solar PERMITTING & INSTALLATION handbook

A GUIDE FOR CONDOMINIUM OWNERS AND ASSOCIATIONS

Prepared by Peregrine Energy Group, Inc., Zapotec Energy Inc., and the City of Cambridge

CAMBRIDGE, MA

Installing Solar Electric Systems on
Condominium Properties in Cambridge, Massachusetts:
A Guide for Owners and Associations

INTRODUCTION

This Guide has been developed by the City of Cambridge to assist condominium owners who are considering installation of a solar electric system (also called photovoltaic or "PV" system). The guide is intended for use by a condominium owner (the "project champion") and/or a condominium association ("Association"). The objective of the Guide is to help owners and associations determine whether solar PV is right for their building and, if it is, how to get a system installed.

This how-to guide is divided into four main sections:

- **Section 1: *Is Your Building Right for Solar?*** focuses on evaluating whether installing a solar PV system is feasible on your building and the variables you should consider **(p. 3)**
- **Section 2: *Securing Association Approval***, addresses issues critical to securing the Association's agreement to installing the solar PV system **(p. 8)**
- **Section 3: *Project Design and Construction***, describes how to get a system installed, including how to select a solar installation contractor **(p. 14)**
- **Section 4: *Operating and Maintaining the System***, provides additional information on how to get the most out of your PV system **(p. 21)**

The development of this Guide reflects the City's ongoing commitment to encourage and support residents and businesses to adopt energy efficient and renewable energy technologies. In 2012, the City unveiled the web-based Cambridge Solar Tool (cambridgema.gov/solar) that maps the solar potential of rooftops throughout the City. The Tool shows that many roofs in Cambridge get enough sunlight to make installation of a rooftop solar electric system feasible. This Guide is intended to complement the Solar Tool and assist interested parties in installing solar systems on their buildings.

As you use this Guide, here are some additional thoughts to keep in mind:

- There are already many buildings in Cambridge with PV systems. As of December 2012, there were at least 500 homes, apartments, condominiums, businesses, and institutional buildings connected to photovoltaic systems in the city.
- To encourage and support the use of renewable energy technologies, both the State and the federal government have created tax credits and other incentives that improve the economics of solar projects. Having the ability to make use of these incentives will make a project more financially attractive.
- Like other building improvement projects, solar projects involve research, choices and decisions, approvals, contracts, and attention to detail.
- We provide a general framework here for obtaining approval for a solar installation on a condominium building, but there are many different sizes of condominiums in Cambridge: 2–3 unit condominiums, 10–20 unit condominiums, and 80 unit and larger condominiums. Condo meetings, decision-making, building maintenance, and addressing legal issues are handled differently in different sized buildings. Smaller condos generally have informal meetings between owners, while

larger condos have management companies to manage condo affairs. As a result, the path to gaining support and the decision-making process may vary significantly from condo to condo.

SECTION 1: IS YOUR BUILDING RIGHT FOR SOLAR?

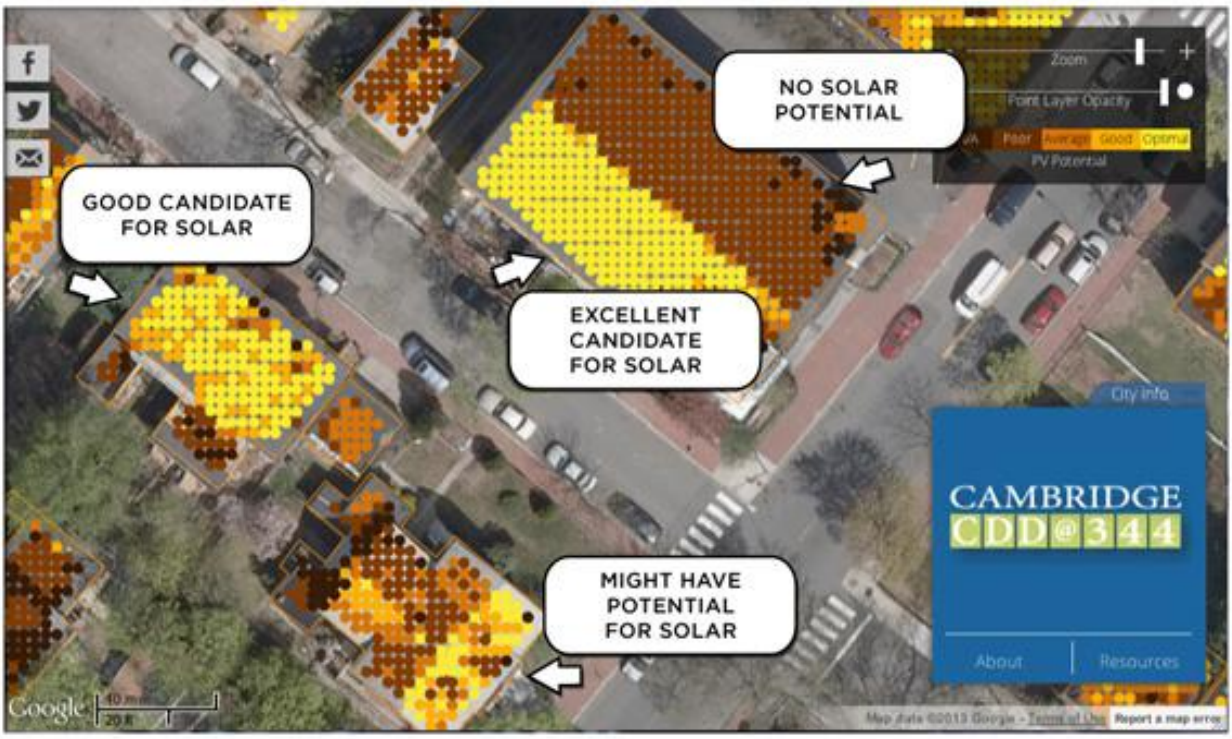
This first series of steps is critical to determine if a building is a good candidate for a photovoltaic system. The project champion should take the lead in answering these initial questions, as a precursor to more detailed analysis of the feasibility of a PV project.

Installing a solar PV system on the roof of a condominium property requires, first and foremost, that the roof receives enough direct sunlight. Without proper sunlight, a solar system will produce an insufficient amount of electricity to outweigh the expense of the system.

