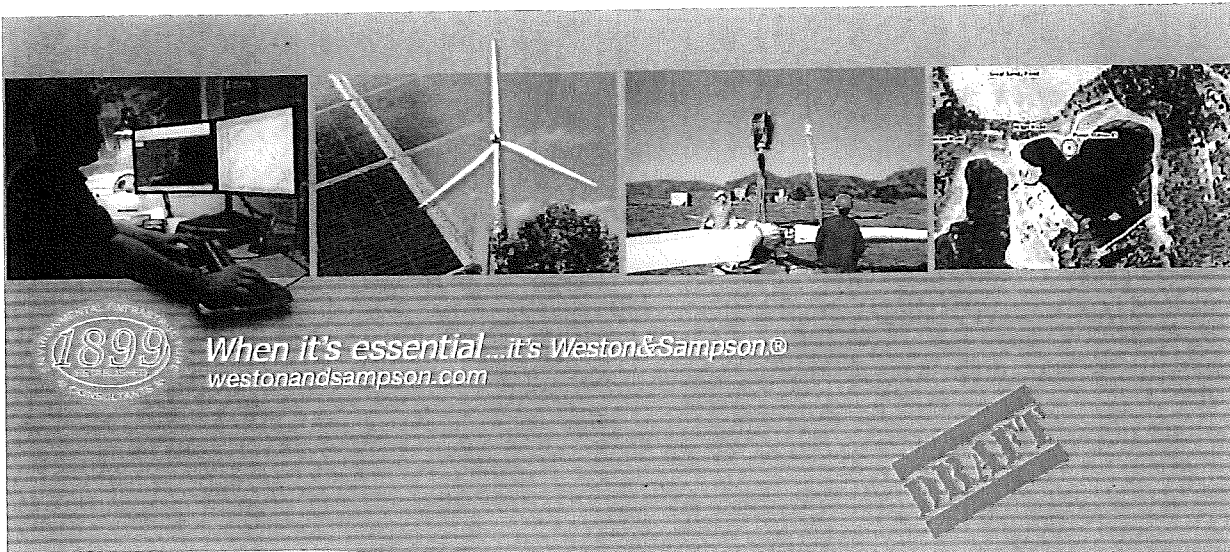


**APPENDIX E – MILLBURY MASSACHUSETTS
WIND TURBINE FEASIBILITY STUDY EXECUTIVE SUMMARY**

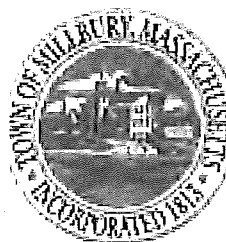
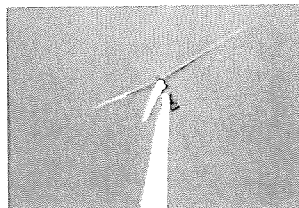
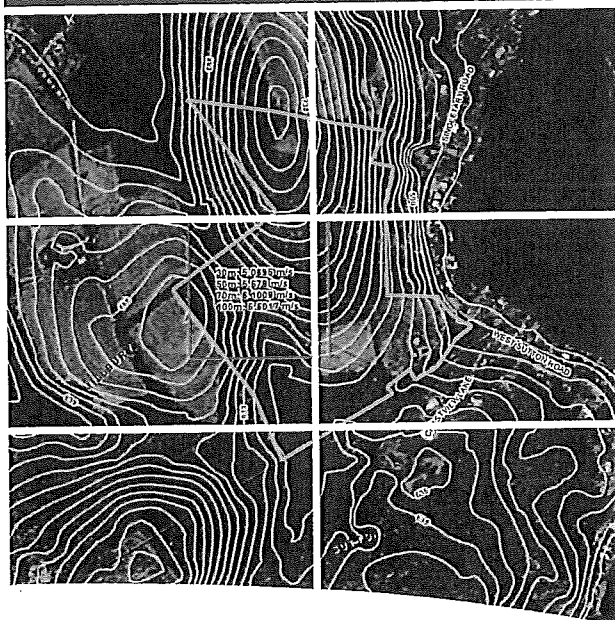


