

**Wind Turbine Options Analysis Process
Final Report to the Falmouth Board of Selectmen
Falmouth, MA**

**FINAL REPORT
January 18, 2013**

Primary Participants: Megan Amsler, Dave Bailey, Karen Cardeira, Alden Cook, Kathy Driscoll, Todd Drummey, Kathryn Elder, Judith Fenwick, Diane Funfar, Joe Hackler Sia Karplus, Jim Luyten, Jeffrey W. Oppenheim, Bob Shea

Alternate Participants: Linda Davis, Malcolm Donald, John Ford, Maurice Rowe

Liaisons: Nils Bolgen, Massachusetts Clean Energy Center; Doug Jones and Mary Pat Flynn, Falmouth Board of Selectmen

Facilitated by: Stacie Nicole Smith, Consensus Building Institute (CBI), with support from Carri Hulet and Eric Roberts, CBI

Table of Contents

1. Introduction	1
2. Overview of WTOP.....	2
2.1 Purpose and Goals of the WTOP	2
2.2 Representation of Core Interests and Concerns on the WTOP	2
2.3 Additional Liaisons to the WTOP	3
2.4 Technical Expertise	4
2.5 Decision-Making	4
3. The Need for Action	5
4. Data Collection and Analysis	6
4.1 Health	6
4.2 Acoustic Data	7
4.3 Noise Mitigation Options	11
4.4 Mechanical Changes to the Turbines to reduce noise	11
4.5 Flicker and Flicker Mitigation	12
4.6 Financial Costs and Revenues of Turbines and Potential Operational Scenarios, PV Development, and Turbine Removal	13
4.7 Turbine Relocation Data	16
4.8 Turbine Resale Data	17
4.9 Community Responsiveness to curtailment vis-à-vis home sales and mitigation	17
5. Packaged Options.....	19
5.1 Full Operation	19
5.2 Curtailed Operation	24
5.2.1 “Break-even” Curtailment Scenario	24
5.2.2 12-hour Curtailment Scenario	28
5.3 Removal of Turbines or Removal of Turbines and Replacement with a Photovoltaic Array.....	31
5.4 Financial Tables.....	36
6. Options Considered but not Recommended at this Time.....	40
6.1 Sound Barriers and Berms	40
6.2 Moving the Turbines	40
6.3 Mechanical Alterations to Reduce Noise	40
6.4 Legal Action Against Engineers, Contractors, and Consultants.....	41
7. Statements from Stakeholder Groups.....	42
8. Appendices	49

1. Introduction

The Town of Falmouth MA owns two 1.65 megawatt Vestas V82 wind turbines, known as Wind 1 and Wind 2, which are located at the Falmouth Wastewater Treatment Facility (WWTF). Soon after Wind 1 began operations on March 23, 2010, the Town began receiving complaints from neighbors about noise, health and safety concerns¹. Since that time, the Town initiated a number of public meetings, curtailment decisions, studies, and other efforts to address the situation.² Among these was an analysis (the “Mitigation Analysis”) by the Town’s consulting team, Weston and Sampson Engineers and subcontractor Harris Miller Miller and Hanson (HMMH), of the costs and benefits of a variety of steps that could be taken to address concerns about noise, flicker, and safety regarding the Wind 1 Turbine. In December 2011, the Board of Selectmen agreed to hire a neutral facilitation firm to recommend a process for productive discussion about the potential options suggested in that mitigation report. The Massachusetts Clean Energy Center (MassCEC) offered to provide technical experts and facilitation services, with a choice from four neutral facilitation firms that had been screened previously by MassCEC through a competitive RFQ process. The Consensus Building Institute (CBI) was selected to design and implement the Wind Turbine Options Analysis Process (WTOP).

This report is the culmination of 8 months of effort by the WTOP. The WTOP was not designed to achieve consensus on a long-term outcome for the wind turbines. Instead, the WTOP was designed to provide the Board of Selectmen with a clear, comprehensive and inclusive analysis of a range of options, their costs and benefits, and their anticipated impacts, drawing on external expertise and based on stakeholder input and interests.

This Final Report to the Board of Selectmen is intended to provide an inclusive analysis and evaluation of the full range of options explored by the WTOP, along with the group’s shared understanding of the implications of these options.

¹ Similar complaints were raised about Wind 2 once it began operation on February 14, 2012.

² See Appendix 8.2.7.13 for a wind energy timeline, as compiled by the WTOP members, of the development of the turbines and the actions that have occurred since operations began.

2. Overview of WTOP

2.1 Purpose and Goals of the WTOP

The volunteer representatives serving on the WTOP met (mostly) weekly on 24 occasions for two and a half hour or three hour meetings between May 2012 and January 2013. The purpose of these meetings was to engage in an open, transparent and collaborative exploration of the range of options for the long-term future of the Town of Falmouth's two wind turbines, Wind 1 and Wind 2.

The goals of the WTOP were to:

- Clarify the range of potentially acceptable long-term options;
- Identify the questions that would need to be answered about each of those options to evaluate their feasibility, costs and benefits;
- Determine legitimate methods for gaining answers to those questions;
- Jointly review and interpret the collected data; and,
- Evaluate options based on the new and reviewed information.

Two additional WTOP goals included:

- Improve relationships and effective communication among the Town officials, affected families and other members of the Town
- Provide an arena for public information and input and transparent deliberation and evaluation

2.2 Representation of Core Interests and Concerns on the WTOP

CBI convened a balanced group of participants to represent five core interests, which were identified during an extensive assessment process.³ Any broadly acceptable long-term plan for the turbines will need to respond, to some extent, to each of the following core interests and concerns:

- Health, safety and well-being of impacted neighbors;
- Property rights and economic impacts on property owners;
- Reduction of fossil-fuel generated electricity in order to reduce the negative impacts of emissions on climate, environment and health⁴;
- Fiscal impacts on the Town's residents and Town services; and,
- An amicable end to a conflict that divided and challenged the Town's relationships and reputation.

³ See Appendix 8.1.1 CBI Revised Assessment Findings with Draft Recommendations and the Final Process Recommendations for the Falmouth Wind Turbines Options Process

⁴ This set of interests was initially framed as "Implementation of Falmouth's climate action protection plan goals to reduce fossil fuel use," and was changed at the request of stakeholders holding this as their core interest.

The WTOP stakeholder representatives, who to the extent possible were selected by their constituencies, participated voluntarily in the meetings. Some of the representatives had one or more alternates who participated in the WTOP meetings on the occasion when the primary participant was unable to attend the meeting. The alternates were expected to attend all meetings as observers even when not participating in the meeting. The stakeholders represented on the WTOP included:

- Five residents who experienced adverse impacts of the turbines, including health and economic impacts and residential and commercial neighbors, selected by the adversely impacted residents themselves
- Two residents primarily concerned with implementing the Town's climate action protection plan to reduce fossil fuel use, selected by Friends of Falmouth Wind and the Falmouth Energy Committee
- Two residents primarily concerned with maintaining the fiscal benefits provided by the turbines, selected at a public meeting in which all self-defined fiscal benefit advocates could weigh-in
- Two residents with strong empathy for all perspectives primarily concerned with a fair and effective process that can lead to an amicable outcome that can reunite the Town, selected at a public meeting in which all stakeholders could provide input
- Three representatives of relevant Town Departments, selected by the Town

It is important to note that, at the outset of the process, participants in the WTOP were asked to accept and not question certain basic foundations of each other's perspectives, including:

- The experience of adverse health impacts by neighbors;
- The motivations of Town officials and the Energy Committee in advancing the wind project; and,
- The fundamental premise that wind energy contributes positively to a reduction of fossil fuel emissions.

This request was made because the WTOP was not in a position to deliberate on the factual basis of these claims, either due to time constraints or lack of existing information. The individual members of the WTOP and their constituents could continue to question the validity of these perspectives; however, for the sake of working together toward a solution to the impasse facing the Town, these issues were not included in the scope of the WTOP process.

2.3 Additional Liaisons to the WTOP

Several volunteer liaisons attended each of the WTOP meetings. These liaisons did not actively participate in the discussions; instead, they participated when called upon by the WTOP to answer specific questions regarding their expertise. The following liaisons attended most of the WTOP meetings:

- Two members of the Town of Falmouth's Board of Selectmen
- One representative of the Massachusetts Clean Energy Center (MassCEC)

In addition, either the Town Manager or Assistant Town Manager of Falmouth attended many of the meetings, and participated in information gathering as needed.

2.4 Technical Expertise

MassCEC supported the participation and assistance of a team of technical representatives from DNV Kema, Sustainable Energy Advantage (SEA) and Acentech, who worked with the facilitator between meetings and attended WTOP meetings to present data and analysis as requested by the WTOP. The group also received technical information upon request from MassCEC, Massachusetts Department of Environmental Protection (DEP), and Town employees.

2.5 Decision-Making

The WTOP was not expected to make a decision around a final recommendation on the outcome for the operation or removal of the Falmouth Wind Turbines. However, the group was expected to make decisions about options to explore, technical questions to pursue, methodologies to employ, and other topics necessary for developing a common analysis of available options and their implications.

To the greatest extent possible, the WTOP operated by consensus, which the WTOP defined as unanimous concurrence of the stakeholder representatives. Consent meant that a participant could at least “accept,” however reluctantly, the decision on the table.⁵ Except where specified, this report reflects the consensus views of the WTOP.

⁵ See Appendix 8.2.7.3, the WTOP Operating Protocols for more details of the decision-making protocols.

3. The Need for Action

For the past 2.5 years, the Town of Falmouth has been in conflict over the impacts, operation and future of the Town-owned wind turbines. Since operation of Wind 1 began in March 2010, and Wind 2 began in February 2012, a number of the turbines' neighbors have expressed serious concerns about the negative impacts of the turbines on their health, well-being, property values, and safety. Surveys conducted by the neighbors, the Falmouth Board of Health, and the WTOP all indicate between 32-41 families reporting negative health effects, particularly with regard to sleep disturbance.⁶ Addressing these concerns is the impetus behind the need for action. Since the turbines were a major public investment and the revenues and energy savings, as well as the costs, from their operation have been built into the Town's financial budgets, solutions must also address the Town's fiscal concerns. The turbines are also a central part of the Town's commitment to reducing carbon emissions and the concern of many citizens about the negative impacts of climate change; thus, the Town's response needs also to consider impacts on the commitment to reduce consumption of fossil fuel-produced energy.

The impacts of this impasse include the physical and psychological suffering expressed by a number of Falmouth residents, threats to homeowners' property values and the Town's fiscal well-being, risks to the Town's ability to meet its renewable energy goals, and disruption of the social and civic fabric of the community. The conflict, along with insufficient and ineffective communication and poor relationships among project proponents, Town officials and neighbors, has fostered mistrust, frustration, anxiety and skepticism. Collectively, these sentiments widened the chasm between those holding differing viewpoints. In December 2011, the Falmouth Board of Selectmen recognized a need for action when it engaged a neutral facilitator, the Consensus Building Institute, to recommend and implement a process that could foster productive discussion about the range of mitigation options for the Town's two wind turbines.

The examination of options presented here by the WTOP is an attempt to clarify the range of options with attention to the collective goals of Town fiscal health; responsible action against climate change; safe, healthy homes and property values for neighbors, and reunification of the community. In its evaluation of each option, the report analyzes the potential impact of the option on each of the core interests except community reunification. While the group lacks the information to quantify the impacts of individual options on this unity, this has nonetheless been a core concern underlying the discussions throughout this process. The WTOP can say with confidence that it was their sincere effort to pursue this goal when developing this report.

⁶ These figures only represent those who completed the surveys. See Appendix 8.2.7.11 for the WTOP neighbor's survey.

4. Data Collection and Analysis

The WTOP representatives jointly identified quantitative and qualitative data they felt were necessary to assess the feasibility and implications of each potential option, and tasked members or technical advisors to prepare and present that data to the WTOP.

It is important to note that the WTOP was limited by the lack of and access to available information, as well as time. There are very important questions that remain unanswered, or whose answers remain a matter of debate. The group did their best to analyze the potential options given the information they were able to collect or commission with the time and expertise they had available. This report attempts to clarify ongoing uncertainties and some ideas for how the Board of Selectmen might answer some of the additional critical questions.

The following is a description of the most important data the WTOP collected and analyzed. After reviewing the data, WTOP participants discussed conclusions that could be drawn from the data and how the findings influenced the five core interests. All descriptions of data presented, and their methodologies, are brief summaries only. Please see the full presentations and reports for more detailed and complete versions of all the data (all data presentations are available on the project website: www.cbuiding.org/falmouthwind.) The order of presentation of this data does not denote order of priority or importance.

4.1 Health

Participants in the WTOP repeatedly expressed a desire to better understand the range of health concerns, the prevalence of those concerns, the basis of those concerns, and the correlation between those concerns and proximity from the turbines. WTOP members were urged to read the report or watch footage of the previous occasions – such as the June 6 and July 11, 2011 Board of Selectmen Meetings and the May 24, 2012 Board of Health Meeting – when turbine neighbors spoke of the health problems they experienced. The WTOP explored the idea of requesting an outside expert to conduct a health survey, and invited Dr. Gail Harkness, chair of Falmouth’s Board of Health, to a WTOP meeting to provide her expertise as an epidemiologist. Dr. Harkness presented a summary of the health complaints submitted in writing by community members at the Board of Health’s May 2012 Public Hearing on the Health Effects of Wind Turbines. This summary of the testimony of 47 individuals with self-reported health effects conveyed that the most prevalent health concern was sleep deprivation (reported by 85% of those stating health impacts). Others reported health complaints included stress (53% of respondents), mental health problems (45% of respondents), hearing problems (32% of respondents), cognitive difficulties (25% of respondents), as well as other effects.

Dr. Harkness informed the WTOP that the Board of Health had requested assistance from the State Department of Health to conduct a more comprehensive health study, and discouraged the group from undertaking such a study on their own.⁷

⁷ It was reported, as of December 17, 2012, that the Falmouth Board of Health is currently formulating such a study to be undertaken with confidentiality.

The specific source of the neighbors' health issues was also a question the group was unable to answer. Representatives of neighbors stated that many impacted neighbors were affected by amplitude modulation (the periodic increase in volume), low frequency noise (sound pressures between 20 – 100 Hz), and/or by infrasound (sound pressures below 20 Hz), which cannot be heard but can be perceived by the body. The WTOP heard an explanation of the meaning of these terms, but did not collectively examine any research on these issues, because of concerns that participants could not agree on the credibility of the sources. Participants continue to disagree about whether infrasound and low frequency sound are elevated due to turbine operation and whether these negatively affect human health.

The group explored the spatial relationship between reported health impacts and the locations of homes. The Town's Geographical Information Systems (GIS) Specialist created a map to illustrate the locations of the Board of Health complaints in relation to the turbines.⁸ Upon review of the map, the WTOP did not draw specific conclusions about the relationship between health impacts and proximity to the turbines.

WTOP Conclusions: Though clearly the heart of the matter, the WTOP did not examine the underlying causes of the neighbors' health complaints. Given the impossibility of explaining, to the satisfaction of all, the relationship between health complaints and the operation of the turbines, the WTOP agreed to treat these concerns as reality for the purposes of this process, and seek solutions to address them.⁹

4.2 Acoustic Data

The WTOP had a number of questions about the sound levels generated by the turbines, as measurable at neighboring properties, as well as about the change in sound levels above ambient, which is the basis of DEP guidelines. The Town had existing acoustic data collected through unattended sound sampling and sound models by the consulting firm Harris, Miller, Miller and Hanson, Inc. (HMMH), and attended sound sampling by the Massachusetts Department of Environmental Protection (DEP), which were reviewed and explained to the group by technical experts from Acentech and DNV Kema. These experts also presented background information about noise, turbine noise, and acoustic monitoring. Later in the process, representatives from the DEP presented its findings from their nighttime acoustic monitoring of Wind 1 to the group.

4.2.1 Overview of HMMH Acoustic Monitoring and Sound Modeling¹⁰

At the request of the Town, HMMH conducted unattended sound sampling for Wind 1 in June 2010 to characterize and better understand the complaints residents made regarding the noise created by Wind 1. (During unattended sound sampling, the acoustical engineers set-up the sound collection devices and leave the area while the devices measure noise levels.) The Town also asked HMMH to model the anticipated noise levels produced by the operation of Wind 2, which was

⁸ See Appendix 8.2.5.1 for the GIS Map.

⁹ As stated earlier, the WTOP was also asked to accept as given that wind turbines help slow climate change by reducing fossil fuel consumption. The group did not discuss exploring the data behind this issue.

¹⁰ This is a brief overview of the process and data developed by HMMH, which was familiar to many members of the WTOP, and discussed during WTOP meetings, but not presented in this form to the group. For more detail, see the reports issued by HMMH on the Falmouth Town Website.

expected to begin operating in the fall of 2010. HMMH measured ambient noise data while Wind 1 was not operating and the turbine noise data while the Wind 1 was operating. This data was used to create a sound model that HMMH hoped would enable them to project when and where noise levels from the operation of Wind 1 and Wind 2 might exceed the DEP's Noise Guidelines, which consider violations to occur when sound emissions increase greater than 10 dBA above the ambient sound level and the Falmouth Windmill By-Law.

After publishing the initial findings in September 2010, the DEP reviewed the HMMH noise study and requested the data be shown in one-hour intervals and that the ambient data be represented by the quietest measured one-hour time of day at each wind speed. HMMH complied with the requests and published the additional analysis findings in April 2011.

The HMMH findings concluded the sound from Wind 1 complied with DEP noise guidelines. However, the noise levels measured at nighttime near Blacksmith Shop Road were very close to exceeding the DEP 10 dBA guideline. The model predicted that simultaneous operation of Wind 1 and Wind 2 was likely to cause exceedances at the homes nearest to the turbines in the early morning when ambient noise is lowest and when wind speeds are less than 8 meters per second (m/s) at the turbine hub.

