MASSACHUSETTS RESIDENTIAL GUIDE TO SOLAR ELECTRICITY

MASSACHUSETTS CLEAN ENERGY CENTER

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Introduction

Solar Electricity Today

Solar electric systems, also known as photovoltaics or PV, convert sunlight into electrical energy through an array of panels that connect to a building's electrical system and/or the electrical grid.

Massachusetts initiated its first incentive program for solar electricity in 2001, funded through a small renewable energy charge on most electric utility bills.

Residents who have already installed solar electric systems cite many different reasons for going solar, including:

- Good financial investment and electricity cost savings;
- Concern about pollution, the environment and climate change; and
- Desire for energy independence, increased control over energy choices and price stability.

For many residents and business owners throughout Massachusetts, installing a solar electric system is a smart investment that converts clean, free sunlight to electricity, reduces air pollution, reduces or eliminates monthly electricity bills and contributes to the local economy by creating local jobs and supporting local businesses.

About this Guide

The aim of this guide is to assist Massachusetts residents who are considering using solar energy to generate electricity to power their homes. This guide can help you determine whether a solar electric system is right for you both technically and economically. It reviews the installation process and provides resources on finding an installer, the incentives available and other pertinent information about solar electricity. This guide focuses on grid-connected solar electric systems; however, the use of solar electric for off-grid electricity generation can be cost-effective in remote locations where it is impractical or uneconomical to connect to the electric grid. While this guide is intended primarily for homeowners, many of the issues discussed apply to small-scale installations in general and may apply to businesses considering installing solar electric systems.

Some of the regulations and incentives discussed in this guide may not apply to certain customers of Municipal Light Plants (MLPs). Customers of MLPs should contact the MLP to determine whether the MLP allows for net metering and interconnection, and whether there are any incentives or requirements in addition to or in place of those described in this guide. See www.masscec.com/content/municipal-lighting-plant-communities for more information.

More Resources

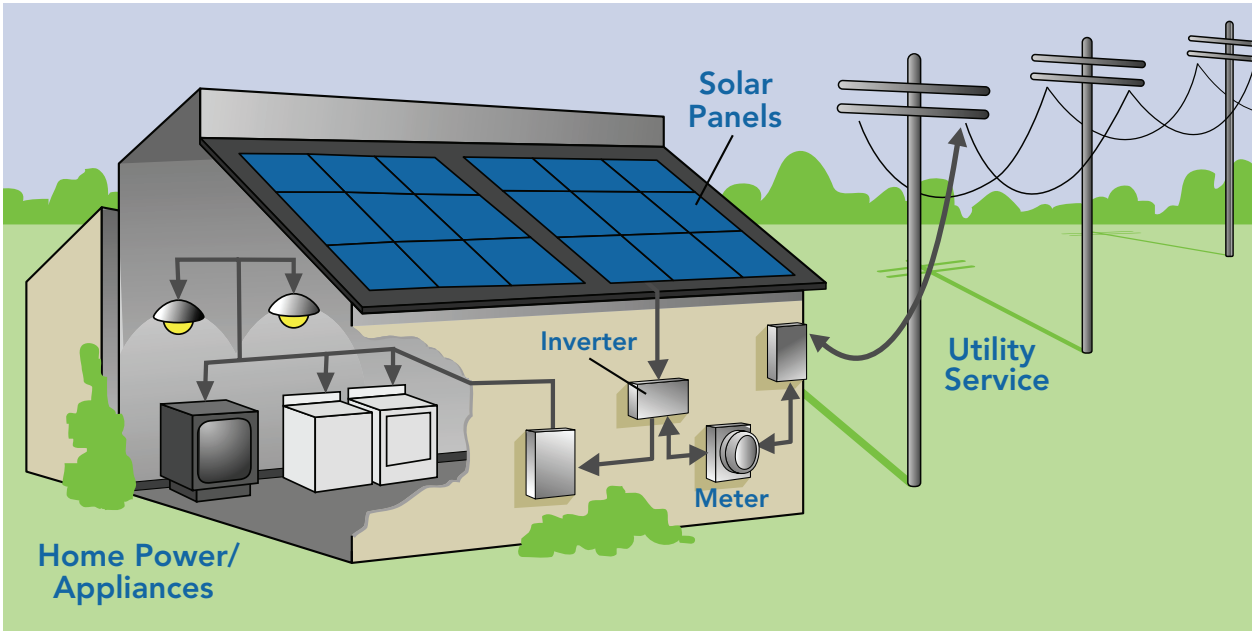
Visit www.MassCEC.com and www.MassCEC.com/Solar for additional resources and information regarding solar electric systems and other clean energy technologies targeted at a broad range of clean energy consumers, producers and stakeholders.

About MassCEC

Created by the Green Jobs Act of 2008, the Massachusetts Clean Energy Center (MassCEC) is dedicated to accelerating the success of clean energy technologies, companies and projects in the Commonwealth—while creating high-quality jobs and long-term economic growth for the people of Massachusetts. MassCEC is a partner, clearinghouse and connector for people in the clean energy sector, making direct investments in clean energy companies, building a strong clean energy workforce and supporting responsibly sited renewable energy projects across the Commonwealth. MassCEC works with the entire clean energy community in Massachusetts to propel promising technologies from the drawing board to the global marketplace. For more information visit: www.MassCEC.com.

