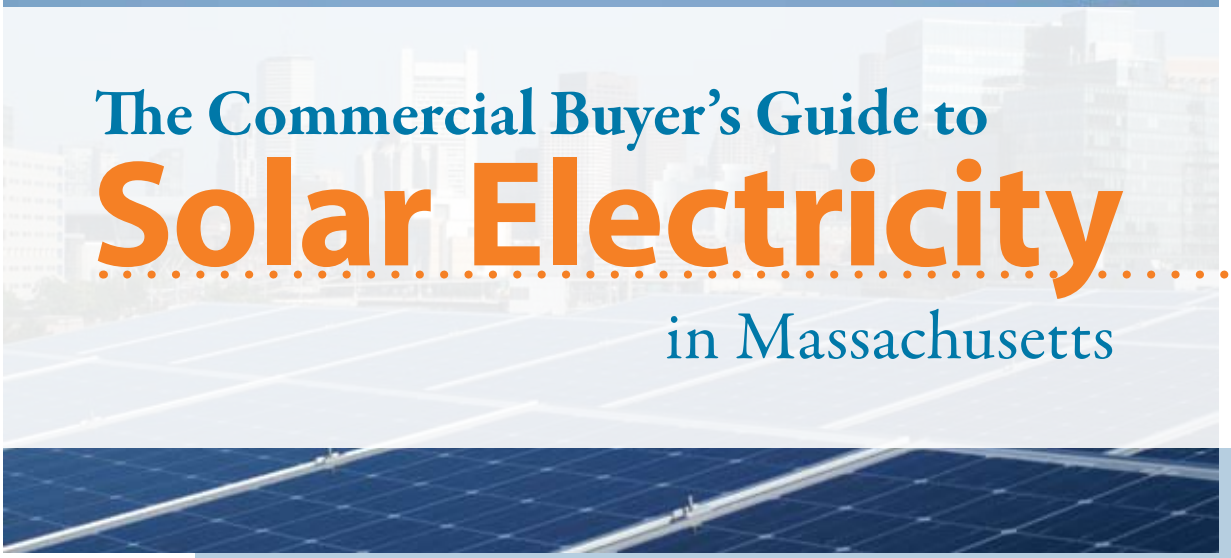
The Commercial Buyer's Guide to Solar Electricity in Massachusetts



Commonwealth Solar

Solar Energy Business Association of New England

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Introduction

There has never been a better time for businesses and other commercial facility owners to purchase photovoltaic (PV) systems to provide electricity for their operations.

- The Energy Improvement and Extension Act of 2008 extended the 30 percent federal tax credit for business investments in PV through 2016.
- Massachusetts continues to offer generous rebates to businesses through the Commonwealth Solar rebate program to encourage installation of PV systems.
- Purchasing a PV system is a great way to hedge against volatile oil and natural gas prices.

This guide has been published to help commercial facility owners identify and pursue opportunities to harness the sun's power to generate electricity. It provides information on how to evaluate whether PV is right for your business, including physical requirements of PV systems and system economics, as well as an overview of the system installation process.

It was prepared by the Solar Energy Business Association of New England (SEBANE), New England's trade association of solar energy equipment manufacturers and installers, for the Massachusetts Renewable Energy Trust (the Trust). The Trust administers the state's Commonwealth Solar rebate program.

It is the mission of the Trust to increase the supply and demand for renewable energy while stimulating economic growth in the clean energy industry, with the primary goal of generating maximum environmental and economic benefits to Massachusetts ratepayers. In addition to supporting solar PV projects through Commonwealth Solar, the Trust's other initiatives support wind, hydropower, bioenergy, and other renewable energy projects.

SEBANE promotes the use of solar energy and the development of the solar energy industry in the region. Its member installers and system designers and integrators have adopted a set of Member Principles that stress: compliance with laws and regulatory requirements; accuracy in representation of the technology's environmental and economic benefits, costs, and operational requirements; provision of clear, written warranties; professional workmanship; and respect for and protection of customer privacy.

Case Studies: Massachusetts PV Installations

Case study: Warehouse rooftop, 139 kilowatts

Wilson Language Training Corporation, Oxford

In 2004, Wilson Language Training Corporation completed construction on their warehouse distribution facility in Oxford. The company provides scientifically-based literacy curricula and comprehensive professional development for teachers to address dyslexia and other language based learning disabilities. As a leader by example in increasing literacy, the company wanted to take a similar approach to improving the environment, and decided to install a solar photovoltaic system.