WTOP Conclusions: The group's discussions of the HMMH data made clear that there was still disagreement among stakeholders regarding the accuracy and reliability of the approach taken by HMMH in its acoustic testing, its analysis, and its modeling. Therefore, the WTOP was not able to reach any conclusions about the feasibility or implications of options based on this data.

4.2.2 Massachusetts Department of Environmental Protection Sound Sampling Study¹¹

To supplement the HMMH data set and ensure accurate measurements, the DEP conducted attended sound sampling of the noise produced by Wind 1 at five locations between 11:30 pm and 4:00 am in March 2012. During four daytime sampling events in June 2012, the DEP conducted additional attended sound sampling of the noise produced by both Wind 1 and Wind 2 at six locations between 9:00 am and 4:00 pm. During both night and daytime sampling events, the DEP conducted sound testing for ambient noise while the turbines were not operating, and for sound produced by the turbines while they were operating. The sound sampling events occurred in a range of wind conditions, directions and speeds and at times when the DEP expected the ambient sound to be the quietest.

The DEP used attended sound sampling—meaning they stayed with the sound collection devices while they collected data—because attended sound collection methods enabled the DEP to focus on the noise attributable to the turbine by identifying and eliminating sound samples containing noise spikes caused by cars, leaf blowers or any other transient noise sources. After the DEP collected ambient sound levels while the turbines were not operating and sound samples during the operation of the turbines, the DEP analyzed the data by comparing the ambient sound levels to turbine sound levels. This comparison analysis permitted the DEP to determine whether or not the turbines were producing noise greater than 10 dBA above ambient sound levels.

¹¹ See Appendix 8.2.2.1 for the full DEP Report.

The DEP concluded that sound levels from Wind 1 exceeded the 10 dBA guideline at 211 Blacksmith Shop Road in the early morning hours between midnight and 4:00 am, under all wind directions and wind speeds tested. The DEP reported to the WTOP that noise from traffic on Route 28 has a significant influence on background or ambient sound at some of the sampling locations. As a result, the ambient sound of some of the sampling locations is most quiet when there is less traffic on Route 28. DEP's report further stated that "while other locations did not demonstrate noise levels of 10 dBA or more above ambient, minor modifications in how the data was collected might have produced different results. For example, if Mass DEP had used the absolute value for L_{max} rather than L_{max} as an average of 3 sampling runs, the 27 Ridgeview Road site would have exhibited an impact sound of 11.5 dBA over ambient on March 15, 2012."

In November 2012, DEP reported their conclusion that during the daytime period tested, the combined sound levels of Wind 1 and Wind 2 did not exceed the 10 dBA guideline.

WTOP Conclusions: While most participants agreed that the DEP's findings formed the basis of the legal requirements for future operation of the turbines, some stakeholders nonetheless disagreed with the methodology that DEP used to reach its conclusions. This led to continued support from some stakeholders for an option that runs the turbines without curtailment. Meanwhile, some neighbors raised the possibility that daytime sound levels might exceed DEP guidelines if testing were done at a time of year when winds are higher and ambient traffic noises are less. The WTOP also noted that acoustical measurement data for the turbines and the background sound are incomplete.

4.2.3 Acentech Sound Model

The WTOP requested Acentech, as the technical expert charged with assisting the group with information about noise, to use the DEP and HMMH data to build a sound model that could help them estimate the number of homes that would likely experience sound from one or both turbines running at night that exceeds 10dB above ambient. The group hoped that the sound model could identify:

- Which hours of day or night and at what wind speeds are exceedances of the DEP guidelines anticipated to occur?
- Which and how many properties are there where exceedances of DEP guidelines could be anticipated?
- Whether exceedances of DEP guidelines should be anticipated if only Wind 2 is operating at night?

To create an ambient sound model, Acentech used the minimum ambient L_{90} noise levels (measurements collected while Wind 1 and Wind 2 were not operating) measured by HMMH at the two long-term monitoring locations, and compared them with calculated turbine sound levels at those locations, based on an analysis of Vestas' updated sound power level data. This resulted in a comparison of L_{90} background to L_{eq} turbine sounds. In response to questions from the WTOP about a comparison between L_{90} background to L_{max} turbine sound, Acentech clarified that it is not possible to model L_{max} because certified wind turbine sound power levels are not available in terms of L_{max} . Acentech suggested that a prediction of L_{90} background to L_{max} turbine sound could be estimated by adding 3-4 dB to each number in the model. When asked their view, MassDEP

responded “The assumption that there may be a 3-4 decibel addition may be correct in a side wind direction but we think the correction is closer to 2 decibels in a downwind direction.”¹²

Acentech’s model predicted that operation of Wind 1 alone at night would result in exceedances at site LT-1 (211 Blacksmith Shop Road); Wind 2 alone at night could result in exceedances at LT-2 (124 Ambleside Drive); and both combined would result in exceedances at both sites. It also raised the possibility of exceedances at hours earlier and later in the night than when such exceedances had been measured by DEP testing. There was disagreement about whether the model could inform the group about the number and location of properties where exceedances might be anticipated because it did not have measured background sound levels for any other locations and did not have a methodology for modeling background sound at new locations.

WTOP Conclusions: Members of the WTOP felt unable to draw any meaningful conclusions from the Acentech Sound Model because it was unable to predict sound differences between L_{90} background to L_{max} turbine sound that was used by DEP in their sound monitoring protocol. Additionally, it was based on limited and not fully accepted background measurement data and calculated turbine sound levels, which were not consistent with DEP’s test results, and it did not estimate the number of homes that would likely experience exceedances. Participants from all stakeholder groups disagreed regarding the use of a model to estimate the number of homes that would experience exceedances, and in the absence of such an estimate, could only recommend further acoustical testing to determine exceedances.

In order to inform the Town about compliance with DEP requirements, Town of Falmouth bylaws, and international standards, and answer questions about the relationship between turbine noise and the health complaints of neighbors, the WTOP recommends that additional acoustical testing be conducted, using a firm and methodology acceptable to all stakeholders. The MassCEC has offered to provide additional sound testing, and the WTOP recommends the Town avail itself of that offer. Most of the WTOP favors that all data collected be publicly posted on the Town’s website to facilitate third party review, and continuous measurements of the wind turbine sound at selected locations during a full range of weather and operating conditions for an extended period, such as six months to a year should be conducted. These measurements would include documentation of amplitude-modulated sound, low-frequency-sound, and infrasound, according to Annex A of the IEC 61400-11 standard, as recommended by the WTOP consultants, DNV Kema (page 22, 3/15/2012 report) and Acentech (page 3, 3/15/2012 report).

The group agreed that an understanding of DEP exceedances would provide information about what operational options were legally possible, but would not assist the group as a standard for resolving the neighbors’ concerns. Although most of the discussion of acoustic measurement centered around whether, where, and how often the turbines exceeded DEP guidelines, most members of the WTOP acknowledged that operation within these guidelines would still not result in acceptance of the turbines by affected neighbors, since neighbors stated that compliance with the guidelines did not alleviate the health concerns they experienced.

¹² Email from Laurel Carlson to CBI on November 28, 2012.

4.3 Noise Mitigation Options

The WTOP requested information about possible noise mitigation options that might help to reduce the volume and improve the adverse conditions reported by some community members. Initial noise reduction ideas included improved outdoor-to-indoor home sound insulation, home or turbine based sound masking devices (to reduce the experience of amplitude modulation), physical structures (such as barriers or berms) to impede noise penetration, or active noise control mechanisms installed at the turbines or in homes to essentially eliminate or reduce turbine noise.

Acentech, as well as DNV Kema, presented to the group on these options, and followed up with memos containing additional information. The analysis of the technical experts clarified that several of these ideas were infeasible (physical structures) or untested (active noise control, turbine-based sound masking). The two noise mitigation approaches that were presented as most promising were improved outdoor-to-indoor sound insulation, which was estimated by Acentech to reduce wind turbine sounds inside the home by 3-9 dBA, and sound masking, which reduces the experience of amplitude modulation but does not reduce the total sound level. Acentech also clarified that sound insulation would not reduce infrasound and very low frequency noise.

WTOP Conclusions: Based on this data and/or their own experiences, fiscal and climate stakeholders felt that home insulation was a valuable option for reducing the noise levels for impacted neighbors. However, the impacted neighbor representatives did not agree, based on their experiences and perspectives, stating that their greatest concern was low frequency noise and infrasound, which would not be mitigated by upgrades to insulation, nor would it address quality of life outside their homes. Some WTOP members acknowledged the potential value of sound masking devices within a room or a few rooms of the home, but neighbors also noted their limitations. The WTOP ultimately did not agree on the value of offering insulation and sound-masking devices to neighbors as a form of mitigation. It is listed as a possibility within the options for the Board of Selectmen to consider, without consensus that it would improve the neighbors' situation.

4.4 Mechanical Changes to the Turbines to reduce noise

Members of the WTOP had heard about a range of mechanical changes that might be made to the turbines to decrease their acoustical impacts. DNV Kema, with some input from MassCEC, provided an overview about these options to the group. The options included modification of the blades, reducing the rotor speed, and changing blade pitching in high winds. DNV Kema informed the group that all mechanical options would require Vestas' assistance or approval, all required additional research, and they would likely only provide moderate sound reductions. Most promising would be the installation of serrated trailing edges, which had been installed on other turbines and led to noise reductions of 2-4 dB, or modified pitch controls, which were untested and had unknown noise reduction benefits. The efforts of the consultants, the Town, and the MassCEC to engage Vestas in the search for mechanical solutions led only to an understanding that Vestas had no commercially available modifications to reduce turbine noise.

The group researched an approach of operational adjustments being developed by Brian Von Herzen and John York, which would yaw the turbine and alter the "angle of attack," in order to reduce overall sound emission, the peaks of the amplitude modulated sounds, and low-frequency

noise generation. The developers estimated overall reductions of 2-3 dBA. DNV Kema examined the approach and raised questions about the claims to reductions in audible amplitude modulation or increased low-frequency noises, and felt further justification and analyses were needed. They estimated a proof-of-concept test would cost around \$3000 and take about 1 month. If viable, the implementation costs were estimated by DNV Kema to be around \$300,000, plus a likely reduction in energy generation, which was estimated at 25% less production.

WTOP Conclusions: The WTOP concluded that they were uncomfortable recommending any options that are not currently available, tested, and implementable without Vestas' support, and this ruled out all the mechanical options they had explored for reducing turbine noise. However, the group agreed that if such technologies or devices were to become available in the future, the Town should certainly consider them.

4.5 Flicker and Flicker Mitigation

To better understand how flicker and flicker mitigation would impact neighbors and turbine operation and revenue generation, the WTOP requested DNV Kema and the MassCEC to model shadow flicker and its mitigation options for all homes impacted by Wind 1 and/or Wind 2.

DNV Kema conducted desktop modeling using WindPRO to analyze flicker for each possible receptor, which is defined as one square meter at human height level for each home. Line-of-sight obstacles like trees, which would reduce flicker in some locations, are not included in the bare-earth analysis used in the model. Given this, additional on-site validation would be required to produce more accurate mitigation analysis. DNV Kema created both a worst-case scenario, which assumed the sun is always shining, the turbine always turning and the angle of the rotor as always perpendicular, and a real-case scenario, which recognizes the worst-case assumptions are not true all the time. The model produced three threshold scenarios for limiting flicker—one that allowed for 30 “real-case” hours of flicker per year per home, a second allowing 10 “real-case” hours per year per home, and a third allowing for 30 “worst-case” hours per year per home.

DNV Kema concluded that, if not curtailed, over 50 homes would be expected to receive more than 10 hours of real-case flicker per year or 30 hours of worst-case flicker per year. To reduce flicker to no greater than 10 hours per year per home, Wind 1 and Wind 2 would need to be curtailed approximately 387 hours per year and 727 hours per year, respectively. The number of curtailed hours increases to 394 and 774 under the 30 worst-case hours per year analysis and decreased to 202 and 276 hours of curtailment under the 30 real-case hours per year analysis. This approach added 30 minutes of curtailment on each end of the expected flicker, to account for the range of locations along a home. Since flicker curtailment for any one receptor would require the turbines to be shut off and thus result in flicker curtailment for all, DNV Kema predicted that this flicker curtailment would result in minimal flicker exposure for any household. They also predicted that flicker curtailment would result in reduced revenue of ~1%.

WTOP Conclusions: Although representatives of the affected neighbors maintain that nobody should experience any flicker at any time, the WTOP members have not expressed strong objection to DNV Kema's inclusion of the 30 hour worst-case flicker curtailment plan (with the additional ½ hour before and after) in the breakeven curtailment scenario, because it was expected to result in minimal flicker exposure for any household.

4.6 Financial Costs and Revenues of Turbines and Potential Operational Scenarios, PV Development, and Turbine Removal

The WTOP sought to understand the revenue implications of operating the turbines to inform several turbine operational scenarios. The group requested financial information from the Town broken into the following categories: debt service, Waste Water Treatment Facility (WWTF) costs, turbine installation costs, Renewable Energy Certificates (RECs), turbine maintenance and service costs, and information about the use of turbine revenues. They also requested and received turbine account information, copies of relevant contracts, and other historical financial information about the development and operation of the turbines.

MassCEC, Sustainable Energy Advantage, and DNV Kema, with input from employees in the Town, put together initial and then revised financial reports that clarified the financial impacts of a range of operational scenarios for the turbines, as well as removal of the turbines and development of a photo-voltaic array.

4.6.1 Costs and Revenues of Turbine Operation

The financial benefits of the turbines are based on the sum of three sources:

- 1) market value of the energy consumed by Waste Water Treatment Facility (WWTF);
- 2) value of Net Metering credits; and,
- 3) revenue from the sale of RECs.

The financial costs are based on the sum of:

- 1) the debt obligations associated with the purchase and financing of Wind 1;
- 2) the costs associated with upkeep, operation, and management of the turbines, including funds for reserves and contingencies; and,

The additional costs of purchasing residences, and other compensatory measures to address the health, noise, and property value concerns of neighbors, are unknown and could be substantial. The These costs are not included in these financial estimates. This is described further in Section 5.1.4.

Projections for components 1 and 2 were calculated by DNV Kema and Sustainable Energy Advantage based on a range of variables. For example, projections of the value of Net Metering Credits are dependent on the forecasts of the range of variables that go into determining that value. Energy prices are projected to escalate based on NYMEX and Henry Hub-based electricity price forecast from EIA.

The WTOP spent considerable time, at the last minute, on the methods for calculating the likely average energy production of Wind 1 and Wind 2 over the 20-year life of the turbines. This occurred after questions arose about the discrepancy between the initial calculations and the actual production levels of the nearby Notus turbine. In order to better understand this question, DNV Kema explored three separate analyses, each with its own data and uncertainties.

- Method 1, the initial method, modeled a power curve for Wind 1 based on direct measurement of Wind 1 production. However, since a full year of production data does not exist, he extrapolated to time periods when the turbine was not operating, using the

operational power curve and the winds as measured at the hub by the nacelle anemometer (the same one used for the power curve). Since nacelle anemometers provide different measurements when the turbine is off or on and in different yaw orientations, there was uncertainty in this method. This analysis led to a finding of 3704 gross MWh, which was 72% of Notus production.

- Method 2¹³ used an almost complete record of production at Notus, and then sought to understand the relationship between the production of Notus and the production of Wind 1. Using 5 months of concurrent Notus and Wind 1 data, he modeled the likely relationship between Wind 1 and Notus, which varies depending on time of day, wind speed and wind direction. This modeling also introduces uncertainty. It led to a finding of 4694 gross MWh, or 91% of Notus production.
- Method 3 compared two almost complete full year sets of nacelle wind data for Wind 1 and Notus, but because nacelle anemometers mis-measure due to the flow around the nacelle and rotor effects change the measurements between operation and non-operation, each data set has uncertainties, which are then compared to each other. This method led to a finding of 4180 gross MWh, or 81% of Notus production.

He then estimated the uncertainty of each result, including the individual uncertainties related to wind speed measurements, the power curve or relationship between Wind 1 and Notus and uncertainties related to extrapolation in time. He concluded that the uncertainty of method 2 is about 5%, Method 3 about 10% and Method 1 in-between. He then got an uncertainty-weighted estimate of the most likely value: about 84% of Notus production.

The projections provided by DNV Kema assume that, over the 20-year life of the turbines, about 14% of the possible generation would not be realized, for a range of reasons including down time for routine and unexpected maintenance, blade icing, and grid outages. It also assumes that the turbines might sometimes operate sub optimally, due to dirt on blades. According to DNV Kema, due to variability in wind speeds (+/- 5-6% variation annually), there is 95% certainty that actual energy generation in any particular year will fall within +/- 21% of the average, and 68% certainty that it will fall within +/- 12%.

Much of the projected 14% of unrealized energy generation is due to maintenance needs, including the lag time that might occur while repairs are awaited. According to DNV Kema, such repairs are more likely to be needed later in the life of the project – therefore, the energy and financial projections assume that down-time for the turbines will occur in greater proportion as the years go on and less often early on.

Other variables impacting the financial calculations were presented and discussed by the WTOP, and are provided in detail in the charts and presentations appended to this report. Some of these assumptions are questions of predictions of the future, (e.g., the future cost of energy). Several of the variables depend in part on budgeting and policy decisions of the Town.

¹³ Methods 2 and 3 relied on 10-minute production data from the Notus turbine that are not publicly available and were not reviewed by the full group. The data was given to DNV Kema by the owner of the Notus turbine.

