PHOTOVOLTAICS

Overview of Solar Power

As one of the most abundant renewable energy sources currently being developed across the United States, solar photovoltaic cells (PV) convert sunlight directly into electricity by using photons from the sun's rays. In Massachusetts solar power is becoming more and more common due to a better understanding of the environmental benefits, as well as the economic incentives offered at the state and federal level.

This section provides a brief history of solar power technology, describes Massachusetts' regulatory framework, and discusses incentives, initiatives and planning and permitting requirements related to solar. It also highlights existing solar power facilities in the Northern Middlesex and Montachusett regions and discusses the potential for solar power to enable a reliable, affordable and environmentally sound future for the Northern Middlesex and Montachusett regions.

History

Solar power technology dates back to the mid-1800s when solar energy plants were developed to heat water that created steam to drive machinery. In 1839 Alexandre Edmond Becquerel described how "shining light on an electrode submerged in a conductive solution would create an electric current" and in 1876, William Grylls Adams and Richard Day discovered that selenium produced electricity when exposed to light.[11] In 1922 Albert Einstein received the Nobel Prize for his work on the photo electric effect, the basis of photovoltaic technology. Later, in 1954 Calvin Fuller, Gerald Pearson, and Daryl Chapin collaborated to produce the first modern PV cell, which produced electricity and was efficient enough to run small electrical devices. The *New York Times* stated that this discovery was "the beginning of a new era, leading eventually to the realization of harnessing the almost limitless energy of the sun for the uses of civilization".

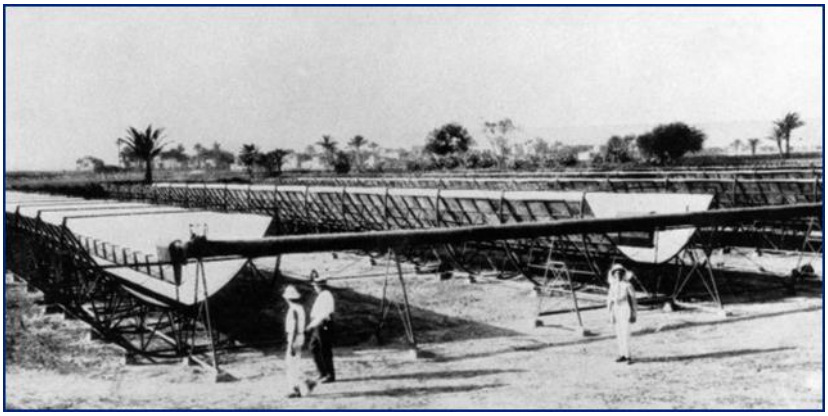


Image 1: Workers Inspect the First Commercial Solar Power Plant (National Geographic)

In 1956 the first solar cells became available commercially, although the cost exceeded the reach of most people. In the early 1970s the price of solar decreased from $100 per watt to around $20 per watt, resulting in a large increase in the use of solar cells into the 1990s. Recent new technology has

[11] http://www.energymatters.com.au/renewable-energy/solar-power/solar-panels.php

created screen printed solar cells, solar fabric that can be used to side a house, and even solar shingles that can be installed on roofs.[12]

Solar Technology

Solar photovoltaic (solar PV) systems convert sunlight into electrical energy using panels that connect to a building's electrical system and/or the electrical grid. Solar installations can be roof-mounted or ground-mounted and consist of solar cells, an inverter, racking, electrical equipment and meters. All of the components work together to produce electricity: solar cells produce direct current (DC), while the inverter converts DC current from the solar modules into household AC current. Mounting and racking fasten the solar panel to the rooftop or to the ground, and wiring and electrical equipment connects the panels to electric meters and to the grid. For residential installations, one meter shows consumption from the utility company's electric grid, while the second meter tracks the electricity produced by the solar array.[13] When connected to the power grid, the excess electricity feeds into the grid and is credited to the customer's electricity account. When the sun is not shining and the system cannot produce electricity, the grid supplies back-up electricity, as necessary.

Figure 3: Residential Grid Connected PV System

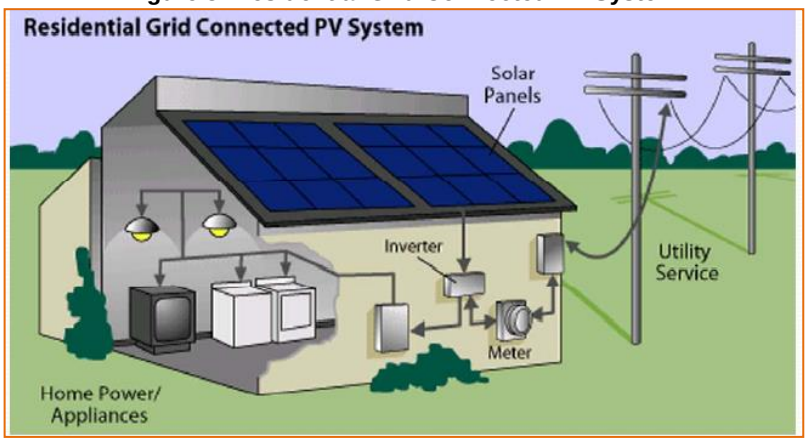


Image Credit: MassCEC

In order to place a solar panel on a residential property, there must be adequate roof space and the roof must be generally south facing. While south is the best angle to mount the panels, they can be mounted less economically to the west, east or north sides of the roof as well. However, this often requires the panels to be mounted on brackets that tilt them toward the south, which can be considered unfavorable aesthetically, and can become a barrier to installation. In addition, a penetration-free and shade-free portion of the roof is needed. For many residents, these building design and layout requirements can be a barrier to the installation of solar panels altogether – even if they have the financial resources. About 80 percent of ratepayers in Massachusetts cannot install solar panels on their roof, either because they have a roof that is not suitable for the panels or no roof at all, as in the case of

12 www.experience.com/alumnus/article?channel_id=energy_utilities&source_page=additional_articles&article_id=article_1130427780670

13 http://www.harmonyenergyworks.com/solar-101/basic-solar-components/

renters or condos.[14] For example, an analysis of 6,400 homes in Westford found that approximately 20% had the potential for solar. The remaining homes were unsuitable due to shading, incorrect orientation or other site factors.[15]