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report



Millbury
Massachusetts

Wind Turbine Feasibility Study
January 2011

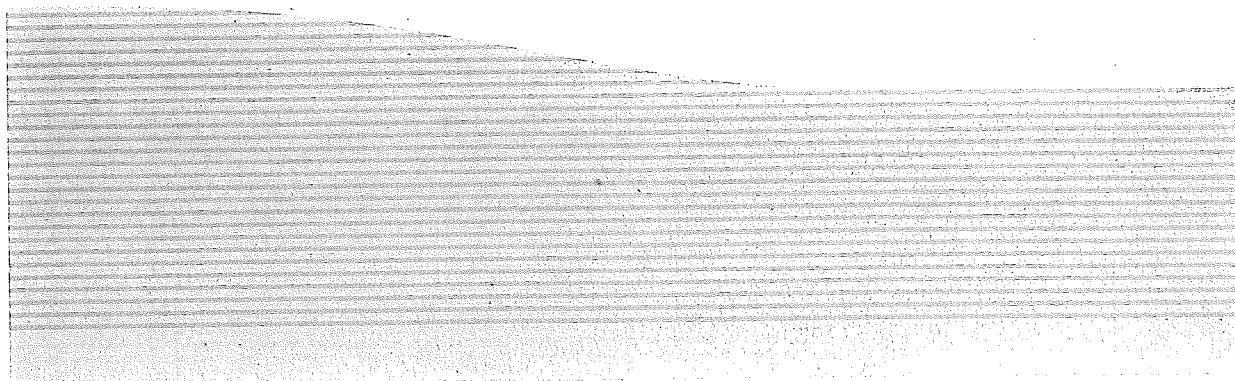


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EXECUTIVE SUMMARY

A feasibility study has been completed for the proposed construction of one large scale wind turbine in the Town of Millbury, Massachusetts. The following report presents a comprehensive review of the critical factors and considerations analyzed as part of the feasibility for installing a wind turbine at the Butler Farm property located at 44 Singletary Road. This feasibility study incorporated thorough evaluation of virtual MET mast and existing published wind data; electrical usage, consumption and generation; economics; environmental, avian and noise impacts; engineering assessments and permitting issues towards development of a commercial-scale wind turbine.

The feasibility study addresses the technical and economic feasibility of construction of one 100 kW to 1.8 MW wind turbine within Millbury. Construction of the wind turbine would offset electrical consumption at multiple Town-owned facilities through virtual net metering. Based on the results of this study, installation of a wind energy conversion facility is considered technically viable, with favorable wind resources and adequate electrical demand town-wide to justify development of a wind turbine in the Town. Long-term wind speed of 6.5 meters per second, at a height of 80 meters, is estimated for the Butler Farm Site. Predicted wind speeds are considered favorable for development of a commercial scale wind turbine at the Butler Farm Site. Aesthetic concerns and the degree of public support or opposition is a potential limiting factor.

The cost for design, permitting, procurement and construction of a single 100 kW to 1.8 MW wind turbine is on the order of \$2,700 to \$10,300 to per kW. A project of this size is therefore estimated to cost on the order of \$1,032,000 to \$4,558,000. The standard figures of merit, including: Net Present Value, Net Cash Flow, Benefit to Cost Ratio and Internal Rate of Return are all positive for the 1.5 MW and 1.8 MW turbines evaluated, suggesting development of one of these size turbines is economically viable. Gross capacity factors range from 18.1% to 26.0% based on an average wind speed of 6.5 m/s at a height of 80 meters based on 3Tier Virtual MET mast data for the Butler Farm Site. Simple payback would be on the order of 8.9 to 18.2 years. Internal rates of return were estimated to be 3.0% to 10.8%. Benefit to cost ratios ranged from 0.27 for a 100 kW turbine to 1.62 for a 1.8 MW turbine. The project economics are improved when factoring the current possible grant funding from the Mass CEC, if determined eligible.

Based upon the above, it is our opinion that development of a large-scale wind turbine is both technically and economically viable. The next steps include an internal assessment by the Town of Millbury to make a "Go" or "No Go" decision on the project. This would include deciding upon a procurement strategy, partnerships with interested third parties (such as Mass CEC), and financing options. One of the first steps should be for the Town to obtain project entitlements for the land on which the proposed wind turbine will be located. If Millbury decides to develop the project under municipal ownership, then a draft Town Warrant article to authorize the debt incurred should be considered. Project permitting could also begin including obtaining a special permit or variance; filing with the USFWS, Natural Heritage, Massachusetts Historical Commission; and filing an electrical interconnection application.

would be able to get rebates equivalent to those provided in MassCEC's Commonwealth Solar II program available at the time⁴. Over the course of the pilot, MassCEC conducted regular conference calls with participating community representatives to track progress and share tactics.



Figure 2. The four communities participating in the Solarize Mass Pilot and corresponding town populations (2010 Census).

