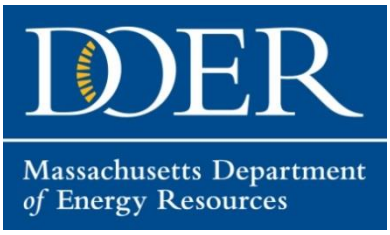
Task 3a Report: Evaluation of the 400 MW Solar Carve-out Program's Success in Meeting Objectives

Prepared for the

Massachusetts Department of Energy Resources



By

Cadmus, Meister Consultants Group, and Sustainable Energy Advantage, LLC

In association with

La Capra Associates, Inc.

September 30, 2013

About the Massachusetts Department of Energy Resources (DOER)

DOER's mission is to create a cleaner energy future for the Commonwealth, economically and environmentally, including:

- Achieving all cost-effective energy efficiencies,
- Maximizing development of cleaner energy resources,
- Creating and leading implementation of energy strategies to ensure reliable supplies and improve relative costs, and
- Support clean tech companies and spurring clean energy employment.

DOER is an agency of the Massachusetts Executive Office of Energy and Environmental Affairs (EEA).

About this Report

The Consulting Team completed the Evaluation of the Current Program's Success in Meeting Objectives (Task 3a Report) in support of the DOER's Solar Policy Program and post 400-MW policy analysis under a competitive contract awarded to The Cadmus Group, Inc. (Cadmus).

As part of the effort, Cadmus, La Capra Associates, Meister Consultants Group, and Sustainable Energy Advantage developed five companion reports:

Task 1: Evaluation of Current Solar Costs and Needed Incentive Levels across Sectors
Task 2: Comparative Evaluation of Carve-out Policy with Other Policy Alternatives
Task 3a: Evaluation of the 400 MW Solar Carve-out Program's Success in Meeting Objectives
Task 3b: Analysis of Economic Costs and Benefits of Solar Program
Task 4: Comparative Regional Economic Impacts of Solar Ownership/ Financing Alternatives

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1 Introduction

In 2010, the Massachusetts Department of Energy Resources (DOER) implemented regulations establishing a 400-megawatt (MW) Solar Carve-out, a distinct tier within the Commonwealth's Renewable Portfolio Standard (RPS).[1] This program, referred to as "SREC-I" for purposes of this report, was designed to promote the continued growth of the solar photovoltaic (PV) industry in Massachusetts. The Solar Carve-out policy has provided support to residential, commercial, public, and non-profit entities through market-based incentives. As discussed further below, the Solar Carve-out achieved the program cap of 400 MW of installed capacity more quickly than anticipated.

In establishing the SREC-I program, DOER identified key objectives that are central to the establishment of a diverse and sustainable solar PV market in the Commonwealth. To review the program's effectiveness in achieving these objectives, DOER commissioned Cadmus (Prime Contractor), Sustainable Energy Advantage, LLC (Project Manager), Meister Consultants Group, and La Capra Associates (collectively, the Consulting Team) to evaluate the program. Further, the Consulting Team was asked to identify the key lessons to be learned from experience with the SREC-I program in order to aid in design of the next phase of the policy (SREC-II program). The SREC-II program is intended to support the growth of the Massachusetts PV market to a total state-wide capacity of 1,600 MW by 2020.[2]

1.1 SREC-I Program

The 2008 Green Communities Act (Section 32 of Chapter 169) amended the Commonwealth's Class I RPS to require that a portion of the required minimum Class I percentage targets come from new on-site renewable energy generating sources up to 2 MW capacity located in Massachusetts. DOER was authorized to specify that a certain percentage of these requirements shall be met through energy generated from a specific technology or fuel type.

DOER was charged with setting the eligibility, the percentage target, and the alternative compliance payment at a level sufficient to stimulate the development of new on-site renewable energy generating sources. It was also charged with designing the program within the framework of the legislation. The requirement would comprise part of the Class I RPS obligation, as a sub-tier or carve-out.

Pursuant to these provisions, DOER determined to focus the on-site program on solar PV generation, and it has established the solar carve-out and a solar renewable energy certificate (SREC) program to implement the carve-out. Rules developed by DOER took effect on January 1, 2010. Starting in that year, all regulated and competitive Retail Electricity Suppliers that serve the Massachusetts load (also known as Load-Serving Entities) needed SRECs to meet the RPS Solar Carve-Out compliance obligation.

[1] This goal has since been expanded through emergency regulations to include installations beyond the original 400 MW cap, the new figure has yet to be established.

[2] This 1,600 MW capacity is inclusive of installations developed under the SREC-I program.

1.2 SREC-I Objectives

DOER first articulated its objectives for the SREC-I program in August 2009 in its original straw proposal,[3] as follows:

- Cultivate solar PV development through varied generator sizes across market sectors,
- Develop a sustainable solar PV market that reduces dependence on state subsidies and has long-term growth potential,
- Transition smoothly from an upfront, rebate-only incentives to production-based, market-priced solar renewable energy certificates (SRECs),
- Sustain long-term growth of the solar market,
- Minimize ratepayer impacts.

