weather package which we did buy for the turbines that keeps them from icing up. The bird kill issue we ended up doing pre and post bird study at the landfill. We were fortunate enough that there were no protected species or anything like that. People were very concerned with an estuary in the close vicinity to Hull Wind 2, so that still takes place trying to identify any birds and we've yet to have anybody bring us a dead sea gull that was hit by the turbine. So that was the big involvement, there were concerns from the neighborhood that being part of the landfill people were concerned with what are you going to do with breaking the membrane on the closed landfill and all of the gas. That wasn't an issue because being a landfill it was already vented just for that reason so you do not have a buildup of methane gas or anything like that. Those were questions that came to be and things we tried to answer. I guess that's it in a nutshell.

In terms of public outreach and community involvement, how early did you let the public know that you were looking into wind turbines and how did you get them on board?

Pat: With our bills we sent a survey around. We probably started to put the word out initially in newspapers and community meetings probably about 2 years prior to installation. Probably 6 months prior to installation we sent out a stuffer in our bills, a questionnaire asking how you feel about additional wind turbines at Hull. That came back quite overwhelmingly positive. I don't remember off the top of my head, but we have about 6500 meters and we got back maybe 700 out of as many stuffers that we sent that people took the time to send back to us and of that there was better than 600 or somewhere in that vicinity positive.

Would we be able to get a copy of the survey results?

Miller: If you me an email reminding me at the end of the week, I will try to get it by Monday. I recall we were looking for it a few months ago, but I don't know if she actually found it or not.

What do you see as some of the benefits that have resulted from the town's implementation of wind turbines?

Cannon: It operates about 11% of our power. So we see a direct savings to about that amount. We spend about 6.5 million dollars on purchase power and we receive about $600,000 to $650,000 from the turbines when you combine all the certificates and the power discounts we get.

As far as disadvantages, one that we have heard a lot about is the potential for decreased property values. Do you have any information about how the turbines may have changed any of the property values around Hull?

Miller: [It] was a concern when we talked about putting Hull Wind 2 down in the neighborhood where Hull Wind 1 was; that question was asked by the community and at the time the assessor for the town got involved and answered the question for us and did a study on any properties that had changed hands anywhere in the vicinity of the turbine. The property values had done nothing but go up, at that point in time we were in a good real estate market. When the question was asked, that's what happened. Today we haven't heard a peep about it after that; no one has said I can't sell my house because the turbine is there. Right now, to the best of our knowledge that is a nonexistent problem.

One of the questions Nantucket is having is maybe eventually having a municipal light department. As Hull has a municipal light department what are the distinct advantages of this?

Cannon: Nantucket used to have a municipal light department and I believe they sold out to National Grid. The advantages as far as selling the power, we are selling it to MMWEC and we get a better deal out of MMWEC than anyone I've heard of selling it to National Grid or NStar. We sell it for about 6 cents a kW and best I've heard out there on the others is 4. Its soft energy so we still have to buy all the power that we need every day.

Being a municipal utility, do you see any disadvantages to this?

Miller: Look at our rates they are almost half of National Grid.

Cannon: We are about 12cents a kWh and any of the investor owned are about 19. We are doing extremely well rate wise. Advantages and disadvantages of owning a municipality has fantastic advantages. Our light department pays attention to only the town of Hull. They keep the maintenance going all the time for us. If you have a problem, that's the only location that they have to go to. Some of these investor owned has a man at night that covers 8-10 towns and you have to wait until he comes from one call to the other. Whereas the town of Hull has someone that's typically at your home within 45 minutes trying to figure out what the problem is. If we're in a storm situation where you need several linemen on board at night or during the storm they pay attention only to Hull. There are great advantages there.

Can you give us any information about various costs associated with a wind turbine project? For example, costs, delivery, installation, altering roads etc.

Cannon: Other than police details for transportation…but it was done in the early hours of the morning so that there wasn't any traffic. There were no operations as far as moving wires or things like that. The actual cost of the turbine we can pretty much give you verbally but we do have a cost sheet that explains what the out of pocket expenses were for each turbine.

Miller: A fax number would be easiest for us, we have scanners but fax would be best.

Back to the financial part of this...What were any of your major funding or financial sources you considered at the beginning of the project, in terms of grants etc.?

Cannon: It was all paid for by cash, we had saved the money over a period of years, so there was no financing or bonded debt. Hull Wind 1 was basically $800,000 total and Hull Wind 2 was $3.1 or $3.2 million.

So you did not apply for any grants or any of that?

Cannon: No we did not. The only money that we get outside of the Energy money is the green certificates and REPI tax credits from the federal government.

What was the process you used for dealing with the turbine manufacturers and how did you choose the manufacturer and model?

Cannon: We put it out for an RFP. Got 3 or 4 bids. The only two that I recall were [that] GE gave us a bid for 1.5MW machine and Vestas for the 1.8MW on Hull Wind 2. GE's machine was more money than the Vestas machine and the Vestas machine had a greater output. The same situation, there was an RFP put out, I can't remember who the other bidders were but to make a long story short we ended up picking Vestas.

Were there any regulations or legislature along the way that hindered the project?

Miller: We just had to deal with the FAA because we are on direct flight landing path for Logan Airport. So they had to approve the height limitations. On Hull Wind 1 we had to deal with local conservation commission through our wind studies, geotechnical studies regarding the foundation and other than that it was not a big deal.

Whereas Hull Wind 2 was a different story because we were working in capped landfill. It had to be monitored more closely and that got involved with some state agencies DDP, and had to be watched closer because it was a capped landfill.

In terms of the FAA regulations, some of the sites that Nantucket is looking at are close to the airport, do advice on handling FAA regulations?

Miller: One thing you want to do if possible is try to get FAA to approve you for red only light, day and night. We have white during the day and red at night and if the red shield doesn't come down over the white light and it's on all night, it can affect the cycle and takes 24 hours to correct itself and I get 1,000 phone calls from the neighborhood about the white strobe at night. It's a lot more efficient to put two separate units of red lights and you don't have to deal with the day to night situation. I've been told by a couple of people, where we already have the red and white light, it's harder for us to get red only from the FAA than if we had just applied for red only. If you can do that, you'll save the people you are working for a lot of aggravation down the road.

Do you have average number of down time per year?

Miller: Less than 5% of the time. That's about 15 days per year. 2 PDMs per year where Vestas comes and maintains the turbines. As a rule, we have a warranty and service agreement and get 24 hour service, if down they are here with 24-48hrs. They take care of it right away. Most of it computerized and we can get it restarted.

This agreement with Vestas, is it standard or specially written into a contract?

Miller: Bought 5 year warranty. At the end of 5 years on Hull Wind 1, we extended another 5 years. At the end of 10 years we don't know if they'll give us a warranty but hopefully they will because we are a small outfit and don't have the facilities to repair these machines.

With these turbines being close to ocean, was there any information about the potential affects they might on marine life?

Cannon: They are not in the ocean. Some might say vibration could transmit. In those PDMs that we have twice a year with Vestas, they do vibration tests and make sure the bolts and stuff are not loose. To our knowledge that is pretty much non-existent.

We spoke already about birds, who did you go through to conduct that study?

Cannon: Contacted the Audubon Society directly. It was set up, handled and designed through Audubon Society.

Are there any additional things that you want to add?

Miller: One of the things you may want to consider is you have to find out what kind of a deal can strike through National Grid, what they will pay you or be willing to pay you for that energy, whereas with a municipality it benefits you 100% and there can be a big difference there.

Cannon: National Grid doesn't want you to build it. They will say pro-wind or pro-solar but they don't want you to build because you are taking money right out of their pocket.

Contact MMWEC or NEEPA (New England Electric Public Power) either one of those organizations should be able to give you what you need. There hasn't been one to our knowledge constituted in many many years for whatever reason, maybe the infrastructure or original buy. There are currently 41 Municipalities in state of MA right now. No one has stepped up to the plate, many have discussed it but for one reason or another they haven't gotten all the way.

May we follow up in the future if we have any more questions? Do you want your name mentioned in the report?

Cannon: Sure. If you send us the transcription, then we will decide if you can use our name. We will fax the documents to you right now.

APPENDIX D8: INTERVIEW TRANSCRIPTION, D. FREDERICKS

Interview with David Fredericks, National Grid, Nantucket, MA.

November 11, 2008. 2-4 pm

Can you tell us what you do with National Grid now?

I run the electrical operations section, [so] philosophically I guess I'm responsible for making sure that the lights stay on in the eastern half of MA, pretty much from just east of Worcester down to just below the Cape and Islands and the state of RI. That includes the island of Nantucket. That includes the responsibility for emergency response as well as the general operation of the day to day electric system across MA and RI.

What particularly do you do with Nantucket?

I am also responsible for the operations and then I'm also generally responsible with the utility itself on the island, which includes everything from meter reading to customer service to the interface with the public, and so on and so forth.

Have you had any experience with wind turbine projects through National Grid?

I have had experience in reviewing their feasibility here on the island as Nantucket Electric Company. So I've been involved in them in my professional career for Nantucket Electric keeping in mind that National Grid has only owned Nantucket Electric for a few years, so as an officer of Nantucket, yes.

Did you see anything from the feasibility studies in terms of benefits and disadvantages to wind turbine implementation?

I've seen studies and I've past quite a bit of information over to the Nantucket Energy Committee back probably a year ago, including some work that was done as part of the first cable in 96, 97, and 98- which if you don't have your hands on you should get a copy of it. It is going to do 75% of what you are trying to talk about right now; it is done and filed at the PUC.

And what was the report called?

The report itself was a study of wind feasibility. What you want to do is - you would find it most likely, the CLF (Conservation Law Foundation) sponsored the study, and it was in 1996 and 1997. It was filed at the Department of Public Utilities at the same time with its findings. If you check with the Wind Group, they did find a copy of it, and it is absolutely mandatory reading if you want to understand what you are undertaking.

What are the options that Nantucket has for connecting to the grid?

I think you need to define 'the grid.'

(We explain what we know about net metering, and about Green Communities Act)

(Mr. Fredericks retrieves diagram of 'generation/distribution')

Now you understand that the way the laws have changed at National Grid itself is not in the generation business, absent of recent legislation that allows us to own some renewable [electricity generation]. The other exclusion to that is in the state of New York where we have recently purchased Keyspan, we do own some generation and where that's going to fall out as we go through some regulatory process is unclear. But typically speaking we do not own generation, we are in the distribution business.

There are 3 different ways that you can own generation. [1] The first is to understand the market itself, and the market is simply the transmission system. That's the market that every single person who generates electricity can push electricity into the market through the transmission system. The transmission system is, by virtue, a generation facility feeds 345[kV] to 115[kV], it can go as low as 69 kV. That's the market, and so if you are big enough, say Cape Wind, you want to tie as directly into the market as you can. [2] The other choice is to tie into, say on the island of Nantucket, the distribution system and feed directly to the distribution system. The downside to that is, and that is one of the issues with Nantucket, is that you then have to pay someone to use their system to get back to the market. [3] The third is what I call net-metering, which is extremely interesting when you consider the scale and the size of Nantucket, where placing the connection point on the customer side of the meter may have the most benefit to the customer themselves, provided they're not getting too grand in scale.

So that's where, and this is another expression for you folks to look up, integrated resource planning - that is the art of understanding these options. So, this [diagram] would be helpful because if it was me, this should include down to 69[kV], and I would draw a line and say this is the market. I would get rid of this picture where it says "generating station" and I would put a wind turbine and say you could put it here, or you can for the average person connect it here on the distribution system, or you connect it on the other side of the school or the meter, and that's the third option.

Most people don't understand the 3 options, it is critical to understand the 3 options. [1] If I sell here, which is the market-which does not exist on Nantucket- as directly into the transmission system I get to sell it for whatever the market will pay, say somewhere between 5 and 8 cents per kilowatt, depending on what's going on in New England at any given moment. [2] If I sell it on the primary side, if you will, the distribution side where I would get the same 5 to 8 cents or whatever the market would bear, except I have to pay the people that are going to transform it and get it back to the transmission system- the market- a fee. In other words, I'm going to pay National Grid to rent some space on their lines to get it to market. [3] If I put it on this side of the meter and I size it correctly, what I am really doing is deferring my total cost of power, which for Nantucket is about 16 cents per kilowatt. But I can only defer the 16 cents and as far as I'm offsetting an expense, I'm never really getting revenue. If I go beyond what I need, I can sell it to the market, but because I'm on this side of the meter I now pay losses through the meter and I pay a piece of it, I have to push it all the way through the distribution system and pay another piece, all to get the excess to the market. So by the time I am done with my 5-9 cents, a large portion of it has been eaten. So the downside to being on this side, if you will a customer-owned or net-metering, if I go much bigger than my use, I have a lot of people to pay to get it to market so the value of the extra is less. If I am big enough to play, the right place is the market. So size becomes critical to answering your question.

So with that lesson in mind, what you have on Nantucket, we have a 115 kV system that runs from one end of Cape Cod to the other, this is called the market. We step down on the 46 kV cables, two of them, and we push power over to the island. This is all considered the distribution part of the system. So you have **two** choices of if you're going to develop it on Nantucket, you can never really get directly to the market without paying us something to get there. And there is a point of confusion for a lot of people - I think some on the Energy Committee and some certainly on the island - who believe if I make the electricity local, I pay somehow a different price locally for that power. It has to get back to the market and get credited at the market and shipped back. It's not really what happens right? Electricity takes the path of least resistance, but from a market standpoint there are controls the government has put in place basically saying you pay the market value of moving it through the system which in this case would include the concept that you would push it over to the cable and take care of metering which is on this side, and push it back to you the customer and you would pay these losses. So the value of it connected to the island's 13,200 kV system, which is our distribution system, is one of the option you can have. I think what you need to do is think about the pros and cons of that. One is understanding clearly what you're going to have to pay us to use our lines to push that around for customers who want to buy it.

Do you have an estimate on that [what Nantucket would need to pay National Grid to use the distribution system]?

No I do not. But Dave Larson is the person you are going to contact with exactly that question, and you're going to copy Ed White, and say that you are working on a study, tell him who you are, and that you've been working with me. I would say you're probably looking at a penny a kilowatt. So if the market says its 5-8 cents, you're going to pay us a penny, maybe a little bit more because of the amount of money that we've tied up in the cable.

For your own education, I don't know that you can get into this in a report unless you're a lawyer and really very crafty, what the state basically says is that National Grid is invested in all of these wires and poles and so on, and so we have this huge net investment of capital, and when people want to use it, we take that entire investment and pro-rate how much of it you want to use and we charge you for that use. So we have 2 cables, both were $30 or $40 million, and we have an electric system worth $30-$40 million, and so when you tie into it, what you're paying - which is different from community to community, location to location - is the value that we've invested in our system. And because we are small, we've invested a lot of money because of the cables and the system, so when you use our distribution system our rates for Nantucket electric may be just slightly higher than other communities, because we have such a huge capital investment in the system. Because mostly it's new. Most utilities have started investing in the 1900s, well we did that with the poles and wires, but the cables are less than 10 years old. They are sitting out there-there is this huge asset with very depreciation haven taken place yet, so when people want to use our system, we can be a bit on the expensive side, compared to other places. So that's option number 1 and you need to understand the pros and cons. And so here you can connect - and this gets into your location 1 which is the landfill, and location 2 which is the sewer plant.

The second option that you have, is to go down the distribution line and I'm going to pick my favorite debate, which is the school. The school has a peak load - what does it use on a worst-case scenario - of about 350 kW on a hot summer day. Its average daily load - completely different issue, which is every single day what it peaks out at as an average - is about 275 kW. It's kilowatt hours used, the amount it uses in a year, is around 3 million kilowatt hours. If I sell here, I get the market minus the "handling fees" from National Grid, maybe a penny, and the market is going to pay me 5-8 cents, and by the way this is all offset by some tax credits - about 2 cents a kilowatt. So the real value of this if you add in the tax credit is probably something more like 7-10 minus the one, and you're going to end up with something between 6 and 9 cents a kilowatt on this side. I think we start with Dave Larson and you ask him what the current rate of electricity on the island of Nantucket is. But it's going to be around let's say its 16 cents. Under this scenario, because the feed comes into the meter in the school, I'm going to go off on the school property on the customer side of the meter and I'm going to hook up a wind turbine. I'm going to push this power under option 3 back into the school. On a peak day the first 350 kW is free, I've offset my bill completely. [On an] average day, [I've] more than offset my bill completely.

If I get too big, in other words, I know that the Wind Group is looking at 1 and 2 MW turbines, the transformer, the electric switch gear, everything in the school has been sized for about 500 kW. So if you get bigger than the school, you have to change out all of the equipment and the economics of all of this completely change. So the general rule of thumb, and there have been a million great studies done, if you were going to do something on the net side of the meter, quite often the right size is 75% of the peak day. So let's take this scenario as an option you would explore. So the pro of this is, up to the use of the building, I sell the power at 16 cents plus the tax credit of 2 cents, or 18 cents/kW. So I can completely eliminate my bill and I can make 2 cents in tax credit. If I size it perfectly, the wind blows every time I need electricity, and the utility is really there for backup when it is not a windy day where they're selling you electricity, the rest of the time you've offset your electric bill. That's a pro. It's smaller, less economics. It's smaller, less social issues, less environmental issues, less financial issues. Maybe less human issues. The con, you've done all this work - the school will benefit, maybe a little of this will get pushed back into the system, but you've really limited who gets to benefit from this particular application. Those are the kinds of things that you guys get to figure out how to build into your model.

I'll play devil's advocate. I was happy to talk to you guys as you are students. I believe this word sustainability is key, I believe this is key, I believe human is key. I think those three things are more important than the economics and the financial. Environmental is always important. And I'll tell you why, my belief only. We're at the brink of trying to make this work, and the reason it has not been working has not been economic or environmental or financial. It's all been perception of the human being, it's all been social concern. There is a barrier yet to be broken which is people have not accepted wind as a viable solution. What option 2 gives you, is a pro that no one wants to explore. If I build a big wind turbine, Cape Wind, and I build all these turbines, do you feel like you personally have input into that, do you personally feel like you personally have benefit? I feel like it's a big rich guy who built a lot of turbines in my backyard and forced them down my throat. I may like the idea, I may think it's a good idea, but because it's so big I don't feel any ownership to it. In fact, I'm kind of caught up in - what has been the fight if you follow Cape Wind? - human, social issues.

So for the sake of debate under option 2 what you get, sized correctly, you can maximize the economics, you can deal with some of the social concerns because let me ask you a question- you're a senior in high school, you're interested in engineering and someone says to you "I'm going to donate a million dollars and I want you 4 students to work with my 5 students and my school board, and I want you to build a 200 kW wind turbine in the school backyard, we are going to make it part of our curriculum, we are going to cut our energy cost in half, and every kid can see it go up in the backyard. Oh and by the way, instead of it being 375 feet tall with big blades, I can get a 200 kW that's 90 feet tall with 25 foot blades. And I can put it in a place where every student - the next generation - gets comfortable that this is no big deal. Everybody in society benefits because who pays the electricity bill at the school? Every taxpayer in town. Who owns the wind turbine? The school committee. Who does the school committee represent? Every taxpayer in town.

That's partly what I was trying to sell them when I convinced them that some of the things they wanted to look at were the sewer plant. What happens is, the economics the bigger you get, the cost per kilowatt goes like this: as I get bigger, the cost per kilowatt is climbing, there is a knee in the curve- around 1 MW by the way - and then it just starts to go up slowly. So if you're a business person, everything beyond this is gravy. So instead of doing 1 MW I should do 5 because there is no real big incremental cost. Here's the problem - externalities. All the other societal impacts of a choice we make today on future generations, and how do you assign a value to that? Carbon footprint is an externality. Social bias is an externality. The human factor is a belief factor. The word human and fear can be tied together in your discussion.

(goes through our objectives quickly)

When you're done, 100 bucks says you're going to come back and say option 1, because of the financial curve I just described- if you're going to do big wind turbines, will win out. But if you do a good job, the social issues and the human issues are going to be something you have to lay out as arguments and go, "not sure how to get over those." Now why is that important? The greatest things in the world that people have thought of, that had failed, had been because of fear or misunderstanding, the last being financial. But fear and understanding stopped everything. Especially because all of this requires a town vote, so you need to sell it to 1600 people, by the way. Hint: this one doesn't. School Committee is authorized to do that, it doesn't require a town vote, you have to sell 7 people. The school committee might choose to be cautious and get a town vote, but they are not obligated to. And I'm assuming that you will meet probably Town Counsel once, if he's not on your list he should be. You should be talking to Whitey to get to him. Town Counsel is the legal advisor, the lawyer, for the town. You're going to want to ask him some questions about very specifically, given some of the properties you are looking at being town owned- what is the process for getting permission to use these properties? That's a key point when you do this part- laws and regulations. He should be doing that for you. Paul DeRensis is his name. When you look at ownership and financial issues, to some extent he will help you understand what a municipal can and cannot own.

The fact that the Committee asked you to layout what are the pros and cons of a municipal utility being formed and taking over our system, if you guys were getting your graduate degree and already had your law degree that might be a realistic paper to write. I'd focus on the wind and not spend a lot of time on that, that may be more than you guys can handle. Seriously, there are big law firms that make their living debating the pros and cons of municipal ownership. I couldn't even begin to help you, and I think I'm one of the last people that have a general view on some of that. In fact, I would say to you that quite often what's going on now is utilities are under pressure, like National Grid, to buy up municipals because they don't fit the regulatory review model, and the state would prefer that most of them go away. That doesn't mean they can't own generation, but it's not a friendly environment for municipals to survive because of the regulatory complexities that are in our industry today.

So is it pretty much impossible to setup a new municipal light department?

It's not impossible, and I think there are 2 different types of municipals. There is a municipal which owns generation, I think that's a possibility - talk a little to Paul DeRensis about how that would work. The idea that the municipal would exist and own the distribution system as it exists on the island today, I think that the regulatory environment that exists today and the overall cost to purchase those assets from National Grid, would make it extremely prohibitive to review in any real detail. You might say it that simply and say that it is something bigger than you would want to undertake. I promise you there are some great papers online written by people who are in law school on this. I went off a little bit on your question, trying to help you understand kind of what is a process that you're going to have to go through.

Based on what you were saying about the school example and it being most cost-effective is if the school uses all of the electricity produced and you don't sell [any] back?

What you want to do, is if you size it to be tied to this type of facility, a school or another major municipal project, is you want to size it in such that there is not a lot of excess power being sold to the market because of both the risk that you really have to spend some big money upgrading the equipment at that location which changes to economics. How much? It could change it- a 250 kW unit completely installed including licensing, procurement, and so on is about $1 million. If you go beyond the size of the switch gear and have to change the switch gear and rearrange the electrical connection at the school, you could add a half-million dollar cost to the project. So sizing it correctly- and again this will be the interesting thing, you guys are going to have to help figure out an argument and I am happy to work with you and figure it out- but there have been people smarter than me who specialize in this and say that typically speaking you will find that 75% of their peak daily use is a great size for a wind turbine if you're looking for that curve of "how big do I want to get". So I maximize the value of the financial impact without forcing myself to make major changes here. And so there was that number somewhere in there.

Do you know what the numbers for peak usage and daily usage at the 2 sites are?

I do and I think we sent you a whole bunch of stuff right? It is not in there. Do you guys know Michael Burns? Mike got sent all of the files for all of the major- and by law I got them sent to me, I can't give them to you unless either Whitey and the Selectmen send me a letter saying it's ok, or the easiest is we gave all of this to Mike last year so he could give it to you. If he can't, you can have Whitey have Libby Gibson send me a simple email and I'll forward it to her and she can forward it to you. So I'm happy to get it for you, it's just considered confidential. So it's an interesting debate, I would pick the school.

There will be 2 options throughout your thing, and you can go over to the sewer plant and layout the costs of doing a 2 MW unit and how would you make that work? Or doing the sewer plant and waste water options both around 500-600 kW and doing a 200 or 300 kW wind turbine and offsetting their costs, and going "look at the difference in economics." And I'm not feeling bad about saying it on tape, because I've been before the committee several times and have said, again because of my concerns if you get too big, you may not get public support, you may not get long term public buy-in. And the economics, you might find when you're all said and done, don't produce the same kind of financial benefit for the risk you have to take relative to social support not financial support. Because I promise you, the bigger the turbine, the better the long-term financial outcome will be, except that the social and the human factor can change the permitting.

If you're not sure, Nantucket Electric Company started its second cable the exact same day Cape Wind started its cable. Installation, licensing and permitting, getting the legal permission to build something, is the front end of the project. When you do licensing, typically speaking, you rate that as risk, and you assign a certain number of years. Submarine cables are the most complicated and risky things that you can permit. We finished ours after 3 years, built our cable in 2 years, and placed it in service took 5 years. Cape Wind started same time we did in 1999. It is now coming up on 2009. It got all of the same permissions but because of a lack of social and human support, it had got caught up in court. It is an art to know what people are willing to let you do. It's not as much science as everybody wants to believe.

Do you know what the maximum amount of electricity that could be produced at the Landfill and Waste Water sites would be without having to add/upgrade equipment?

I do not. But I can give you a ballpark of a half-Megawatt. And again the town has an engineering firm, EIS, that had worked on both of those and should be able to give you some of that interconnect information.

(goes on to explain fault duty interrupted and gets into electricity in a more advanced way)

Can electricity travel in both directions through the cables?

If someone was to ask us to do that, that is a very complicated study that they would have to pay to do. It is technically feasible, there would be costs because there is complex relaying that would have to be changed. And the issue is not the cables, the issue is the transmission system and the market we are tying to- there are a lot of really complicated things going on on it- and you might find that pushing power back into the system could force changes all the way to New York City or Boston because of how it all kind of ties together and works.

Do you have any idea of the costs of the equipment for that?

I would say it's an extremely complex system, it can be addressed, but the study itself is probably in the $50,000-$100,000 range. And the changes could far exceed the study.

Going back to the electricity that could be produced at the sites, do have any idea how expensive the equipment would be if an upgrade was needed?

There are a lot of different ways that they could set up metering, and again those require interconnect studies, and so I suggest you setup a call with Dave Larson and talk to him. If he doesn't answer your questions, I may have to setup a call with all of us to explain better and get more answers. But the interconnect cost could easily be a few hundred thousand dollars.

If Nantucket was not its own electrical utility, would wind turbines still be feasible?

There are two types as far as you're concerned. One is net-metering, on the customer side of the meter. The other is should the town of Nantucket become a generation company selling power into the grid. And again, that one is where the economics, along with the externalities may scare most people away. I'm going to talk in a little bit about this, this is a philosophical debate.

Do you know what the different ownership options would be as far as if Nantucket wanted turbines, would National Grid want to own them, or would it be fine for the town to own them?

Right this minute, National Grid does not have a mechanism to own them; we are out of the generation business. They would really look at 3 options. One is completely owned by the municipal. The second is owned by a third-party. That is, they would find a generation company - Solar Turbines, American Wind, someone - and setup a relationship. They would make the land available and so on, and the good wind regime of Nantucket and support a location and letting a third party own it. The last is a municipal/private party ownership or collaborative if you will, where it's possible because of the unique financial characteristics of the island, that they could get a joint venture either with public or private money. That's very practical out here as a possibility.

As far as net-metering goes, do you first off know that there is more than one meter at each site?

Yes there is more than one.

Do you know if you used net metering if you could use it on more than one meter?

Typically it would be just one.

I would go to Cape Wind if you have not; they have an outline of the process you go through to permit something. And I would make sure you get your arms around what it takes to permit it. And typically speaking, you are going to have, and if you start at the top which is almost always the case - you have the local, state, and federal - and normally there is going to be, across the top, environmental permits required. There's going to be use permits like for federal there is going to be FAA at the airport. Because you're on school property I'm sure there will be some kind of state permit. And locally here, you are going to have things like HDC, the building department, so you're going to want to think about the different groups you're going to have to talk to. You're going to need zoning and planning here, and all of these folks are very nice people and happy to talk to you. Andrew Vorce probably took you through what the permitting issues may be.

(gives us documents)

On the state side, you're probably going to have PUC issues or regulatory agency issues as in the DTE, department of electric and telecommunication. When you start getting into that, if you get a hold of me, and I can't promise it, I will see if a friend of mine - David Rosensquag, who runs a law firm that specializes in licensing - might be able to give you a half hour discussion on just what are the issues and how do you lay them out. But again, Bartlett will tell you what he had to go through. He should be able to give you a paper and say these are the permits I had to get. And they really shouldn't change.

So you have all of your permits, then you need a social/public outreach program, because you need their support. And it starts with public input, starts with educating all of the key players. You win this by not surprising the key players. We did something, it's how I got successful, we call it the Technical Advisory Group. We go to the Selectmen in a town we are going to do something complicated in. In this case you would go to the school committee and say I would like you to work with me and go to the Selectmen. And say we are going to ask them to form a group of 6-8 people that would work with us for a fixed period of time, 45 days, we are going to review these options and we are going to make a recommendation. And normally what we look for is someone from the DPW, someone from the planning board, someone from police and fire, someone from the environmental groups in town. And what I'm doing is bringing in the smartest people in town with all of the issues that I need to address and putting them in a room and closing the door and saying "what are the issues?" Without saying that to them. Guess what they do? They help me define. I may find the best place to put this is the sewer plant. But the environmental group is going to say that you're in the last bit of eel grass protecting the last dune on Nantucket.

Now, I've done this for years, I know that a barrier beach is a tough thing to build on, and if there are certain kinds of grass on it, I can't disturb it. So when I get done the economics would say this is great, but because I want to listen when I talk to those people, if they said to me that grass cannot be disturbed, I now need to be very careful and say how do I get this off the list? Because guess what? If I can't disturb the grass, I can't install the thing and I'm back to being Cape Wind. I didn't listen and I'm going to try and force it because some other piece of this made so much sense that I'm going to force it. It's my belief that the school, and possibly the compost site, both have the least amount of environmental issues, and also have the maximum potential to get the public support, that's my belief. But that's the soft side of permitting and that's the social outreach.

(We go on to explain our tasks pertaining to economics and explain we are not going in depth with it)

Follow-up Interview, December 9, 2008, 6:30-8 pm

I think the trick here is that you need to remember that we bill monthly, and if you have a month of light wind, July and August- a very light wind period- you could have any energy bill that this doesn't offset much more than 5 or 6%. You then could have months in the Spring and the Fall, in particular say the months of October/November where the winds are very high, and this can easily zero out a bill. So I think you need to have a footnote here that says "actual percentage given how the bills are calculated monthly and how the wind patterns and therefore the wind energy produced can vary monthly"- may not correlate directly to your 16.07%. And I think it's ok covered by a footnote for this kind of report.

Energy price… and you have your 16 cents per kilowatt.

Also, one site it was this 16 cents (surfside), and the landfill was about 20 cents.

I think it depends on the month you look at. There is a winter and summer rate. So what we are going to have to get for you tomorrow when Mike calls are the winter and summer rates. And I'm actually going to challenge you to do a little bit of what we call sensitivity testing. Once you get this set up its going to be like 4 scenarios, where you're going to say 14 cents and 16 cents, and say those are the winter rates, and that's a range. And actually you should always do the baseline, which in this case is the 16 cents in the winter. Do 14 cents if energy costs go down, do 18 cents if energy costs go up. And now what you have done is called the sensitivity. That's now starting to do real engineering. Engineering economics is about understanding the 'what-ifs'.

And now you're going to do the summer price, which would be the 20 cents on the high side, 18 cents is the price in the summer here right now, and 16 cents would be on the low side. Now you have at least a pattern to say "look how energy prices (like the oil prices have gone crazy)- do you believe oil prices and energy prices are going to go down?" If you do, then this is your benefit. If you believe they are going to escalate, than this is your annual savings in future years. *Sensitivity Analysis*. Really critical. One of the big things if you're doing state projects or finance projects, they want to understand what sensitivities you tested.

(goes through breakdown)

What's the RPS?

Renewable Portfolio Standard or renewable energy credits. (I explain it)

So I would spell this out though more clearly so people understand. So this is really a tax credit back to you. There's a state tax and a federal tax credit. So really you're going to get back what looks like a total, really if you added these together correct? So you are going to add those to the 16 cents for a total value. Bigger than I thought.

(goes further down breakdown)

(talking about estimated annual revenue) Again, this footnote about it being linked to the timing of the bills needs to go back to this one as well, because again, this will be tied to timing issues. Just make sure you don't miss that point. Maintenance and insurance, 1 penny a kilowatt is an industry standard. Yeah, the industry standard for all of these, if you don't know what to do for generation, is a penny a kilowatt. A lot of time you are going to look for something a lot smaller, in really big power plants it's significantly smaller. But these kinds of things, a penny is probably a reasonable cost.

(goes over more rows)

So you're saying that for a 1.5 MW turbine, that at these prices you are projecting, you expect to offset the town's electricity bill by about $400,000. Conceptually, at least that's not off like I go "oh my god that doesn't add up mathematically." So from that standpoint that works.

(turned off- resuming)

So that's the first thing you want to do, is test the sensitivities of the price of power, the value of energy. The next is, if you're really good, you are going to run 'what-if'- you don't have to worry if the cost goes down do you really? Because you ran a scenario and you said I can cost justify it at this number, what's Dave Fredericks worried about- you're way off. So I would take each of these and add 50%. Because you don't want to run 50 scenarios, I would normally do this if it was Dave Fredericks doing this for National Grid- I would do it in 10% increments. And I would say that the people that work for me- "I want to see 4 factors run out just to make sure I understand." Again, if you don't like 50% this again is not my study- but if I was selling this to the public I would say 'what-if' the price goes up 50%. Because it takes 3 years to license and everything goes up. So the value of my 2.8 becomes 3.6 (price for 1.5MW turbine). And then what I would do is I would take the 3.6 and rerun it. And now what have I done? I've just tested the cost if things got out of control.