After the towns were selected in late April, MassCEC began a public education campaign, hosting Solar 101s in each of the selected communities to educate residents on solar PV. While MassCEC was hosting these information events, it also issued a Request for Proposals (RFP) to solar PV installers. This RFP requested bids to become the Solarize Mass designated installer for one or more of the four participating communities. Applicants were required to have prior experience installing solar PV systems in Massachusetts, offer both a direct purchase and a leasing/power purchase agreement option and a competitive tiered pricing model. In addition, input from the participating community was considered during the proposal review. After a competitive selection process, New England Breeze Solar was selected to partner with the town of Harvard, Alteris Renewables (now Real Goods Solar) was selected to partner with the towns of Winchester and Hatfield, and Munro Distributing Company was selected to partner with the town of Scituate.

MassCEC met with building department officials in the four communities and discussed means of streamlining the building and electrical permitting process, and whether a flat permitting rate could be offered. All communities recognized the need to streamline the permitting process. As a result, the communities worked with building department officials to clarify their permitting process. In addition, the communities of Harvard, Hatfield and Scituate established lower flat rates for residential solar PV building and electrical permits (as seen below in Figure 3). Winchester had an existing permitting fee structure and decided to keep it the same.

| Town | Building Permit | Electrical Permit |
|------------|------------------------------|-------------------|
| Harvard | \$125 fixed | \$36.00 fixed |
| Hatfield | \$100 fixed | \$50.00 fixed |
| Scituate | \$150 fixed | \$35.00 fixed |
| Winchester | \$15 per \$1,000 system cost | \$50.00 fixed |

Figure 3. Summary of permitting costs

⁴ The Commonwealth Solar II Rebate Program is funded on a quarterly basis, and rebates are awarded on a first come, first served basis, subject to funding availability. Solarize Massachusetts projects were subject to the same minimum technical requirements as those under the Commonwealth Solar II Rebate Program, which included shading and warranty requirements. For more information about the program, visit the website at www.masscec.com/solar.

After each installer was selected and introduced to community members, MassCEC and the selected installer hosted Solar 201 presentations in each town. These presentations included a recap of the informational Solar 101 presentation as well as specific information about the selected installer, the tiered pricing, and the process to sign up and contract for a solar PV project.

Throughout the pilot, MassCEC, the installer, and the local volunteer groups attended numerous community events to promote the program, and utilized various online and traditional communications channels to educate residents about solar PV and the opportunity presented by Solarize Mass.

Figure 4. Timeline of Solarize Massachusetts Pilot

| | |
|------------------------|---|
| 4/5/2011 | Pilot communities selected |
| 4/20/2011 | RFP released to the solar installers industry |
| 5/13/2011 | Installer proposals due |
| 5/23/11-5/31/11 | Solar 101 presentations in each of the four communities |
| 6/10/2011 | Selected installers for each community announced |
| 6/16/11-6/29/11 | MassCEC and chosen installers conducted Solar 201 presentations in each community |
| 7/1/2011 | MassCEC began accepting Solarize Mass rebate applications |
| 9/1/2011 | Solarize Mass pilot enrollment period was extended from 9/30/11 to 10/31/11 |
| 9/8/11-10/15/11 | Final Solarize Now events with communities and installers |
| 10/31/2011 | Last day to enroll in Solarize Mass |

Tiered Pricing Structure

The tiered pricing structure under the Solarize Mass model creates a mechanism to pass cost savings on to consumers, while creating an incentive for early adopters to help spread the word about the benefits of solar and become part of marketing efforts themselves.

One of the key features that distinguish the Solarize Mass Pilot from typical marketing and outreach of solar PV is the involvement of volunteers and public entities. By engaging in a community-wide effort, customer acquisition costs are reduced because the installer is able to reduce its investment in educating the public about solar PV. This creates a mechanism to ensure that the economies of scale are being passed along to the consumer and provides a financial incentive for individuals who have already contracted, or who are seriously considering contracting, to encourage their friends and neighbors to consider solar PV.

When the Solarize Mass Pilot RFP was issued to the installer community in May 2011, the average installed cost for residential and small-scale commercial systems in Massachusetts was \$6.00/Watt.⁵ Over the course of the pilot, the average installation cost in the state declined to \$5.72/watt. Pricing at Tier 1 started below the average installed cost for the duration of the pilot and continued to drop in successive tiers. The selected installers were not only able to provide competitive pricing at the beginning of the pilot, but their proposed pricing remained competitive over the course of the pilot, enabling them to stay ahead of industry-wide cost declines.

