Massachusetts' Solar Leaders

The Cities and Towns at the Forefront of the Clean Energy Revolution

ENVIRONMENT MASSACHUSETTS
RESEARCH & POLICY CENTER

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Executive Summary

Massachusetts has leapt to the forefront of the rising solar energy economy. Since 2007, solar energy in Massachusetts has grown 30-fold – from less than 4 megawatts of solar panels to more than 110 – putting the Commonwealth well on its way to meeting Gov. Deval Patrick's goal of installing 250 megawatts of solar power by 2017 and the state's commitment to installing 400 megawatts of solar power by 2020.

Massachusetts' emerging leadership in solar energy is no accident. Rather, it is the result of strong public policies designed to make it easier for Bay Staters to "go solar" and of the commitment of homeowners, businesses, local governments and non-profit organizations in cities and towns across Massachusetts to the vision of a cleaner energy future.

Massachusetts should embrace an ambitious agenda for solar energy, with a short-term target of installing 1 gigawatt of solar photovoltaic (PV) systems by 2017 and a long-term goal of obtaining 10 percent of our total energy from the sun by 2030. To achieve those goals, Massachusetts should continue to work to eliminate barriers to solar energy through public policy.

Solar energy is taking hold across the Commonwealth.

- Solar PV systems, which generate electricity from solar energy, have now been installed in at least 333 of Massachusetts' 351 cities and towns, according to data from the Massachusetts Clean Energy Center, with 21 towns having

installed their first solar panels since the beginning of 2011. (See Figure ES-1, page 6.)

Solar panels can be found throughout Massachusetts, but residents, businesses and institutions in certain cities and towns have led the way. Data from the Massachusetts Clean Energy Center shine a spotlight on the "solar cities" and "solar towns" that are leading the Commonwealth on four measures of solar energy deployment:

1) Number of solar PV installations per 1,000 residents, which measures the breadth with which solar energy has been adopted in a community relative to its size.
2) Solar PV capacity per capita, which measures the amount of electricity a community is capable of producing from solar energy, divided by its population.
3) Total number of solar PV installations per municipality.
4) Total solar PV capacity per municipality.

- Among Massachusetts' largest cities and towns (population >50,000), Plymouth has the highest number of s*olar photovoltaic installations per 1,000 residents*, followed by Newton, Cambridge, Framingham and Lawrence. Springfield has the largest amount of *solar PV capacity per capita* among large cities and towns, followed by Haverhill, Waltham, Framingham and Revere. (See Table ES-1.)
- Among all Massachusetts cities and towns, three towns on Martha's Vineyard – Chilmark (1st), Aquinnah (2nd) and West Tisbury (4th) – rank in the top five for the number of *solar PV systems installed per 1,000 residents*. They are joined by Hawley (3rd) in Western Mass. and Truro (5th) on Cape Cod. The small Berkshire County town of Sheffield ranks first for *solar capacity per capita*, thanks to a large school-based solar installation there. Sheffield is followed by Barre, Chilmark, Sterling and Hancock in the top five for solar capacity per capita. (See Table ES-2, next page.)

Table ES-1. Solar Capacity per Capita and Installations per 1,000 Residents for Cities and Towns Over 50,000 Population

Capacity per Capita			**Installations per 1,000 Residents**		
Municipality	**Capacity per Capita (kW)**	**Rank**	**Municipality**	**Installations per 1,000 Residents**	**Rank**
Springfield	0.019	1	Plymouth	0.832	1
Haverhill	0.019	2	Newton	0.763	2
Waltham	0.018	3	Cambridge	0.732	3
Framingham	0.018	4	Framingham	0.644	4
Revere	0.016	5	Lawrence	0.511	5

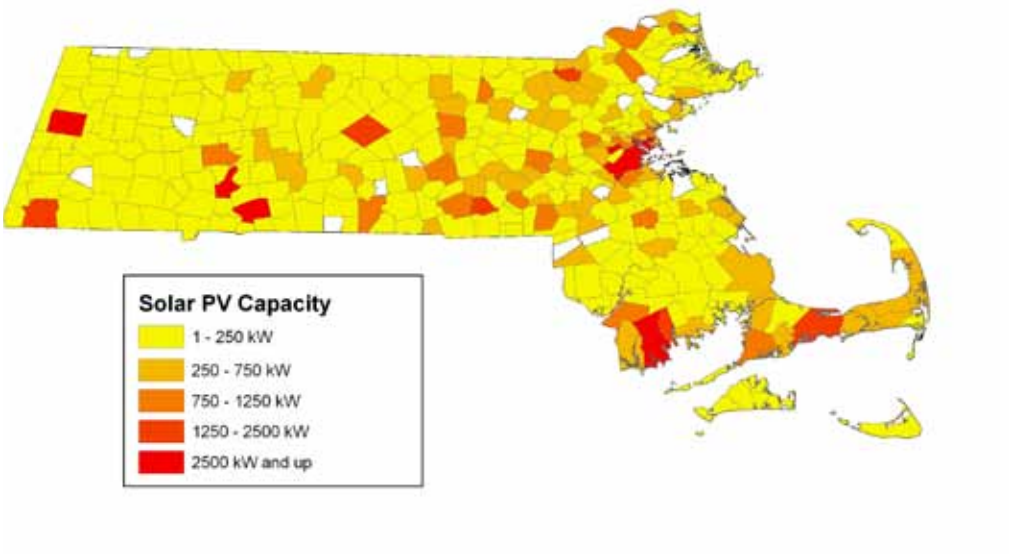
Table ES-2. Solar Photovoltaic Capacity per Capita and Installations per 1,000 Residents

Capacity per Capita			Installations per 1,000 Residents		
City/Town	Capacity per Capita (kW)	Rank	City/Town	Installations per 1,000 Residents	Rank
Sheffield	0.636	1	Chilmark	37.0	1
Barre	0.369	2	Aquinnah	35.4	2
Chilmark	0.222	3	Hawley	26.7	3
Sterling	0.159	4	West Tisbury	16.4	4
Hancock	0.159	5	Truro	16.0	5

Table ES-3. Top Municipalities for Total Solar Photovoltaic Capacity and Installations

Solar Energy Capacity			Solar PV Installations		
City/Town	PV Capacity (kW)	Rank	City/Town	PV Installations	Rank
Boston	5,647	1	Boston	157	1
Holyoke	4,527	2	Falmouth	127	2
Pittsfield	4,326	3	Barnstable	112	3
Springfield	2,959	4	Northampton	81	4
Dartmouth	2,808	5	Amherst	81	4

Figure ES-1. Installed Solar Photovoltaic Capacity by Municipality, May 2012
(See Appendix for full list of towns.)



- The city of Boston leads Massachusetts in both the *total number of solar PV installations* (157) and *total installed solar PV capacity* (5.6 MW). Several much smaller cities and towns – Falmouth, Barnstable, Northampton and Amherst – round out the top five municipalities for total number of solar installations, while three western Massachusetts municipalities – Holyoke, Pittsfield and Springfield – followed by Dartmouth, round out the top five for installed solar capacity. (See Table ES-3.)

Western Massachusetts is the region of the Commonwealth with the most solar energy installations and the largest amount of solar generating capacity, while the Cape and Islands lead Massachusetts in per capita measures of solar energy deployment. The top cities and towns for solar installations by region are as follows:

- **Cape and Islands:** Installations: Falmouth (127); Capacity: Barnstable (2.1 MW); Installations per 1,000 residents and Capacity per capita: Chilmark (37 systems per 1,000 residents, 0.22 kW per capita)
- **Central Mass.:** Installations: Harvard (47); Capacity: Northbridge (2.4 MW); Installations per 1,000 residents; Harvard (7.2 systems per 1,000 residents); Capacity per capita: Barre (0.37 kW per capita)
- **Greater Boston (excluding Boston):** Installations and Capacity: Cambridge (77 installations, 1.2 MW capacity); Installations per 1,000 residents: Winchester (1.2 systems per 1,000 residents); Capacity per capita: Winthrop (0.04 kW per capita)
- **MetroWest:** Installations: Framingham (44); Capacity: Lowell (1.3 MW); Installations per 1,000 residents and Capacity per capita: Sherborn (3.2 systems per 1,000 residents, 0.05 kW per capita)
- **North Shore:** Installations: Lawrence (39); Capacity: Haverhill (1.2 MW); Installations per 1,000 residents: West Newbury (4 systems per 1,000 residents); Capacity per capita: Newburyport (0.05 kW per capita)
- **South Shore:** Installations and Capacity: Plymouth (47 installations, 609 kW capacity); Installations per 1,000 residents: Plympton (1.8 systems per 1,000 residents); Capacity per capita: Hanover (0.02 kW per capita)
- **Southeast:** Installations, Capacity, and Capacity per capita: Dartmouth (46 installations, 2.8 MW capacity, 0.08 kW per capita); Installations per 1,000 residents: Marion (2.9 systems per 1,000 residents)
- **Western:** Installations: Northampton and Amherst (tie, 81); Capacity: Holyoke (4.5 MW); Installations per 1,000 residents: Hawley (26.7 systems per 1,000 residents); Capacity per capita: Sheffield (0.64 kW per capita).

Massachusetts has made great progress in deploying solar energy, but there is still tremendous room for growth.

- Massachusetts has become a solar energy leader on the strength of its strong solar policies. Net metering, the nation's most effective market in Solar Renewable Energy Certificates (SRECs), rebates, and tax breaks – coupled with unique initia-

tives focused on specific towns and specific categories of energy users – have helped make Massachusetts the second-best market for solar energy in the United States, according to a recent report by the firm of Ernst & Young.

- Massachusetts has excellent solar energy resources, with the technical potential to host at least 8.7 gigawatts of solar photovoltaic generating capacity – enough to produce the equivalent of 17 percent of the electricity Massachusetts consumes each year. Solar photovoltaic installations in Massachusetts to date have tapped only 1.3 percent of that potential.
- Massachusetts' economy can benefit from further expansion of solar energy. A recent study conducted for the Massachusetts Clean Energy Center found that there were more than 64,000 clean energy workers in the Commonwealth in 2011 – a 6 percent increase from the year before. A separate study estimated that there were more than 2,300 solar energy workers in the Commonwealth.
- Photovoltaics are not the only tools Massachusetts can use to obtain useful energy from the sun. Solar water heating, space heating and cooling systems can also reduce the Bay State's dependence on fossil fuels and help clean our air.

Massachusetts should set a goal of obtaining 10 percent of its energy from the sun by 2030. To get there, the Commonwealth should maintain and expand its existing solar energy programs, with a particular focus on:

- Lifting the cap on the amount of solar energy eligible for net metering, a key financial incentive that ensures that homeowners and businesses are compensated adequately for their investment in solar energy.
- Investing in improvements to the electricity grid that will enable the electricity system to accommodate the maximum possible amount of renewable energy, including solar power.
- Working with municipal utilities to improve and expand their programs for encouraging their customers to "go solar."
- Eliminating barriers to solar energy, such as the long utility delays in interconnection that can result in consumers waiting weeks or months for their solar panels to be connected to the grid.
- Continuing to look for new opportunities and approaches to promote solar power and maximize its benefits for Massachusetts. Massachusetts may wish to explore options such as fixed-price contracts with solar energy suppliers, consider additional tools to ensure that solar energy is available to people of all income levels, and find ways to encourage deployment of solar energy in locations where it delivers the greatest benefit to electricity consumers.
- Developing effective strategies to promote solar water heating and other technologies that capture energy from the sun and reduce Massachusetts' dependence on fossil fuels.