One of these variables is the electricity demand of the WWTF. When turbines began operation, the financial resources that had been allocated to electricity for the WWTF were removed from the WWTF operating budget. Because of this, there is an expectation that the options for the future of the turbine operations account for the generation or the cost of electricity at the WWTF. The WTOP discussed this issue in detail, and agreed to include this in their analyses.

Another variable discussed in detail by the group is the rebuilding of a reserve fund for the operation of the turbines. The Town started with a \$1 Million reserve fund that would be available to cover essential turbine expenses – from unexpected repairs to turbine debts – that came before or went beyond the revenues available from the turbines. Over the past 2.5 years, due in part to turbine curtailment and maintenance issues that have resulted in reduced revenues, that reserve fund now contains approximately \$240,000. Renewable Energy Stabilization Fund (MassCEC/REC) funding has been used only for debt payments on Wind I, as appropriated by Town Meeting. Based on industry standards and the preferences of the Town, the financial model in this report includes the rebuilding of an approximately \$1 Million reserve fund over the course of the next 5 years, at a rate of about \$130K per year, and adds that amount to the “costs” category for the turbines. (Contributions to a decommissioning reserve of \$9K/year apply in all cases.) Some participants in the WTOP feel the Town should consider reducing its expectations for the quantity and timing of the reserve fund to allow some of the fiscal resources to be allocated to other parts of the solution.

4.6.2 Costs and Revenues of Turbine Removal

The estimated financial impacts of removal and sale of the turbines includes the costs associated with the debt obligations for Wind 1 and removal costs for both turbines, minus the revenues from sale of the turbines. The debt obligations include the two bonds for Wind 1, including interest, as well as the stipulated refund for the MassCEC REC contract. The costs, as analyzed in this report, also include the costs of electricity at the WWTF. There are also costs associated with removal of the turbines; however, preliminary investigations by MassCEC into the resale market for V82 wind turbines suggest that a buyer would pay the costs of dismantling and transportation of the turbines.

4.6.3 Costs and Revenues of PV Array

The estimated financial impacts of the development of a 2.0 MW PV array are dependent on projections of the costs to purchase and install the array and projections of the energy produced, market value of energy produced, and market value of the Solar Renewable Energy Credits (SRECs) and RECs associated with the project. Projections for each of these components is calculated based on a range of variables, and the WTOP was presented with an analysis that explored the financial impacts under a range of assumptions about these variables.

The base case assumed a 20-year municipal bond of approximately \$6 million (the entire estimated development and capital costs), selling SRECs for \$150, an all-inclusive development/capital cost of \$3.00/watt, and a 14.5% capacity factor. Alternative cases assumed some changes to these assumptions, and/or envisioned the availability of external financial resources to reduce bond payments.

WTOP Conclusions: The production estimates were fully revised at the group’s second-to-final meeting. Due to this major revision, the WTOP required several iterations of the financial cost and revenue projections during the final week of this process. The short timeline available for exploring and vetting this information, as well as the significant levels of uncertainty that remained, left many members dissatisfied. Group members noted that they could not engage in a detailed vetting of all

the detailed factors used to estimate cash flow for the options. Nonetheless, all participants were able to approve the use of the long-term estimates provided by DNV Kema and SEA regarding the average production levels and financial implications, while noting the large uncertainty involved in predicting yearly energy revenues. The WTOP also accepted the other basic assumptions included in the final financial projections.

4.7 Turbine Relocation Data

The WTOP considered relocating the turbines and reviewed relevant information regarding this option. Some of the questions the group asked in regards to relocating the turbines were:

- Where would the turbine(s) go?
- Where do the wind maps indicate sufficient wind for effective operation within Falmouth?
- What are the potential economic impacts of moving the turbines?
- How will the generated energy be transmitted? Where will the energy be used?
- How long would it take to complete the relocation process?
- What are the Federal Aviation Administration's (FAA) considerations for potential relocation sites?
- What are the Town's contractual obligations related to the turbines?
- How would moving the turbines affect their warranties?

Weston and Sampson assessed the potential costs the Town would incur from relocating the turbines to another Town-owned property, which they estimated as approximately 4.4 million dollars. Additional analyses requested by the WTOP have generally agreed with this as a ballpark amount, with additional, unknown costs for interconnection.

Falmouth's Town GIS Specialist worked with MassCEC and others to identify the full range of potential sites within Falmouth where the turbines might be relocated. After a detailed examination using a set of criteria (including a 2500 foot setback), MassCEC and the Town identified a number of challenges with the only viable location, a site next to the Massachusetts Military Reservation (MMR). Since FAA approval was a clear "show-stopper," the WTOP requested that MassCEC submit the most promising locations within the site to the FAA for evaluation of potential hazards. Ultimately, the FAA responded with a finding of potential hazard because the turbines would exceed obstruction standards and have adverse physical or electromagnetic interference upon the navigable airspace or air navigation facilities.

WTOP Conclusions: The FAA's finding of potential hazard persuaded the WTOP to conclude that moving the turbines was not a feasible option. Even before this finding was provided, the WTOP was skeptical that it would be a desirable option due to the cost, the timeline, the significant number of uncertainties (permitting, easements, interconnection, etc.), and the impacts of the turbines on residents in base housing on MMR, who would be located within ½ mile of the relocated turbines.

4.8 Turbine Resale Data

The WTOP considered whether selling the turbines would be a feasible option to include in a package. The turbine resale value provided the group with an understanding of how much money could be earned and applied toward options that would require dismantling the turbines. MassCEC gathered turbine resale data from the internet and personal communications with a broker of used wind turbines.

The Weston and Sampson report had estimated the resale value of the turbines without a manufacturer's warranty at \$300,000 to \$600,000, which did not include the dismantling and transportation costs. Alternatively, if the turbine's copper, steel and spare parts were harvested for resale, they estimated approximately \$182,000 could be raised. However, if the cost of dismantling, preparing and shipping the materials to the purchaser's location were considered, then selling the turbine's precious metals and spare parts would generate very little to no revenue.

MassCEC's research indicates the Town could likely raise between \$200,000 to \$600,000 for selling both turbines. The buyer would most likely pay the cost of dismantling and transporting the turbines to a new location, although the Town would need to confirm this with the purchaser. The MassCEC reports that the quantity of V82 turbines in operation increases the likelihood the Town's turbines could be sold for scrap and parts.

Uncertainties that will affect the price of turbine resale include whether or not the turbines are still under warranty when sold and if the Town can provide detailed maintenance records with the sale.

4.9 Community Responsiveness to curtailment vis-à-vis home sales and mitigation ¹⁴

The WTOP requested CBI design and administer a survey of homeowners located within ½ mile of the turbines and to residents outside ½ mile who had formally complained to the Town or the Board of Health in the last 2 years.¹⁵ The limited purpose of the survey was to estimate how much money the Town might expect to spend if home purchases were included as part of turbine operation scenario packages, and to understand the potential impacts of curtailment vis-à-vis home sales. The survey only presented five turbine operation scenario questions, each with a different operating scenario. For each of the five operating scenarios, respondents were asked to indicate which, if any, of the mitigation options they would prefer given the specific operational scenario. Because of the limited purpose of the survey, no option was presented for removing the turbines, or about neighbors desire to remain in their homes. In order to make correlations between reported negative impacts and mitigation preferences, participants were also asked to report whether they experienced adverse impacts.

CBI sent the survey to 211 addresses, which were divided into three respondent groups: 34 addresses from the official complaint list, 12 addresses located within ¼ mile of the turbines, and 165 addresses located between ¼ and ½ mile from the turbines. The addresses included on the

¹⁴ See Appendix 8.2.7.11 and 8.2.7.12 for the full survey questions and presentation of results.

¹⁵ There was confusion as to whether all members of the WTOP wished the survey to go to households who had complained but lived outside ½ mile.

official complaint list were from the Town's records of who had complained through official lines of communication with the Town. To eliminate overlap between the respondent groups and ensure that each property owner only submitted one response, CBI did not include those on the official complaint list in either of the other two respondent groups. Seventy-eight households submitted survey responses for an overall survey response rate of 37%. Response rates across the three categories varied. The official complaint list had the highest response rate at 71%. The response rate of the zero to ¼ mile group was 58% and the response rate of the ¼ to ½ mile group was 28%.

The survey results indicate that of the 78 people who responded, 32 (41%) (21 of whom were from the official complaint list) indicated that at least one person from their household was negatively impacted by the noise or suffered negative health impacts from Wind 1 and Wind 2. If turbines operated, most respondents would prefer the Town to purchase their homes under the various operating scenarios and few respondents desire insulation upgrades to reduce noise levels in their home. A greater number of respondents from the ¼ to ½ mile group than either of the other respondent groups indicated they did not experience adverse health affects from the wind turbines. Additionally, these respondents were more likely to report concerns with property values and, under most operating scenarios, were more likely to select payment of home electricity costs after selecting home purchases as a preferred option.

WTOP Conclusions: The WTOP agreed that the survey results indicate:

- 1) There is a lack of interest in the option of window, door, insulation and air-conditioning upgrades to mitigate turbine sounds.
- 2) There is some interest in revenue sharing/financial compensation for home electricity costs, especially among non-health affected neighbors.
- 3) There is significant interest in home purchasing across all respondent groups given turbine operation scenarios. As turbine operation becomes more limited under the scenarios, the number of respondents preferring home purchasing decreases slightly, but not significantly.
- 4) Many respondents expressed concerns about property values.

The survey had a range of limitations. One of the limitations was the lack of differentiation of those concerned about Wind 1 or Wind 2 from those concerned about the Notus turbine when asking about mitigation preferences, as well as a lack of information about the distance from the turbines among those on the complaint list. Some people may be affected by more than one turbine. Some WTOP participants did not support conducting this survey.

5. Packaged Options

5.1 Full Operation

5.1.1 Turbine Operation

Turbines would operate whenever wind conditions allow, without curtailment, which the Town could accomplish by either purchasing homes where noise levels exceed DEP guidelines and then reselling the home with a noise easement, or by acquiring noise easements for the homes where noise levels exceed DEP guidelines. The WTOP recommends that the Town take measures to ensure that operation of the turbines complies with required DEP Noise guidelines.

5.1.2 Measures to Respond to Health, Noise, and Property Value Concerns

Representatives of adversely impacted neighbors have made clear that operation of the turbines within the sound levels required for compliance with DEP noise policies will not alleviate their noise and health concerns. In order to respond to the noise and health concerns of neighbors for whom a noise easement is not required, the Town could decide to voluntarily purchase residences according to a pre-determined set of eligibility criteria to ensure the decisions are fair and predictable. Some potential eligibility criteria discussed by the group include:

- Residences within a certain distance of Wind 1 or Wind 2 (e.g., ¼ mile, 1/3 mile, or ½ mile)
- Residences where occupants have documented health concerns
- Residences where occupants have expressed noise or health concerns – in the form of complaints or testimony – over the past 2.5 years

The Town might also offer some quantity of financial compensation to residents within a certain distance of the Town's turbines, to compensate them for the reductions to quality of life and/or potential property value losses. Residents could then apply these payments as they choose, be it upgrading insulation to reduce noise, installing sound masking mechanisms, payment of utility bills, or any other purpose.

Finally, the Town might offer a Property Value Guarantee, which establishes a methodology for determining an "Asking Price" reflective of the value of the property without turbines, and guarantees that homeowners forced to sell their homes below that price will be compensated. This would also be applied based on appropriate criteria.

Determination of these criteria might be influenced by the available financial resources and the level of interest demonstrated. In order to implement the process, the WTOP recommends the Town contract a neutral, third party assessor to ensure fair implementation of all of these measures based on the criteria. The Town may also develop other measures to respond to health, noise, and property value concerns.

5.1.3 Energy Impacts

Energy projections developed for the WTOP have estimated production of a combined uncurtailed average of 7513 MWh per year over the life of the turbines. Based on the ISO New England

standard approach for calculation, at about 0.44 tons of carbon per MWh,¹⁶ this would reduce carbon emissions by about 3306 tons of carbon per year.

The projected electricity production from running the turbines without curtailment over 5 years is approximately 38,551 MWh. Over the 18-year life the project, the energy production estimate is approximately 135,486 MWh.

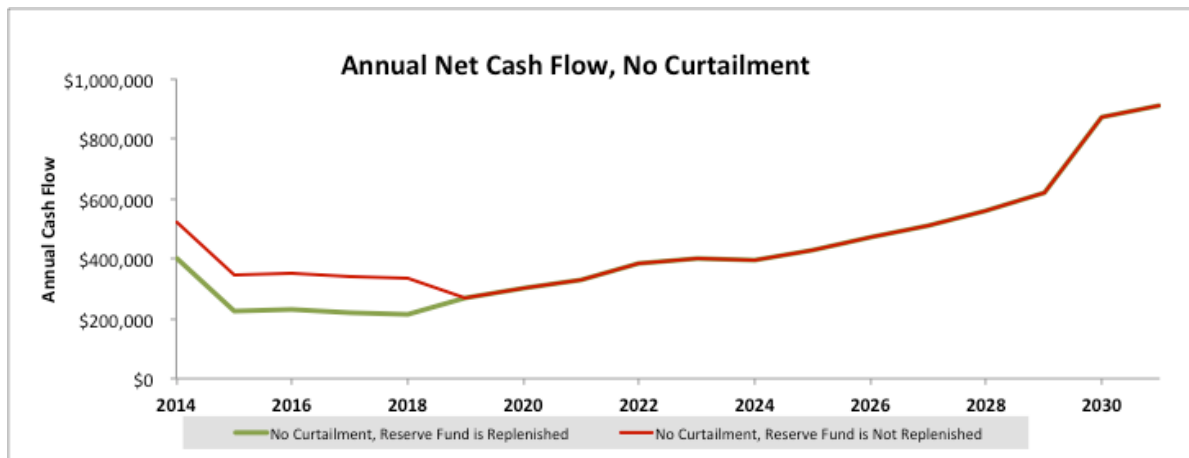
	5-year Cumulative Estimate (FY 14-18)	18-year Cumulative Estimate (FY 14-31)
Projected Energy Production	38,551 MWh	135,486 MWh

5.1.4 Financial Impacts¹⁷

5.1.4.1 Projected Financial Impacts of Turbine Operations only (not including the cost of home purchases and compensatory measures)

The following table and chart show the financial projections for the cash flow that could be generated from running the turbines without curtailment cumulatively over 5 years and 18 years, after payment of all costs and electricity used at the WWTF, under two different assumptions for the replenishment of reserve funds.

Available Revenue Surplus from Turbines	5-year Cumulative Estimate (FY14-FY18)	18-year Cumulative Estimate (FY14-FY31)
With full contributions to reserve fund (\$130K/year)	\$1.3 M	\$7.7 M
With no contributions to reserve fund	\$1.9 M	\$8.4 M



¹⁶ See http://www.cpg-advisors.net/wind_and_cost_of_carbon_puf.pdf

¹⁷ Detailed financial estimates are located at the end of this Section.

5.1.4.2 Financial Projections of Property Purchases and Compensatory Measures

This option potentially includes two types of property purchases – those that would be required in order to allow for turbine operation consistent with required DEP guidelines, and those that would be offered to property owners, based on predetermined criteria (whatever the Town decides they should be), to respond to noise and health concerns.

Given incomplete acoustical measurement data and limitations of noise modeling, there is uncertainty about the number of properties with the potential to experience noise in excess of DEP guidelines. The WTOP analyzed the existing data to estimate the range of properties that might require purchasing or noise easements, and found that there was insufficient data to determine which homes might experience exceedance of the DEP guidelines. If the Town selects the option of running the turbines and purchasing homes, the WTOP recommends that additional acoustical measurement be conducted, using a firm and methodology acceptable to all stakeholders. The MassCEC has offered to provide additional sound testing, and the WTOP recommends the Town avail itself of that offer, and provide input from stakeholders into the selection of the acoustical consultant, as well as sound testing and data analysis protocols. If properties are found to be in exceedance, the Town could offer either to purchase the home, or to purchase a noise easement.

The WTOP also discussed the estimated cost to the Town for each property purchased. The Town's Director of Assessing has indicated that within a ½ mile radius of the two turbines the average residential property assessment is \$433,600, and the average assessed value of the 34 Complainants' homes is \$414,000. If the Town decides to run the turbines without curtailment and purchase homes, the Town will need to estimate the costs. In order to estimate the actual cost to the Town of purchasing properties, the WTOP recommends the development of an estimation tool which includes variables such as the number of months it will take to sell the home, the cost to maintain the home per year, the finance cost, and the transactions cost, as well as the likely value reduction due to the need for an expeditious sale, rather than waiting for the best price.

The total cost of properties that the Town might buy voluntarily and the additional monetary compensations that the Town might provide depend upon the criteria that the Town adopts. As previously stated, the WTOP recommends the Town use a neutral, third party assessor to implement the criteria determining allocation of these mitigations.

5.1.5 Impacts on Noise, Health and Property Value Concerns

Based on statements of the representatives of the neighbors expressing health and noise concerns, as well as the informal on-line survey¹⁸ undertaken by the WTOP, it seems that 1) most would prefer to remain in their homes rather than moving, and see leaving their homes as a tremendous loss, and 2) among those who replied to the survey, most indicated they would nonetheless opt to move rather than remain in their homes if the turbines were going to run without curtailment. Those who relocated would experience an end to their health and noise concerns, though many may suffer quality of life costs associated with leaving the homes and neighborhoods they love. If the Town's criteria for property purchases resulted in neighbors with noise and health concerns who are unable to relocate away from the turbines, those neighbors would experience this package as providing no

¹⁸ See survey results in the Appendix 8.2.7.12.

solution to their concerns. Representatives of those expressing noise and health concerns have stated that monetary compensation would not be helpful to them in resolving their concerns.