Step 1: Confirm that your building gets enough sunlight

Confirming that your building gets enough sunlight is the first step in evaluating whether your building is right for solar. Consult the Cambridge Solar Tool on the web: cambridgema.gov/solar

1. Enter your building address.
2. Look at the map colors on your roof to determine potential. See the example below.



Your building has ***good solar potential*** if the roof:

- Is colored mostly light orange (good) or yellow (excellent) and has no major obstructions

OR

- Has large areas of yellow and orange, even if other areas are light brown/dark orange (poor) or dark brown (no potential)

Your building has ***little or no solar potential*** if the roof:

- Is mostly light brown/dark orange (poor) or dark brown (no potential) in color, i.e. does not face south or has obstructions

- **Go to the next step if you find that your roof has good to excellent solar potential.**
- **If your roof has little or no solar potential, installing a solar PV system is not recommended. The small amount of electricity a system may generate would not justify the cost of installing a system.**

If you are still unsure about the solar potential, ask a solar contractor to evaluate your building.

There are other ways to support the generation of electricity from renewable sources and to reduce your use of conventionally generated electricity.

- Investigate NSTAR Green—renewable power available for purchase from NSTAR. You can find more information at: www.nstar.com/residential/customer_information/nstar_green/nstar_green.asp
- Take steps to increase your building's energy efficiency through the Mass Save program offered by NSTAR (www.MassSave.com).
- Consider installing a solar hot water system, which is feasible sometimes where solar PV is not.
- Make a donation to a renewable energy project through New Generation Energy or some other similar organization.

Step 2: Confirm that your roof is ready for solar

After you have determined that the roof has enough sunlight, you will need to determine the age of the roof. Ideally, the remaining life of the roof will coincide with the lifetime of the PV system; otherwise, having a PV system on the roof will create additional expense during its lifetime for the association when roof replacement is necessary. If the roof must be replaced 10 or 12 years after a PV system is installed, doing so will require removing all the panels, replacing the roof, and then reinstalling the panels. As the following Case Study illustrates, this can be quite expensive.

Case Study

In 2004, a PV system costing approximately $100,000 was installed on a flat roof of a commercial building in Cambridge. The roof was expected to last until 2020, but by 2008, for a variety of reasons, including extensive interior renovation work, the building owner decided to install a new roof with additional insulation.

The self-ballasted PV system had only one attachment to the building, at the point where the electrical conduit from the array entered the building. In order to replace the roof, however, the PV system had to be completely removed, stored, and then redeployed with some new electrical cabling. The total cost of the PV redeployment, not including the cost of the new roof, was 15 percent of the initial cost of the system, or $15,000. This was on the low side of the average cost for removal and redeployment, since the panels could be stored in an indoor space at roof level and did not need to be craned to the ground, and/or stored at another site. On the high side of average, the removal and redeployment could have cost as much as 30 to 40 percent of the initial cost, or $30,000 to $40,000.

This situation can be avoided by a careful assessment of the roof's remaining life and, if appropriate, by repairing or replacing the roofing material before the PV system is installed. Since the typical lifetime of a solar PV system is 25 years or more, PV systems should only be placed on roofs that are expected to last 15 to 25 years. When this is not the case, careful planning of cost implications is advised.

If you expect that the roof will need to be replaced within the lifetime of the solar PV system, the cost of removing and reinstalling panels should be factored into the economic analysis of the PV system. If the Association is unwilling or not ready to replace an old roof to accommodate a PV project, installing the PV system should probably be put off until there is a plan for replacing the roof.

To determine the remaining lifetime of the roof and when replacement or major repairs are likely,

- ✓ Check the building's maintenance records.
- ✓ Ask other unit owners.
- ✓ Find a recent home inspection report that was done when a condo unit was sold.
- ✓ Bring in a qualified roofer to provide a condition report on the roof.

When you know the condition of the roof, use the following chart to decide next steps.

Roof Condition	**Recommendation**
Remaining lifetime is less than 5 years	- Replace roof now and install solar **or** - Wait until end of roof life to install solar.
Remaining lifetime is 5-15 years	- Replace roof now and then install solar **or** - Wait until end roof life to install solar **or** - Repair roof to extend its life (you want at least 15 years of remaining life) and then install solar **or** - Install solar now on the existing roof (factoring in future costs to remove and reinstall solar panels when you re-roof) and replace the roof later.
Remaining lifetime is greater than 15 years	You are good to go. Proceed to next step.

➔ **An additional note about roof warranties:**

This Guide urges prospective purchasers of PV systems to consider the age and condition of the roof as part of planning the project and, if possible, to install the system on a new or nearly new roof to avoid the cost of removing the system to replace a failing roof.

This raises the question of how installation of a PV system could affect the warranty on a roof.

A warranty is a written guarantee of the integrity of a product and the manufacturer's responsibility for the repair or replacement of defective parts. A roof warranty is a legal contract between a roofing-materials manufacturer or contractor and a building owner. It defines the limits of liability the manufacturer or contractor assume, should problems arise. This contract also defines specific requirements the roof's owner must fulfill to keep the warranty in effect.

It is recommended that the Association review the language in the existing roof warranty to understand any specific limitations that could result from installation of a PV system. While a roof-mounted PV system should not increase the rate of wear of a roof (and might actually decrease it because it offers some protection from weather), penetrations through the roof membrane to fasten the system to structural elements could result in leaks. Where roof penetrations are proposed to mount a PV system, you should have specific discussions with the contractor about steps they will take to prevent future leaks and warranties the contractor offers against leaks. Ballasted systems (i.e. systems that sit on a roof and are held down with weights) may pose less risk of roof damage, but this should be discussed with the contractor as well.

The bottom line is to understand what new or additional exposure you are assuming and to take steps to mitigate your risk.

Step 3: Gauge the interest of other owners and the Association

The rooftop of a condominium building is often a common resource shared by all condo owners; however there are exceptions such as the case where owners of the top floor unit(s) have exclusive roof rights for a roof deck or other specific uses. To learn the situation at your building, look at your condo documents and/or the Master Deed, filed with the South Middlesex Registry of Deeds (www.sec.state.ma.us/rod/rodmidsth/midsthidx.htm). Usually, a roof-mounted solar project requires the agreement and approval of a certain majority of owners.