One way in which communities are striving to overcome this barrier is to install local community solar farms. Community solar (a.k.a. solar farms, solar gardens) refers to any solar project that has multiple participants where each person finances a small portion of the total project cost and shares proportionally in the project's benefits. Community shared solar is often a good alternative for those whose property may not be conducive to solar panels. In the Montachusett region, the Town of Harvard recently installed a solar garden, which is located on a tract of land in Harvard. Local residents in the correct utility zone can purchase a share of solar power, and benefit from decreases in electricity costs through a credit on their National Grid electric bill. The Harvard Solar Garden held their opening ceremony on June 27, 2014. As of May 2014, almost 300kW had been installed of the total anticipated capacity of 500kW.[16]

PV System Size and Cost and Placement

There are three typical sizes of solar PV systems. The Residential System size is about 5kW, and costs about $20,000 to install ($4 per watt). A small commercial system is about 300kW and costs about $1,000,000 to install ($3.33 per watt), and a larger commercial system is sized at about 10,000W or 1 MW and costs about $3,000,000 to install $3.00 per watt.

Image 2: Residential, small commercial and large commercial solar installations

From left to right: Typical residential solar, small commercial and large commercial installation at Westford Solar Park. (Source: MassCEC and Cathartes Investments).

Installation of solar panels can be relatively expensive when compared to conventional power sources, and as a result, upfront cost can be one of the major barriers to installing solar panels. Fortunately, as the PV market has matured, the price of PV has decreased – over the last 10 years the installed cost for solar PV has dropped by 30%. In addition, over the past few years, solar projects have become more economical due to the numerous incentives available at both the state and federal level.[17] Power purchase agreements (PPA) and leases are one way to overcome the cost barrier. PPAs are

[14] http://www.enterprisenews.com/article/20140526/News/140527216
[15] http://www.sustainablewestford.org/2013/06/09/solar-challenge/
[16] http://www.harvardsolar.org/
[17] DOER Solar PV Financial Webinar for Massachusetts Financial Institutions

particularly attractive for municipalities and have become more common as a way to purchase renewable energy at the municipal level. A PPA is a contract that allows a consumer to purchase energy produced by a renewable energy facility owned by a third party. The energy can be used either for a specific purpose or delivered into the electric distribution grid, or both.

Today many solar companies are working directly with municipalities as well as residents to assist with project financing through leases and PPA agreements. For example, the City of Lowell recently joined in a PPA with Ameresco, Inc. to improve defunct and aging equipment, increase monetary savings, and develop environmentally sustainable infrastructure. [18] Ameresco secured financing for the project, and the City of Lowell pays Ameresco an expected 20-year discounted electricity rate as compared to anticipated National Grid rates plus the commodity cost of electricity. The agreement impacts 47 buildings with a total of 2,864,730 square feet, and will result in an estimated annual energy savings of $1,522,679. The project is also expected to save the equivalent of 6,158 tons of carbon dioxide emissions per year. To date five rooftop-mounted solar PV systems, located at three elementary schools, a middle school, and the Lowell Memorial Auditorium have been installed. Ameresco did face several challenges during the design and installation phase including constraints of the existing roof systems, the age of the roof structure, obstructions on roofs and shade from existing buildings and/or trees. [19]

Installation and Maintenance

In general, solar panels are relatively low maintenance because they have no moving parts, the inverter turns on and off automatically, and rain keeps the panels clean. Snow slides off the panels, and is not typically an issue in Massachusetts. For smaller systems, annual inspections are recommended, while for larger systems, performance should be continuously monitored remotely. An installer warranty covers parts and labor and typically lasts 1 to 5 years. The manufacturer warranty typically lasts 25 years for the solar panels and 5 to 10 years for the inverters.[20] DOER recommends installation by a licensed Massachusetts electrical contractor with North American Board of Certified Energy Practitioners (NABCEP) certification.

Today, hundreds of thousands of houses and buildings around the world have solar PV systems on their roofs.[21] In 2013 there were 140,000 new solar installations in the U.S., bringing the total to over 445,000 PV systems producing over 13,000 MW of cumulative solar electric capacity, which is enough to power more than 2.2 million average American homes.[22] In Massachusetts the solar installations

[18] Ameresco, Inc. is an independent provider of energy efficiency and renewable energy solutions for facilities throughout North America.
[19] http://www.lowellsun.com/todaysheadlines/ci_24852844/lowell-turns-former-landfill-into-lucrative-solar-venture#ixzz35Bue0IPD
[20] DOER Solar PV Financial Webinar for Massachusetts Financial Institutions
[21] U.S. Energy Information Administration
[22] http://www.seia.org/research-resources/solar-industry-data

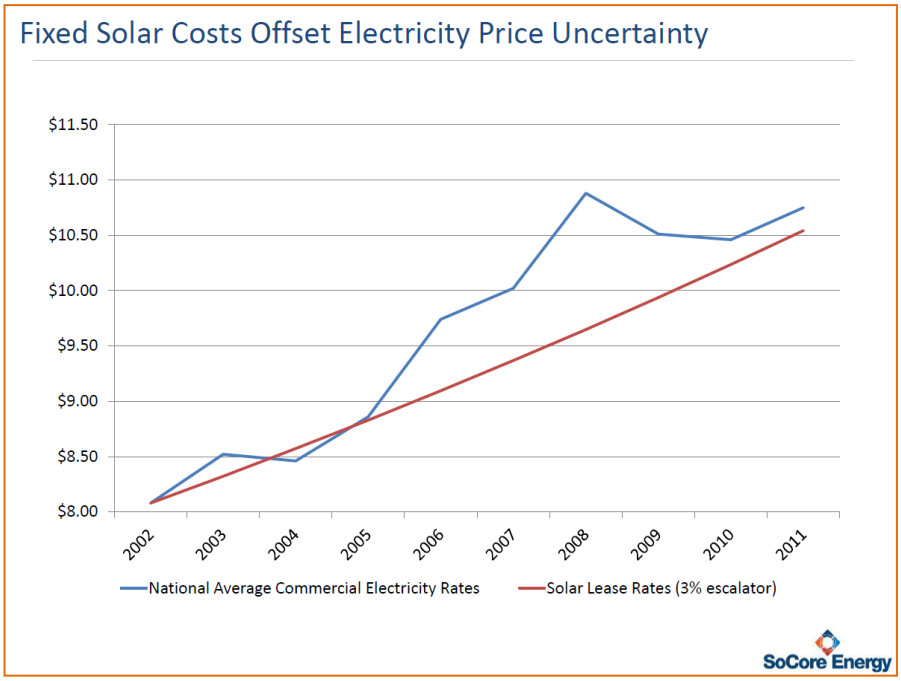
produce over 464 MW of solar power – enough to power 75,200 homes.[23] The average New England household uses 7,452 kWh per year.[24]