The last one you have to write a paragraph about. You do not have time to study a correlation. Now what can you do though? You write a paragraph and you take your capacity factor, run it at the 25% and say 'what-if' and then run one at the RERL's number. Now you didn't have to argue with them and have to say to them "your way is wrong". I ran the numbers you gave me; I ran a practical number that another company has used to give you a test of the sensitivity. So now when you're done you're doing these five, then you're re-doing these 5 with a 50% price, so now you've done 10. Then you jump and did these 2. And again, I wouldn't accept this if you worked for me. I would actually ask you to go 10% above what you think, and 10% below the worst. We know that 25 is expected, so I want to know 15. What if we are wrong, what if there is something on the edge of where you're building that thing, and the wind doesn't produce. That doesn't mean it's a failure, because what I said to you would happen is that instead of 7 years it would take 9 years [payback]. But I would've tested it.

So when you're done testing sensitivities you end up with these 5, so again, Test #1- you've tested the price, Test #2- you've tested the construction price, Test #3- the synergies between capacity factor and timing of wind. Each one you should draw a very simple 3 sentence conclusion. My guess is, on price, it's realistic to assume that energy costs will go up, not down. The value of the wind turbines will only improve. On construction costs, even at a 50% markup, the value of wind is still there; it's payback period may be 2-3 years greater- that's my guess and what you're going to see. Then you're going to jump down and see 'wind' and you're going to go- same thing, still cost justified at the lower end value, however, the payback could be 2-3 years longer. That's an economic comparison.

(tries to get into explaining Net Present Value)

You have to at least know if somebody asks if these are net present value numbers, you can say no they are simple numbers- the pay back, and this is your argument, is somewhere less than 7 years so we tried not to complicate the model. Don't get into anything else. Most people don't get into this until a graduate program. But you at least need to know what the idea here is- as you forecast those costs you have to convert them back into something I can talk about today as a total package- that's net present value.

So straighten out the table…

(phone call)

You're an engineer, you're completely unbiased, right? And it is probably going to be, in the short-term, a 250 [turbine], as this value, 450. Now you're writing the conclusion about the financial impact.

(explain conclusion/recommendation section… tell him our final recommendation of on 250 kW at each site)

There is one other benefit, and I am sure you point this out. I want to put this into simple terms.

(draws graph for dump with kWh/year- fluctuating from winter to summer… so then they have an average… graphs out output of 250 kW turbine against this…

Some of these things, and the absolute capacity value tied to the value of the market are a little bit up there. So by keeping it right sized, you are going to keep it below the daily use, thereby maximizing the price in selling it for 18 cents instead of the market price, that's the point. And if you're not playing that up on the 250-kW you should be. Don't just touch upon, I would make that a key assumption that it drives the best promise per economic liability.

So you have to tell that story in your conclusions. Sensitivities will help tell that. And so if people say "well what if you can't deliver it or it gets delayed because it has to come in by barge?" Here's a scenario so "oh, by the way this is what it does to the impact. Turnaround on a 1.5 MW is around 7. So when you make the capacity higher to about the 40, the 250 is going to be about 2.5 years, and the other is going to be about 4. I'm actually kind of surprised about that.

(explain how we got cost per kWh)

Did you increase the cost for Nantucket? Every project on Nantucket has a cost in doing business called "the Nantucket cost of doing business". And so I would take every cost I have, and say that you added a flat 20% to all project costs due to this

Follow-up Telephone Call, December 10, 2008

In the course of a month, we bill monthly, we keep track of what is the average demand during the day. And for that site, the dump, it is 280 kW from September through about May, and then for June, July, and August it's about 300 kW. A 250-kW turbine has the potential, depending on timing, to all but eliminate the peak demand, as well as have other long-term impacts on the bills that you can't analyze easily, but can ultimately really impact the bill as well. So there may be the ability, through timing, to really affect the electric bill even further.

This physical year should come in about 600,000. The previous year was about 501,000. The peak demand for the non-summer months is the 280, and the summer months about 300-310 kW.

(describes the value we have of the 82,000 kW is all the other things at the site like offices and such)

The big one that was 501,000 [kW], that meter this year used just about 600,000 [kW]. I think what you do is put a footnote in there that basically says in the year 2008 we expect that they will use closer to 600,000 rather than the previous years at 500,000. Which will only improve the economics.

APPENDIX D9: INTERVIEW TRANSCRIPTION, S. MELVIN

Telephone interview with Scott Melvin, Massachusetts Division of Fisheries and Wildlife Endangered Species Program

November 12, 2008. 3-3:30 pm

I'm fine with being quoted; I'll probably put some qualifications and disclaimers on some of the things I say as we go along. But I'm fine with being quoted.

Can you tell us a little bit about your educational background, and your credentials and experiences with endangered species and birds?

I'm the senior zoologist with the Natural Heritage and Endangered Species Program which is part of the Massachusetts Division of Fisheries and Wildlife so we are the state agency that has legal authority for conservation protection of wildlife in the commonwealth of Massachusetts including species that are listed as endangered, threatened or species of special concern and receive special protection pursuant to our state endangered species act. I've been in this position for about 25 years.

I have a Ph.D. in wildlife ecology and zoology from the University of Wisconsin at Madison.

How long have you been studying birds and endangered species?

All of that time. That's my principal area of expertise and work responsibility, conservation of rare and endangered birds.

Can you tell us a little about the work you do with the Natural Heritage and Endangered Species Program?

My work and responsibilities include developing and implementing conservation programs for state listed rare species particularly birds that involves monitoring programs to track abundance and distribution and in some cases reproductive success. And to coordinate overall conservation programs for these species which includes, habitat management or protection of breeding birds, habitat acquisition.

Do you have any prior knowledge of wind turbines?

Yes. Siting of wind turbines is an important conservation issue that has come up in this state over the past 5 or 6 years. I've been involved in several of the regulatory deliberations and opinions issued by this agency on wind power proposals and their potential affect on rare and endangered water birds.

Can you tell us what your opinions and concerns are with wind turbines?

Our concern is that they be sited in areas where they are least likely to have adverse affects on rare and endangered species and their habitats. In the area, where we've had the most concerns in recent years has been for proposals for very large wind turbine facilities located offshore particularly in Nantucket Sound with the Cape Wind Project and more recently with the proposals for wind farms in Buzzards Bay offshore.

Do you know anything about the endangered species and birds on Nantucket?

Yes.

We know that many people were opposed to turbines in Nantucket Sound due to hazardous effects on birds. Do you think land based turbines, they're looking at 4-6 turbines at the Landfill site and 2-3 turbines at the Waste Water site, and do you think these will have similar affects on birds as people feared the Cape Wind Project would?

Ok this is where one of my disclaimers is going to come in. What I'm going to be offering are some very general opinions based on this very general information that you are giving me. Realize that any sort of proposed wind turbines that would be proposed to occur in areas on the map that are designated as priority wildlife habitats by Mass Wildlife need to be reviewed for potential impacts to state listed species. So projects like this very likely would go through a formal review process through our agency. They'd be reviewed by additional people within the agency possibly including myself, and a formal opinion would be rendered as to potential affects. So anything I'm going to say now is very informal and would in no way preclude formal regulatory review somewhere down the road.

In terms of impacts to state listed birds, in general potential adverse affects of what you are talking about, that is a relatively small number of turbines located on the island itself would very likely have less of an adverse affect than the larger facilities that have been proposed offshore.

The two possible sites are the Landfill site and Waste Water Treatment Facility. Do you foresee any fatal flaws with these sites regarding endangered species and birds?

I don't think we are in any position to talk about fatal flaws. We can talk in general terms. I think with all of the locations and the particularly smaller magnitude of the proposed work it is less likely to have an adverse affect on state listed birds, particularly terns, Piping Plovers and any of our four state listed species of terns: Least, Common, Arctic and Roseate, in part because there are many fewer turbines and they are located on the mainland. Only one of the sites, the Waste Water Treatment Facility, would be close to coastal habitats and we currently don't have these birds nesting right at or immediately adjacent to the sewer beds, although undoubtedly there are birds moving along the coastline in that vicinity.

We've been told by a few other people that Piping Plovers and Least Terns could be affected at the Waste Water Treatment Facility, and might potentially feed at the sewer beds. Can you tell us a little about these birds and the concerns you might have with them and the turbines at this site?

In terms of birds actually feeding right at the sewer bed, I don't have that information so you'd need to rely on your local observers. Certainly it is likely that Piping Plovers and Terns could be flying right along the beach immediately adjacent to the treatment facility. Plovers could be feeding right on the beach there in the dunes. Terns could be feeding just offshore. Certainly under conditions of fog or cloudy weather or wind they might actually fly into the turbine area.

We’ve also been told that Short-eared Owls and Northern Harriers use the area for foraging and close by nesting. Do you think that turbines could have an effect on these species?

Yes they could, I was coming to those. That could be a concern and would be more likely to be a concern at the sewage treatment plant as opposed to the other site.

Bob Kennedy told us about the possibility of Piping Plovers and Least Terns feeding at the sewer beds, which hasn’t been studied on Nantucket, so a study would need to be completed. Do you know what a study like this would entail or have any recommendations for the committee for someone who could conduct the study?

I’m not familiar with what the sewer beds look like. But if some of these are completely drawn down during spring or summer, so they’re just wet sand or a wet substrate that might be a possibility.

Would this be something that Mass Wildlife could study or would someone else be needed?

Somebody else would need to. It wouldn’t be something we would have staff to be able to undertake.

At the landfill site, adjacent to the dump are nesting Ospreys. We were told that they are attracted to poles. Do you think that they could be a concern with turbines as well?

I’m not sure. I think the first question to ask would be, would the design of turbines and the poles be such that an Osprey could locate a nest on them? We have lots of situations in this state and elsewhere, where Ospreys will nest on power transmission lines, chimneys, unoccupied boats, lights on baseball fields, so those can be dealt with but I guess it’s a potential issue.

Do you have any concerns of any endangered species other than birds at either of the sites?

Potentially but that’s where the more complete and formal review by our agency would come in. Realize that we track, and have a fairly taxonomically diverse of species listed as endangered, threatened or species of special concern in the state which includes invertebrates and numerous plants. So one of the questions that would have to be asked would be does the siting of these result in any adverse affects particularly physical disturbance and mortality, to the state listed plants or invertebrates on the island.

Do you have any concerns on plants, animals or birds that the possible construction project in regards to the foundation or access roads etc.?

That is in large part what I was referring to in the preview answer. So for example if this was sited at a site that had the Nantucket shad bush, would there be a physical mortality or disturbance to the plants and their habitat at that site by the construction or an access road or by siting of a transmission line.

Any structure over 200ft must be lighted. Do you know anything about the effect of lighted towers on birds?

Under some conditions, they may attract birds. I think that is an area that still is not terribly well understood as far as the impact of turbines on birds.

Red lights are better for reasons unrelated to birds, for residents and such. Do you know if red lights are particularly harmful to birds?

I'm not sure.

Do you have any suggestion to minimize these affects on birds, such as color of the light or the tower?

I'd have to get back to you on that and talk with some folks who have been more directly involved with some of the wind power deliberations than I have.

Other concerns have been with fog and birds; can you tell us how fog can affect birds?

Obviously fog can obscure the presence of the turbines, the blades or the towers themselves, and result in mortalities. That's one of the biggest concerns that we have when you get beyond the question of can and will the birds avoid the towers and the spinning blades under good visibility conditions, then you raise the question what's the potential for mortality under foggy conditions. And certainly fog is a common phenomenon in places like Nantucket including during periods when the birds are in the area nesting chicks and periods during migration in the spring and summer.

Do any of the sites appear to be in any migratory bird paths that might be a concern?

I'm not sure I would term them major migratory pathways but the one down by the sewage treatment plant again would be much closer to areas that Terns and Piping Plovers could be moving back and forth through. Any site on Nantucket could potentially cause mortality to a variety of birds including migratory song birds under the right conditions, with a broad front migration in spring or fall. But again I think the locations we are talking about and the relatively small number of turbines would be much less risky to seabirds whether it be Plovers or Terns or some of the large concentrations of sea ducks that winter and forage off Nantucket. What you are talking about on the island itself would be much less of a risk than larger numbers of offshore turbines. Now having said that, obviously the on island turbines could pose more of a risk to Harriers and Short-eared Owls, but I think that risk would be somewhat more diffuse in that the distribution of the Harriers and Owls is much broader on the island.

We talked to the head of the Princeton Municipal Light Department, they are putting up two turbines and had a few prior turbines, and he told us in October during a two week period they have a big path of migratory birds so their plan is to shut the turbines down during that two week period. When we were talking to some of the birders at the Energy Study Committee meeting last Thursday, they mentioned that there's some time in the fall when the migrations can be predicted. Do you know anything about this and does this happen during other times of the year?

It's a fairly broad time of the year when song birds are migrating. It can begin in late August and continue into November. One can also generally predict when large migrations will occur with the arrival of a high pressure system with a northwest winds basically blowing from north to south and also with clear conditions. But then you can have songbirds coming onto land or forced to low elevations by poor weather which of course is a little harder to predict exactly where along the migration route this will occur. But I would rely on the local knowledge out there and if there is a specific time of the year or particular conditions that they can predict will result in a large number of songbirds or other species passing over or landing on the island in the vicinity of the turbines, I think I'd want to press them into specific and how well that can be determined.

Can you tell us about what you did to come up with the Cape Wind data like what is used to determine how the birds will be affected by the turbines?

Well if you take a look at those documents, part of the problem is there is not a lot of data to go on. We've raised our concerns based on a lot of monitoring work that's gone on monitoring the Piping Plovers and Roseate Terns along the coast of Massachusetts and the Atlantic Coast. There have been some surveys done specific to the Cape Wind Project that have been done from airplanes and boats that derive data on occurrence and distribution of Terns offshore.

You said that Mass Fish and Wildlife would have to conduct a study before constructing turbines on Nantucket, would this be similar to the study done for Cape Wind?

No I'm not necessarily suggesting that a study or study of that magnitude would need to be done. One of the things that we'd want to look at is what is the known distribution of Northern Harrier nests on the island relative to these sites. There exists some very good recent data with that information. Karen Beattie with the Nantucket Conservation Foundation has all of that mapped.

Are there any other concerns or issues that you think the Energy Committee would need to investigate?

Not that are immediately coming to mind.

Someone from the Maria Mitchell Association had mentioned concern that land based turbines and their vibrations could affect marine life. Do you know if this is a concern?

I don't know, that goes beyond my understanding and area of expertise.

It sounds like you will make an effort to contact Karen Beattie. Have you contacted Edie Ray? Well Edie works for Karen in the summer, she would be a good source of information on these more general birding questions like what are the patterns of the various migratory songbirds in the spring and fall, what are some of the conditions when they get large numbers of birds on the island and be most affected by turbines.

APPENDIX D10: INTERVIEW TRANSCRIPTION, V. LAUX

Interview with Vernon Laux, Linda Loring Nature Foundation, Nantucket, MA

November 13, 2008. 1:30-2: pm

Tell us a little bit about your background as well as your credentials and experiences with birds.

I've been watching birds since I was in the eighth grade in Wellesley Massachusetts. My goal was to see all the birds in North America by the time I got out of college, which is why I took a year off, and lived in Alaska and worked in a research boat. And then I went to the University of Arizona in Tucson, because I needed to see the birds of the desert southwest, and I did in fact manage to see all the birds in North America by the time I got out of college. That was over 700 species now it's almost I've seen a lot of birds and I've worked in all 50 states. Sadly that wasn't enough for me than I had to go see birds elsewhere and over the ensuing decades I have been to all seven continents. I've been to Antarctica 40 times, I've seen most of the birds of Australia, half the birds of South America. Actually I've led bird tours all over the world. I'm the American expert on birds in the Middle East. I used to go to Israel and Jordan every year.

I'm settling down now, I'm trying to stay home a little more. I lived on Martha's Vineyard for a long time, 27 years. I started writing about birds back in the I don't know when; I've written a lot of articles in the Science section of the New York Times, I've written weekly columns in the Martha's Vineyard Times, the Vineyard Gazette. I wrote a weekly column in the Cape Cod Times, it comes out every Saturday. I write in Nantucket's Natural World and the Inquirer and Mirror, and I also have a thing on National Public Radio on the Cape and Islands station its podcast, I do a commentary that's broadcast three times a week and I do a show the first Thursday of every month; and I'm working on a TV show that we just won a finalist in the Jackson Hole Wildlife Film Festival. I just finished filming this fall for an hour special that we're airing it in New York right now.

I've been birding in Massachusetts; I think I've seen more birds then anyone in Massachusetts. For a while it starts out as a game, it's like an Easter egg hunt. Then you start learning… I'm actually an expert on butterflies, I know a lot about dragonflies. I've been doing the Christmas count on Nantucket, I only moved here like 14 months ago. This foundation was created back in [19]99, but the land didn't come over, it didn't really get started till last year. I'm one of the first two employees, they didn't want to lose me so they hired me, they gave me a place to live they pay all my utilities, they give me a truck, I have a month's paid vacation, I have everything. It's a pretty good job. I'm very happy. Also I have a radio station upstairs. I have a mixing board. I can do a lot of broadcasts from upstairs you can do any radio interviews…

I'm very qualified about birds, especially in Massachusetts and actually anywhere in this country or some other places.

Massachusetts is what we really care about.

What we're talking about is right over there [gestures out his window toward the landfill]. I won't see them [wind turbines at the landfill] at all.

Well hopefully [the turbines] won't be too big.

They didn't sound that big. I mean Nantucket's a real problem, where are you going to put wind mills. I really think that the further we can stay away from the south shore and any shoreline, cause birds tend to migrate along those and anywhere along this western end of the island. If they have to have them it's probably [the best place for them], I mean it's all screwed up over there anyway. That's about the only spot that would make any sense.

The turbines shouldn't even be half the height of that tower you're looking at.

How tall is that?

467 feet.

467? Seems taller than that to me, but I was watching some guys two months ago climbing up there to do maintenance. I don't want that job. They'll be plenty visible, that's for sure. We've gotta do something. The first thing we gotta do is start conserving energy, and turn of the lights.

You're not the first person to say that [the first thing the town should do is turn off lights to conserve energy]. I guess a lot of the buildings just leave the lights on.

If you don't need to use it, don't use it. Just looks like a city over there. Did I answer that question?

You answered that, and several other ones. I just want to double check and see if I have the right answer, so you've been working for the Linda Loring foundation since you got here, 14 months ago?

Correct. Or 15 or 16 months ago, I started work Labor Day weekend a year ago. [14 months]

Can you tell us what kind of work you do for the Linda Loring Foundation?

I'm the education director, resident naturalist, which means whatever you want it to mean, property manager, and I also do all the maintenance. I just ordered new storm windows, and will be putting them. It's sort of evolving as we go. I spent this last winter going from the conservation commission doing all sorts of work out here. I got approval for a trail system, 100 foot boardwalk and a little bridge across this creek, two blinds down the edge of the water. I do all sorts of stuff. I do a lot of public stuff. I did a talk at Bartlett's Farm last weekend. Today I was taking to all the fourth and fifth graders on field trips at the elementary school. Today was international literacy day; I went down and read for a couple hours.

Since you were at the Energy Study Committee meeting last week, I assume you know that they identified the Landfill and Waste Water Treatment Facility as possible sites for wind turbines, which they are investigating now. Are there any birds, in particular, that nest or forage or migrate through those areas that you think might be of particular concern?

Well, I think that we talked about this at the meeting. Nantucket has [Northern Harriers]. This past summer there were 59 nesting pairs of Northern Harriers. It's a very threatened species that only breeds in a few locations on the coast of Massachusetts. Nantucket has the highest known density anywhere in the world, and it's unclear, I know the wind farm out in Altamont Pass had a lot of raptors running into wind mills and getting killed. There talking two or three blades? Somehow the birds when they lock they see something they don't notice the blades they lock right on so they just fly right into it. That would be a concern for red-tailed hawks here, Northern Harriers. I don't think we will actually have the answer to that until we actually see one work. I guess just any hawk that flies through there might get bumped off, that would be very bad. I don't know if that's a real or imaginary problem, I don't know if that's going to happen. It certainly could happen, but I don't think that's enough reason to stop the wind mills. I think the birds will be smart. My other concern with wind farms or any, what are we talking about 6-8 or?

4-6, but I think that's further down the road.

I mean that would be a lot of spinning blades. Do these things turn and face the wind too? Do they rotate around?

I don't think so, Nantucket makes it a little more difficult but they are supposed to be sited and positioned in the direction perpendicular to the northwest wind.

Because the prevailing wind in the summer when you need the most energy its south west. It blows hard from the southwest, from the northwest, and from the northeast. The rarest wind is what it's doing right now, a light southeast wind. You'd almost think they would have to swivel around.

They all don't. I think most do.

Right they are propeller blades like in generating an air foil in a plane, so they have to stay with the wind or it won't work right.

Are any the locations that they are talking about, the Waste Water Treatment Facility or the Landfill, are they similar to the Bartlett's farm area? Do you think they would be able to do studies on the turbines there, to give reasonable results for what may happen?

I think there are actually more birds at Bartlett's Farm. It will be interesting; they are going to start building that pretty soon. This fall there are some little ponds over there at the dump, and they attracted incredible numbers of shore birds this fall. Including some very rare things, maybe a bird that has never been seen in North America before, we are still trying to work it out. I've been sending the pictures around to different people. I wonder what happens to the shore birds in those ponds, if there's a wind. I would think the turbines would scare away a lot of birds. Out in the Midwest they wanted to put them out in the Flint Hills in Kansas, there is so much screwed up land in farmland. I think a wind farm should go along the spot on the Cape, on the mid Cape highway on the medium strip. You've got the infrastructures there; it's already dead of wildlife because it's a killer road on both sides. You've got transmission lines there, it' up high. Why not put wind mills there? See on Nantucket there's really no [good place to put them] the dump is really the only logical place. Siting is the big problem with these things. Out west they want to put them in these short grass prairies, and the prairie chickens won't come. They like the open. If there's any structure you've just made it a prairie chicken free zone for miles. We don't have anything like that here that I am aware of. Of course there would be a few nights in the fall, we would have to come up with some authority to close them down or there would be massive kills. That wouldn't happen often, but there would be a few nights in the fall when the right wind conditions would be a northwest wind, and fog coming in the morning. You could go down there in the morning and there would be thousands of dead birds, and I don't think anyone wants that. They'd have that. Some mechanism, I'd be happy if I'm here we could put together, there's some radar sites we can look at right at sunset, see what's getting up and if they are all coming then we have got to shut them down until tomorrow morning.

The Energy Committee is very interested in having that [making a sub-committee to determine when to shut down turbines (on nights likely to kill many birds)].

As long as they are agreeing to do that, the other stuff …Sure a few things are going to run into them probably, but who knows.

Yes that is there goal too. They want the clean energy but they also want to make sure that they don't destroy anything here.

Yes, that's important. Try to do the right thing anyway.

I know you have been talking a lot about tracking the birds, websites and things like that, are there any documents or anywhere we could find photographs of the paths they take?

I will send you some links. The only things we have transmitters on here, and we are going to catch in three weeks, December 5th they are coming up, we are going to try to catch 11 or 12 more [Long-tailed] Ducks to put transmitters on.

Those are Long-tailed Ducks?

Yes. We have a vet come up from Washington because they have to surgically implant it, the ducks don't like it much… They fly sometimes; last winter here when it's cloudy like this, Long-tailed Ducks will come right up over the dump. I've seen them come up right over Mount Trashmore. That would be a really bad thing if they started running into wind mills. That's why I'm very unhappy about the whole Cape Wind thing, that's a bad deal for the ducks, a real bad deal.

Do you know how high they normally fly, or is it [how high they fly] not 'normal'?

It's not normal for them to [fly at any consistent altitude]… Last year it [the daily migration] started on November 12th. Yesterday was the first big flight… It seems like they know when they come across land and they climb like crazy, those things they cut by, I've seen clouds of them cut by probably half way up that tower, about 250 feet up. That would be a real tragedy if they got caught in those. I think that would be very rare. I don't know, I've been trying to figure out what they're doing, when they're doing, trying to correlate the wind direction speed, but they're ducks. They don't do the same things.

Are they the size of a mallard duck?

[The Long-tailed Duck is] a little smaller, but much prettier, really amazing birds.

I know you talked about a number of Harrier pairs [nesting on Nantucket]. Do you have any information about the other types of birds like the numbers that are on the island? For example, the Short-eared Owl?

Short-eared Owls used to nest all over Nantucket as a stronghold, but they have been gone now, for I guess 11 or 12 years. They used to nest right out here they used to nest out at the Miacomet, right near the treatment plant. Nobody really knows why they expired from here because normally wherever Harriers can live, they feed on the same stuff, and they usually coexist beautifully with Short-eared, same type of habitat, same prey base. The only known nesting Short-eared Owls anywhere on the eastern seaboard now are right over on Tuckernuck and there were two pairs this year, that's it. It's extricated as a breeding bird. Fortunately they breed all over the arctic and they come down winter in places, so we still have a migratory population, but the ones that used to live here for some reason, nobody really knows why they are wiped out: feral cats, too much overdevelopment. I mean there is still plenty of open land for prey, for mice and rabbits. It's unclear what has caused their demise. Also, [their demise] on the Vineyard. They used to nest on the Vineyard, they used to nest on the Cape and there just wiped out everywhere. It's a very sad tale. Nobody really knows why. Osprey there's what 18 pairs on the island, we have the two most, actually this nest pole right here is the most successful one on the island. They raised three young again this year.

Are you concerned with any of the smaller song birds? I've heard people bring up the migrations of those [birds].

Again, we don't really know what is going to happen. Depends, nobody… siting a wind mill anywhere is kind off dicey because they move. I don't think it's going to be a big problem here, especially if we can shut it off on the biggest nights of the year, because they will definitely kill things then.

I think you have probably mentioned this already, but either of the two sites we talking about, did any of them raise any red flags of reasons we absolutely can't have a turbine there?

No, not to me. Nothing that I'm aware of. But I'm sure things will pop up once it happens.

Do you have any concerns on the effects that the actual construction of the turbine will have along with the disturbed land during the short time that they are actually building them on the birds or even plants and animals if you know about those.

Not at the dump. It's pretty horrific over there all ready.

Do you know if there is any record of bird deaths at the various towers, such as the communication tower out there?

I've actually gone over there looking a few times, after night. I've never found anything, but I think the crows are really smart, and they know. I haven't really made a big effort. That should be checked because that thing [467 foot communications tower at the landfill] is like a death star.

There are some of these that I've gone to out in the Midwest and Kansas where literally thousands of birds are there dead in the morning. I picked up like eighty species. [The towers are] these huge things out in the middle of the plains, just gigantic towers. I'm not aware of any [bird deaths at the communication towers on Nantucket]; certainly it's killing some, I don't know how many.

You've talked a little bit about the effect that fog has on birds, can you tell us a little bit about exactly what happens with birds flying in fog?

They don't take off in the fog. Actually, they come in from southern Canada they go three to four hundred miles a night. They get up and they go the northwest wind, which carries them out the southeast, which is the coastline. The stronger the northwest wind, the more birds that move that night, the more they get pushed out. Most of these are young birds, it's their first time, they are just going by some little microchip inside, and then they realize as the light starts to come up, or its time to land. They look and they are over water and realize they've gone too far, and have to turn back and are fighting into a head wind. A lot of times, after a big movement all day long on the south side of the island you will see little birds fly in off the ocean. A lot of times gulls figure it out and are sitting there sitting on the beach, and the Harriers, and you see the gulls just go out and knock them [little song birds] into the water and eat them. The exhausted Robins and Sparrows. It's pretty horrible. So fog disorients them, they don't know where they are and they come down. Birds utter call notes, or contact notes at night; it's how they stay [together]. Every species has a nocturnal flight call. They start calling to each other more and more in the fog and they get lower and lower. I've seen big kills and wrecks at light houses over on Mohegan Island in Maine. There are certain nights in the fall where it's foggy and the lights are on, and all the birds are crashing into the windows, the other ones hear them by staying in contact and they all come down and get wiped out. So I can imagine a scenario with the wind mills going, especially if they are going to put lights on the top of these things, which in the fog attracts birds. In a foggy night the lights, I don't know what they think it is but it attracts them. Attracting them in to get killed, which would not be good.

Would a blinking light be better than a steady light?

I don't know. I don't think so. When you think about a lighthouse, a lighthouse is blinking as far as a bird is concerned. I don't know what the advantage or disadvantage of strobing [is]. I don't know if there have been studies. I would think that the strobing one would be worse, but I don't know. That would be something very interesting that somebody should find out.

Do you know anything about different colors that might be more likely to attract the birds?

I don't know that, if different lights are attracted, I don't know.

Such as the blinking red light at the tower there, do you know if that would be any worse than the lighthouse, or just because it's smaller maybe not?

I don't know. I don't know why they put those red. Do they show up better at night or something for pilots? They have to mark them so people don't hit them. If you are flying over here they want you to fly 2,000 feet over the island, but the FAA [says] you are supposed to be 800 feet above ground. So if you're that [high in altitude] you wouldn't run into that tower. If you're up [fooling around] at a couple hundred feet you would be in trouble.

You were talking about possibly shutting off the turbines, or definitely shutting them off during those big migrations.

Just a few nights a year starting from September 15 to October 15, just during that time period that's when we [Nantucket] get our biggest flights of birds.

You already described the conditions.

Yes, it will be nights with a northwest wind of anywhere from 10-30 mph.

Do you know how many days in advance you would be able to predict this? Or would it be that day?

It would be an hour after sunset that day you would be able to know.

You would be able to tell when they leave Canada, so it wouldn't be like they are going to be here in ten minutes there would be a little bit of time.

I will send you the website too to some of these NEXRAD radar sites, then you can look at every night it's incredible. You can go all around the country. There are a lot of birds moving down in Florida still.

We've got this a little bit, but can you tell us what your opinion is with wind turbines on the island?

What my opinion is when these are finally built?

Do you like the idea of wind turbines? Or do you flat-out not like them but you are just accepting it because you feel it's inevitable.

I think wind turbine technology is not the best. I think there's a lot of other sources of ways to make energy, there's photovoltaic here. There are all kinds of new technology and I think wind mills are getting better and better. I like the little wind mills, did you see the one over there, I don't know how those would work, but there are no big moving parts, nothing to run into.

They are not big enough.

They don't make them that big.

Just residential size.

I'm just not sold, anything with moving parts, plus they really are with these big blades, anything that flies is going to have problems.

Do you know anything about bats on the island?

I know I've seen three species. There aren't that many bats. Bats are really getting hurt by this fungus, this thing that's killing them. There is a brand new article that was in the science times last week, about this fungus. It doesn't grow in the summer, it likes it cold. It is transmitted in the caves where they are spending the winter, so they are all getting wiped out its bad. I don't think there are that many bats here but wind turbines are spectacularly bad for bats. There was a study that was just done in England that they just released. That was also in Nature last month. Describing how they got the bats and they looked fine, and they picked them up and they were dead. Then they necropsied them, and the sudden change in the airfoil from the pressure shift when the blade goes by, their lungs were exploded. It wasn't from coming into contact with it, it was just from proximity. Bats hate turbines.

Comparing the considered project of 4-6 wind turbines on the island to Nantucket Sound, do you think that the land turbines will have similar effects on birds that people feared from cape wind or do you think it will be a much smaller magnitude?

I think it will be completely different. I used to be in the airline business. Aviation in itself is not inherently dangerous but to an even greater extent than the sea it is terribly unforgiving of any carelessness, incapacity, or neglect. I just think you know in the homeowners insurance, all insurance companies are cancelling people's homeowners insurance that live within 2 miles of the coast all over Cape Cod and the islands. Anyone who owns a boat knows that the maintenance in salt water is insane, it's incredible, and it just eats stuff. To think about building 140 turbines over 2 sq. miles, and to think that technology doesn't even [work], there is only one turbine that big anywhere in the world, it's on land in Spain, it doesn't work. So this is a really giant experiment and the degree of difficulty got 100 times more difficult putting it in the ocean. Plus this is the largest concentration of Long-tailed Ducks in the world out here [Nantucket Sound] and they are going to be gone. I'm really not happy with the one out here in the water.

I think that's about all the questions we had.

Do you mind if we contact you again in the future?

You don't mind if we use your name for this?

Nope.

APPENDIX D11: INTERVIEW TRANSCRIPTION, A. VORCE

Interview with Andrew Vorce, Nantucket Planning and Economic Development Commission

November 14, 2008. 10-10:30 am

How long have you lived on Nantucket?

Vorce: 16 years

How long have you worked for the Nantucket Planning and Economic Development Commission?

Vorce: 16 years

Can you tell us about the kind of work you do here?

Vorce: I am the director of planning. We have a combination of traditional local town related responsibilities regarding land use, and we also have a regional authority because we serve as the Nantucket Regional Planning Agency, so we're a hybrid type agency that really deals with land use transportation all of those traditional planning duties at both a local and a regional scale.

We know you know a little bit about the Energy Study Committee and their feasibility study for wind turbines. The two possible sites are the Landfill and the Waste Water Treatment Facility. Do you see any fatal flaws with those sites as areas for turbines?

Vorce: No, I think their study was very comprehensive, and rigorous in getting to those points.

We've seen in the WECS by-laws the set of permits. Can you just tell us about what some of the permits they would need with regard to your office?