Wayne National Forest

Solar Electric System Components



NREL

A solar electric system consists of a few pieces of equipment wired together and connected to a home's power distribution network.

Components can include:

Solar Electric Array

When sunlight strikes the semiconductor material inside a solar cell it frees electrons, which form an electric current in the cell. This process converts sunlight directly into electricity. The more intense the sunlight striking the cell, the greater the amount of electricity produced. Solar cells are aggregated together to form a panel or a module. A solar array generally includes several modules wired together to achieve the desired system capacity or power producing capability.

Inverter

Solar electric panels produce direct current (DC) power, which must be converted to alternating current (AC) power that is supplied by electric utilities in the United States. This is accomplished by an inverter. Typically, the inverter is located near where the electric service from the local utility enters the house (close to the electrical panel). Alternatively, micro-inverters may be individually placed directly behind each panel, which converts the electricity from DC to AC at the panel level. In grid-connected systems, inverters are designed so that if power from the utility goes down, the solar electric system will shut down as well. This is an important safety precaution for utility workers, and the solar electric system will not restart until power has been restored to the grid.

External Shut-Off

Massachusetts utilities require solar electric systems to have an external shut off, often called a "disconnect," so the power company can shut down the system when workers are fixing the power lines or in any other necessary situations.

Battery

Most solar electric systems installed to date in Massachusetts do not have a battery, because batteries add to the cost of a system. Due to net metering (discussed later in this guide), owners of solar electric systems in Massachusetts do not need a battery to balance their load (the process of matching generation to consumption). However, only systems with a battery will operate when the electric grid is offline.

Meter(s)

To utilize net metering, a solar electric system must have a special net meter, which spins backwards when the system is producing more electricity than is being consumed on site. A second meter is also required to exclusively track cumulative production from the solar electric system for purposes of reporting production and receiving Solar Renewable Energy Certificates (SRECs—the state production based incentive program discussed later in this guide).

Data Acquisition System (DAS)

A data acquisition system automatically reports the amount of the electricity generated by a solar electric system to an online database managed by MassCEC. A DAS can automate the process of receiving SRECs, and is required for systems above 10 kilowatts in order to qualify to receive SRECs.

Solar Electric System Life

Solar electric systems have few moving parts and are designed to last at least 20 years. Solar panel production is typically guaranteed by manufacturer warranties for 20 years. While the electricity output of solar panels slowly degrades over time, this warranty means that the panels will produce at least 80 percent of what they originally produced when they were first installed. A number of systems installed in Massachusetts in the 1980s continue to produce power today. While the inverter's life is shorter than panel life, manufacturing improvements have extended the inverter life to around 15 years or more for some equipment. Typically warranties average around 10 years for central inverters, and 25 years for micro-inverters.

Equipment life will be a function of the equipment selected, the environmental conditions under which it is maintained and overall system design.

More Resources

Solar Electric System Components

Energy.gov: Small Solar Electric Systems

www.energy.gov/energysaver/articles/small-solar-electric-systems

National Renewable Energy Laboratory (NREL): Solar Research

www.nrel.gov/solar/

Flickr user SandTDesign

Sizing and Optimizing a Solar Electric System

It is important that a homeowner understand their electricity usage in order for a solar electric system to be appropriately sized. Monthly utility bills include a summary of how much power a homeowner has used each month for the past year. The installer will want a copy of a recent bill to determine an appropriate system size based on the site's characteristics, power needs and the homeowner's budget.

Utilities charge residential customers for actual consumption, measured in kilowatt-hours (kWh) of electricity consumed, which can be seen on the electric bill. As an example, if a 40 watt light bulb is turned on for 100 hours, a total of 4,000 watt-hours (4 kWh) of electricity would be consumed. The average New England household uses 7,536 kWh per year,[1] though both higher and lower levels of consumption are common.

For residential systems, system size is measured in kilowatts (1,000 watts).

The actual electricity generated by a solar electric system is a function of its size, efficiency, sun exposure and a variety of other factors discussed below. Residential solar electric systems are generally sized around 6,000 watts, or six kilowatts (kW). In Massachusetts, a one kilowatt (kW) solar electric system will generally produce 1,100 kWh of electricity per year, which means that a 6 kW system will produce roughly 6,600 kWh per year.[2] This means that a solar electric system of that size will produce enough electricity to cover about eighty five percent of the average New England household's electricity usage every year.