The WTOP did not collectively examine any data regarding the existence or extent of actual property value losses, and came to no agreement on this subject. Some stakeholders expressed certainty about property value losses caused by the turbines, others expressed certainty that there were no such losses, and others were unsure. In the WTOP's informal survey, many of those who did respond indicated that they had concerns about their property values. The WTOP did minimal investigation into how to satisfy the property value concerns of turbine neighbors who were not experiencing health and noise concerns, so the WTOP cannot estimate the extent to which monetary compensation or a Property Value Guarantee, if adopted, might adequately address those concerns. Among those who expressed property values concerns, some indicated that they would opt for payment of their electricity (as opposed to having their home purchased, receiving insulation, or receiving nothing – the options that were offered in the survey). Those for whom no additional compensatory measures were offered would feel this package provided no solution to their concerns. This package would also provide no resolution for those affected by shadow flicker.

5.1.6 Uncertainties

The WTOP noted a number of uncertainties remaining regarding the feasibility and impacts of this package, including:

- Financial projections and the production estimates are uncertain, and actual production levels in any given year may vary (positively or negatively) by up to 21% (to reach 95% confidence);
- The actual number and cost of properties that would need to be purchased due to exceedance of DEP noise guidelines;
- The actual number and cost of properties that the Town would voluntarily purchase to respond to health concerns;
- Potential future changes to noise guidelines and policies, including the outcome of the current legal case about the applicability of the Town's 40dB maximum noise bylaw;
- The potential for additional legal action taken against the Town;
- Potential for health regulations stemming from the DPH/DEP report or other sources.

5.1.7 Potential Future Additions/Variations

This package should include the future addition of any new technology that becomes available to reduce the absolute noise output or the noise character (i.e., amplitude modulation) of the turbine. This package can also take advantage of any changes in electricity prices that increase the available revenue surplus, thus allowing for additional compensatory measures to respond to noise, health and property value concerns.

5.1.8 Actions Needed to Move this Forward

The WTOP recommends that if this option is selected, additional acoustical measurement be conducted, using a firm and methodology acceptable to all stakeholders. The MassCEC has offered to provide additional sound testing, and the WTOP recommends the Town avail itself of that offer. Data collected will help inform the Town about compliance with DEP requirements, Town of Falmouth bylaws, and international standards. The WTOP recommends the following conditions

involving additional noise testing: All data collected should be publicly posted on the Town's website to facilitate third party review. Continuous measurements of the wind turbine sound at selected locations during a full range of weather and operating conditions for an extended period, such as six months to a year should be conducted. These measurements would include documentation of amplitude-modulated sound, low-frequency-sound, and infrasound, according to Annex A of the IEC 61400-11 standard, as recommended by the WTOP consultants, DNV Kema (page 22, 3/15/2012 report) and Acentech (page 3, 3/15/2012 report).

Given DNV Kema and SEA's financial projections, and depending upon the number of properties to purchase and total cost to the Town for each, it seems likely that additional money will be needed to cover the costs of mitigation. Moving this package forward would also require commitment of a funding source to cover the gap between the costs for purchasing homes and other mitigation measures and revenues from operating the turbines.

5.1.9 Request for Financial Assistance

The WTOP recommends that the Town seek the value of the additional costs for home purchases and other mitigations from the State, and or other sources, once that amount is determined.

5.2 Curtailed Operation

The WTOP examined a range of curtailment scenarios, and selected two approaches as the most promising to forward to the Board of Selectmen. These are described here as 5.2.1) “Break-even” Curtailment and 5.2.2) 12-hour Curtailment.

5.2.1 “Break-even” Curtailment Scenario

5.2.1.1 Turbine Operation

Turbines would be curtailed such that the projected revenue produced by the turbines is equal to the projected costs. Input to and from WTOP participants suggested that evening, nighttime, and early morning curtailment offered the greatest benefit to the most people, so the break-even curtailment scenario focused on that timeframe. The group also looked at curtailing during higher wind speeds, but found that a break-even scenario designed around high wind speeds was unlikely to provide very much curtailment, since revenues are also greatest at higher wind speeds.

This package would also curtail the turbines during early morning hours, using a calculation designed to prevent any receptor¹⁹ from experiencing over 30 hours (worst-case²⁰) of shadow flicker, with 30 minutes added on each side of the time of the expected flicker to cover the whole home and maybe beyond. Since flicker curtailment for any one receptor will turn off the turbines and result in flicker curtailment for all, this flicker curtailment is estimated to result in minimal flicker exposure for any household – this is the intent of this option. Flicker curtailment was estimated by DNV Kema to be ~1% of total generation, or approximately 66 MWh per year.

Calculation of a “break-even” operational plan varies depending on the requirements for rebuilding a reserve fund and paying for electricity at the WWTF. It also changes year to year, as the revenues and costs for the turbines fluctuate (as explained in Section 4.6). Because actual costs and revenues are likely to vary (up or down) from the projections in any given year, analysis was provided in five-year increments. Therefore, this report attempts to look at two options that may be considered “break-even” under different assumptions of how the costs are defined. Both scenarios include payment of electricity at the WWTF.

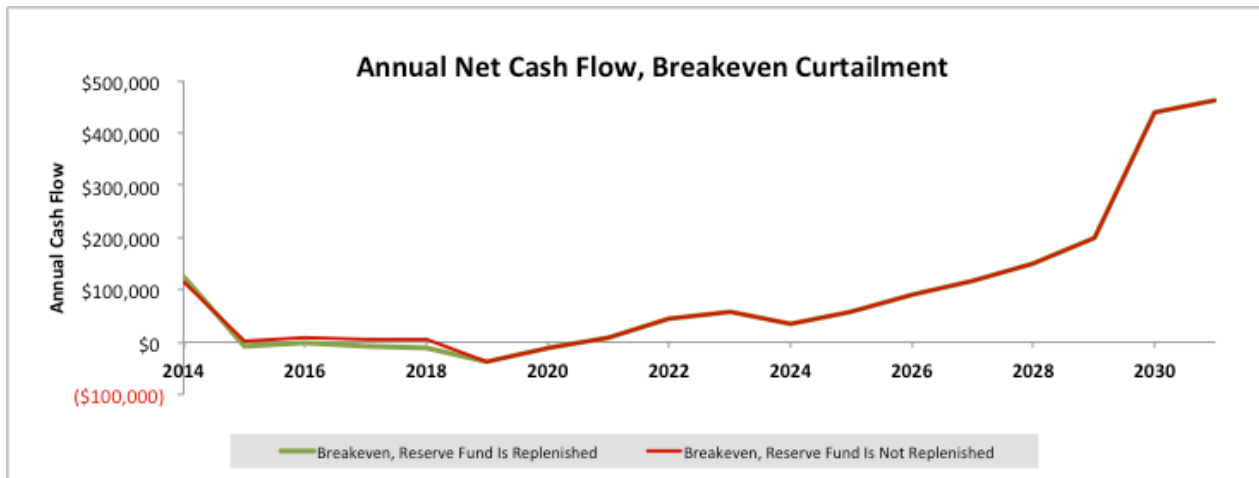
This analysis shows that, in scenario 1, if the turbines must generate sufficient revenue to rebuild a \$1M reserve fund and cover the costs of electricity at the WWTF, Wind 1 and Wind 2 could be curtailed only during the quietest hours of night (11:00 pm – 4:30 am) during the first 5-years (FY14-FY18). This would mean a curtailment of both turbines during the times when exceedances of DEP guidelines were reported for Wind 1, and which the noise model suggests might be needed to avoid possible exceedance of DEP guidelines for Wind 2. Both turbines would be further curtailed during early morning hours during parts of the year to avoid flicker. In scenario 2, if the rebuilding of a reserve fund were not required, the turbines could be curtailed between 10:30 pm – 7am (plus early mornings to prevent flicker) in those first five years. Between FY18-23, no matter whether reserves are rebuilt during the first five years, the energy production and financial projections suggest that the hours of curtailment could be 11 pm-7am (plus early mornings to prevent flicker) while still maintaining revenues that are equal to costs.

¹⁹ Receptor is defined as one square meter at human height level for each home.

²⁰ That is, not adjusted for actual weather conditions such as cloudiness or insufficient wind to operate the turbine.

The following table and chart show the financial/break-even operational projections over the first 5 years and the second 5 years, after payment of all costs and electricity used at the WWTF, under two different assumptions for the replenishment of reserve funds.

Operating Scenario if Revenue equals Cost, when Cost includes:	First 5-year Cumulative Estimate (FY14-FY18)	Second 5-year Cumulative Estimate (FY19-FY23)
With full contributions to reserve fund	Curtailed of turbines, 11:00-4:30 am, plus flicker	Curtailed, 11pm-7am, plus flicker
With no contributions to reserve fund	Curtailed 10:30-7 am, plus flicker	Curtailed, 11pm-7am, plus flicker



There may also be other acceptable “break-even” curtailment scenarios – such as increasing curtailment during summer, weekends, holidays, or other times that residents are more likely to be exposed to turbine noise.

If additional resources were available, even as an interest-free loan, (whether applied to the reserve fund, the WWTF electricity costs, or direct turbine expenses) curtailment times could be expanded. Lower reserve fund requirements would also allow for more curtailment, as demonstrated by the breakeven operating scenario in which reserve funds are not replenished.

5.2.1.2 Measures to Respond to Health, Noise, and Property Value Concerns

The purpose of curtailment is to respond to neighbors’ health and sleep concerns. As the premise of this package is a revenue-neutral approach, the package would not include additional measures to respond to the noise, health, and property value concerns of neighbors. However, if additional financial resources were available, these could be used to provide either additional curtailment or some compensatory measures.

5.2.1.3. Energy Impacts

The projected energy production from curtailing the turbines from 11 pm – 7 am averages 5078 per year, over 5 years is approximately 26,055 MWh of electricity. Over the 18-year life of the project, the energy production estimate is approximately 91,570 MWh. At about 0.44 tons of carbon per MWh, this would reduce carbon emissions by about 2234 tons of carbon per year.

	5-year Cumulative Estimate (FY14-FY18)	18-year Cumulative Estimate (FY14 -FY31)
Projected Energy Production for curtailment from 11 pm – 7 am	26,055 MWh	91,570 MWh

Alternative curtailment scenarios would change the energy production impacts, with the largest decreases in electricity production coming from curtailment during times and seasons when winds were highest.

5.2.1.4 Financial Impacts

The premise of this approach is to equalize the revenue and costs of the turbines, resulting in zero net financial impacts.

5.2.1.5 Impacts on Noise, Health and Property Value Concerns

In their testimony to the Board of Health, 40 out of 47 speakers stated that they suffered from sleep deprivation or fatigue. Many of those speakers also noted other health concerns. In the WTOP's informal survey, very few respondents indicated that curtailment would change their decision about whether or not to sell their homes. Statements to the WTOP by neighbors concerned about noise and health, and by their representatives on the WTOP, indicated that this level of curtailment does not adequately address their health and sleep concerns. These statements have pointed out that curtailment that does not include the full night would be insufficient to reduce the impacts of sleep loss, especially for children, who need more hours of sleep. Some neighbors have also stated that the temporary relief from operation does not lead to significant improvements in health and quality of life. Nonetheless, it is suggested by some members of the WTOP that this option may improve the health and quality of life for some neighbors, because sleep deprivation will be addressed to some degree, especially in the hours where ambient noise is lowest and especially after the first five years. The value of this option to neighbors' health increases as the hours of curtailment increase. Because this approach includes curtailment for shadow flicker, this option offers significant relief from shadow flicker.

The WTOP did not investigate whether curtailment of the turbines would have an impact on the property value concerns of turbine neighbors who were not experiencing health and noise concerns.

5.2.1.6 Uncertainties

The WTOP noted a number of uncertainties remaining regarding the feasibility and impacts of this package, including:

- Financial projections and the production estimates are uncertain and may vary by up to 21% in any given year (to reach 95% confidence);

- Whether operation of Wind 1 and Wind 2 together outside the hours of 9:00 AM to 4:00 PM would lead to exceedance of DEP noise guidelines;
- Potential future changes to noise guidelines and policies, including the outcome of the current legal case about the applicability of the Town's 40dB maximum noise bylaw;
- The potential for additional legal action taken against the Town; and,
- Increases or decreases in the cost of electricity, thereby changing the revenues accruing from the project.

5.2.1.7 Potential Future Additions/Variations

This package should include the future addition of any new technology that becomes available to reduce the absolute noise output or the noise character (i.e., amplitude modulation). This package can also take advantage of any changes in electricity prices that increase the available revenue surplus, thus allowing for additional curtailment, or other compensatory measures.

5.2.1.8 Actions Needed to Move this Forward

The WTOP recommends that, if this option is selected, additional acoustical measurement be conducted between 4pm and 11pm, and 4:30am to 9 am, with both turbines running, using a firm and methodology acceptable to all stakeholders. Some stakeholders believe that this testing should include the conditions described in section 5.1.8. The MassCEC has offered to provide additional sound testing, and the WTOP recommends the Town avail itself of that offer, and provide input from stakeholders into the selection of the acoustical consultant and sound testing, as well as data analysis protocols. Data collected will help inform the Town about compliance with DEP guidelines.

5.2.1.9 Request for Financial Assistance

The WTOP recommends that the Town seek the additional financial support from the State in order to replenish the reserve fund, forgive the REC contract with MassCEC to allow the Town to keep Wind 1 REC revenue, and/or provide additional support for curtailment.

5.2.2 12-hour Curtailment Scenario

5.2.2.1 Turbine Operation

Turbines would be curtailed from 7 pm to 7 am, and during additional early morning hours to curtail for shadow flicker.

5.2.2.2 Measures to Respond to Health, Noise, and Property Value Concerns

The purpose of curtailment is to respond to neighbors' health and sleep concerns. As this package would already result in a fiscal loss, the package would not include additional measures to respond to the noise, health, and property value concerns of neighbors. However, if additional financial resources were available, these could be used to provide additional compensatory measures.

5.2.2.3 Energy Impacts

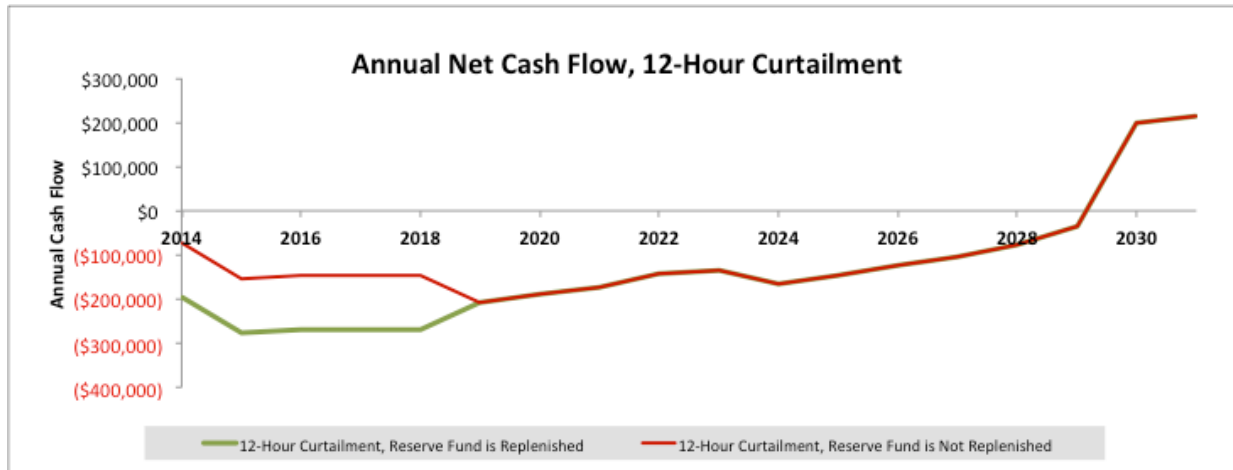
The projected energy production from curtailing the turbines from 7 pm to 7 am would average 3758 MWh per year. Over the first 5 years, this would be approximately 19,285 MWh of electricity. Over the 18 year life of the project, the energy production estimate is approximately 67,775 MWh. At about 0.44 tons of carbon per MWh, this would reduce carbon emissions by about 1654 tons of carbon per year.

	5-year Cumulative Estimate (FY14-FY18)	18-year Cumulative Estimate (FY14-FY31)
Projected Energy Production	19,285 MWh	67,775 MWh

5.2.2.4. Financial Impacts

The following table and chart show the financial projections for the projected cash flow from running the turbines from 7 am to 7 pm cumulatively over 5 years and 18 years, with additional curtailment for shadow flicker, after payment of all costs and electricity used at the WWTF, under a two different assumptions for the replenishment of reserve funds.

Available Revenue Surplus/ from Turbines	5-year Cumulative Estimate (FY14-FY18)	18-year Cumulative Estimate (FY14-31)
With full contributions to reserve fund	- (\$1.3 M)	- (\$2.4 M)
With no contributions to reserve fund	- (\$672 K)	- (\$1.8M)



5.2.2.5 Impacts on Noise, Health and Property Value Concerns

In their testimony to the Board of Health, 40 out of 47 speakers stated that they suffered from sleep deprivation or fatigue as a result of the turbines. Many of those speakers also noted other health concerns. In the WTOP's informal survey, very few respondents indicated that curtailment – even if provided 12-hours a day – would change their decision about whether or not to sell their homes. Neighbors' representatives and some other commenters to the WTOP stated that the temporary relief from operation does not lead to significant improvements in health and quality of life. Nonetheless, given the prevalence of complaints related to sleep concerns, some members of the WTOP feel that nighttime curtailment should offer significant improvement for many neighbors concerned about health and quality of life. For those most concerned about shadow flicker, those scenarios that include curtailment for flicker will offer significant relief.