Vorce: Well it's interesting because if this is sponsored by municipality it will be a municipal use and not necessarily subject to the WECS by-law. This is what happened with the proposed turbine that is being erected at the Bartlett Farm, because its agricultural use it doesn't fall in the category of residential or commercial. So what I think we would, as they have, look to meet the intent of the law here. So under commercial, commercial WECS would be the closest, and that's permitted by special permit with major site plan review. It's fairly flexible in one problem that may arise is the number of towers per lot is limited to one. And Mike, aren't we talking about potentially multiple [towers]?

Burns: Yes, 5 to 7.

Vorce: So that's one, one area that may need in fact to be well this is limited by special permit in the WECS so that's actually ok.

So you could do more with a special permit?

Vorce: Yes. The maximum tower height is limited by special permit, so again this permit granting authority, which in this case will be the planning board can set those distances, so that's good. Minimum tower set back distance from the nearest property line is the distance measured from the mean grade surrounding the support pad to the tip of the blade in a vertical position. Is that possible? I mean that might be something that we want to change.

Burns: Say that one more time.

Vorce: Ok, the minimum tower setback is from the nearest property line is the distance measured from the mean grade surrounding the support pads at the tip of the blade in a vertical position measured along the axis of the tower. So basically, whatever the maximum height to the top of the rotor blade will be the setback from all property lines. Has that been accounted for do you think?

Burns: Yes, I believe we did.

Vorce: You did?

Burns: Yes.

Vorce: Ok, so that one's not a problem. And the guy wire? This won't have guy wires, so that's again an obsolete kind of thing. Blade color white or light gray any problem with that?

As far as we know that's fine. We've been trying to talk with bird people and see if they know anything, and they know nothing about colors affecting birds, so that should be fine. I think those are standard. Actually, there's one thing we saw: some turbines have the tips of the blades painted red. It's just some pictures we saw. I don't know if that was done for any special reason, visibility or whatever. So we will look into that but that is the only change I could possibly foresee with that.

Vorce: So that's good. Tower access is inaccessible by unauthorized personnel. That's standard.

Public interest and public benefit: to grant this special permit for a commercial WECS shall be conditional upon a finding by the special permitting granting authority, the proposal is in the public interest and provides substantial benefits to the community the burden of proof which shall rest with the applicant. The only thing about a special permit that you need to know is that it is, it has to be a super majority of the board, so four of the five members have to vote in favor of it. It's not a simple majority. And with any new emerging technology, our average, not that old people are definitely resistant to change but our average age on the Board is about 70 years of age right now.

Have you seen the wind tower that's up that's sitting there all rusted out?

Is [that wind tower] the one that used to have many small blades, it was a truss type structure?

Vorce: Yes.

I think we saw that.

Vorce: It's on Vesper land and that is something that is an unfortunate reminder of technology that didn't work out so well. Plus you should know that there was a windmill farm where out near the golf course, the public golf course, that failed, basically was put up and failed and during the construction. There was a local kid that got killed constructing it so there's some creeping issues that may be in the back of some peoples mind on it, so that's something to overcome.

I know there was something with a setback distance of 1,000 feet to the nearest property line, or was that the 250 feet and I'm just misinterpreting that one? I thought I remembered 1,000 feet to something, I can't remember. [The 1000 feet was a guideline mentioned in the RERL report – set back approximately 3 times the blade-tip height.]

Vorce: You know, I'm looking at that and I don't see anything about 1,000 feet in here. Let me just go to, wait a minute they have to make a finding that the location does not substantially adversely affect the surrounding area, and again very subjective, what does that mean? It may adversely affect but the key finding is not substantially. So there can be some adverse effect but where does it cross the line between minimally and substantially?

Submission requirements was a plot plan, a structural drawing how you are going to make it inaccessible; abandonment building inspector may cause the owner to remove the WECS, specifically if it fails to generate power for one or more years.

There's decibel readings, to be measured at the closest property line, to comply with Federal Communication Commission regulation 47C FR-15, I don't know what that is.

I think we looked into that, I can't remember what it is but I know we found it.

Vorce: You did find that one?

Yes.

Vorce: Sometimes, that's one of the problems with this by-law, where WECS has referenced specific things and then they become obsolete.

It was some document I found online I can't remember the details of it though.

Vorce: Then there's a thing about electromagnetic interference.

It could have been a state law that I found something regarding that, so we will look into that more.

Vorce: So that's about it for that, I don't see [it]. Where do you think you found the 1,000?

Do you remember that table? Something came up, it also could have been something like a suggestion that the renewable energy research lab made, but I thought I remember it being a law.

Vorce: Mike, are you aware of that? Or is it about the airport? I know there was a certain distance from the airport, but I think you...

They are sufficiently far away from those, it would just be the height of the turbines that could possibly be affected but the distances are ok. I'll look into that more.

Vorce: I don't see anything locally. The major site plan review does require referrals, is a series of review objectives on that its 139-23i, and that may be a thing that this needs to change to minor not major. Yes, it's Major site plan review.

What exactly would that [major site plan review] entail?

Vorce: This is sort of laid out here and basically is a series of referrals. So Commercial and where it's located where it's allowed, this has definitely got to be updated. This is in LUG 1, LUG 2, LUG 3, and RC2 - that's a district that we are phasing out.

I believe it was in LUG 1, 2, or 3 in both locations

Vorce: It's in the outlaying districts. The review objectives basically there are 11 criteria here which are: conformance with the zoning code; protection of public amenities is number 2; protection of unique natural scenic or historic features; number 4 is safety and convenience of pedestrians that wouldn't apply; adequate sewage/refuse 5 that doesn't apply; protection of the aquifer doesn't apply; protection of public health and safety in a flood hazard area, doesn't [apply]; adequate off street parking, minimization of traffic and safety impacts on a public way; adequacy of water supply; will not place excessive demands on town services and infrastructure, so none of that has, so I don't know why.

Burns: What about the scenic features?

Vorce: Yes, and that of course could be a trap.

Burns: Sure it is.

Vorce: Because it's so subjective, 'well it's ruined my scenic vista so you can't approve it.' That might be an unintended consequence and a bad consequence of sending it to this review. This major site plan review is intended for a major development of some kind not one individual wind turbine sticking up.

So what if you made it a minor site review? Would that be a lot less stress?

Vorce: Yes. A minor site plan review can be done. We would do this at the same time, but a minor site plan review would just go to the zoning enforcement officer. Site plan review I think is just a simple majority, but of course, since you have to get a special permit anyway, if you don't make it through your going to have a problem.

Can you tell us a little bit about the process of getting the special permits, for things such as the height and the number of towers?

Vorce: Yes. There's an advertising period that occurs, any abutter and that's defined as someone who has direct boundary, shares boundary with the property, is directly across the street from the property or is an abutter to somebody with direct access. So it's an abutter to an abutter, direct abutter, someone who is across the street. Generally anyone within 300 feet has standing. And so a notice is sent to them, a notice is put in the paper for two weeks. At least seven days prior to a public hearing, board hears a public hearing, anyone who wants to testify can come forward and testify. When the board feels that they've heard enough testimony or had enough input they begin there're own deliberations on it. They do there're deliberations in public they don't have to take any further comments, they can answer questions, but don't have to listen to anymore so-and-so's well I have a new point, that time is closed unless the board members motion to reopen. They have, with a special permit, I think its 120 days to issue a decision unless an extension is granted, and that has to be agreeable to all parties, and by all parties I mean by applicant and board. The decision has to be filed with the town clerk, there's a 20 day appeal period running from them. The only other things I think in here that may come up is lighting which is 0.5, the maximum illumination of a 0.5 foot candle, unless otherwise permitted by a review authority so there's an out with that. Our land use planner is the lighting enforcement officer. I think that these might have to have certain lights on them that meet aircraft standards and other things, right so, and then noise, any noise due to construction or operation will have to comply with Chapter 101 of the town code, entitled noise.

As far as lighting, we heard something about a by-law: the dark sky initiative.

Vorce: Yes, and that has pretty much been included in Chapter 101, I think it's Chapter 101. No, I'm sorry 101 is noise, and lighting is something else.

Because one thing we were considering with lighting for reasons of just public interest is having a red light all the time, and we weren't sure if [the dark sky initiative] had anything to do with if there were any rules in this about the color of the light. I know we'll have to work with the FAA as well. Do you know if there are any big issues with the towers, with the existing lights they have on those if they needed to go through any hoops?

Vorce: No, because see there is a pecking order to any of these laws anyway. Federal requirements are always going to trump state and local laws. So, that will always happen. I'm thinking of what is the one outside of Boston, have you seen the one that's been constructed by the IBEW?

I've never been there at night, so I don't know what the lighting is on that.

Vorce: Well, what they do, they kind off almost do it like an art. It's right by the highway and they actually make it turn colors, so anyway.

That's pretty close to the airport, too - Logan Airport - so I think color must not be a huge issue to the FAA if they can do that.

Vorce: You've seen that right Mike, the one that's outside.

Burns: I haven't seen it change colors. I thought it was red.

Vorce: They make it blue and purple.

Do you know anything about the process that the Energy Committee would need to go through in order to use the town land for the turbines?

Vorce: Yes, that's town meeting, there needs to be, it's going to be a long term lease. I think it's over 5 years; it needs to get authorization from the town meeting, so the town meeting can authorize either a long term lease or it can enter transfer of the land or anytime you convey out town property you need to get a vote, and that does require 2/3 majority as well. So there's a higher bar for that.

Burns: Chapter 102 for [lighting].

Burns: Tom Broderick, the town land use planner.

Vorce: This is Tom Broderick, our town land use planner and lighting enforcement officer.

We will quickly let you know who we are. We're a project team from Worcester Polytechnic Institute and we're working on a project with the Energy Study Committee and we just came up with the question about lighting of the possible wind turbines on the island. We know that there's something called a dark sky initiative, and would like to know a little more about that. One of the things with the turbine that we are looking at is the color of the light on the turbine. Red would be preferable for reasons that we had discussed with someone else.

Broderick: The FAA.

Actually not the FAA, the FAA requires a light, but I don't know necessarily what color it is. I know one town had white during the day and red at light, and said if you do red all the time, it's a lot easier. Does color apply in any of the Dark Sky [initiative]?

Broderick: No, in fact the dark thing is that we want to have all lighting facing downward. We don't want to have any fixtures where light is escaping up into the atmosphere, that's the idea behind dark sky. Our lighting by-law really addresses lighting on building structures like Stop and Shop and things like that. We do have some restrictions on single family homes, but it's really limited to the size of the light bulbs you can put in your fixtures. We don't get into too much about saying that it has to be directed down, but you can't have flood lights, just bare bulb flood lights shining up at your neighbor's house. You can't do that, but you can have flood lights shining down on your own property. That's ok. But then getting back to your question, we don't address the color issue in here or the certainly not for a wind turbine, I don't think there's anything in here on flag poles either because if you fly a flag at night you're supposed to have it light up. We can't really regulate that. I don't think there's really any other things that we regulate through our zoning by-law so as you know there are all those other agencies that you have to talk to.

Obviously with turbines, FAA wants it lighted so that can be pointing up so that the airplanes can see it, so it overrides the by-laws?

Broderick: Any safety issue overrides this and again, this is not a zoning by-law this is a general by-law in our code, this is the code of the town of Nantucket, it's got everything from the health rules and regulations to the zoning to the traffic and all that kind of stuff. So, this is not a zoning by-law, it is not enforced through our zoning enforcement.

…

Do you mind if we contact you in the future if we come up with more questions?

Vorce: Not at all

Is email a good form to contact you?

Vorce: Yes, if you do want to schedule appointments go directly to Jeri and she will give you a time slot right on the calendar, that's the best way to schedule an appointment.

Do you mind if we use your name in our report, or would you like to see the transcription first?

Vorce: Not at all.

…

After the recorder was turned off, we were given permission to use Tom Broderick's name in our report.

Follow-up question, December 3, 2008. (e-mail)

In the Nantucket bylaws, § 139-21 B, regarding commercial WECS, the Code of Nantucket states "(7)Tower access. The tower shall be made inaccessible to unauthorized personnel." Is the intent of this law that a fence must be built around the wind turbine so that people cannot get close to the tower, or does it mean that the door to enter the tower is locked at all times so that no one can get into the tower?

At the time, most wind turbines had a lattice tower, not a monopole. Therefore I believe a fence was intended.

Leslie will send you the citizen article that would delete this and other obsolete requirements.

Leslie Snell from the Nantucket Planning Office provided the citizen article.

The citizen article for revisions to the WECS can be found in Appendix G: Citizen Article WECS. This Article will be considered and brought to a vote at the Annual Town Meeting in April, 2009.

APPENDIX D12: INTERVIEW TRANSCRIPTION, D. LARSON & M. PETERSON

Telephone interview with Dave Larson and Mike Peterson, National Grid

November 14, 2008. 1-2 pm

*In this transcription, Dave or David means Dave Larson unless otherwise noted

Do you know what the current rate of electricity is on Nantucket for residents as well as municipal buildings?

Mike: It is different, National Grid has four different electric rates depending on how much electricity a customer uses and that determines which rate is applied. Residential in general are always assigned an R-1 rate whereas all other customers fall into the general service category and there are literally small, medium and large entitled G-1, G-2 and G-3. For estimating purposes you can probably consider that residential rates are something in the vicinity of 17 cents/kWh, whereas the commercial or general service rates that are generally applied to the commercial and industrial areas are general service and anywhere from 2-3 cents/kWh more expensive.

Dave: Is the rate the same for Mass[achusetts] as it is on Nantucket?

Mike: No it isn't because on Nantucket you have the cable service charge. Possibly what you guys could do since obviously you have internet access if you go to www.nationalgrid.us.com, then go under electric and Nantucket. Probably the best place is under "for your business" you'll see things about rates and pricing with some of the exact numbers. If you get hung up let me give you my telephone number and you can give me a call and we can talk about it a little bit, Dave isn't going to need to be involved in that part of the conversation, let me give you my direct dial contact is 508-482-1239.

Dave: Mike, I'm going to send them a link to the rates on Nantucket.

Mike: Ok. If you have any questions just give me a holler.

Would you be able to tell us anything about the exact electricity consumption at either the Landfill or the Surfside Waste Water Treatment Facility?

Mike: Yes and No. Here's the problem, we have what is called a Third Party Law here in Massachusetts which does not allow me to share information on a specific account unless I receive written permission to do so from the customer. So if you could get somebody from Town Hall which has the overall responsibility for both of those facilities to send me an email or give me some information, it would be most helpful to have the account number and/or the meter number. Then I can put together some information for you. Now having said that, you guys interviewed Dave Fredericks Thursday, right? Did he mention to you that I've already supplied a guy named Mike Burns who works for the town; I've already supplied him with a significant amount of information which is exactly what you are looking for. So if you guys either directly or through the group you are working for can get to Mike Burns, you can get all this information on the specifics of the Waste Water Treatment and everything else.

We've had numerous contacts with Mike Burns and we've asked him if he still had this and he seemed to either not understand us correctly or misplaced it perhaps. We will ask them to send an email your way to let us acquire this. I don't know what he did with it, we were told that he did receive it but we have been having trouble getting that from him.

Mike: Who are you working for with the town, other than Mike Burns? Are you working with Libby or any of the people in the front office, the town administrator's office?

We are not, but through the Energy Study Committee that we are working for, they are all involved with the town somehow. Everybody pretty much knows everybody around here, so it wouldn't be a problem to get in touch with her at all.

Mike: Have her send me an email or give me a telephone call because I know all the players in town hall. She'll just have to give me permission that I can share this information with you. It's not all together that confidential but you still have to treat it with a certain level of respect. But once I get that I can very easily get you the information that you are looking for.

What is the maximum electricity that could be produced at each site without updating the existing equipment there? As far as like peak loads go without having to update any of the equipment.

Dave: That kind of falls to me. You are talking [an] asynchronous wind turbine. There may be updates required right off the bat on our distribution system. If you are talking an inverter based machine or induction, it would really be based on what type of wires are out at the street. I'd have to look at the location. Mike I think we went through this at the landfill at one point didn't we?

Mike: Yes that is correct.

Dave: It seems to me that there were 3 phase out there and I don't remember the size of the lines. Let me see if I can find that.

Mike: I think there are 336 or 477 aluminum. Really what it comes down to is if you are going to use the power internally for a specific facility and never ship any of the excess power out to the rest of the world that is one set of calculations. However on the other hand, if you are going to be shipping power out to the rest of the world during down periods, as Dave was saying we have to look at the size of the wire and make sure there is enough capacity in the wire to accept for the power that you are going to export.

Ok so it really depends on what the existing infrastructure. You don't know what that is offhand?

Mike: Its very site specific.

Dave: There are lots of different things that go into it. The first of which is do we have 3 phase power, what's the size of the step down transformer. But then even beyond that there are specifics about relaying protection and what might be required on our distribution system or the substation or on the high side of the step down transformer, so there's a lot to it that can't be answered sometimes even if the site is known. However, if you gave me a specific account I could go look at it and figure out what size transformer is there and that would be sort of an initial first look at what could be installed there without any upgrades at all.

Mike: Just out of curiosity so that Dave and I can more tailor our responses, are you guys all seniors?

We are all juniors.

Mike: What departments are you in?

This project that we are working on is not our major project - that we will be completing next year. So we are of various majors, environmental engineer, computer science, mechanical engineer and biomedical engineer. So this is a project that is supposed to combine science and technology with the aspects of society, so we are dealing with both the technology and society's acceptance of growing technology.

Mike: What I was looking for was you do not have any EE on the group?

No.

Mike: Ok that tells me how I can answer your questions to make it easier. I am an ME by trade.

Dave: That's a good point Mike. I just realized that when I was talking about 3 phase power somebody might not know what that means. If there's ever a point where you don't know what I'm talking about just stop me.

If the existing infrastructure would not be able to support the exporting of any extra power produced what would be the scale of upgrading one of the sites, for instance the landfill? I know there won't be any hard numbers, just in general, what would be the scale?

Dave: That really depends on what kind of machine or machines you are talking about. For example we have a 1.5MW GE turbine going in the town of Portsmouth in Rhode Island and they have not required any extraordinary relay and protection upgrades but even the new poles and primary metering plus the taxes and everything is $26,000 that was very easy to integrate. Holy Name Central Catholic School was similar, we had to do some removals of equipment and put in 3 new poles and primary metering (which means that the customer is taking power at 13kV from a distribution spot on the street and was close to $30,000 there. Even fairly easy implementation of sizable wind turbines will cost probably $20,000-$30,000 for facility upgrades.

If you have a size turbine that could export power through the existing distribution system, let's say you have a 500kVA transformer, at a high school you might have a 500kVA transformer, if you put a 500kW wind turbine on that you may not have to upgrade anything. Just to give you an idea.

If you had several large wind turbines, say five 1MW or five 2MW wind turbines and you wanted to integrate those through one service there might be major cost to that. What's the voltage out there on Nantucket Mike?

Mike: 13.2 [kV]

Dave: So 13,200V, let's say you had five 2.2MW wind turbines there's a high likelihood we wouldn't even be able to carry that on our feeder. There's a large array of answers based on what you are looking to put in. So looking at a single 1MW wind turbine is a different animal than a small wind farm for instance.

Would it give you a better idea if we told you what the preliminary thoughts were on what they we actually putting at the sites or is this something that's really specific and would have to be looked at?

Mike: Are we specifically talking about the Waste Water Treatment Plant?

We've narrowed it down to two sites, the Landfill and the Waste Water Treatment Plant.

Mike: Ok. Is it the Waste Water Treatment Plant at Surfside?

Yes.

Mike: The one that they just put in?

Yes.

Dave: I'm going to bring up GIS while we are talking, and take a look at those sites.

Mike: While you are doing that I'll get you the addresses if I can find it.

In any case, while David was talking about the $20,000 or $30,000 or $40,000 cost, you can very quickly and very easily get up into the hundreds of thousands. I've got a project that I am doing now that looks like the construction advance that we as a utility call it, is going to be in excess of $200,000. I did one not that many years ago that is going to be a similar project to what you are looking at right now out in the Berkshires and that was $1,000,000. You can be talking some serious dollars depending on what exactly you are looking to install.

At the landfill if will probably be a total of 6-9MW from four to six 1.5MW turbines and at the Waste Water Treatment Plant we're looking at a total of 1.3-2MW from two to three 660kW turbines.

Mike: David, What they refer to as the landfill is 188 Madaket Road, that's M-A-D-A-K-E-T. They have a 1,000kVA transformer out there right now and they typically run about 315KW.

I'm going to have to go to a different folder to get you the Waste Water Treatment Plant just to make sure that we are talking about the right thing. Why don't you guys continue and I'll dig up that folder.

Going back to selling the electricity back into the market or back to National Grid to distribute, do you know what the approximate cost per kWh that they would receive by selling this back?

Dave: If they sold as a qualifying facility to the market via National Grid they would get the wholesale prices plus any capacity payments. It's roughly 7 or 8 cents I think when all is said and done on that per kWh.

Would you have any information about using the existing cost of Nantucket's distribution system if they wanted to take that over perhaps?

Dave: That cannot do that. We have franchise rights to be the distribution utility they can't take it over. But with the new provisions under the Mass Green Communities Act, are you familiar with that?

We have some information on that but we understand that it is still under some litigation and some things are still being worked out. So if you have any information that you could share with us that'd be a great help too.

Dave: The law was passed and signed on July 3rd. There are several different areas in it. One area expands net metering, that essential makes what people call virtual net metering available to wind and photovoltaic resources. If the town owned or contracted for the power from these wind facilities and the wind facilities produced more than they can use they'd essentially be getting credits on the accounts that have the renewable resource. The credits are near the retail which is that 15-17cents, or whatever it was Mike said, 17 or 19. So the credits would be the exported power times almost all of the distribution charges, all of them except for the renewable energy charge and the conservation and load management charge which are probably only 3/10ths of a cent. So if the retail rate is 17cents/kWh they would get a little bit over 16-16.5 cents/kWh for anything that they exported. They can then transfer that credit to other accounts.

I don't know of any litigation but the Department of Public Utilities is charged with issuing a ruling on net metering and changes in net metering and then the investor owned utilities in the state will have to make a compliance to follow it. That process just started two weeks ago with an informational hearing at the Department of Public Utilities. We don't know the details on exactly how it's going to work yet but for facilities to for a city or town I think as long as the turbine's 2MW or smaller they can bank them together and I think that all of these probably would be eligible for retail rates.

You may want to look at the email I'm crafting for you and I'll try to attach the portion of the Green Communities Act. The bottom line now is they can sell as a qualifying facility and get wholesale whereas in the future it is very likely that they will get at meter retail rates which are almost double.

If the town net metered electricity from the wind turbines and provided electricity more than the site used, could this be transferred to other meters on the site or must all of the excess be sold back to the market?

Dave: That's really where we have to get into what the ruling is from the Department of Public Utilities. If you read the law, it talks about transferring credit. Essentially if you export power, if you are net metering and you export power, we determine a cash credit and apply it to that account. So if they exported 1,000,000 kWh that month and the retail rates when you add them all up are 15cents/kWh, we now apply $150,000 credit to that account. And the way the law is written the customer can transfer that credit to another account. That's how the law is written with a singular account. We don't know how that's going to pan out. I mean if they wanted to make it simple for the utilities they would just allow the utilities to just cut a check each month or quarterly for any power that is being sort of net metered and allow the customer to do whatever they want to it. But there are all these provisions in the law for the customer to be able to transfer credits, which may have some tax implications and things like that where they don't have to consider it income or something.

That being said, I'm trying to answer your question now. The credit, which is essentially the kWh times the value of the kWh, gets transferred to another account which might have an account balance based on the power that they use. So you're not really transferring the kWh you are transferring dollars. The law was written and the spirit of the law is that you are transferring those kWh.

Ok. But indirectly, they are monetary values.

Dave: Right. And if you guys understand this at the end of this conversation you are doing better than most people do.

We had a little crash course from Dave Fredericks so he gave us a good head start.

Dave: I needed to hear it about 5 times myself.

I'm going to try and find the landfill site. Mike do you have a cross street for me off Madaket.

Never mind, you already found it, 188 Madaket. There are a couple transformers out there, a 150, a 1500kVA and a 300kVA.

Mike: The 1500[kVA transformer] is the one the one that actually has the load on it and that's only got the 300.

Dave: So a 1500kVA transformer, again I'm not the one that does the study but I don't think it would be that hard to install a 1-1.5MW turbine on that account. I don't think you'd want to put two turbines on that without upgrading, and even then you'd have to add another transformer. We can overload some transformers but not over 2500kVA because there's a part in there that's essentially a connector that will blow up after you overload it.

So if we were talking four to six 1.5MW turbines, this would take multiple additional transformers?

Dave: Yes. And let me look at what this wire is, it's underground.

Mike: Do you know what voltage you are going to be generating at? That's something else to consider.

Dave: It's usually around 440[V] or 600[V] or something like that.

Mike: That's what I was wondering because I'm pretty sure that all of those voltages out there are 480[V] or 277[V].

Dave: Yes. And a lot of times what customers will do, like Holy Name they have a step up transformer and I think they are going from 440[V] to 13.8[V]. On the GE I'd have to go look and try and figure out what that is because that is more like what you guys are looking at.

I'd say you can get one turbine on a net transformer pretty easily, beyond that you're going to need to start adding transformers and maybe upgrading some of the underground cable etc.

That will give us a starting point to at least suggest that they will be looking at a bigger project if they do decide to put turbines there.

Mike: Have you guys done your wind study yet to see how much available wind you have?

Yes. They've actually had through the Massachusetts Technology Collaborative, had the UMass RERL do a preliminary wind feasibility study and from that they've gained wind maps and things like that. They are actually looking forward on moving toward the second phase of their study. The first report gave them ten sites and since then they've narrowed down to these two. So the next study will get into these two sites a little more in depth, like setting up met towers and getting hard data.

Mike: Good.

Dave: The GE turbine that Portsmouth is installing, no it's not actually a GE its AAER, I'm sorry. Output is 690V, 3 phase. So they are stepping that up to primary voltage through their own step up transformer. That's one thing: if they have a lot of turbines, that you might want to own some primary distribution at the system voltage of 13.2. 13,200V. Might be cheaper to do that. We can't install any transformers over 2500kVA so we would have to put a bunch of stuff in parallel and I don't know if that's such a great idea.

Mike: You definitely need an EE to get you through some of this stuff.

We're going to have this recorded so we can go back over some of the parts we don't understand and Mr. Fredericks said we could be in constant contact with him and he'd have us over there again to sit down with us if there's really any big things we need help with.

The Committee isn't really expecting us to get into all these hard numbers and voltages, they really just want to know what their limits and boundaries are if they are going to put this many turbines there. Is this going to become a more expensive project with upgrading

the equipment? They are really trying to figure out their limitations right not as to what the scale of the project could be. We're not expected to get any of these hard numbers, but it will be nice to give them at least some of the hard numbers that you have given us and convey to them that it may be more of a project than they actually believe it to be.

Dave: Hey Mike, did you get a location for the Waste Water Treatment Plant?

Mike: I'm working on it right now, its listed at 62 South Shore Rd. I can give you an account number if that helps.

I'm pretty sure they put a 750kV transformer in there.

Dave: It's a 300kVA, 12208. That's number 72. That's not it? Is it 62?

Mike: 62 is the other choice

Dave: This is down at the end. There's this big blue line around it, a big facility. This is probably it. There's a bunch of square areas probably tanks. Down at the end of the road.

Mike: Exactly

Dave: It says 300kVA here.

So for that site, say they were going to do two to three 660kW. Do you see that needing any additional?

Dave: It's a lot of underground. It's kind of unusual to have this tying into a system that is primarily underground, so I don't know the limits on those.

Number 2 xlpe, Mike you don't know the amperage on that do you?

Mike: I do not.

Dave: I don't have that. I also am a mechanical engineer. I don't have those figures in front of me.

The minimum they are going to have to expand the transformation there. Let me see how far it is back to overhead. So that's going to be...I need to locate a file, hold on.

I just wanted to ask a question. Did you mention that when you normally interconnect turbines it's not through underground cables?

Dave: No. It's mostly what the local distribution is. Most of what our distribution is overhead. I'm just more familiar with the ratings are on that.

Mike: Nantucket has a regulation that tries to put all the wires underground. So that's something they'd have to take care of.

Dave: I'm not sure if I'm going to be able to find it. But it's fairly limited, about 1MW is about all we could carry on that, so we might even have to upgrade the overhead section.

The other thing we have to consider is... I can't research this right now but depending on how the substation is set up and what the minimum loads are on the feeders, we might have to install if there's a chance that there will be reverse power at the substation you might have to add quite a bit of protection equipment back there. I have a similar job right now at one location where it's going to cost $250,000 because of all the reverse power relaying and ground protection that will be required at the substation. So that's another thing that we kind of have to look at.

When you start talking multiple turbines, if you stick one 660 on a 13,000V feeder you are probably not going to have a problem because the minimum loads are a couple MW. When you start talking the number of turbines that your capacity would equal half the capacity of the feeder itself then there's usually a lot more expense because there's usually substation work that has to happen.

I'm going to go back a second, and kind of relate a substation and a feeder to your electrical panel in your house or apartment. You've got power coming into your electrical panel, then your electrical panel has a bunch of circuit breakers. Each of those circuit breakers is rated for a certain amount of power. You can pass power through that circuit breaker and it goes out through the wires in your house and you can plug in your appliances and lights and everything. If you use too much power on one circuit because you've got 5 space heaters going, the circuit breaker opens and you have to go figure out what happened and turn the circuit breaker back on.

Substations are a very similar situation to that, it's about the best parallel I can make. A substation takes power in this case from the mainland and it comes over to Nantucket by some submarine cables and I think it's 47kV. Is that right Mike? Then it goes into the transformers and the transformers reduce the voltage to 13,200 volts, that's our main distribution voltage out at the street. The reason we like to use high voltage is because you can move a lot of power over long lengths without having a lot of losses [resistance]. The problem with high voltage is, the higher the voltage the more clearance you need. Clearance being the distance you need between things that shouldn't be near the wire and the wire itself.

So our substation, you'll have 47,000 volts coming into the substation and you'll have a transformer that brings it down to 13.2[V] and you have multiple feeders, like the circuits in your house, that go out. Those can each handle about, depending on the wires, maybe 8MW of power.

If you are expecting power to go out from the substation and let's say at night in the fall when there are not a lot of people out there, the minimum load is only a MW and you have 3MW of wind generation out there. Now suddenly you have power coming back into the substation. A lot of times that's a problem because we have trouble isolating faults, so we may require some additional protection at the substation and now suddenly you are feeding into that fault from the wind turbines and there's nothing in the circuit that says it should open up. So when we start putting things into the substation, you start adding zeros pretty fast to that front number.

Anytime, if they are talking about putting in more capacity than the minimum load on the feeder, right off the bat I'm thinking its $250,000. Don't quote me on that one but it's usually a lot of money when you start doing that kind of stuff. They might want to think about starting small and then going from there.

When we were talking to Dave Fredericks he also suggested the same thing, he put out a number like 75% of the peak load of the building and use that as a baseline. So put say a 250kW at one of the sites so it makes just enough for the building to use and they won't have to worry about upgrades or distribution. It would just directly benefit that place, lower their energy costs and almost pay for all of it.

Could you tell us about any other options for interconnecting the wind turbines to the grid or what you think would be the most beneficial from an economic standpoint for the committee?

Dave: I agree with Dave [Fredericks], if you start with something that you know you won't have major system upgrade requirements, you'd be able to construct that and then see how it goes. It doesn't mean that you can't add wind turbines later. By going through the interconnection process once they can learn a lot about what we're looking at. We might even be able to while we're doing our studies be able throw a what if in there, what if we had 5MW, what are the major stumbling blocks in there. We would be able to get an idea.

When you are talking multiple 1.5MW turbines there's going to be a major cost interconnecting those with the grid. I don't think there's any way around that.

Mike: Let me offer just a comparison. When you were talking to Dave Fredericks did he mention to you the total requirement for electricity for all customers on the island? Did you get into that matter at all?

We actually received a document that had the last ten years of usage; I think it was broken down into resident and municipal. I'm not sure, but we do have a document that does give us the total consumption by months over the last ten years.

Mike: For David's sake what we're talking about is the requirement for the total electricity on the island, let's say during the month of August when all the tourists are there and they're running their air conditioners and everything like else is probably in the area of about 35MW, David.

Dave: Ok.

Mike: Whereas you get to a time period like we are today, it's probably going to be more like 18 or 19MW maximum. So when we start talking about distribution systems and the number of turbines that may be installed, if you're talking a 1.5MW turbine literally you are talking almost 5% of the requirements of the island just in that turbine alone.

So you transfer that conceptual data to all of the electrical wires all over the island and you know there are hot spots in 'Sconset and stuff there on the other end of the island and the downtown area and all of that together only adds up to 35MW and one turbine is 1.5MW.

Dave: Another thing Mike and I can't recall if this has been discussed or not, is technical Massachusetts Electric and Nantucket Electric are different companies and there is a limit that's eligible for net metering. I don't know if Nantucket would be considered separate or not. I'd have to check on that.

Mike: I don't know.

What I was saying is you are taking on an exceptionally interesting project that has the potential of being incredibly beneficial for the future but it's unbelievably complex.

We've come to that conclusion as well. You are saying that the scale I talked about and the preliminary thinking is something looking more towards down the road and actually reducing the entire island's electricity costs but maybe now they should start with just these municipal sites with just one turbine that benefits that site and get a feel of the interconnection changes and upgrades. It sounds like that is going to end up being a lot more costly but a lot more beneficial in the long run.

Mike: Keep It Simple Stupid.

Dave: There's a limit to, I'll have to check on this because if Nantucket is considered a separate utility, net metering is only up to a certain percent capacity. I'll have to look at it. You may actually exceed that with one turbine. I'll have to check on that.

The other thing is, Mike there's two substations out there right?