As part of your due diligence process, you may want to determine the interest in a solar project among other owners and the Association. Communicate with the members of your condo association about your ideas for a solar project. Share information you have gathered. Arrange face-to-face interactions to explain your idea and listen to their responses. If asked about costs and benefits on the project (information you do not have yet), explain that this information will be secured before any final decision is made. You might want to share this Guide, the solar map report, and information on other installations in Cambridge and nearby towns. For more information on solar installations in the Greater Boston area, visit the Massachusetts Clean Energy Center: www.masscec.com/index.cfm/page/Commonwealth-Solar-Installers,-Costs,-Etc./cdid/13416/pid/11163

Again, while we provide a general framework here for obtaining approval for a solar installation on a condominium, please keep in mind that there are many different types of condominiums in Cambridge, and the path to gaining support and approvals may vary significantly from condo to condo.

Follow these steps to gauge the interest of the condo association:

1. Take a "straw poll" of whether the owners will support the concept of putting solar on the building.
   - If you find that most of the condo owners are enthusiastic and have positive attitudes towards solar, then you can move on to the next step.
   - On the other hand, if you learn that a majority of the condo owners are indifferent or have negative attitudes towards solar, you will need to build support and convince them that having a PV system on their building's roof will benefit them.
   - If opposition is strong, it may not be worth pursuing solar at this time.
2. If there is sufficient support for the idea, share it with the Association Board. Get on their meeting agenda to explain the opportunity for solar and the interest of other owners. Ask them for their support and cooperation as you continue your research.

If the Association agrees that this idea is worth considering further, seek out a solar contractor to address technical issues requiring expert input.

Step 4: Engage a solar contractor to support your research

Once you know your building has good solar potential and that other condo owners support this idea, you should enlist a solar contractor to provide expert technical advice and support. Although the project is still speculative and focused on project feasibility at this stage, a contractor will be willing to advise you for no charge if the contractor believes there is serious interest. For this reason, gauging condo interest as described in the last section is essential.

The purpose of engaging a solar contractor at this stage is to get expert advice on whether solar is technically feasible. The contractor will address technical issues such as shading, cost, and permitting. Note that this step does not involve soliciting or selecting the contractor that will ultimately design and install your system. This solicitation and selection process happens after the Association has committed to build, and is discussed separately in the section, ***Project Design and Construction*** **(p. 14)**.

Although a solar contractor is providing free advice to you at this stage, you will be developing a relationship, and your experience will likely determine if you want this contractor to ultimately design and install your solar project. Consider the following when you look for this contractor:

- ✓ Previous experience in commercial building or multi-unit building installations
- ✓ Previous installation experience in Cambridge
- ✓ Knowledge of local codes and ordinances and enforcement practices

The Massachusetts Clean Energy Center has prepared an excellent, concise handbook on Residential Solar that describes system fundamentals and provides tips on how to select a contractor. While this publication targets single-family projects, much of the information could be relevant to condominiums. Go to: www.masscec.com/index.cfm/page/Residential-Solar-Guidebook/cdid/13301/pid/11163

Both the Solar Energy Business Association of New England (www.sebane.org) and the Northeast Sustainable Energy Association (www.nesea.org) have designer and contractor lists on their websites. You may also contact the Cambridge Energy Alliance for help with how to choose a contractor.

Step 5: Address technical issues with the help of a solar contractor

The contractor you have chosen will determine if your building has any "show-stopper" technical issues. These issues include:

- Is your building located in a special NSTAR network distribution area?
- How much roof space is there for solar, eliminating areas that are shaded or have other uses?
- Will the roof structure support the weight of the solar panels?
- Will the Cambridge Historical Commission object to a solar project at that location?

See the ***Additional Information*** **(p. 23)** section of this Guide for more details about these issues.

If the contractor feels that the project is still viable after considering these questions, your next step is to seek approval from the Association.

SECTION 2: SECURING ASSOCIATION APPROVAL

At this point, the Association will need information on the economic and legal considerations of the proposed solar project before any decisions can be made. What are the costs and benefits? How will ownership of the PV system work?

To help the Association understand these considerations, the contractor and project champion should explore the economic, legal, and ownership issues of the solar project and meet with the Association to discuss these details. Finally, the Association should vote on the solar project, including how it should be owned and financed.

Step 1: Estimate project economics

The first question most people have about solar often concerns project economics: What will the proposed PV system cost? How much electricity will it generate? What is the potential value of this electricity? Are there any other financial offsets that will improve the project economics?

Ask the contractor to prepare a rough estimate of the PV system economics. This estimate should include:

- ✓ The cost of any roof repairs and structural upgrades (if known and required).
- ✓ A description of the proposed system with installed costs, including: mounting hardware, the PV modules, the inverter, monitoring equipment, and any other construction details associated with this particular installation.
- ✓ The value of power generated, including anticipated annual savings and cash flows.
- ✓ Estimated payback period (how long will it take to pay back the total installed cost).

If the project is still worth considering based on this economic analysis by the solar contractor, proceed to the next step.

To better understand project economics, review the following brief discussion of solar project ownership and financing. You may also consult your contractor for more details.

Traditionally, for a single-family home, there are two ways to acquire a solar PV system: purchase and leasing.

- ***Purchasing*** means you own the complete solar PV system and have complete responsibility for its operation and maintenance; all power produced belongs to you to use or to sell.
- ***Leasing*** means that someone else owns the PV system and is responsible for operating and maintaining it; you purchase the power produced at a negotiated rate and pay for the system through a long-term power purchase agreement.

While leases are currently available to homeowners and businesses to finance solar projects, solar companies have not yet offered this option locally to condominium owners and associations. Therefore, it is most likely that only a purchasing option is available for your condominium at this time. Since there may be exceptions, you may still want to ask your solar company whether they can offer a lease arrangement for your particular case. Getting condo approval may also increase financing options. In the future, perhaps leasing options for condominiums will become increasingly available as solar companies develop new financing options.

There are two standard ownership options for a solar PV system on a condominium building. Your condominium may identify other creative strategies for shared ownership. See ***"Identify Interconnection Options"* (p. 11)** for further discussion on ownership structures. The key difference between the two ownership options is tax credits.

1) ***Owned by the Association:*** The Association does not pay income tax and therefore cannot take advantage of tax credits allowed for solar installations.
2) ***Owned by an individual condo unit owner:*** An individual condo owner purchasing a system can qualify to use those credits if she owes enough taxes to claim these credits against.

The following case studies illustrate the relative economics of a condo owner-purchased photovoltaic system and an Association-purchased photovoltaic system. The table below provides an example of typical cost and potential benefits for a solar project and is used in both case studies.