The WTOP did not investigate whether curtailment of the turbines would have an impact on the property value concerns of turbine neighbors who were not experiencing health and noise concerns.

5.2.2.6 Uncertainties

The WTOP noted a number of uncertainties remaining regarding the feasibility and impacts of this package, including:

- Financial projections and the production estimates are uncertain and may vary by up to 21% in any given year (to reach 95% confidence);
- Available financial resources to pay for the costs of this operational scenario
- Potential future changes to noise guidelines and policies, including the outcome of the current legal case about the applicability of the Town's 40dB maximum noise bylaw; and,
- The potential for additional legal action taken against the Town.

5.2.2.7 Potential Future Additions/Variations

This package should include the future addition of any new technology that becomes available to reduce the absolute noise output or the noise character (i.e., amplitude modulation). This package can also take advantage of any changes in electricity prices that increase the available revenue surplus, thus allowing for less fiscal losses.

5.2.2.8 Actions Needed to Move this Forward

The WTOP recommends that additional acoustical measurement be conducted between 4pm and 7pm, and 7am to 9 am, with both turbines running, using a firm and methodology acceptable to all stakeholders. Some stakeholders believe that this testing should include the conditions described in section 5.1.8. The MassCEC has offered to provide additional sound testing, and the WTOP recommends the Town avail itself of that offer, and provide input from stakeholders into the selection of the acoustical consultant and sound testing and data analysis protocols. Data collected will help inform the Town about compliance with DEP guidelines.

Moving this package forward would also require commitment of a funding source to cover the gap between the costs and revenues for operating the turbines.

5.2.2.9 Request for Financial Assistance

The WTOP recommends that the Town seek financial support from the State or other sources in order to cover the gap between the costs and revenues for operating the turbines. This amount is estimated at \$2.4 Million dollars, over 18 years, assuming the need to replenish the \$1M reserve fund. The State or other sources might also support replenishment of the reserve fund and forgive the REC contract with MassCEC to allow the Town to keep Wind 1 REC revenue, thereby reducing the gap between costs and revenues.

5.3 Removal of Turbines or Removal of Turbines and Replacement with a Photovoltaic Array

This package includes the combination of two otherwise distinct components – removal and sale of the turbines and development of a PV array. Either of these components could be undertaken separately, and so the analysis in this report shows the impacts of doing so. Some members of the WTOP see both financial and environmental benefits in combining these two components into a single approach, and only when combined does this package approach the goal of addressing all the core concerns of all the stakeholder groups at the table. Meanwhile, other participants feel that these options may prove to be more financially viable when pursued separately. Therefore, this report provides information about the components of this package in a manner that allows the Town to examine their impacts individually, should the Town choose to explore them as such.

5.3.1 Turbine Operation

In the case of turbine removal (with or without development of PV), there would be no long-term turbine operation. The turbines would be sold and removed. Investigation by MassCEC suggests that the turbines should remain in their location and operational²¹ until the time they are purchased, to avoid the costs of removal and proper storage.

5.3.2 Measures to Respond to Health, Noise, and Property Value Concerns

Removal of the turbines (with or without PV development) would resolve all noise, health, and property value concerns of neighbors concerned about Wind 1 and Wind 2 over the long-term (once sold and removed.)

5.3.3 Energy Impacts

If turbines are removed without replacement by a PV array, the resulting long-term renewable energy production would be zero, (once sold and removed.).

In order to include a contribution to the Town's commitment to renewable energy and carbon reduction, the WTOP also investigated a scenario in which the Town would purchase a 2.0 MW Photovoltaic array to be erected at the Town's landfill or other location. The projected energy production from operation is estimated to average 2393 MWh per year, or 12,576 MWh of electricity over the first 5 years. Over the 25-year life of the project, the energy production estimate is 59,841 MWh. At about 0.44 tons of carbon per MWh, this would reduce carbon emissions by about 1056 tons of carbon per year over 25 years.

	5-year Cumulative Estimate	25-year Cumulative Estimate
Projected Energy Production	12,576 MWh	59,841 MWh

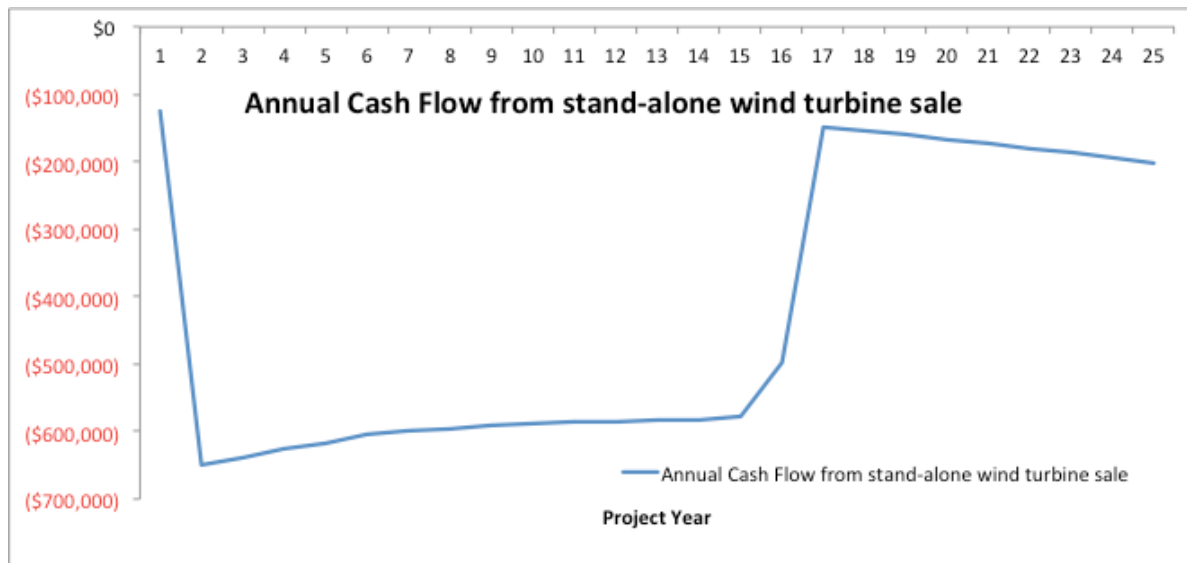
²¹ MassCEC recommends that the Town seek advice from Vestas as to what minimum level of operation would be necessary.

5.3.4 Financial Impacts

5.3.4.1 Costs and Revenues of Turbine Removal

The estimated financial impacts of removal and sale of the turbines includes the costs associated with the debt obligations for Wind 1, the cost of electricity at the WWTF, and removal costs for both turbines, minus the revenues from sale of the turbines. The debt obligations include the two bonds, including interest, for Wind 1 as well as the stipulated refund from the MassCEC REC contract. There are also costs associated with removal of the turbines; however, preliminary investigations by MassCEC into the resale market for V82 wind turbines suggest that a buyer would pay the costs of dismantling and transportation of the turbines. In addition, MassCEC found that resale might yield revenues of \$200 K - \$600 K for both turbines. The following table and graph summarize and illustrate the financial impacts of removing and selling Wind 1 and Wind 2 over a 5-year period and over the lifetime of the costs. Please note that these payback amounts assume yearly payments of debt obligations with substantial interest charges – some of these total amounts might be lower if they were repaid early or as lump sums. The WWTF electricity obligation is an annual expense that would need to be added to the annual operating budget.

Estimated costs for Turbine Removal and Sale:	5-year Cumulative Estimate (FY14-FY18)	18-year Cumulative Estimate (FY14-FY31)
Wind 1 Debt	-\$2 M	-\$5.6 M
Stipulated refund for MA CEC REC Contract ²²	-\$548 K	-\$2 M
Electricity at the WWTF	-\$475 K	-\$2 M
Resale	\$200 - \$600 K	\$200 - \$600 K
TOTAL	-\$2.8 - \$2.4 M	-\$9.4 - \$9M



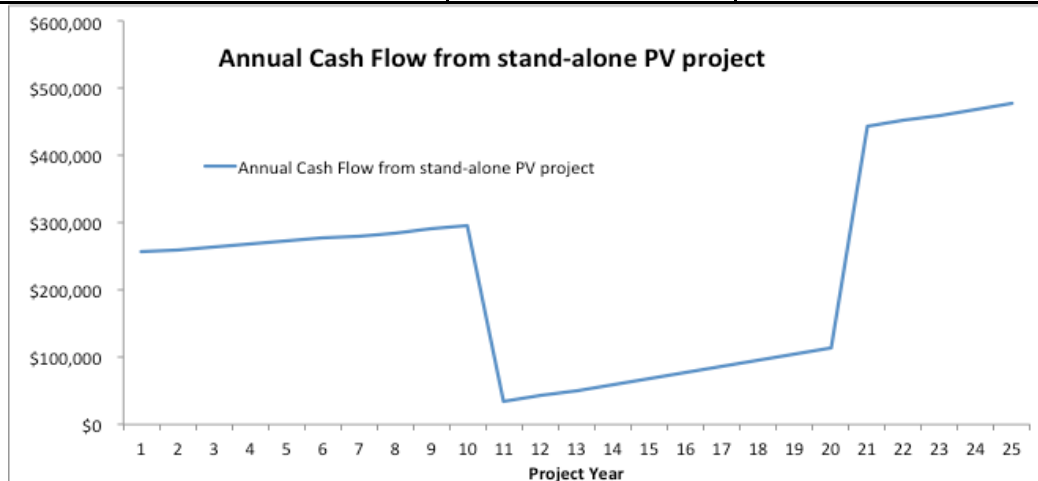
²² MassCEC prepaid for RECs from Wind 1. The funds would need to be repaid to MassCEC.

5.3.4.2 Costs and Revenues of PV Array

The estimated financial impacts of the development of a 2.0MW PV array are dependent on projections of the costs to purchase and install the array and projections of the energy produced, market value of that energy, and market value of the SRECs and RECs associated with the project. Projections for each of these components is calculated based on a range of variables, and the WTOP was presented with an analysis that explored the financial impacts under a range of assumptions about these variables.

The initial capital cost is estimated to be \$6 M to install a PV array. The base case assumes a 20-year municipal bond of \$6 M at a rate of 3.75%, selling S-RECs for \$150 for the first 10-years, then as RECs at \$40 (escalating at 2%) thereafter, an all-inclusive development/capital cost of \$3.00/W, and a 14.5% capacity factor. The following table and graph show the projected financial impact of this project, for the first 5-years and over the 25-year life of the project.

Assumption	5-year Cumulative Revenue Estimate	25-year Cumulative Revenue Estimate
Base Case	\$1.3 M	\$5.8 M

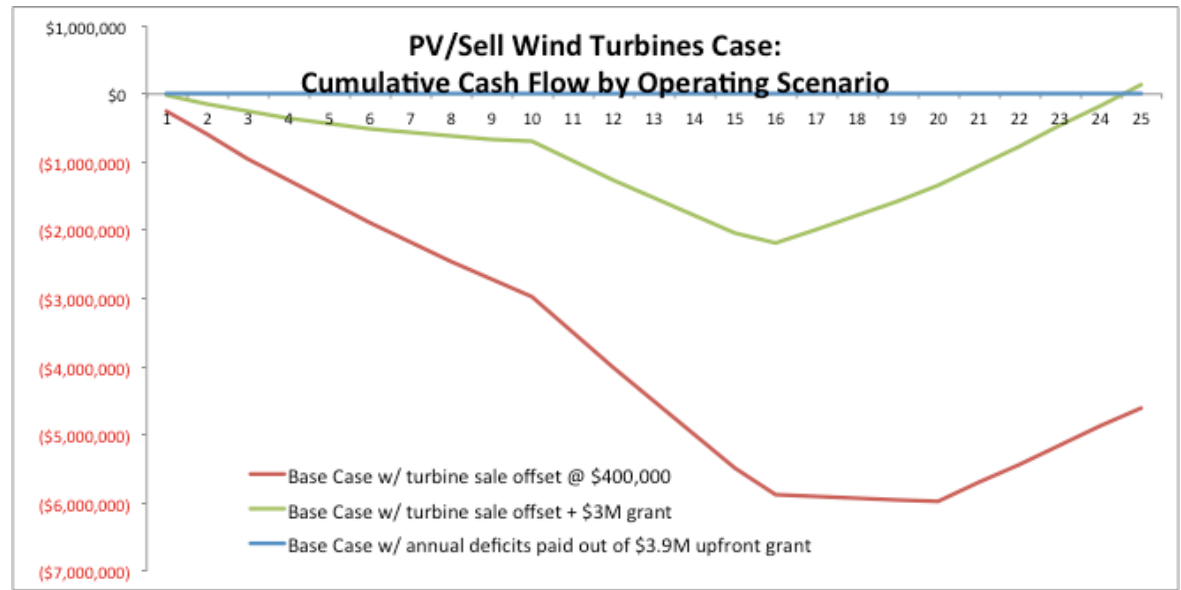
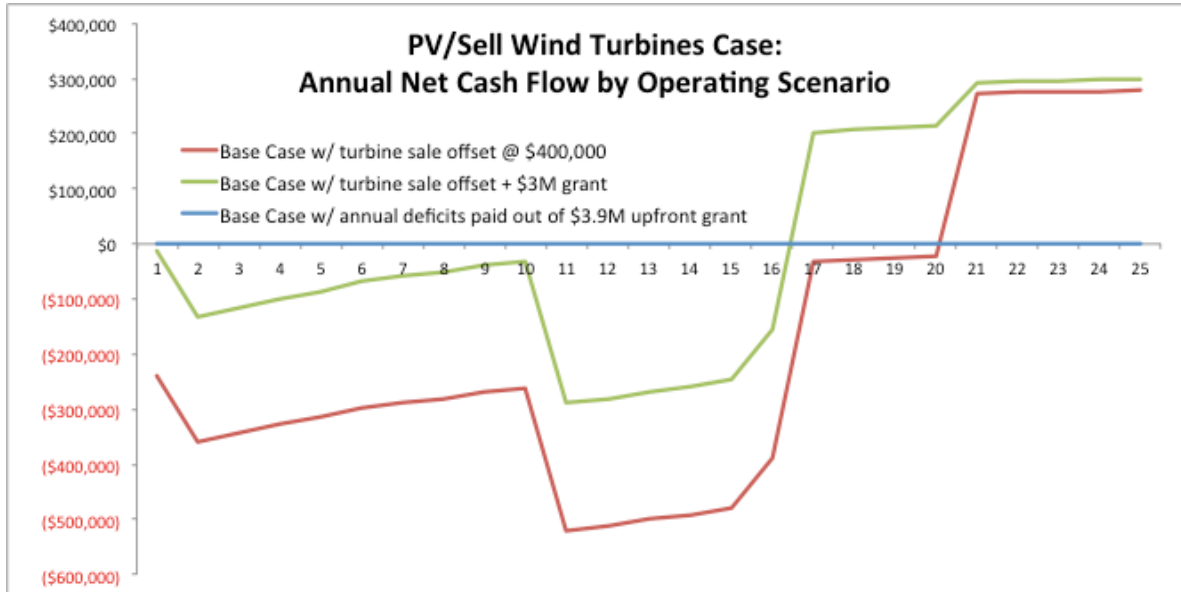


5.3.4.3 Combined Costs and Revenues of Turbine Removal and PV Development

The financial implications of removal and sale of the turbines and development of a PV array are based on a combination of the costs and revenues associated with each of these components. The following table shows the projected cash flow of turbine removal and PV deployment under two scenarios: the base case, assuming that revenues of \$400 K from the sale of the turbine are applied to the purchase of the PV; and the base case plus an additional \$3 M in up-front financial support which would be applied toward capital costs which enables PV project to achieve positive cumulative cash flow by year 25 (but still leaves annual operating deficit).

In order for the revenues of the PV array to cover the costs of its own operations and maintenance, its own debt obligation, the Wind 1 debt obligation, the WWTF electricity expense, and the Stipulated Refund owed to MA CEC, while avoiding negative cumulative cash flow, the Town would require upfront financial support of approximately \$3.9 M, which would be deposited into a reserve fund, (not applied toward capital cost) to cover annual expenses beyond cash flow generated by the PV project. This third scenario is included in the graph along with the previous two.

Turbine Removal and PV Deployment Case:	Cumulative Cash Flow Over Specified Period:	
	After 1 st 5 years	After 25 years
Base Case (including the revenues from turbine sale and PV revenues, minus the PV and turbine costs)	-\$1.6 M	-\$4.6 M
Base Case + \$3M financial support	-\$442 K	\$129 K



5.3.5 Impacts on Noise, Health and Property Value Concerns

Removal of the turbines (with or without PV development) would fully resolve all noise, health, and property value concerns of neighbors regarding Wind 1 and Wind 2.

5.3.6 Uncertainties

The WTOP noted a number of uncertainties remaining regarding the feasibility and impacts of this package, including:

- The actual amount for which the Town could sell Wind 1 and Wind 2
- The actual capital costs, capacity factor, and S-REC price for the PV array
- The likelihood of receiving upfront financial support to help pay for PV deployment and/or Wind 1 obligations
- The timeline for Town Meeting approval of borrowing required
- The timeline for development of PV for permitting, grid connection, and installation.

5.3.7 Potential Future Additions/Variations

The group didn't suggest any future additions or variations at this time.

5.3.8 Actions Needed to Move this Forward

Moving this package forward would require commitment of a funding source for the PV capital costs and/or Wind 1 debt obligations.

5.3.9 Request for Financial Assistance

If the removal of the Turbines is pursued, the WTOP recommends that the Town seek financial support to cover the cost of the bond payments for Wind 1, the stipulated refund to MassCEC, and the electricity payments at the WWTF, approximately \$8.9-\$9.3 Million.