Introduction

In Holyoke, the local municipal utility has built New England's largest solar power plant, generating enough power to supply 5 percent of the city's homes. In Brockton, a local community college is benefiting from a new solar array, part of the college's effort to reduce its consumption of fossil fuels and electricity from the grid by 40 percent.[1] In Aquinnah, at the western tip of Martha's Vineyard, workers are installing solar panels on a former landfill. Meanwhile, rooftop solar energy systems are springing up in cities and towns across the Commonwealth, saving money for residents while reducing Massachusetts' dependence on fossil fuels and its emissions of pollutants that cause global warming.

Welcome to the solar energy revolution, Massachusetts-style.

Over the past three years, solar energy has been transformed from a novelty – one sure to draw stares from passers-by – into an increasingly common sight in many Massachusetts communities. Massachusetts isn't the only state to experience dramatic growth in solar energy – falling prices resulting from technological advances and growing economies of scale, as well as strong solar energy policies in other states, helped the United States to nearly double its solar photovoltaic capacity in 2011 alone.[2] But solar energy is an especially good idea in the Commonwealth, with the potential to reduce air pollution, help Massachusetts meet its goals for reducing our contribution to global warming, curb our dependence on out-of-state fossil fuels, and help build a new economic future on a foundation of clean energy.

Photo: Massachusetts Executive Office of Energy and Environmental Affairs, made available under a Creative Commons Attribution-Non-Commercial 2.0 license

Workers install solar panels at a solar energy park in Westford – one of many new solar energy projects installed across Massachusetts in recent years.

The future for solar energy is bright. Lower prices and the development of an experienced corps of solar energy professionals promise to make solar energy accessible to a greater number of Massachusetts residents than ever before. But to continue to reap the benefits of solar energy – and to hasten the day when solar power can compete economically with electricity from dirty power plants – Massachusetts must continue to use public policy to build a strong clean energy economy.

Solar Energy Is Good for Massachusetts

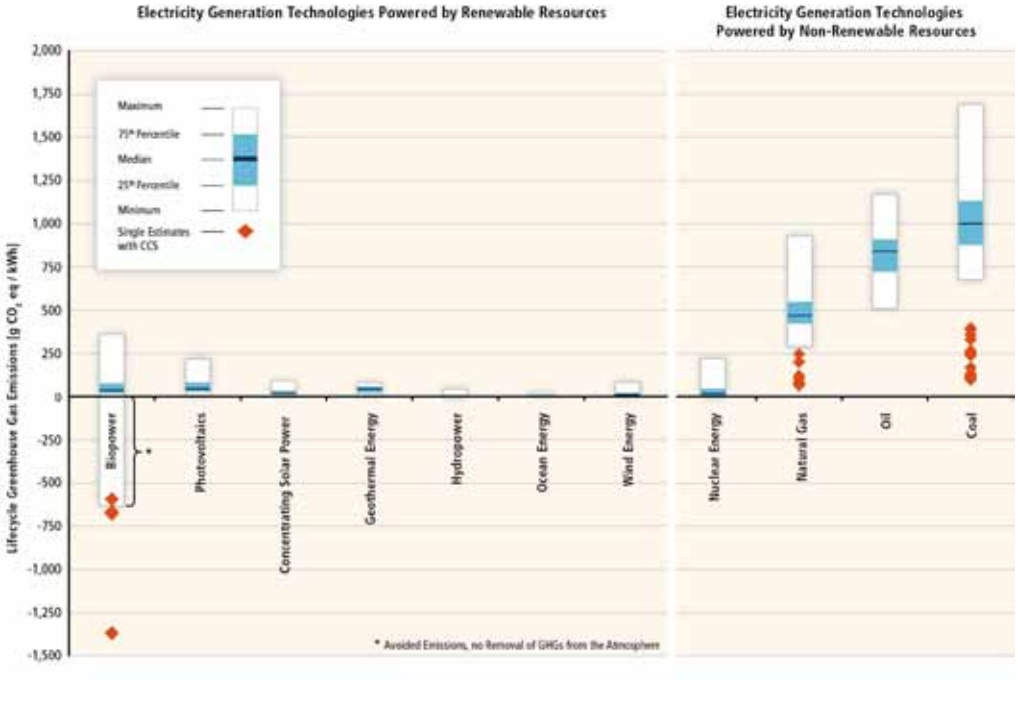
Massachusetts has a great deal to gain by "going solar." Cleaner air and a more robust economy are among the many benefits solar energy can deliver to Massachusetts.

Solar Power Reduces Consumption of Dirty Energy, Curbs Air Pollution and Addresses Global Warming

Generating electricity using solar panels on rooftops and vacant land reduces the need to produce power by burning fossil fuels. Solar power saves energy and reduces air pollution, including pollution that contributes to global warming.

Solar photovoltaics produce dramatically lower emissions of global warming pollutants than fossil fuel-based forms of electricity generation. That is true even when emissions produced in the manufacture, transport and installation of the solar panels are taken into account. (See Figure 1, next page.) By expanding Massachusetts' use of solar energy, the Commonwealth can take an important step toward achieving the goals of the Global Warming Solutions Act, which commits Massachusetts to reducing its emissions of global warming pollutants to 25 percent below 1990 levels by 2020. Meeting that goal would enable Massachusetts to do its part to prevent the worst impacts of global warming – including sea level rise, shifts in precipitation patterns, and changes in ocean conditions that threaten key ecosystems and important sectors of the Commonwealth's economy.[3]

Figure 1. Life-Cycle Emissions of Global Warming Pollutants from Various Electricity Generation Technologies[4]



Solar energy provides similar benefits when it comes to avoiding emissions of smog- and soot-forming pollutants from power plants. Solar photovoltaics produce no local air pollution, unlike fossil fuel-fired power plants, which produce nitrogen oxides and other pollutants that contribute to local air-quality problems. By curbing emissions from electricity generation, solar energy can reduce the ozone pollution that exceeded federal safety standards in Massachusetts on 14 days during the summer of 2010, jeopardizing the health of children, the elderly and those with respiratory disease.[5] Nitrogen oxides also contribute to water pollution via atmospheric deposition of nitrogen into waterways. Excess nitrogen can fuel algae blooms that reduce oxygen levels in waterways, threatening the health of aquatic species.

While it does take energy to manufacture, transport and install solar panels, PV systems generate far more energy over their lifetimes than is required to produce them. A recent life-cycle analysis of solar photovoltaic (PV) systems found that PV systems "repay" the energy used to create them within 10 to 22 months of their installation.[6] Since photovoltaic systems continue to generate electricity for 20 years or more, every solar panel installed in Massachusetts reduces the world's dependence on dirty and dangerous sources of energy.

Solar Energy Benefits Massachusetts' Economy

Solar energy can help break Massachusetts' dependence on dirty sources of energy – virtually all of which comes from outside the state – creating new opportunities for economic growth in the Commonwealth. It can also contribute to the development of a

Capturing the Sun: Solar Energy Technologies

This report focuses on the dramatic increase in Massachusetts' ability to generate electricity from the sun through the use of solar photovoltaic (PV) panels. Solar PV, however, is just one of many tools that Massachusetts can use to capture energy from the sun, reducing our dependence on fossil fuels.

Other solar energy technologies include:

- **Solar water heaters –** Rooftop-mounted collectors capture solar energy as heat and produce hot water. Solar heat collectors can be extremely efficient; low-temperature heaters can capture up to 87 percent of the solar energy that reaches them. Solar water heaters can be adapted for uses ranging from residential water heating to large-scale industrial use.
- **Solar space heating and cooling –** Collectors similar to those used for hot water can also be used to heat air in place of furnaces or boilers. These systems can contribute 50 percent or more of the energy needed to heat a building. Solar energy can even be used to cool buildings through the use of absorption chillers.
- **Passive solar design –** For centuries, skilled builders have designed homes and other buildings that take the best possible advantage of solar energy. "Passive" solar design can contribute to the overall efficiency of a building, reducing the need for energy for lighting, heating and cooling.

Massachusetts' success in designing effective policies to promote photovoltaics should inspire policy-makers to identify strategies that maximize the use of all solar energy technologies.

more localized and resilient electricity system.

More than 90 percent of the electricity produced in Massachusetts comes from dirty sources such as fossil fuels and nuclear energy.[7] To add insult to injury, virtually all of the fuel for these dirty power sources comes from outside Massachusetts, as there is no significant production of fossil fuels in the Commonwealth. Of the $22 billion Massachusetts residents, businesses, utilities and government agencies spend on energy each year, 80 percent is spent on out-of-state sources, representing an $18 billion lost economic opportunity to the Commonwealth.[8]

By contrast, solar energy supports a growing number of jobs in system design, installation and financing across Massachusetts. Even though many solar panels are manufactured elsewhere in the nation or the world, Massachusetts' recent boom in solar energy has created thousands of jobs in the Commonwealth.

A recent study conducted for the Massachusetts Clean Energy Center found that there were more than 64,000 clean energy workers in the Commonwealth in 2011 – a 6 percent increase from the year before. Solar energy is a big part of the Commonwealth's clean energy economy, with more than two out of every three renewable energy employers

in Massachusetts engaged in solar energy, according to the report.[9] Another 2011 report found that Massachusetts ranked 10th in the nation for solar jobs, with 410 establishments employing more than 2,300 people.[10]

Solar energy also helps protect Massachusetts consumers against volatility in fossil fuel prices. While natural gas prices are currently low, Massachusetts electricity consumers have been battered over the last decade by natural gas prices that have varied by nearly a factor of three – causing electricity rates to rise and fall along with them.[11] Once installed on a building or vacant land, solar panels continue to produce electricity at minimal cost for decades – helping to insulate Massachusetts customers and businesses from future spikes in fossil fuel prices.

Finally, solar power can reduce the cost of electricity by providing power locally, and at times when it is needed the most. New England's electricity system is built to supply power whenever it is needed, including the very few hours each year when high temperatures and high demand for air conditioning cause electricity demand to spike. To meet the demand for electricity at these times, grid operators must bring online a series of rarely used, very expensive – and often very dirty – fossil fuel generators. Fortunately, solar photovoltaic panels tend to produce the most energy at the times when power is in greatest demand. A recent study in New York estimated that these and other power system benefits result in solar energy providing a net benefit to ratepayers and taxpayers in parts of that state, with the benefits expected to grow over time as prices for solar panels continue to fall.[12]

Massachusetts has much to gain from expanding the number of solar energy systems in the Commonwealth. Bay State residents and businesses are already starting to reap those benefits through the rapid adoption of solar energy.

Massachusetts' Solar Energy Leaders

In recent years, Massachusetts has vaulted into the top tier of states for deployment of solar energy – the result of a strong commitment by state policy-makers and the on-the-ground efforts of homeowners, businesses, local governments and non-profit groups to install solar energy systems in communities across the Commonwealth.

Solar panels can now be found in nearly every town in Massachusetts. But some cities and towns have exhibited noteworthy leadership in moving Massachusetts toward a clean energy future.