Mounting

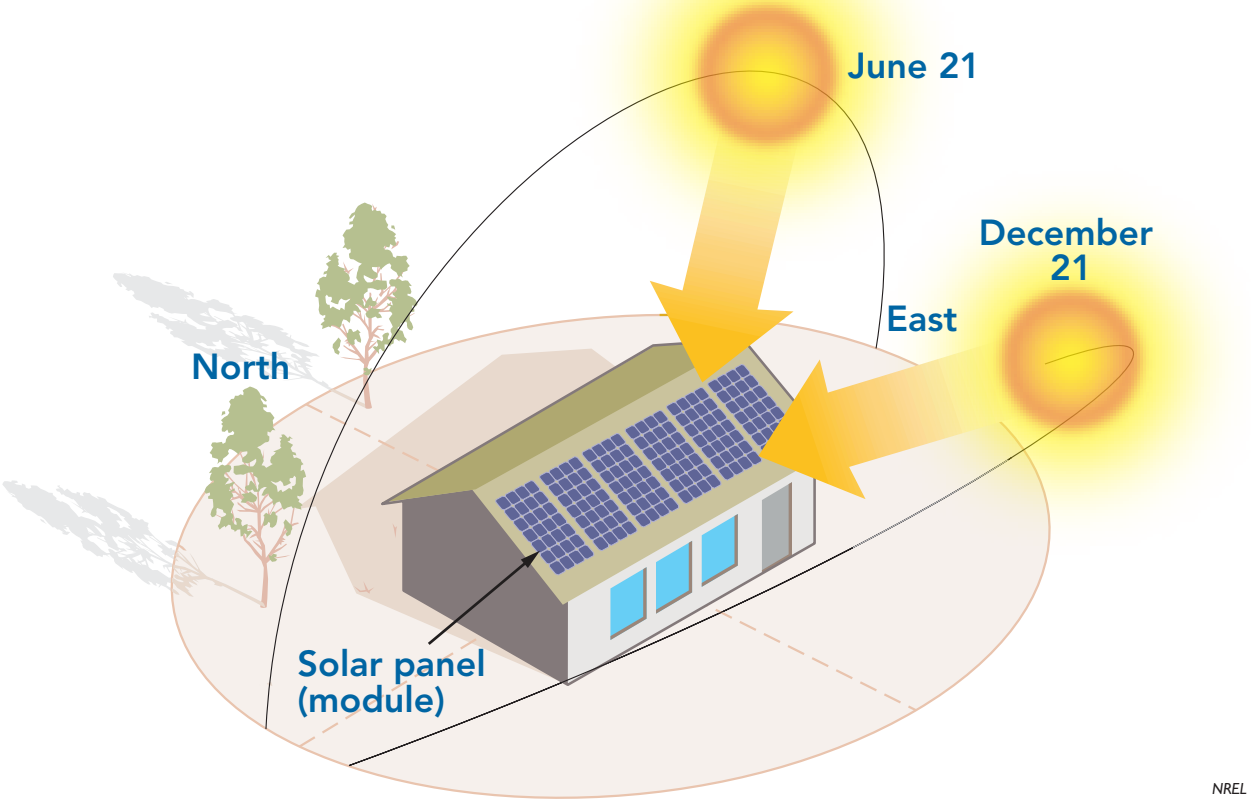
For most Massachusetts homeowners, rooftop installations are the easiest and most practical way to use solar electricity to power their homes. Rooftops provide a ready location for solar electric arrays and are unlikely to have competing uses. Roofs in New England are usually tilted to shed water and snow, which helps to keep solar electric modules clear from debris. Roof mounted systems also allow for a simple interconnection to a home's existing wiring, and a roof's elevation decreases the likelihood of shade falling on the array.

Massachusetts homeowners with open land on their property may also choose to install a ground-mounted solar electric system. The advantage of a ground- or pole-mounted system is that it can be oriented to the optimal south-facing direction and at the ideal tilt to maximize electricity production, without the limitations of a roof's exposure or slant. However, ground or pole-mounted systems typically have a higher cost than similar roof-mounted systems due to the expense

1 Energy Information Association, EIA-861- schedules 4A-D, EIA-861S and EIA-861U.

2 Calculation using PVWatts Tool, National Renewable Energy Lab, based on 1kW in optimal conditions, Boston, MA

Sun's Path During Summer and Winter



NREL

of the ground-based substructure and racking that the panels are mounted to, the potential for existing and future vegetation to cast shadows on a system, and the potential for damage or vandalism.

Roof Orientation

Roof-mounted solar electric systems should be oriented as close to due south as possible in order to maximize annual power production. Systems whose orientation is not due south have less direct sun exposure, resulting in lower electricity output. However, systems can still perform economically even if their orientation is not perfect.

Tilt

For maximum annual generation in Massachusetts, a solar array should be installed at approximately a 30-45 degree angle to the horizon. Most homes in New England have roofs that are pitched at 33 degrees or more in order to shed snow and ice. A solar electric system can also be installed at a more shallow tilt, though it may produce slightly less electricity.

Shading

Even a small amount of shading on solar panels can reduce a solar electric system's productivity. Ideally, a system should have no shade for at least 6 hours a day. Systems should be sited to maximize their direct exposure to sunlight and to avoid shading by a home's structural elements (such as window dormers or chimneys), nearby trees and vegetation (including smaller trees that could later become obstacles) or other buildings. Technologies like micro-inverters enable solar electric systems to be somewhat more shade tolerant, as the shading will only

Paul Armstrong

This site is an ideal location for a solar electric system. The roof has a southern orientation, with minimal structural impediments on the roof, and no shading.

Flickr.com/RBerteig

This site presents challenges for installing a solar electric system. The east-west orientation and heavy shading are both impediments to solar electricity. These problems could be remedied, but would add cost to the project.

effect the panels that are directly shaded, rather than reducing the output of the entire system. A solar installer will present options to help a customer maximize solar production for their particular site.