If they are fed from two cables and each cable is feeding one substation, then that loop, I don't think we would be able to export power from the island. The protection issues would be big; I don't think they would want that. So depending on which substation they might feed into, while the minimum load is 18 or 19MW it is 1/3 of that. I think just from what I know and I'm not in the protection department but I think people would take a hard look at having power going the other direction in the submarine cable and it's not that it's impossible but I think the protection requirements would be very stiff.

In terms of substations, we are only aware that the two cables connect into one, the Candle Street substation.

Mike: There's only one substation, two cables but only one sub that's near the downtown area.

Dave: I'll try and find out if Nantucket Electric will be considered a separate utility for purposes of capping the net metering.

That would be great to know, especially if that would be a big hindrance to their plans that they hope to move forward with. Ok so that was a lot of information on that at least.

Mike: One of the things you need to know and what to keep in the back of your mind, is many times when lay people consider a study like this they really have big eyes and look at the big opportunities and everything else. One of the things I want to make sure that you guys, not only when you put together your report but when you go out to the real world and get a job two years from now, maintenance is something that you always have to be cognoscente of because these things do need attention. You don't just put them up and they run for 30 years then they break and you take them down and put a new one up.

There are circumstances when high winds, I haven't been intimately involved with wind power in some time but I know at one point the rule of thumb was you needed 8mph of relatively consistent wind to start the thing working but if you got above 50mph winds they went into freewheeling and didn't work at all because of the mechanical stress on the unit was too much. So Nantucket is definitely able to see 50 or 60mph winds under the proper circumstances, a coastal hurricane or something like that.

What kind of maintenance do you need to do these things to make sure they continue to be operational and producing power. If you are doing net metering internal to just the Waste Water Treatment Plant or just the Landfill, what happens if the thing goes offline? These things are considerations that have to be at least mentioned in your study because they cost money.

Dave: I imagine this has been addressed as well but there are restrictions with tower heights near airports.

There's actually at the landfill there's a cell tower that already exists that over 400ft.

Dave: That doesn't necessarily mean that it will be allowed by the FAA.

We were actually in a meeting today and the committee was talking with the Mass Technology Collaborative about the second phase of the grant that I was talking about. And they are actually moving forward with an airspace review to determine if there are any fatal flaws before moving forward with the second phase of the grant. So I'm sure they'll be able to determine that for the committee.

Dave: I think the landfill is like 3 miles from the airport but the Waste Water Treatment Plant is close. That might be a major issue because there's a glide slope of about 1 to 50 within a mile or two that you cannot exceed without a special waiver. So if they haven't looked at that yet, they need to.

Mike: You've also got the tower at the Coast Guard station at the other end of the island and that's over close to the airport to so they are going to begin getting worried when you start picket fencing a whole bunch of towers on the island near an airport.

In the preliminary study, that's why it was suggested for that site because of its proximity that they go with the smaller 660kW and not even consider the 1.5MW because of its size. But they also said that maybe 250kW would be better because of the height restrictions around that airport. That is definitely something that we will suggest the committee look into and like I said the airspace review will be getting done and will hopefully be comprehensive enough to suggest what they should be looking at since it is close to the airport.

The last thing that we really have to ask, is something that hasn't happened in Massachusetts in a number of years but whether or not if Nantucket decided to become its

own municipal electricity again, what would the scale or the cost of the equipment be if it is even possible?

Mike: Oh wow. With infinite time and infinite money anything is possible. I know 20 years ago, I was involved in reverse where we were looking at the possibility of purchasing a municipal electric light company. They were considering being part of what now is the National Grid System and our cost to purchase the facilities in this community was hundreds of millions of dollars. This community population-wise probably isn't that much different than Nantucket. So you're definitely talking about a lot of money to buy the infrastructure, I mean you're talking all the utility poles, all the wires, the transformers and everything else. It might easily be in the hundreds of millions of dollars if the town wanted to pursue that. I'm pulling on 30 years experience and grabbing a number out of the air.

Dave: I don't think you should include anything right there, that's more of a law school thing.

Actually Dave Fredericks said the same thing that it would require many years of law school. In our report we are going to be including a recommendations section, so at least we can say from a couple sources this isn't something that is easy or something you should worry about at this time. We just want to make sure we can let them know this but it's not just coming from us as students but people from National Grid who deal with this.

Dave: I know that we don't have interest in that, not as a National Grid employee but just as somebody who knows about it, I would not want my town buying an electric system here.

The last organization you want running anything is government.

We've just talked with other municipal light departments, and they have been municipal from the start so it's a different situation but we've realized that the direct…

Dave: One advantage that they have is they don't get taxed.

From talking with them it just seems that those towns are more accepting when a wind turbine project is going to start because they know that they are going to reap directly because they are in charge of setting their prices.

Dave: They are also not really regulated by the Utilities Commission. We are so we pretty much have to listen to and the stakeholders and please all the stakeholders to get anything done. A town can do something on its own because it's closer to its constituents and they have a say in it. You start talking about stuff like this and we have a lot more people to answer to.

Mike: Something David that you mentioned that they should probably be aware of and that's the fact that on Nantucket National Grid pays the town of Nantucket a personal property tax on all of our facilities. If the town of Nantucket were even to pursue the concept of becoming a municipal light company, all of that tax income that they are dependent on by the town to operate town facilities, police department, fire department or anything else, would go away. So they would be saving money on electricity but lose tax revenue income because the municipal light wouldn't pay taxes. All of a sudden town government would be tipped upside down for a period of time. It's something to keep in the back of your mind.

This will definitely help when we are offering suggestions to the committee for what they should be looking at long term.

Mike: It's not uncommon that National Grid is at least in the top 5 tax payers for a community. It is very common if we have a substation, and on Nantucket we do, it is not uncommon that we are the largest tax payer.

Thank you.

Mike: That's something you could probably find out pretty easy by looking at the tax account in the town.

We could contact them just to see. This isn't really something we want to spend a lot of time with because it is a bit out of our concern for this project.

Mike: Truthfully it's your junior project, not your do you call the senior project. What do you call it?

At WPI it's called a Major Qualifying Project or MQP.

Thank you for taking the time. We got a wealth of information that will definitely help our project.

May we contact you in the future if we have further questions?

Mike: Sure

Dave: Sure. I'll send you an email in a little while with Mike's email address and some other information.

The best way to contact is through email?

Dave: Yes.

One last thing is it ok if we use your name in our report, or would you like to see the transcription before?

Dave: I don't have a problem.

Mike: I don't have a problem with it but I just want to make sure since we are dealing with such a complex issue… David and I do this every day, unfortunately you guys at this point in your careers do not so it's easy to misunderstand or misinterpret something we might have said. That's just something we want to make sure that the report reflects the proper rules and regulations that David and I work with every day.

Follow-up Telephone Call, December 11, 2008, 3-3:05pm

At the compost facility, also called the recycling facility, it looks like the annual kWh consumption is right around 1,700,000 kWh/year with an average demand of approximately 300 kW.

Now the waste water treatment facility, as you might realize they have just done some major renovations and some upgrades, so the numbers we have are not necessarily what I would consider to be really perfectly representative of the future. But for the sake of discussion we could probably say that the total kWh consumption for the facility, let's say for the 2009 calendar year, is probably going to be something like 550,000 to 600,000 kWh, with an average demand requirement of probably somewhere around 200 kW. But that one I feel a little bit less comfortable with making guesstimates because waste water treatment plants can be all over the scale.

APPENDIX D13: INTERVIEW TRANSCRIPTION, J. WILLETT

Interview with Jeff Willett, Nantucket Department of Public Works Director

November 16, 2008. 9-9:40 am

How long have you lived on Nantucket?

20 years last Tuesday and I know that for sure because that's when I started working for the town.

Have you been with the Department of Public Works the whole time?

Yes.

Can you tell us about the work you do for the Department of Public Works?

I am the chief executive of the department. There are seven major divisions within the department; those divisions are engineering, street maintenance-roads, streets and bridges, solid waste, Waste Water Treatment, sewage, fleet maintenance and urban forestry. A lot of my work is not the day to day stuff, its long term planning, what's going to happen 10 or 20 years down the road.

We assume you know a little bit about the Energy Study Committee's work and their plans looking at a couple of different sites that are actually both on Department of Public Work's land at the Landfill and Waste Water Treatment Facility. Do you have any concern with the turbines potentially being constructed on DPW land?

Yes. Let's take each site separately.

The solid waste facility site… When I arrived 20 years ago, it was expected that within 7 years the town would exhaust its solid waste capacity at the site and we would have to find an alternative. 20 years later rather than the 7 years of expected landfill capacity we now have, with no more acquisition of property, about 35 years of landfill space left. We did that through very comprehensive recycling, composting, wood waste recycling and landfill mining. As far as I know, we are the only community in the country that has taken those five components and combined them. A recycling rate of 40% is extraordinary, Nantucket diverts from its waste stream at the rate of 86%. I know of no other community and have given papers at half a dozen locations across the country, I know of no other community that recycles at that rate. Having said that, my concern with the wind power is that it has the potential of conflicting with designated use, to what extent I don't know. Is it a project killer? I doubt it. We need to really understand how this will impact the future use of the site for solid waste disposal. That's a critical concern because there is no other alternative to solid waste on the island and we cannot significantly impact or reduce our solid waste capability.

At Surfside Waste Water Treatment Facility, I have two concerns. One is that we are very aware that coastal erosion could be a problem at that site. We've invested now, some $70 million in that facility. Based on bathymetry and coastal erosion analysis dine by Woods Hole that shows us that the site should be stable over the next 20 years with some erosion but followed by periods of accretion. If you invest in wind power at that site, you need to understand that there is a potential that it could be gone. That's the first concern.

The second is during the recent work we've been doing at the surfside treatment plant in upgrading that facility, we've discovered rare and endangered species that very much limit the use at that site. As a matter of fact as mitigation we had to place an additional 12 acres of land in conservation trust for preservation of the habitat. So that may limit what we can do in that site. A further restriction would be now that the site has been restricted because of mitigation and rare and endangered species, the remaining land that is unrestricted becomes that much more valuable for future expansion 20 years down the road that cannot be impacted. We must be able to expand the facility to meet the needs of the island. Again there is no other alternative location for a Waste Water Treatment Facility. So there may be very limited areas to which we can apply this technology. I think it's great but we need to address these issues.

At the Waste Water Treatment Facility, they are considering putting the turbines in the beds, so that would displace about 3000 square feet.

So about 8% of the bed area, that's a significant impact. As engineers or computer people, you understand than when you have percolation rates of 4 gallons per day per square foot, if you take 8% of that away, you impact the design of the facility which could jeopardize the discharge meant for that facility. We'd have to know what that was. It could happen, that could be a possibility. We might have to construct another bed to compensate for the land that would be used for the base of these towers.

You mentioned that they discovered several rare species at the Waste Water site. Do you have any documents or know where we can get the documents that talk about the species that they discovered there?

Yes. They were all plants. There was concern about Harrier and Burrowing Owls but those were not found. However, there were several species of plants.

(Diane gives us a copy of report)

Do you have concerns with turbines possibly being constructed near the recycling facility other than the land space?

I don't know enough about what's being proposed to make an informed answer. I don't know what the rotational velocities are. I don't know the turbine size or the blade size. There might be some concerns, not so much at this facility. My concern isn't so great here as it is at the Surfside Facility. Maybe these concerns aren't justified; however the control mechanisms at the Surfside Waste Water Treatment Facility are technologically advanced, a lot of computer systems, systems which are sending signals back and forth. I don't know how well insulated these generating facilities are and whether there may be some electrical interference. We can't have any electrical interference at this facility. Somehow either the generators must be shielded to prevent that or the equipment shielded. So I'm concerned about that.

What kind of decibels are these things putting out? We do have people who work around these locations, but from what I know about these things that really not an issue. For us the height isn't an issue, but it's going to be a huge issue politically and sociologically to overcome. If you just invested 15 or 20 million dollars into your dream cottage on Nantucket the last thing you want is a 200ft tower in your backyard. I think will be one of the big issues. They're very supportive until the NIMBY, Not In My Back Yard.

Do you know anything about the employee housing at the Waste Water Treatment Facility?

Yes.

Do you know who's in charge of the lease for that housing?

Yes.

Would that person happen to be you?

Yes.

One thing we were considering based on the possible locations of the turbines, would it be possible to write into the lease that the houses are located "x" number of feet from the wind turbines?

I haven't determined yet whether the leases are going to be at will or not at will. Only employees of the Waste Water division of the Department of Public Works would be housed in those units, they won't be police officers or school teachers, they will only be workers of the Waste Water treatment facility or sewage collection system. They can only occupy the dwellings so long as they are employed by that division. We have not included at this point anything in the lease regarding the potential for wind generation. These buildings will probably be occupied by the end of December. I don't know that we're going to have an opportunity to include something in that lease before then.

Since it is the worker's living in the housing, will they have to renew the lease and sign a new one every year?

No, they won't be renewed every year. It will probably be at will, in other words as long as they are employed by that division of the Department of Public Works they can stay in that housing provided that they don't break some other condition.

If the turbines ended up being on DPW land as they were proposed, how would you feel about being in charge of them or would you want someone else to be in charge of them?

What I would hope would happen if the town decides to build these things, they would have some sort of arrangement with an owner operator where the town would derive some benefit whether it be from lease of the property, cut of the profits, whatever would be negotiated. But I don't think the town wants to be in a position where it is owner of these things and responsible for maintenance. I don't know enough about them, and I don't think that we'd want to be responsible for maintenance and operations.

Some of the turbine components can be very large, and come in sections that are considerably large. Do you think it would be an issue transporting the components from the center of town to the two sites?

It's always problematic when delivering large pieces of equipment. However, some of the components that we were delivering for the Waste Water Treatment Facility are absolutely massive. They wouldn't fit on the ferries, we had to bring them by barge but we still managed to get them out to the facility. Whether you have to do it by night, under police patrol and close down the roads, you can get it there.

One of the concerns that they have been having with moving forward with the feasibility study is they are afraid that a fatal flaw is not being able to transport the components to the island because they are too big and heavy.

It could be a possibility but if you've been to the solid waste facility, you've seen the digester, the large rotating drum. It's huge. That got here. I can't believe that one of the heads at the top of the pylon that generates electricity would be any larger than that.

Do you know the size of the digester?

I can't remember. Its 100 ton per day capacity. I think its 125ft by 15ft, somewhere in there. That could be a real problem, but I have no idea about the size of the components. You'll have to make special arrangements, bring things by barges and get bigger trucks. Length and weight are a real consideration. It could be a fatal flaw, but it all depends on how much will there is to get these things constructed. It could be done but it's very expensive.

If you have anything else you want to share with us feel free.

I've always been fascinated by alternative energy. In 1993, I commissioned a $90,000 report on alternative energy potential at the solid waste facility site. We looked at gathering the gases produced in the landfill and burning those in either turbines or engines to generate electricity. That did not turn out to be feasible because the site is so small and doesn't generate enough gas. However, as far back as 1993 or whenever that report was, that site was deemed to be an excellent site for the potential for wind power. We've known now for nearly 15 years that this site as the potential.

(Tells us about home in Colorado) We had talked seriously about putting a wind turbine but then we moved to Nantucket and eventually sold that property. It can be done and the construction is a little bit more expensive but the long term payback is realized pretty quickly. These things can be done and I hope that they would be. There's a place to use what we have without burning up the limited resources. We don't have coal and oil so use what we've got.

APPENDIX D14: INTERVIEW TRANSCRIPTION, J. PALATINE

Interview with Jim Palatine, Toscana Corporation, Nantucket, MA

November 17, 2008. 3-3:45pm

The Energy Committee is trying to determine if there are any fatal flaws with the project and before they move on to do an actual feasibility study. Mass Technology Collaborative will give potentially them a grant if they deem that it is possible for wind turbines to be implemented on the island. The Committee needs to rule out any fatal flaws and one thing that Mass Technology Collaborative is concerned about is transportation.

MTC has funding and did a preliminary study that determined that Nantucket has adequate wind speeds for the turbines. Now if the Committee receives the MTC grant for a feasibility study, they will do more in depth studies into endangered species, birds, and all of that. But they have to determine if they can get a turbine out to the island, and MTC seems to be convinced that they cannot get a turbine out to the island.

What kind of work does Toscana Corporation do here on Nantucket?

There is a variety of things we do. We are predominately a site work and excavating company. So we are doing everything in the ground. We'll dig foundations, we do retaining walls, we do de-watering systems, utility work, sewers, electric, cable, anything that is in the ground. We do what is generically called the site work. That is the bulk of our business.

We also have a ready mix concrete plant; you've probably seen our concrete trucks that are another part of this. We sell to the contractors who need concrete. We also do building moving so that's another part of our business. We also have a materials yard that's out here. We have bins of materials for all the landscapers to come in and drop of their yard waste and pick up materials for their use and all that.

We have a tug and a barge. Which is probably what you are interested in and we do that. It's a relatively new operation, only a couple years old now.

That kind of rounds up our business.

Do you do trucking at all?

We do but not really for retail. We do it for ourselves. But we do tug and barge for other people.

The Energy Committee is looking at feasibility for implementing land based turbines and they are currently considering two sites. One is the landfill, and they are considering 4-6 1.5MW turbines which are a little bit over 200ft tall. The other site is the Surfside Waste Water Treatment Facility where they are considering 2-3 660kW turbines, which are a little bit less than 200ft tall. That's the highest point when the turbine blade is straight up,

and [it's] about 3000 square ft for the base. At the Waste Water Treatment Facility, they are considering putting the turbines in the sewer beds.

Based on your knowledge of construction, do you have any problems with either of those sites?

It depends on what's underneath there. Generally you can get away with a foundation. You can do piles; it depends on what the forces are. I'm sure this is going to be more than a gravity situation. You can always drive pylons down. But again you'd really have to look at the forces and talk to an engineer about how deep the piles, what kind of piles you'd have to put in. I mean you couldn't just put a concrete slab down. You might be able to with a huge amount of ballast, just a massive slab of concrete just to weight it down.

What is the length of the largest object you have transported on the barge?

I want to say 60 feet.

How heavy would be the heaviest you've ever carried?

They [large objects] aren't very heavy.

What's the heaviest you can carry [on land]?

Oh my goodness, we can carry hundreds of tons. There's not really… We've got dollies and we've moved houses and buildings over the road. So weight limit, I don't think that would be as much of an issue. We've moved houses with chimneys, masonry, and foundations, hundreds of tons.

You said the trucks you use are for your purposes only not for…

We would consider a hire. We do have a fleet of flat bed trucks that we do use for ourselves.

How long of an object can you transport [on your trucks]?

45 feet or something like that, but [we] can get over the length there are special permits and stuff like that.

But your trucks aren't like that [extended bed]?

No, we do not have the telescoping trucks.

Do you know anyone on the island who does [have a telescoping truck]?

Not like that. How long are you talking about?

The longest piece of the largest turbine we are looking at is the rotor blade, and its 122 feet.

Your problem is not going to be getting it to the shores. It's going to be getting it through town. That's going to be a real trick. We'd probably want to talk to Bruce, our tug and barge captain. I don't know if they'd want to go to the south shore on a calm day and beach it somewhere. Its open ocean and I don't know what the permit would be or if they'd even allow us to do that.

*****(Calls Bruce Beebe)** Hey Bruce its Jim. I've got two young ladies here from Worcester Polytech who are doing a study about bringing over wind turbines to Nantucket and they've got a 122ft long wind spar for one of the turbines and bringing something like that through town might be a challenge, right?
They are talking about on the south shore, do you think there's any way we can bring the barge in on a calm day and offload something that big? Or think of any ideas?
And they have an 85 foot long one too.
Bruce: Where are they erecting them?
Jim: One's at the Waste Water Treatment Plant at Surfside and the other is out by the landfill. What are you thinking, Madaket?
Bruce: Yes you could get them off…
Jim: Over at Eel Point, do you have deep water there?
Bruce: Yes…
Jim: You'd have to have a shot of beautiful weather. Pick it off with a helicopter.
Bruce: ….
Jim: We were talking about doing that for Jack Whelan's. Were you part of that discussion with Jack Whelan and using a helicopter?
Bruce: ….
Jim: How do you snake that through town? You couldn't get it around the corner.
Bruce: ….
Jim: But you couldn't come out of Steamboat Wharf with something that big.
Bruce: ….
Jim: They could also pick it with a helicopter if they had to. It's 7 tons for the biggest [longest] part.
It's just a feasibility study at this point and they are trying to get a feel for this stuff because they are being told that there is no way they can get it here. So think about it. Thanks, bye. *******
He's talking about, I don't know if you heard some of it… Beaching it on the south shore wouldn't work because you can't get the equipment there, but on Eel Point there's a way we can get in there and it can be tracked and put on dollies and probably driven over the road to at least get to the landfill. You could at least get some big items that way.

The other option is to pick it with a helicopter and that's certainly an idea.

How much weight can they carry?

7 tons…

7 tons is [the weight of] the largest one [longest component] if they got with the 1.5MW turbine and, if they go to the 660kW it's a little over 2.5 tons.

The blade itself is 7 tons. I should be able to tell you that. A little over 14,000 lbs. But let me call my helicopter friend. I should know this. You could do that, that's what they did for the project on Esther's Island, you were talking about that. A lot of that was picked and brought over Madaket with a helicopter.

*****(Calls Bill)** Bill it's Jim. How are you doing? I'm here with a couple of young ladies from Worcester Polytech and we are talking about bringing some wind turbines to Nantucket. These parts are pretty big; we've got a 120ft long 7 ton rotor blade to pick. Can you do that? Does a Sky Crane do that? Do you do something that big?
Bill: …
Jim: Well I think we'll bring it over here and bring it up onto the beach or even pick it right off the deck of the barge if you had to. But that's a pretty big item.
Bill: I can give you a phone number to call.
Jim: Well what kinds of pay loads were you picking with the Sky Crane?
Bill: I'm not so sure there are any Sky Cranes on the East Coast. It can do 20,000 lbs static…
Jim: It's 14,000 lbs or 7 tons.
The K-Max could probably do that too.
Bill: …
Jim: Anything's a possibility. The Sikorsky Sky Crane can do 20,000lbs but we don't know if there are any on the East Coast. But there's out of Connecticut they make the K-Max.
Hey Bill, I'm good. I'll catch up with you later, I just wanted to get an order of magnitude.
Bill: …
Jim: Carson Helicopters S-61.
Bill: Carson Helicopters might cost at least $20,000. Can't you just bring a crane out?
Jim: Well it's got to get from one point of the island to the next. So it's not a…the problem is it's so big you can't land it in town and wheel it through town.
Bill: I'd check out Carson Helicopters.
Jim: Ok, thanks Bill.*******

So that's possible but very expensive.

Yes. He said that it could cost up to $20,000 to do it; it'd be expensive but doable.

Carson Helicopters if you want to look them up online. That's a way, that's one way I could think of doing it.

Do you think with the 85 ft long piece for the smaller turbine, do you think that would also be a problem getting through town or do you think that's doable?

Let me try calling somebody else. It'd be getting around that corner; I mean you might be able to.

Did you say that you think the barge would be able to get the 122ft piece across?

We have a 110ft barge and even if it hangs off that's fine. You'll be fine.

Getting it onto the barge down at Fish Island that could be interesting. That could be a problem.

I just want to get you the right answers.

*****(Calls Bruce Beebe)** Sorry to bother you again. In New Bedford, would you be able to deal with a 120ft long spar? Could you bring something that long into Fish Island and put it on the barge?
Bruce: …
Jim: It's heavy, actually 7 tons. This is one of the rotor blades.
Bruce: …
Jim: Yes. They are 120ft; it's the big one, 14,000lbs or 7 tons.
Bruce:…
Jim: Each blade.
And they have a smaller one that's 85ft.
Bruce: …
Jim: You could bring it in from the East off the bridge.
Bruce: …
Jim: Would it come by road? You could probably barge it all the way up from New York. Unless it came to the West Coast. But if it came to the East Coast you'd bring it up to New Jersey or somewhere or into Long Island Sound. That would be the way to go.
Bruce: …
Jim: If that's the case barge it all the way over to Nantucket and pick it with a helicopter somewhere.
Bruce: …
Jim: Go into Madaket Harbor and pick it. How about 85 ft? We couldn't bring that through town could we?
Bruce: On dollies you could.
Jim: You think you could?
Bruce: Yes….. Put some dollies together, chain them together.
Jim: Like a hook and a ladder. Ok thanks. Bye*******

So he thinks that 85ft is doable for the town?

Yes. We could put a dolly in the back and it steers. I don't know if you heard him. So you could put the front one on and then the back one just like a hook and a ladder.

The heaviest component we have is almost 70 tons and that is not a problem on the barge? It's only 25'x13'x13'.

Our barge is rated for 100 tons. But getting that on and off and I don't know about the roads out here. Now I have to call somebody else.

Before you get to that, the smaller turbine is only 30 tons for its heaviest part.

I'll just talk to the guys who do this stuff. It's good because I can get all these people to get you the answers.

*****(Calls Bernie Perkins)** Hey Bernie, could you roll a 70 ton piece of equipment through town?
Bernie: Well how big is it?
Jim: 25'x13'x13'.
Bernie: Yes.
Jim: It's part of a turbine. It fits on the top of the mast.
Bernie: 13'x13'x25' on dollies.
Jim: Anymore big stuff you need to move?
That's the heaviest.
Jim: Ok. If you could send us some pictures of the stuff, that'd be great. Thanks. Bye*****

So I think we've hit most of the big things, the last question is do you have a crane?

We do not have a crane. You'd need a special crane.

They did say someone on the island has a 240ft crane.

Yes. Dave La Fleur has a crane but it's not going to handle this stuff. You have to get 70 tons up 200 feet.

There are only a couple cranes out here. You'd want to bring that equipment out here. We are talking about bringing a large crane out to Martha's Vineyard in pieces. You'd need a massive crane to erect something like this.

Was your company involved in the transportation components for the Waste Water Treatment Facility?

Yes.

We were told they were very large and very heavy pieces.

Yes, we did one. We brought over a couple of pieces of equipment for them last fall.

Do you know how large or heavy those components were?

I can find out.

Do you have any concerns with transported something large or heavy to any of those sites?

*****(Calls Bruce Beebe)** I have another question for you. What was it that we brought over for the Waste Water Treatment Plant?
Bruce: ...

Jim: How big and heavy was that?
Bruce: I don't remember the weight. But it was 14 feet wide and the tractor and trailer was over 70 feet long.
Jim: What was it some sort of…
Bruce: A big air cleaner.
Jim: Thank you Bruce.***
Now as far as trucking, any concerns?

Do you know if there are any not real strong roads or anything like that?

No. I don't think so. I mean of course you have the Madaket Bridge over Long Pond Creek down there but I think that's a pretty strong bridge, I don't even think that's a span bridge. As far as this, you just have in town to deal with.

One more thing, where do your barges typically unload? Do you go in through Steamboat Wharf?

Yes. That's the only place you can do it here.

Ours is just a ramp that actually mates up with the boat. If you go down by Steamboat Wharf (Draws a picture). We have a ramp that is 12ft wide.

I think you're going to be pulling the big one off with a helicopter. You are not going to be able to go over land with it. Pull the barge into Madaket Harbor and use a helicopter to pick it and drop it. You can probably use the helicopter for construction too rather than a crane. A crane to [lift] over 100ft at those kinds of weights would be a massive piece of equipment.

I'd have a good discussion with Carson Helicopters and talk to them about your project. It'd be expensive but it might not be as expensive as adding up all of the other things.

Do you mind if we contact you again in the future if we have more questions?

No.

Do you mind if we use your name in our report?

No problem.

When they construct the foundation and everything for the turbine, would you be able to do such a large project like that?

Sure. I mean it depends on what the design of the foundation is. These are very large piles that need to be driven and we certainly have our limitations but we can always subcontract. But we could make it happen, absolutely.

(Talk about our project and interviews)

I think they've picked two really good locations. I mean you've got the neighbors issues and those parts of it and you'd need to get over those. But if you can get it on the backside of that meatloaf, it would channel the wind back there too. You have a little more population on the south shore, so that'd be a bigger concern.

(Discuss birds and literature on birds)

(Discuss our majors and future careers)

APPENDIX D15: INTERVIEW TRANSCRIPTION, C. COLLIER

Interview with Cormac Collier, Nantucket Land Council, Nantucket, MA

November 19, 2008. 10-10:30 am

How long have you lived on Nantucket?

Moved here in 2001.

How long have you been working for the Nantucket Land Council?

Since 2001, I moved here for the job.

How long have you been in the Executive Director position?

4 years.

What does your work here entail?

Nantucket Land Council is a nonprofit 501C3 environmental organization. Original purpose of us being formed was to research old sheep commons tax title and see how that old title could be combined and then put into open space. And then we started taking on an environmental watch dog role reviewing development applications at the various boards. Also taking an active role in policy decisions at the selectman level at Town Meeting, our governing body, every April and making recommendations on articles. Also in the 80's we took on the role of a land trust, we took on the role of a land trust work where we actually hold conservation restrictions as they are called in Massachusetts but they are called conservation easements elsewhere. It's just another tool for protecting open spaced land. That's the main stuff that we do.

As it relates to here, we don't do too much alternative energy work but I'd like to start getting into more of that, just because there hasn't been that much of it on the island. There was a little kick in the 1970's, early 80's but that's about it. We do a lot of work in terms of permitting. We haven't touched the Cape Wind Project but other projects that are coming down the line, on island projects we would be reviewing for potential environmental impacts and potential benefits as well.

The Energy Committee is looking at two sites right now for their feasibility studies, the landfill and the Surfside Waste Water Treatment Facility. What would be the process for acquiring town land for use in a project such as this? Do you do anything with that or just the conservation type land?

We just do the conservation land. The Land Bank is the separate agency, separate from the Land Council they're the agency that gets the 2.5% transfer fee and they use that in their pool for open space purchases. Their charter is for open space and passive recreation. I don't think you could put alternative energy structures on their land as the law reads right now. But maybe the lawyers could look into that. It would take a whole new petition to change that rule. In terms of what we do, in terms of acquiring town owned land, we wouldn't be involved in that.

So there's no town owned land that is conservation land that you know of?

There's town owned Article 97 land, which is basically for the purpose of open space but again I don't know the intricacies of that land and how that land is set up and if that would allow alternative energy structures either.

Do you know if there is conservation land in close proximity to the landfill or Waste Water Treatment Facility?

Yes there definitely is.

At the Waste Water Treatment Facility, they are talking about putting them right in the sewer beds.

The landfill is surrounded on all sides. Everything to the south is Conservation and Land Bank. Everything to the north is Land Bank and a conservation restriction we hold on the Linda Loring Foundation's land. So there's a bunch in proximity.

Surfside, it's mostly land bank to the west. I can't remember to the east and it's sort of private to the north.

So if the construction was contained to the area, it wouldn't affect the conservation land around it?

I don't think so. In terms of sensitive species you have Harrier Hawks and other species in this area. One thing that would probably be of interest potentially is the Massachusetts Natural Heritage and Endangered Species Program Atlas of two categories, one's priority habitat and one's a lesser category. That basically delineates all the property where you have to go to Heritage to get a permit for. So if you put something up on Surfside, just because I know they were trying to do something else and ran into trouble with Heritage, you would have to go through Mass Heritage to make sure that there wasn't any impact on the species that were listed down there such as the Harriers or maybe any other plant species and whatnot.

Does Mass Heritage do the actual study or do you have to contact someone else?

You contact Mass Heritage to basically say we have a project and it is going right here. They will come back to you with a very official sounding letter saying this is an area of priority habitat you will potentially be impacting A, B, C, and D species and you have to do surveys for these species and tell us how you are either not going to impact these species or how you are going to mitigate for the impact of those species. That's their key road block, Mass Heritage.

We were told that you are very knowledgeable about Sand Plain Grasslands and that there is Sand Plain Grassland in those locations.

Yes. There are. Let me print out some real maps.

There are and there aren't down at Surfside in terms of your classic Sand Plain Grasslands. They are more in proximity to the area.

Do you know if there are any restrictions as far as how close you can have constructions to them?

It's species based in terms of impacts to certain areas. It's based on the Heritage review. Let me back up a little, all those species that Heritage would say that you are impacted are protected under the Massachusetts Endangered Species Act, the ESA. Mass Heritage has the authority to provide regulations to protect the species under that act.

Did you speak with Jeff Willett at all?

Yes. We did earlier this week.

He's got some thoughts on it as well. They had to do a bunch of surveys and permit applications when they did upgrades to the Surfside Facility.

Any particulars for exactly where (map of Surfside)?

[The turbines at the Waste Water Treatment Facility would be placed] in the sewer beds.

In terms of siting them in here or previously disturbed areas, you are not going to have any plant impacts. All this area is your classic Scrub Oaks and lots of insects, and listed moth habitat. This is your classic Sand Plain Grassland and Coastal Heathland in here.

It's a mix of Sand Plain Grassland and Coastal Dune land. I haven't really been here, but I know just looking over it, it's a lot of dune land. But in terms of impacts to Sand Plain Grasslands, you are not going to have any impacts to plants. You may have impacts to bird species, either song birds or raptors such as the Harrier Hawk, and Owls.

But as far as construction, as long as they stay on the roads and away from the little side roads it should be all right?

Yes. I think its fine. It's just going to be the scenic views and noise. I don't know enough about the studies in terms of noise impacts on animals either foraging or nesting. Scenic views are basically just people based.

That's the dump. (Map of Landfill)

I imagine it's probably on this side. This is the hill if you go out here. This is the Linda Loring piece. You can just see, conservation land, Land Bank, Conservation Foundation, it's just completely surrounded. There's one private house right here.