Benefits of Solar Power

PV systems are quiet and non-polluting, and offer stable pricing and reduced electricity costs when compared with traditional fuel sources (Exhibit 1). Solar power pricing is estimated to be more stable and less volatile than fossil fuel pricing, resulting in a more predictable and lower electricity bill.

Installing a solar PV system can add equity to a home, and systems that produce more energy than used on site receive a credit on their bill through the process of net metering. Additionally, there are also environmental and health benefits associated with solar power. By switching to solar energy, there is a reduction in the emission of harmful greenhouse gases, cancer causing agents, smog forming VOCs, and particulate matter.

Exhibit 1: Cost of Solar versus Traditional Electricity Sources



Source: SoCore Energy Presentation, November 14, 2012

One of the drawbacks of solar power is that it does not generate power when the sun is not out (e.g. at night, or on rainy days). As a result, it is not typically considered a base power source. However, thanks to new storage technologies, the world's first utility-scale commercial baseload solar power plant is now in existence in the Spanish province of Andalucia. The plant is called Gemasolar and is run by Torresol Energy.[25] Using molten salt heat storage technology, the plant was capable of producing 36

[23] http://www.seia.org/state-solar-policy/massachusetts
[24] Mass CEC Solar Guide
[25] http://www.forbes.com/sites/tonyseba/2011/06/21/the-worlds-first-baseload-247-solar-power-plant

days of 24-hour power production in the summer of 2013. The ability to store solar power and use it as a baseload opens up new opportunities for the use of solar power.

Interconnection

Interconnection is the process of connecting a solar PV system to the electric grid. Prior to interconnecting, solar PV owners must have written approval from the local utility in the form of an 'Interconnection Service Agreement' and 'Authorization to Connect'. Interconnection can occasionally serve as a barrier to solar PV installations. For example, if the power grid is not equipped to handle the amount of power that will be produced from a solar PV project, that project will not be able to move forward. In addition, solar installations that are too far from the interconnection source can prove problematic because it may not be economically feasible to build the infrastructure needed to connect to the grid. It is vital that the interconnection process be streamlined, uniform, and as transparent as possible. Toward that end, Massachusetts has created Distributed Generation (DG) and Interconnection standards, which contain comprehensive information on the utility interconnection process. [26] The Massachusetts Clean Energy Center (MassCEC) also provides guidance on this process through their *Interconnection Guide for Distributed Generation*, which can be found on their website. [27]

Existing Facilities

Solar installations across the Northern Middlesex and Montachusett Regions are listed in the DOER database for Qualified Generation Units for the Renewable Portfolio Standard (RPS) Class I Solar Carve-Out, which contains all the projects currently generating SRECs. While this database is quite extensive, there are some projects that do not produce SREC's and would not be contained in the database. In particular, projects funded through the American Reinvestment and Recovery Act (ARRA) are not included. To obtain the most inclusive list of solar installations across the region we combined the DOER SREC database with the ARRA project database, which contains projects affiliated with the Supplemental Energy Program (SEP), Energy Efficiency Conservation Block Grant (EECBG) program and Clean Energy Results Program (CERP).

Installations listed in the SREC database are categorized as Agricultural, College/University, Commercial/Office, Hospital/Healthcare, Industrial, Mixed-Use, Multi-family Residential, Municipal/Government/Public, Other, Religious, Residential, Restaurant/Food Service, Retail, School (k-12) and Utility. The types of installations listed in the ARRA database are categorized as Commercial, Farm, Municipality, Regional School District, State Agency, State Authority, State Community College, and State University.

To display this data, SREC and ARRA data have been combined using the following general categories: Agricultural, College/University, Commercial, Industrial, Multi-family residential, Municipal, Religious, Residential, Retail, School (k-12) and other. It is important to note that some larger solar installations (e.g. solar parks, solar farms and solar gardens) are classified as "Industrial", while others are classified as "Other". In addition, it is also important to note that despite our effort to create an all-

[26] https://sites.google.com/site/massdgic/
[27] http://www.masscec.com/content/interconnection-guide-distributed-generation

inclusive data asset, some projects may still not be listed in the tables below due to the fast pace at which solar projects are being developed. In particular, projects that have not produced SRECs as of July 9, 2014 (the data download date) may be excluded from the tables and charts below. Whenever possible, an effort has been made to manually add these projects.

Northern Middlesex Region

There are approximately 645 solar installations across the Northern Middlesex region, producing 20,901 kW of solar power, as of July 9th, 2014. Due to the large number of solar installations across the region, individual installations are not shown in the tables and data is presented in a summary format. Solar installations across the region include large-scale solar facilities in Billerica, Westford and Tyngsborough. Additional local projects include solar installations at the Lowell Regional Transit Maintenance Facility, the Lowell Regional Wastewater Treatment Facility, and the United Teen Equality Center (UTEC) in Lowell and the Stony Brook School in Westford. As shown in Table 2, Lowell has the highest number of installations at 187, followed by Billerica at 110.

Projects funded through the Massachusetts Energy Management Pilot Program for Drinking Water and Wastewater are not included in the databases because they do not generate SRECs. These projects have been manually added, and include a 485 kW installation at the Chelmsford Water Treatment Facility, and a 30 kW installation at the Lowell Regional Wastewater Treatment Facility.[28] An 8.8 kW solar installation on the Chelmsford Library as well as a 37 kW installation at the Parker Middle School in Chelmsford were not included in the databases and have been manually added.