The installer should conduct a thorough shading analysis of the roof or proposed location of a ground-mounted system, identifying the best location and configuration to avoid shading by trees and roof protrusions.

Roof Condition

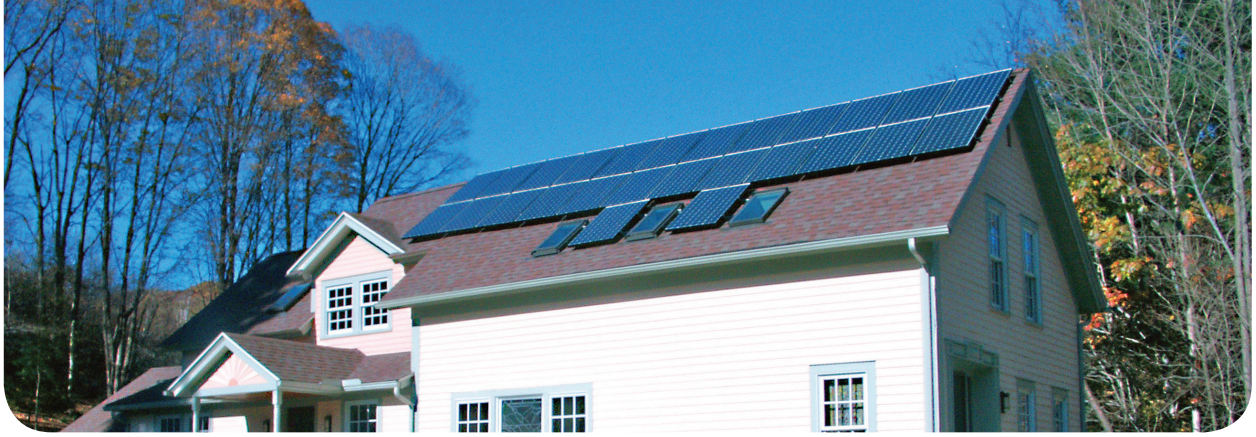
With the guidance of a solar contractor, homeowners should evaluate the structural condition of their roof and shingles before a system is installed to ensure that roof repairs or replacement will not be necessary in the near future. Removal of a solar electric system may add cost to a roof replacement, as a solar contractor or electrician would need to be employed to remove the panels before in order for the roof to be replaced, and re-install them once the roofing was complete.

Ideally, any necessary roof repairs should be made before a solar electric system is put in place. Although the panels may act as a shield for sun or rain directly hitting the roof, potentially prolonging the roof life, some installers recommend replacement if the roof has a remaining lifetime of eight years or less.

Cyclical Fluctuations

Because the sun moves across the sky at varying heights from sunrise to sunset and from season to season, the amount of electricity generated by a module varies during the daylight hours and over the course of the year.

Residential solar electric installations are typically stationary, meaning they do not follow the track of the sun over the course of the day, and are generally fixed, meaning they are not adjusted to account for changes in sun angle from season to season. Therefore, to maximize the production of electricity, the design of individual solar electric systems must take into consideration and optimize for module tilt, orientation and shading.



Bob Gaffney

Important Regulations

Massachusetts has laws and regulations in place to ensure that solar electric systems are safely installed and seamlessly connected to the electricity grid. Some regulations also provide additional benefits for installing solar electric systems.

Electrical Grid Interconnection and Net Metering

Most Massachusetts homes with solar electric systems are able to interconnect with the electrical grid, allowing the homeowner to purchase power from the electric distribution company when the solar electric system is not producing as much electricity as the homeowner is using. Utilities may require a special inspection prior to interconnection to ensure that the solar electric system complies with established technical, performance, and safety requirements.

Electricity customers with solar electric systems can sell any excess power they produce back to their utility and receive a credit at almost the full retail rate for the power produced. This practice is called net metering. As a customer produces electricity, the net meter will spin backwards, just as it spins forward when the customer consumes electricity. At the end of each billing period the customer is billed for the net electricity consumed over the entire billing period. This is the difference between the amount of electricity delivered from the electric grid and the electricity generated by the solar electric system and put onto the grid. Customers receive net metering credits for any net excess, which can be applied toward future electricity bills.

Investor-owned utilities are prohibited from imposing special fees on net metered customers as long as the system meets the established interconnection standards. In rare instance when a homeowner has a particularly large system, charges may apply to the interconnection process.

Renewable Portfolio Standard: Solar Carve-Out

Load serving entities in Massachusetts (investor-owned electric utilities and competitive suppliers) are required to procure a certain amount of their electricity from solar electric systems. To comply with this requirement, load serving entities must purchase Solar Renewable Energy Certificates (SRECs) equivalent to their annual compliance obligation as established under the Solar Carve-Out I and II Programs. SRECs under these programs are issued to owners of solar electric generating assets. Residents may elect to participate in the Solar Carve-Out or any successor program. For more information, see the "Economics of Solar Electricity" section of this guide.

Local Permitting

Installation of a solar electric system will require the same local approvals as any other building construction and electrical work. A building and electrical permit will need to be pulled by the installer, and inspections will be required to verify that the installation meets state and local code requirements.