⁵ The average cost is based on applications received in the Commonwealth Solar II program. To see the most up to date cost information, go to www.MassCEC.com/solar

| Harvard | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|-------------------------------|-----------|--------------|--------------|--------|
| Contracted Capacity | 1kW-100kW | >100kW-200kW | >200kW-300kW | >300+ |
| Installed Price (\$/W) | 5.50 | 5.00 | 4.50 | 4.00 |
| Leased Price (\$/kWh) | 0.14 | 0.135 | 0.13 | 0.125 |

| Hatfield/Winchester | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|---|-----------|--------------|--------------|--------|
| Contracted Capacity | 1kW-100kW | >100kW-200kW | >200kW-300kW | >300+ |
| Installed Price (\$/W) | 5.08 | 5.03 | 4.98 | 4.93 |
| 3rd Party Pre-Paid (\$/W) | 2.88 | 2.86 | 2.81 | 2.78 |
| Leased Price (\$/kWh) | 0.108 | 0.104 | 0.10 | 0.096 |

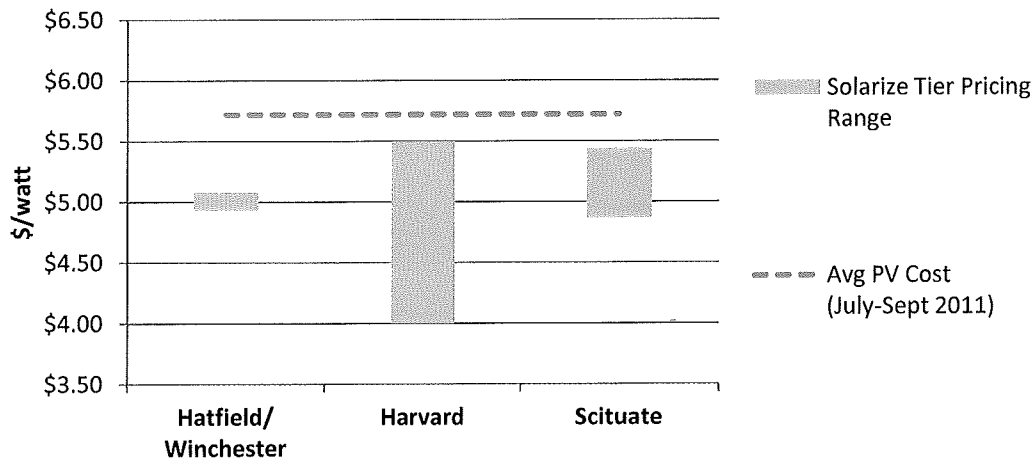
| Scituate | Tier 1 | Tier 2 | Tier 3 | Tier 4 |
|-------------------------------|-----------|--------------|--------------|--------|
| Contracted Capacity | 1kW-100kW | >100kW-200kW | >200kW-300kW | >300+ |
| Installed Price (\$/W) | 5.428 | 5.266 | 5.116 | 4.866 |
| Leased Price (\$/kWh) | 0.17 | 0.165 | 0.162 | 0.154 |

Figure 5. Tiered pricing structure for Solarize Mass.

To illustrate the effect of the tiered pricing, consider a hypothetical homeowner in Harvard who contracted for a 5,000 watt solar PV system at Tier 1 pricing of \$5.50/watt. The cost of the system before rebates and incentives would be \$27,500. Once 100 kW of capacity, or around 20 systems, were under contract in Harvard, all contracted systems in Harvard would get Tier 2 pricing of \$5.00/watt. The cost to the homeowner with the 5,000 watt system would then be reduced by \$2,500, to \$25,000. Since Harvard reached Tier 4, this homeowner would ultimately pay \$4.00/watt, or \$20,000 for the system. The tiered price reduction mechanism meant this hypothetical homeowner had a \$7,500 incentive to encourage friends, neighbors, and local business owners to consider purchasing or leasing a system during the pilot.⁶

⁶ The Installers bid a base price for each tier level, but they also specified instances where a project could result in higher costs. These were identified as “adders” and varied by project. Examples of adders included electrical upgrades at a site, building structural work, and costs associated with ground-mounted systems.

Figure 6. Tiered pricing structure.



Alteris Renewables, the installer for Hatfield and Winchester, offered an up-front 15 percent cost savings in their Tier 1 pricing, but had smaller price drops between each successive tier. New England Breeze, the installer in Harvard, began at a more modest \$5.50/watt, but with more aggressive price reductions. The tier structure for Scituate installer Munro Distributing was in the middle of these two tier models.

Community Outreach

The use of established, grassroots community groups to drive the marketing and outreach around solar PV is an effective strategy and is an essential piece of the Solarize Mass model.