Table 2: Number of Solar Installations per Community in the Northern Middlesex Region

Municipality	College/ University	Commercial	Industrial	Multi-family residential	Municipal	Residential	Retail	School (k-12)	Other	Total
Billerica	0	5	1	0	0	104	0	0	1	111
Chelmsford	0	6	0	0	3	88	0	1	0	97
Dracut	0	1	0	1	0	81	0	0	0	83
Dunstable	0	0	0	0	0	7	0	0	0	7
Lowell	5	10	0	6	3	163	0	0	0	187
Pepperell	0	0	0	0	0	11	0	0	0	11
Tewksbury	0	5	0	0	0	33	1	0	0	39
Tyngsborough	0	3	1	0	0	35	0	0	0	39
Westford	0	3	4	0	1	64	0	0	0	72
Total	5	33	6	7	7	586	1	1	1	646

Source: DOER SREC Database July 9, 2014, Massachusetts ARRA Database, DOER
http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/qualified-generation-units.html

28 http://water.epa.gov/aboutow/eparecovery/upload/2010_01_26_eparecovery_ARRA_Mass_EnergyCasyStudy_low-res_10-28-09.pdf

The Northern Middlesex region has five communities - Chelmsford, Lowell, Tewksbury, Tyngsborough and Westford - which have been designated as Green Communities by the Commonwealth of Massachusetts. In addition, Chelmsford and Lowell participated in the SolarizeMass program and both were awarded funding for an Energy Manager. In Westford, the non-profit "Sustainable" Westford partnered with Next Step living to initiate a solar outreach campaign called the Westford Solar Challenge, which was designed to encourage solar at the local level.

Various scale solar facilities have been developed or are proposed in the Northern Middlesex region. The Westford Solar Park is a 4.5 MW solar plant with more than 14,000 panels situated on 22 acres. The Park opened in 2012 and is expected to generate 150 GWh of energy over its lifetime. A 6 MW project is also under development for the closed Shaffer landfill in Billerica. In Chelmsford, town officials are using a $12,500 state grant to explore the possibility of a solar farm at the Swain Road landfill. In addition, as previously mentioned, a solar array on Lowell's closed and capped landfill on Westford Road, recently went live producing 1.5 megawatts of electricity (Exhibit 2).

Exhibit 2: Lowell's closed and capped landfill with solar array

When viewed in terms of kilowatts, as shown in Table 3, Billerica has the highest production with 6,830 kW produced, which is followed by Westford with 5,551 kW produced. These are likely due to the large-scale solar installations in these communities.

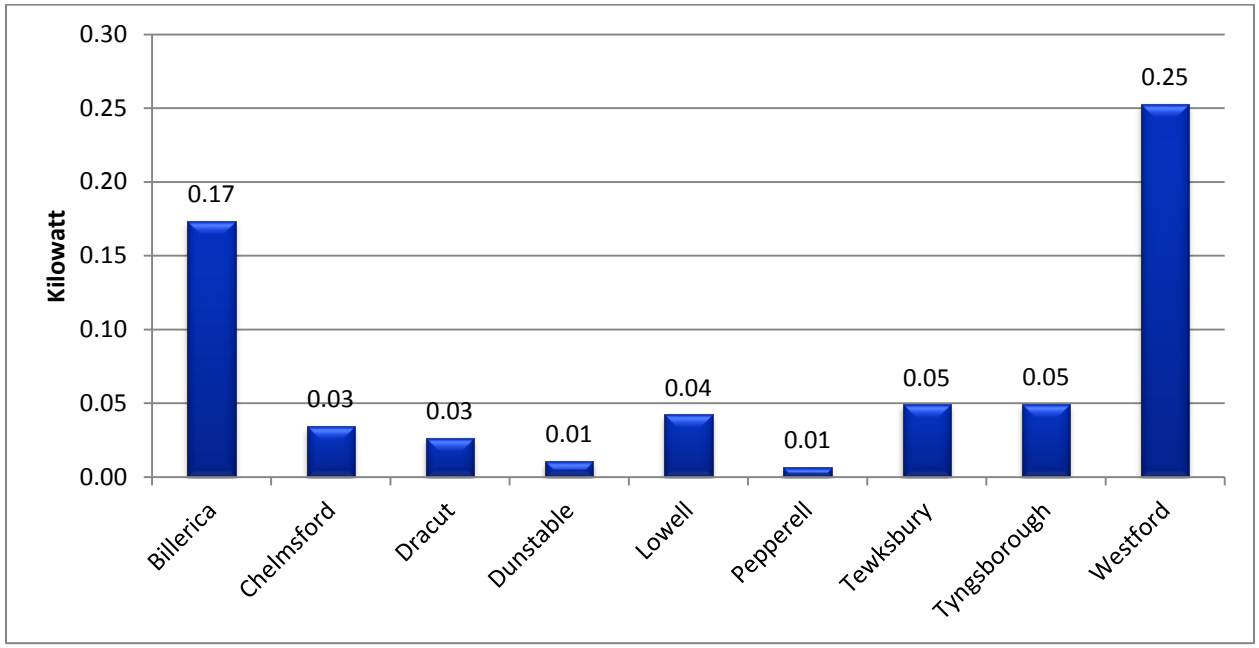
Table 3: Number of kW of Solar Produced by Community in the Northern Middlesex Region

Municipality	College/ University	Commercial	Industrial	Multi-family residential	Municipal	Residential	Retail	School (k-12)	Other	Total
Billerica	0	312	82	0	0	580	0	0	5,999	6,973
Chelmsford	0	140	0	0	515	506	0	37	0	1,161
Dracut	0	65	0	229	0	484	0	0	0	779
Dunstable	0	0	0	0	0	35	0	0	0	35
Lowell	492	642	0	495	2,144	721	0	0	0	4,495
Pepperell	0	0	0	0	0	75	0	0	0	75
Tewksbury	0	898	0	0	0	198	323	0	0	1,420
Tyngsborough	0	298	47	0	0	210	0	0	0	555
Westford	0	526	4,547	0	39	439	0	0	0	5,551
Total	492	2,881	4,676	725	2,698	3,248	323	37	5,999	21,044

Source: DOER SREC Database July 9, 2014, Massachusetts ARRA Database, DOER
http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/qualified-generation-units.html

In terms of kilowatts per capita, Westford has the highest at 0.25kW per capita, followed by Billerica at 0.17 kW per capita, as shown in Exhibit 3.