So it's a really nice site but it's pretty ideal because it's a dump. You won't have people complaining about it. This side is the recycling facility, its land is leased. This is DPW offices and storage and ware houses. No Sand Plain Grasslands around here. Again as long as it's in disturbed area and you don't have to clear any vegetation you are not going to have the impact on plants. But you are going to be again impacting potential animal species and birds.

Do you see any fatal flaws with a wind turbine project in either of these areas?

No fatal Achilles heel. No fatal flaws.

But again if somebody is going to come up and say it's a major flight path or affect some species we'd probably get up and raise some concerns.

But in terms of a fatal flaw I don't think there is any.

That's all our questions. Do you have anything else that came to mind that you'd like to tell us about?

They really have to do diligence with the neighbors on scenic impacts. I like the look of turbines myself. But I understand although I don't agree with people who don't like them on the landscape. So you have to respect that and do diligence with educating the neighbors about that.

I don't know exactly if there is an echoing problem to neighbor but I don't think that will be that much of a problem because the technology is up there but you never know. I think the nice thing about John Bartlett putting up his on Bartlett Farm is his will be a nice template in terms of how big it actually is on the landscape and sounds.

It's expensive. It's a huge and expensive endeavor to get this going. The other fatal flaw unfortunately might be money and the lack of funds to do it. It's really going to be on the committee or other people to come up with the grants with if not all of it, at least a sizeable chunk of it. Unfortunately that's just the way it is. Town meetings are really not supporting a lot of expenditures at this point.

Again in terms of permitting, I think the permitting here would really be the species impact and avian is probably the most. There might be something else that's out there that I don't know about but I think that would be their major one. I don't know the exact permits that would be required on a local level; you'll probably have to go through the Historic District Commission and the planning board. If it's within 100 feet of a delineated wetland they have to go to the Conservation Commission. So they will most likely need to go to the Conservation Commission. But again, I don't see that as an astronomical hurdle.

I think it's a good idea overall. We certainly need more of it. I live on the east side, if one was out there I'd think it was pretty cool, I mean not next door but maybe two doors down.

I think the economics of it is potentially the other fatal flaw. If it just doesn't come out to dollars being reduced, it's just not going to go. Although I think even if it's a no profit gain, you are potentially reducing carbon and not burning fuel out there. It's not always about the money.

Do you mind if we contact you in the future?

No. Email is best.

Can we use your name in our report?

Yes.

APPENDIX D16: INTERVIEW TRANSCRIPTION, E. RAY

Interview with Edie Ray, Shorebird Biologist, Nantucket, MA

November 19, 2008. 1-1:45 pm

Can you tell us a little bit about your background on Nantucket, as well as the work that you do here?

I started out coming here summers and as a kid was lucky enough to spend every summer. After college, I thought I would spend one winter here and just see it in the winter because I had never seen it. That was like 30 years ago, I just never got around to leaving. So that's how I sort of came to be here.

I've always been interested in birds and stuff since I was a little kid. When I came here I actually started a group of us that would get together to go on a walk every Sunday and make brunch and stuff. I got really curious about the differences in the birds here than what I was used to, I grew up in Pennsylvania. So I actually started talked some of the Maria Mitchell Science Center walks and got to know some of the people. I eventually started leading the walks, which was fun.

I've always been like a tree hugger and always been into the environment. I've always been extraordinarily curious about everything. I'm always wanted to find out something or look it up in a book. So that's how I got really interested in birding and specifically birding on Nantucket.

About my work, what I do for my job:

I do want to say right up front and loud and clear that anything that I say is me. It's no reflection on who I work for because I'm not working for them right now, it's a seasonal job. I work for the Nantucket Conservation Foundation as their shorebird biologist. So I work with Terns, Plovers and nesting things on the beaches they own. I've worked for the town of Nantucket in the same capacity. Previous to that I worked for the trustees of reservations in the same capacity on their properties.

I've sort of been doing the loop of different organizations but I've found my home with the Conservation Foundation, definitely. It's seasonal; I start usually mid-March or so, and go usually end of September, depending on when stuff comes and goes and what's going on. But again anything I say is Edie Ray the person, and not in any way representing what the Conservation Foundation says or whatever. I always have to be very careful because the Conservation Foundation is entirely member supported so I just have to make sure it's me. In the summer, it's them but in the winter it's me. There you go.

How long have you been studying birds? Maybe moving from just watching to be more involved in their habits and things like that.

I would say probably...You know always curious. I mean from the time I was a little kid I had a window feeder in my bedroom. But really really interested in birds, about 30 years, pretty much when I first moved here is when I really got into it.

Do you think you can tell us anything about what your opinions and concerns are with land based turbines on the island?

Not just on the island, but anywhere in general. I think that you have to very carefully balance the good of anything against what its repercussions might be. Although it may seem like a really great idea to slap up some wind turbines somewhere because it's a really windy place, you really have to look at how it's going to impact and what the trickledown effect is going to be.

I know that out in California where they put those wind turbines, out there on that ridge and it just diced everything that came by, that was well intentioned-they certainly didn't put them up thinking oh yeah we're going to kill a lot of birds but they didn't take the time to do the research that is required. Anything that you do, that's going to have an impact, you really have to take the time to figure out what's going to happen and it can't just be one field season. As you guys certainly know, and most people understand that one year does not give a trend on make; you really have to go way out there, you have to look at historic data and gather some data for a period of time.

So I think that anything, it's almost like a holistic approach, you have to look at everything. You know is the shade of the tower going to affect some plant that's growing that provides food for something else. There are a lot of things that are involved. We all want to save the earth using solar and wind energy instead of other fuels and other fossil fuels. You know if we are saving the earth by using those things but destroying the earth in the process, it doesn't to me make a whole hell of a lot of sense.

I think that anything that's done, you need to make an investment of time to make sure that you are not making a big unholy mistake. I think the rush right now to install things; I think there could be some problems in the future if it's not carefully monitored.

I think that you can't just look at the wind turbine experts, you have to look at the plant experts and the bird experts and whoever else you think it might impact experts.

You also have to look at long range planning. Let's say specifically if the town of Nantucket plans on putting one up at the dump, sanitary landfill. Well you have to have some sort of a master plan because you don't want to have to take that thing down in a couple of years, or even 10 years from now, because suddenly you have to expand the facility for something else. You can't just fire it in somewhere and say well there you go. You have to have a master plan for expansion. I'm sure at Mass Maritime when they put there's up, they thought carefully about are we going to need to expand the parking lot or are we going to need to expand this building. What are our needs going to be down the road, that we can at least figure out right now?

It's a lot of things that come into play and not just oh this is a good windy spot let's stick it there. I think it's an investment of time to make the right choices and to find out, I think that's the most important thing if I had to pick one thing.

I know you are not asking about water based turbines but that was one of the things that I was very vocal about with the Horseshoe Shoal Project that was being proposed. They took a field season and were like we got it, we know where the whales swim, the sea turtles are and where the birds fly because we were there you know for 15 minutes and we watched and didn't see anything so it's ok. That doesn't work that way. Populations of animals and things are cyclic and sometimes it's there and sometimes it's not. So I think an investment of time to really plan it carefully is the most important thing.

Someone mentioned a concern about land based turbines on marine life, from vibrations and stuff, do you know if this would be an issue?

I'm not an expert in acoustics. That information has been very carefully studied by a lot of other people. I know that for instance they just had, the underwater sanctuary north of here I can't remember the name of it, but anyway they just actually had some of the routes of ships changed because they did acoustic studies of ship engines and it's affect on whales. So I think that we are just beginning to realize water-based what that means and I don't know if a lot of research has been done about land based stuff. Certainly they emit vibrations, and they're at certain levels. That'd be interesting to find out. Do some geology work out there and find out what kind of soils are out there and do they transmit sound, it'd be easy enough to do. Put some probes in.

One of the other concerns was with a certain turtle on the island that is sensitive to vibrations.

Well there was the spotted turtle. Spotted Turtles are a creature that was just delisted as a species of special concern in Massachusetts. Many people believe that it was delisted because when it was listed any kind of project that went on had to find out if there were turtles there before they could begin a project. So all of a sudden they were finding lots more turtles, and so they delisted it. There are other people who believe the population is still not vibrant and healthy. I don't know that any one has done any research as far as that's concerned. You'd definitely need to do a study to find out what's there at any given site. Again it's the investment of time and money but in the end it's going to save you a lot if you decide 'hey look that's the only place we're considering and are going to put it there' and as you go through the permitting process and find out there's Bushy Rock Rose growing there. I don't know about that [turtles and vibrations] at all. I really don't know.

The two possible sites, as you know, are the landfill and Waste Water Treatment Facility. Are there any birds in particular that nest, forage or migrate through either of the sites that would be of particular concern?

I think probably the one that comes to mind the most is the Northern Harrier because that is a state listed bird. The Cape and islands have a large share of Northern Harriers in the state. They're nesting sites are carefully monitored by the Nantucket Conservation Foundation as far as how many eggs are laid, how many chicks, survivability all that stuff. So that's the one that sort of jumps to mind right now.

The other birds certainly would be affected. I know that we've mentioned Long-tailed Ducks. Vern and I were out watching Long-tailed Ducks. What was funny was the other night we were standing out at the end of Madaket Road waiting for them. A few of them were coming over and we looked back toward the dump where the tower is and there's just like clouds of them coming by. We totally missed it. Probably several hundred thousand, I've counted them many times, it's astonishing if you happen to be in the right place at the right time.

That's one of the problems with their flight is we can't totally predict where they are going to be and what the height of their flight is going to be. They do this twice a day. Some of them are flying before dawn and after dark. At the meeting I mentioned that they are not a threatened species because there are tons of them but this is their biggest wintering place on the eastern seaboard. So this is where the population is on the eastern seaboard in the winter is around here. So it's certainly a consideration.

As far as we were talking about shutting down in certain times where we know there are tweety birds, passerines, passing through, we can predict that by using radar and some weather information. But the flight of the Long-tailed Ducks I have tried for years to figure out. We know that when it's foggy, they fly over land; almost invariably they fly over land. Sometimes right over the middle of the island almost never over the east end of the island, it's always from the middle west. But what they are going to choose, where the path is going to be that particular night is really tough. The other thing is sometimes they start out flying in one area and for reasons known only to themselves they will change flight. The ones coming in off the ocean go either this way or that way and sometimes they merge. It's really tough to predict where exactly they'll be and what height they are going to be. We know that when they come off the ocean they are very low over the water and then they bump up over the land and drop back down when they get to the Sound. Good luck figuring that out.

They do sometimes mix it up with the airplanes because one of the approaches is over the water and in and you'll see the mass of birds split and the airplane goes through and they join back up again. I mean they are not stupid and aren't going to fly into something on purpose. I think the biggest problem is going to be the birds that migrate at night, the passerines, and the little tweety birds, it could be tough. I think it would be very interesting for you guys to do some research about some other land based places that are close and what sort of plans they already have in place to deal with stuff.

In terms of any red flags for these sites, other than the big migrations and the old squaws…

Long-tailed Ducks, you have to try to always call them Long-tailed Ducks because some people get very testy about it. So what other red flags?

What other red flags do you see with this project?

In citing them or just in general?

Both.

In general, obviously since years ago there was a small wind farm out by Bartlett's Farm. The big problem was, with salt spray and other decay and the crazy winds we get here and all of that stuff, maintenance. They had to get parts from Denmark or somewhere and the thing was down more than it was up. I think that would be a consideration. Like what kind of a track record does the various companies that maybe the energy people are looking into have with maintenance? Can parts be here immediately? Is there going to be a technician here to deal with it right now? If the wind is howling and the boats aren't running and the planes aren't flying and everything goes down, obviously you are going to have backup electricity but what kind of maintenance records do they have? What kind of longevity are we talking? I think that is a very big consideration. From past performance, that would be what I would be worried about the most.

Obviously if they intend on putting it wherever they are going to put it, they are going to have to go though all sorts of permitting, studies and whatnot. I think would answer a lot of the questions that we have right now. I think that the maintenance records and just how these things hold up to the crazy winds and salt spray is going to be really key.

It's not only the sites where the Harriers are nesting right now, if the population increases or they have to move for some reason, so you can't just say there's no nest right there right now we are good to go. It's all about habitat and food. Out at the sewer bed and the dump, there's a lot of mice, moles, rats and all kinds of yummy things that these birds would eat. They might be attracted to hunt near there because there's available food, like a smorgasbord.

Any structure over 200ft has to be lighted per FAA. Do you know anything about lights attracting birds or anything like that?

The answer is yes. You can go back in history, literally years ago, I know Vern mentioned it, at lighthouses you'd go after a foggy night and there would be piles of birds around the base of the lighthouse. There are wonderful accounts of the birds in Cape May, NJ, literally piles of dead and dying birds. In New York City and actually in many of the major cities, there are groups that will go out before dawn and collect birds as specimens and try to rehab some around some of the buildings. There's been a lot of work with some of the high rises to try and get them to get rid of some of the lights. It's really buildings that have reflective surfaces and windows that the birds don't see a wall; they just see some of those buildings that look like sky. They don't know about that. There's a huge history of lights. They get bedazzled, it's like a deer in the headlights they're sort of just drawn into it and then they get whacked.

Is there a particular color that they are attracted to?

That I don't know. There's been a lot of talk about, I know that's one of the things they were talking about the water based Horseshoe Shoal project was the lighting, you know there's requirements for lighting because of the FAA but then what's the best thing. Is it a strobe thing? What is least attractive? I'm sure that there have been many studies, I just don't know, but I'm sure you can find it. Massachusetts Audubon has done a tremendous amount of work; the person you should probably talk to there to get you started would be Simon Perkins. He grew up here on Nantucket. He asked me to mention to you guys that Mass Audubon has a tremendous amount of work that they've already done and research. They could put you to some sources that could probably answer a lot of your questions, to save you a lot of time. He in turn could turn you on to whoever would be able to give you the most information.

I'm sure also the Cornell Institute of Ornithology has done a tremendous amount of work on bird vocalizations, response to sounds, communication and stuff like that. That's probably another excellent place, if you start looking up stuff. They probably have a lot of information on things that are going on.

Do you know if there's any record of bird deaths or anything at any of the various towers on the island that already exist?

I don't think that anybody has done. Personally I have gone out and at the big Loran Tower out in 'Sconset I've picked up a Great Blue Heron that had its wing ripped off and I think two Red-tailed Hawks from that sight. Again sometimes it's difficult to get good data because if you're not right there when the thing falls to earth some cat comes along and carries it off. That is less of a problem here on Nantucket than it is in other places because we don't have a lot of four legged varmint things but unless you are standing under there day and night just waiting for something to drop from the sky I think it's tough to have really good data. Personally I've been there and fetched up those things, there's probably some other things that I can't remember right now but those are the ones that stick out in my mind.

Do you have any documented information or do you know if it's possible to gain anything on specific flight patterns of the various birds?

Yes. Did Vern give you websites for the radar ones? I believe that you can go back and get historic data, I know they archive stuff. I mean you guys could spend your whole lives studying this, people do. There are some tremendous new books written on bird migration, mostly passerine and tweety bird stuff. There's several sort of old but still really good books, one that's called <u>How Birds Migrate</u>. Because you have limited time to figure this out I would definitely talk to Audubon and Cornell first because they are going to have the newest stuff out especially since in books, the information is old before the book even comes out. There's so much right now with bird migrations. From the dawn of time people have been studying it.

The radar thing is the big new thing. There's also a tremendous amount of work being done with implanted devices or harness devices that transmit signals and we are finding out huge numbers of things. It used to be that the only way you figured out how a bird got from point A to point B was you caught it and put a band on it and then somebody later found it dead. Well you know that it got from Boston to Florida but you don't know what route it took them to get there. Now with the transmitters and stuff they can tell how long the flight is, where they roost, how they react to known weather patterns that are going on. So that kind of data is just astonishing. It's not to the point yet where they can put it in some of the smaller birds because due to the weight of the birds it would actually hinder the bird while it was migrating and you can' t do that. It's the bigger birds that they are putting them on now.

I would say start with stuff that you can find online and go to some websites. A couple of sites blog about the birds, it's amazing what you can find on there now and how much more we are learning.

I know Vern mentioned to you that there are some Long-tailed Ducks that have been outfitted with transmitters.

There's concern about the fog…

Yes we have that, a lot of it.

Can you tell us a little bit about birds and fog?

When it's foggy, you can't see. That's pretty much it in a nutshell.

I mean the birds are migrating, most small tweety birds, passerines don't choose to fly over this part of the ocean. They do choose to fly over some oceans, like the Gulf of Mexico and whatnot, but we think that most of the birds that migrate here are caught out over the ocean. They are flying at night and headed in the right direction and dawn comes up so they pull into Nantucket or any kind of land. They land on boats offshore or whatever. So any type of fog would confuse the issue because they can't see land. They also use other senses and can smell the land. But fog is definitely an issue because they wouldn't see the structure; they'd just see the glow and get whacked. That's when most of those incidences of birds piled up around light houses used to happen, during foggy nights. Like I said I know I've read some amazing accounts, specifically in Cape May, NJ. It's a foggy night and then the next morning there's death and destruction. In the fog you can't see, those are words to live by.

Are there any other concerns or issues that you think the Energy Committee would need to investigate or think about in their travels?

I think pretty much what I've said. The technology is certainly getting better. We'd want to think about long range planning and what the actual cost for maintenance and all of that. I know personally my husband and I are talking very seriously about putting solar panels on our roof, but we are kind of waiting for the technology to catch up with the idea. Sometimes it's a really great idea but the technology really isn't there right now. If you are able to wait three years that gives you the time to gather the information anyway, it's going to get better like computers.

I know that they were talking about putting up multiple towers at one point. You know put up one tower and see how it goes. But definitely think ahead and take the time to do your homework, that's so huge. You certainly don't want to waste a bunch of tax payer money because we will get agitated.

I think it's going to be very important to make this process very public because this is tax payer supported and you definitely want everyone to be behind the project. Have the process very transparent and give people the opportunity to weigh in on it. They're going to have to do public meetings and whatever.

I think they really have to look into these things. If the town didn't they would be stupid. But they really have to make sure that they tread carefully.

Do you mind if we contact you with any further questions?

Nope. Call me up. Call me. I look at my email rather infrequently.

I think this whole project you guys are doing is very cool.

It's really interesting because the whole Horseshoe Shoal project really divided the green people. You had the people who really wanted to do wind energy because it's such a good idea, wind is free. But then you had the people on the other side of the coin who were worried about environmental impacts. I think we all, the greenies, have to stand together to have an impact because we will certainly be outvoted by a lot of other people.

APPENDIX D17: INTERVIEW TRANSCRIPTION, A. STERN

Tour and Interview with Andrew Stern, New England Wind Power, Inc., President; Action for Clean Energy, Inc., Co-founder. Windmill Point, Hull, MA

November 21, 2008. 1:15-1:45 pm

Andrew: (showing a picture of Windmill Point when the original turbine was there) We are looking at Hull's older machine…..this is the older machine that went right into the high school, so it was all behind the meter. And that's a 40kW machine that was installed from 1984-96. It generated a savings of about $70,000 over those 12 years. That was decommissioned – taken down – in '96 and shortly thereafter a small group of citizens wanted to install or investigate installing a new one. It's called repowering, this site had a wind machine, it was taken down, and now we are going to repower it and site a new machine. This whole area is known as windmill point (points to map). They have been using it...the whole regions has been utilizing wind power for several centuries. And this spot specifically used to be a salt works. They would use them to pump sea water and then it would freeze and the salt would naturally separate. A pair of brothers, Henry and John Tudor, I believe, from Ipswich owned the plan and that was in the 1820's.

Andrew: I'll be real quiet. It's about 50dB.....(airplane – too loud to hear) Hull is interesting. There are 351 cities and town in MA, 41 of which have their own electric or electric and sewer, or electric sewer water. Everyone else is served by like and NStar or national Grid or some other, Berkshire Electric, some other conglomerate. Often times when a project is studied or reviewed or looked over for how it got built, folks use that as kind of 'Hull's a municipality, they can do that because they own the land,' and so you just have to tweak the formula a little bit, in order to have similar scenario.

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I made a presentation in Weymouth to the Selectmen about putting 100wind machines at the air base. Instead they'd like to have a golf course, or Mall of America. The wind going by our ears right now…first of all the wind speed right about now is 8 or 10 miles per hour. Not much more than that. It takes about 7-8 mph wind or 3.5 m/s wind for this wind machine to start up. It is a constant RPM machine, so it is rotating at 28 ½ revolutions a minute, or a revolution every 2 seconds. It's a Danish Vestas, a Danish machine. It's a 660kW. That's its maximum output, and that will be achieved around 20 mph, maybe a little bit more, maybe 22. It achieves constant RPM by pitching the blades, so the blades actually rotate on the nose cone, and the whole machine turns around on its base

At what speed does this machine [Hull Wind 1] shut off?

It will shut off at 50MPH for 10 minutes or more. It will shut right off and put a big break on.

Does the breaking cause any damage to it [the turbine]? I have heard concerns about the lubrication not working so well when it is started up again.

I am not aware of any problems. It's just the way the machine operations, so I don't know of any problems.

So interesting enough, in a similar manner to how myself…When you talk about these sorts of projects you get a few folks who start it, but it's really the community that contributes. The invested about $1 million - $780,000. It paid for itself in about 4 years. It's pretty good. It should have a 20 year life span, and has been running since December 27, 2001. Similar to how we started this, working with the selectmen and women and the Hull electric light board, they're looking into a project right here. So that would be a water turbine project. We're very early, because you have to measure your resources first.

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As you can see there are no special gates or fences.

I know in Nantucket they have a law that any wind energy system has to be gated off from the public.

I've never actually heard of that.

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On Nantucket they are very concerned about salt spray. They had turbines in the '80's and they were damaged by this. Are there any problems with this?

No problems. We have a winter and marine package. The winter package keeps the machine inside, keeps a pretty constant temperature and humidity, so it's a concern but it's manageable. This thing's been out here for 7 years times 365. You're going to get wear and tear. There's scheduled maintenance twice a year. About a month and a half ago out here on a tour, there were folks physically on the blades, checking the blades out. But no real major problems as far as sea spray, and one thing to note, (points to location) Hull is considering putting 4 more machines. The two machines you see now are kind of book ends, one on one end of Hull and one on the other. They provide Hull with 13% of the entire town's annual energy load. Sometimes they do not work at all, they are not generating at all, but the lights don't go out. And then sometimes we are at full capacity supplying closer to 60% but on average during the course of the year – but that could be in the winter when a/c's aren't going – the load's low but the wind's high. Again, it's somewhere in between. This is a 660kW; the other's a 1.8 MW. This is a Vestas V-47, the 47 denotes rotor diameter in meters. And that's a V-80, so it's 80 meter or 240 foot. And that's a 15 RPM, this is a 28 ½. The capacity factor which is the… If you look at the whole year, 8,760 hours in a year, at what point is this thing generating at full capacity. It's 27 ½ %. It's like a batter's average ion baseball. He doesn't hit a home run every time and he doesn't strike out every time, it's just somewhere in the middle. That figure is taking the annual energy that is produces, which is about 1,600,000 kWh or 1,600 MWh and dividing that by the number of hours in a year. That will give you that capacity factor. And of course taking into effect the output capacity of the machine. That one's [Hull Wind 2] a little lower, but that one has had less time so this...we've had more experience with this one [Hull Wind 1]. And it is right here out exposed; there are not a lot of tall buildings. This [HW1] is a 50 meter tower, that [HW2] is a 60 meter tower. That's on a 20 meter high landfill.

There is concern about the effects that the vibrations have on marine life by turbines being close to the water. Do you know if there were any studies done here [in Hull], or if that wasn't a concern here?

I don't know if there have been any studies done because this is one land and not in salt. But it's my understanding that…I don't know about vibrations specifically but certainly the foundation installation [for ocean-based turbines] provides a little bit of an artificial reef for marine life and it's my understanding that marine life flourishes and thrives.

When the turbine shuts down for whatever reason, about how long does it take before it's back up and running?

It's automated. Once the winds die down or go to a low enough speed. But also there's a stop button inside that you can manually stop and stuff like that.

Do you know if they have had much for problems when they've had to manually stop it for whatever reason?

No. I don't think it's ever been manually stopped. For maintenance they shut it down.

Vestas does the twice a year maintenance on it?

They do. Some of it they contract out. It's just 1 or 2 machines so sometimes there's a crew that comes out. Like the blade-walkers, they were just contractors.

Vestas provides this [maintenance] for whatever fee?

Yes.

So the town does not have to worry about that.

That's correct. Usually that's part of a package for the first 5 years, or 3-5 years; can be extended. That's pretty normal. And then after that, the manufacturer…Like this one put a maintenance package on for 10 years.

There are credits that are generated. For every MWh that gets generated there's a credit. This machine, Mass Energy buys the credits, so it's a piece of paper saying 'I'm green.' This is 1,600 credits per year. Hull 2 is about 4,500 per year, and Harvard has bought 10 years worth of credits or about $1 ½ million dollars. So that's a $3million project and had of it was paid for by Harvard by buying the credits. Also, although Hull is green, they sold that green component.

APPENDIX D18: E-MAIL RESPONSE FROM A. PETERSON

E-mail correspondence with Al Peterson, Manager, Nantucket Memorial Airport, Nantucket, MA

November 7, 2008. 12:01 pm

Do you know the height of the existing tower at the landfill site?

I believe the tower is 342 ft. MSL.

Are there height restrictions that come with different proximities to the airport? Can you explain any or tell us where we can find documents or information on these?

There are definitely height restrictions. However, they typically do not extend beyond one mile and are up-sloping planes from the airport on a 20:1 or 40:1 rate.

Two sites have been chosen as proposed sites for the project. One is at the landfill site which is more than 5 miles from the airport (turbines of about 260ft.). The second is at the Surfside Waste Water Treatment Plant which is within 2 miles of the airport (turbines of less than 200ft.). Would either of the two proposed sites be of any concern?

I don't think either of these would affect air traffic. Radar issues might come into play since the FAA ASR-9 radar is located in the SE corner of the airport.

Do you foresee any problems the Committee may have in getting approval for such a project?

The process to get approval from both FAA and Mass. Aeronautics can be time consuming.

APPENDIX D19: E-MAIL RESPONSE FROM K. BEATTIE

E-mail correspondence with Karen Beattie, Nantucket Conservation Foundation, Nantucket, MA

November 13, 2008 1:52 PM

Do you know of any flora, fauna, or avian life that relies on any of these areas for nesting, hunting, etc? Do any of these areas have any "fatal flaws" making them very dangerous for plant, animal, or bird life?

The Waste Water Treatment Facility in Surfside and the Madaket Landfill are both located immediately adjacent to rare sandplain grassland and coastal heathland habitat that is owned and managed by the Nantucket Land Bank and the Nantucket Conservation Foundation. This habitat is considered to be globally rare and hosts over ten species of rare plants and two rare birds of prey: the Northern Harrier and Short-eared Owl. Both have historically nested at these sites, and Harriers have been documented as nesting here within the last few years (see attached map).

Although no Short-eared Owls have been documented as nesting in the past five years, I observed at least two individuals hunting the area immediately west of the Surfside Treatment facility on numerous occasions during the winter of 2008 (beginning in January and ending in mid-March), indicating that this is still an important site for wintering owls. Given the rarity of these two species (especially the Short-eared Owl) and possibility of wind turbines interrupting their flight paths and possibly causing injury or death to bird life in the area, I do not believe that they would be responsible choices for wind power sites.

Do you have any information about nesting birds on Nantucket?

In particular we are interested in the number of nesting Harrier pairs, and any other endangered birds on Nantucket.

Please see the attached report [Nantucket Harriers All Years], which was prepared by Dr. Rhys Bowen, who has conducted research on Northern Harriers during the2000, 2002, 2003, 2006, 2007, and 2008 nesting seasons on Nantucket.

Do you have any documents showing where these nesting pairs are located?

Please see the attached map [Nantucket Harriers 2007], which I prepared using Dr. Bowen's nest site data that was collected with a GPS (Global Positioning System) unit.

Could you provide us with copies of any documents showing the flight patterns of birds over the Island of Nantucket?

I do not have any documents that show flight pattern data.

I would suggest that you consider contacting the following individuals if you have not already done so, as they have a tremendous amount of knowledge about Nantucket's bird populations:

Vernon Laux, Resident Naturalist and Property Manager for the Linda Loring Nature Foundation: vlaux@llnf.org

Edie Ray, head of the Nantucket Sunday Birding Club and seasonal Shorebird Biologist for the Nantucket Conservation Foundation: ACKbird@aol.com

Feel free to use my name and association with NCF in your report (sent November 14, 2008 9:56 AM)

APPENDIX D20: E-MAIL RESPONSE FROM S. OKTAY

E-mail correspondence with Sarah Oktay, University of Massachusetts Boston, Nantucket Field Station

November 20, 2008. 10:44 am

Here is a written answer to your question:

One proposed site for turbines is in the sewer fields at the Surfside Waste Water Treatment Plant, and the other is at the Landfill. Do you know if leakage of things such as lubricants and oil from turbines would be a concern if they went into the sewer beds? Or any other ramifications leakage at the two proposed sites may have on ground water, or other water sources?

The amount of lubricants and oil used in the operation of most current brands of wind turbines are relatively minor and most systems have redundant ways of retaining oil (double walled containers, etc.). The turbines would not represent any significant threat to groundwater or drinking water supplies on the island if sited appropriately in regards to state and local wetland protection laws (not within 100 feet of wetlands and in areas where the depth to groundwater is at least 6 feet). There location near a sewer bed or treatment facility poses no unique concerns.

In scenarios where wind power replaces either oil tanks (above and below ground) or propane tanks, the amount of oil and lubricants that could be potentially released into the environment would be reduced. In addition, pressure and leak sensors are typically installed on all newer equipment, from pipelines to oil tanks. If concerns were significant for interaction of leaked material into the groundwater, a filtration mechanism similar to a "wash down" facility used at boat yards could be sited underneath a turbine to catch and treat any leaks.

APPENDIX E: CITIZEN ARTICLE WECS

Article: ___

(Zoning Bylaw Amendment: Wind energy conversion systems (WECS))

To See if the Town will vote to amend Chapter 139 (Zoning) of the Code of the Town of Nantucket as follows:

1. To amend section 21 as follows (*NOTE: new language is shown as highlighted text, language to be deleted is shown by strikeout; these methods to denote changes are not meant to become part of the final text):*

A. Residential WECS.

(1) Permitted as an accessory use in all districts. ~~in the following districts: LUG-1, LUG-2, LUG-3, R-2, R-10, RC-2.~~

(2) A ~~M~~maximum ~~number~~ of one towers per lot ~~or on contiguous lots held in common ownership: one.~~ shall be permitted. Additional towers may be allowed by special permit.

~~(3) Maximum tower height: 60 fee measured from the mean grade surrounding the support pad(s) to the base of the wind generator measured along the vertical axis of the tower, except that tower height may exceed 60 feet by special permit.~~

(3) ~~(4)~~ ~~Minimum tower setback distance from nearest property line:~~ Towers greater than 30 feet in height shall be setback from the property line a distance measured from the mean grade surrounding the support pad(s) to the tip of a blade in vertical position measured along the vertical axis of the tower. Towers 30 feet or less in height shall be subject to the setback requirements of § 139-16.

~~(5) Minimum distance from guy wire to property line: 15 feet.~~

~~(6) Blade color: white or light gray.~~

~~(7) Tower access. The tower shall be made inaccessible to unauthorized personnel.~~

B. Commercial WECS.

(1) Permitted as an accessory use in the CI district and as a primary use in the following districts by special permit with major site plan review: LUG-1, LUG-2, LUG-3, RC-2, CN, CTEC, VN, VTEC and [Amended 4-14-1997 ATM by Art. 49, AG approval 8-5-1997]

(2) Agricultural WECS in all zoning districts shall be subject to the restrictions of this subsection, however, no special permits shall be required.

(3) ~~(2)~~ The ~~M~~maximum number of towers per lot~~:~~ shall be limited by special permit~~.~~ except in the in the CI district where one may be permitted as an accessory use.

~~(3) Maximum tower height: limited by special permit.~~

(4) ~~Minimum tower setback distance from nearest property line:~~ Towers greater than 30 feet in height shall be setback from the property line a distance measured from the mean grade surrounding the support pad(s) to the tip of the blade in a vertical position measured along the vertical axis of the tower. Towers 30 feet or less in height shall be subject to the setback requirements of § 139-16.

~~(5) Minimum distance from guy wire to property line: 15 feet.~~

~~(6) Blade color: white or light gray.~~

~~(7) Tower access. The tower shall be made inaccessible to unauthorized personnel.~~

(5) Maintenance. Every two years the owner shall submit a structural report to the Building Inspector attesting to the structural integrity of the wind generator, tower and/or support system.

(6) ~~(8)~~ ~~Public interest and public benefit:~~ The granting of a special permit for a commercial WECS shall be ~~conditional~~ based upon a finding by the ~~special permit granting authority~~ Planning Board ~~that the proposal is in the public interest and provides substantial benefit to the community, the burden of proof which shall rest with the applicant.~~ that the location of the WECS does not have a substantial adverse impact on the surrounding area.

~~(a) Location. Before it may approve the installation of a commercial WECS, the Planning Board, as the special permit granting authority, shall make a finding of fact that the location of the facilities do not substantially adversely affect the surrounding area.~~

~~C. Special permit granting authority. The Planning Board shall be the special permit granting authority for those installations where a special permit is required.~~

C. ~~D.~~ Submission requirements. The application for a building permit for WECS shall be accompanied by the following documents in addition to those documents required by § 139-26:

(1) A plot plan prepared and stamped by a registered land surveyor indicating the location of the proposed WECS, existing and proposed structures, aboveground utility lines and any other significant features or appurtenances.