Solar Energy Is on the Rise Across Massachusetts

Massachusetts produced nearly 30 times more electricity from solar power in June 2012 as it did at the end of 2007. Massachusetts ranked 12th in the nation for installed solar capacity in 2010 and 2011, and the growth in solar power installations has accelerated in the first half of 2012.[13] Nearly as much solar generating capacity was installed in the first five months of 2012 as in the Commonwealth's entire history through 2010.

Solar panels have sprung up in every kind of community in Massachusetts – urban, suburban and rural – and from the Cape and Islands to the Berkshires. As of May 2012, at least 333 of Massachusetts' 351 cities and towns had solar photovoltaic panels, with 21 towns having installed their first solar panels since the beginning of 2011, according to data from the Massachusetts Clean Energy Center, (See "Measuring Solar Energy in Massachusetts Cities and Towns," page 17.)

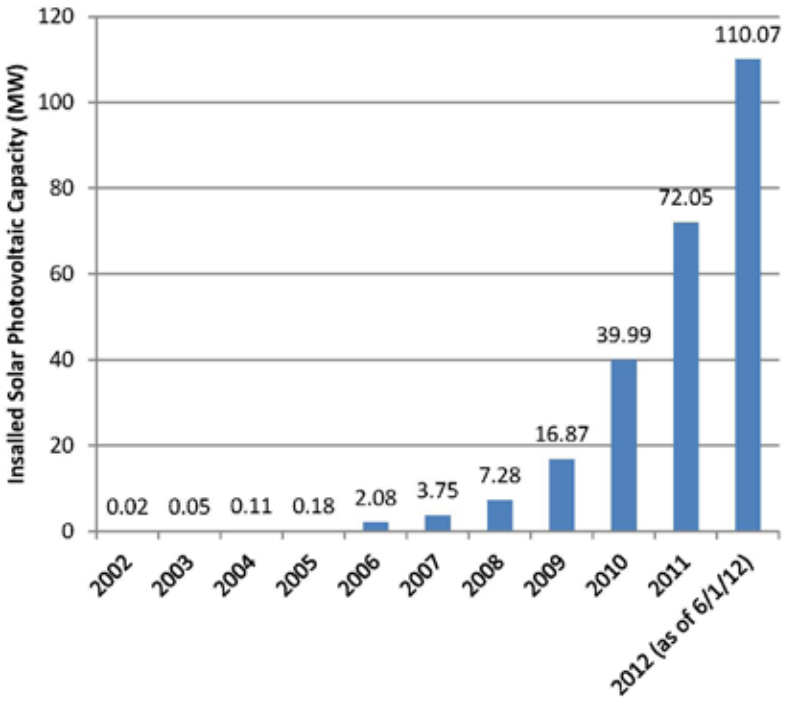
Identifying Massachusetts' Solar Energy Leaders

Massachusetts' cities and towns vary by geography, demographics and size. No single measure, therefore, can provide a complete picture of the degree to which cities and towns have adopted solar power.

In this report, we present four measures of solar energy penetration:

- **Total solar generating capacity**, which measures the amount of electricity that can be produced by the solar panels installed in each city or town. Cities and towns that rank highly on this measure will tend to be larger municipalities or those with large solar power systems installed by electric utilities, local governments or businesses.
- **Number of solar photovoltaic installations,** which measures the number of solar PV systems installed in a city or town, providing an indication of the breadth with which solar energy is being adopted in a community. Cities and towns that rank highly on this measure will tend to be larger municipalities with a high number of small-scale residential and commercial solar enrergy systems.
- **Solar generating capacity per capita**, which represents the total amount of electricity that can be

Figure 2. Cumulative Installed Solar Photovoltaic Capacity (Since 2002)[14]



Measuring Solar Energy in Massachusetts Cities and Towns

The estimates of solar photovoltaic installations by municipality in this report are based on data provided by the Massachusetts Clean Energy Center (MassCEC), which works to develop the clean energy industry in the Commonwealth and administers the state's Renewable Energy Trust Fund. MassCEC primarily tracks the size and location of solar photovoltaic systems that are eligible for Solar Renewable Energy Certificates (SRECs), a form of economic incentive for solar power deployment. The data in this report represent solar PV systems that are registered as in service in MassCEC's Production Tracking System as of May 24, 2012. Due to lag time between the installation of some solar projects and their appearance in the MassCEC database, some recently installed solar projects are not reflected in the totals presented in this report. Similarly, this report excludes older (pre-2002) solar photovoltaic installations.

The data presented in this report include 97 megawatts (or 88 percent) of the 110 megawatts of solar PV capacity installed in Massachusetts between the beginning of 2002 and June 1, 2012.

produced by solar panels in a municipality, divided by its population. Cities and towns that rank highly on this measure will tend to be those with low populations but with one or a few large solar energy projects.

- **Solar installations per thousand residents**, which divides the number of solar PV systems installed in a municipality by its population in thousands. Cities and towns that rank highly on this measure will tend to be those with a high penetration of residential and commercial solar energy systems.

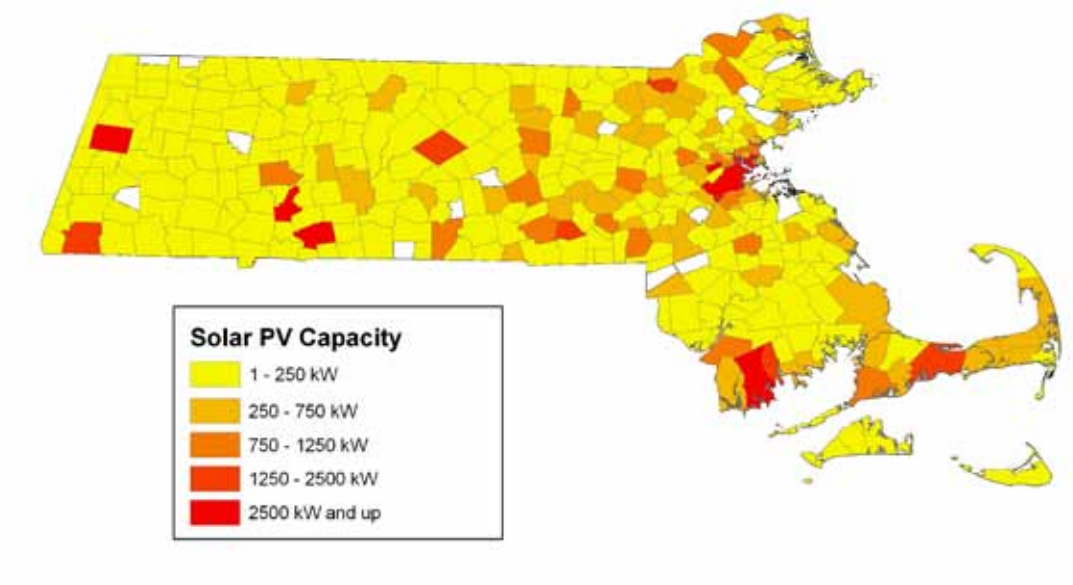
In addition to presenting these measures statewide, this report also presents the leading solar cities and towns for each region of Massachusetts, the leading municipalities among cities and towns in specific size categories, and the cities and towns in which certain types of institutions – schools, colleges, and public and private-sector actors – have exerted leadership in the adoption of solar energy.

Leading Cities and Towns for Total Solar Generating Capacity

The Commonwealth's largest city – Boston – is also the city with the largest amount of solar photovoltaic capacity. The city of Boston has 5.6 megawatts of solar photovoltaic generating capacity, about 5.8 percent of the 97 megawatts of solar power listed in the MassCEC database. Boston's position at the top of the list for solar generating capacity, however, is largely due to its size – the city ranks in the bottom half of all cities and towns in Massachusetts when it comes to per-capita deployment of solar energy.

The next three cities for total solar photovoltaic capacity – Holyoke, Pittsfield and Springfield – are all in western Massachusetts. Holyoke is home to New England's largest solar energy installation, a 4.5 megawatt project commissioned by Holyoke Gas & Electric, the city's municipal utility. Pittsfield and Springfield have similar

Figure 3. Total Solar PV Capacity by Municipality



large-scale solar energy installations. (See Figure 3 and Table 1.)

All in all, at least 21 Massachusetts cities and towns had more than 1 megawatt of solar energy capacity as of May 2012, up from four municipalities with that much solar power 17 months earlier.

Leading Cities and Towns for Total Solar Installations

Boston again leads the Commonwealth in the total number of solar PV system installations, which is a measure of the broad implementation of small-scale solar projects on homes and businesses. The Cape and Islands are well represented among the top towns for total number of solar installations, with Falmouth, Barnstable, Harwich, Orleans and West Tisbury all in the top 20. The combination of favorable economics due to the heavy prevalence of electric heating, early efforts to pave the way for solar energy through the region's Million Solar Roofs partnership, and aggressive efforts by local electricity cooperatives has contributed to the rapid spread of solar energy in that region. Northampton and Amherst rank fourth and fifth on the list. (See Figure 4 and Table 2.)

Leading Cities and Towns for Solar Capacity per Capita

Measured on a per capita basis, the leading towns for solar PV capacity – the amount of electricity that can be provided by the sun in each town – tend to be small municipalities with one or a few large solar energy installations within their borders. Sheffield in western Massachusetts (population 3,335) leads the Commonwealth for solar energy capacity per capita on the strength of a 2-megawatt solar farm at a private school located in the town. The towns of Barre and Sterling in Worcester County, Chilmark on Martha's Vineyard, and Hancock in Berkshire County round out the top five. (See Figure 5 and Table 3, page 20.)

Table 1. Leading Massachusetts Cities and Towns for Total Solar Photovoltaic Capacity

City/Town	Solar PV Capacity (kW)
Boston	5,647
Holyoke	4,527
Pittsfield	4,326
Springfield	2,959
Dartmouth	2,808
Northbridge	2,445
Barnstable	2,076
Sheffield	2,073
Barre	1,992
Lowell	1,336
New Bedford	1,286
Sutton	1,249
Sterling	1,245
Framingham	1,213
Cambridge	1,196
Falmouth	1,195
Haverhill	1,170
Worcester	1,130
Everett	1,122
Brockton	1,082

Table 2. Top 20 Cities and Towns for Total Number of Solar PV Installations

City/Town	Solar PV Installations
Boston	157
Falmouth	127
Barnstable	112
Northampton	81
Amherst	81
Cambridge	77
Harwich	66
Newton	65
Orleans	49
Harvard	47
Plymouth	47
Dartmouth	46
Worcester	46
Arlington	45
West Tisbury	45
Framingham	44
Greenfield	44
Lawrence	39
Marshfield	39
Townsend	38