Typical Cost and Potential Benefits for a Solar Project Note that the table includes a potential revenue stream from Solar Renewable Energy Credits (SRECs). SRECs are "minted" when a PV system generates electricity. They are used as the record of solar electricity produced. Because there are Massachusetts goals and requirements for solar electricity production, these SRECs have market value. In order to receive credit for SRECs that are produced by a PV system, each PV system owner must sign up for an account with the Massachusetts Department of Energy Resources. For small residential systems, this is generally done through an Aggregator. Aggregators are businesses that have been established to gather and sell SRECs produced by smaller solar electric generators in exchange for a percentage of the proceeds. For more information about SRECs and Aggregators go to www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/about-the-rps-solar-carve-out-program.html

System Size	5 kW
Total System Cost*	- $25,000
Estimated Energy Production	6500 kWh/ year
Savings on Electric Bill @ 14¢/kWh	+ $910/ year
Revenue from SRECs** @ 20¢/kWh	+ $1300/ year
Federal Tax Credit (30% of total system cost)	+ $7500
State Tax Credit (15% of total system cost or not to exceed $1000)	+ $1000

*Does not include costs for roof replacement or structural improvements that may be necessary
**SREC = Solar Renewable Energy Credit

Case Study

Suppose you are an individual condo owner and have permission to install your own 5-kW solar PV system on the roof. Since you own the solar PV system and you pay taxes, you can take advantage of state and federal tax credits.

When a condo owner purchases the 5 kW system, the simple payback period is roughly 8 years. The simple payback period represents the time over which the system pays for itself. This value can be calculated from the numbers given in the table. If you add up the total amount saved and revenue generated in 8 years, you would get roughly $25,000.

Total $ saved and revenue generated after 8 years are calculated as follows (from the chart above):

$910/ year x 8 years + $ 1300/year x 8 years + $7500 + $1000 = $ 26,180

Case Study

Now suppose your condo association installs a 5-kW solar PV system on the roof. Since the condo association owns the solar PV system, but is not a tax-paying entity, tax credits do not apply.

With the Association owning the system, the simple payback period becomes significantly longer, extending to 12 years without tax credits.

Total $ saved and revenue generated after 12 years (from the chart above):

$910/ year x 12 years + $ 1300 year x 12 years = $ 26,520

In this case, the inverter also needs replacement every 10 years. If inverter replacement costs are factored in, the payback period extends another 3 years. SREC pricing may also vary widely from year to year, creating more uncertainty in the revenue generated beyond 10 years.

Step 2: Identify interconnection options

Ownership of the solar PV system will also depend on or dictate the interconnection to the utility distribution system, i.e. which electric account the solar PV system is connected to. Every solar PV system on a building is connected to the NSTAR power grid through an electric meter. Interconnection allows the sale of any excess generation back to the grid at nearly retail value when the PV system is producing more power than the owner is using. The excess value is added as a credit on your bill. This is called "net metering." Go to: www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/agencies-and-divisions/dpu/net-metering-faqs.html for more information.

There are three standard ways for condominiums to interconnect a solar PV system. Again, each of these approaches has it merits in a condominium setting. Briefly, these three approaches are,

Option 1) Use the Association's electric account and connect to the building's common meter. Connecting to this meter will make the Association the system owner. Since an Association is tax-exempt, it will not be able to take advantage of special tax credits programs designed to make PV economically attractive. The value of any excess electricity generation above what is consumed for shared purposes could be used to offset other shared Association fees or redistributed to condo owners.

Option 2) Design the system to connect to the electric meter of one condo unit. Connecting to this meter will make the condo unit owner the system owner and make use of available tax credits, significantly reducing the effective purchase price of the system. Traditionally in this approach, the condo owner is solely responsible for the system, using the energy produced and enjoying the cost savings. However, if the system is large, it is possible to share the installation cost across multiple condo owners, and also share the energy production and cost benefits with those other condo members. This latter case includes the option to "net meter to other condo owners", or allocate energy production to other condo owners. Talk to your solar contractor about how this net metering may be applicable to you.

Option 3) Install multiple separate PV systems on the roof that each connect to the electric meter of an individual condo unit. In this scenario, separate systems are installed for condo units and each of the system owners can take advantage of available tax credits. This may require apportioning the roof

between owners and detailing who would be responsible for roof and project costs over time. For example, if several systems are installed at different times, condo owners will need to agree on how roof replacement in the future will affect costs for removing or replacing these PV systems.

Important note: There may be other creative strategies for addressing ownership and interconnection that allow multiple owners to share benefits and make use of tax credits. Talk to a solar contractor about other options that may apply to you. It is beneficial to consult a tax accountant to confirm where IRS tax benefits apply and ensure proper accounting.

Step 3: Evaluate legal issues

The project champion should review the condominium documents and bylaws to confirm how ownership of the roof is treated and who has rights to use it. If these documents are not readily available, they can be obtained from the Registry of Deeds. It is critical to confirm if there are any Condo restrictions on placing equipment on the roof, and to identify the legal process for making changes to allowable uses if they are necessary. The condominium documents should state what the voting requirements are for such changes.

Ultimately, it may be necessary to involve a lawyer in this analysis before all questions can be definitively resolved. The cost for legal services should be borne by the project proponent, be it an individual or the Association. Legal fees can vary, and it will be wise to shop around, unless the Association has a lawyer it typically works with.

Additional issues to consider are potential changes to roof warranty and insurance policies, including master condo or individual policies.

Step 4: Meet with the Association

Once you are prepared to address the potential economics of the project and legal questions around use of the building's roof, you should meet with the Association to share the concept, discuss project details, and seek Association approval to proceed with securing contractor bids. We recommend bringing the solar contractor you have been working with to the meeting to help answer questions.

The purpose of this meeting will be to formally present the proposed PV project to the Association as the decision making body, explain what completing such a project will entail, and discuss in detail any options to be considered. By the end of this meeting, the Association should have a good understanding of the proposal, you should have a better sense of the likelihood of success, and there should be a to-do list of additional unanswered questions and unresolved issues to be addressed. This step may require multiple meetings. If there are still questions that need discussion or answers prior to voting, schedule as many meetings as necessary to further clarify the project and to secure support.