Exhibit 3: kW of Solar per Capita in the Northern Middlesex Region



Source: DOER SREC Database July 9, 2014, Massachusetts ARRA Database, DOER
http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/qualified-generation-units.html

Montachusett Region

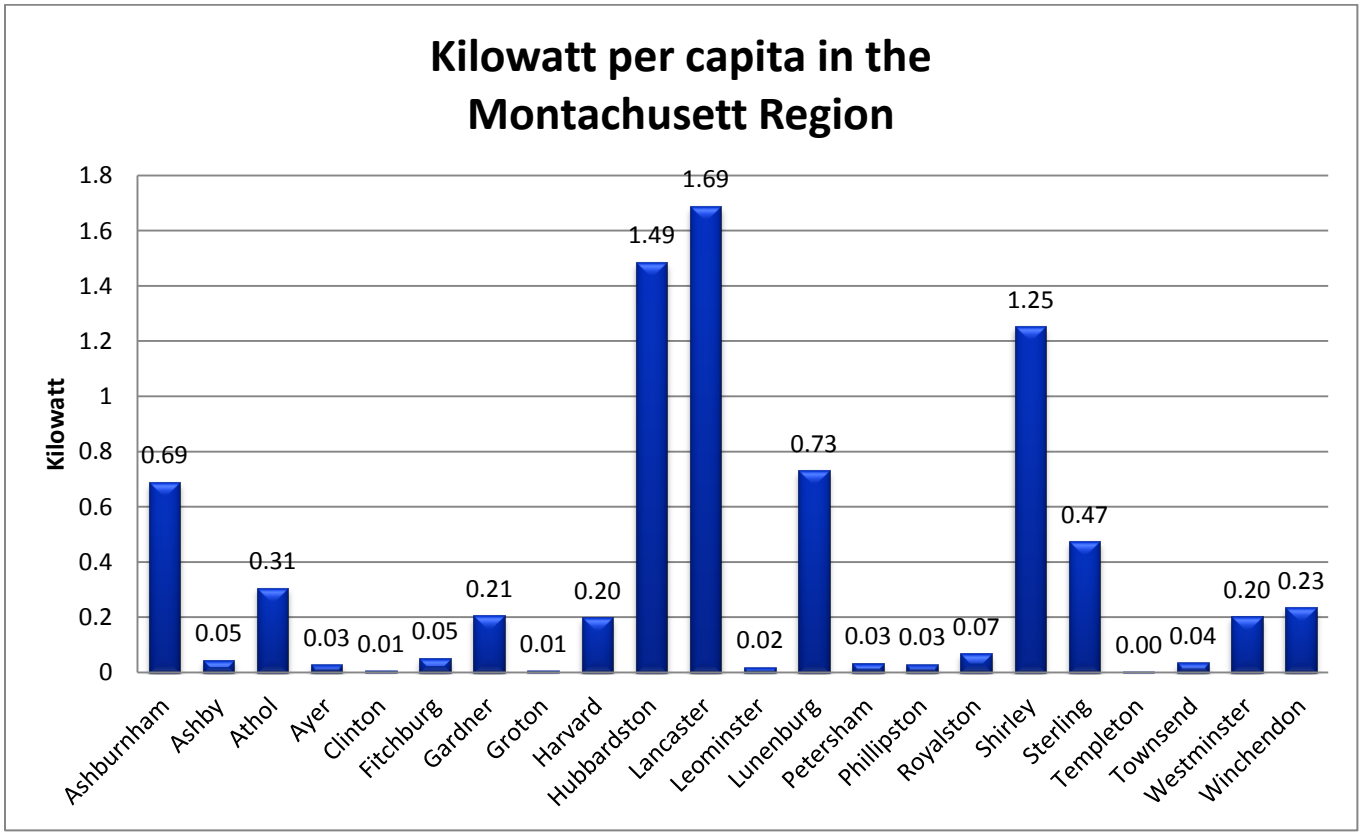
According to the SREC and AARA database there are approximately 558 solar installations in the Montachusett Region, producing 56,648 kW of solar power as of July 9th, 2014. MRPC has eleven green

communities – Ashby, Athol, Ayer, Gardner, Harvard, Lancaster, Leominster, Petersham, Shirley, Townsend and Westminster. In addition, Harvard and Shirley have participated in the SolarizeMass program.

While many of the solar installations in the Montachusett Region are at the residential level, there are a variety of larger installations throughout the region. In 2012 the Town of Lancaster developed one of the first municipally-owned and operated solar facilities in the State. The Lancaster landfill solar facility consists of a 500kW array on 2.78-acre gravel pit adjacent to the closed landfill. In Shirley, a 3 MW solar array containing 37,047 panels was completed in the spring of 2014 and provides power to Devens.

As with the Northern Middlesex Region, there are some installations in the Montachusett Region not included in the SREC or AARA database. The solar installation at Carlson Orchard in Harvard, MA is not included in the database because its grant funding meant it was not eligible for SRECs. Carlson Orchards received grants totaling $595,000 to help in the installation of the 1,050 solar photovoltaic panels at their Harvard, MA farm. In addition, a 40 KW Townsend Water Treatment Facility Project funded through the Massachusetts Energy Management Pilot Program for Drinking Water and Wastewater has been manually added to the table in Appendix D.1 and D.2.

Exhibit 4: kW of solar produced per capita in the Montachusett Region



Source: DOER SREC Database July 9, 2014, Massachusetts ARRA Database, DOER

In the Montachusett Region the Town of Harvard has the highest number of installations with 86, and is followed by Fitchburg with 55 and Leominster with 53. Lancaster is the highest producer of solar energy with a production of 10,689 kW, followed by Lunenburg at 7,430 kW and Shirley at 7,280 kW. When viewed per capita, Lancaster and Hubbardston have the highest per capita production at 1.69 kW per capita and 1.49 kW per capita respectively, followed by Shirley at 1.25 kW per capita.