Figure 4. Solar PV Installations by Municipality

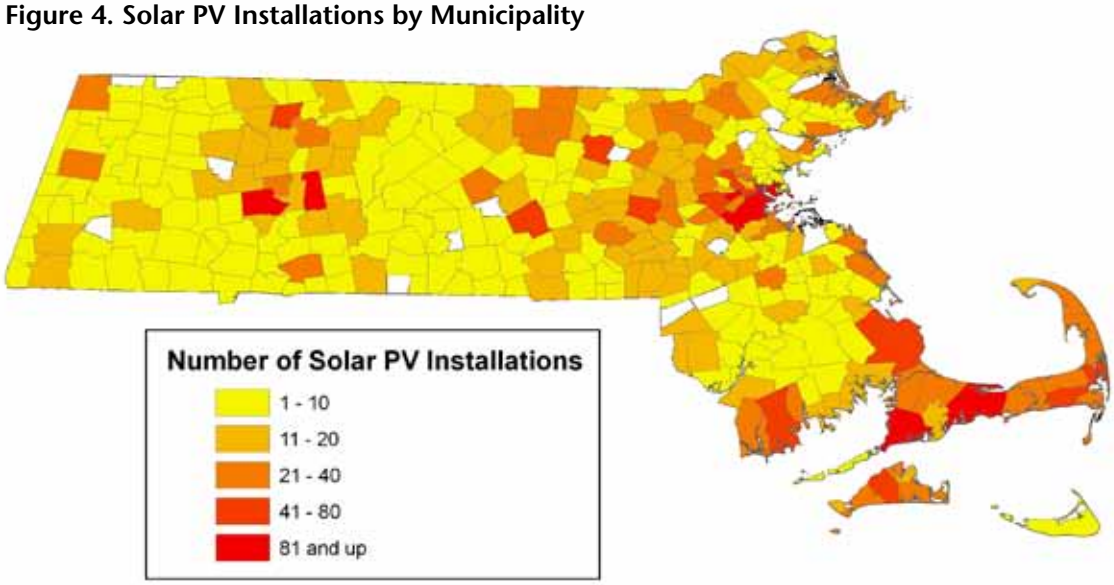


Figure 5. Solar PV Capacity per Capita by Municipality

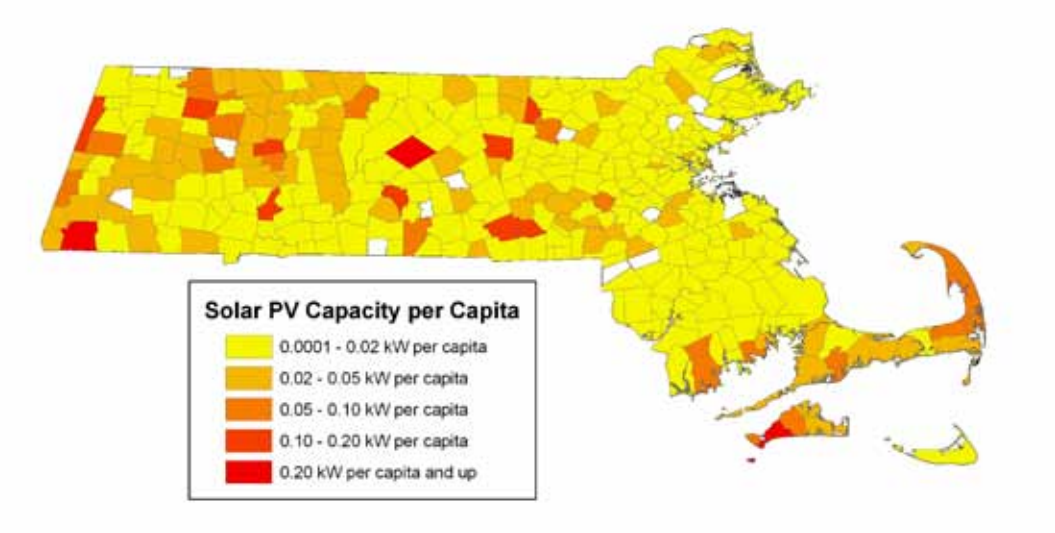


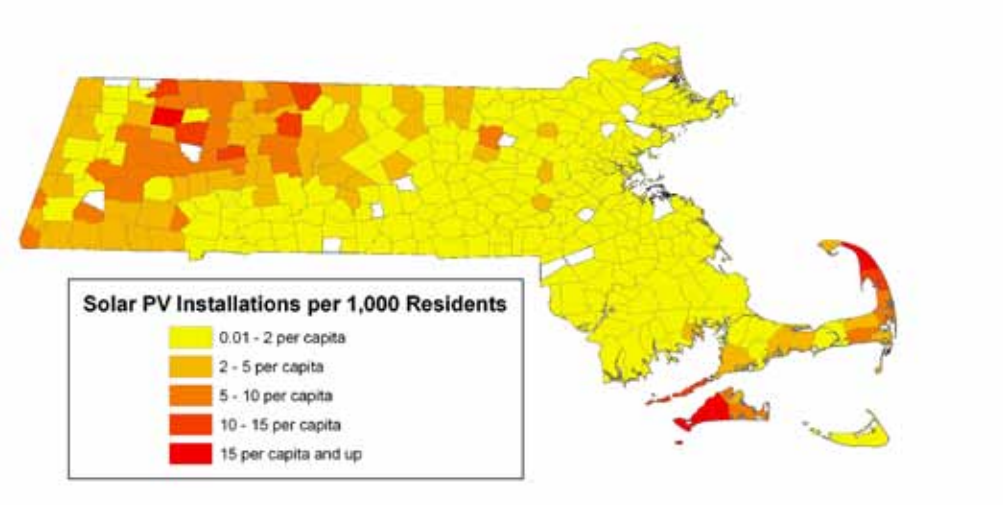
Table 3. Top 20 Municipalities for Solar Photovoltaic Capacity per Capita

City/Town	Capacity per Capita (kW)
Sheffield	0.636
Barre	0.369
Chilmark	0.222
Sterling	0.159
Hancock	0.159
Northbridge	0.156
West Brookfield	0.141
Sutton	0.139
Whately	0.123
Shirley	0.115
Holyoke	0.114
Hawley	0.104
Wellfleet	0.099
Pittsfield	0.097
Harvard	0.096
Sturbridge	0.094
Aquinnah	0.090
Rowe	0.083
Dartmouth	0.083
Truro	0.077

Table 4. Top 20 Municipalities for Solar Energy Installations per 1,000 Residents

City/Town	Solar Installations per 1,000 residents
Chilmark	37.0
Aquinnah	35.4
Hawley	26.7
West Tisbury	16.4
Truro	16.0
Wendell	14.2
Wellfleet	13.5
Gosnold	13.3
Rowe	12.7
Whately	11.4
Ashfield	10.4
Warwick	10.3
Middlefield	9.6
Monterey	9.4
Shutesbury	9.0
Chesterfield	9.0
Hatfield	8.5
Orleans	8.3
Edgartown	8.1
Alford	8.1

Figure 6. Solar PV Installations per 1,000 Residents by Municipality



Leading Cities and Towns for Solar Installations per 1,000 Residents

Cape and Islands towns lead the list for total number of solar photovoltaic installations per 1,000 residents – a measure of the breadth of adoption of small-scale photovoltaic systems divided by a town's population. Chilmark on Martha's Vineyard has 32 solar photovoltaic installations – about one-fifth as many as the city of Boston – but with a population in 2010 of only 866 residents. Aquinnah, West Tisbury, Truro, Wellfleet, Gosnold, Orleans and Edgartown also rank highly, as do many smaller towns in western Massachusetts. (See Figure 6 and Table 4.)

Clearly, many of Massachusetts' smallest communities rise to the top in comparisons of solar energy capacity and installations per capita. Among Massachusetts' mid-sized (10,000 to 50,000 population) and large

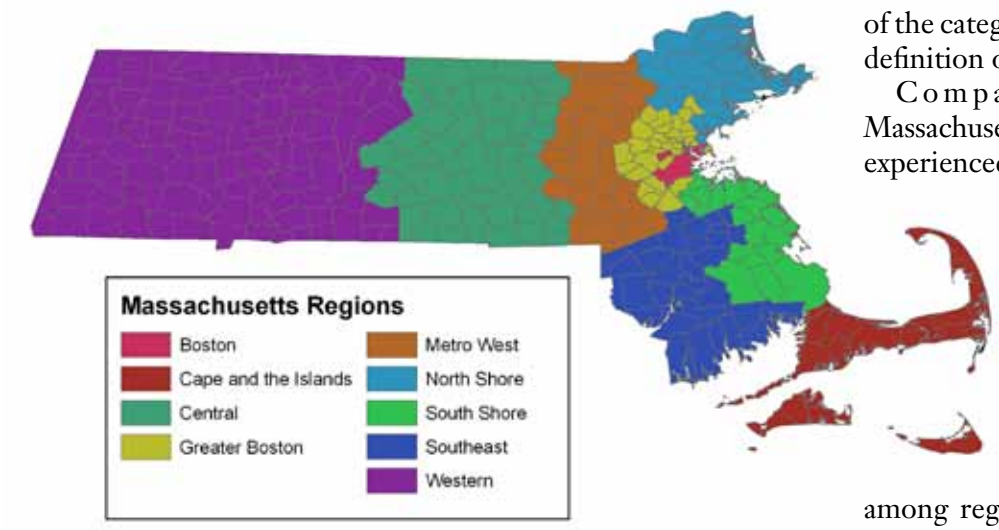
Table 5. Solar PV Capacity and Installations per 1,000 Residents for Municipalities 10,000-50,000 Population

Municipality	Solar PV Capacity per Capita	Municipality	Solar Installations per 1,000 Population
Northbridge	0.156	Harwich	5.39
Holyoke	0.114	Falmouth	4.03
Pittsfield	0.097	Northampton	2.84
Dartmouth	0.083	Greenfield	2.52
Mashpee	0.051	Barnstable	2.48
Medway	0.049	Wayland	2.31
Newburyport	0.047	Lunenburg	2.18
Barnstable	0.046	Amherst	2.14
Winthrop	0.043	Maynard	1.88
Harwich	0.042	Ipswich	1.75
Ashland	0.039	Westport	1.74
Leicester	0.039	Hopkinton	1.61
Falmouth	0.038	Sandwich	1.60
Hopkinton	0.036	Bourne	1.57
Norfolk	0.035	Marshfield	1.55
Swampscott	0.034	Dennis	1.48
Milton	0.033	Scituate	1.38
Westborough	0.033	Newburyport	1.38
Foxborough	0.032	Dartmouth	1.35
Franklin	0.030	Acton	1.32

Table 6. Solar Capacity per Capita and Installations per 1,000 People for Cities and Towns Over 50,000 Population

Municipality	Solar PV Capacity per Capita	Municipality	Solar Installations per 1,000 People
Springfield	0.019	Plymouth	0.832
Haverhill	0.019	Newton	0.763
Waltham	0.018	Cambridge	0.732
Framingham	0.018	Framingham	0.644
Revere	0.016	Lawrence	0.511
New Bedford	0.014	Waltham	0.495
Lowell	0.013	Brookline	0.460
Brockton	0.012	Medford	0.392
Cambridge	0.011	New Bedford	0.316
Plymouth	0.011	Weymouth	0.298
Fall River	0.011	Brockton	0.288
Boston	0.009	Haverhill	0.279
Worcester	0.006	Lowell	0.272
Lawrence	0.006	Quincy	0.260
Somerville	0.006	Boston	0.254

Figure 7. Massachusetts Regions



(50,000+) municipalities, certain communities have also established themselves as leaders in solar energy deployment when measured on a per-capita basis.

Among mid-size municipalities, the central Massachusetts town of Northbridge leads for solar photovoltaic capacity per capita, followed by Holyoke, Pittsfield, Dartmouth and Mashpee. Harwich leads for solar installations per 1,000 people, followed by Falmouth, Northampton, Greenfield and Barnstable. (See Table 5,previous page)

Among the Commonwealth's largest municipalities (50,000+ population), Springfield and Haverhill top the list for solar PV capacity per capita, while Plymouth is the leading municipality for solar installations per 1,000 residents. (See Table 6.)