If the combination of the turbine removal and purchase of PV is pursued, the WTOP recommends that the Town seek financial support to cover the difference between the costs of turbine and PV debt and the PV revenue, approximately \$3.9 Million. This financial support would be needed up front in order to go into reserve to cover the yearly costs of Wind 1 debt obligations, electricity costs of WWTF, MassCEC Rec repayments and development costs of PV array.

5.4 Financial Tables

Estimated Market Value of Production, by operating scenario

	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
24/7	\$1,206,189	\$1,020,936	\$1,014,316	\$990,748	\$977,290	\$967,102	\$995,602
12-Hour	\$610,516	\$517,756	\$514,391	\$502,668	\$496,062	\$491,121	\$505,502
Breakeven, Reserve Fund Is Replenished	\$929,397	\$787,119	\$781,991	\$763,990	\$753,778	\$661,419	\$680,812
Breakeven, Reserve Fund Is Not Replenished	\$797,412	\$676,041	\$671,620	\$656,275	\$647,614	\$661,419	\$680,812

TOTAL ANNUAL EXPENSE + CASH OBLIGATIONS --> WITH RESERVE REPLENISHMENT

	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
DNV KEMA Fixed O&M Estimates (total, both turbines combined)	(\$122,389)	(\$122,389)	(\$122,389)	(\$122,389)	(\$122,389)	(\$190,721)	(\$190,721)
Electrical Equipment Inspection & Maintenance	(\$11,038)	(\$11,314)	(\$11,597)	(\$11,887)	(\$12,184)	(\$12,489)	(\$12,801)
Insurance	(\$6,836)	(\$7,007)	(\$7,182)	(\$7,362)	(\$7,546)	(\$7,734)	(\$7,928)
Comcast Cable + Verizon Phone + Power Dash	(\$9,908)	(\$10,156)	(\$10,409)	(\$10,670)	(\$10,936)	(\$11,210)	(\$11,490)
Total FY Debt Service Obligation	(\$425,569)	(\$416,106)	(\$406,706)	(\$396,806)	(\$389,481)	(\$377,331)	(\$367,281)
(Contributions to), and Liquidation of, Reserve Accounts	\$130,548	\$130,548	\$130,548	\$130,548	\$130,548	(\$9,091)	(\$9,091)
TOTAL	(\$706,288)	(\$697,520)	(\$688,832)	(\$679,662)	(\$673,084)	(\$608,576)	(\$599,312)

TOTAL ANNUAL EXPENSE + CASH OBLIGATIONS --> WITHOUT RESERVE REPLENISHMENT

	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
DNV KEMA Fixed O&M Estimates (total, both turbines combined)	(\$122,389)	(\$122,389)	(\$122,389)	(\$122,389)	(\$122,389)	(\$190,721)	(\$190,721)
Electrical Equipment Inspection & Maintenance	(\$11,038)	(\$11,314)	(\$11,597)	(\$11,887)	(\$12,184)	(\$12,489)	(\$12,801)
Insurance	(\$6,836)	(\$7,007)	(\$7,182)	(\$7,362)	(\$7,546)	(\$7,734)	(\$7,928)
Comcast Cable + Verizon Phone + Power Dash	(\$9,908)	(\$10,156)	(\$10,409)	(\$10,670)	(\$10,936)	(\$11,210)	(\$11,490)
Total FY Debt Service Obligation	(\$425,569)	(\$416,106)	(\$406,706)	(\$396,806)	(\$389,481)	(\$377,331)	(\$367,281)
(Contributions to), and Liquidation of, Reserve Accounts	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)
TOTAL	(\$584,831)	(\$576,063)	(\$567,375)	(\$558,205)	(\$551,628)	(\$608,576)	(\$599,312)

Replacement Cost of Electricity Provided to WWTF

	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
Replacement Cost of Electricity Provided to WWTF	(\$100,019)	(\$96,771)	(\$94,800)	(\$92,453)	(\$91,247)	(\$90,403)	(\$94,120)
Retail Rate Escalation Index (from Production_Revenue file)	1.00	0.97	0.95	0.92	0.91	0.90	0.94

Free Cash Flow, WITH Reserve Replenishment

	2014	2015	2016	2017	2018	2019	2020
	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
No Curtailment, Reserve Fund is Replenished	\$399,882	\$226,645	\$230,684	\$218,633	\$212,958	\$268,123	\$302,170
12-Hour Curtailment, Reserve Fund is Replenished	(\$195,791)	(\$276,535)	(\$269,241)	(\$269,447)	(\$268,270)	(\$207,858)	(\$187,930)
Breakeven, Reserve Fund Is Replenished	\$123,090	(\$7,172)	(\$1,640)	(\$8,125)	(\$10,553)	(\$37,561)	(\$12,619)

Free Cash Flow, WITHOUT Reserve Replenishment

	2014	2015	2016	2017	2018	2019	2020
	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020</u>
No Curtailment, Reserve Fund is Not Replenished	\$521,339	\$348,102	\$352,141	\$340,090	\$334,415	\$268,123	\$302,170
12-Hour Curtailment, Reserve Fund is Not Replenished	(\$74,334)	(\$155,079)	(\$147,784)	(\$147,990)	(\$146,813)	(\$207,858)	(\$187,930)
Breakeven, Reserve Fund Is Not Replenished	\$112,561	\$3,207	\$9,445	\$5,617	\$4,739	(\$37,561)	(\$12,619)

5.4 Financial Tables

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
\$1,023,315	\$1,070,697	\$1,088,225	\$1,131,919	\$1,167,865	\$1,210,220	\$1,249,222	\$1,293,380	\$1,327,394	\$1,368,459	\$1,413,277
\$519,458	\$543,312	\$552,207	\$574,184	\$592,283	\$613,618	\$633,244	\$655,478	\$672,636	\$693,320	\$715,909
\$699,641	\$731,827	\$743,814	\$773,473	\$797,893	\$826,675	\$853,159	\$883,158	\$906,298	\$934,203	\$964,674
\$699,641	\$731,827	\$743,814	\$773,473	\$797,893	\$826,675	\$853,159	\$883,158	\$906,298	\$934,203	\$964,674

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
(\$190,721)	(\$190,721)	(\$190,721)	(\$245,396)	(\$245,396)	(\$245,396)	(\$245,396)	(\$245,396)	(\$297,500)	(\$297,500)	(\$297,500)
(\$13,121)	(\$13,449)	(\$13,785)	(\$14,130)	(\$14,483)	(\$14,845)	(\$15,216)	(\$15,597)	(\$15,987)	(\$16,386)	(\$16,796)
(\$8,126)	(\$8,329)	(\$8,537)	(\$8,751)	(\$8,969)	(\$9,194)	(\$9,423)	(\$9,659)	(\$9,900)	(\$10,148)	(\$10,402)
(\$11,777)	(\$12,072)	(\$12,374)	(\$12,683)	(\$13,000)	(\$13,325)	(\$13,658)	(\$13,999)	(\$14,349)	(\$14,708)	(\$15,076)
(\$361,856)	(\$348,956)	(\$341,159)	(\$332,100)	(\$327,738)	(\$317,850)	(\$312,600)	(\$301,988)	(\$217,875)	\$0	\$0
(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)
(\$594,692)	(\$582,618)	(\$575,667)	(\$622,151)	(\$618,677)	(\$609,701)	(\$605,385)	(\$595,730)	(\$564,702)	(\$347,833)	(\$348,864)

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
(\$190,721)	(\$190,721)	(\$190,721)	(\$245,396)	(\$245,396)	(\$245,396)	(\$245,396)	(\$245,396)	(\$297,500)	(\$297,500)	(\$297,500)
(\$13,121)	(\$13,449)	(\$13,785)	(\$14,130)	(\$14,483)	(\$14,845)	(\$15,216)	(\$15,597)	(\$15,987)	(\$16,386)	(\$16,796)
(\$8,126)	(\$8,329)	(\$8,537)	(\$8,751)	(\$8,969)	(\$9,194)	(\$9,423)	(\$9,659)	(\$9,900)	(\$10,148)	(\$10,402)
(\$11,777)	(\$12,072)	(\$12,374)	(\$12,683)	(\$13,000)	(\$13,325)	(\$13,658)	(\$13,999)	(\$14,349)	(\$14,708)	(\$15,076)
(\$361,856)	(\$348,956)	(\$341,159)	(\$332,100)	(\$327,738)	(\$317,850)	(\$312,600)	(\$301,988)	(\$217,875)	\$0	\$0
(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)	(\$9,091)
(\$594,692)	(\$582,618)	(\$575,667)	(\$622,151)	(\$618,677)	(\$609,701)	(\$605,385)	(\$595,730)	(\$564,702)	(\$347,833)	(\$348,864)

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
(\$97,784)	(\$103,784)	(\$110,779)	(\$116,429)	(\$121,193)	(\$126,754)	(\$131,964)	(\$137,828)	(\$142,503)	(\$148,076)	(\$154,142)
0.98	1.04	1.11	1.16	1.21	1.27	1.32	1.38	1.43	1.48	1.54

2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
\$330,839	\$384,295	\$401,779	\$393,339	\$427,994	\$473,765	\$511,873	\$559,822	\$620,189	\$872,549	\$910,271
(\$173,018)	(\$143,090)	(\$134,239)	(\$164,396)	(\$147,587)	(\$122,837)	(\$104,105)	(\$78,080)	(\$34,569)	\$197,410	\$212,903
\$7,166	\$45,425	\$57,368	\$34,893	\$58,023	\$90,221	\$115,810	\$149,600	\$199,093	\$438,294	\$461,668

2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031

<u>FY 2021</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>FY 2027</u>	<u>FY 2028</u>	<u>FY 2029</u>	<u>FY 2030</u>	<u>FY 2031</u>
\$330,839	\$384,295	\$401,779	\$393,339	\$427,994	\$473,765	\$511,873	\$559,822	\$620,189	\$872,549	\$910,271
(\$173,018)	(\$143,090)	(\$134,239)	(\$164,396)	(\$147,587)	(\$122,837)	(\$104,105)	(\$78,080)	(\$34,569)	\$197,410	\$212,903
\$7,166	\$45,425	\$57,368	\$34,893	\$58,023	\$90,221	\$115,810	\$149,600	\$199,093	\$438,294	\$461,668

5.4 Financial Tables

PV Cash Flow Analysis	Project Year	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
		1	2	3	4	5	6	7	8	9	10	11
Estimated Production (kWh)		2,540,400	2,527,698	2,515,060	2,502,484	2,489,972	2,477,522	2,465,134	2,452,809	2,440,545	2,428,342	2,416,200
Cash Flow from stand-alone PV project												
Base Case w/o turbine sale offset		\$256,347	\$260,166	\$264,098	\$268,145	\$272,310	\$276,595	\$281,000	\$285,529	\$290,182	\$294,963	\$34,090
Base Case w/ turbine sale offset @ \$400,000		\$286,732	\$290,591	\$294,564	\$298,653	\$302,861	\$307,190	\$311,641	\$316,216	\$320,917	\$325,746	\$64,923
Base Case w/ turbine sale offset + \$3M grant		\$514,619	\$518,777	\$523,057	\$527,462	\$531,993	\$536,653	\$541,443	\$546,366	\$551,424	\$556,618	\$296,171
Expenses												
Wind 1 Debt (P+), from FY'14 on		\$425,569	\$416,106	\$406,706	\$396,806	\$389,481	\$377,331	\$367,281	\$361,856	\$348,956	\$341,159	\$332,100
Est. WWTP Electricity Expense		\$100,019	\$96,771	\$94,800	\$92,453	\$91,247	\$90,403	\$94,120	\$97,784	\$103,784	\$110,779	\$116,429
Stipulated Refund from MA CEC REC Contract <i>(requires waiver of other contract provisions as well)</i>		\$0	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$137,004
TOTAL EXPENSES		\$525,588	\$649,881	\$638,510	\$626,263	\$617,732	\$604,739	\$598,405	\$596,644	\$589,744	\$588,942	\$585,533
Annual CF												
Base Case w/o turbine sale offset		(\$269,241)	(\$389,716)	(\$374,412)	(\$358,118)	(\$345,422)	(\$328,144)	(\$317,405)	(\$311,115)	(\$299,562)	(\$293,980)	(\$551,443)
Base Case w/ turbine sale offset @ \$400,000		(\$238,856)	(\$359,291)	(\$343,946)	(\$327,610)	(\$314,871)	(\$297,549)	(\$286,764)	(\$280,428)	(\$268,828)	(\$263,197)	(\$520,610)
Additional Financial Support (Options): Grant (deposited in escrow, not applied toward capital cost) to cover annual expenses beyond cash flow generated by PV project (NPV, @ 5%, of negative CF)		(\$10,970)	(\$131,105)	(\$115,453)	(\$98,801)	(\$85,739)	(\$68,086)	(\$56,962)	(\$50,278)	(\$38,320)	(\$32,324)	(\$289,362)
		\$3,870,852										
Base Case w/ annual deficits paid out of \$3.9M upfront grant (upfront grant assumed invested at 5% annual return)		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Grant, applied toward capital cost, which enables PV project to achieve positive cumulative CF by year 25 (but still leaves annual operating deficit)		\$3,000,000										
Cumulative CF												
Base Case w/o turbine sale offset		(\$269,241)	(\$658,956)	(\$1,033,369)	(\$1,391,487)	(\$1,736,908)	(\$2,065,052)	(\$2,382,457)	(\$2,693,572)	(\$2,993,134)	(\$3,287,113)	(\$3,838,556)
Base Case w/ turbine sale offset @ \$400,000		(\$238,856)	(\$598,147)	(\$942,093)	(\$1,269,703)	(\$1,584,574)	(\$1,882,123)	(\$2,168,887)	(\$2,449,316)	(\$2,718,143)	(\$2,981,340)	(\$3,501,949)
Base Case w/ turbine sale offset + \$3M grant		(\$10,970)	(\$142,074)	(\$257,527)	(\$356,328)	(\$442,067)	(\$510,152)	(\$567,114)	(\$617,392)	(\$655,712)	(\$688,036)	(\$977,398)
Annual Cash Flow from stand-alone PV project		\$256,347	\$260,166	\$264,098	\$268,145	\$272,310	\$276,595	\$281,000	\$285,529	\$290,182	\$294,963	\$34,090
Cumulative Cash Flow from stand-alone PV proje		\$256,347	\$516,513	\$780,611	\$1,048,756	\$1,321,067	\$1,597,662	\$1,878,662	\$2,164,191	\$2,454,373	\$2,749,336	\$2,783,426
Assumed Net Proceeds from Sale of Turbines		\$400,000										
Annual Cash Flow from stand-alone wind turbine :		(\$125,588)	(\$649,881)	(\$638,510)	(\$626,263)	(\$617,732)	(\$604,739)	(\$598,405)	(\$596,644)	(\$589,744)	(\$588,942)	(\$585,533)
Cumulative Cash Flow from stand-alone wind turb		(\$125,588)	(\$775,469)	(\$1,413,980)	(\$2,040,243)	(\$2,657,975)	(\$3,262,714)	(\$3,861,119)	(\$4,457,763)	(\$5,047,507)	(\$5,636,449)	(\$6,221,982)

5.4 Financial Tables

FY 2025 12	FY 2026 13	FY 2027 14	FY 2028 15	FY 2029 16	FY 2030 17	FY 2031 18	FY 2032 19	FY 2033 20	FY 2034 21	FY 2035 22	FY 2036 23	FY 2037 24	FY 2038 25
2,404,119	2,392,099	2,380,138	2,368,237	2,356,396	2,344,614	2,332,891	2,321,227	2,309,621	2,298,072	2,286,582	2,275,149	2,263,773	2,252,455
\$42,383	\$50,821	\$59,407	\$68,144	\$77,034	\$86,080	\$95,283	\$104,648	\$114,177	\$443,591	\$451,786	\$460,128	\$468,621	\$477,265
\$73,267	\$81,758	\$90,398	\$99,190	\$108,136	\$117,240	\$126,503	\$135,929	\$145,520	\$446,213	\$454,474	\$462,883	\$471,444	\$480,159
\$304,898	\$313,783	\$322,826	\$332,032	\$341,402	\$350,940	\$360,649	\$370,531	\$380,590	\$465,876	\$474,629	\$483,542	\$492,619	\$501,864
\$327,738	\$317,850	\$312,600	\$301,988	\$217,875	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
\$121,193	\$126,754	\$131,964	\$137,828	\$142,503	\$148,076	\$154,142	\$160,292	\$166,649	\$173,100	\$179,967	\$187,126	\$194,525	\$202,203
\$137,004	\$137,004	\$137,004	\$137,004	\$137,004	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
\$585,935	\$581,608	\$581,568	\$576,820	\$497,382	\$148,076	\$154,142	\$160,292	\$166,649	\$173,100	\$179,967	\$187,126	\$194,525	\$202,203
(\$543,552)	(\$530,786)	(\$522,160)	(\$508,675)	(\$420,348)	(\$61,996)	(\$58,858)	(\$55,644)	(\$52,472)	\$270,491	\$271,820	\$273,003	\$274,095	\$275,062
(\$512,667)	(\$499,850)	(\$491,170)	(\$477,630)	(\$389,245)	(\$30,836)	(\$27,639)	(\$24,363)	(\$21,130)	\$273,113	\$274,507	\$275,757	\$276,919	\$277,956
(\$281,036)	(\$267,825)	(\$258,741)	(\$244,788)	(\$155,980)	\$202,864	\$206,507	\$210,239	\$213,940	\$292,777	\$294,662	\$296,416	\$298,094	\$299,661
\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
(\$4,382,108)	(\$4,912,894)	(\$5,435,054)	(\$5,943,730)	(\$6,364,077)	(\$6,426,074)	(\$6,484,932)	(\$6,540,576)	(\$6,593,048)	(\$6,322,557)	(\$6,050,737)	(\$5,777,734)	(\$5,503,639)	(\$5,228,577)
(\$4,014,617)	(\$4,514,466)	(\$5,005,636)	(\$5,483,266)	(\$5,872,512)	(\$5,903,348)	(\$5,930,987)	(\$5,955,350)	(\$5,976,480)	(\$5,703,367)	(\$5,428,860)	(\$5,153,102)	(\$4,876,183)	(\$4,598,228)
(\$1,258,435)	(\$1,526,259)	(\$1,785,001)	(\$2,029,789)	(\$2,185,768)	(\$1,982,904)	(\$1,776,397)	(\$1,566,158)	(\$1,352,218)	(\$1,059,442)	(\$764,780)	(\$468,363)	(\$170,269)	\$129,391
\$42,383	\$50,821	\$59,407	\$68,144	\$77,034	\$86,080	\$95,283	\$104,648	\$114,177	\$443,591	\$451,786	\$460,128	\$468,621	\$477,265
\$2,825,809	\$2,876,630	\$2,936,038	\$3,004,182	\$3,081,216	\$3,167,295	\$3,262,579	\$3,367,227	\$3,481,404	\$3,924,996	\$4,376,782	\$4,836,910	\$5,305,531	\$5,782,796
(\$585,935)	(\$581,608)	(\$581,568)	(\$576,820)	(\$497,382)	(\$148,076)	(\$154,142)	(\$160,292)	(\$166,649)	(\$173,100)	(\$179,967)	(\$187,126)	(\$194,525)	(\$202,203)
(\$6,807,917)	(\$7,389,524)	(\$7,971,092)	(\$8,547,911)	(\$9,045,293)	(\$9,193,369)	(\$9,347,511)	(\$9,507,803)	(\$9,674,452)	(\$9,847,552)	(\$10,027,519)	(\$10,214,644)	(\$10,409,170)	(\$10,611,373)

6. Options Considered but not Recommended at this Time

6.1 Sound Barriers and Berms

Sound barriers and berms refer to physical structures used to block sound by diffracting the sound waves moving directly from the sound source to a defined location. To effectively reduce sound levels, sound barriers and berms must be placed directly between the sound source and the sound receiving location. Large concrete walls constructed between highways and neighborhoods are common sound barriers used to limit highway sounds from reaching neighborhoods. Berms function similar to the concrete walls, but are constructed of earthen fill materials.