In the Solarize Mass Pilot, the financial incentive provided by the tiered pricing structure was an important motivator for many residents. However, the work of promoting Solarize Mass, and facilitating communication between MassCEC, town officials, installers, and residents and business owners was carried out by a group of dedicated volunteers who lived in the community, most of whom were members of the town's energy committee or sustainability group.

To help spur grassroots marketing and activism around the program, MassCEC provided each community with an outreach toolkit – including banners, yard signs, bumper stickers, and other marketing materials— and framed the program as a friendly competition to achieve widespread solar adoption. Across the four pilot communities, Solar 101 presentations provided a starting point for the program, and focused on providing basic information about solar PV – what it is, how it works, where it works (and doesn't), what it costs, available incentives, and how the Solarize Mass Pilot would run. This was followed by a Solar 201 presentation, which introduced the selected installer to the community and provided detailed information about program participation, timelines, and processes.



Solarize Mass 4th of July Float. Harvard, MA.

Community volunteers lead a variety of outreach efforts that took advantage of the unique characteristics of their community. The community driven outreach strategies combined social media, media outreach, cable access television, visibility at town-wide events, and personal outreach by Solarize Mass volunteers and program participants. Figure 7 (below) shows examples of community volunteer activities undertaken in the four communities.

Figure 7. Summary of community marketing and outreach efforts

| | |
|-------------------|--|
| Harvard | <ul style="list-style-type: none"> Electronic survey of 1,100 households gauging initial community interest Pilot Community-wide email updates, community-wide direct mail Solarize float at local July 4 Parade, table at various community events, including the town parade and fireworks display, peach festival and town transfer station. News articles, ad and letters to the editor in the town newspaper, town webpage dedicated to Solarize, Solarize Harvard Facebook page and Google group discussion board. |
| Hatfield | <ul style="list-style-type: none"> Table at the Hatfield Fall Festival and Homecoming Flyers, direct outreach to neighbors and town contacts. Community-wide direct mail Solar 101 and 201 broadcast on public access TV channel and online |
| Scituate | <ul style="list-style-type: none"> Town flyers, a booth at heritage days, community outreach letter Articles and advertisement in town newspaper Community-wide email blasts Solarize Massachusetts flyer in town water bills Radio announcements |
| Winchester | <ul style="list-style-type: none"> Table at En Ka fair, Saturday farmers markets, Town Day, and environmental fair Community-led Solarize Massachusetts information sessions at town library and chamber of commerce Articles in town newspaper, TV news segment Solarize flyer in town water bills Updates at board of selectman meetings Flyers on community bulletin boards and at transfer station |

Solarize Mass Pilot Results

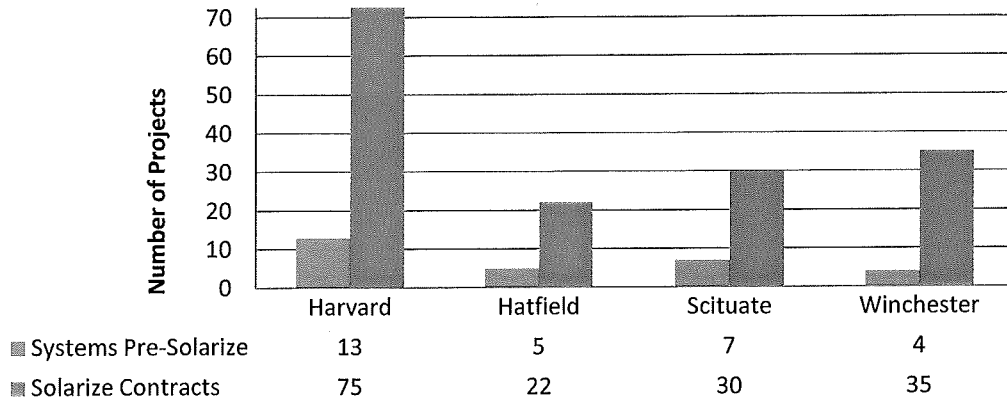
Through the Solarize Mass Pilot, 162 residents in the four towns signed contracts to install solar in the four month sign up period. These solar PV systems represent 829 kW in new capacity. The table below summarizes the final results by town. Figure 9 provides an overview of the number of solar PV projects in each community prior to the launch of the pilot and the number of contracts signed during the pilot.