SUGGESTED AGENDA FOR MEETING WITH ASSOCIATION

- ✓ ***Summary of the Proposal***
- ✓ ***Background Information:*** Findings to date, including technical matters, potential costs and benefits
- ✓ ***Ownership Options*** (if appropriate)
- ✓ ***Legal Questions:*** Issues to resolve associated with putting a PV system on the roof (including by-laws changes, options for ownership models within the Association, potential legal costs, any effects on existing roof warranty and home insurance policies)
- ✓ ***Additional Open Issues and Decisions to be Made***
- ✓ ***Next Steps***

Step 5: Secure Association approval for the project

A final meeting must be scheduled to vote on the solar project and to secure approvals for using the roof for this purpose and for proceeding with securing cost proposals for a PV project. Come to the meeting with an understanding of the number of votes you require. Most requests for a new use of the roof will require a unanimous vote from Association members. The bylaws of the Association have guidelines for these types of votes. If practical, prior to the meeting, engage each prospective voter to assess any concerns they have and how they will vote. Take the time to bring them to "yes".

When the time for the meeting comes,

- ✓ Try to get all owners that support this proposal to attend.
- ✓ Provide opportunities for others to speak in favor of the proposed project
- ✓ Summarize all findings and discussions to date as part of your proposal. Describe the meetings held and research completed so that the Association is aware of all due diligence activity.
- ✓ Identify any unknowns and be clear of the point in the process when they will be resolved, describe next steps for proceeding with the project if there is agreement to move forward.
- ✓ Ask meeting participants again to identify any concerns or objections they have about the proposal so you can respond to them and perhaps correct misconceptions.
- ✓ Request the vote, asking for approval to use the roof for a PV system and to secure proposals for final design and installation of the project.

If the project is approved, use this guide to explain next steps. Depending on the scope of the proposed project, who the owner(s) will be, and who will be affected by the construction, additional approvals and discussions may be needed before proceeding with design and construction.

If the project is not approved, determine why and whether or not it is feasible to get another hearing at a later date.

SECTION 3: PROJECT DESIGN AND CONSTRUCTION

After the Association agrees to proceed with the project, the prospective purchaser, be it the Association or individual condo owner(s), will solicit bids and select a contractor to design and install the system. Regardless of whom the owner will be, the design, permitting, and interconnection requirements to get the PV system installed will be the same.

How long will it take to get a PV system installed and in operation at your building? You should expect this process could require four to ten months if you follow the steps outlined in this guide.

Case Study

The following timeline for a recent condominium project in Cambridge is illustrative of the effort that can be required to bring a project to fruition. Two small PV arrays, rated at 6kW each, were installed on the flat roof of a 15-unit condominium building in Cambridge. The building is 100 years old and underwent extensive renovation when it was converted to condominiums 10 years ago. The systems began to generate electricity in August 2012. This was the project timeline:

- **October 2011**—Several members of a condominium in Cambridge decided that they were ready to move forward with a PV installation.
- **November 2011**—The proponents contacted a Cambridge firm with significant local experience and arranged a site visit. This firm was subsequently hired to design the PV systems and to coordinate the structural engineer's evaluation.
- **Mid-December 2011**—A condominium meeting was held where the plans were presented, followed by a one hour Q&A session. The proposal was received favorably, and a resolution authorizing the construction was drafted.
- **January 2012**—The project was authorized by all 15 members of the association, consistent with the condominium documents.
- **April 2012**—A final design for two 6kW systems was submitted to the City of Cambridge for a building permit and materials were ordered.
- **Mid-June 2012**—The installation on the roof began.
- **Mid-July 2012**—Construction completed after four weeks, with some delay due to rainy weather.
- **August 2012**—All permits and utility interconnections were completed by the end of the month, approximately 10 months after the initial site visit.

Step 1: Select a solar PV installation contractor

Installing solar is much like any other construction project. The first step is to qualify several solar contractors and secure price quotes. Consult www.energysage.com or the MassCEC Residential PV guide: www.masscec.com/index.cfm/page/Residential-Solar-Guidebook/cdid/13301/pid/11163

The installation contractor will be responsible for both design and construction of the project. Quotes from contractors should include separate prices for the Design Phase and Construction Phase, so that if you decide to opt out of the project after the Design phase and not proceed to construction, you will be obligated to pay the design costs.

One of the prospective contractors you are considering could be the one you worked with earlier during the feasibility phase of the project. Though this contractor is the most familiar with your building and could be your favorite to install the project, we recommend getting at least two other quotes for comparison.

When asking for quotes, you should provide prospective bidders with all information gathered to date, but also require the bidders to confirm that this information is correct and that they take responsibility for its accuracy. Providing this level of specification to prospective bidders will help get "apples-to-apples" pricing to compare.

Prospective contractors also should visit the site before preparing quotes in order to verify building details. This site visit should be scheduled as part of the solicitation process. Generally, once the site visit is held, the bidders should be able to provide quotes within two weeks.

In choosing a contractor, you will want to evaluate cost, qualifications, and work style. The quote with the lowest price might not be the best option for your building. Try to find a contractor with experience installing solar in Cambridge and/or surrounding areas. Work style is also important because successful solar projects require the buyer to work closely with the contractor throughout construction. The buyer should select a contractor that understands the building's needs and requirements (work hours, noise, parking, staging areas, building access, etc.) and appears willing to cooperate with your needs.

Overview of Contractor Selection Procedure:

1) Select three qualified contractors and request quotes.

2) Schedule site visit for contractors.

3) Receive quotes (2 weeks after site visit).

4) Evaluate and select contractor

The following outline addresses the type of information the buyer should provide and request in securing quotations and selecting a Contractor and should be reflected in your Request for Proposals.

General Information (to be provided to prospective bidders)

- Project address and brief description of association
- Interconnecting utility (in this case NSTAR)
- Existing conditions (e.g. description of building, energy use, roof, potential PV roof area)
- Any known project constraints such as location in historic district, line of sight requirements, structural issues with the roof (contractor to confirm)

Bid Logistics (to be provided to prospective bidders)

- Contractors required to confirm existing conditions
- Proposal due date
- Submission requirements
- Mandatory pre-bid site visit

Qualifications (requested from bidders)

- Proof of licensing
- Prior experience developing PV projects in comparable buildings
- Other successful projects in the City of Cambridge
- References regarding past performance
- Any subcontractors to be used, identifying who they are and providing their qualifications
- Proof of Liability and Workers' Compensation insurance coverage?