Sound barriers are infrequently used to reduce the sound produced by turbines. Since wind turbines are constructed high above the ground, placing barriers between a turbine and a sound receiving location is challenging, but not impossible. Very tall sound barriers and berms would need to be constructed to disrupt the sound waves moving from the turbine to a receiver location.

Weston and Sampson investigated the potential to construct sound barriers to reduce noise conditions at two homes in Falmouth. For one of the locations, the investigation concluded 41-foot tall barrier would be needed to reduce sound levels between 7 to 9 decibels on the first floor of the home. If noise reduction on the second floor of the home were desired, it would require a 50-foot tall wall. If a 50-foot earthen berm were used in this location, it would have a 200-foot wide base. To reduce the sound levels at the four homes located nearest to Wind 1, Weston and Sampson estimated a 41-foot tall wall constructed at a length of approximately 900 feet would be needed and would cost approximately one to two million dollars.

Due to the costs, scale, and limited sound-reduction value, the WTOP decided this was an impractical mitigation option and should not be considered further.

6.2 Moving the Turbines

As described in the data section, the WTOP considered the possibility of moving the turbines to a new location. The WTOP does not recommend this option because of the empathy for the people living in nearby housing on MMR who might experience potential impacts, the amount of time it would take to implement, the expense associated with deconstructing and reconstructing the turbines, and the denial of FAA approval, necessary state and local permits, easements for access to adjacent lands, interconnection ability and costs, among others.

6.3 Mechanical Alterations to Reduce Noise

As described in the data section, the WTOP learned that there are no existing mechanical options commercially available to reduce the sound of the Town's V82 turbines. The WTOP concluded that the Town did not have the time, expertise, or resources to evaluate or implement any options that were not market-ready, commercially available, and able to be implemented without Vestas' support, and this ruled out all the mechanical options they had explored for reducing turbine noise.

However, the group agreed that if such technologies or devices were to become available in the future, the Town should certainly consider them.

6.4 Legal Action Against Engineers, Contractors, and Consultants

During the initial brainstorming of options, participants suggested the potential for the Town to take legal action against the technical experts who provided them with information, advice, and/or recommendations in siting the turbines. Participants asked about whether there might be errors or omissions within the studies conducted, and whether all critical studies and examinations were completed. After discussion, the group agreed that, because of its public nature, the WTOP was not the appropriate forum for an exploration of potential legal action.

7. Statements from Stakeholder Groups

Climate Stakeholders Statement: Like many coastal communities, Falmouth is vulnerable to the dual threat of rising sea levels and intensifying storms. Climate change is an urgent matter, with increasingly significant effects. If Hurricane Sandy had hit the Cape, a large fraction of Falmouth would have been underwater. The January 7 2013 *New York Times* published an article on warming in the United States, entitled “It’s Official: 2012 Was Hottest Year Ever in U.S.” Falmouth is likely to experience hurricane and storm damage, displaced people, and severe flooding in our grandchildren’s lifetime, if not sooner.

Another dimension of climate change is health. Water temperature and the acidity of the oceans are being altered, which in turn impacts the fisheries and shelled animals. According to researchers at Harvard Medical School, two-thirds (2/3) of the nitrogen deposited in U.S. East Coastal waters comes from burning coal. This loading of nitrogen from the atmosphere contributes to the 350 “dead zones” globally and harmful algal blooms that lead to illness, shellfish bed closures, and harm diminishing fisheries resources. Further, the Harvard study shows that the externalized costs of coal are between \$175 - \$523 billion per year, and that premature deaths directly caused by air pollution from electricity generation ranges from 13,000 - 34,000 deaths annually. These staggering numbers are published in “Full Cost Accounting for the Life Cycle of Coal” (2011 *NY Academy of Sciences*). **Much of our electricity comes from the nearby coal-burning Brayton Point station, which emits ~ 16,000 tons of CO₂ daily (EPA).** The neighbors to Wind 1 and Wind 2 continually state that the harm from these turbines is unacceptable even if it were to just one person. **It is a fact that has been well-researched, and documented for decades that fossil-fuel generated electricity causes real negative health impacts, and causes premature death to tens of thousands.**

The town’s reliance on fossil fuels is part of the problem. Every watt-hour of energy produced by renewables serves to reduce these carbon emissions. Wind 1 and Wind 2 are part of the solution. The town’s Climate Action Plan set a goal of reducing town greenhouse gas emissions by 10% over 2001 levels by 2010. Our wind turbines meet and exceed that goal, producing almost 7,500 MWh of clean electricity and offsetting 3030 tons of CO₂ annually (808 lb/MWh according to ISO-NE). Cape Cod has an extraordinary wind resource, among the best in New England, and a centuries-long history of industrial use of wind power. The town of Falmouth made a decision to erect its two municipal turbines because of our commitment to environmental stewardship and our desire to utilize of our town’s wind resource. These turbines help protect townspeople from the negative effects of the use of fossil fuels.

In terms of the risk of exceedances, none were found by the Mass DEP study of Wind 1 or Wind 2 during daytime hours. Moreover, the sampling protocol that the Mass DEP used, which found exceedances of the 10 dba state maximum level was flawed. The DEP violated their own protocols, and measured background over 2 hours before measuring the sound of the turbines + bkgd. When background levels were normalized for wind speed at the time the operational sound levels were measured, **no exceedances would have occurred.** This was brought to light by an independent expert review of DEP’s report. Another weakness of the report is DEP’s controversial new practice of comparing maximum operational sound level (Lmax), which includes an “average” background level, to a “minimum” ambient level (L90), which overstates the increase in ambient level. This concern was the topic of an email from Chris Menge of HMMH to several Town officials on 6/28/12.

The Climate Protection Stakeholders urge that the town continue to run the turbines, with or without curtailment. We also urge that the town move forward to determine the number of homes that would need to be purchased and other mitigations for the affected neighbors.

Fiscal Stakeholder Perspective: To ensure fiscal and community well-being, this stakeholder group recommends that the wind turbines continue to operate for the benefit of all and incur no costs to the town, citizens, or community at large.

The Falmouth Wind Turbine project has been under enquiry for over two years. Comments, statements and complaints have been well documented and aired across our community and beyond. Members of our government have been listening including the Boards of Selectmen, Planning and Health and Town Meeting. They listened and responded to the well-being of all residents.

- The process to own and operate the turbines took over eight years to complete and included multiple town meeting votes that received positive votes. The turbine project was not a back-door, behind the scenes project; we knew all of the changes and costs before installation and it was met with overwhelming approval including some of the now remonstrating neighbors.
- The siting for the project is at one of the highest locations in town, on 300+ acres of municipal land at the sewage treatment plant, and surrounded by a highway, an industrial park, gravel and mulching operations, and the town's dump. The site also allows for direct energy usage from the turbines by the sewage plant and those residents in proximity to the turbines. It is the most appropriate site for this project. Questions have been made regarding the use of solar; to install solar to generate the same energy output and benefits as the turbines would require well over \$20 million and 24 acres of land/space.
- The project looked at several financial aspects including grant funding, availability of bond money, up-front payment for renewable energy credits, the potential for significant rise in energy costs for the town and within the region, and the availability of turbines. This is an important part of the fiscal operation and benefit of a project with a large capital expenditure. When the turbine project was initiated, it had overwhelming support across our community; an aspect it still enjoys today despite the scrutiny.
- Fiscal well-being means community well-being and commitment to the general public. When the town is able to support our police and fire departments, provide human services, maintain roads, update water infrastructure, provide sound education, and allow citizens the ability to go about their daily routine, it has met its commitment to community well-being and the public. Are we willing to forsake \$9,300,000 in our current economic state to meet the demands of so few (less than 50 out of 32,000+) in which there truly are other solutions? If the town has to divert revenue from the FY14 budget from the fire department, or close an elementary school, or be unable to update water lines to pay off the debt to remove the wind turbines, would it still be meeting its commitment to community well-being or public welfare? In our current economy, money is constrained and we need to look at all sources of revenue and provide a sound fiscal basis of spending to promote community well-being and provide for the public welfare.
- We will conclude with a few numbers as that is our perceived role: should the town decide to operate the turbines as much as permissible, the potential **free cash** over the next five years could be \$1.2 to \$1.8 million. Should the turbines operate under its current 12-hour curtailment, there could be a gain of \$500 to \$40,000 over the next five years. In contrast to taking the turbines down at a cost of up to \$9.3 million, curtailment provides a greater level of fiscal well-being. And it serves to meet most of the logged complaints. And it achieves what the Wind Turbine Options Analysis Process was trying to produce – viable alternatives to the future operation of Wind I and Wind II.

Health Impacted Neighbors Statement

The neighbors of Wind 1 and Wind 2 were shocked during the first days of operation to discover that the reality of living near the 1.65 Megawatt turbines was very different from what the town was told to expect. Two years later the Board of Selectmen initiated the WTOP “in response to the noise, safety and health concerns that were raised by members of the community.”¹ CBI summarized the problem in the following way, “neighbors living near the turbines report significant impacts to their health, well-being, and quality of life. Most of the affected neighbors describe these impacts as “profound,” impairing their health, sleep, and enjoyment of their homes and properties.”²

Early in the process, the WTOP acknowledged the likely ineffectiveness of the current Mass DEP Noise Policy to evaluate and mitigate wind turbine noise. Increasing the hours of operation to meet a financial ‘break-even’ objective or to meet a literal interpretation of the DEP guidelines would be a significant blow to the health and welfare of the neighbors. There is no moral basis for deciding to expand the nighttime hours of operation. Four or five hours of uninterrupted sleep are certainly not enough to maintain good health. The Acentech noise model clearly indicated that Wind 1 and 2 operating together will likely exceed DEP guidelines and the Falmouth Windmill bylaw at multiple locations beyond 12AM to 4AM (sec. 4.2.3.).

The WTOP fully explored the options available and found no feasible way to resolve the negative impacts on the neighbor’s health, well-being and property values in any meaningful way other than by removing the people (buying homes) or removing the turbines. The cost of removing the turbines and replacing them with a photovoltaic array is estimated to be \$3.9 million. Acentech was tasked with estimating the number of properties which would need to be purchased in order to run the turbines with no curtailment. They did not provide that estimate. When asked to consider how many properties would require testing to confirm the exceedences indicated by the Acentech noise model, Tony Rogers replied to Stacie Smith; “DNV KEMA suggests that the number of houses to be considered for mitigation is between 20 and 40...” Based on the average price of homes in the area, the cost to purchase them would be in the range of \$8 -16 million.

Both options require substantial sums to implement. The neighbors believe that this is the fundamental decision faced by the Board of Selectmen. Raise the money required to decommission the turbines and resolve the problem, or raise a larger sum of capital to purchase homes. We do not see the option of buying homes to run the turbines uncurtailed as a viable solution. We prefer to remain in our homes and see being forced to abandon them as a tremendous loss which will only prolong the suffering of neighbors and the degradation of our community as a whole.

No one voted for a renewable energy project that would cause this kind of damage to the neighbors and the community. We recommend the Town pursue a solar energy project to achieve the original climate action goals, regain the trust and faith of the community, and offset the costs of this option with support from the state. The state, and particularly the MassCEC (formerly MTC), promoted this project. It is time they were asked to take responsibility for their recommendations. Senate President Theresa Murray, our State Representatives David Vieira and Timothy Madden, and recently Governor Duval Patrick, have all expressed a willingness to help Falmouth solve this daunting problem. It’s time to ask them to provide that help. Put the health and well-being of your neighbors first and ask for the financial help to remove these poorly sited turbines. The Board of Selectmen needs to put an end to the suffering, the testing, and the litigation. It’s time we put this disaster in the past and move the entire community forward in a positive direction.

Multiple Perspectives Statement

Jeffrey Oppenheim and Judith Fenwick and Linda Davis (alternate) – 10 January 2013

Overwhelmed by the task of synthesizing many months of discussions and complex information, we went back to the five core interests and concerns agreed upon in May 2012 by the WTOP and at the heart of the Group's work: 1) Health, safety and well-being of our neighbors; 2) property rights and economic impacts on property for abutters; 3) implementation of Falmouth's climate plan; 4) fiscal impacts on the town's taxpayers and town services; and 5) Town unity and reconciliation to achieve an amicable end to a conflict that has divided and challenged the town's relationships and reputation. Focusing on these core interests, we prepared a tool for our group to evaluate the 4 options presented by WTOP at the Nov. Town Meeting. This tool was sent to the 14 WTOP primary participants by us and the 3 Town employees, with a note on the tool's purpose and use (more below). We have questions remaining and many observations from our multiple perspectives. We have grappled with these questions and raise them here with our observations for your benefit.

First, what is in the best interest of Falmouth? We took the challenge of being empathetic to all interests to ensure a fair process, frankly a daunting role that was a naïve construct, albeit well intentioned at its inception. It has left us feeling torn between the hard lines of our fellow WTOP members. We voted enthusiastically as Town Meeting members for acquisition of the turbines and promised revenues. In retrospect we should have asked more questions during the acquisition phase that have now been raised because of the adverse impacts on our neighbors. We were remiss as individuals, and not informed enough as a community.

Second, how do we assess the relative weight of the 5 core interests? Should health, safety, and well-being of our neighbors carry the same weight as any of the four other interests? We conclude that it should be more heavily weighted above the other interests. Should town unity and reconciliation be weighted the same as climate action implementation or fiscal impacts? We conclude that town unity is second only to the health, safety, and well-being of our neighbors. If the Board of Selectmen seeks to end the tumult surrounding the turbines, then there is only one option.

Third, what have been the group's successes? We consider the group's commitment and tenacity in coming together to talk about wide ranging issues to be a success. As a group we did a reasonable job of gathering requested information in a cooperative spirit to get to the bottom of some factual issues, but the group was always hungry for more information. Generally, participants listened to one another, and some were more able to distinguish the subtleties of issues. Most were active listeners and active questioners. We have deliberated and discussed our way through more than 24 meetings over an 8 month period and still feel that the completion of our work has been rushed. We understand the need to bring closure to our part of the process. Yet, we have not concluded the process with a thorough, complete feeling. The overarching duel continues between the safety, health, and well being of our neighbors weighed against the quantifiable fiscal impacts for the town. What value will the Board of Selectmen assign to the health and well being of our neighbors?

Finally, what can we do to assist you, the Board of Selectmen, with digesting this report and making an informed decision? To this question we offer the answer and opportunity to complete a 1-page tool (referenced above), which we will give you. We recommend after WTOP's final report is presented and you have read it, that you use this evaluation tool in your deliberations. A similar evaluation was completed by 10 of the 14 Primary Participants in December to take a pulse and help distill a sense of the WTOP. That analysis won't be made public at request of some of our members, but one package did achieve clear dominance in acceptability. Your evaluations should be openly shared so that the community will know by what route you have come to your decision.

In closing and to move us forward, we offer this quote from a man whose leadership style is much prized these days: "I like to see a man proud of the place in which he lives. I like to see a man live in it so that his place will be proud of him." (*Abraham Lincoln, Oct. 1854, Peoria, Illinois*).

Property Value Concerned Neighbors Statement (James Luyten; Maurice Rowe, Alternate)

We chose to defer any specific discussion of property values on the 150 to 200 homes within a 3,000 foot radius of Wind 1 and Wind 2 for three reasons:

1. The health and noise issues were considered to be the top priority. (Craggy Ridge homeowner's survey confirmed this) and have been addressed.
2. Specific discussion and details of pricing and values would hurt early sellers regardless of long term trends, which will require years of sales and analysis.
3. The WTOP Open Meeting rules decision made all discussion of individual homes and trends public and would have hurt specific homeowner's sale prices.