Figure 8. Solarize Mass Pilot Results

| | Contracts Signed | Contracted Capacity | Feasible Site Assessments | Initial Interest Contacts ⁷ | Final Tier | Avg. System Size |
|--------------|------------------|---------------------|---------------------------|--|------------|------------------|
| Harvard | 75 | 403 kW | 151 | 429 | 4 | 5.4 kW |
| Hatfield | 22 | 147 kW | 40 | 134 | 2 | 6.6 kW |
| Scituate | 30 | 115 kW | 135 | 321 | 2 | 3.9 kW |
| Winchester | 35 | 165 kW | 56 | 479 | 2 | 4.6 kW |
| Total | 162 | 830 kW | 382 | 1363 | | 5.1 kW |

⁷ An Initial interest contact is defined as an individual who showed interest in the Solarize Massachusetts pilot and gave their contact information to the installer or to the town or community contacts during the pilot.

Figure 9. Solar PV projects in each community prior to the pilot and the number contracted during the pilot



The tables below show the percentage of initial interest contacts that resulted in feasible site assessments, the conversion rate of feasible sites to signed contracts, the rate of signed contracts to initial interest contacts, the proportion of signed contracts which utilized a PPA or lease model.

Figure 10.1. Feasible Sites / Initial Interest Contacts

| | |
|------------|-----|
| Hatfield | 31% |
| Harvard | 35% |
| Scituate | 42% |
| Winchester | 12% |

Figure 10.2. Contracts Signed / Feasible Sites

| | |
|------------|-----|
| Hatfield | 52% |
| Harvard | 50% |
| Scituate | 22% |
| Winchester | 63% |

Figure 10.3. Contracts Signed / Initial Interest Contacts

| | |
|------------|-----|
| Hatfield | 16% |
| Harvard | 18% |
| Scituate | 9% |
| Winchester | 7% |

Figure 10.4. Solar Lease or PPA / Contracts Signed

| | |
|------------|-----------------|
| Hatfield | 86% |
| Harvard | 0% ⁸ |
| Scituate | 43% |
| Winchester | 43% |

Timing proved to be an important consideration. The start and end date of the program, existence of deadlines, and timing of major town-wide events played a role in driving the ultimate outcome. Figure 10 summarizes the cumulative capacity contracted within each community over the course of the pilot.⁹

⁸ New England Breeze offered a loan to own option in place of a lease or PPA; it was not contracted for during the Solarize Mass pilot.

⁹ In September, the pilot deadline was extended from September 30, 2011 to October 31, 2011. In Harvard, the tier pricing was frozen at the level achieved by September 30th.

Figure 11. Aggregate contracted capacity by town.

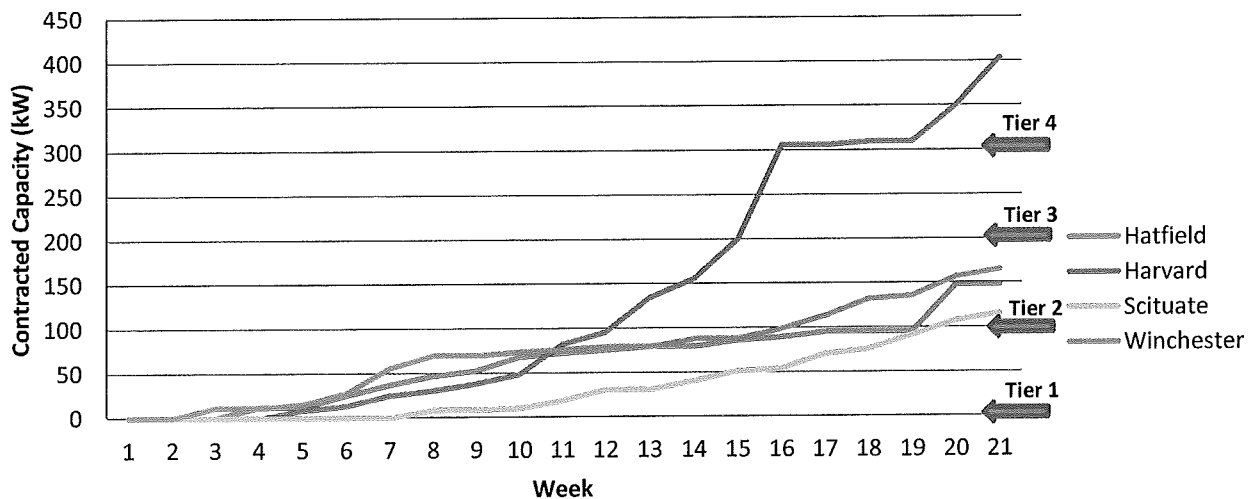
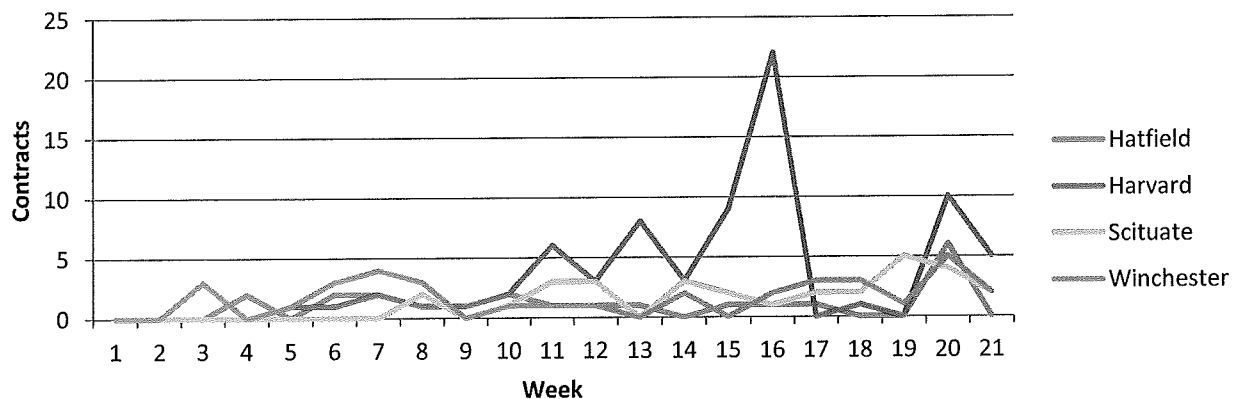