Equipment and Project Specifications Proposed (requested from bidders)

- System size (kW)
- Estimated Energy Production
- Equipment to be installed with cut sheets (including but not limited to panels, inverter(s), monitoring equipment such as a web-enabled Data Acquisition System)
- General design of layout of equipment

Scope of Work (requested from bidders)

- Contractor responsibilities
- Schedule proposed, including progress meetings with the Association and/or owner

Project Pricing (requested from bidders)

- Price for structural analysis
- Price for full design
- Price for project construction
- Timeline for payments

In summary, when choosing a contractor, consider the following questions:

- ✓ Is the contractor fully licensed and insured?
- ✓ Has the contractor had prior experience developing PV projects in comparable buildings?
- ✓ Has the contractor had successful projects in the City of Cambridge or surrounding communities that demonstrate familiarity with local inspection and approval requirements?
- ✓ What do the references say about the contractor's past performance?
- ✓ Will the contractor be doing the work themselves? If no, who are the subcontractors that will be used and what are their qualifications?
- ✓ Will all parties that are employed on the project carry Liability and Workers' Compensation insurance coverage?

Step 2: Contract execution

Generally, the installer/contractor will bring a contract to the buyer for execution. The Association should review the contractor's proposal and negotiate any additional details that are critical to the Association. The buyer must ensure that the contract confirms all representations made by the contractor during the proposal process and any subsequent negotiations. It should also reflect any requirements by the owner for how and when work is performed.

The time from selecting a contractor to signing a contract generally takes two weeks, but it can take longer if contract details require negotiating. Expect to execute a single contract with the contractor that will cover both the Design and Construction phases of the project. The contract should specify what is covered in the Design Phase and in the Construction Phase, including deliverables, separate prices for design and for construction, and payment schedule. It should also allow the buyer to opt out of Construction at the end of Design with payment for the negotiated design price (and not for the full project cost).

The description of both the Design and Construction Phases covered in the contract should clearly address the following:

- ***Responsibilities—***Responsibilities of the contractor.

- ***Subcontractors—***Any subcontractors that will be brought on to the job.

- ***Insurance—***Insurance carried by all parties (including certificates of insurance from the contractor and any subcontractors naming the Association or others as an additional insured).

- ***Schedule and Milestones—***Start and completion dates for Design and Construction, with specific milestones identified, including, as applicable:
  - Roof structural analysis and introduction of the structural engineer being used.
  - Completion and delivery of the structural analysis report.
  - Component selection and configuration.
  - Completion of final design documents and drawings.
  - Buyer authorization to proceed to construction.
  - Introduce electrical subcontractor or electrical foreman.
  - Deliver materials and lift to roof.
  - Mount racking on the roof.
  - Install the solar panels and inverter.
  - Complete wiring.
  - Complete project commissioning.
  - Set-up data monitoring.
  - Complete inspections and closeout.
  - Operation and maintenance training.

- ***Commissioning and Interconnection—***Project commissioning and interconnection approval requirements and procedures, as well as the contractor's obligation to commission the project and get it interconnected.

- ***Budget—***Itemized budget, with confirmation that this includes all anticipated project costs, including structural engineering analysis, permits, and interconnection-related fees.

- ***Payment schedule—***Progress payments including amounts to be held until the system is fully operational, inspected by the City, and interconnected with the NSTAR grid.

- ***Warranty—***Terms for the project as a whole and individual project components.

For your protection, consider having your attorney review the final contract prior to your signing.

Do not allow construction to begin until you receive the certificates of insurance for the contractor and subcontractors.

Step 3: System design

After selecting the contractor and signing a contract, the Design Phase of the project begins. The contractor will prepare a final system design for review and approval by the Buyer. The design process includes equipment selection and layout of the system on the roof.

Roof structural analysis

The first task in the design phase is a structural analysis of the roof. The structural analysis will determine what structural improvements, if any, will be required and what these improvements will cost. Cambridge Inspectional Services requires a report on the roof's structural characteristics before they will issue a building permit. This is to ensure that the roof can support the solar structure proposed.

A Massachusetts-registered structural engineer must prepare this analysis and report. The contractor identifies, secures, and coordinates the structural engineer that completes this work. The Association should confirm ahead of time if an allowance for this expense is included in the contract.

The full structural engineering analysis will determine:

- The reserve capacity of the roof and the exact costs of structural upgrades, if necessary.
- How the solar mounting system will attach to the building structure.

The structural engineer will first confirm the reserve capacity of the roof. To do this, the engineer will inspect the underlying roof structure.

- If there is no reserve capacity, the solar project cannot move forward unless specified structural improvements are made. The structural engineer would advise on next steps here.
- If there is limited reserve capacity, the contractor may need to modify the mounting solution or increase the structural capacity of the roof.

If structural upgrades are required, the structural engineer and contractor will determine the exact costs and provide these costs to the Buyer. Any necessary structural improvements will need to be factored into the construction budget and timeline and could adversely affect the economic attractiveness of the project.

The contractor and structural engineer will also discuss the most appropriate mounting solution for this PV system and a plan for how the PV system will be attached to the building structure. All this information is included in the final design documents provided by the Contractor to the Association.

Component selection and configuration

The contractor will propose the components for the system (modules, inverters, and monitoring devices) and identify where they will be located. Some components will be on the roof while others, such as inverters and metering equipment, may be in the building mechanical room near the electric service panel. The Buyer should talk to the installation contractor about issues and options associated with location of this equipment. Often, there are concerns about the equipment location and appearance. For example, should components or conduits be painted in order to conform to historic ordinances or to meet aesthetic concerns of Association members?

By the end of this effort, the contractor should have a drawing set for construction.

Step 4: Approve final design and authorize start of construction

The Buyer should review and formally approve the design documents prepared by the contractor. After approving the design, the Buyer will authorize start of construction.

Step 5: City building permits and interconnection application to NSTAR

The contractor is responsible for submitting all paperwork necessary to start construction. This includes: 1) obtaining building permits from the City and 2) submitting an application to NSTAR for interconnection approval. The costs for the building permits and interconnection application should be already included in the construction contract.

Your contractor will coordinate with the Buyer to complete the necessary paperwork. For the NSTAR interconnection application, the contractor will want information about the NSTAR electric account the PV system will connect to. If the PV system is interconnecting through the common meter, there will only be one interconnection application, signed by an authorized representative of the Association. If the system or systems are interconnecting to individual condo units, there will be an application for each condo unit, signed by the owner of each condo unit.

Step 6: Construction

The contractor and the Buyer should have meetings where the contractor provides updates on construction progress. A construction schedule should have been part of the project contract. The contractor is responsible for keeping this schedule current, and the Buyer should formally approve any changes to the schedule.