Solar Leadership at the Regional Level

Cities and towns in each of Massachusetts' diverse regions have taken leadership in solar energy deployment. In this section, we review the leading cities and towns in each region in each of the categories above. (See Figure 7 for definition of regions.)

Comparing the regions of Massachusetts, the Cape and Islands have experienced by far the fastest adoption of solar energy when measured on a per-capita basis. The Cape and Islands have 13 times more solar PV systems per 1,000 residents than the city of Boston. Western Massachusetts ranks first for total solar PV capacity and for total PV installations among regions of the Commonwealth. (See Table 7.)

Table 7. Solar Energy Installations and Capacity by Region

Region	PV Capacity per Capita (kW)	Solar PV Installations per 1,000 Residents	Total PV Capacity (kW)	Number of Solar PV Installations
Cape and the Islands	0.036	3.388	8,824	822
Western	0.026	1.216	21,447	1,015
Central	0.022	0.751	18,146	612
MetroWest	0.016	0.764	12,700	603
Southeast	0.013	0.480	9,813	372
North Shore	0.010	0.505	7,894	384
Greater Boston	0.010	0.501	10,571	521
Boston	0.009	0.254	5,647	157
South Shore	0.006	0.530	2,586	237

Leading cities and towns, ranked by solar PV capacity per capita, within each region follow:

Cape and Islands

In the Cape and lslands region, Chilmark on Martha's Vineyard leads in both capacity per capita and installations per 1,000 residents, while Barnstable leads for total solar energy capacity and Falmouth leads for total number of solar energy installations. (See Table 8.)

Table 8. Cape and Islands Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/ Town	PV Capacity per Capita (kW)	City/ Town	PV Installations per 1,000 Residents
Barnstable	2,076	Falmouth	127	Chilmark	0.222	Chilmark	37.0
Falmouth	1,195	Barnstable	112	Wellfleet	0.099	Aquinnah	35.4
Brewster	742	Harwich	66	Aquinnah	0.090	West Tisbury	16.4
Mashpee	709	Orleans	49	Truro	0.077	Truro	16.0
Yarmouth	561	West Tisbury	45	Brewster	0.076	Wellfleet	13.5

Central Massachusetts

Among Central Massachusetts cities and towns, Northbridge ranks first for total solar PV capacity, Harvard for both the number of solar installations and solar installations per 1,000 residents, and Barre for solar energy capacity per capita. (See Table 9.)

Table 9. Central Massachusetts Solar Leaders

City/Town	PV Capacity (kW)	City/ Town	PV Installations	City/Town	PV Capacity per Capita (kW)	City/Town	PV Installations per 1,000 Residents
Northbridge	2,445	Harvard	47	Barre	0.369	Harvard	7.2
Barre	1,992	Worcester	46	Sterling	0.159	Townsend	4.3
Sutton	1,249	Townsend	38	Northbridge	0.156	Rutland	3.5
Sterling	1,245	Rutland	28	West Brookfield	0.141	West Brookfield	2.4
Worcester	1,130	Fitchburg	24	Sutton	0.139	Hardwick	2.3

Greater Boston

In Greater Boston (excluding the city of Boston), Cambridge leads for total solar energy capacity and number of solar PV installations. Winthrop leads the region for solar energy capacity per capita, while Winchester leads for installations per 1,000 residents. (See Table 10.)

Table 10. Greater Boston Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/Town	PV Capacity per Capita (kW)	City/Town	PV Installations per 1,000 Residents
Cambridge	1,196	Cambridge	77	Winthrop	0.043	Winchester	1.2
Everett	1,122	Newton	65	Milton	0.033	Westwood	1.1
Waltham	1,080	Arlington	45	Everett	0.027	Arlington	1.1
Milton	904	Waltham	30	Canton	0.026	Weston	1.0
Winthrop	747	Brookline	27	Watertown	0.022	Needham	0.8

MetroWest

In the MetroWest region, Lowell leads for solar PV capacity and Framingham leads for the number of solar PV installations. Sherborn leads the region in both measures of per-capita solar PV deployment. (See Table 11.)

Table 11. MetroWest Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/ Town	PV Capacity per capita (kW)	City/ Town	PV Installations per 1,000 residents
Lowell	1,336	Framingham	44	Sherborn	0.051	Sherborn	3.2
Framingham	1,213	Natick	36	Medway	0.049	Carlisle	3.1
Franklin	938	Wayland	30	Ashland	0.039	Wayland	2.3
Chelmsford	704	Lowell	29	Hopkinton	0.036	Maynard	1.9
Ashland	642	Acton	29	Norfolk	0.035	Lincoln	1.7

North Shore

On the North Shore (which includes part of the Merrimack Valley), Haverhill leads for solar PV capacity, while Lawrence leads for total number of solar energy installations. On a per capita basis, Newburyport leads for solar energy capacity, while West Newbury leads for the number of installations per 1,000 people. (See Table 12.)

Table 12. North Shore Solar Leaders

City/Town	PV Capacity (kW)	City/ Town	PV Installations	City/Town	PV Capacity per Capita (kW)	City/Town	PV Installations per 1,000 Residents
Haverhill	1,170	Lawrence	39	Newburyport	0.047	West Newbury	4.0
North Andover	831	Salem	34	Swampscott	0.034	Newbury	2.4
Newbury-port	827	Gloucester	32	North Andover	0.029	Ipswich	1.7
Revere	806	Beverly	25	West Newbury	0.025	Rockport	1.6
Salem	618	Newbury-port	24	Haverhill	0.019	Newburyport	1.4

South Shore

Among cities and towns on the South Shore, Plymouth leads for both total solar capacity and the number of solar energy installations. On a per capita basis, Hanover leads for solar PV capacity per capita, while Plympton tops the list for solar PV installations per 1,000 residents. (See Table 13.)

Table 13. South Shore Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/Town	PV Capacity per Capita (kW)	City/Town	PV Installations per 1,000 Residents
Plymouth	609	Plymouth	47	Hanover	0.024	Plympton	1.8
Quincy	465	Marshfield	39	Carver	0.017	Marshfield	1.6
Hanover	329	Scituate	25	Plympton	0.013	Scituate	1.4
Marshfield	299	Quincy	24	Marshfield	0.012	Kingston	1.3
Carver	201	Hanover	17	Plymouth	0.011	Hanover	1.2

Southeastern Massachusetts

In Southeastern Massachusetts, Dartmouth leads the region in three categories of solar energy deployment – total capacity, installations, and capacity per capita. Marion leads the region in the number of installations per 1,000 residents. (See Table 14.)

Table 14. Southeastern Massachusetts Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/Town	PV Capacity per Capita (kW)	City/Town	PV Installations per 1,000 Residents
Dartmouth	2,808	Dartmouth	46	Dartmouth	0.083	Marion	2.9
New Bedford	1,286	New Bedford	30	Mattapoisett	0.057	Mattapoisett	1.8
Brockton	1,082	Brockton	27	Marion	0.021	Westport	1.7
Fall River	956	Westport	27	Fairhaven	0.019	Dartmouth	1.4
Attleboro	560	Fall River	16	Westport	0.019	Rochester	1.3

Western Massachusetts

In Western Massachusetts, Holyoke leads for total solar photovoltaic capacity, while Northampton and Amherst share the lead for individual solar energy installations. In the per-capita measures, Sheffield leads for solar capacity per capita, while Hawley leads for installations per 1,000 residents. (See Table 15.)

Table 15. Western Massachusetts Solar Leaders

City/Town	PV Capacity (kW)	City/Town	PV Installations	City/ Town	PV Capacity per Capita (kW)	City/ Town	PV Installations per 1,000 Residents
Holyoke	4,527	Northampton	81	Sheffield	0.636	Hawley	26.7
Pittsfield	4,326	Amherst	81	Hancock	0.159	Wendell	14.2
Springfield	2,959	Greenfield	44	Whately	0.123	Rowe	12.7
Sheffield	2,073	Hatfield	28	Holyoke	0.114	Whately	11.4
Northampton	783	Montague	28	Hawley	0.104	Ashfield	10.4

Leaders by Type of Entity Installing Solar Power

The growing momentum in solar energy in Massachusetts comes from many sources – homeowners and businesses, government agencies, local governments and both investor-owned and municipal utilities. The MassCEC database provides limited information about the type of entity installing solar panels, providing a window into the contributions of various types of institutions in driving solar energy deployment in the Commonwealth.[15]

Private Sector

Private businesses and homeowners (including those who lease their solar energy systems from third-party installers) are responsible for at least 37 MW of solar photovoltaic capacity in Massachusetts. Boston ranks first for privately installed solar energy capacity and for the number of private solar installations. Sutton, which plays host to a 983 kW solar installation on the rooftop of a National Grid warehouse, ranks second for privately installed solar capacity, followed by Framingham, Falmouth and Fall River. Falmouth ranks second for the number of private solar PV installations, followed by Barnstable and Northampton. (See Table 16.)

Table 16. Top Cities and Towns for Private Solar Energy Capacity Installations

City/Town	Solar PV Capacity (MW)	Solar PV Installations
Boston	1,791	108
Sutton	1,039	10
Framingham	930	34
Falmouth	858	107
Fall River	849	13
New Bedford	756	14
Barnstable	682	89
Lowell	636	16
Cambridge	625	60
Northampton	573	67
Northbridge	566	5
Foxborough	544	9
Ashland	543	11
Yarmouth	526	16
Brewster	518	29

Schools (K-12)

In many communities, schools have been among the first facilities to install solar panels. Solar energy is particularly well suited to schools since the buildings are used primarily during the day, when solar energy can meet a large share of a facility's needs, and because many schools have flat roofs that can easily accommodate solar panels. In addition, the installation of solar panels on schools provides an opportunity for on-site education about the science of energy production.

Kindergarten through 12th grade schools – both public and private – currently accommodate at least 8.6 MW of solar generating capacity in Massachusetts. Sheffield, which is host to a 2 MW solar energy system on the campus of the private Berkshire School, leads Massachusetts cities and towns in school-based solar energy, followed by Sturbridge and Milton. Boston leads all municipalities for the number of school-based solar energy installations with seven. (See Table 17.)

Colleges and Universities

Watertown, which hosts a large Harvard University-initiated solar project, ranks first in the Commonwealth for solar power capacity on college and university buildings, followed by Brockton (Massasoit Community College), Pittsfield (Berkshire Community College), Waltham (Brandeis University) and Dartmouth (UMass Dartmouth). (See Table 18.)

Public Sector

Government agencies at all levels have a responsibility to "lead by example" in the adoption of solar energy, even as they safeguard taxpayer resources by guarding against wild swings in fossil fuel prices. The MassCEC data for public sector solar installations includes installations by municipal utilities. As a result, Holyoke, whose municipal utility has invested heavily in solar energy, ranks first for public sector solar energy capacity by a wide margin, followed by Winthrop, Brockton, Waltham and West Boylston.