Figure 12. Weekly contracts signed by town.



Solarize Mass Pilot Participant Feedback

Upon completion of the pilot, MassCEC conducted separate feedback sessions with the Solarize Mass Pilot installers and with town officials and volunteer organizers. The feedback was generally positive, and all parties indicated they would be happy to be involved in similar efforts going forward.

Town and Community Volunteer Feedback

Town officials and community volunteers that participated in the Solarize Mass Pilot invested a significant amount of time in driving the program. Volunteer participants estimated that a total of 400 to 600 volunteer hours were dedicated to driving interest during the pilot's four month period. Community contacts also felt it was important that one project be built – not just contracted – very early in the program to serve as an example for others considering adopting solar PV, but not yet comfortable with the technology. Volunteers also felt it was important to find a way to engage interested community

members with non-feasible sites, such as through energy efficiency, solar hot water or a community solar garden. Additionally volunteers noted that the timing of the pilot may have impacted who participated in the pilot. In particular, volunteers in Winchester and Harvard noted that many residents go on vacation during the summer months.

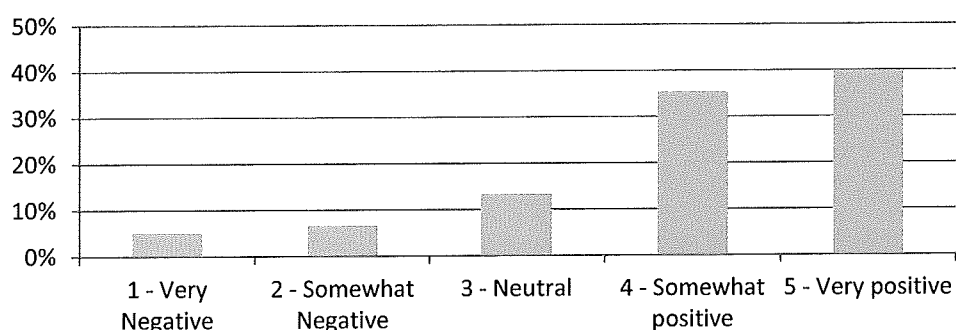
Installer Feedback

The Solarize Mass Pilot installers also provided positive feedback, and each installer indicated an interest in participating in Solarize Mass in the future. Both the installers and the community and town participants felt that communication between the parties was crucial, and that subsequent iterations of the program would benefit from clearly delineating each party's responsibilities and prerogatives before the program is underway.

Participant Feedback

In order to better understand the experience of individual residents and business owners, MassCEC conducted a post-pilot email survey that was sent to residents that provided email contacts over the course of the pilot. Of the respondents who completed the survey, 75 percent had a very or somewhat positive experience with the pilot, and most respondents gave high marks on the Solar 101 and Solar 201 programs. When asked how they heard about Solarize Mass, the most common response was a local community or civic group (43%), followed by television, radio or newspapers (30%), Solarize Mass community meetings or events (30%), and neighbor/friend (24%)¹⁰.

Figure 13. Solarize Mass Pilot survey responses by overall experience.