Licensing

Massachusetts law establishes specific licensing requirements for system installers, including a requirement that solar electric systems be installed by Massachusetts licensed electricians. In addition, there are various training and certification programs which many installers go through, such as those offered by the North American Board of Certified Energy Practitioners (NABCEP).

More Resources

Regulatory, Net Metering, and Interconnection Resources

Massachusetts Department of Energy Resources (DOER)

www.mass.gov/doer

Massachusetts DOER: RPS Solar Carve-Out

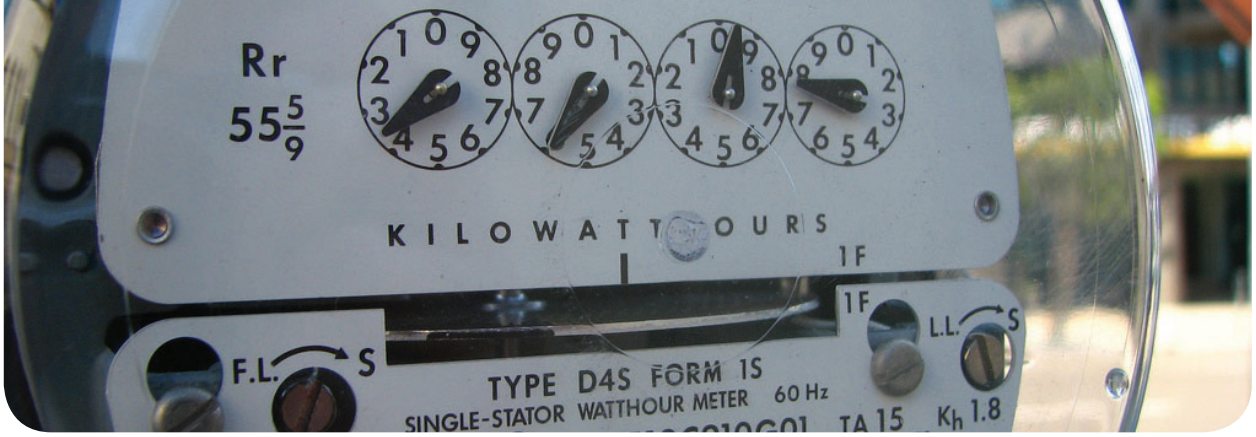
www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/

Massachusetts Department of Public Utilities

www.mass.gov/dpu

Massachusetts Distributed Generation and Interconnection Information by Utility

sites.google.com/site/massdgic



Flickr.com/brutalworks

Economics of Solar Electric Systems

The financial return on investing in a solar electric system in Massachusetts can be very favorable for homeowners with a suitable site. Solar electric systems in Massachusetts often have a six-to-eight-year payback period, and will continue to produce financial returns long after the system is paid off. The life of a solar electric system is 20 years, if not much longer. Purchasing a solar electric system often requires upfront installation and equipment costs, but there are significant economic benefits that are realized over time.

Homeowners considering solar electric systems are advised to consult a professional to determine if the potential project would be eligible for available tax incentives, how these tax incentives may impact one another and the taxability of any revenues received for a project. System paybacks will vary depending on the net system cost. Homeowners are encouraged to discuss the financial aspects of owning a solar electric system with their installer and any other expert.

Upfront Costs and Incentives

The cost of solar electric systems has declined considerably over the last few years. Actual costs will vary based on system size, site characteristics, permit fees and any optional equipment additions. To learn more about solar in Massachusetts, go to www.MassCEC.com/solar.

Upfront costs can be offset by the following:

Federal Tax Credit: Most owners of new residential solar electric systems qualify for the federal Residential Renewable Energy Tax Credit for 30 percent of total system costs.[3] Note that the Federal Tax Credit is subject to change at the end of calendar year 2016. www.Energy.gov can be monitored for future updates.

Massachusetts Personal Income Tax Credit: Most owners of new residential solar electric systems, located on their primary residence in Massachusetts, qualify for a state personal income tax credit for the lesser of 15 percent of the total cost of the solar electric system, or up to $1,000.[4]

Massachusetts Sales Tax Exemption: Equipment purchased for a residential solar electric system in Massachusetts is usually exempt from state sales tax.[5]

Massachusetts Property Tax Exemption: Homeowners with a solar electric system may be eligible for a property tax exemption on the value added by the system. Homeowners are encouraged to discuss this with their installer and the local tax assessor's office.

3 26 USC § 25D

4 M.G.L. c. 62, sec. 6(d)

5 M.G.L. c. 64H, sec. 6(dd)

Long Term Costs, Savings and Incentives

Solar electric system owners will also realize long term economic benefits such as:

Avoided Electricity Costs

The most fundamental benefit a homeowner will receive from a solar electric system is the electricity generated, which directly displaces electricity that the homeowner would otherwise purchase from an electric distribution utility. Fuel cost increases, rising demand for fuel or electricity and fuel supply constraints can all cause the cost of purchasing electricity from an electric distribution utility to increase. Purchasing a solar electric system is the equivalent to paying for many years of electricity use in advance, at a fixed and stable price. Homeowners can get a very accurate projection of the cost they are paying for the solar power produced today and into the future, because the fuel price is stable (sunlight will always be free), solar resource (days of sunlight per year in a given region) is generally predictable, and there is little system maintenance required. Due to net metering, solar electric system owners can realize the value of all of the electricity they generate.