Table 17. Top Cities and Towns for School-Based Solar Capacity and Installations

City/Town	Solar PV Capacity (kW)	Solar PV
Sheffield	2,000	1
Sturbridge	862	2
Milton	785	5
Medway	517	2
Swampscott	451	2
Leicester	374	3
Mashpee	314	2
New Bedford	282	4
Boston	268	7
Cambridge	260	1
Warren	221	2
Sutton	202	1
Dedham	167	3
Lynn	147	1
Marlborough	141	1

Table 18. Top Cities and Towns for College and University Solar Capacity and Installations

City/Town	Solar PV Capacity (kW)	Solar PV Installations
Watertown	501	1
Brockton	370	5
Pittsfield	364	5
Waltham	277	1
Dartmouth	269	5
Lowell	246	4
Worcester	205	4
Salem	148	1
Boston	119	3
Springfield	113	2

Table 19. Top Cities and Towns for Public Sector Solar Capacity and Installations

City/Town	Solar PV Capacity (kW)	Solar PV Installations
Holyoke	4,527	2
Winthrop	737	3
Brockton	481	3
Waltham	378	1
West Boylston	370	1
Norfolk	342	3
Boston	288	3
Concord	216	3
Shirley	206	1
Walpole	164	2

Massachusetts' Solar Energy Programs: Fueling the Solar Boom

The dramatic increase in solar energy in Massachusetts over the last three years is no accident. Rather, it is the result of the state's strong commitment to clean energy and embrace of a variety of creative policy tools that make it easier for Massachusetts residents and businesses to "go solar." A recent report by the firm of Ernst & Young listed Massachusetts as the second most attractive solar energy market in the United States (tied with Hawaii and trailing California), due to in part to a favorable policy environment.[16]

Massachusetts' decision to invest in solar energy has come at a fortuitous time – the installed price of solar photovoltaic systems declined by 17 percent between 2009 and 2010 and by an additional 20 percent in 2011.[17]

The Commonwealth's strong solar energy policies, coupled with the dramatic drop in prices, have put solar energy within the reach of an increasing number of residents and businesses.

Key Massachusetts Solar Policies and Programs

Among the most important policies and programs that are contributing to Massachusetts' solar boom are the following:

- **Solar carve-out in the state Renewable Electricity Standard** – Massachusetts' Renewable Electricity Standard (formally known as the Renewables Portfolio Standard) requires the state's investor-owned utilities to obtain a growing share of their electricity from renewable sources, including solar. The standard, however, targets solar

energy for an additional level of support through a "carve-out" designed to bring as much as 400 MW of new solar photovoltaic capacity to the Commonwealth. Compliance with the solar carve-out is ensured through the trade of Solar Renewable Electricity Certificates (SRECs), which vary in price with supply and demand. Individuals or firms who install solar photovoltaics receive SRECs for each unit of solar electricity they produce, with proceeds from the sale of SRECs providing an economic incentive for the installation of solar power. In addition, because SRECs are tied to the amount of electricity produced by PV systems, they provide an incentive for ensuring that solar panels are well maintained over time.

- **Net metering** – Net metering enables individuals or businesses with solar panels to sell the extra electricity they generate into the grid at full retail price in order to offset electricity taken from the grid at times when the solar panels are not generating power. Net metering enables many solar energy customers to eliminate much or all of their electricity bills – providing the ongoing savings that make solar photovoltaics a winning financial proposition.
- **Solar rebates** – Customers of Massachusetts' investor-owned utilities are eligible for up-front rebates on solar photovoltaic systems. The Commonwealth Solar II program currently provides grants of $0.40 per Watt (with added incentives available for moderate income homeowners, purchasers of solar PV systems with Massachusetts-made components, and those recovering from natural disasters).[18] The program – which is an extension of a previous rebate program funded under the American Recovery and Reinvestment Act – is paid for through the state's Renewable Energy Trust Fund, which in turn is funded through a small charge on consumers' utility bills.
- **Creation of new financing options** – The 2008 Green Communities Act broadened the solar financing options for individuals and businesses by enabling third-party ownership of solar PV systems on customer rooftops. Third-party arrangements allow homeowners or businesses to obtain many of the benefits of solar energy, but without the upfront investment. Often these arrangements take the form of "solar leases" in which a third-party firm owns and maintains the solar panels (and reaps state and federal financial incentives) while the homeowner receives ongoing monthly savings. Third-party arrangements are not always preferable – customer ownership of solar panels often conveys greater financial benefits over time while keeping money in the Commonwealth – but they have succeeded in making solar photovoltaics a more easily accessible option for many Massachusetts families.
- **Solarize Massachusetts** – The Solarize Massachusetts initiative works with cities and towns on community-wide approaches to encouraging solar energy. Begun as a pilot program in 2011, Solarize Massachusetts is open to municipalities participating in the Green Communities program, through which cities and towns commit to a series of actions to reduce energy consumption and become eligible for state clean energy grants. Through Solarize Massachusetts, communities

benefit from bulk pricing for solar panels and take part in coordinated, grassroots public education and marketing efforts.

- **Tax credits** – Massachusetts offers numerous tax incentives for solar energy. Residential customers are eligible for an income tax credit of up to 15 percent of the cost of installing renewable energy. Solar panels are also exempt from sales and property taxes.[19]
- **Sector-specific initiatives** – Massachusetts has also taken advantage of opportunities to promote solar energy use among particular categories of energy users. The Commonwealth used funding available through the American Recovery and Reinvestment Act to install 4.1 megawatts of solar photovoltaic systems at water and sewage plants in 12 cities and towns – a step that will eventually save the municipalities roughly $650,000 per year in energy costs.[20] The Massachusetts Department of Agricultural Resources operates the Agricultural Energy Grant Program, a competitive program that provides grants for clean energy projects, including solar energy projects, on farms in the Commonwealth.
- **Local initiatives** – Cities, towns and local residents across the Commonwealth have taken important steps to promote solar energy at the grassroots level. The Cape and Islands region, for example, has been fertile ground for local efforts, including the Cape Cod Million Solar Roofs partnership, which helped to facilitate solar PV installations on the Cape, as well as the efforts of the region's energy cooperatives, who have actively sought out opportunities to expand solar energy.
- Massachusetts' municipal electric utilities have also, in some cases, been leaders in developing solar energy. Holyoke Gas & Electric, for example, has invested in two utility-scale solar photovoltaic plants. Several municipal utilities operate their own solar energy incentive programs, while several others have opted to join the Renewable Energy Trust, enabling their customers to become eligible for upfront grants and other programs funded by the Trust.

Continuing Massachusetts' Progress Toward a Solar Future: Recommendations

People across Massachusetts are embracing solar energy as an important step toward a cleaner energy system. As this report demonstrates, Massachusetts' embrace of solar energy extends to both the public and private sectors and every kind of community across the Commonwealth.

There are plenty of opportunities for Massachusetts to expand solar energy deployment. The Commonwealth has the technical potential to host at least 8.7 gigawatts of solar electric generating capacity – enough to produce the equivalent of 17 percent of the electricity Massachusetts consumes each year.[21] Despite the recent growth in solar energy in Massachusetts, the Commonwealth has tapped only 1.3 percent of that potential. In addition, Massachusetts has the potential to use a variety of other technologies – including solar water heating, solar space heating and solar cooling – to further reduce our dependence on polluting fossil fuels.

Strong public policies have fueled the recent solar energy boom in Massachusetts, and strong public policies can help Massachusetts realize its solar energy potential and reap the resulting benefits in cleaner air, a healthier environment, and a more robust economy.

To get there, Massachusetts should adopt bold goals to drive the deployment of solar power in the Commonwealth, and build upon successful solar energy policies to achieve those goals.

Specifically, Massachusetts should commit to installing 1 gigawatt of solar energy capacity by 2017 and to obtaining 10 percent of our energy from the sun by 2030.

Achieving these goals will require Massachusetts to **maintain and expand its existing solar energy programs**, with particular emphasis on:

- **Lifting the cap on net metering** to ensure that any Massachusetts resident or business will be able to receive adequate compensation for the solar electricity they feed into the electric grid.
- **Investing in the grid** to enable Massachusetts to receive 10 percent of its energy from the sun while maintaining reliable electricity service.
- **Ensuring that residents of all Massachusetts towns can "go solar"** by working with Massachusetts' municipal utilities to expand and improve their solar energy programs.
- **Removing barriers to the quick and efficient installation of solar electricity systems**, including long interconnection delays on the part of utilities that can keep customers waiting for weeks or months to connect their solar panels to the grid.
- **Continuing to look for new opportunities and approaches to promote solar power and maximize its benefits for Massachusetts.** Massachusetts may wish to explore options such as fixed-price contracts with solar energy suppliers, consider additional tools to ensure that solar energy is available to people of all income levels, and find ways to encourage deployment of solar energy in locations where it delivers the greatest benefit to electricity consumers.
- **Developing effective strategies to promote solar water heating and other technologies** that capture energy from the sun and reduce Massachusetts' dependence on fossil fuels.

Sources and Methodology

The estimates of solar photovoltaic installations by municipality in this report are based on data provided by the Massachusetts Clean Energy Center (MassCEC), which works to develop the clean energy industry in the Commonwealth and administers the state's Renewable Energy Trust Fund. MassCEC primarily tracks the size and location of solar photovoltaic systems that are eligible for Solar Renewable Energy Certificates (SRECs), a form of economic incentive for solar power deployment. The data in this report represent solar PV systems that were registered as in service in MassCEC's Production Tracking System as of May 24, 2012. Due to lag time between the installation of some solar projects and their appearance in the MassCEC database, some recently installed solar projects are not reflected in the totals presented in this report. Similarly, this report excludes older (pre-2002) solar photovoltaic installations.

Data on the total number of installations are based on the number of individual records in the MassCEC database – that is, each individual record in the MassCEC database was treated as a separate installation project. The definitions of Massachusetts regions are based on a listing of towns by region produced by the Massachusetts Executive Office of Energy and Environmental Affairs, accessed at www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/mass-enviro-trust/massachusetts-towns-and-regions.html on 12 June 2012.

All population figures are from the 2010 Census.

Appendix: Solar Energy Installations and Capacity by Town

Towns not listed here had no solar PV systems listed in the MassCEC database as of May 24, 2012.