Solarize Mass Pilot Conclusions

The dramatic increase in the number of solar PV projects installed in each of the Solarize Mass Pilot towns demonstrated that the Solarize Mass model is an effective method for accelerating the rate of adoption of solar PV technology. By engaging grassroots networks to help educate and promote the benefits of solar PV, the Solarize Mass model created competitive prices for residents and resulted in more installations in the community. While a number of variables affected solar adoption rates in the four Solarize Mass Pilot communities, MassCEC found several factors that likely contributed to the results seen in the pilot. Below are preliminary conclusions drawn from the Solarize Mass Pilot:

¹⁰ Respondents were asked to indicate every way in which they heard of Solarize Mass, so the total exceeds 100%.

- **(Tiered) Pricing Matters.** All installers responded to the RFP with Tier 1 prices significantly below market rates over the course of the pilot. This was justifiable from a business perspective due to the potential volume. While the town of Harvard did not have the lowest Tier 1 price, Harvard's installer offered the steepest price drops and the lowest Tier 4 price. The steep price drops from tier-to-tier clearly motivated residents to participate, and resulted in significant increases in contracts signed as each tier was achieved. Responses from the post-pilot survey also show that individuals made purchasing decisions primarily for economic reasons.
- **Timing and Deadlines Drive Participation.** A deadline was important in motivating community members to take action to review their proposal and make the decision to sign a contract as part of the Solarize Massachusetts Pilot. In each town there was a clear spike as the town approached and achieved the next price tier. In all towns, the number of signed contracts peaked near the enrollment deadline.
- **Communities have unique challenges and advantages.** Figure 9.1, above, provides important context for the final results. Installers reported that in the towns of Harvard, Scituate, and Winchester, many residences had extensive tree cover and shading. Winchester reportedly had many sites with multiple roof dormers, East-West facing roofs, and small yards that were not feasible for ground-mounted systems. Conversely, residences in the town of Hatfield typically had less tree cover and shading. Due in part to the location of the Connecticut River and corresponding street construction, many residences were built with south facing roofs, which is the optimal orientation to install solar PV projects. Hatfield tended to have larger roofs with fewer dormers, which is reflected in their average system size of 6.6 kW/project, the highest of the four communities.
- **Community engagement is key.** Each of the local volunteer groups and town officials had different characteristics. Some had dedicated employees, others large volunteer groups. The degree to which there was an active, local presence is a key aspect in motivating community members to learn about solar PV and consider investing in the technology.
- **Utilizing a variety of outreach methods allows program organizers to reach a broader population.** Each of the four communities was provided with the same community marketing and outreach toolkit, but use of the outreach tools varied significantly from town to town, as organizers tailored their outreach efforts to fit the needs of their community members. Tables at community events and farmers markets, articles in print news, online media, social media, community mailings, flyers in town water bills, radio announcements, community access television, and outreach at community gathering places were among the methods utilized by the communities to reach out to different segments of their respective community. Although one-time events brought in larger groups of people, sustained information campaigns were equally valuable.

About the Massachusetts Clean Energy Center

The Massachusetts Clean Energy Center (MassCEC) is dedicated to accelerating the success of clean energy development and implementation—while creating high-quality jobs and long-term economic growth in Massachusetts. MassCEC is the first state agency in the nation dedicated solely to facilitating the development of the clean energy industry. We are led by people who bring knowledge, experience and an entrepreneurial attitude to help clean energy companies take full advantage of all the state's unique assets, to help accelerate the development of renewable energy generation projects, and to help develop a workforce that is ready to roll up its sleeves to ensure Massachusetts' place as a national and global clean energy hub.

About the MA Department of Energy Resources

The Massachusetts Department of Energy Resources (DOER) develops and implements policies and programs aimed at ensuring the adequacy, security, diversity, and cost-effectiveness of the Commonwealth's energy supply within the context of creating a cleaner energy future. To that end, DOER strives to:

- Ensure deployment of all cost-effective energy efficiency
- Maximize development of clean energy resources
- Create and implement energy strategies to assure reliable supplies and improve the cost of clean energy relative to fossil-fuel based generation
- Support Massachusetts' clean energy companies and spur Massachusetts' clean energy employment

DOER is an agency of the Executive Office of Energy and Environmental Affairs (EEA).

About the Green Communities Division

Created in 2008 by the Green Communities Act, the Green Communities Division's charge is to guide all 351 cities and towns along a path of enhanced energy efficiency and renewable energy toward zero net energy. Whether they are advanced energy savers or newcomers to this field, each municipality will be well served by the energy experts in the Green Communities Division.

Our goal is to help cities and towns maximize energy efficiency in public buildings, including schools, city halls, and public works and public safety buildings; generate clean energy from renewable sources; and manage rising energy costs.

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