"The cure for our world's environmental problems is achieved one step at a time, very much like we approach helping our students achieve literacy for life. Our motivation to install solar panels initiated from a desire to contribute to the solution," says Bert Baldarelli, Director of Financial Services for Wilson Language Training. "We also feel that there is significant public opinion benefit associated with being a leader in the sustainable energy movement, as is evidenced by the comments we have received from our customers and employees."

Wilson Language Training had its 139-kilowatt (kW) system installed across 9,000 square feet on its warehouse roof, with help from a Commonwealth Solar rebate. The system provides a 22% reduction in electricity use annually or approximately $19,000 per year—with an expected positive cash flow in the sixth year of operation. The capital saved in energy costs allowed the company to install an air-conditioning system on the distribution center, protecting their products and improving employee comfort during the hot summer months when the PV system is at peak production.

Wilson Language Training's success with its PV system has inspired it to take on other energy-saving projects: the company has upgraded the lighting in its warehouse to efficient T5 lighting, and is also considering installing motion detectors for light switches to help manage the electricity usage in areas that are used less often.

Case study: Large commercial complex, 170 kilowatts

Osgood Landing, North Andover

Ozzy Properties had a 170-kW PV system installed at its flagship property, Osgood Landing in North Andover. The system, which produces more than 190 megawatt-hours (MWh) of electricity per year, was integrated primarily using components made by Massachusetts companies. It consists of Evergreen Solar modules manufactured in Marlborough, a PanelClaw mounting system from North Andover, and Solectria Renewables inverters manufactured in Lawrence. The system is expected to pay for itself in about 4 to 5 years and will further provide decades of free electricity. With the incentives offered by the Trust, the return on investment was similar or even better than most other energy conservation projects with far greater programmatic benefits for the building and tenant businesses. Ozzy Properties already has installed another 70 kW at Heritage Place in Lawrence.

"The cornerstone for our business is being able to transform under-utilized office, manufacturing, and warehouse space into thriving commerce centers," says Orit Goldstein, President of Ozzy Properties, Inc. "Solar and other renewable technologies help us excel in our industry not only by offering a great return on investment, but also in attracting top companies to our facilities. Our clients take great pride in knowing their businesses are powered in part by solar panels on site."

Case study: Urban corporate headquarters, 100 kilowatts

WGBH, Brighton

WGBH's 100-kW solar array was installed at its new Brighton headquarters with partial funding from a Renewable Energy Trust grant. The new building is certified by the US Green Building Council's Leadership in Energy and Environmental Design (LEED) program: in addition to the solar panels, it is built on a former polluted "brownfield," using environmental construction practices, and has a "green" roof.

WGBH worked with Renewable Energy Communities, LLC under a power purchase agreement: Renewable Energy Communities will own the solar array for the first seven years, after which WGBH will have the option to buy the system at a predetermined contract price. This is a mutually beneficial relationship which allows the project to take advantage of federal tax credits.

"Our commitment to the environment motivated us to build a facility that would be as green in design as we could reasonably make it.," says David Norton, WGBH's Director of Physical Plant. "From the onset of the building design, we wanted a renewable energy source if at all possible and the PV system was the most practical choice for us."

Case study: Manufacturing facility, 18 kilowatts

Nanmac Corporation, Framingham

Nanmac recently had an 18-kW solar PV array installed at its temperature sensor manufacturing facility in Framingham. The system has reduced the company's electricity bills by 25%. Through the Commonwealth Solar program, Nanmac secured rebates worth 40% of the system cost. The project is expected to break even in year 5, but the business will continue to receive free electricity for more than 25 years.

All of the major PV components for the project were manufactured locally: the solar panels were manufactured by Evergreen Solar in Marlborough and the inverter was manufactured by Solectria Renewables in Lawrence. The system also has a web-based monitoring system that allows the company to monitor its electricity production and emissions savings.

"The programs in place in Massachusetts have made the economics work, and I hope that more companies will see that the benefits of solar power far outweigh the costs," says Dan Nanigian, President of Nanmac Corporation. "The PV array on Nanmac's roof will not only help the company reduce its electricity bills, but will also reduce greenhouse gases."

Nanmac has long been a pioneer. The company has worked with NASA for over 50 years, supplying temperature sensors for many space missions, as well as industrial applications to over 5,000 degrees F.