Step 7: Commissioning the system

Once the construction is complete, the Buyer should require that the contractor commission the equipment to confirm that all components are operating properly.

Step 8: City inspections and interconnection to the power grid

The contractor has not completed the work until the City inspects the system and confirms that all aspects of the installation conform to the building code. The project will require a final wiring inspection, followed by a final building inspection. The contractor will coordinate these inspections.

Once these inspections are successfully completed, the contractor notifies NSTAR, and NSTAR must agree that the PV system can interconnect to the power grid. The contractor will coordinate the final interconnection approval.

When all these approvals are secured, the system can officially be turned on and begin producing power.

Step 9: Project closeout

The PV system is now producing electricity. Before making a final payment, the Buyer should confirm that the contractor has completed all contractual responsibilities.

Ask the contractor for guidance regarding SRECs and securing an SREC aggregator.

As part of the project closeout process, the contractor should provide copies of technical manuals, equipment specification sheets, as-built design drawings, and warranties to the Association or owners of the individual systems. The contractor should also provide training to the owner(s) about safety and system operations and maintenance requirements.

Step 10: Homeowner insurance

The system owner(s) should notify their home insurance companies and the master insurance company that the PV system has been installed on the roof. This ensures that in the case of damages to the system or related to the system, an insurance claim can be filed. The insurance company will confirm whether the system is protected with existing coverage or advise if a separate rider is needed to cover the system.

SECTION 4: OPERATING AND MAINTAINING THE SYSTEM

One of the great features of a PV system is that, once installed, it requires little maintenance. It is recommended that the contractor inspect the system once a year to ensure that all hardware and wiring is intact and that the system is functioning properly. There will likely be a charge for this service. Beyond this, the solar panels, inverter, and mounting system require no routine maintenance.

Take care that no shading of panels occurs over time due to vegetation growth or future placement of equipment or obstructions on the roof that block the panels from direct sunlight. Any such shading, even when it is temporary (i.e. only for a short time during the day) will reduce the electricity production of the system.

The following additional information is provided to supplement Operations and Maintenance Manuals provided by the contractor as part of the closeout process.

Key Features of Solar PV

A system disconnect is required on the outside of the building

Per requirements of NSTAR, a means of disconnecting the PV system from the utility grid is required on the outside of the building. This disconnect is intended to be used only by NSTAR technicians and is usually locked by your solar contractor to prevent unauthorized opening of the protective enclosure.

The PV system will not supply your building with electricity during power outages

Unless you have invested in battery storage, which is typically quite expensive, your grid-connected PV system will not produce electricity when utility power is not available to your building (i.e. during a power outage). This auto-disconnect feature is to protect the safety of utility line crews that may be working to repair the electrical distribution system. The inverter's grid monitoring and fault detection capabilities prevent islanding (the flow of power from the PV system onto the utility grid and to your building) when the grid's power is down. Thus, when the neighborhood experiences a utility power outage, the PV system will immediately stop producing power.

You can monitor the status of the PV system on the internet

PV systems will typically come with a Data Acquisition System (DAS) that allows for web-based data monitoring. This should have been specified in your contract. The DAS can be configured to send email alerts when the system is not working properly or requires maintenance. Talk to your contractor about email alert options. Also, you can use the internet to view the daily energy production as well as factors that affect production such as the amount of sunlight and the ambient air temperature.

NSTAR will credit your utility account for any excess power the PV system produces

It is important to try to maximize the production of the PV system at all times. PV systems that are interconnected to the grid are allowed to "net meter" the production of excess power. That means that any power that the system produces that is not used on-site can flow back across the electric meter to the NSTAR grid for a credit against power purchased.

Most grid-connected PV systems do not include battery storage. Power must be used as it is produced. During daylight hours, the PV system may be producing more electricity than the building can use at that time. This net surplus of electricity flows into the NSTAR electric grid, turning the electrical meter backwards and, thereby effectively reducing the power purchased from NSTAR. Every kilowatt-hour produced saves the customer on electricity supplied by and purchased from NSTAR.

Solar Renewable Energy Credits (SRECs)

Solar Renewable Energy Credits are an additional source of revenue from a PV system you own. When a system is leased, these SRECs are usually the property of the party that owns the system. SRECs are "minted" when a PV system generates electricity. They are used as the record of solar electricity produced.

Because there are Massachusetts goals and requirements for solar electricity production, these SRECs have market value. In order to receive credit for SRECs that are produced by a PV system, each PV system owner must sign up for an account with the Massachusetts Department of Energy Resources. For small residential systems, this is generally done through an Aggregator. Aggregators are businesses that have been established to gather and sell SRECs produced by smaller solar electric generators in exchange for a percentage of the proceeds.

Once a month, the DAS will report the production data from your PV system to the Production Tracking System (PTS) of Massachusetts. The PTS records solar energy production from your system every month for SREC purposes.

For more information about SRECs and Aggregators go to www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/about-the-rps-solar-carve-out-program.html

Additional Information

Approximately how large should my system be?

The size of the system on your building, measured in kilowatts (kW), will determine how much power it will produce, measured in kilowatts per hour (kilowatt hours or kWhs). The Cambridge Solar Tool can only get you so far in estimating system size, so you will need an experienced solar contractor to estimate the appropriate size for the system. Among the issues that are relevant are shading, rooftop equipment, and open roof area. The ultimate size of a system can affect how the system is owned, the economics of the project, and its physical design.

Some solar contractors will make these determinations with the assistance of satellite imagery, and some will want to visit the property. Still others will ask you to take a few photographs and email them to the contractor's office.

Will my roof need costly structural repairs or upgrades in order to carry the equipment?

A PV system adds weight load to the roof and this additional load needs to be within the roof's structural carrying capacity. A full structural analysis by a Massachusetts-registered structural engineer is the only way to determine if and what structural upgrades are needed to accommodate a PV system and to determine associated costs. This analysis is important to determine if structural upgrades are necessary for the project to proceed and if so, whether this expense will be acceptable to the Buyer. The contractor should know how much such a structural analysis would cost.

The solar contractor should examine your roof and the underlying structure to determine whether or not your roof structure may require major alterations and repairs to accommodate a PV system. Making such improvements could make the project financially unfeasible.