Planning, Permitting and Zoning

Installation of a solar PV system requires the same local approvals as any other building construction and electrical work. At the local level, solar PV Systems must obtain a municipal building permit, municipal electrical permit and a Utility Interconnection Agreement. In addition, installations must be in accordance with any local zoning bylaws and must meet standards enforced by the Conservation Commission, the Historical Commission, the Planning Board and the Zoning Board.

The Massachusetts General Laws include a *Solar Easements & Rights Law*, M.G.L. Chapter 40a §9B, which is designed to protect solar exposure and authorize zoning rules that prohibit unreasonable infringements on solar access. In addition, the statute allows local zoning boards to issue permits creating solar rights. Furthermore, M.G.L. c. 40a §3 prohibits local governments from enacting local laws that "unreasonably regulate" solar energy systems. Within the Northern Middlesex Region, the towns of Billerica, Dracut, Dunstable and Tyngsborough have solar bylaws in place, while the towns of Ashburnham, Gardner, Royalston, Templeton, and Winchendon all have bylaws in place in the Montachusett Region. As part of this project, MRPC worked with the Royalston Planning Board to draft a local photovoltaic system that was brought to the Fall 2013 Town Meeting and adopted (it is included as Appendix D.5).

The Massachusetts Executive Office of Energy and Environmental Affairs Department of Energy Resources (DOER) has created two model bylaws for municipalities. The *Model As-of Right Zoning Ordinance or Bylaw for Large-Scale Solar Facilities* was created in 2012 and has served as a model for many municipalities across Massachusetts. [29] However, this bylaw only addresses large scale facilities, and with increasing installation of roof-mounted and small-scale ground mounted systems, municipalities expressed a need for a model bylaw that addressed all solar installations.

Toward that end, in March 2014 DOER released a model zoning bylaw for small-, medium- and large-scale installations as well as both ground-mounted and roof-mounted installations, including canopy-mounted installations. The bylaw, entitled *Model Zoning for the Regulation of Solar Energy Systems* was developed under the SunShot Initiative Rooftop Solar Challenge (RSC). This initiative, through the U.S. Department of Energy, provided incentives to address the “soft costs” (e.g. non-hardware costs) associated with permitting, zoning, metering, and connection for solar installations. The bylaw allows as-of-right siting for small-scale ground-mounted systems (the size that would service a house, small businesses, or small municipal building) as well as for medium-scale ground-mounted systems in all districts except residential zoning districts, where Site Plan Review is required.[30]

[29] http://www.mass.gov/eea/docs/doer/green-communities/grant-program/solar-model-bylaw-mar-2012.pdf
[30] http://www.mass.gov/eea/docs/doer/green-communities/grant-program/model-solar-zoning.pdf

The model bylaw may be modified and adopted, as necessary, by local governments that want to promote solar development. In general, the municipality should establish the zones where solar will be allowed by right as an accessory or as a main use. Solar definitions should be included in the definitions section and the bylaw should clarify that solar is exempt from building height restrictions, and that solar panels need to be built in compliance with State law. A site plan review should be required for systems greater than 250KW. In addition, the by law should stipulate liability insurance for larger installations and should indicate that the panels should be removed within 150 days at the end of useful life. Finally, the bylaw should specify that the utility should be notified and that an operation and maintenance plan should be in place. Municipalities may also want to consider financial surety for removal when the useful life is complete. Construction of solar panels should not be restricted on new construction. [31]

In some instances, the complexity of permitting and zoning requirements can be a barrier to solar PV development. To overcome this, DOER recommends each town create a solar zoning bylaw to clearly outline what is permitted in each community, and to ensure that solar development is consistent with community desires and characteristics. Communities should focus on both large-scale and ground mounted systems.

Special Considerations/Sensitive Areas

Roof-mounted units in historic districts or on historic buildings, ground-mounted units in residential zones, and ground-mounted units on agricultural or forested lands often warrant special consideration. In addition, sensitive areas, such as well-head protection districts, also require additional permissions. Special permits can be used to provide review for use in these sensitive areas. Typically, the municipality should issue a special permit if the use is in harmony with general purpose of the bylaw, if it is a public benefit, if the appearance is not detrimental to the neighborhood and no nuisances are created (noise, odors, etc.).[32]

If solar is going to be placed within the boundary of a Water District the installer needs to get special permission from the Massachusetts Department of Environmental Protection (MassDEP). One of the State's recent initiatives is to assist with the review of solar installations in water districts. Toward that end, the state has developed guidelines for water districts to site solar PV (or wind) on water district owned properties, including those within Zone 1 – 500 feet within a well head.[33]

The guidelines state that public water suppliers shall submit a written certification to MassDEP that the "solar energy project will have no significant adverse impact on the public water supplier's present and future ability to provide continuous adequate service to consumers under routine and emergency operating conditions, including emergencies concerning the contamination of sources of supply, failure of the distribution system and shortage of supply". If a public water supplier submits a

[31] Siting Renewable Energy Facilities Citizen Planners Training Collaborative & Northern Middlesex Council of Governments, Carolyn Britt AICP

[32] Siting Renewable Energy Facilities Citizen Planners Training Collaborative & Northern Middlesex Council of Governments, Carolyn Britt AICP 3+6

[33] http://www.mass.gov/eea/docs/dep/water/laws/numeric/1101g.pdf

written certification in accordance with this guideline, MassDEP will respond within 30 days of submission.[34]

Siting Photovoltaics

For rooftop, ground-mounted, carport, and landfill solar energy systems, it is crucial to understand the various factors at a site including shadowing, the placement of drains and vents, site undergrowth and allowable structure penetration depth. In addition, it is important to coordinate installations with the weather as well as the site's relation to stakeholders, including Historical Commissions, the National Heritage and Endangered Species Program and the Federal Aviation Administration (FAA). [35]