Questions Businesses Frequently Ask about PV

Why use solar electricity and not some other renewable energy source?

For most businesses, solar electricity is the most practical and attractive renewable energy source.

Solar electricity is widely available in the built environment, helps to avoid transmission and distribution charges, and can be located on otherwise unused rooftops.

Photovoltaic (PV) panels gather solar energy and convert it to electricity, for use on-site or for sale back to the grid under net metering guidelines.

Genzyme Center's 25-kW array in Cambridge

I've seen PV systems on homes, but will they work on businesses?

The consumption patterns and physical design of commercial and industrial buildings make them very well suited to include PV systems.

Since business electrical loads (such as lighting, air conditioning, office equipment, and manufacturing) remain fairly constant during the daytime hours of electricity generation by photovoltaic systems, power produced can be used on-site, offsetting the need for power purchases from the electric utility.

The flat roofs that are typical of most commercial buildings and manufacturing spaces are ideal platforms for mounting these systems.

What about new construction?

In new construction, where a business may want to make a particular statement about its forward vision and philosophy through the design of a building, incorporating PV and other green design features can help position the company as an industry leader. Of course, a business has the same opportunity in an upgrade or refurbishment of an existing building. Installation of PV can also provide a hedge against rising energy costs.

If a new construction project is not immediately ready for PV, for low to no incremental cost the business can ensure that the roof is designed (*e.g.*, structural integrity and orientation) and constructed so that it is "PV-ready" for installation at a later date.

Why should I invest in PV now?

There have never been more incentives available than there are today to encourage businesses to install PV systems.

With the state rebates and federal tax credits that are available in Massachusetts, businesses with a tax appetite can expect that a PV system will generate a simple payback of as few as 5 years and come with a warranty of 5+ years for the system and 20+ years for the modules.

This takes into account equipment rebates, cash flows from electricity generation, tax credits, and depreciation deductions. Of course, not all businesses may have the tax appetite to take full advantage of all available credits.

For up to date information on average PV system costs, rebate levels, and a PV pro forma, please visit *www.commonwealthsolar.org*.

Overview of PV Technology

PV equipment

PV systems convert sunlight directly into electricity. They work whenever the sun is shining, when sunlight striking the semiconductor material in a solar panel frees electrons and captures them in an electric current. The more intense the sunlight striking the panel, the greater the amount of electricity produced.

The solar cell is the basic block of PV technology. Solar cells are aggregated together to form a PV module or panel. One or more panels are ganged together and connected to an inverter which converts the direct current (DC) produced by panels into the alternating current (AC) used by electrical devices in the United States and supplied by our electric utilities.

Massachusetts has grown a number of locally-based technology companies that manufacture PV components, including solar cells, modules, and inverters, for sale both domestically and internationally.

PV electricity production

Electricity production from PV systems is a function of PV panel (or arrays of PV panels) orientation and DC to AC conversion losses. These factors are described in detail below. In Massachusetts an average 1 kilowatt (DC) of PV, at the optimal orientation and tilt for maximum annual production, can produce between 1,000 and 1,500 kilowatt-hours of electricity annually.

Of course, PV systems only produce electricity when the sun is shining. However, this is not a problem for grid-connected installations where any electricity demand that exceeds on-site production is automatically met by electricity delivered by the serving utility, day or night.

For businesses, PV-generated power is available during daylight hours when businesses usually experience their highest electricity consumption.

System sizing

Larger systems are somewhat more cost effective than smaller systems due to economies of scale associated with system design, installation, and interconnection. A good rule of thumb when sizing systems is that 1 kilowatt of PV requires 100 square feet of unobstructed roof area.

Integration with other building components

PV systems are easily installed on the flat roofs typical of commercial buildings, using racking systems for panel mounting. Panels are installed on different roof surfaces, including shingles or membranes, tar, and pea gravel.

Effective placement of modules requires areas of unobstructed roof surface. "Unobstructed" means without chimneys and other roof vents, rooftop HVAC systems, and hatchways that can not be blocked. Also, building systems and architectural elements on the roof (such as chillers and parapet walls) that can shade nearby PV modules are considered obstructions in that they prevent installation of PV panels in those shaded areas.

460-kilowatt Brockton Brighfield project on former brownfield site

Cummings Properties' 109-kW PV array in Woburn

Siting for maximum production

Solar panels generate electricity at their rated output intermittently, only when the sun is shining. And 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.