(2) Structural drawings prepared and stamped by a registered professional engineer of the wing tower, including pad design and guy wire design, if applicable.

(3) Drawings and specifications prepared and stamped by a registered professional engineer of the generator, hub and blades, electrical support facilities, including transformers, cables and control devices.

(4) Drawings indicating method of making tower inaccessible to unauthorized personnel.

D. ~~E.~~ Abandonment. The Building Inspector may cause the owner to remove WECS, including all appurtenances thereto, if the facility fails to generate power for one year or more.

~~F. Noise control.~~

~~**(1) Prior to the issuance of a building permit, the WECS manufacturer shall provide sufficient data and documentation to establish that the WECS will not produce noise levels in excess of those stipulated in the following table:**~~

~~**Ambient Reading Without Windmill (decibels)**~~	~~**Maximum Permitted Reading with Windmill Operating (decibels)**~~
~~**45**~~	~~**55.4**~~
~~**50**~~	~~**56.2**~~
~~**55**~~	~~**61.0**~~
~~**60**~~	~~**61.2**~~
~~**65**~~	~~**65.4**~~

~~**(2) Decibel level readings shall be measured at the closest property line to the WECS.**~~

~~**(3) After the WECS has been approved and installed, sound measurement shall be performed to determine ambient and operating decibel levels. The sound level shall be measured on a sound level meter using the A-weighing network.**~~

~~**(4) Upon the complaint of an abutter, ambient and maximum permitted decibel measurements shall be performed by an agent designated by the Planning Board. The agent shall submit recorded sound measurements to the Planning Board for review and evaluation. A fee for the service shall be established by the Planning Board. The fee shall be paid for by the complainant unless maximum permitted decibel readings have been exceeded, in which case the WECS owner shall pay the fee.**~~

~~**(5) If maximum readings are exceeded, the installation shall be considered a public nuisance in violation of § 139-20A of this chapter. The violation shall be corrected within 90 days from the date of notification, and if the noise violation cannot be remedied, the WECS shall be removed or relocated.**~~

E. ~~**G.**~~ **Electromagnetic interference.**

(1) Prior to the issuance of a building permit, the manufacturer shall provide sufficient data and documentation to establish that the installation will not cause electromagnetic interference to any abutter.

(2) The WECS installation shall comply with Federal Communications Commission Regulation 47 CFR 15.

(3) Upon the complaint of an abutter, an investigation shall be performed by an agent of the Planning Board. The agent shall submit a report of his findings to the Planning Board for review and evaluation. A fee for the report shall be established by the Planning Board. After review and evaluation of the report, the Planning Board shall determine if the installation causes electromagnetic interference to any abutter. The fee for the report shall be paid by the complainant, unless the Planning Board determines that there is electromagnetic

interference to an abutter, in which case the owner shall pay the fee.

(4) If electromagnetic interference is caused by the installation of a WECS, the installation shall be deemed a public nuisance in violation of § 139-7F of this chapter. The violation shall be corrected within 90 days from the date of notification. If the electromagnetic interference cannot be remedied, the WECS shall be removed or relocated.

~~H. Maintenance. Every two years the owner shall submit a structural report to the Building Inspector attesting to the structural integrity of the wind generator, tower and/or support system.~~

2. To amend section 17 as follows (*NOTE: new language is shown as highlighted text, language to be deleted is shown by strikeout; these methods to denote changes are not meant to become part of the final text):*

In all districts, the height of buildings and other structures shall not exceed 30 feet, subject to the following:

A. Building and structure height. [Amended 4-12-1994 ATM by Art. 55, AG approval 4-29-1994; 4-12-1999 ATM by Art. 37, AG approval 8-10-1999]

(1) The average height of all sides of a building or structure shall not exceed 30 feet as measured from the average mean grade to the highest point of the building or structure. No one building side shall exceed 32 feet.

(2) There shall be only one highest point for each building or structure.

B. The following uses are permitted to exceed such height limitation to an extent reasonable and customary:

(1) Roof structures for ornamental purposes, such as roof walks, cupolas, spires and steeples.

(2) Penthouses on buildings to the extent necessary for mechanical purposes, not higher than eight feet and with area less than 25% of the building ground cover.

(3) Chimneys attached to a building, provided height shall not exceed 40 feet.

(4) Building mounted vertical wind turbines and ~~R~~residential-type antennas, provided height shall not exceed 40 feet.

(5) Lighthouses and beacons.

(6) Residential WECS and WECS as an accessory use in the CI district provided that maximum tower height shall not exceed 60 feet. Height shall be measured from the mean grade surrounding the support pad(s) to the base of the wind generator measured along the vertical axis of the tower.

C. Exceptions by special permit [See also § 139-21A(3) below]. The special permit granting authority may grant a special permit to allow the following structures to exceed such height limitations: [Amended 4-15-2003 ATM by Art. 31, AG approval 8-27-2003]

(1) Chimneys.

(2) Antennas.

(3) Water towers and stand pipes.

(4) Residential WECS greater than 60 feet in height and Commercial WECS. Height shall be measured from the mean grade surrounding the support pad(s) to the base of the wind generator measured along the vertical axis of the tower.

(6) ~~(4)~~ Buildings located within the RCDT Zoning District, provided that a finding is made by the special permit granting authority that the proposed height exceeding 30 feet is:

(a) Both necessary and desirable to the restoration or preservation of an existing, historic structure, if applicable;

(b) Both complementary and appropriate to the scale of the adjoining streetscape which is supported by the existence of surrounding buildings of equivalent height and the receipt of approval from the Historic District Commission; and

(c) Not detrimental to adjoining properties by substantially casting them in shadow or resulting in the loss of privacy, air circulation, sunlight, safe ingress and egress or overcrowding.

3. To amend section 2 as follows (*NOTE: new language is shown as highlighted text, language to be deleted is shown by strikeout; these methods to denote changes are not meant to become part of the final text):*

RESIDENTIAL WECS — A WECS designed or operated to provide energy principally to the residence and accessory structures located on the lot, or on contiguous lots held in common ownership ~~which must be combined by either executing a covenant with the Town of Nantucket or by means of a subdivision plan approved by the Nantucket Planning Board~~. A WECS designed or operated to provide more than 50% of its rated energy production for off-site consumption shall not be considered residential except in cases where such power is consumed by residences of adjacent property or within 1,000 feet, whichever is greater.

APPENDIX F: WASTE WATER TREATMENT FACILITY IMAGES

Figure 20. Waste Water Treatment Facility Sewer Beds and Rare Plant Locations. From ENSR, 2008

Rare Species and Common Names:
Amelanchier nantucketensis (Nantucket shadbush)
Helianthemum dumosum (bushy rockrose)
Helianthemum spp. (sunrose)
Liatris scariosa var. novae-angliae (New England Blazing Star)
Sisyrinchium fuscatum (coastal plain blue-eyed grass)
Spiranthes tuberosa (little lady's tresses)

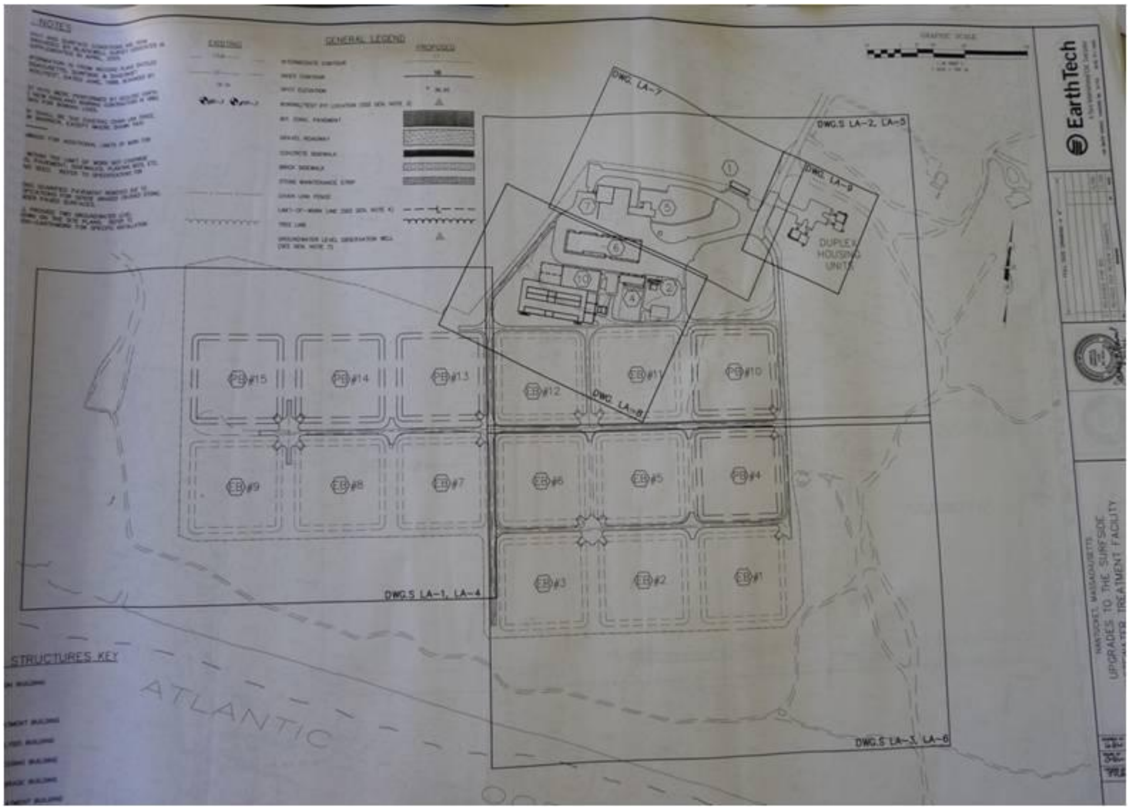

Figure 21. Diagram of Waste Water Treatment Facility Property and Sewer Beds. Photo Courtesy of Diana Berlo

APPENDIX G: PRINCETON, MA TURBINE COST DATA

Documents obtained from Jonathan Fitch on October 17, 2008.

Princeton Wind Farm Upgrade Project

Description	Price ($)
Wind Turbines*	$3,329,248
Customs*	$83,231
Tower and Foundation Insert	$770,000
Freight to Project Site	$400,000
Prepare Site/Grading/Access Road	$206,300
Turbine Site Construction	$378,400
Design/Grading Plan Development	$15,600
Foundation Construction	$458,300
Crane Costs	$272,700
Turbine & Tower Assembly	$55,121
Switchgear	$114,500
Power System Installation	$245,300
Excavation for Electrical Work	$40,800
System Commissioning	$14,200
Additional Year Warranty	$30,800
Site Restoration	$10,000
Contingency	$875,500
Total Project Cost	**$7,300,000**

Turbine & Tower Equipment Capital Cost

Wind Turbines*	$3,329,248
Tower and Foundation Insert	$770,000
Freight	$400,000
Customs*	$83,231
Additional Year Warranty	$30,800
	$4,613,279

*Pricing of turbine equipment & customs duties are based on the conversion of 1 Euro = 1.30 US Dollars.
Actual price of the turbine equipment & customs is based on actual exchange rate at time each payment is made.

Chart 2, PMLD Finances Project with Bond - (2) 1,500kW Wind Generator Project

		(A) Current $/kWh for market energy	(B) 3,300 kW Wind Farm kWh	(C) Cost of Market Energy =A*B	(D) $5,750,000 Bond Principal Repayment (based on 0%)	(E) Bond Interest Repayment (based on 0%)	(F) Insurance Cost	(G) Warranty Cost	(H) Annual Maintenance Cost	(I) Total Cost =D+E+F+G	(J) Wind Cost per kWh =H/B	(K) Cost Savings vs. purchasing market power =C/H or (A-I)*B
Year 1	FY2007	0.07	7,358,000	$ 515,060	$ 287,500	$ -	$ 22,900	$ -	$ 50,000	$ 360,400	0.0490	$ 154,660
Year 2	FY2008	0.07	7,358,000	$ 515,060	$ 287,500	$ -	$ 23,358	$ -	$ 50,000	$ 360,858	0.0490	$ 154,202
Year 3	FY2009	0.07	7,358,000	$ 515,060	$ 287,500	$ -	$ 23,825	$ 25,000	$ 50,000	$ 386,325	0.0525	$ 128,735
Year 4	FY2010	0.07	7,358,000	$ 515,060	$ 287,500	$ -	$ 24,302	$ 25,000	$ 50,000	$ 386,802	0.0526	$ 128,258
Year 5	FY2011	0.07	7,358,000	$ 515,060	$ 287,500	$ -	$ 24,788	$ 25,000	$ 50,000	$ 387,288	0.0526	$ 127,772
Year 6	FY2012	0.08	7,358,000	$ 588,640	$ 287,500	$ -	$ 25,283	$ -	$ 50,000	$ 362,783	0.0493	$ 225,857
Year 7	FY2013	0.08	7,358,000	$ 588,640	$ 287,500	$ -	$ 25,789	$ -	$ 50,000	$ 363,289	0.0494	$ 225,351
Year 8	FY2014	0.08	7,358,000	$ 588,640	$ 287,500	$ -	$ 26,305	$ -	$ 50,000	$ 363,805	0.0494	$ 224,835
Year 9	FY2015	0.08	7,358,000	$ 588,640	$ 287,500	$ -	$ 26,831	$ -	$ 50,000	$ 364,331	0.0495	$ 224,309
Year 10	FY2016	0.08	7,358,000	$ 588,640	$ 287,500	$ -	$ 27,368	$ -	$ 50,000	$ 364,868	0.0496	$ 223,772
Year 11	FY2017	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ 27,915	$ -	$ 50,000	$ 365,415	0.0552	$ 230,583
Year 12	FY2018	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ 28,473	$ -	$ 50,000	$ 365,973	0.0553	$ 230,025
Year 13	FY2019	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ 29,043	$ -	$ 50,000	$ 366,543	0.0554	$ 229,455
Year 14	FY2020	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ 29,624	$ -	$ 50,000	$ 367,124	0.0554	$ 228,874
Year 15	FY2021	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ 30,216	$ -	$ 50,000	$ 367,716	0.0555	$ 228,282
Year 16	FY2022	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ -	$ -	$ 50,000	$ 337,500	0.0510	$ 258,498
Year 17	FY2023	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ -	$ -	$ 50,000	$ 337,500	0.0510	$ 258,498
Year 18	FY2024	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ -	$ -	$ 50,000	$ 337,500	0.0510	$ 258,498
Year 19	FY2025	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ -	$ -	$ 50,000	$ 337,500	0.0510	$ 258,498
Year 20	FY2026	0.09	6,622,200	$ 595,998	$ 287,500	$ -	$ -	$ -	$ 50,000	$ 337,500	0.0510	$ 258,498
			139,802,000	$ 11,478,480	$ 5,750,000	$ -	$ 396,019	$ 75,000	$ 1,000,000	$ 7,221,019	0.0517	$ 4,257,461
											Average	$ 212,873
											NPV (5%)	$ 2,515,163
											IRR	5.67%

Notes and Assumptions:

1. Produced kWh is based on energy production estimates and manufacturers report dated SEP03.
2. After year 10 the kWh's produced decreases 10% annually to account for age and turbine inefficiencies.
3. Market power in years 2007 through 2011 is assumed to be $.07 per kWh
4. Market power in years 2012 through 2026 is assumed to be $.08 kWh
5. REPI benefit is $.019 per kWh (Congress approved on an annual basis)
6. Renewable Portfolio Standard credits are presently worth between $.025 per kWh and $.05 per kWh.
7. Insurance costs are based on $.50/$100 value of $4,580,000 plus loss of income. Insurance increases 2% annually
8. Project cost includes (2) year warranty. PMLD purchases extended warranty for years 3, 4, and 5
9. Extended warranty costs are included in up front capital cost
10. Depreciation is calculated at 3% of total cost, but is a non-cash effect

APPENDIX H: HULL, MA TURBINE COST DATA

Documents obtained from Richard Miller and Patrick Cannon on November 10, 2008

SCHEDULE I - HULLWIND I

3:45 PM Hullwind.xlsHWI (3)

CONSTRUCTION COSTS, ESTIMATED REVENUES AND EXPENSES THROUGH 2021 AND INTERNAL RATE OF RETURN

prepared 5/1/03 by R Kasperowicz

			2001	2002	2003	2004	2005	2006	2007	2008	Annual 2009 through 2011	Annual 2012 through 2014	Annual 2015 through 2017	Annual 2018 through 2020	2021
	Revenues														
1	REC revenue			15,649	43,220	46,560	42,480	82,100	71,775 a	71,775 a	71,775 b	63,800 c	55,825 d	55,825 d	55,825
2	REPI revenue					35,876	27,438	11,633	10,000	10,000	10,000	10000	10,000	-	-
3	MMWEC credits			51,196	82,776	83,855	108,706	88,506	105,806	101,232	101,232	101232	101,232	101,232	101,232
4															
5				66,845	125,996	166,291	178,624	182,239	187,581	183,007	183,007	175,032	167,057	157,057	157,057
	Expenses														
6	Maintenance			-	-	642	-	7,439	2,098	2,000	2,000	2,000	2,000	2,000	2,000
7	Annual service/warranty			8,000	8,000	9,880	10,951	12,072	17,500	18,063	20,000	23,000	27,000	30,000	32,000
8	Insurance			8,825	8,975	8,650	6,410	6,160	6,000	7,500	7,500	10,000	12,000	12,000	10,000
9				16,825	15,975	19,172	17,361	25,671	25,598	27,563	29,500	35,000	41,000	44,000	44,000
10	Net income			50,020	109,021	147,119	161,263	136,568	161,983	155,444	153,507	140,032	126,057	113,057	113,057
11	Construction costs		$ 822,341												
12	Annual Hullwind I energy output (kwh)			750,006	1,500,000	1,550,456	1,415,988	1,537,537	1,587,594	1,520,000	1,520,000	1,520,000	1,520,000	1,520,000	1,520,000
13	MMWEC credit per kwh			$ 0.0683	$ 0.0552	$ 0.0541	$ 0.0768	$ 0.0568	$ 0.0666	$ 0.0666	$ 0.0666	$ 0.0666	$ 0.0666	$ 0.0666	$ 0.0666
14	Operating cost per kwh			$ 0.0224	$ 0.0113	$ 0.0124	$ 0.0123	$ 0.0165	$ 0.0161	$ 0.0181	$ 0.0194	$ 0.0230	$ 0.0270	$ 0.0289	$ 0.0289
15	Efficiency			13%	26%	27%	24%	27%	27%	26%	26%	26%	26%	25%	26%
16	Internal rate of return	15.75%													
	Cash in / (out)														
17	2001	0.0	(822,341)												
18	2002	0.0		50,020											
19	2003	1.0			86,620										
20	2004	2.0				100,985									
21	2005	3.0					95,632								
22	2006	4.0						69,967							
23	2007	5.0							71,696						
24	2008	6.0								59,440					
25	2009	7.0									60,712				
26	2010	8.0									43,812				
27	2011	9.0									37,850				
28	2012	10.0										29,830			
29	2013	11.0										25,771			
30	2014	12.0										22,264			
31	2015	13.0											17,315		
32	2016	14.0											14,959		
33	2017	15.0											12,924		
34	2018	16.0												10,014	
35	2019	17.0												8,651	
36	2020	18.0												7,474	
37	2021	19.0													6,457
38	IRR total: 51		(822,341)	50,020	86,620	100,985	95,632	69,967	71,696	59,440	132,374	77,864	45,198	26,139	6,457

a Full year billing to Mass Energy Consumers Alliance of 1,595 certificates at $45/certificate.
b Full year billing to Mass Energy Consumers Alliance of 1,595 certificates at $45/certificate based on anticipated renewal for 3 years.
c Full year billing to Mass Energy Consumers Alliance of 1,595 certificates at $40/certificate.
d Full year billing to Mass Energy Consumers Alliance of 1,595 certificates at $35/certificate.

11/10/2008 09:46 17819256125 PAGE 02

SCHEDULE II - HULLWIND II

CONSTRUCTION COSTS, ESTIMATED REVENUES AND EXPENSES THROUGH MID 2026 AND INTERNAL RATE OF RETURN

prepared 5/1/08 by R Kasperowcz

3:46 PMhullwind.xlsHWII (3)

			6/30/2006	2006 (half year)	2007	2008	2009	2010	Annual 2011 through 2015	Annual 2016 through 2020	Annual 2021 through 2025	2026 (half year)
	Revenues											
1	REC revenue			104,550	189,050 a	179,598 b	151,240 c	132,335 d	85,073 e	85,073 f	85,073 f	42,536 f
2	REPI revenue				3,397	2,000		-		-	-	-
3	MMWEC credits			105,091	254,334	255,740	255,740	255,740	255,740	255,740	255,740	127,870
4												
5				209,641	446,781	437,338	406,980	388,075	340,813	340,813	340,813	170,406
	Expenses											
6	Maintenance			4,882	3,158	20,000	10,000	20,000	20,000	20,000	20,000	5,000
7	Annual service/warranty			29,200	29,901	36,000	36,000	36,000	40,000	43,000	45,000	22,500
8	Builder's risk insurance			10,514								-
9	Insurance			6,160	19,895	21,000	21,000	21,000	23,000	25,000	28,000	14,000
10				49,956	52,954	77,000	67,000	77,000	83,000	88,000	93,000	46,500
11	Net income			159,685	393,827	360,338	339,980	311,075	257,813	252,813	247,813	123,906
12	Construction costs		$3,310,169									
13	Energy output (kwh)			2,091,011	3,779,402	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	3,800,000	1,900,000
14	MMWEC credit per kwh			$ 0.0503	$ 0.0673	$ 0.0673	$ 0.0673	$ 0.0673	$ 0.0673	$ 0.0673	$ 0.0673	$ 0.0673
15	Operating cost per kwh			$ 0.0239	$ 0.0140	$ 0.0203	$ 0.0176	$ 0.0203	$ 0.0218	$ 0.0232	$ 0.0245	$ 0.0245
16	Efficiency			20%	24%	24%	24%	24%	24%	24%	24%	24%
	Internal rate of return	6.22%										
	Cash in / (out):											
17	6/30/2006	0.0	(3,310,169)									
18	2006	0.3		154,480								
19	2007	0.5			369,553							
20	2008	1.5				318,328						
21	2009	2.5					282,756					
22	2010	3.5						243,567				
23	2011	4.5							190,042			
24	2012	5.5							178,914			
25	2013	6.5							168,437			
26	2014	7.5							158,574			
27	2015	8.5							149,288			
28	2016	9.5								137,820		
29	2017	10.5								129,750		
30	2018	11.5								122,152		
31	2019	12.5								114,999		
32	2020	13.5								108,265		
33	2021	14.5									99,909	
34	2022	15.5									94,059	
35	2023	16.5									88,551	
36	2024	17.5									83,366	
37	2025	18.5									78,484	
38	2026	19.5										38,201
39	IRR total: (613)		(3,310,169)	154,480	369,553	318,328	282,756	243,567	845,255	612,987	444,370	38,201

a Full year billing to Harvard of 3,781 certificates at $50/certificate.
b Full year billing to Harvard of 3,781 certificates at $47.50/certificate.
c Full year billing to Harvard of 3,781 certificates at $40/certificate.
d Full year billing to Harvard of 3,781 certificates at $35/certificate.
e Full year billing to Harvard of 3,781 certificates at $22.50/certificate.
f Full year billing of 3,781 certificates at $22.50/certificate; assumes market will hold at $22.50/ certificate after current Harvard contract expires.

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APPENDIX I: RESULTS TABLES

Objective 1: Laws, Regulations, and Permits

Interviewee	Objective 1: Laws, Regulations, and Permits	Interviewee's View
Bartlett	Historic District Commission	"That was the first thing that I did, which I thought was going to be the hardest thing was actually the easiest thing. I had HDC approval in May of 2007 for this project."
Voigt		"You have to contact us to get it because it is a three-part triplicate application."
		HDC just approved a turbine near the sewer beds
		advice: read directions, fill our properly to move fastest; HDC meets on a Tues. within 11 days; app. returns additional information by Fri., second meeting next Tues; "if you were trying to get a decision, we have to decide in 60 days"
Voigt	Historic Preservation Act (section 106)	If receive federal funds, fed. Gov. can't exempt itself from local rules and regulations
		If local approval, give feds approved plans, they will likely approve no problem
Bartlett	Mass Historic Commission	
Bartlett	Department of the Interior	required due to ACK's designation as a historic landmark; balloon float test
Voigt		check guideline through secretary of the interior
Bartlett	Archaeological Assessment	"I also had to do an archeological assessment to make sure there were no Native American artifacts or remains on the turbine site, part of the USDA application."
Fitch		"PMLD received a grant from the USDA, as we are a rural community...It was a very [labored] long process to go through in order to get this grant. I think I spent $300,000 in environmental studies to get $470,000. So it was almost a waste of time and money to be honest with you....."
Voigt	Local, State, Fed Historic permits	"I would do it parallel. I think you should do both at the same time. " "Start it with MA Historical and the first thing they will tell you is you need to get all of these different things, and you can opt out of some of these things if you just come to us to do the local review, and they will give you a couple other pieces."
Bartlett	FAA	"I did go through FAA review."

Fitch		"FAA permitting is a very easy process, and you can get a determination pretty quickly, and they may need more information as well."
RERL		time consuming - start soon
Hull		Miller: "We just had to deal with the FAA because we are on direct flight landing path for Logan Airport. So they had to approve the height limitation."
A. Peterson		"The process to get approval from both FAA and Mass. Aeronautics can be time consuming."
		"There are definitely height restrictions. However, they typically do not extend beyond one mile and are up-sloping planes from the airport on a 20:1 or 40:1 rate."
		"Radar issues might come into play since the FAA ASR-9 radar is located in the SE corner of the airport."
Hull	FAA - light color	Miller: "One thing you want to do if possible is try to get FAA to approve you for red only light, day and night... if the red shield doesn't come down over the white light and it's on all night, it can affect the cycle and takes 24hours to correct itself and I get 1,000 phone calls... about the white strobe at night..... If you can do that, you'll save the people you are working for a lot of aggravation down the road."
A. Peterson	radar interference	possible at Waste Water site, as "FAA ASR-9 radar is located in the SE corner of the airport"
A. Peterson	air traffic interference	should be no problems with air traffic interference at Landfill or Waste Water sites
RERL	FAA form	File FAA form 7460-1
Hull	FAA lighting	Apply with FAA for red light both day and night
Bartlett	Mass Aeronautics Commission	"I went through Mass Aeronautics Commission (MAC) review." - may have been for USDA only
A. Peterson		time consuming
Bartlett	U.S. Fish and wildlife notification	"Since I applied for and accepted USDA fund that was an extensive application. I needed to send notification to U.S fish and wildlife."
Bartlett	local Indian Affairs Council notification	
Bartlett	storm water notice of intent, plain water act	"I didn't do anything with the storm water notice of intent or plain water act. I eliminated some of these because weren't in a protected watershed or flood district. These were all things I had to identify for the USDA. "
Fitch	interconnection permit through National Grid	"Nantucket as a community itself could put the turbines up and not even own the distribution system. National Grid has to connect it, there's nothing to prevent them, or let them say no to Nantucket."
Bartlett		

Bartlett	Federal Funding (NOT a law)	federal funding is very time consuming - requires additional permits
Fitch		time consuming and expensive - additional permits require additional studies
Steinauer	Mass Heritage	"A new project that goes into that habitat it has to file with I don't know if it's MEPA or directly to Heritage and they have to sign off on the project" because Nantucket is a priority habitat of rare species.
Collier		"You contact Mass Heritage to basically say we have a project and it is going right here. They will come back to you with a very official sounding letter saying this is an area of priority habitat you will potentially be impacting A, B, C, and D species and you have to do surveys for these species and tell us how you are either not going to impact these species or how you are going to mitigate for the impact of those species."
Melvin		"The Natural Heritage and Endangered Species Program which is part of the Massachusetts Division of Fisheries and Wildlife so we are the state agency that has legal authority for conservation protection of wildlife in the commonwealth of Massachusetts including species that are listed as endangered, threatened or species of special concern and receive special protection pursuant to our state endangered species act."
		"Any sort of proposed wind turbines that would be proposed to occur in areas on the map that are designated as priority wildlife habitats by Mass Wildlife need to be reviewed for potential impacts to state listed species. So projects like this very likely would go through a formal review process through our agency. They'd be reviewed by additional people within the agency possibly including myself and a formal opinion would be rendered as to potential affects."
Schultz	bylaw - proximity house/property line	"So, about 250 feet. Now that is according to this drawing, and I think that from looking at this, that is probably pretty close to what it is."
		"So the nearest turbine is 1000 feet from that house, I'm not sure where the property line is, but it's probably around there. So you would probably not be able to use these 3 beds (the 3 corner ones closest to house)."
Hull	geotechnical studies	Miller: "On Hull Wind 1 we had to deal with local conservation commission through our wind studies, geotechnical studies regarding the foundation and other than that it was not a big deal."
Fredericks	permit process	"I would go to Cape Wind if you have not, they have an outline of the process you go through to permit something. And I would make sure you get your arms around what it takes to permit it."

Vorce		"The only thing about a special permit that you need to know is that it has to be a super majority of the board, so four of the five members have to vote in favor of it. It's not a simple majority."
		"Federal requirements are always going to trump state and local laws."
		"So under commercial, commercial WECS would be the closest, and that's permitted by special permit with major site plan review."
		"Yes, that's town meeting, there needs to be, it's going to be a long term lease. I think it's over 5 years; it needs to get authorization from the town meeting…and that does require 2/3 majority as well. So there's a higher bar for that."
Vorce	WECS	"So under commercial, commercial WECS would be the closest, and that's permitted by special permit with major site plan review."
		"The maximum tower height is limited by special permit, so again this permit granting authority, which in this case will be the Planning Board can set those distances."
		"Well it's interesting because if this is sponsored by municipality it will be a municipal use and not necessarily subject to the WECS by-law."
Fitch	required setback	"In 24 years of operation we haven't had any issues with setbacks, hikers, fences, or other restrictions."
Collier	Endangered Species Act (ESA)	"It's species-based in terms of impacts to certain areas. It's based on the Heritage review. Let me back up a little, all those species that Heritage would say that you are impacted are protected under the Massachusetts Endangered Species Act, the ESA. Mass Heritage has the authority to provide regulations to protect the species under that act."
Collier	Local Permitting	"Again in terms of permitting, I think the permitting here would really be the species impact and avian is probably the most…..you'll probably have to go through the Historic District Commission and the planning board. "
Collier	Conservation Commission	"If it's within 100 feet of a delineated wetland they have to go to the Conservation Commission. So they will most likely need to go to the Conservation Commission. But again, I don't see that as an astronomical hurdle."
Collier	Town Owned Land	"There's town owned Article 97 land, which is basically for the purpose of open space but again I don't know the intricacies of that land and how that land is set up and if that would allow alternative energy structures either."
Broderick	dark sky initiative	Nantucket by-law not a problem, FAA law will override this

Schultz	DPW housing near sewer beds	"No, nothing will be owned. These houses are for employees who are within the sewer enterprise fund... so that would include people who work for the waste water facility and people who work for the town sewer department.....Obviously you have to work for the DPW, and if you leave the DPW you have to leave the house."
Willett		"We have not included at this point anything in the lease regarding the potential for wind generation. These buildings will probably be occupied by the end of December. I don't know that we're going to have an opportunity to include something in that lease before then. " "It will probably be at will, in other words as long as they are employed by that division of the Department of Public Works they can stay in that housing provided that they don't break some other condition."

Objective 2: Ownership and Financial Arrangements

Interviewee	Objective 2: Financial Analysis and Ownership Arrangements	Interviewee's Views
Fitch	municipally purchased and owned	"So right now I've actually told the community that it's going to be at or near what they pay otherwise, so almost a net-zero with today's rates. But long term it's going to be a fixed, stabilized cost of electricity." "There's not a lot of muni's, but from what there are of us, we think that we do a better job than investor utility companies (IOU's). We usually compare ourselves to National Grid, Unitel, Boston Edison. And they're much bigger than most muni's but we tend to have much lower rates because of our non-profit status, and we report directly to the rate payers, not shareholders."
Hull		Cannon: "The advantages as far as selling the power, we are selling it to MMWEC and we get a better deal out of MMWEC than anyone I've heard of selling it to National Grid or NStar. We sell it for about 6 cents a kW and best I've heard out there on the others is 4." Miller: "Look at our rates they are almost half of National Grid." Cannon: "We are about 12cents a kWh and any of the investor owned are about 19. We are doing extremely well rate wise."
	Financing Options	

Fitch	borrow as a town, through bonds (borrowing $)	"I could have either gone out as a town and borrowed through bonds as if we were building a school and back them up from PMLD's electric rates. We would take a town vote, but getting a bond vote in a small town is very difficult.....Asking for bond funding for wind turbines is very risky because it takes 2/3 voter approval, but that is an option for Nantucket- they can go thru the town process of voting on borrowing money for a project like this and getting the money."
Fitch	MMWEC (Mass Municipal Wholesale Electric Company)	"We decided to finance the project through a 'wind cooperative' with MMWEC. MMWEC is a joint public action agency (Mass Municipal Wholesale Electric Company)." (for muni's only)
Fitch	financing by private corporation	"Early on we were able to find private corporations that wanted to develop the wind farm with us as a joint project- they would finance it and own and operate it, we would get a share of the output and benefits, and both our names would be on the project. You could try to do something like that as well."
Fitch	MTC Massachusetts Technology Collaborative	"Nantucket can get money through MTC (Mass. Technology Collaborative). MTC has some funding available for projects like this in town's served by IOU's."
Collier	Financing	"It's expensive. It's a huge and expensive endeavor to get this going. The other fatal flaw unfortunately might be money and the lack of funds to do it. It's really going to be on the committee or other people to come up with the grants with if not all of it, at least a sizeable chunk of it. Unfortunately that's just the way it is. Town meetings are really not supporting a lot of expenditures at this point."
Willett	ownership	"What I would hope would happen if the town decides to build these things, they would have some sort of arrangement with an owner operator where the town would derive some benefit whether it be from lease of the property, cut of the profits, whatever would be negotiated. But I don't think the town wants to be in a position where it is owner of these things and responsible for maintenance."
Fredericks	ownership options	"They would really look at 3 options. One is completely owned by the municipal. The second is owned by a third-party- that is, they would find a generation company- Solar Turbines, American Wind, someone- and setup a relationship. They would make the land available and so on, and the good wind regime of Nantucket and support a location and letting a third party own it. The last is a municipal/private party ownership or collaborative if you will, where it's possible because of the unique financial characteristics of the island, that they could get a joint venture either with public or private money. That's very practical out here as a possibility."
Fredericks	Net meter	"Typically it would be just one [meter]."