Solar Renewable Energy Certificates

Under the current Solar Carve-Out II program, solar electric system owners can generate income from the sale of Solar Renewable Energy Certificates (SRECs), which are the positive environmental attributes of the clean energy produced by a solar electric system. SRECs are tradable certificates that are issued to owners of solar electric systems at a rate of one SREC per megawatt-hour (1,000 kWh) generated. Installers will assist customers in finding an aggregator or broker who will guide customers through the process of qualifying with the Massachusetts Department of Energy Resources (DOER), so that the owner can can sell SRECs. The DOER also maintains a list on their website of companies that offer SREC aggregation services.[6] SRECs create a way to obtain long-term financing for solar electric systems, and are intended to be one of the primary incentives to help pay for the installation of a residential solar electric system. An average residential system of 6 kilowatts will generate between six and seven SRECs per year. While the value of the SRECs will vary based on the quarter in which they are sold and current market demand, the system owner may elect to participate in a mechanism called the Solar Clearinghouse Auction, where an SREC may sell for a specified amount. Please see the DOER's SREC page for more information.[7] Residents may elect to participate in the Solar Carve-Out, or any successor program.

Home Value Appreciation

Market conditions and the interests of particular buyers will ultimately determine the sale price of a home. However, recent research suggests a solar electric system can increase a home's market value if prospective buyers understand the financial benefits that the system creates. A 2014 study by the Lawrence Berkley National Lab, called Selling Into the Sun,[8] found that prospective home buyers in Massachusetts and other states in the U.S. were willing to pay more for a property with a resident-owned solar electric system. The average premium across various states, housing markets, electric markets and home types was $4 per watt. This equated to a premium of about $15,000 for a typical electric system.

System Maintenance

As is the case with any appliance, solar electric systems require some maintenance over their lifetime. This generally includes making sure the solar panels are receiving unobstructed sunlight, and replacing the inverter (if it is a central inverter rather than micro-inverters) generally once during the life of the solar electric system, which should be at least 20 years. Installers should provide a minimum five year labor warranty to protect the equipment against defective workmanship, component breakdown or significant degradation in electrical output. In addition, the solar electric equipment should have appropriate manufacturer's warranties. See the "How to Go Solar" section of this guide for more information on warranties.

6 www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/market-resources-aggregators-retail.html

7 www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/

8 emp.lbl.gov/sites/all/files/selling-into-the-sun-jan12.pdf

Financing Options

Third Party Ownership

Massachusetts' vibrant solar industry offers a variety of ownership and financing options for residents and businesses looking to install a solar electric system. One way to use solar electricity on a home, but avoid the large upfront cost, is to work with a company that will own the solar electric system and either sell the homeowner the electricity generated on a dollar per kilowatt hour basis through what is called a power purchase agreement (PPA), or lease the system to the homeowner for a monthly rate. Companies like these will generally be responsible for the installation work and any ongoing operation and maintenance work on the system. Many different forms of this third-party ownership model have emerged to respond to increasing demand from consumers.

When considering a PPA or leased solar electric system, review the contract carefully to fully understand the terms and conditions. While contractual terms will vary, items to consider are the length of the contract, whether there is a buy-out option, the initial price and any applicable price escalators, who will be responsible for system operation and maintenance, which party is entitled to any applicable incentives and what happens at the end of the contract term.

Mass Solar Loan

MassCEC and DOER have partnered together to offer the Mass Solar Loan program, which is focused on enabling lower cost financing for residents interested in purchasing a solar electric system. The loan support provided under the program includes an interest rate buy-down, income-based loan support, and a loan loss reserve for qualified projects. To learn more, please visit www.masssolarloan.com.

In addition, many solar electric system owners in Massachusetts utilize traditional financing mechanisms, such as home equity loans or other bank loans, to finance the purchase of their system. See the DOER Residential Financing Guide[9] and the CESA's Homeowner's Guide to Solar Financing[10] for more information.

More Resources

Economics of Solar Electric Systems

MassCEC: About Solar

www.MassCEC.com/Solar

Database of State Incentives for Renewables and Efficiency (DSIRE)

www.dsireusa.org

9 http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/solar-financing-initiative.html

10 http://www.cesa.org/assets/2015-Files/Homeowners-Guide-to-Solar-Financing.pdf

Flickr.com/knile

Environmental Benefits of Solar Electricity

Use of solar electric systems to generate electricity dramatically reduces the environmental impact of the myriad personal, industrial and commercial processes which rely on electricity. Solar electric modules do not emit greenhouse gases or other pollutants, and do not require intensive mining operations to provide fuel. Compared to the mix of fossil fuel power sources typically used to produce power for New England consumers, every 1,000 kWh generated by a solar electric system avoids sending 0.32 pounds of sulfur dioxide, 0.36 pounds of nitrogen oxides and 730 pounds of carbon dioxide emissions into the atmosphere.[11] In addition, solar electric systems reduce the production of particulates that contribute to respiratory problems.