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Abington	26.9	254	5	226	0.002	306	0.3	271
Acton	630.0	40	29	35	0.029	79	1.3	130
Acushnet	72.2	186	7	193	0.007	217	0.7	199
Adams	12.4	308	3	277	0.001	312	0.4	262
Agawam	31.9	241	6	210	0.001	321	0.2	303
Alford	25.9	261	4	253	0.052	32	8.1	20
Amesbury	252.8	91	14	109	0.016	138	0.9	177
Amherst	566.8	47	81	4	0.015	143	2.1	92
Andover	203.4	107	23	57	0.006	230	0.7	195
Aquinnah	27.9	249	11	140	0.090	17	35.4	2
Arlington	314.8	81	45	14	0.007	213	1.1	159
Ashburnham	132.3	138	14	109	0.022	102	2.3	88
Ashby	16.2	293	5	226	0.005	243	1.6	110
Ashfield	112.7	147	18	74	0.065	24	10.4	11
Ashland	642.2	39	18	74	0.039	52	1.1	156
Athol	38.1	228	7	193	0.003	270	0.6	216
Attleboro	559.9	50	14	109	0.013	158	0.3	267
Auburn	19.0	288	5	226	0.001	318	0.3	275
Avon	4.9	326	1	314	0.001	320	0.2	297
Ayer	86.6	171	7	193	0.012	172	0.9	172
Barnstable	2,075.9	7	112	3	0.046	41	2.5	80
Barre	1,991.7	9	6	210	0.369	2	1.1	150
Becket	57.5	203	12	127	0.032	66	6.7	31
Bedford	242.5	93	16	91	0.018	118	1.2	140
Belchertown	351.5	77	19	69	0.024	93	1.3	132
Bellingham	185.3	114	17	82	0.011	177	1.0	161
Belmont	218.2	100	7	193	0.009	201	0.3	285
Berkley	14.5	298	1	314	0.002	297	0.2	315
Berlin	27.7	250	5	226	0.010	191	1.7	106
Bernardston	32.0	240	6	210	0.015	142	2.8	72
Beverly	543.4	52	25	46	0.014	152	0.6	207
Billerica	617.7	44	29	35	0.015	139	0.7	193
Blackstone	37.1	229	4	253	0.004	257	0.4	249
Blandford	12.8	306	3	277	0.010	187	2.4	81
Bolton	52.7	210	11	140	0.011	182	2.2	90
Boston	5,647.4	1	157	1	0.009	197	0.3	290

Appendix: Solar Energy Installations and Capacity by Town (continued)

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Bourne	489.6	58	31	30	0.025	88	1.6	115
Boxford	48.2	215	9	166	0.006	234	1.1	146
Boylston	21.4	276	4	253	0.005	251	0.9	173
Braintree	10.8	313	1	314	0.000	332	0.0	333
Brewster	742.3	33	37	21	0.076	21	3.8	59
Bridgewater	449.8	63	15	102	0.017	126	0.6	228
Brimfield	29.5	244	4	253	0.008	207	1.1	152
Brockton	1,081.9	20	27	41	0.012	174	0.3	282
Brookfield	3.6	329	1	314	0.001	323	0.3	279
Brookline	147.7	130	27	41	0.003	290	0.5	247
Buckland	12.0	311	3	277	0.006	224	1.6	114
Burlington	50.1	212	7	193	0.002	299	0.3	283
Cambridge	1,196.0	15	77	6	0.011	176	0.7	192
Canton	565.8	48	9	166	0.026	87	0.4	252
Carlisle	91.9	165	15	102	0.019	115	3.1	67
Carver	200.6	109	10	154	0.017	123	0.9	176
Charlemont	83.5	176	10	154	0.066	23	7.9	23
Charlton	58.2	202	10	154	0.004	253	0.8	187
Chatham	189.3	112	25	46	0.031	70	4.1	52
Chelmsford	704.3	35	22	61	0.021	107	0.7	204
Chelsea	394.2	70	7	193	0.011	178	0.2	306
Cheshire	64.4	197	1	314	0.020	110	0.3	274
Chester	8.0	317	2	297	0.006	235	1.5	118
Chesterfield	68.1	193	11	140	0.056	30	9.0	16
Chicopee	101.6	158	2	297	0.002	303	0.0	332
Chilmark	192.5	111	32	27	0.222	3	37.0	1
Clinton	112.6	148	7	193	0.008	205	0.5	238
Cohasset	47.6	216	5	226	0.006	225	0.7	202
Colrain	49.7	213	12	127	0.030	75	7.2	26
Concord	266.9	89	13	114	0.015	140	0.7	190
Conway	66.2	194	12	127	0.035	58	6.3	34
Cummington	26.8	256	5	226	0.031	71	5.7	38
Dalton	43.8	222	9	166	0.006	221	1.3	128
Danvers	73.9	184	1	314	0.003	284	0.0	331
Dartmouth	2,807.9	5	46	12	0.083	19	1.4	126
Dedham	460.1	61	12	127	0.019	116	0.5	244
Deerfield	176.7	117	19	69	0.034	59	3.7	60
Dennis	254.1	90	21	65	0.018	119	1.5	119
Dighton	20.4	284	4	253	0.003	281	0.6	230
Douglas	66.1	195	11	140	0.008	209	1.3	131
Dover	51.9	211	8	182	0.009	195	1.4	121
Dracut	460.0	62	9	166	0.016	136	0.3	276
Dudley	33.4	237	7	193	0.003	280	0.6	213
Dunstable	13.9	300	3	277	0.004	255	0.9	171
Duxbury	26.6	258	6	210	0.002	304	0.4	255

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
East Bridgewater	15.7	295	3	277	0.001	319	0.2	302
East Longmeadow	53.3	209	6	210	0.003	268	0.4	258
Eastham	301.9	84	31	30	0.061	27	6.3	35
Easthampton	95.3	163	18	74	0.006	236	1.1	148
Easton	93.4	164	10	154	0.004	259	0.4	250
Edgartown	174.1	118	33	25	0.043	47	8.1	19
Egremont	35.0	234	6	210	0.029	80	4.9	45
Erving	21.9	274	5	226	0.012	164	2.8	74
Essex	17.3	290	3	277	0.005	249	0.9	178
Everett	1,122.0	19	7	193	0.027	83	0.2	314
Fairhaven	306.1	83	16	91	0.019	113	1.0	164
Fall River	956.2	22	16	91	0.011	183	0.2	309
Falmouth	1,195.2	16	127	2	0.038	54	4.0	56
Fitchburg	681.8	37	24	52	0.017	127	0.6	219
Florida	2.3	333	1	314	0.003	278	1.3	129
Foxborough	544.4	51	9	166	0.032	67	0.5	235
Framingham	1,213.2	14	44	16	0.018	121	0.6	205
Franklin	938.2	23	12	127	0.030	76	0.4	259
Freetown	151.8	127	10	154	0.017	125	1.1	147
Gardner	239.9	94	11	140	0.012	169	0.5	233
Georgetown	3.7	328	1	314	0.000	330	0.1	320
Gill	45.5	218	10	154	0.030	73	6.7	32
Gloucester	165.8	121	32	27	0.006	238	1.1	151
Gosnold	3.0	332	1	314	0.039	50	13.3	8
Grafton	388.9	71	11	140	0.022	100	0.6	212
Granby	101.1	159	13	114	0.016	131	2.1	93
Granville	36.6	230	7	193	0.023	97	4.5	48
Great Barrington	214.7	101	14	109	0.030	74	2.0	98
Greenfield	431.4	66	44	16	0.025	89	2.5	78
Groton	13.8	302	2	297	0.001	313	0.2	307
Groveland	14.6	297	2	297	0.002	296	0.3	273
Hadley	225.9	96	19	69	0.043	46	3.6	61
Halifax	24.4	266	5	226	0.003	272	0.7	201
Hamilton	25.9	262	4	253	0.003	269	0.5	237
Hampden	10.1	315	2	297	0.002	302	0.4	257
Hancock	113.8	144	2	297	0.159	5	2.8	73
Hanover	329.1	80	17	82	0.024	94	1.2	138
Hanson	15.3	296	3	277	0.001	311	0.3	280
Hardwick	41.4	224	7	193	0.014	151	2.3	86
Harvard	624.4	42	47	10	0.096	15	7.2	25
Harwich	510.8	56	66	7	0.042	49	5.4	41
Hatfield	204.7	106	28	38	0.062	26	8.5	17
Haverhill	1,169.8	17	17	82	0.019	114	0.3	286
Hawley	34.9	235	9	166	0.104	12	26.7	3

Appendix: Solar Energy Installations and Capacity by Town (continued)

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Heath	32.1	239	5	226	0.046	42	7.1	27
Hinsdale	12.9	304	2	297	0.006	222	1.0	165
Holbrook	10.4	314	2	297	0.001	325	0.2	308
Holden	202.1	108	13	114	0.012	173	0.7	189
Holland	5.0	325	1	314	0.002	301	0.4	254
Holliston	114.3	143	13	114	0.008	202	1.0	169
Holyoke	4,527.0	2	2	297	0.114	11	0.1	328
Hopedale	5.0	324	1	314	0.001	326	0.2	313
Hopkinton	542.8	53	24	52	0.036	56	1.6	111
Hubbardston	26.8	255	4	253	0.006	231	0.9	174
Hudson	45.9	217	4	253	0.002	293	0.2	304
Huntington	19.3	287	5	226	0.009	198	2.3	89
Ipswich	140.5	133	23	57	0.011	186	1.7	105
Kingston	91.2	167	16	91	0.007	215	1.3	135
Lakeville	113.5	146	5	226	0.011	185	0.5	246
Lancaster	77.7	179	10	154	0.010	192	1.2	137
Lanesborough	35.2	232	8	182	0.011	175	2.6	77
Lawrence	446.0	65	39	18	0.006	237	0.5	239
Lee	200.1	110	7	193	0.034	63	1.2	143
Leicester	423.9	67	10	154	0.039	53	0.9	175
Lenox	24.8	264	7	193	0.005	250	1.4	123
Leominster	642.8	38	22	61	0.016	135	0.5	234
Leverett	56.1	207	13	114	0.030	72	7.0	29
Lexington	128.1	140	25	46	0.004	258	0.8	185
Leyden	20.5	282	5	226	0.029	78	7.0	28
Lincoln	75.2	183	11	140	0.012	171	1.7	108
Littleton	27.7	251	2	297	0.003	276	0.2	300
Longmeadow	23.7	268	5	226	0.002	310	0.3	268
Lowell	1,336.1	10	29	35	0.013	161	0.3	287
Ludlow	54.6	208	9	166	0.003	288	0.4	251
Lunenburg	214.1	102	22	61	0.021	105	2.2	91
Lynn	245.2	92	11	140	0.003	285	0.1	319
Lynnfield	6.0	323	1	314	0.001	329	0.1	324
Malden	221.5	98	7	193	0.004	262	0.1	321
Manchester	69.2	191	5	226	0.013	154	1.0	167
Marblehead	21.9	275	4	253	0.001	322	0.2	305
Marion	105.1	153	14	109	0.021	104	2.9	70
Marlborough	221.5	99	12	127	0.006	239	0.3	272
Marshfield	298.5	85	39	18	0.012	168	1.6	116
Mashpee	708.7	34	17	82	0.051	34	1.2	139
Mattapoisett	345.6	78	11	140	0.057	28	1.8	101
Maynard	89.5	168	19	69	0.009	199	1.9	100
Medfield	29.6	243	6	210	0.002	291	0.5	242