The contractor will need to visit your building to see the building's roof structure and potentially review existing building plans. Review of existing plans and drawings may be required to get more information about the structure. The Massachusetts Building Code was updated recently and the guidelines for adding solar equipment to a roof have been tightened.

Will the Cambridge Historic Commission allow my project?

Cambridge has two historic and four neighborhood conservation districts that have defined and limited the type of renovations that can be made to visible areas of buildings. The Cambridge Historic Commission is responsible for determining if and how rooftop solar systems can be installed on a particular building that is within one of these districts.

Ask the solar contractor to see if your building is within one of these districts and to review the ordinances that apply to alterations to your property. Note that there are already PV systems installed within these districts throughout Cambridge, so installation is possible. It does take time and careful consideration to meet the specific requirements of these City ordinances, so plan accordingly.

Is my building located in a special NSTAR network?

The solar contractor will need to consult NSTAR Electric to definitively determine whether your building is located in a special area network. If you are within such a network, you will probably not be able to install a PV system.

How will my PV system connect to the power grid?

Practicality and project economics require that a PV system on a building be interconnected through an electric meter to the NSTAR power grid. This allows the building to continue to receive power when the sun is not shining and the system is not producing power (e.g. evening hours). It also permits the sale of any excess electricity generation back to the grid at nearly retail value when the PV system produces more electricity than is needed on-site.

Condominium PV Checklist

1. Is Your Building Right for Solar?

Step 1: Confirm that your building gets enough sunlight

- If your roof has good to excellent solar potential, proceed to Step 2.
- If your roof has little or no solar potential, the project is not worth pursuing at this time.
- If you are still unsure about the solar potential, ask a solar contractor to evaluate your building.

Step 2: Confirm that your roof is ready for solar

- ***If remaining roof lifetime is less than 5 years***,

  Replace roof now and install solar **or** wait until end of roof life to install solar.

- ***If remaining roof lifetime is 5 to 15 years,***

  Replace roof now and then install solar
  or wait until end roof life to install solar
  or repair roof to extend its life (you want at least 15 years of remaining life) and then install solar
  or Install solar now on the existing roof (factoring in future costs to remove and reinstall solar panels when you re-roof) and replace the roof later.

- ***If remaining lifetime is greater than 15 years,***

  Proceed to Step 3.

Step 3: Gauge the interest of other owners and the Association

- If there is sufficient support for the idea, share it with the Association Board.
- If the Association agrees that this idea is worth considering further, seek out a solar contractor to provide the expert support needed to address more technical questions.

Step 4: Engage a solar contractor to support your research

Step 5: Address technical issues with the help of a solar contractor

- After considering the following questions, if the contractor feels that the project is viable, return to the Association to share information, get feedback, and seek approvals to proceed.
  - ✓ Is your building located in a special NSTAR network area?
  - ✓ How much roof space is there for solar, eliminating areas that are shaded or have other uses?
  - ✓ Will the roof structure support the weight of the solar panels?
  - ✓ Will the Cambridge Historical Commission object to a solar project at that location?

2. SECURING ASSOCIATION APPROVAL

Step 1: Estimate project economics

Step 2: Identify interconnection options

Step 3: Evaluate legal issues

- Identify if there are any restrictions on placing equipment on the roof and the legal process for making changes to allowable uses.
- If a vote is required to authorize the project to proceed, determine the majority required

Step 4: Meet with the Association

- Discuss project economics, legal issues, ownership, and interconnection options

Step 5: Secure Association approval for the project

- If the project is approved, proceed to Project Design and Construction.
- If the project is not approved, assess the issues that are preventing approval, schedule additional meetings as necessary, then vote again

3. PROJECT DESIGN AND CONSTRUCTION

Step 1: Select a solar PV installation contractor

- Qualify several solar contractors and secure quotes from them.
- Quotes from contractors should include pricing for both design and construction.
- Each contractor should confirm building information and take responsibility for its accuracy.
- Schedule a site visit for prospective contractors.
- Select a contractor based on cost, qualifications, and work style.

Step 2: Contract execution

- Review the contractor's contract and negotiate additional details as necessary.
- Ensure that the contract confirms all representations made during the proposal process and subsequent negotiations.
- Ensure contract specifies what is covered in the Design Phase and in the Construction Phase, including deliverables, separate price for design and for construction, and payment schedule.
- The contract should allow the buyer to opt out of construction at the end of the Design Phase.
- Consider having your attorney review the final contract prior to your signing.
- Do not allow construction to begin until you receive the certificates of insurance for the contractor and subcontractors.

Step 3: System design

- Confirm the Design Phase contract includes the cost of a Massachusetts-registered structural engineer providing a structural analysis and report.
- If structural upgrades are required, ensure that the structural engineer and contractor provide exact costs and the scope of work to factor into the construction budget and timeline.
- Contractor produces design and construction drawings.

Step 4: Approve final design and authorize start of construction

- Review and formally approve the design documents prepared by the contractor.
- After approving the design, authorize start of construction.

Step 5: City building permits and interconnection application to NSTAR

- Confirm that costs for the building permits and interconnection application were in the contract.
- Confirm that contractor completes all paperwork necessary to start construction, including obtaining building permits from the City and submitting interconnection application to NSTAR.

Step 6: Construction

- Hold regular meetings where the installation contractor provides updates on construction progress.
- Formally approve any changes to the construction schedule included in the contract.

Step 7: Commissioning the system

- Ensure that the contractor tests all equipment to confirm it is operating properly.

Step 8: City inspections and interconnection to the power grid

- Ensure that the contractor arranges for City wiring and building inspections
- Ensure that the contractor coordinates the final interconnection approval by NSTAR.

Step 9: Project closeout

- Before making final payment:
  - ✓ Confirm the contractor has met all contractual responsibilities.
  - ✓ Ensure you have received technical manuals, equipment specification sheets, as-built design drawings, and warranties.
  - ✓ Insist on receiving training about safety and system operations and maintenance.

Step 10: Homeowner insurance

- Notify your home insurance company and the master insurance company that the PV system has been installed on the roof.
- Add supplemental coverage if advised to do so by your insurance agent

4. Operating and Maintaining the System

- Have your system inspected once a year to ensure that all hardware and wiring is intact and the system is functioning properly.
- Take care that no shading of panels occurs over time due to vegetation growth or future placement of equipment or obstructions on the roof that block the panels from direct sunlight
- Use the web-based Data Acquisition System (DAS) to view energy production
- Have DAS configured to send you email alerts when the system is not working properly or requires maintenance.