Observations

1. The property tax department needs historical sales to adjust assessment values. Water view property value increase is an exception.
2. If water view premiums are reviewed by the tax department and assessed/adjusted regularly can we assume that Wind Turbine *visual stigma* will negatively affect property values?
3. *Visual Stigma* impact may be questioned in the short term, unless the town has already made adjustments. The question is at what distance will home property values be affected over time and by how much?
4. The *visual stigma* issue will likely impact the larger number of homes in Falmouth, even if health issues have a larger impact on fewer homes. It will take time to figure out which is more expensive.
5. Many studies on property value impact by wind farms have been done and the state is conducting its own at this time. A recent peer reviewed study is *Values in the Wind: A Hedonic Analysis of Wind Power Facilities*, Martin D. Heintzelman & Carrie M. Tuttle (*Land Economics*, July 16, 2011). In their conclusions, they find **"... that landowners, particularly those who do not have turbines on their properties and are thus not receiving direct payments from wind developers, are being harmed and have an economic case to make for more compensation."**
6. Property value decline appears largely due to site and turbine size selection and turbine distance to existing homes. See above study. Falmouth's site selection assessment seems to have ignored proximity to residences as a factor in the site selection process. The lack of review of the visual impact of the turbines on the West Falmouth Historic District only makes this omission worse.

Conclusion

If the Turbines remain in operation, it is likely that the property value issue will then begin in earnest and may only be resolved in court. If the Selectmen buy-out homes of health affected neighbors, the larger area encompassing 200+/- properties will become a *toxic* neighborhood, which may be the negative tipping point for their property values and fuel fair compensation? The arithmetic will not be tricky to prove by then and the conflict will hurt the town's finances and image for decades. This is just the beginning of calculating the total costs for the Wind Farm.

Town Employee Stakeholder Statement

Upon appointment by the town manager, 3 town employees entered into this consensus building process in hopes of finding a resolution that would be satisfactory to all stakeholders in the town. We firmly believe that any course of action regarding the wind turbines will eventually impact all residents of Falmouth to some degree. Therefore, as public employees, each of us tried to represent the interests of the public as a whole while bringing our government experience to the table.

There were a number of challenges to the work and to some degree these challenges have impeded the eventual outcomes of the process. 1) Many of us had the expectation that there would be considerable funds available (from the turbine revenue) for mitigation purposes. Not only is this not the case, but the urgent need to rebuild the reserve fund in order to stabilize the financial risk for the town and taxpayers has become blatantly evident. 2) The fundamental core interests identified at the outset of the WTOP were intentionally not ranked or weighted in terms of importance so as to avoid verbal sparring and advocating at meetings. While this facilitated the building of relationships and open discussion, decision making was hampered as time went on. 3) It became clear early on in the process that some stakeholders felt so profoundly impacted by the operation of the wind turbines, that they were unwilling to fully consider any options other than turbine removal. This made a compromise solution across interests unachievable through consensus means. 4) Finally, the ground rules which served to keep the discussions courteous also tended to stifle respectful challenging of individual assertions and, as a result, many stones were left unturned.

Despite the intense schedule of meetings over a 6 month period, there are a number of items that we wish we had time to explore further. Some of the sound and financial modeling by consultants was done quickly and seemingly superficially in order to give the group a quick sense of the answers we sought. As a result, there are times when the numbers seemed to be a moving target or they did not fully address the question at hand. More in depth analysis in these areas will be needed in order to fully comprehend the exact implications of any chosen course of action. Further scientific health studies are needed on a grand scale (not town) to identify and verify any causal relationship between turbine operation and the health concerns of neighbors in close proximity. The WTOP did not have the ability to explore the availability of financial support for mitigation purposes and/or debt payments. Every option will require a considerable infusion of capital to accomplish all the mitigation components. The need for outside financial assistance will be in the millions no matter what option is chosen so that Falmouth taxpayers are not burdened with large increases during this difficult economic time.

One certainty is that the Board of Selectmen must act quickly to determine a course of action to settle this controversy which has caused considerable discord and financial instability in our community. Combining strategies and/or mitigation options should be explored in order to leverage funds from all possible sources (i.e. private/public partnerships in the case of PV development). Finally, we believe the town government of Falmouth has the responsibility to closely monitor the turbine operations and its impact on neighboring residents over the life of the turbines.

Submitted by: David Bailey, Director of Assessing, Karen Cardeira, Director of Human Services and Robert Shea, Geographic Information System Coordinator

8. Appendices

8.1. CBI Resources

- 8.1.1. Revised Assessment Findings with Draft Recommendations (03/23/12)
- 8.1.2. Final Process Recommendations for the Falmouth Wind Turbines Options Process (04/19/12)
- 8.1.3. Presentation to Falmouth Town Meeting, (S. Smith, 11/13/12)

8.2. Resources and Reports Used by or Relied Upon by the WTOP

8.2.1. Acentech

- 8.2.1.1. Sound Mitigations Options Review and Recommendations, (E. Wood and J. Barnes, 7/24/12)
- 8.2.1.2. Monitor and Document Wind Turbine Sounds (E. Wood, 09/11/12)
- 8.2.1.3. Wind Turbines Sound Modeling, Falmouth, Massachusetts, (E. Wood and J. Barnes, 11/20/12)
- 8.2.1.4. Wind Turbines Sound Modeling Summary Presentation (E. Wood and J. Barnes, 11/20/12)

8.2.2. DEP

- 8.2.2.1. Attended Sampling of Sound from Wind Turbine #1, Falmouth, Massachusetts, (MassDEP, 05/2012)

8.2.3. DNV Kema

- 8.2.3.1. Wind Turbine Mitigation Options – Tony Rogers, DNV Kema (T. Rogers, 7/31/12)
- 8.2.3.2. Revised Wind Turbine Mitigation Options – Tony Rogers, DNV Kema (T. Rogers, 8/14/12)
- 8.2.3.3. Response To Additional Questions Memo (T. Rogers, 08/14/12)
- 8.2.3.4. Falmouth Shadow Flicker Summary (S. Meyer, 10/10/12)
- 8.2.3.5. Example Break-even Curtailment Scenario Memo (T. Rogers, 10/10/12)
- 8.2.3.6. Updated Wind Turbine Curtailment Scenarios (T. Rogers, 11/07/12)
- 8.2.3.7. Revised Updated Wind Turbine Curtailment Scenarios (T. Rogers, 11/27/12)
- 8.2.3.8. Updated Wind 1 Production Estimates Presentation (T. Rogers, 1/8/13)

8.2.4. Sustainable Energy Advantage

- 8.2.4.1. An Evaluation of the Revenue, Expenses, Production and Financial Performance of Falmouth Wind 1 and Wind 2 Under Multiple Operational Scenarios (T. Rogers and J. Gifford, 10/30/12)
- 8.2.4.2. Draft Revenue, Expense and Cash Flow Analysis Presentation (J. Gifford, 11/07/12)
- 8.2.4.3. Financial Analysis Objectives Presentation by Tony Rogers and Peter McPhee (J. Gifford, 11/28/12)
- 8.2.4.4. Draft PV Cash Flow Analysis (J. Gifford, 12/03/12)

8.2.5. Town of Falmouth

- 8.2.5.1. “Board of Health Turbine Testimony Locations”, Falmouth GIS map showing locations of Board of Health complaints in relation to the turbines, Fig. 1, Board of Health hearing, May 24, 2012 (B. Shea, 6/14/2012)
 - 8.2.5.2. Falmouth Board of Health Hearing Health Effects of Wind Turbines (05/24/12)
 - 8.2.5.3. Long Pond and Town Maps (B. Shea, 8/14/12)
 - 8.2.5.4. Contracts Relating to Wind 1 and 2 Presentation (7/10/12)
 - 8.2.5.5. ARRA Grant for Wind 2 (2/23/10)
 - 8.2.5.6. Brokerage Agreement (5/24/12)
 - 8.2.5.7. Interconnection Agreement Wind 1 (12/2/09)
 - 8.2.5.8. Interconnection Agreement Wind 2 (1/11/12)
 - 8.2.5.9. NSTAR Invoices (9/10 to 6/12)
 - 8.2.5.10. Powerdash Contract
 - 8.2.5.11. REC Agreement with CVEC (5/17/10)
 - 8.2.5.12. REC Agreement with MassCEC (7/29/09)
 - 8.2.5.13. Wind 1 Vestas Service Agreement (7/29/09)
 - 8.2.5.14. Wind 2 Vestas Service Agreement (9/9/10)
 - 8.2.5.15. Wind 1 Debt Repayment Schedule (Town of Falmouth, 10/10/12)
 - 8.2.5.16. Projected Financial (and Renewable Energy) Impacts of TM Art 9 (10/20/11, A. Lowell)
 - 8.2.5.17. Summary of Falmouth Energy Accounts (A. Lowell, 10/23/12)
 - 8.2.5.18. Climate Protection Action Plan (Falmouth, Massachusetts, 09/12/05)
 - 8.2.5.19. List of average tax increases should the town provide \$1- to \$5-million to solve the issue, (D. Bailey, 11/15/12)
- 8.2.6. MassCEC
- 8.2.6.1. Description of the MassCEC/Town of Falmouth REC Contract (N. Bolgen, 7/10/12)
 - 8.2.6.2. Net Metering Overview (N. Bolgen, 8/6/12)
 - 8.2.6.3. Site Evaluation and Development Process for the Falmouth WTOP memo (8/13/12)
 - 8.2.6.4. Site Evaluation and Development; Town Site Near MMR; Net Metering (N. Bolgen, 8/14/12)
 - 8.2.6.5. Shadow Flicker Impact Analysis for Falmouth’s Wind 1 and Wind 2 (P. McPhee, 10/3/12)
 - 8.2.6.6. PV System, Turbine Resale Value, Airspace Review, Acoustic Monitoring (N. Bolgen, 11/20/12)
- 8.2.7. WTOP/Other
- 8.2.7.1. List of WTOP Participants, Stakeholder Groups, Contact Info.
 - 8.2.7.2. Transcript of the Neighbors Statement of the WTOP (06/06/12)
 - 8.2.7.3. Falmouth Wind Turbine Option Analysis Process (WTOP) Final Operating Protocols (WTOP, 6/19/12).
 - 8.2.7.4. Turbines Relocation Maps (B. Shea, 7/10/12)
 - 8.2.7.5. Photovoltaics: Alternative Renewable Energy Option Overview (M. Amsler and S. Karplus, 8/6/2012)
 - 8.2.7.6. WTOP Fact Sheet (WTOP, 9/12/12)

- 8.2.7.7. Summary of Craggy Ridge Wind Turbine Survey Results (09/2012, Craggy Ridge Homeowners Association)
- 8.2.7.8. WTOP Presentation to the Craggy Ridge Neighborhood Association, Process Overview (L. Davis and J. Oppenheim, 9/22/12)
- 8.2.7.9. WTOP Notes from Craggy Ridge Meeting (L. Davis and J. Oppenheim, 9/22/12)
- 8.2.7.10. WTOP Falmouth Wind Turbine Neighbors' Survey Invitation Letter (11/02/12)
- 8.2.7.11. WTOP Falmouth Wind Turbine Neighbors' Survey (11/20/12)
- 8.2.7.12. WTOP Falmouth Wind Turbine Neighbor's Survey Analysis (11/20/12)
- 8.2.7.13. Falmouth Wind Energy Time Line (K. Cardeira with WTOP input, 01/10/13)
- 8.2.7.14. 11th International Meeting on Low Frequency Noise and Vibration and its Control, Netherlands (Van Den Berg, 09/2004)

8.3. WTOP Meeting Summaries:

- 8.3.1. May 30, 2012 – Meeting topics included an overview of CBI's involvement to date; assessment methodology and findings; process design; joint fact finding process; WTOP participation and representation.
- 8.3.2. June 6, 2012 – Meeting topics included stakeholder representation and strategies for increasing participation; Board of Selectmen's Statement of Principles; review the purpose of the process; potential options brainstorm; identification of data and information needs; distribution of draft operating protocols and groundrules.
- 8.3.3. June 12, 2012 – Meeting topics included defining the problem; stakeholder representation issues; process documentation and the WTOP website; budget implication of short-term turbine shut-down and Town data the WTOP would like to review; complaint maps; introduction of possible expert resources.
- 8.3.4. June 19, 2012 – Meeting topics included a statement from representatives of the neighbors; surveys to gather data; operating protocol review; discussion of potential options; information needs to analyze the option of relocating the turbines.
- 8.3.5. June 27, 2012 – Meeting topics included information needs for the turbine relocation option; information needs for the option of mechanical changes to address sound impacts; information needs for the noise control option; information needs for installing other renewable energy generation infrastructure.
- 8.3.6. July 10, 2012 – Meeting topics included information needs for turbine relocation option; potential relocation sites; information needs for mechanical changes to address sound impacts; considerations about designing a survey to collect data; information needs for the noise control option; information needs for installing other renewable energy generation infrastructure; turbine service agreements and warranties.
- 8.3.7. July 18, 2012 – Meeting topics included: Board of Health Testimony and Health Studies and future surveys and studies. Presenters in attendance: Dr. Gail Harkness.
- 8.3.8. July 24, 2012 – Meeting topics included turbine relocation's potential impact on base housing and issues with airspace; scientific overview wind turbines and sound measurements; noise mitigation options. Presenters in attendance: Tony Rogers and Eric Wood.
- 8.3.9. July 31, 2012 – Meeting topics included a review of the process; economic options for addressing the issue; mechanical options for addressing turbine sound including smart curtailment. Presenters in attendance: Tony Rogers.

- 8.3.10. August 6, 2012 – Meeting topics included smart curtailment; the option of installing a new renewable energy infrastructure in place of the turbines; draft community impact survey methodology and potential respondents.
- 8.3.11. August 14, 2012 – Meeting topics included the results of a survey completed by the WTOP to facilitate discussion of the community impact survey; unattained data and information needs; when and how to submit an article for Town Meeting; the option of moving the turbines; permitting and net metering. Presenters in attendance: Nils Bolgen.
- 8.3.12. September 12, 2012 – Meeting topics included the draft option analysis worksheets; total package cost; compliance with DEP guidelines vs. neighbors concerns; draft package A (maximum operation of turbines in compliance with DEP guidelines); draft package B (remove turbines and replace with different renewable energy infrastructure); key points the Town should discuss with the State.
- 8.3.13. September 19, 2012 – Meeting topics included the Town’s climate action goals; Vestas and FAA information request updates; the moving the turbines option; curtailment options; additional noise studies; Package A2 (curtailed operation to achieve tolerable noise levels).
- 8.3.14. October 3, 2012 – Meeting topics included a report on a meeting of the Craggy Ridge Neighborhood Association; shadow flicker analysis; financial/economic data; break-even scenario analyses. Presenters in attendance: Peter McPhee.
- 8.3.15. October 10, 2012 – Meeting topics included Package A2 (maximum operation while complying with DEP guidelines); figures used to calculate curtailment scenarios; guidelines for recalculating curtailment scenarios; the meeting with the neighbors of Blacksmith Shop Road.
- 8.3.16. October 16, 2012 – Meeting topics included the Energy Receipts Reserved Fund; cost predictions; Package A2 (maximum operation while complying with DEP guidelines) vs Package A3 (curtailed operation to meet tolerable noise levels); challenges of purchasing homes as a mitigation option; estimating and funding mitigation expenses.
- 8.3.17. October 23, 2012 – Meeting topics included the Massachusetts Department of Environmental Protection’s Falmouth Wind Turbine test results; Package A1 (maximum operation in compliance with DEP guidelines); differences between Package A1 and A2; survey to estimate potential mitigation costs. Presenters in attendance: Martin Suuberg and Laurel Carlson.
- 8.3.18. October 30, 2012 – Meeting topics included an evaluation of the revenue, expenses, production and financial performance of the turbines under different operational conditions; turbine resale; potential forms of compensation for affected neighbors; review and revision of survey to estimate potential mitigation costs; Board of Selectmen bylaw related to wind energy. Presenters in attendance: Nils Bolgen.
- 8.3.19. November 7, 2012 – Meeting topics included the option of moving the turbines; draft break-even and curtailed operation scenarios; draft revenue, expense and cash flow analysis. Presenters in attendance: Tony Rogers and Jason Gifford.
- 8.3.20. November 20, 2012 – Meeting topics included the results of the survey to estimate potential mitigation costs; Acentech noise modeling and mapping results; options for installing a photovoltaic array in place of the turbines; turbine resale; FAA update; acoustic monitoring update. Presenters in attendance: Nils Bolgen, Eric Wood and Eric Roberts.

- 8.3.21. November 28, 2012 – Meeting topics included updated break-even and curtailed operation scenarios; updated revenue, expense and cash flow analysis; updated photovoltaic array cash flow scenario analysis; Package A; additional noise studies; Package B. Presenters in attendance: Tony Rogers and Peter McPhee.
- 8.3.22. December 18, 2012 – A meeting summary was not produced because the objective of the meeting was to revise and edit the first draft of the recommendations report.
- 8.3.23. January 8, 2013 – A meeting summary was not produced because the WTOP revised and edited the second draft of the recommendations report. Further revisions of the financial analysis were also discussed.
- 8.3.24. January 9, 2013 – A meeting summary was not produced because the WTOP revised and edited a third draft of the recommendations report. Further revisions of the financial analysis were also discussed.
- 8.3.25. January 15, 2013 – A meeting summary was not produced because the WTOP revised and edited the recommendations report. Further revisions of the financial analysis were also discussed.