		"If I put it on this side of the meter and I size it correctly, what I am really doing is deferring my total cost of power, which for Nantucket is about 16 cents per kilowatt...If I go beyond what I need, I can sell it to the market, but because I'm on this side of the meter I now pay losses through the meter and I pay a piece of it, I have to push it all the way through the distribution system and pay another piece, all to get the excess to the market. So by the time I am done with my 5-9 cents, a large portion of it has been eaten. So the downside to being on this side, if you will a customer-owned or net-metering, if I go much bigger than my use, I have a lot of people to pay to get it to market so the value of the extra is less. If I am big enough to play, the right place is the market. So size becomes critical to answering your question"
Larson	net meter	"if Nantucket is considered a separate utility, net metering is only up to a certain percent capacity. I'll have to look at it. You may actually exceed that with one turbine."
Fredericks	net meter, sized perfectly: pros	[for a facility using 350kW per day,] "On a peak day the first 350 kW is free, I've offset my bill completely. Average day, more than offset my bill completely." "So the pro of this is, up to the use of the building, I sell the power at 16 cents plus the tax credit of 2 cents, or 18 cents/kW. So I can completely eliminate my bill and I can make 2 cents in tax credit. If I size it perfectly, the wind blows every time I need electricity, and the utility is really there for backup when it is not a windy day where they're selling you electricity, the rest of the time you've offset your electric bill."
		sustainability: "...let me ask you a question- you're a senior in high school, you're interested in engineering and someone says to you 'I'm going to donate a million dollars and I want you 4 students to work with my 5 students and my school board, and I want you to build a 200 kW wind turbine in the school backyard, we are going to make it part of our curriculum, we are going to cut our energy cost in half, and every kid can see it go up in the backyard..... And I can put it in a place where every student- the next generation- gets comfortable that this is no big deal.'"
		"Oh and by the way, instead of it being 375 feet tall with big blades, I can get a 200 kW that's 90 feet tall with 25 foot blades."
		Pro: maximize economics
	net meter, sized perfectly: cons	"The con, you've done all this work- the school will benefit, maybe a little of this will get pushed back into the system, but you've really limited who gets to benefit from this particular application."

Fredericks	pay National Grid to use distribution system to get to market	"I would say you're probably looking at a penny a kilowatt. So if the market says its 5-8 cents, you're going to pay us a penny, maybe a little bit more because of the amount of money that we've tied up in the cable."
		"If I sell here, I get the market minus the 'handling fees' from National Grid, maybe a penny, and the market is going to pay me 5-8 cents, and by the way this is all offset by some tax credits- about 2 cents a kilowatt. So the real value of this if you add in the tax credit is probably something more like 7-10 minus the one, and you're going to end up with something between 6 and 9 cents a kilowatt on this side"
		good for large wind farms
		con: larger turbine, need to upgrade equipment
Fredericks	export electricity off-island	"It is technically feasible, there would be costs because there is complex relaying that would have to be changed. And the issue is not the cables, the issue is the transmission system and the market we are tying to- there are a lot of really complicated things going on on it- and you might find that pushing power back into the system could force changes all the way to New York City or Boston because of how it all kind of ties together and works."
		"I would say it's an extremely complex system, it can be addressed, but the study itself is probably in the $50,000-$100,000 range. And the changes could far exceed the study."
Fredericks	municipal light department/generator	"For your own education, I don't know that you can get into this in a report unless you're a lawyer and really very crafty..." "The fact that the committee asked you to layout what are the pros and cons of a municipal utility being formed and taking over our system, if you guys were getting your graduate degree and already had your law degree that might be a realistic paper to write. I'd focus on the wind and not spend a lot of time on that, that may be more than you guys can handle. Seriously, there are big law firms that make their living debating the pros and cons of municipal ownership. I couldn't even begin to help you, and I think I'm one of the last people that have a general view on some of that."
Larson	municipal light department	"I don't think you should include anything right there, that's more of a law school thing"
M. Peterson		"on Nantucket National Grid pays the town of Nantucket a personal property tax on all of our facilities. If the town of Nantucket were even to pursue the concept of becoming a municipal light company, all of that tax income that they are dependent on by the town to operate town facilities, police department, fire department or anything else, would go away." "It is very common if we have a substation, and on Nantucket we do, it is not uncommon that we are the largest tax payer"

M. Peterson	municipal light department	"With infinite time and infinite money anything is possible.....you're definitely talking about a lot of money to buy the infrastructure, I mean you're talking all the utility poles, all the wires, the transformers and everything else. It might easily be in the hundreds of millions of dollars if the town wanted to pursue that. "
Fitch	Municipalization	"They'd have to buy the electrical distribution system out, and that's a big endeavor." "legislature in Lexington may make municipalization easier."
Fredericks	cost analysis	showed us some basic calculations to do with actual numbers for analysis
Larson	equipment upgrade costs for use of a turbine (NOT exporting)	"Even fairly easy implementation of sizable wind turbines will cost probably $20,000-$30,000 for facility upgrades" "If you have a size turbine that could export power through the existing distribution system...you may not have to upgrade anything."
Larson	expense - multiple turbines per site	"You can get one turbine on a net transformer pretty easily, beyond that you're going to need to start adding transformers and maybe upgrading some of the underground cable etc." "That's one thing: if they have a lot of turbines, that you might want to own some primary distribution at the system voltage of 13.2. 13,200V."
Larson	income per kWh of exported electricity	"If they sold as a qualifying facility to the market via National Grid they would get the wholesale prices plus any capacity payments. It's roughly 7 or 8 cents I think when all is said and done on that per kWh."
Larson	Green Communities Act	"If the town owned or contracted for the power from these wind facilities and the wind facilities produced more than they can use they'd essentially be getting credits on the accounts that have the renewable resource.....they would get a little bit over 16-16.5 cents/kWh for anything that they exported."
		"If you are net metering and you export power, we determine a cash credit and apply it to that account…And the way the law is written the customer can transfer that credit to another account."
Bartlett		"Also looked into trying to determine how some of the net metering worked because that ultimately depends on how quick the payback is, can you use all the power you are generating versus selling the power wholesale back to the grid which is much less beneficial from a profit standpoint."

M. Peterson	maintenance	"Maintenance is something that you always have to be cognizant of because these things do need attention…..If you are doing net metering internal to just the Waste Water Treatment Plant or just the Landfill, what happens if the thing goes offline? These things are considerations that have to be at least mentioned in your study because they cost money."
Stern	down time	"It's [shutting down] automated. Once the winds die down or go to a low enough speed. But also there's a stop button inside that you can manually stop and stuff like that."
		"I don't think it's ever been manually stopped. For maintenance they shut it down."
Larson	landfill site generation	"A 1500kVA transformer...I don't think it would be that hard to install a 1-1.5MW turbine on that account. I don't think you'd want to put two turbines on that without upgrading, and even then you'd have to add another transformer."
Larson	Waste Water site generation	"It's a lot of underground. It's kind of unusual to have this tying into a system that is primarily underground…..it's fairly limited, about 1MW is about all we could carry on that, so we might even have to upgrade the overhead section" "Depending on how the substation is set up and what the minimum loads are on the feeders...if there's a chance that there will be reverse power at the substation you might have to add quite a bit of protection equipment back there" --one will not add this cost
Fredericks	max power production	"...I can give you a ballpark of a half-Megawatt."

Objective 3: Concerns Regarding Wind Power for Nantucket

Interviewee	Objective 3: Concerns	Interviewee's Views
Steinauer	birds	"I would be concerned about would be Ospreys because they really like poles, and are just big birds"
Melvin		"Any site on Nantucket could potentially cause mortality to a variety of birds including migratory song birds under the right conditions, with a broad front migration in spring or fall. But again I think the locations we are talking about and the relatively small number of turbines would be much less risky to seabirds whether it be Plovers or Terns or some of the large concentrations of sea ducks that winter and forage off Nantucket. What you are talking about on the island itself would be much less of a risk than larger numbers of offshore turbines. Now having said that, obviously the on island turbines could pose more of a risk to Harriers and Short-eared Owls, but I think that risk would be somewhat more diffuse in that the distribution of the Harriers and Owls is much broader on the island."

		"I think with all of the locations and the particularly smaller magnitude of the proposed work it is **less likely to have an adverse affect on state listed birds**, particularly Terns, Piping Plovers and any of our four state listed species of Terns: Least, Common, Arctic and Roseate, in part because there are many fewer turbines and they are located on the mainland."
		"In terms of impacts to state listed birds, in general potential adverse affects of what you are talking about, that is a relatively small number of turbines located on the island itself would very likely have less of an adverse affect than the larger facilities that have been proposed offshore."
Laux		Nantucket=highest known density of Harriers anywhere
		"This past summer there were 59 nesting pairs of Northern Harriers. It's a very threatened species that only breeds in a few location[s] on the coast of Massachusetts. Nantucket has the highest known density anywhere in the world"
		Harriers (all raptors) lock eyes on prey and dive, don't look where they're going
		"Osprey there are 18 pairs on the island" 2 pair by landfill
		"Short-eared Owls used to nest all over Nantucket as a stronghold, but they have been gone now, for I guess 11 or 12 years. They used to nest right out here they used to nest out at the Miacomet, right near the treatment plant."
		Long-tailed Duck
Ray		Long-tailed Ducks: "this is their biggest wintering place on the eastern seaboard."
		particular concern: "one that comes to mind the most is the Northern Harrier because that is a state listed bird"
Steinauer	birds: Waste Water	"We also have two birds that would be problems down at the Surfside area Northern Harriers, a type of hawk, and Short-eared Owls. Nantucket is really that last stronghold in the Northeast for Northern Harriers, at least locally they are very important. Short-eared Owls are getting very uncommon so they would be very important. "
		Rare birds: "most of them are coastal and we do have some federally ranked birds: Piping Plovers and Least Terns. But we also have Roseate Terns which are federally endangered and they migrate through here."

		"We are a major sea duck wintering grounds, they’re typically lower and tend to hang out in the water, and don’t cross land a lot although I know we do get some in the ponds. Surfside plant is really pretty close to Miacomet Pond so that again could be a concern. The Long-tailed Ducks, we have a tenth of the world’s Long-tailed Ducks here and if you get a chance they migrate back and forth, hundreds of thousands of these birds fly over every day."
Kennedy		"So you have Short-eared Owls and Northern Harriers using that facility for foraging and very close by nesting."
Kennedy		"You also have Least Terns who are very close to and will be flying back and forth along the shoreline... possibly even Piping Plovers because that is basically right on the beach there. You could have migratory shore birds feeding within the sewer beds... in many places of the world shorebirds are attracted to the sewer beds."
Melvin		"Only one of the sites, the Waste Water Treatment Facility, would be close to coastal habitats and we currently don’t have these birds [Terns] nesting right at or immediately adjacent to the sewer beds, although undoubtedly there are birds moving along the coastline in that vicinity."
		"Certainly it is likely that Piping Plovers and Terns could be flying right along the beach immediately adjacent to the treatment facility. Plovers could be feeding right on the beach there in the dunes. Terns could be feeding just offshore. Certainly under conditions of fog or cloudy weather or wind they might actually fly into the turbine area."
		"[Northern Harriers and Short-eared Owls] could be a concern and would be more likely to be a concern at the sewage treatment plant as opposed to the other site."
Kennedy	birds: landfill	"At the dump... There are lots of gulls... there is potential for bird strikes, especially under foggy conditions. It’s also a place where if we get Bald Eagles on the island, they can show up there, so they are another species of special concern. Adjacent to the dump there are nesting Ospreys. Least Terns do utilize Long Pond for foraging. You’ve got migratory water fowl concentrated in Long Pond. There are even some sites with low wetlands that have also attracted some pretty important migratory birds."
Melvin		"I think the first question to ask would be, would the design of turbines and the poles be such that an Osprey could locate a nest on them? We have lots of situations in this state and elsewhere, where Ospreys will nest on power transmission lines, chimneys, unoccupied boats, lights on baseball fields, so those can be dealt with but I guess it’s a potential issue."

Laux		away from shores is best, "about the only spot that would make any sense"
		[ponds near the landfill] "attracted incredible numbers of shore birds this fall. Including some very rare things, maybe a bird that has never been seen in North America before."
Ray		"The other birds certainly would be affected. I know that we've mentioned Long-tailed Ducks. Vern and I were out watching Long-tailed Ducks…..we looked back toward the dump where the tower is and there's just like clouds of them coming by."
		"It's all about habitat and food. [Not where the birds nest.] Out at the sewer bed and the dump, there's a lot of mice, moles, rats and all kinds of yummy things that these birds would eat. They might be attracted to hunt near there because there's available food, like a smorgasbord"
Laux	tracking birds	Long-tailed Ducks have implanted radio transmitters - sent us the sites via e-mail
Ray	siting in general:	"Populations of animals and things are cyclic and sometimes it's there and sometimes it's not. So I think an investment of time to really plan it carefully is the most important thing."
Melvin	Cape Wind studies	"Part of the problem is there is not a lot of data to go on. We've raised our concerns based on a lot of monitoring work that's gone on monitoring the Piping Plovers and Roseate Terns along the coast of Massachusetts and the Atlantic Coast. There have been some surveys done specific to the Cape Wind Project that have been done from airplanes and boats that derive data on occurrence and distribution of Terns offshore."
Melvin	rare and endangered species	"Our concern is that they be sited in areas where they are least likely to have adverse affects on rare and endangered species and their habitats. In the area, where we've had the most concerns in recent years has been for proposals for very large wind turbine facilities located offshore particularly in Nantucket Sound with the Cape Wind Project and more recently with the proposals for wind farms in Buzzards Bay offshore."
Ray	vibrations	"Do some geology work out there and find out what kind of soils are out there and do they transmit sound, it'd be easy enough to do. Put some probes in."
Beattie	Con: both sites	"Given the rarity of these two species (especially the Short-eared Owl) and possibility of wind turbines interrupting their flight paths and possibly causing injury or death to bird life in the area, I do not believe that they would be responsible choices for wind power sites."

Steinauer	Fog	"The other big concern about birds out here is fog. In the daylight from what I understand they're pretty good at missing objects but at night lighting is really important you'd want to get the best information about lighting because at night those lights really mess with birds. During migration, birds fly at night often so that's a concern."
Melvin		"Obviously fog can obscure the presence of the turbines, the blades or the towers themselves, and result in mortalities. That's one of the biggest concerns that we have when you get beyond the question of can and will the birds avoid the towers and the spinning blades under good visibility conditions, then you raise the question what's the potential for mortality under foggy conditions. And certainly fog is a common phenomenon in places like Nantucket including during periods when the birds are in the area nesting chicks and periods during migration in the spring and summer."
Laux		"They [birds] don't take off in the fog."
		"So fog disorients them, they don't know where they are and they come down. Birds utter call notes, or contact notes at night; it's how they stay [together].....There are certain nights in the fall where it's foggy and the lights are on, and all the birds are crashing into the windows, the other ones hear them by staying in contact and they all come down and get wiped out."
Ray		"Any type of fog would confuse the issue because they can't see land. They also use other senses and can smell the land. But fog is definitely an issue because they wouldn't see the structure; they'd just see the glow and get whacked. That's when most of those incidences of birds piled up around light houses used to happen, during foggy nights."
Melvin	migrations	"It's a fairly broad time of the year when song birds are migrating. It can begin in late August and continue into November. One can also generally predict when large migrations will occur with the arrival of a high pressure system with a northwest winds basically blowing from north to south and also with clear conditions. But then you can have songbirds coming onto land or forced to low elevations by poor weather which of course is a little harder to predict exactly where along the migration route this will occur. But I would rely on the local knowledge out there and if there is a specific time of the year or particular conditions that they can predict will result in a large number of songbirds or other species passing over or landing on the island in the vicinity of the turbines, I think I'd want to press them into specific and how well that can be determined."
Steinauer		"We may get other migrants, lot of peregrines and things that don't necessary live here but are here during

		migration."
Ray		"when it's foggy, they [Long-tail Ducks] fly over land; almost invariably they fly over land. Sometimes right over the middle of the island almost never over the east end of the island, it's always from the middle west."
Fitch		in Princeton: "One thing on the bird kill, since some people still had a concern, and the main a concern was during the October migration period for raptors, I agreed to turnoff the turbines under the right conditions in October where it might lead to more risk of bird kill."
Kennedy		"When they [Long-tailed Ducks] move from place to place in the afternoon they often fly at heights of about 200-300 feet. When they do that they could be flying at those heights over land too..... But they traditionally fly at heights that would interact with a wind turbine at 300 ft."
Laux	shut off turbines	only a few says a year, September 15-October 15; nights with a northwest wind of anywhere from 10-30 mph; will know an hours after sunset if it needs to be shut off that night
		"There would be a few nights in the fall, we would have to come up with some authority to close them down or there would be massive kills...a few nights when the right wind conditions would be a northwest wind, and fog coming in the morning. You could go down there in the morning and there would be thousands of dead birds, and I don't think anyone wants that." right conditions: "nights with a northwest wind of anywhere from 10-30 mph."
Ray		"As far as we were talking about shutting down in certain times where we know there are tweety birds, passerines, passing through, we can predict that by using radar and some weather information"
Steinauer	bats	"They found that bats have not got the ability to miss the turbines nearly as well birds, especially these big turbines.....they seem to be finding that bat mortality is a bigger problem relative to the number of bats around than bird mortality relative to the number of birds around"
Kennedy		"I can tell you that our bat populations are significantly low…..To be honest with you I've probably only seen ten bats in 8 ½ years on the island. I think that there is very very low density on this island."
Laux		"I don't think there are that many bats here but wind turbines are spectacularly bad for bats." (explode lungs)
		"I know I've seen three species. There aren't that many bats."

Hull	affect on marine life	Cannon: "Some might say vibration could transmit. In those PDMs that we have twice a year with Vestas, they do vibration tests and make sure the bolts and stuff are not loose. To our knowledge that is pretty much non-existent."
Stern		" I don't know if there have been any studies done because this is one land and not in salt."
Melvin	plants	"One of the questions that would have to be asked would be does the siting of these result in any adverse affects particularly physical disturbance and mortality, to the state listed plants or invertebrates on the island."
Steinauer		"Several of those [town owned] parcels are in really high priority habitat as far as the plant communities that were there."
		"We have Sandplain Grasslands and Coastal Heathlands that are ranked by the Nature Conservancy."
		"Our Scrub Oak Barons...are pretty uncommon and are very important for hosting a lot of rare species. "
		"if they did put the turbines there [in an area with rare species] depending on how many, how big the base perhaps they could not impact any particular plant."
Beattie		"The Waste Water Treatment Facility in Surfside and the Madaket Landfill are both located immediately adjacent to rare sandplain grassland and coastal heathland habitat that is owned and managed by the Nantucket Land Bank and the Nantucket Conservation Foundation."
Willett		"There was concern about Harrier and Burrowing Owls but those were not found. However, there were several species of plants."
Willett	rare plants in WWTF vicinity	Amelanchier nantucketensis (Nantucket shadbush) Helianthemum dumosum (bushy rockrose) Helianthemum spp. (sunrose) Liatris scariosa var. novae-angliae (New England Blazing Star) Sisyrinchium fuscatum (coastal plain blue-eyed grass) Spiranthes tuberosa (little lady's tresses)
Steinauer	brush control/prescribed fires	"Another concern I'd have as a big picture item would be land management. Especially the grass and heathlands need to be fairly regularly and intensely managed with say brush cutting or prescribed fire"
Fitch	Benefits	stabilized rates (muni's)
Fitch	disadvantages	"The biggest thing is risk, the financial risk of committing this much money, $7 million, to a project that may fail."
Laux		"I'm just not sold, anything with moving parts, plus they really are with these big blades, anything that flies is going to have problems."

		"I think wind turbine technology is not the best. I think there's a lot of other sources of ways to make energy, there's photovoltaic here. There are all kinds of new technology and I think wind mills are getting better and better."
Fitch	decreased property values	"Certainly Princeton is very high end, and even with our old turbines, I don't think there has ever been a concern with property values, and this is about as high end as it gets in terms of Nantucket. Not an issue."
Hull		Miller: "...that question was asked by the community and at the time the assessor for the town got involved and answered the question for us and did a study on any properties that had changed hands anywhere in the vicinity of the turbine. The property values had done nothing but go up, at that point in time we were in a good real estate market."
Laux	landfill pro	"Not at the dump. It's pretty horrific over there all ready." - will not affect too much life
Steinauer		lots of building in the area, so not a lot of birds, other than seagulls and Canada geese
Hull	icing	Cannon: "The ice ball issue can be addressed easily because they do make a cold weather package which we did buy for the turbines that keeps them from icing up."
Stern		" I don't know if there have been any studies done because this is one land and not in salt."
Stern	salt spray	"We have a winter and marine package. The winter package keeps the machine inside, keeps a pretty constant temperature and humidity, so it's a concern but it's manageable. This thing's been put here for 7 years times 365. You're going to get wear and tear. There's scheduled maintenance twice a year. About a month and a half ago out here on a tour, there were folks physically on the blades, checking the blades out. But no real major problems as far as sea spray."
Willett	landfill	"...my concern with the wind power is that it has the potential of conflicting with designated use, to what extent I don't know."
Laux		"See on Nantucket there's really no [good place to put them] the dump is really the only logical place."
Collier		"So it's a really nice site but it's pretty ideal because it's a dump. You won't have people complaining about it. "

		"Again as long is its in disturbed area and you don't have to clear any vegetation you are not going to have the impact on plants. But you are going to be again impacting potential animal species and birds."
Willett	Waste Water	"One is that we are very aware that coastal erosion could be a problem at that site..... Based on bathymetry and coastal erosion analysis done by Woods Hole that shows us that the site should be stable over the next 20 years ... If you invest in wind power at that site, you need to understand that there is a potential that it could be gone."
		"... during the recent work we've been doing at the surfside treatment plant in upgrading that facility, we've discovered rare and endangered species that very much limit the use at that site….. So that may limit what we can do in that site."
		"if you take 8% of that away, you impact the design of the facility which could jeopardize the discharge meant for that facility. We'd have to know what that was. It could happen, that could be a possibility. We might have to construct another bed to compensate for the land that would be used for the base of these towers."
		"however the control mechanisms at the Surfside Waste Water Treatment Facility are technologically advanced, a lot of computer systems, systems which are sending signals back and forth. I don't know how well insulated these generating facilities are and whether there may be some electrical interference. We can't have any electrical interference at this facility. Somehow either the generators must be shielded to prevent that or the equipment shielded. So I'm concerned about that."
Schultz		"We must be able to expand the facility to meet the needs of the island. Again there is no other alternative location for a Waste Water Treatment Facility. So there may be very limited areas to which we can apply this technology." "...they were saying the concrete structure would take up about 3,000 square feet of space, which doesn't bother me too much... our discharge permit is based upon a square footage of sand infiltration beds that we possess..... So it would impact it a little bit, I mean your adding 3,000 square feet of non-percable land... but I don't foresee a major problem. Also, I don't see us ever achieving 3.5 MGDs in our lifetime."
Collier		"In terms of siting them in here or previously disturbed areas, you are not going to have any plant impacts."

		"In terms of impacts to Sand Plain Grasslands, you are not going to have any impacts to plants. You may have impacts to bird species, either song birds or raptors such as the Harrier Hawk, and owls."
Willett	noise	"What kind of decibels are these things putting out? We do have people who work around these locations, but from what I know about these things that really not an issue."
Stern		"It's about 50dB." - very near Hull wind 1, the 660kW Vestas machine
Voigt	historic perspective	pro: "You go out to the dump and you look at the buildings that are there. Do you think there is anything historic about them? Is there anything that needs to be protected? It's a dump." "But you're certainly not going to hurt anything at the dump or the sewer beds. And I don't think it's just restricted to those areas, it could be other places." "So I think that for the dump it's a perfect location. I think that the sewer beds are as well. "
Collier	environmental Pro	good for Nantucket even if it doesn't decrease costs - it reduces carbon footprint
Collier	Disadvantage and Benefit	"I think the economics of it is potentially the other fatal flaw. If it just doesn't come out to dollars being reduced, it's just not going to go. Although I think even if it's a no profit gain, you are potentially reducing carbon and not burning fuel out there. It's not always about the money."
Fitch	how to make people support	direct benefits: provide free power to all streetlights; "I would also go as far to say 'rate stabilization,' because rates for us tend to fluctuate depending on our contracts and the market. With wind power, the fuel is zero. Most power plants today in MA demand natural gas, but natural gas prices fluctuate tremendously. Our wind turbines will help stabilize our rates due to natural gas fuel price fluctuations."
Fitch	dealing with opposition	"The biggest thing is to answer the questions. And no matter what question they came up with, you have got to answer honestly and sincerely. No matter how trivial or how crazy it may be, you have to always provide an honest answer- address the question head on."
Hull		Cannon: "At that time there were people that had come out with a lot of research about they thought the turbines could do such as throwing ice balls, killing birds, noise, and strobe effect. So we addressed their concerns as best that we could."
Fitch	public outreach	start early!

Hull		Cannon: "With our bills we sent a survey around. We probably started to put the word out initially in newspapers and community meetings probably about 2 years prior to installation. Probably 6 months prior to installation we sent out a stuffer in our bills, a questionnaire asking how you feel about additional wind turbines at Hull"
Fredericks		see cable feasibility study, 1997-8, CLF Conservation law Foundation conducted; filed at Public Utilities Commission
		"...then you need a social/public outreach program, because you need their support. And it starts with public input, starts with educating all of the key players. You win this by not surprising the key players. We did something, it's how I got successful, we call it the technical advisory group..... And what I'm doing is bringing in the smartest people in town with all of the issues that I need to address and putting them in a room and closing the door and saying "what are the issues?" Without saying that to them. Guess what they do? They help me define. I may find the best place to put this is the sewer plant. But the environmental group is going to say that you're in the last bit of eel grass protecting the last dune on Nantucket."
Collier		"They really have to do diligence with the neighbors on scenic impacts. I like the look of turbines myself. But I understand although I don't agree with people who don't like them on the landscape. So you have to respect that and do diligence with educating the neighbors about that."
Schultz	sewer beds	"They are 1-acre sand infiltration beds. They actually sit about 8 feet below our ground level, and they are about 8 feet or so above the water table. And the effluent from the plant goes to them, and I rotate them daily or every other day. And the effluent from the treatment plant just percolates into the groundwater."
Oktay	Leakage	"The amount of lubricants and oil used in the operation of most current brands of wind turbines are relatively minor and most systems have redundant ways of retaining oil (double walled containers, etc.). The turbines would not represent any significant threat to groundwater or drinking water supplies on the island if sited appropriately in regards to state and local wetland protection laws (not within 100 feet of wetlands and in areas where the depth to groundwater is at least 6 feet). There location near a sewer bed or treatment facility poses no unique concerns."

		"In scenarios where wind power replaces either oil tanks (above and below ground) or propane tanks, the amount of oil and lubricants that could be potentially released into the environment would be reduced. In addition, pressure and leak sensors are typically installed on all newer equipment, from pipelines to oil tanks. If concerns were significant for interaction of leaked material into the groundwater, a filtration mechanism similar to a "wash down" facility used at boat yards could be sited underneath a turbine to catch and treat any leaks."
Schultz	maintenance	"They are on land, you can drive to them. I don't see any problem with that."
Ray		"what kind of a track record do the various companies...have with maintenance? Can parts be here immediately? Is there going to be a technician here to deal with it right now?"
Hull		Miller: "2 PDMs per year where Vestas comes and maintains the turbines. As a rule, we have a warranty and service agreement and get 24 hour service, if down they are here with 24-48hrs. They take care of it right away."
Stern	breaking/stopping turbine - lubrication	"I am not aware of any problems [due to breaking or having the blades not spinning]. It's just the way the machine operations, so I don't know of any problems."
Fitch	turbine purchasing	"the demand for these turbines today is extremely high worldwide. So if you make an order for any turbine at any size turbine that's popular today, you're going to wait 2 years."
Bartlett	transportation through town	"The biggest section now is 10 meters, so it will all fit on the standard truck so it won't be a problem. For the 50 meter tower, it came in two 25 meter sections, so it would have been two 82ft and 9ft in diameter. People told me that it was possible to get that through town but again I didn't want to get it stuck and encounter unforeseen expense involved. I'm a business owner and don't have the resources that a municipality would have to do some of that stuff."
Willett		"I think its 125ft by 15ft, somewhere in there. That could be a real problem, but I have no idea about the size of the components. You'll have to make special arrangements, bring things by barges and get bigger trucks. Length and weight are a real consideration. It could be a fatal flaw, but it all depends on how much will there is to get these things constructed. It could be done but it's very expensive."
		expensive

Fitch		"You do have to take into consideration how to get the components to your site. The turbine pieces are very heavy; the blades are very long, meaning they are going to have a turn radius that is very long and wide.....Nantucket might have an issue given that it is an island, but this stuff is coming out of port. Hull did it, and Hull has very similar circumstances and almost the same address as Nantucket, so Nantucket shouldn't have an issue. The components might have to be barged out there, and a crane would have to be barged out there, but that's do-able. But you'd have to take that into consideration, you can tell the turbine manufacturer who is typically responsible for getting it to the site. Sometime they are not, but you can build it into the price and say "You get it to me". And then the crane guy is going to need to know where to go, you'll need a massive crane out there. Our access road had to be modified to accommodate the turn radius"
Palatine	transportation	"Your problem is not going to be getting it to the shores. It's going to be getting it through town."
Palatine	transportation to island	"We have a 110ft barge and even if it hangs off that's fine. You'll be fine." - saying that his barges can get a 122' rotor blade to the island
Palatine	transportation to sites	1.5MW's 122ft blade cannot get through town; can use a helicopter to pick off barge and bring to site: "He said that it could cost you $20,000 to do it; it'd be expensive but doable" Look into Carson Helicopters S-61, Sikorski Sky Crane
		answering, 'can an 85ft blade me driven through town?': "Yes. We could put a dolly in the back and it steers."
Collier	Bartlett's turbine	"I think the nice thing about John Bartlett putting up his on Bartlett Farm is his will be a nice template in terms of how big it actually is on the landscape and sounds."