Alexey Sergeev

Flickr.com/Knile

11 2013 ISO New England Electric Generator Air Emissions Report

Frank Stiebel

Complementary Technologies and Alternatives to Solar Electric Systems

Whether due to shading, roof obstructions or other constraints, there are some residences where a solar electric system may not be feasible. Additionally, some homeowners considering a solar electric system may be wondering what more they can do to save money and reduce their energy footprint.

Consider other Clean Energy Technologies

There are several technologies that may be a good fit for your residence that can be paired with a solar electric system, or installed if a solar electric system is not an option. These technologies include:

Solar Hot Water

A solar hot water system captures heat from sunlight and circulates the thermal energy to your water tank. Additional state incentives may be available to residents who install a solar hot water system in addition to a solar electric system.

Heat Pumps

Heat pumps are highly-efficient heating and cooling systems that work by moving heat into or out of a building. Heat pumps require electricity to operate, so they pair well with solar electric systems.

Air-Source Heat Pumps

In the winter, air-source heat pumps take naturally-occurring heat from the outside air and distribute it throughout a building. In the summer, they remove heat from warm indoor air and distribute the cool air throughout a building. Air-source heat pumps can be a solution for a single room or a whole home.

Ground-Source Heat Pumps

Ground-source heat pumps use the nearly constant temperature underground to transfer heat, and are the most efficient type of heat pump. Ground-source heat pumps require a trench or well to operate.

Biomass Heating

Biomass heating technologies can use wood pellets or chips to provide heat to an entire home or business. Biomass pellet heating systems are fully automated central heating systems and can often integrate into existing heating systems.

See the More Resources section below to learn more about these technologies.

Community Shared Solar Model

Community Shared Solar (CSS) is a solar electric system built at a remote site that provides benefits to multiple participants. A CSS project is hosted by an entity with a suitable roof or parcel of land and is supported by participants, who invest in the project or purchase the electricity or net metering credits.[12] The CSS model is supported by the state through the SREC-II program and the Mass Solar Loan program.

More Resources

Complimentary Technologies and Alternatives to Solar Electric Systems Resources

Solar Hot Water

www.masscec.com/technology/solar-hot-water

Air Source and Ground Source Heat Pumps

www.masscec.com/technology/heat-pumps

Biomass Heating

www.masscec.com/technology/biomass-heating

Community Shared Solar

www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/community-shared-solar.html

12 For more information, see www.nrel.gov/docs/fy12osti/54570.pdf

Julie Chen

How to Go Solar

1) Consider Energy Efficiency First

Energy efficiency is generally considered to be the "low hanging fruit" when it comes to making fiscally sound, environmentally friendly choices about a home's energy use, and it is the most cost-effective way to reduce a home's total electricity use and cost. Massachusetts utilities offer free energy efficiency audits, advice and services to customers. Call Mass Save at 1-866-527-7283 or visit www.masssave.com for more information. If you live in a municipal light plant territory, contact your MLP to determine if they offer a free residential energy audit.

2) Contractor selection

How to find a Contractor

MassCEC maintains a list of online resources for finding solar electric installers, which can be found at www.MassCEC.com/Solar.

Multiple Bids

As with any home improvement project, a homeowner should seek multiple bids to find someone he or she is comfortable working with. Ask for a written description of what the installer will be doing, the proposed timeline, pricing, and potential expenses not included in the price.

References and Licenses

Potential solar electric customers should ask for references from previous customers, call and—if possible—visit one or more of the installer's previous installations. According to Massachusetts law, the primary vendor must be a registered home improvement contractor, have a licensed construction supervisor on staff, and have a Massachusetts licensed electrician either on staff or subcontracted to do the electrical work. If the installer plans to use subcontractors, get their references as well.

Liability and Workers Compensation Insurance

For liability protection homeowners should insist that a vendor carry a certificate of insurance for general liability insurance. A homeowner should also verify that workers' compensation insurance is carried to protect against liability for any on-site, work related injuries. These are required to obtain a building permit.

Warranties

Homeowners should ensure that equipment and workmanship are covered under appropriate warranties. It is recommended that customers request equipment warranties that, at a minimum, meet the requirements outlined below. Equipment should be UL listed and also be on the California Energy Commissions' list of approved equipment, found at http://www.gosolarcalifornia.ca.gov/equipment/index.php.

- **Workmanship:** Minimum five-year labor warranty provided by the installer to protect the purchaser against defective workmanship, solar electric project or component breakdown, or degradation in electrical output of more than fifteen percent from their originally rated electrical output during the warranty period. The warranty must cover the solar electric project, including modules and inverters, and provide for no-cost repair or replacement of the solar electric project or system components, including any associated labor during the warranty period.

- **Photovoltaic Modules:** Minimum of one year product warranty from date of sale to first consumer purchaser for product workmanship and materials. MassCEC recommends that the system have a minimum performance warranty of 20 years within which time the module will produce, under standard test conditions, a minimum of 80 percent of the product's minimum rated power at time of sale.

- **Inverters:** Minimum of 10 years product warranty from date of sale to first consumer purchaser for product workmanship and materials

- **Revenue grade production meters:** two-year product warranty.

- **Mounting equipment:** five-year product warranty.