Both the Environmental Protection Agency (EPA) and the State of Massachusetts have begun to prioritize siting solar facilities on contaminated land, such as Brownfield and landfills. Through the RE-Powering America's Land initiative, EPA encourages renewable energy development on potentially contaminated land when aligned with the community's vision for the site. Massachusetts DOER strongly discourages designating locations that require significant tree cutting, prime farm soils, or land actively farmed due to the important water management, cooling and climate benefits. DOER encourages designating locations in industrial and commercial districts, or on vacant, disturbed land. [36]

EPA and the Department of Energy's National Renewable Energy Laboratory (NREL) have created a decision tree to guide state and local governments and other stakeholders through a process for screening sites for their suitability for future redevelopment with solar photovoltaic (PV) energy (Exhibit 5).[37] Targeted sites include brownfields, Superfund sites, Resource Conservation and Recovery Act (RCRA) sites, mining sites, landfills, abandoned parcels, parking lots, and

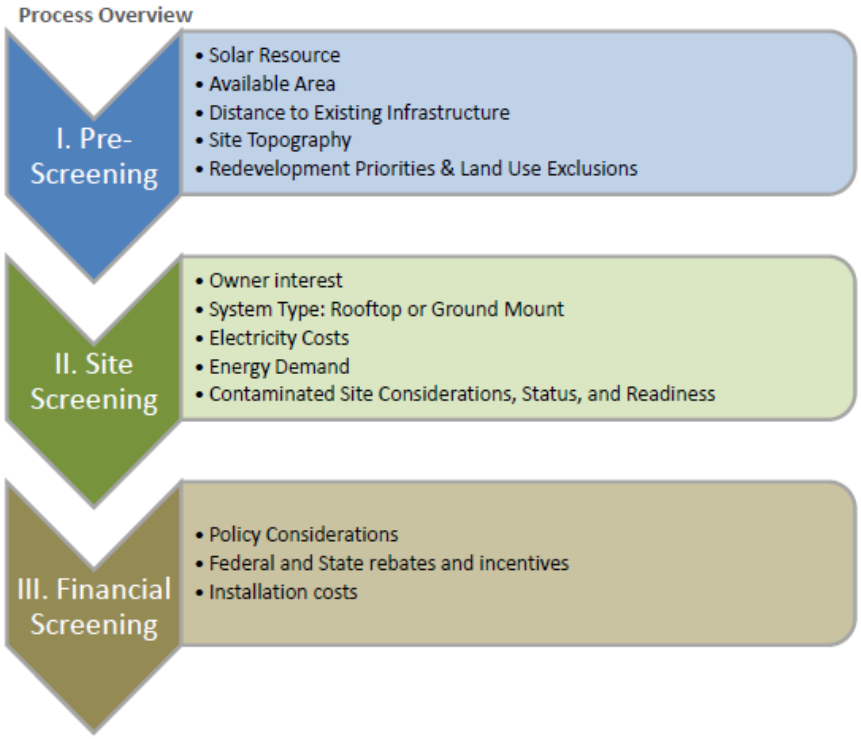


Exhibit 5: Decision Tree for siting Solar PV on contaminated lands

[34] http://www.mass.gov/eea/docs/dep/water/laws/numeric/1101g.pdf

[35] Solar siting workshop, John Langton, Vice President American Capital Energy Solar Energy Market presentation

[36] Siting Renewable Energy Facilities Citizen Planners Training Collaborative & Northern Middlesex Council of Governments, Carolyn Britt AICP

[37] http://www.epa.gov/oswercpa/docs/solar_decision_tree.pdf

commercial/industrial rooftops. EPA encourages the development of these targeted sites, instead of green space. This decision tree can be used to screen individual sites for solar potential or for a community-scale evaluation of multiple sites. It is not intended to replace or substitute the need for a detailed site-specific assessment that would follow an initial screening based on the decision tree. Tips on how to obtain information relevant to various parameters in the decision tree are provided.

EPA has also created a tool that outlines considerations specific to the redevelopment of potentially contaminated sites. Potentially contaminated land includes sites where contamination is suspected but has not been confirmed and sites where contamination has been identified.[38] EPA's RE-Powering Mapper, a series of maps, makes it possible to view EPA's information about renewable energy potential on contaminated land, landfills, and mine sites, alongside other information contained in Google Earth or in a GIS system.[39] Features include over 66,000 sites for solar, wind, biomass, and geothermal energy. Locations for solar potential on contaminated land in the Northern Middlesex and Montachusett Regions can be found in Appendix D.3. The map highlights "brownfields", landfills, RCRA and superfund sites that would be suitable for solar. Sites outlined in yellow are suitable for large-scale solar.

The U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) Center for Program Analysis (CPA) initiated the RE-Powering America's Land Initiative to demonstrate the potential that contaminated lands, landfills, and mine sites provide for developing renewable energy in the United States. EPA developed national level site screening criteria in partnership with the U.S. Department of Energy (DOE) National Renewable Energy Laboratory (NREL) for wind, solar, biomass, and geothermal facilities. While the screening criteria demonstrate the potential to reuse contaminated land for renewable energy facilities, the criteria and data are neither designed to identify the best sites for developing renewable energy nor are all-inclusive. Therefore, more detailed, site-specific analysis is necessary to identify or prioritize the best sites for developing renewable energy facilities. EPA cautions that these sites were only pre-screened for renewable energy potential and were not evaluated for land use constraints or current conditions. Additional research and site-specific analysis are needed to verify viability for renewable energy potential at each site.

In addition, students at Worcester Polytechnic Institute (WPI) have created a screening tool to assist with siting renewable energy on Brownfield's in MA. The screening tool is a table that contains information for investors to reference when assessing feasibility of a site. Step-by-step instructions on how to implement the chart are included in the document entitled *Siting Renewable Energy on Brownfields* (Appendix D.4).