PV installations typically are "stationary" and do not follow the track of the sun. Furthermore, they are generally "fixed" installations that are not adjusted to account for changes in sun angle from season to season. (A cost-effective design that increases performance by tracking the sun's movements and/or seasonal adjustments has not yet been invented.)

Therefore, to maximize the production of electricity, the design of individual PV installations must consider (and optimize) the factors of shading, orientation, and module tilt.

Shading

The system design should avoid placing solar panels in any area that is shaded at any point during the day. The only exceptions are up to 90 minutes after sunrise in the morning and before sunset in the afternoon.

The most common features that cause shading are trees, other buildings, and telecommunications or HVAC systems. PV systems are designed to avoid panel-to-panel shading except near sunrise or sunset.

Orientation

South-facing is best to maximize the panel's annual power production, but you can still get up to 95 percent of optimal production even if your roof faces Southeast or Southwest.

Tilt

For maximum annual generation at our latitudes in Massachusetts, a solar array should be installed at about a 33-degree angle to the ground. For maximum summer generation, a solar array should be installed at about an 18-degree angle to the ground. Even if you place modules flat on a roof, they will produce up to 80 percent of optimal generation. Most designs allow for a slight angle to promote array self-cleaning and cooling of the panels, which improves their performance.

Greenwood Farm of Sherborn's PV arrays total 18 kW

Installation considerations

Beyond the questions of system orientation and tilt, the existing condition of the roof, including its structural integrity, is perhaps the most important planning consideration with regards to installation.

PV systems can be installed on any type of roof, with necessary care taken to insure that any penetrations of the waterproof membrane do not result in leaks. Installation over common EPDM rubber membrane roofs has proven to be very effective.

If the building roof is older and will need to be replaced in the foreseeable future, it may be sensible to replace it in conjunction with the PV installation to avoid the trouble and expense of removing and reinstalling the PV system later. There also may be economies in completing both jobs at once.

Regulatory considerations

Electric grid

While use of PV for off-grid electricity generation is cost-effective in areas where it is impractical or uneconomical to connect to the electric grid, this Guide focuses on grid-connected systems and the opportunity they offer to address Massachusetts' need for clean, reliable, and affordable electricity.

Electricity customers with renewable energy generation systems are allowed to interconnect with the grid and purchase whatever additional power they need from their electric distribution company.

Net metering

Under Massachusetts law, customers with PV systems of a designated size can sell excess power back to their utility and receive a credit for power produced. This practice is called "net metering." The customer is billed for the "net" electricity purchased from the utility over the entire billing period: the difference between the amount of electricity delivered from the power grid and the electricity generated by the PV system.

Utilities are prohibited from imposing special fees on these customers, such as backup charges and demand charges, additional controls, or liability insurance, as long as the generation facility meets established interconnection standards and all relevant safety and power quality standards.

Permitting and grid interconnection

As with any building construction and electrical work performed, local permits must be pulled, and inspections are required to verify that installations are consistent with code requirements.

PV panels shade the MITRE Corporation' of Bedford's walkway while generating 15.4 kW of electricity. 9.6 additional kW are installed on the building's roof.

Massachusetts has specific guidelines governing interconnection by on-site generators to the power grid, to ensure that requests for such interconnections are processed promptly and fairly, and that on-site generators do not create safety or performance issues for the power grid. The utility will inspect interconnected systems to verify that they conform to safety requirements.

An application for interconnection should be completed on a customer's behalf by the PV system integrator.

Is PV Right for Your Business?

Your business objectives

The decision to invest in PV today will likely be a reflection of a number of company business objectives, which could include:

- Financial considerations: the investment will make "good business sense" using some financial benchmark—either return on investment or a company's long-term perspective on future energy prices.
- Green values: the project will support the vision that the company wants to share with employees, stakeholders, or customers.
- A desire to foster energy independence or to support a local solar company.

Today, the combination of proven technology, available incentives, rising energy costs, and societal benefits makes PV an attractive investment and compatible with a range of business objectives.

Feasibility and planning considerations

As part of its decision making process, a company should ask a number of questions related to energy use, site characteristics, sizing, building integration, and of course, cost.

- How much electricity do we use and when do we use it?
- Is PV viable for my location given its orientation and exposure?
- What size system do I want or need?
- What is the availability and condition of the roof?
- Does the project pro forma demonstrate financial viability?
- What assistance is available to my company for such a project?