Written Contract

The written contract with an installer should, at minimum, specify the exact equipment to be installed, all applicable warranty information, the project's start and completion dates, the itemized budget with any exclusions or potential adders, a list of any subcontractors that are going to be used, and a progress payment schedule. It is recommended that an installer provide a minimum five-year labor warranty to protect equipment against defective workmanship, electric component breakdown or significant degradation in electrical output. In addition, the solar electric equipment should have appropriate manufacturer's warranties.

3) Design

Prior to installation, the contractor will prepare a design for the solar electric system. The design can range from a simple site plan and electrical diagram to a more detailed set of plans and specifications, depending on the nature of the solar electric project and site. Where a solar electric system is being incorporated into new construction, it is advantageous to integrate the solar electric design process into the overall site planning and building design process to realize certain construction efficiencies and ensure optimal orientation and tilt of the system.

4) Permitting

All solar electric installations must comply with the requirements of the Massachusetts Electric Code. In addition, when an installation results in a structural change in an existing building, a solar electric system is subject to the Massachusetts Building Code. Solar electric installations require local permits and inspections by a local inspector. The licensed electrician on the job is responsible for ensuring that the installation meets state electrical code requirements.

The installation contractor must secure all necessary approvals from local permitting officials prior to putting the system into service.

5) Interconnection Application

State regulations govern the procedures for the interconnection between a solar electric system and the serving electrical distribution company. This includes the application process, technical specifications for the interconnection, and inspection requirements. The installer will be responsible for securing the approval to interconnect from the utility. In most cases, where the residence does not already have a net meter in place, the utility will need to install a new meter that will credit the customer for power sent back to the grid. This upgrade would take place after the system is installed, but before it is turned on.

6) Inspection and Interconnection

Once a solar electric system is fully installed, a local wiring inspector will come to the project site, review the system, and make sure it was installed properly and sign a certificate of completion (a copy of which is provided to the utility). The building inspector may also require a final inspection.

Commissioning is not complete until the system is satisfactorily inspected by the wiring inspector and the utility has confirmed that the system can interconnect to the power grid.

7) System Testing and Warranties

When the installation is complete, the installer should test the equipment to confirm that it is operating properly. Homeowners should also ensure that the installer provides copies of any technical equipment manuals and warranties. Many installers will provide a copy of commissioning test results to the owner and register the warranties. Finally, the installer should educate the owner about safety, operations, and maintenance requirements.

8) Participating in the SREC-II Program and System Monitoring

Once the system is operational, the selected SREC aggregator or broker will need to submit a System Qualification Application to the DOER to qualify the solar electric system under the SREC-II program. This will enable the solar electric system to generate and later sell SRECs. For information on how to sign up for SRECs, please go to www.MassCEC.com/PTS

Solar electric systems that participate in the SREC-II program are required to report production to MassCEC's Production Tracking System. Systems up to 10kW in nameplate capacity can report manually or automatically. Systems over 10kW will be required to report automatically via a Data Acquisition System (DAS) in order to participate in the SREC-II program. A DAS can add to the total system cost for a solar electric project and may require periodic fees. For more information, please visit www.masscec.com/content/data-acquisition-systems-das-service-providers.

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Homeowner's Solar Electricity Checklist

Preliminary Questions

- ☐ Do I know how much electricity I currently consume and how much it costs?
- ☐ Do I have a south, southeast, or southwest-facing roof? If not, do I have property with open space that might accommodate a ground-mounted solar electric system?
- ☐ Do I know where there is shading on my roof (or on my property) during different times of the day and at different times of year?
- ☐ Do I want to purchase and own the solar electric system, or do I want to work with a third-party company and either buy the electricity generated through a power purchase agreement or pay a monthly lease payment?
- ☐ Does the installer have any additional industry certifications, such as OSHA 40 or NABCEP?

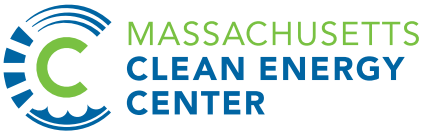
Purchasing and Contracting

- ☐ Am I comfortable with the installer's knowledge and experience?
- ☐ Does the installer have credible references?
- ☐ Is the installer adequately insured to protect me, as well as the company's employees and subcontractors?
- ☐ Does the contract include performance specifications for the system being installed, including an estimate of the power that will be produced annually or under different conditions?
- ☐ Does the installation contract clearly lay out what is included and what is not included in the price?
- ☐ Do I want or need a DAS installed to measure, track and record power produced, or do I want to track system production manually?
- ☐ Does the proposed payment schedule protect me by allowing payment to be withheld until the system: 1) passes local code inspections, 2) receives utility interconnection approval and 3) is shown to be operating properly?
- ☐ Are all warranties clearly stated with information on how to exercise them?

Post Installation

- ❑ Has the installer tested and activated the system?
- ❑ Have all necessary inspections occurred?
- ❑ Has the installer left descriptive materials and equipment operating manuals as reference materials?
- ❑ Has the installer offered recommendations on aggregators or brokers who will work with me to participate in the SREC-II program?

Notes



63 Franklin Street, 3rd Floor | Boston, MA 02110

Phone: 617-315-9355 | Fax: 617-315-9356

Info@masscec.com | www.masscec.com