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Medford	113.7	145	22	61	0.002	300	0.4	256
Medway	626.1	41	16	91	0.049	36	1.3	136
Melrose	65.9	196	6	210	0.002	292	0.2	301
Mendon	75.5	182	10	154	0.013	157	1.7	109
Methuen	164.3	122	12	127	0.003	265	0.3	292
Middleborough	16.8	291	1	314	0.001	328	0.0	329
Middlefield	20.5	281	5	226	0.039	51	9.6	13
Milford	752.9	31	17	82	0.027	84	0.6	214
Millbury	15.8	294	3	277	0.001	317	0.2	298
Millis	72.3	185	11	140	0.009	196	1.4	122
Millville	14.2	299	2	297	0.004	254	0.6	209
Milton	904.0	24	18	74	0.033	64	0.7	200
Monson	58.4	201	11	140	0.007	218	1.3	133
Montague	133.8	136	28	38	0.016	134	3.3	63
Monterey	29.7	242	9	166	0.031	69	9.4	14
Montgomery	6.4	322	1	314	0.008	211	1.2	142
Mount Washington	7.8	318	1	314	0.047	40	6.0	36
Nahant	7.2	319	2	297	0.002	298	0.6	223
Nantucket	26.7	257	6	210	0.003	287	0.6	222
Natick	342.1	79	36	23	0.010	188	1.1	155
Needham	226.9	95	23	57	0.008	208	0.8	184
New Ashford	4.6	327	1	314	0.020	109	4.4	49
New Bedford	1,286.0	11	30	32	0.014	153	0.3	269
New Braintree	10.0	316	2	297	0.010	190	2.0	97
New Marlborough	19.9	286	4	253	0.013	156	2.7	76
New Salem	13.9	301	4	253	0.014	150	4.0	55
Newbury	85.4	174	16	91	0.013	159	2.4	84
Newburyport	826.7	28	24	52	0.047	39	1.4	125
Newton	449.2	64	65	8	0.005	242	0.8	188
Norfolk	396.6	69	13	114	0.035	57	1.2	145
North Adams	102.5	157	9	166	0.007	212	0.7	203
North Andover	831.0	26	17	82	0.029	77	0.6	218
North Brookfield	13.4	303	3	277	0.003	282	0.6	206
North Reading	98.2	161	4	253	0.007	220	0.3	288
Northampton	783.1	30	81	4	0.027	82	2.8	71
Northborough	88.0	169	18	74	0.006	228	1.3	134
Northbridge	2,444.7	6	8	182	0.156	6	0.5	240
Northfield	149.1	129	20	67	0.049	35	6.6	33
Norton	6.6	321	1	314	0.000	331	0.1	327
Norwell	71.5	188	6	210	0.007	219	0.6	226
Oak Bluffs	98.7	160	19	69	0.022	101	4.2	51

Appendix: Solar Energy Installations and Capacity by Town (continued)

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Oakham	3.3	331	2	297	0.002	305	1.1	158
Orange	505.7	57	15	102	0.065	25	1.9	99
Orleans	313.4	82	49	9	0.053	31	8.3	18
Otis	12.4	307	5	226	0.008	210	3.1	66
Oxford	167.8	120	5	226	0.012	163	0.4	260
Palmer	28.6	247	7	193	0.002	294	0.6	225
Pelham	35.0	233	9	166	0.027	86	6.8	30
Pembroke	48.4	214	8	182	0.003	286	0.4	248
Pepperell	70.1	189	12	127	0.006	232	1.0	160
Peru	20.4	283	5	226	0.024	92	5.9	37
Petersham	18.3	289	3	277	0.015	147	2.4	83
Phillipston	26.9	253	4	253	0.016	133	2.4	85
Pittsfield	4,325.8	3	25	46	0.097	14	0.6	231
Plainfield	12.8	305	3	277	0.020	111	4.6	46
Plainville	23.1	269	2	297	0.003	283	0.2	294
Plymouth	608.6	45	47	10	0.011	180	0.8	179
Plympton	36.1	231	5	226	0.013	160	1.8	103
Princeton	41.5	223	6	210	0.012	165	1.8	104
Provincetown	58.9	200	12	127	0.020	108	4.1	53
Quincy	465.0	59	24	52	0.005	246	0.3	289
Randolph	110.2	149	4	253	0.003	267	0.1	318
Raynham	20.2	285	4	253	0.002	309	0.3	277
Rehoboth	139.1	134	13	114	0.012	166	1.1	149
Revere	805.7	29	4	253	0.016	137	0.1	325
Richmond	34.9	236	6	210	0.024	95	4.1	54
Rochester	56.4	206	7	193	0.011	181	1.3	127
Rockland	76.3	181	6	210	0.004	256	0.3	265
Rockport	56.9	204	11	140	0.008	206	1.6	113
Rowe	32.6	238	5	226	0.083	18	12.7	9
Royalston	20.9	279	5	226	0.017	128	4.0	58
Russell	22.0	273	9	166	0.012	162	5.1	43
Rutland	213.0	103	28	38	0.027	85	3.5	62
Salem	618.0	43	34	24	0.015	144	0.8	180
Salisbury	25.2	263	5	226	0.003	277	0.6	217
Sandisfield	22.1	272	3	277	0.024	91	3.3	64
Sandwich	172.9	119	33	25	0.008	203	1.6	112
Saugus	270.7	88	6	210	0.010	189	0.2	299
Savoy	11.9	312	2	297	0.017	124	2.9	69
Scituate	103.5	155	25	46	0.006	240	1.4	124
Seekonk	207.2	105	13	114	0.015	141	0.9	170
Sharon	110.0	150	17	82	0.006	227	1.0	168
Sheffield	2,072.7	8	16	91	0.636	1	4.9	44
Shelburne	85.1	175	15	102	0.045	43	7.9	22
Sherborn	209.4	104	13	114	0.051	33	3.2	65

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Shirley	827.0	27	13	114	0.115	10	1.8	102
Shrewsbury	26.9	252	4	253	0.001	327	0.1	322
Shutesbury	78.1	178	16	91	0.044	44	9.0	15
Somerset	56.6	205	10	154	0.003	275	0.6	232
Somerville	421.8	68	18	74	0.006	241	0.2	296
South Hadley	29.2	245	5	226	0.002	307	0.3	284
Southampton	22.9	270	3	277	0.004	260	0.5	236
Southborough	86.2	172	15	102	0.009	200	1.5	117
Southbridge	21.4	277	4	253	0.001	315	0.2	295
Southwick	24.5	265	3	277	0.003	289	0.3	270
Spencer	45.4	219	8	182	0.004	261	0.7	196
Springfield	2,958.9	4	26	44	0.019	112	0.2	312
Sterling	1,244.6	13	8	182	0.159	4	1.0	162
Stockbridge	12.1	310	4	253	0.006	229	2.1	96
Stoneham	20.7	280	3	277	0.001	324	0.1	316
Stoughton	138.0	135	11	140	0.005	245	0.4	253
Stow	21.0	278	4	253	0.003	273	0.6	215
Sturbridge	866.5	25	3	277	0.094	16	0.3	266
Sudbury	164.2	123	12	127	0.009	194	0.7	198
Sunderland	60.7	199	10	154	0.016	130	2.7	75
Sutton	1,248.7	12	13	114	0.139	8	1.5	120
Swampscott	464.3	60	5	226	0.034	62	0.4	261
Swansea	132.6	137	9	166	0.008	204	0.6	227
Taunton	68.8	192	10	154	0.001	316	0.2	311
Templeton	24.2	267	4	253	0.003	279	0.5	241
Tewksbury	384.7	73	18	74	0.013	155	0.6	211
Tisbury	146.4	131	21	65	0.037	55	5.3	42
Tolland	3.5	330	1	314	0.007	214	2.1	94
Topsfield	38.6	227	5	226	0.006	223	0.8	181
Townsend	188.4	113	38	20	0.021	106	4.3	50
Truro	154.3	126	32	27	0.077	20	16.0	5
Tyngsborough	182.7	116	12	127	0.016	132	1.1	157
Upton	80.7	177	9	166	0.011	184	1.2	141
Uxbridge	43.9	221	8	182	0.003	271	0.6	220
Wakefield	6.9	320	1	314	0.000	333	0.0	330
Walpole	356.9	76	15	102	0.015	146	0.6	210
Waltham	1,080.2	21	30	32	0.018	120	0.5	243
Ware	108.8	152	8	182	0.011	179	0.8	183
Wareham	108.9	151	16	91	0.005	247	0.7	191
Warren	225.5	97	3	277	0.044	45	0.6	224
Warwick	26.4	260	8	182	0.034	61	10.3	12
Washington	12.3	309	3	277	0.023	98	5.6	39
Watertown	692.6	36	18	74	0.022	103	0.6	229
Wayland	121.0	141	30	32	0.009	193	2.3	87

Appendix: Solar Energy Installations and Capacity by Town (continued)

City/Town	PV Capacity (kW)	Rank - Capacity	Installations	Rank - Installations	Capacity per Capita (kW)	Rank - Capacity per Capita	Installations per 1,000 Residents	Rank - Installations per 1,000
Webster	375.4	74	8	182	0.022	99	0.5	245
Wellesley	102.8	156	3	277	0.004	263	0.1	323
Wellfleet	271.8	87	37	21	0.099	13	13.5	7
Wendell	40.3	225	12	127	0.047	38	14.2	6
Wenham	22.2	271	4	253	0.005	252	0.8	182
West Boylston	369.6	75	1	314	0.048	37	0.1	317
West Bridgewater	16.3	292	2	297	0.002	295	0.3	281
West Brookfield	520.8	55	9	166	0.141	7	2.4	82
West Newbury	103.8	154	17	82	0.025	90	4.0	57
West Springfield	97.6	162	7	193	0.003	266	0.2	293
West Stockbridge	91.3	166	6	210	0.070	22	4.6	47
West Tisbury	154.5	125	45	14	0.056	29	16.4	4
Westborough	606.7	46	13	114	0.033	65	0.7	194
Westfield	144.1	132	3	277	0.004	264	0.1	326
Westford	388.7	72	13	114	0.018	122	0.6	221
Westhampton	26.5	259	4	253	0.017	129	2.5	79
Westminster	85.9	173	15	102	0.012	170	2.1	95
Weston	159.0	124	11	140	0.014	148	1.0	166
Westport	287.7	86	27	41	0.019	117	1.7	107
Westwood	76.6	180	16	91	0.005	244	1.1	154
Weymouth	87.1	170	16	91	0.002	308	0.3	278
Whately	184.3	115	17	82	0.123	9	11.4	10
Whitman	71.6	187	5	226	0.005	248	0.3	263
Wilbraham	44.5	220	9	166	0.003	274	0.6	208
Williamsburg	69.9	190	20	67	0.028	81	8.1	21
Williamstown	115.7	142	23	57	0.015	145	3.0	68
Wilmington	28.6	248	4	253	0.001	314	0.2	310
Winchendon	62.7	198	8	182	0.006	233	0.8	186
Winchester	150.5	128	25	46	0.007	216	1.2	144
Windsor	29.0	246	5	226	0.032	68	5.6	40
Winthrop	746.5	32	6	210	0.043	48	0.3	264
Woburn	535.1	54	26	44	0.014	149	0.7	197
Worcester	1,129.8	18	46	12	0.006	226	0.3	291
Worthington	39.8	226	9	166	0.034	60	7.8	24
Wrentham	130.4	139	12	127	0.012	167	1.1	153
Yarmouth	561.2	49	24	52	0.024	96	1.0	163

Notes

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20. Commonwealth of Massachusetts, Office of the Governor, *Patrick-Murray Administration Announces Award of Largest-Ever State Contract for Installation of Solar Power* (news release), 5 February 2010.

21. "Technical potential" is a measure that excludes areas where solar energy is theoretically possible but technically impractical, such as rooftops with poor orientation, shading, or pre-existing rooftop equipment. "8.7 gigawatts": Massachusetts Department of Energy Resources, *Potential for Renewable Energy Development in Massachusetts*, September 2008; "17 percent" based on 13 percent capacity factor for solar energy in Massachusetts from Hilary Flynn, et al., "System Dynamics Modeling of the Massachusetts SREC Market," *Sustainability*, 2: 2746-2761, 2010, doi: 10.3390/su2092746, and annual retail electricity sales for 2010 from U.S. Department of Energy, Energy Information Administration, *State Electricity Profiles with Data for 2010*, 30 January 2012. Note that the comparison of solar electricity production with electricity consumption is for illustrative purposes only – the contribution of solar energy to electricity production in a high-penetration scenario depends on the ability of the electric grid to absorb the solar energy produced.