Financing Your PV System

Third-party ownership can be a valuable option for commercial building owners who do not have the up front capital to invest in a PV system, or for public or non-profit building owners that are unable to take advantage of state and federal tax incentives for renewable energy.

Advantages of third-party ownership

- Installing the PV system requires no up-front capital from the building owner.
- This model provides energy price stability by creating a hedge against future increases in energy costs.
- Maintenance and operating costs are shifted to the third-party system owner.

In a typical third-party ownership arrangement, a property owner will enter into a Power Purchase Agreement with a solar installer or solar financing company who will own the PV system. In the agreement, the installer/financier will provide the installation and maintenance of the system with no up-front cost to the business owner, and sell back the electricity produced by the panels at a predetermined rate for the length of the contract (usually 15-20 years.) These agreements may also contain a buyout option after a certain term.

The installer/financier will be able to take advantage of the federal investment tax credit as well as the Commonwealth Solar rebate, while your business reaps the previously mentioned benefits, as well as the environmental and public image benefits of using renewable energy.

Getting It Done

Project design and equipment installation

A PV installation is no different than the many other physical improvements and construction projects that businesses readily undertake. Installation of PV modules can be completed using a "turnkey" design / build contractor or by separating the design and construction processes and engaging separate contractors for each.

Many small, relatively simple projects are completed using the design / build process. These are generally projects that are less than 10 kilowatts and cover no more than 1,000 square feet of roof area.

Larger projects over 10 kilowatts may benefit from the specialized expertise of an experienced PV system designer, with assistance from an architect and electrical contractor. This is also particularly true in new construction, where there may be significant advantages to integrating the planning, design, and wiring for PV into the overall design of the building.

A separate design process might make it easier to competitively bid the procurement / construction / installation phase of the project, retaining the designer as "owner's agent" to oversee the construction process and ensure that the system has been properly installed.

Massachusetts businesses and nonprofits are fortunate to be in a state with numbers of PV-experienced architects, electrical engineers and contractors, system design specialists, and installers that can be engaged to analyze, design, and complete PV projects.

Next, you will learn about the steps you need to take to successfully navigate the PV design and installation process.

Selecting a PV system integrator

Medium to large systems: For larger systems, or building integrated systems, choose a specialized PV integrator who will understand the requirements and issues associated with larger or complex installations. Their expertise may be particularly important in new construction, or when integrating PV with other building features.

Small systems: For smaller systems an experienced installation contractor will be able to design and install your project.

Electrical: Interconnection with the building's wiring and the electrical meter will require an electrical contractor and local electrical permits. There are many integrators who are not electrical contractors, but who will bring in an electrical contractor as a subcontractor.

Lists of designers and installers are available through the Solar Energy Business Association of New England (*www.sebane.org*) and the Northeast Sustainable Energy Association (*www.nesea.org*).

Some PV installers also are certified by the North American Board of Certified Energy Practitioners (*www.nabcep.org*). This voluntary certification program awards a professional credential to PV installers that pass a rigorous examination and sign a code of ethics.

Considerations

Multiple bids: Get at least three bids, using written specification so you are comparing apples to apples. Engage your designer in the bidding selection. Request an example bid specification by emailing cs@masstech.org.

References: Use due diligence and get references from previous customers of your prospective bidders and their subcontractors.

Site visit: Visit at least one of the bidder's previous installations.

Licensing and insurance: Determine if the bidders or their subcontractors are licensed electricians and insist upon a certificate of insurance for general liability coverage and worker's compensation for any on-site work related injury. Commonwealth Solar requires certain levels of insurance for any rebate funded projects; however, consult your own carrier to determine if other coverage should be required.

Written contract: For your protection, have your attorney review a written contract with your designer and installer, which outlines the respective responsibilities of each party. Also include the identity of any subcontractors, define the insurance requirements for all parties, and specify the dates and timeline for the job. An itemized budget, warranty terms and a progressive payment schedule should similarly be included.

Construction and commissioning

State rebate application

Rebates for PV systems are available through the Commonwealth Solar rebate program (*www.commonwealthsolar.org*), administered by the Massachusetts Renewable Energy Trust. These rebates must be pre-approved prior to construction.

Applications for rebates are usually submitted on the owner's behalf by the PV integrator. Links to descriptions of subsidy programs and application materials are provided in the **PV Resources and Links** section of this Guide. Installation contracts are often conditional upon an award from the Trust.