Recommendations for Regional Potential

The Northern Middlesex Council of Governments and the Montachusett Regional Planning Commission are committed to helping the region site solar energy facilities and encourage adoption of solar power. This section contains a series of recommendations that NMCOG and MRPC can undertake

[38] http://epa.gov/oswercpa/rd_mapping_tool.htm
[39] http://www.epa.gov/renewableenergyland/rd_mapping_tool.htm#i_map

to overcome barriers such as structural constraints, upfront cost, interconnection, permitting and zoning. Recommendations will also encourage the development of solar power throughout these regions and will encourage private investment in the solar industry to encourage the creation of jobs throughout the region. [40]

Planning

To help promote solar throughout the region, NMCOG and MRPC will help communities clarify goals and priorities related to solar energy use. In particular, the agencies will help incorporate solar energy into the community's master plan and/or comprehensive plan. NMCOG will continue to incorporate solar into the Northern Middlesex Region's Comprehensive Economic Development Strategy (CEDS), and will work on obtaining funding to create a regional energy plan, which will also prioritize solar. MRPC's Regional Energy Plan currently prioritizes solar, and MRPC will work to ensure that the recommendations outlined in the plan are implemented.[41]

NMCOG and MRPC will also help communities write zoning bylaws to eliminate uncertainty around where solar energy systems may or may not be allowed, ensure that installations are placed in appropriate locations, and mitigate any potential negative impacts. Utilizing DOER's *Model Zoning for the Regulation of Solar Energy Systems*, NMCOG and MRPC can adapt the model bylaw to suit the needs of local municipalities.

Clear standards can also help communities avoid conflicts over competing values, such as tree cover or historic character of protected districts or structures. The RPAs will work with communities to ensure zoning ordinances do not restrict the types of districts in which solar facilities are allowed and to ensure there are no height restrictions, lot coverage limitations, or setback requirements that do not allow for the placement of solar panels on existing rooftops or building sites. The RPAs will work with communities to ensure expedited permitting for solar projects and to ensure homeowners' association covenants do not restrict solar. The RPAs could work to create additional unique incentives for solar such as waiving permit fees and allowing density bonuses for developments that use solar power.

Education

NMCOG and MRPC will help educate residents about solar at the regional and community level. As learned through this grant, community workshops can help educate residents and business owners about the local solar market through workshops and outreach events. Community outreach can also be conducted through site visits, via booths/tables at local events, or even within the school system. Education is a crucial component of renewable energy siting because residents who are educated about the importance of renewable energy may be more likely to install solar on their own property, and may be more accepting to large-scale solar installations.

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[40] Implementing Residential Solar Energy in the Montachusett Region, Worcester Polytechnic Institute (Feyler 2014); Integrating Solar Energy into Local Development Regulations by Ann Dillemuth, AICP, APA Research Associate.

[41] Montachusett Region Regional Energy Plan

NMCOG and MRPC will also educate land-owners, developers and business owners about solar siting. Documents can be developed that includes a step-by-step process for public and private sector developers and business owners to site solar facilities. The document could include information on zoning regulations, permitting and financing. The RPAs will particularly reach out to those land-owners who have been pre-sited through the EPA RE-mapping technology as especially suitable for solar power.

Capacity Building

MRPC and NMCOG will encourage communities to hire an energy manager to help advocate for solar development and help quantify energy and cost-savings. As previously mentioned, Chelmsford and Lowell recently received funding for full time Energy Managers through the state's Energy Manager Grant Program. The RPAs can assist their communities with Energy Manager Grant Program applications and, in particular, can bring together smaller municipalities to discuss the possibility of a "shared" Energy Manager. A shared Energy Manager may be an option for communities that do not have the capacity for a full time position. The RPAs can also encourage communities to take advantage of various state-run green programs by assisting with SolarizeMass and Green Community applications, and by assisting with group procurement for solar installation.

Financing and Affordability

NMCOG and MRPC can partner with banks to create specialized green loans as a way to reduce costs of solar installations for homeowners. The RPAs could work to promote low-interest loans and group purchasing, and can promote the SolarizeMass program to communities across the region.

Solar Siting

As discussed, less than 20% of homes are suitable for residential solar. NMCOG and MRPC will promote community solar for those homes that are not suitable for residential solar. We will work to pre-site locations for solar farms/community solar gardens on contaminated land, and could conduct outreach to recruit shareholders to participate in the community solar program. The program could be designed specifically for those who do not qualify for residential solar. NMCOG and MRPC should conduct a detailed, site-specific analysis of EPA's RE-mapping sites, to identify or prioritize the best sites for developing renewable energy facilities based on the technical and economic potential. This will involve visiting each site to determine its true suitability for solar and to conduct prioritize locations for installations.

Job Development

NMCOG and MRPC will work closely with the local Workforce Investment Boards to encourage training for solar industry-related jobs throughout the region. Promoting solar throughout the region will help create jobs in installation, manufacturing and development. It will also indirectly help create jobs in research and development. For example, in June 2010 the Greater Lowell Workforce Investment Board received funding from the United States Department of Labor to create an integrated system of education and training to promote skill attainment and career development benefiting business, incumbent workers and job-seekers. Using a portion of this funding, 37 incumbent workers and 36 unemployed individuals received solar related training and obtained HVAC, BPI and LEED; industry

recognized credentials. NMCOG and MRPC should continue to work with the local Workforce Investment Boards to encourage job training throughout the regions.[42]

Conclusion

The regulatory and land use policies in a community form the foundation for building renewable energy infrastructure. Effective and streamlined local rules and regulations help reduce installation costs and can significantly improve the market environment for solar energy technologies. Creating consistent permitting policies across the Montachusett and Northern Middlesex regions will encourage the development of renewable energy projects by providing a standard set of practices and procedures, thereby reducing uncertainty for developers and private investors.

NMCOG and MRPC are uniquely poised to work at the local level to remove some of the most critical barriers to widespread adoption of solar technology. By working with municipalities to overcome barriers associated with zoning, upfront cost, technical knowledge, and siting, we can work to encourage solar installations at the local and regional level and advance the use of renewable energy to reduce dependence on fossil fuels. In addition, assisting municipalities with capacity building and job development will also encourage economic growth across the regions. Facilitating the siting of solar projects and implementing the recommendations listed above will assist in meeting the state's renewable energy goals of reducing GHG emissions, preventing global warming, decreasing our reliance on petroleum, reducing energy consumption overall, and creating jobs in the clean energy sector.

[42] Solar siting workshop, Gail Brown presentation