APPENDIX J: SIMPLE PAYBACK PERIOD ANALYSES

Appendix J1: Cost Analysis with Simple Payback Period for 250 kW Wind Turbine at Madaket Landfill Site Under Various Conditions

	Madaket Landfill		*How to figure*	*Value*	*Units*
A	***1. Production***	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	207,967	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	199,229	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	3.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	225,443	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	216,705	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.298	gross rev/kWh
P		Estimated Annual revenue	P = E*N	260,395	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	251,657	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	**1. Production**	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	123,790	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	118,589	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	520,125	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	134,192	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	5,201	$/year
T		Estimated annual income	T = P-S	128,991	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.298	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	154,997	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	149,796	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	5.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	207,967	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	199,229	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	5.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	225,443	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	216,705	net $/year
U		Estimated installed cost/ kW	assumption	4,500	$/kWh
V		Estimated installed cost	V = B*U	1,125,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.298	gross rev/kWh
P		Estimated Annual revenue	P = E*N	260,395	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	251,657	net $/year
U		Estimated installed cost/ kW	assumption	4,500	$/kWh
V		Estimated installed cost	V = B*U	1,125,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	4.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	123,790	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	118,589	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	9.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.258	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	134,192	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	128,991	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	8.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		*How to figure*	*Value*	*Units*
A	***1. Production***	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.298	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	154,997	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	149,796	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	7.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Appendix J2: Cost Analysis with Simple Payback Period for 660 kW Wind Turbine at Madaket Landfill Site Under Various Conditions

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**73.69%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.128	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.206	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	476,209	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	453,141	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	3.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**73.69%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.144	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.222	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	513,244	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	490,175	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	3.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	2,306,858	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	73.69%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.177	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.255	gross rev/kWh
P		Estimated Annual revenue	P = E*N	587,312	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	23,069	$/year
T		Estimated annual income	T = P-S	564,244	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	1,457,280	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	2.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.238	gross rev/kWh
P		Estimated Annual revenue	P = E*N	326,805	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	313,074	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	1,457,280	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	4.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	354,268	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	340,536	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	1,457,280	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	4.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.298	gross rev/kWh
P		Estimated Annual revenue	P = E*N	409,193	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	395,461	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	1,457,280	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**73.69%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.128	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.206	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	476,209	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	453,141	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	2,306,858	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	73.69%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.144	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.222	gross rev/kWh
P		Estimated Annual revenue	P = E*N	513,244	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	23,069	$/year
T		Estimated annual income	T = P-S	490,175	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	4.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	2,306,858	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	73.69%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.177	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.255	gross rev/kWh
P		Estimated Annual revenue	P = E*N	587,312	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	23,069	$/year
T		Estimated annual income	T = P-S	564,244	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.9	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.238	gross rev/kWh
P		Estimated Annual revenue	P = E*N	326,805	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	313,074	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	7.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	1,373,130	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.258	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	354,268	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	13,731	$/year
T		Estimated annual income	*T = P-S*	340,536	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	6.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.298	gross rev/kWh
P		Estimated Annual revenue	P = E*N	409,193	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	395,461	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Appendix J3: Cost Analysis with Simple Payback Period for 1.5 MW Wind Turbine at Madaket Landfill Site Under Various Conditions

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*42.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**32.43%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.079	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.157	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	822,657	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	770,229	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	4.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**32.43%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.089	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.167	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	874,372	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	821,943	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	5,242,860	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	32.43%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.109	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.187	gross rev/kWh
P		Estimated Annual revenue	P = E*N	977,800	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	52,429	$/year
T		Estimated annual income	T = P-S	925,372	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	3,312,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	3.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	54.47%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.105	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.183	gross rev/kWh
P		Estimated Annual revenue	P = E*N	572,249	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	541,041	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	3,312,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	6.1	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	54.47%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.119	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.197	gross rev/kWh
P		Estimated Annual revenue	P = E*N	613,352	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	582,145	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	3,312,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	54.47%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.145	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.223	gross rev/kWh
P		Estimated Annual revenue	P = E*N	695,560	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	664,352	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	3,312,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		*How to figure*	*Value*	*Units*
A	***1. Production***	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**32.43%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.079	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.157	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	822,657	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	770,229	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. RPS rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**32.43%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.089	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.167	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	874,372	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	821,943	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

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P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

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U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		*How to figure*	*Value*	*Units*
A	***1. Production***	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**32.43%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.109	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.187	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	977,800	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	925,372	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	5.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	1,700,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	54.47%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.105	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.183	gross rev/kWh
P		Estimated Annual revenue	P = E*N	572,249	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	541,041	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	4,968,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	9.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**54.47%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.119	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.197	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	613,352	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	582,145	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	8.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Madaket Landfill		*How to figure*	*Value*	*Units*
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	1,700,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**54.47%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.145	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.223	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	695,560	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	664,352	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	7.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is for year 2008.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Appendix J4: Cost Analysis with Simple Payback Period for 250 kW Wind Turbine at Surfside Waste Water Treatment Facility Site Under Various Conditions

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**68.66%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.122	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.200	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	175,110	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	166,371	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**68.66%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.138	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.216	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	188,479	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	179,741	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**68.66%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.168	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.246	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	215,217	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	206,479	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	3.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	***1. Production***	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	123,790	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	118,589	net $/year
U		Estimated installed cost/ kW	*assumption*	3,000	$/kWh
V		Estimated installed cost	*V = B*U*	750,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	520,125	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	134,192	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	5,201	$/year
T		Estimated annual income	T = P-S	128,991	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	520,125	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.298	gross rev/kWh
P		Estimated Annual revenue	P = E*N	154,997	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	5,201	$/year
T		Estimated annual income	T = P-S	149,796	net $/year
U		Estimated installed cost/ kW	assumption	3,000	$/kWh
V		Estimated installed cost	V = B*U	750,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.0	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	873,810	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**68.66%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.122	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.200	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	175,110	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	8,738	$/year
T		Estimated annual income	*T = P-S*	166,371	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	68.66%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.138	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.216	gross rev/kWh
P		Estimated Annual revenue	P = E*N	188,479	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	179,741	net $/year
U		Estimated installed cost/ kW	assumption	4,500	$/kWh
V		Estimated installed cost	V = B*U	1,125,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	6.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	873,810	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	68.66%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.168	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.246	gross rev/kWh
P		Estimated Annual revenue	P = E*N	215,217	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	8,738	$/year
T		Estimated annual income	T = P-S	206,479	net $/year
U		Estimated installed cost/ kW	assumption	4,500	$/kWh
V		Estimated installed cost	V = B*U	1,125,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	5.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.160	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.238	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	123,790	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	118,589	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	9.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	250	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	520,125	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	100.00%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.180	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.258	gross rev/kWh
P		Estimated Annual revenue	P = E*N	134,192	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	5,201	$/year
T		Estimated annual income	T = P-S	128,991	net $/year
U		Estimated installed cost/ kW	assumption	4,500	$/kWh
V		Estimated installed cost	V = B*U	1,125,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	8.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*25.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	250	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	520,125	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**100.00%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.220	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.298	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	154,997	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	5,201	$/year
T		Estimated annual income	*T = P-S*	149,796	net $/year
U		Estimated installed cost/ kW	*assumption*	4,500	$/kWh
V		Estimated installed cost	*V = B*U*	1,125,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	7.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Appendix J5: Cost Analysis with Simple Payback Period for 660 kW Wind Turbine at Surfside Waste Water Treatment Facility Site Under Various Conditions

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.071	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.149	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	344,209	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	321,141	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	4.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.080	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.158	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	364,744	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	341,675	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.098	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.176	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	405,812	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	382,744	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	3.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	43.70%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.092	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.170	gross rev/kWh
P		Estimated Annual revenue	P = E*N	234,029	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	220,298	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	1,457,280	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	6.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

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U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	1,373,130	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**43.70%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.104	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.182	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	249,895	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	13,731	$/year
T		Estimated annual income	*T = P-S*	236,164	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

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U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		*How to figure*	*Value*	*Units*
A	***1. Production***	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	1,373,130	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**43.70%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.127	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.205	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	281,626	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	13,731	$/year
T		Estimated annual income	*T = P-S*	267,895	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	1,457,280	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	5.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.071	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.149	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	344,209	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	321,141	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.080	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.158	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	364,744	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	341,675	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

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	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	2,306,858	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**26.01%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.098	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.176	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	405,812	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	23,069	$/year
T		Estimated annual income	*T = P-S*	382,744	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	5.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

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Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	43.70%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.092	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.170	gross rev/kWh
P		Estimated Annual revenue	P = E*N	234,029	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	220,298	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	9.9	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

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J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	660	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	1,373,130	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	43.70%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.104	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.182	gross rev/kWh
P		Estimated Annual revenue	P = E*N	249,895	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	13,731	$/year
T		Estimated annual income	T = P-S	236,164	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	2,185,920	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	9.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	660	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	1,373,130	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**43.70%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.127	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.205	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	281,626	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	13,731	$/year
T		Estimated annual income	*T = P-S*	267,895	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	2,185,920	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	8.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

Appendix J6: Cost Analysis with Simple Payback Period for 1.5 MW Wind Turbine at Surfside Waste Water Treatment Facility Site Under Various Conditions

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		*42.0%*	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	*2. Revenue*	Energy used on-site (%)	*G = F/E*	**11.44%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.054	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.132	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	690,657	gross $/year
R	*3. Costs*	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	638,229	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	*4. "Simple Payback" period, per turbine*		*W = V/T*	5.2	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**11.44%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.060	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.138	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	725,872	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	673,443	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.9	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**11.44%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.074	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.152	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	796,300	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	743,872	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	4.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	19.23%	
H	per turbine	Your electricity price	from utility bill	0.160	$/kWh
J		Energy price (when sold wholesale)	assumption	0.040	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.063	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.141	gross rev/kWh
P		Estimated Annual revenue	P = E*N	440,249	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	409,041	net $/year
U		Estimated installed cost/ kW	assumption	2,208	$/kWh
V		Estimated installed cost	V = B*U	3,312,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	8.1	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	***1. Production***	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**19.23%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.180	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.045	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.071	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.149	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	464,852	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	433,645	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	7.6	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**19.23%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.087	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.165	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	514,060	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	482,852	net $/year
U		Estimated installed cost/ kW	*assumption*	2,208	$/kWh
V		Estimated installed cost	*V = B*U*	3,312,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	6.9	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***42.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	5,242,860	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**11.44%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.054	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.132	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	690,657	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	52,429	$/year
T		Estimated annual income	*T = P-S*	638,229	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	7.8	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine.
Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	5,242,860	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	11.44%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.060	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.138	gross rev/kWh
P		Estimated Annual revenue	P = E*N	725,872	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	52,429	$/year
T		Estimated annual income	T = P-S	673,443	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	4,968,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	7.4	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		42.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	5,242,860	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	11.44%	
H	per turbine	Your electricity price	from utility bill	0.220	$/kWh
J		Energy price (when sold wholesale)	assumption	0.055	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.074	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.152	gross rev/kWh
P		Estimated Annual revenue	P = E*N	796,300	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	52,429	$/year
T		Estimated annual income	T = P-S	743,872	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	4,968,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	6.7	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**19.23%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.160	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.040	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.063	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.141	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	440,249	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	409,041	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	12.1	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	1. Production	Capacity factor:		25.0%	
B	per turbine	Rated Power per turbine:	assumption	1,500	kW
C		Availability	assumption	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	E = A*B*C*D	3,120,750	kWh/year
F		Annual peak kWh at site annually	from utility bill	600,000	kWh/year
G	2. Revenue	Energy used on-site (%)	G = F/E	19.23%	
H	per turbine	Your electricity price	from utility bill	0.180	$/kWh
J		Energy price (when sold wholesale)	assumption	0.045	$/kWh
K		Energy value	K = G*H + (1-G)*J	0.071	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	assumption	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	assumption	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	N = K+L+M	0.149	gross rev/kWh
P		Estimated Annual revenue	P = E*N	464,852	gross $/year
R	3. Costs	Maintenance & insurance (rate)	assumption	0.010	$/kWh
S	per turbine	Annual costs	S = E*R	31,208	$/year
T		Estimated annual income	T = P-S	433,645	net $/year
U		Estimated installed cost/ kW	assumption	3,312	$/kWh
V		Estimated installed cost	V = B*U	4,968,000	installed cost
W	4. "Simple Payback" period, per turbine		W = V/T	11.5	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

	Surfside Wastewater Treatment Plant		How to figure	Value	Units
A	*1. Production*	Capacity factor:		***25.0%***	
B	*per turbine*	Rated Power per turbine:	*assumption*	1,500	kW
C		Availability	*assumption*	95.0%	
D		# hours in an annual period		8,760	hrs/year
E		Annual Energy Production	*E = A*B*C*D*	3,120,750	kWh/year
F		Annual peak kWh at site annually	*from utility bill*	600,000	kWh/year
G	***2. Revenue***	Energy used on-site (%)	*G = F/E*	**19.23%**	
H	*per turbine*	Your electricity price	*from utility bill*	0.220	$/kWh
J		Energy price (when sold wholesale)	*assumption*	0.055	$/kWh
K		Energy value	*K = G*H + (1-G)*J*	0.087	$/kWh
L		Massachusetts Tax Credit or RPS (REC's)	*assumption*	0.059	$/kWh
M		Federal tax credit (PTC) (1st 10 years only)	*assumption*	0.019	$/kWh
N		Revenue Rate, Gross (per kWh)	*N = K+L+M*	0.165	gross rev/kWh
P		Estimated Annual revenue	*P = E*N*	514,060	gross $/year
R	***3. Costs***	Maintenance & insurance (rate)	*assumption*	0.010	$/kWh
S	*per turbine*	Annual costs	*S = E*R*	31,208	$/year
T		Estimated annual income	*T = P-S*	482,852	net $/year
U		Estimated installed cost/ kW	*assumption*	3,312	$/kWh
V		Estimated installed cost	*V = B*U*	4,968,000	installed cost
W	***4. "Simple Payback" period, per turbine***		*W = V/T*	10.3	years

ASSUMPTIONS

A. Capacity factor is obtained from Nantucket RERL Wind Site Analysis from May 08, estimate for a Vestas 1650 turbine. Capacity factor is the actual energy output for the year divided by the energy output if operated at its rated power output for the entire year.

B. Availability is taken from Richard Miller of Hull stating their downtime makes up less than 5% of their operations.

F. Annual peak kWh at site is obtained from personal communication w/Mike Peterson and is predicted for year 2009.

H. Electricity price is varied between 16, 18, and 22 cents.

J. Wholesale price will be represented by 25% of the retail price.

L. Renewable Portfolio Standard (RPS) rate obtained from http://www.mass.gov/doer/rps/acp.htm and is for the year 2008.

M. Federal tax credit (PTC) rate: Dave Fredericks noted it was 2 cents, confirmed it was 1.9 from example by RERL (http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2b_Wind_Economics_Intro.pdf).

P. Does not consider wind variability in this, and as National Grid bills monthly this could be altered.

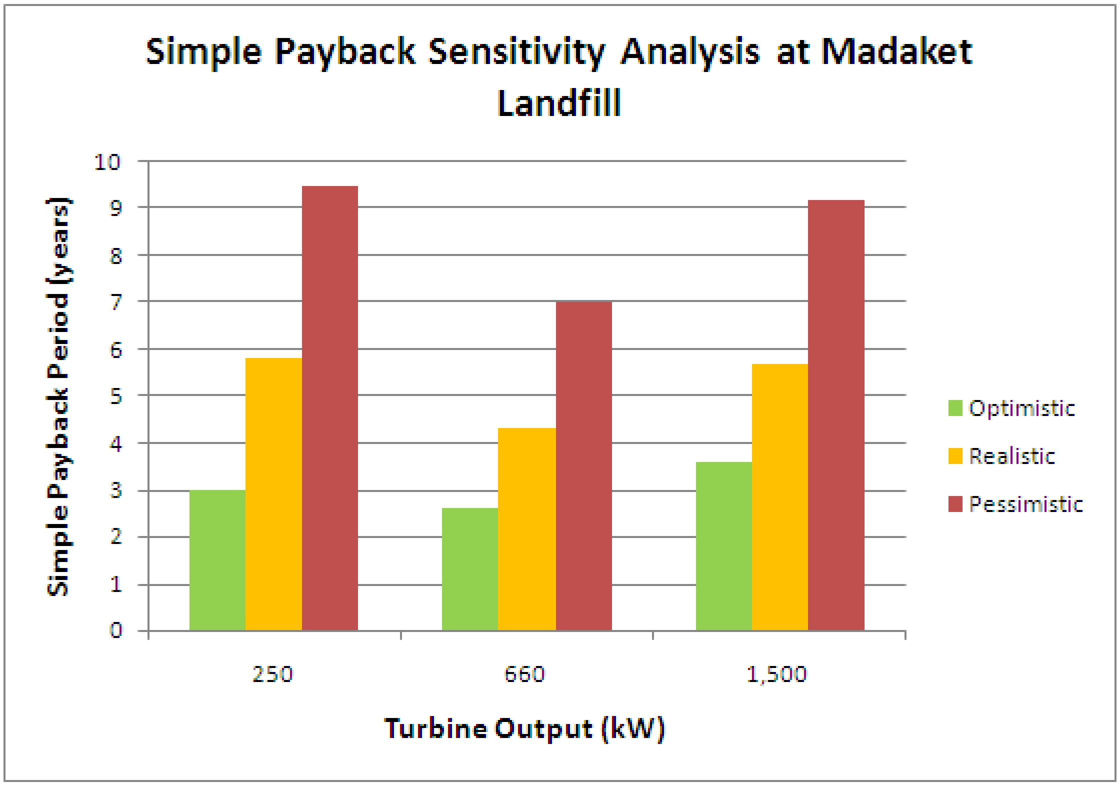
R. Maintenance and insurance rates were determined from average annual expenses of Hull's 1.8 MW turbine.

U. Estimated installed cost per kW obtained from total cost of the town of Princeton's project ($7,300,000) divided by the total kW of the project (3,000). This was then averaged with Hull's cost for their 1.8 MW turbine ($3,310,109) divided by the total kW (1,800), and their 660 kW turbine ($822,341) divided by the total kW (660). 20% is then added to this to account for Nantucket being unique. For 250 kW, estimates from personal communication with Dave Fredericks used. 50% is then again added to account for potential increase in costs due to permitting, construction, etc.

Other: Does not take into account Nantucket's unique transportation needs (may be added costs)

APPENDIX K: SENSITIVITY ANALYSIS

Appendix K1: Sensitivity Analysis for the Madaket Landfill



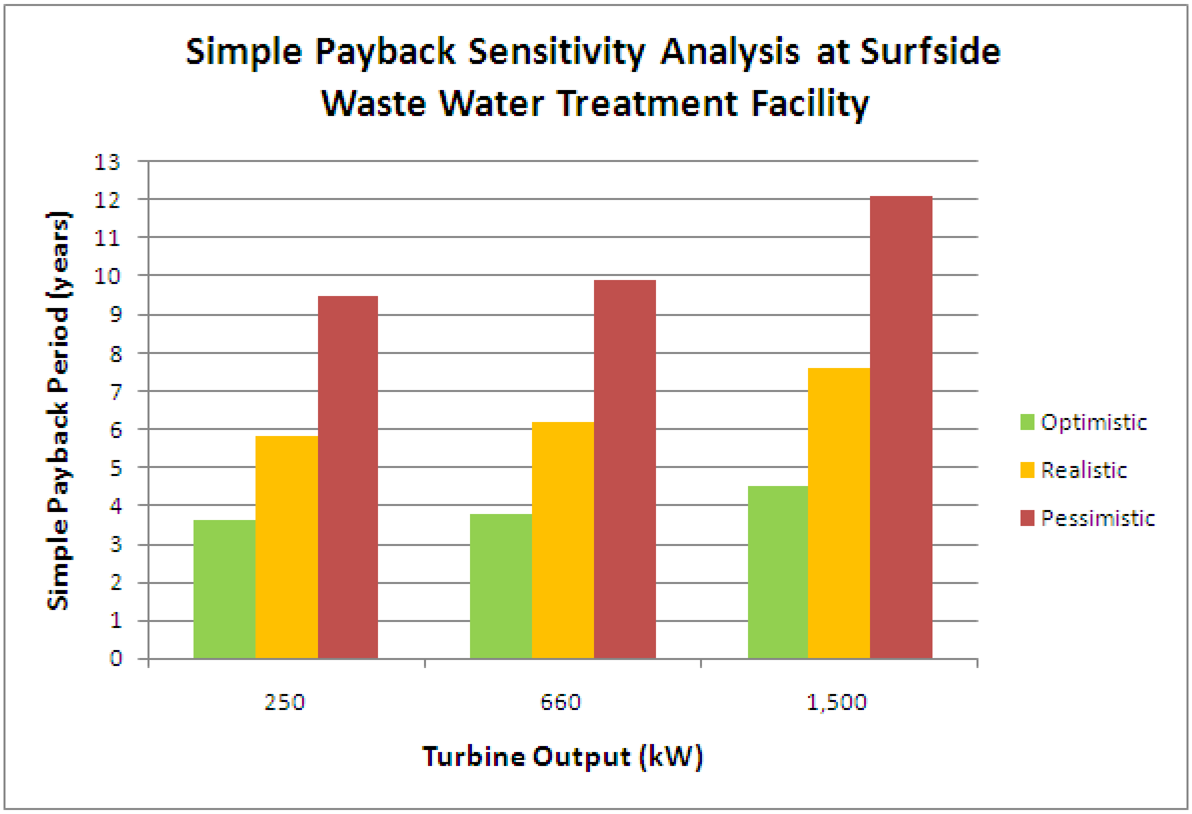
Optimistic:	capacity factor	=	42%
	retail cost of electricity	=	$0.22 per kWh
	wholesale cost of electricity	=	$0.055 per kWh
	installed cost per kW	=	$2208 per kWh

Realistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.18 per kWh
	wholesale cost of electricity	=	$0.045 per kWh
	installed cost per kW	=	$2208 per kWh

Pessimistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.16 per kWh
	wholesale cost of electricity	=	$0.04 per kWh
	installed cost per kW	=	$3312 per kWh

Notes: - installed cost per kW for 250 kW turbine is either $3000 or $4500

Appendix K2: Sensitivity Analysis for the Waste Water Treatment Facility



Optimistic:	capacity factor	=	42%
	retail cost of electricity	=	$0.22 per kWh
	wholesale cost of electricity	=	$0.055 per kWh
	installed cost per kW	=	$2208 per kWh

Realistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.18 per kWh
	wholesale cost of electricity	=	$0.045 per kWh
	installed cost per kW	=	$2208 per kWh

Pessimistic:	capacity factor	=	25%
	retail cost of electricity	=	$0.16 per kWh
	wholesale cost of electricity	=	$0.04 per kWh
	installed cost per kW	=	$3312 per kWh

Notes: - installed cost per kW for 250 kW turbine is either $3000 or $4500

APPENDIX L: TWENTY YEAR PROJECTION

Appendix L1: 20 Year Projections with Percent Return on Investment for the Madaket Landfill

Madaket Landfill			
	(under Optimistic conditions)		
Positive Return by year (cumulative)	Turbine Size		
	250 kW	660 kW	1.5 MW
0	-$750,000.00	-$1,457,280.00	-$3,312,000.00
1	-$498,343.00	-$893,036.00	-$2,386,628.00
2	-$246,686.00	-$328,792.00	-$1,461,256.00
3	$4,971.00	$235,452.00	-$535,884.00
4	$256,628.00	$799,696.00	$389,488.00
5	$508,285.00	$1,363,940.00	$1,314,860.00
6	$759,942.00	$1,928,184.00	$2,240,232.00
7	$1,011,599.00	$2,492,428.00	$3,165,604.00
8	$1,263,256.00	$3,056,672.00	$4,090,976.00
9	$1,514,913.00	$3,620,916.00	$5,016,348.00
10	$1,766,570.00	$4,185,160.00	$5,941,720.00
11	$2,018,227.00	$4,749,404.00	$6,867,092.00
12	$2,269,884.00	$5,313,648.00	$7,792,464.00
13	$2,521,541.00	$5,877,892.00	$8,717,836.00
14	$2,773,198.00	$6,442,136.00	$9,643,208.00
15	$3,024,855.00	$7,006,380.00	$10,568,580.00
16	$3,276,512.00	$7,570,624.00	$11,493,952.00
17	$3,528,169.00	$8,134,868.00	$12,419,324.00
18	$3,779,826.00	$8,699,112.00	$13,344,696.00
19	$4,031,483.00	$9,263,356.00	$14,270,068.00
20	$4,283,140.00	$9,827,600.00	$15,195,440.00
% return based on initial investment	82.49%	85.17%	78.20%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Madaket Landfill

Positive Return by year (cumulative)	(under Realistic conditions) Turbine Size		
	250 kW	660 kW	1.5 MW
0	-$750,000.00	-$1,457,280.00	-$3,312,000.00
1	-$621,009.00	-$1,116,744.00	-$2,729,855.00
2	-$492,018.00	-$776,208.00	-$2,147,710.00
3	-$363,027.00	-$435,672.00	-$1,565,565.00
4	-$234,036.00	-$95,136.00	-$983,420.00
5	-$105,045.00	$245,400.00	-$401,275.00
6	$23,946.00	$585,936.00	$180,870.00
7	$152,937.00	$926,472.00	$763,015.00
8	$281,928.00	$1,267,008.00	$1,345,160.00
9	$410,919.00	$1,607,544.00	$1,927,305.00
10	$539,910.00	$1,948,080.00	$2,509,450.00
11	$668,901.00	$2,288,616.00	$3,091,595.00
12	$797,892.00	$2,629,152.00	$3,673,740.00
13	$926,883.00	$2,969,688.00	$4,255,885.00
14	$1,055,874.00	$3,310,224.00	$4,838,030.00
15	$1,184,865.00	$3,650,760.00	$5,420,175.00
16	$1,313,856.00	$3,991,296.00	$6,002,320.00
17	$1,442,847.00	$4,331,832.00	$6,584,465.00
18	$1,571,838.00	$4,672,368.00	$7,166,610.00
19	$1,700,829.00	$5,012,904.00	$7,748,755.00
20	$1,829,820.00	$5,353,440.00	$8,330,900.00
% return based on initial investment	59.01%	72.78%	60.24%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Madaket Landfill

Positive Return by year (cumulative)	(under Pessimistic conditions) Turbine Size		
	250 kW	660 kW	1.5 MW
0	-$1,125,000.00	-$2,185,920.00	-$4,968,000.00
1	-$1,006,411.00	-$1,872,846.00	-$4,426,959.00
2	-$887,822.00	-$1,559,772.00	-$3,885,918.00
3	-$769,233.00	-$1,246,698.00	-$3,344,877.00
4	-$650,644.00	-$933,624.00	-$2,803,836.00
5	-$532,055.00	-$620,550.00	-$2,262,795.00
6	-$413,466.00	-$307,476.00	-$1,721,754.00
7	-$294,877.00	$5,598.00	-$1,180,713.00
8	-$176,288.00	$318,672.00	-$639,672.00
9	-$57,699.00	$631,746.00	-$98,631.00
10	$60,890.00	$944,820.00	$442,410.00
11	$179,479.00	$1,257,894.00	$983,451.00
12	$298,068.00	$1,570,968.00	$1,524,492.00
13	$416,657.00	$1,884,042.00	$2,065,533.00
14	$535,246.00	$2,197,116.00	$2,606,574.00
15	$653,835.00	$2,510,190.00	$3,147,615.00
16	$772,424.00	$2,823,264.00	$3,688,656.00
17	$891,013.00	$3,136,338.00	$4,229,697.00
18	$1,009,602.00	$3,449,412.00	$4,770,738.00
19	$1,128,191.00	$3,762,486.00	$5,311,779.00
20	$1,246,780.00	$4,075,560.00	$5,852,820.00
% return based on initial investment	9.77%	46.37%	15.12%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Appendix L2: 20 Year Projections with Percent Return on Investment for the Surfside Waste Water Treatment Facility

Surfside Wastewater Treatment Facility			
	(under Optimistic conditions)		
Positive Return by	Turbine Size		
year (cumulative)	250 kW	660 kW	1.5 MW
0	-$750,000.00	-$1,457,280.00	-$3,312,000.00
1	-$543,521.00	-$1,074,536.00	-$2,568,128.00
2	-$337,042.00	-$691,792.00	-$1,824,256.00
3	-$130,563.00	-$309,048.00	-$1,080,384.00
4	$75,916.00	$73,696.00	-$336,512.00
5	$282,395.00	$456,440.00	$407,360.00
6	$488,874.00	$839,184.00	$1,151,232.00
7	$695,353.00	$1,221,928.00	$1,895,104.00
8	$901,832.00	$1,604,672.00	$2,638,976.00
9	$1,108,311.00	$1,987,416.00	$3,382,848.00
10	$1,314,790.00	$2,370,160.00	$4,126,720.00
11	$1,521,269.00	$2,752,904.00	$4,870,592.00
12	$1,727,748.00	$3,135,648.00	$5,614,464.00
13	$1,934,227.00	$3,518,392.00	$6,358,336.00
14	$2,140,706.00	$3,901,136.00	$7,102,208.00
15	$2,347,185.00	$4,283,880.00	$7,846,080.00
16	$2,553,664.00	$4,666,624.00	$8,589,952.00
17	$2,760,143.00	$5,049,368.00	$9,333,824.00
18	$2,966,622.00	$5,432,112.00	$10,077,696.00
19	$3,173,101.00	$5,814,856.00	$10,821,568.00
20	$3,379,580.00	$6,197,600.00	$11,565,440.00
% return based on initial investment	77.81%	76.49%	71.36%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Surfside Wastewater Treatment Facility

Positive Return by year (cumulative)	(under Realistic conditions) Turbine Size 250 kW	660 kW	1.5 MW
0	-$750,000.00	-$1,457,280.00	-$3,312,000.00
1	-$621,009.00	-$1,221,116.00	-$2,878,355.00
2	-$492,018.00	-$984,952.00	-$2,444,710.00
3	-$363,027.00	-$748,788.00	-$2,011,065.00
4	-$234,036.00	-$512,624.00	-$1,577,420.00
5	-$105,045.00	-$276,460.00	-$1,143,775.00
6	$23,946.00	-$40,296.00	-$710,130.00
7	$152,937.00	$195,868.00	-$276,485.00
8	$281,928.00	$432,032.00	$157,160.00
9	$410,919.00	$668,196.00	$590,805.00
10	$539,910.00	$904,360.00	$1,024,450.00
11	$668,901.00	$1,140,524.00	$1,458,095.00
12	$797,892.00	$1,376,688.00	$1,891,740.00
13	$926,883.00	$1,612,852.00	$2,325,385.00
14	$1,055,874.00	$1,849,016.00	$2,759,030.00
15	$1,184,865.00	$2,085,180.00	$3,192,675.00
16	$1,313,856.00	$2,321,344.00	$3,626,320.00
17	$1,442,847.00	$2,557,508.00	$4,059,965.00
18	$1,571,838.00	$2,793,672.00	$4,493,610.00
19	$1,700,829.00	$3,029,836.00	$4,927,255.00
20	$1,829,820.00	$3,266,000.00	$5,360,900.00
% return based on initial investment	59.01%	55.38%	38.22%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

Surfside Wastewater Treatment Facility

Positive Return by year (cumulative)	(under Pessimistic conditions) Turbine Size		
	250 kW	660 kW	1.5 MW
0	-$1,125,000.00	-$2,185,920.00	-$4,968,000.00
1	-$1,006,411.00	-$1,965,622.00	-$4,558,959.00
2	-$887,822.00	-$1,745,324.00	-$4,149,918.00
3	-$769,233.00	-$1,525,026.00	-$3,740,877.00
4	-$650,644.00	-$1,304,728.00	-$3,331,836.00
5	-$532,055.00	-$1,084,430.00	-$2,922,795.00
6	-$413,466.00	-$864,132.00	-$2,513,754.00
7	-$294,877.00	-$643,834.00	-$2,104,713.00
8	-$176,288.00	-$423,536.00	-$1,695,672.00
9	-$57,699.00	-$203,238.00	-$1,286,631.00
10	$60,890.00	$17,060.00	-$877,590.00
11	$179,479.00	$237,358.00	-$468,549.00
12	$298,068.00	$457,656.00	-$59,508.00
13	$416,657.00	$677,954.00	$349,533.00
14	$535,246.00	$898,252.00	$758,574.00
15	$653,835.00	$1,118,550.00	$1,167,615.00
16	$772,424.00	$1,338,848.00	$1,576,656.00
17	$891,013.00	$1,559,146.00	$1,985,697.00
18	$1,009,602.00	$1,779,444.00	$2,394,738.00
19	$1,128,191.00	$1,999,742.00	$2,803,779.00
20	$1,246,780.00	$2,220,040.00	$3,212,820.00
% return based on initial investment	9.77%	1.54%	-54.63%

Assumptions:

1. Model uses constant electricity rates for 20 years based off of 2007 costs at site.
2. Model after 10 years still contains Federal tax credit which is only applicable to first 10 years.
3. Model does not factor in decreased efficiencies due to age of turbines.
4. Model does not factor in increased spending on maintenance as turbines age.
5. Numbers do not reflect actual values that can be expected as payback but are rather to provide an overview for sizing turbines.
6. Initial cost of larger turbines may increase do to the electrical equipment at the site needing to be updated to handle the loads.
7. Model does not consider interests or net-present values.

Red indicates initial investment

Orange indicates first full year a positive return is obtained

Green indicates final return after 20 year period

APPENDIX M: CONTACT INFORMATION

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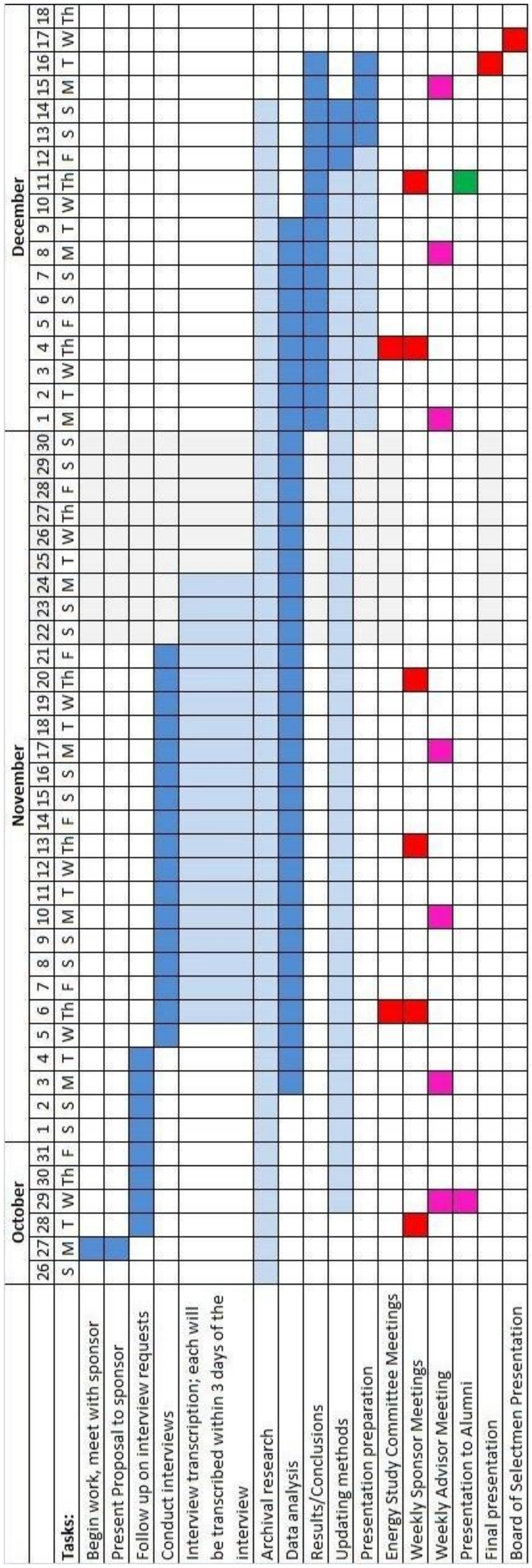
APPENDIX N: TIMELINE



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