Design

Prior to installation, the PV integrator will prepare a design for the PV system. The design can range from a simple site plan and electrical diagram to a more detailed set of plans and specifications depending upon the nature of the PV project and site. For new construction, it is advantageous to perform the PV design in conjunction with the overall design.

Installation and permits

PV installations require local building and electrical permits and inspections by a local inspector. The electrical contractor on the job will be responsible for ensuring that the installation meets state electrical code requirements. The installer must secure all necessary approvals from local code officials prior to the system being put into service. Owners should consult with local inspection services to confirm what is required for a particular installation prior to committing to a contract.

For additional information, please refer to the Commonwealth Solar Rebate Program Manual and Minimum Technical Requirements, available at *www.commonwealthsolar.org*.

Boston Sand & Gravel Company's 109-kW PV array at its flagship plant off Interstate 93 in Boston

16-kW thin film solar electric laminate array at MI Realty of Leominster

Commissioning and final inspections

When the installation is complete, the owner should require the installer to test the equipment to confirm that it is operating properly. As part of this process, the installer should provide copies of technical manuals, spec sheets, and warranties to the owner. The installer also should educate the owner about safety and operations and maintenance requirements. Finally, the commissioning is not complete until the system is satisfactorily inspected by a local wiring inspector and the utility has confirmed that the system can interconnect to the power grid.

Interconnection process

Interconnecting the PV system is required to take advantage of net-metering laws. State regulations govern the procedures for interconnection on an on-site generator and the serving electrical distribution company, including the application process, technical specifications for the interconnection, and inspection requirements. The PV integrator will be responsible for securing approval to interconnect from the utility. Details on interconnection are available at: *www.masstech.org/cleanenergy/howto/interconnection*.

System monitoring, operations, and maintenance

The Trust requires that commercial PV systems include electronic monitoring equipment that enables a system owner to track system production and to benchmark power generation against installer projections to ensure that systems are operating properly. Monitoring systems can also be used to automate the recording of kilowatt-hour generation to help monetize the value of Renewable Energy Certificates created.

In addition, some businesses may choose to explore long-term service arrangements with the PV integrator, if this is not already addressed in a contract.

PV Resources and Links

Financial resources for PV in Massachusetts

State rebates for small and large systems

For information on the Commonwealth Solar rebate program for PV installations in Massachusetts, please visit *www.commonwealthsolar.org* or call 508-439-5700.

This website is a valuable resource for current information on the program and rebate levels, as well as pro forma financial information, and links to other PV related resources.

State and federal tax incentives

Additional information is available at the Database of State Incentives for Renewables and Efficiency (DSIRE) website, which is a comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy: *www.dsireusa.org*. This site is maintained by the Interstate Renewable Energy Council (IREC), funded by the U.S. Department of Energy and managed by the North Carolina Solar Center.

Note: System purchasers are advised to consult with tax attorneys, accountants, and other experts to confirm if a particular energy project is eligible for each tax incentive and how these tax incentives may impact one another.

Technical resources

Finding a PV system integrator or supplier

The Solar Energy Business Association of New England (SEBANE) lists a Solar Energy Yellow Pages on its website, *www.sebane.org*. Listings include designers, installers, manufacturers, consultants, and other professionals and suppliers in the solar energy field.

The Northeast Sustainable Energy Association has a Sustainable Yellow Pages on its website (*www.nesea.org*) that lists a broad range of solar professionals, services, and suppliers.

The North American Board of Certified Energy Practitioners (NABCEP) awards PV installers a professional credential based on their experience and knowledge. Installers who have received this voluntary certification are listed, by state, at *www.nabcep.org*.

Background information on PV technology

In addition to information available on the Commonwealth Solar website, the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy hosts an excellent website with information on all renewable energy technologies: *www.nrel.gov*.

Information on photovoltaic systems with many links to specific information can be found at: *www.nrel.gov/solar*.

NREL also offers a cost estimator for PV grid-connected systems at a site maintained by its Renewable Resource Data Center: *http://rredc.nrel.gov/solar/calculators/PVWATTS*.

Raytheon Company's 100-kW PV array at their Integrated Air Defense Center in Andover

Solar photovoltaic images (clockwise from top left): Westborough Car Wash, Westborough, MA; Cambridge Savings Bank, Newton, MA; North Coast Seafoods, Boston, MA

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This document was printed on paper with recycled content.

Published in Massachusetts by the Massachusetts Renewable Energy Trust: March 2009