1.3 Purpose of This Report

Based on data available on program performance to date, this report assesses the success and shortcomings of the SREC-I program in meeting DOER's program objectives and describes the extent to which DOER's objectives have or have not been met or could have been met better. This report also considers factors that may have improved or limited results realized by the SREC-I program and comments on how any shortcomings could be addressed in the design of the forthcoming SREC-II program.

1.4 Limitations of This Analysis

Under the SREC-I program as currently instituted, minting and sales of SRECs are expected to continue through 2023. Thus, this evaluation of the program experience over the first three years of implementation cannot provide a full program review. A full evaluation can only be completed after the program has ended.

Further, only about half of the initial SREC-I target of 400 MW of capacity planned for installation was installed as of the end of the second quarter (Q2) of 2013 and is available for analysis. If the characteristics of the PV installations to be installed diverge substantially from those that have already been installed, this analysis may not be representative of the full population of PV installations benefiting from the SREC-I program.

[3] See: http://www.mass.gov/eea/docs/doer/renewables/solar/solar-rps-carve-out-program-straw-proposal-stakeholder-mtg-corrected-090409-doer.pdf.

2 Summary

Overall the SREC-I program has met most of the early goals that were set for it. However, there are several lessons to be learned that can help improve the design and implementation of the SREC-II program.

- The SREC-I program clearly met the goal of cultivating PV growth with a variety of installation sizes and across market sectors. Both the residential and commercial sectors experienced strong growth in PV capacity and number of installations, and the commercial capacity represented a range of sizes from less than 100 kilowatts to multi-megawatt systems. PV capacity installed under the SREC-I program was roughly evenly split between roof-mounted and ground-mounted installation types.
- The program can be credited for contributing to growth of the market during a period of decreasing dependence on state subsidies. This growth led to increased demand for skilled labor in the solar PV market, which may prove to be sustainable provided the market remains consistent in growth rate and participation levels.
- The transition from rebate-only incentives to a market-based system under the SREC-I program was ultimately successful for the commercial sector, which represents a majority of the capacity installed under the SREC-I Program.[4] However, there was a gap in time between the end of the rebates under the Commonwealth Solar program for commercial projects and the start of the SREC-I program, and the market was slow to get started in 2010 for reasons that were mainly outside of DOER's control. Because of this experience, the Consulting Team recommends that DOER maintain flexibility in the design of the SREC-II program to allow for adjustments to the program as market conditions warrant. Further, improved transparency in the SREC-II program will help alleviate volatility in the market.
- The transition from rebate-only to a mix of rebate and market incentives for residential scale PV installations went smoothly. Rebate levels were lowered as the market gained confidence in the SREC-1 program.
- The ratepayer impact resulting from the SREC-I program over the first three years of the program is lower than originally projected by DOER. This is due to SREC prices in 2012 – 2013 having fallen below the auction floor price established by DOER. Despite these early, positive indicators, it is not possible to estimate the full impact the SREC-1 program will have on ratepayers over the next ten years.

2.1 Diversity in Solar PV Installations

A key component of DOER's SREC-I program was to cultivate solar PV development through varied generator sizes across market sectors. Program designers sought to support a diverse fleet of solar PV installations by providing incentives to a wide cross-selection of Commonwealth residents, businesses, and other entities and encouraging installations at a variety of locations.

[4] As of the time of this report, rebates are still available for residential and some small commercial (15 kW or less) PV installations.

2.2 Evaluation Approach

The Consulting Team commenced the evaluation effort by identifying key characteristics of a diverse market and considering whether or not these characteristics were demonstrated during the SREC-I program (2010-2013). These market characteristics were:

- Diverse participation by a variety of sizes and customer sectors that included residential, commercial, public/non-profit, and utility-owned,
- Diversity in installation type (roof-mounted, ground-mounted, or carport installations),
- Growth in capacity and quantity of installations in all size categories and customer sectors, and
- Substantial participation in the program, directly or indirectly, by state residents, public, and private entities.

The Consulting Team examined the results of the SREC-I program to date for each of these characteristics. To determine if the program exhibited these attributes, the Consulting Team analyzed data compiled by DOER from Statement of Qualification Applications (SQA) through Q2, 2013. The applications included information on two questions relevant to this assessment:

- **Customer Sector** indicates the property owner's self-described market-sector classification. Specifically, this indicates the type of property on which the PV generator is installed. Qualified responses were residential, commercial, public/non-profit, and utility.[5]
- **Installation Type** indicates the type of installation on a property. Qualified responses were roof, ground, and carport.

Two additional sources of solar PV installation data in Massachusetts were used to estimate the scale of third-party-owned projects within the SQA dataset. The Consulting Team reviewed data collected in the MassCEC's Renewable Energy Production Tracking System (PTS) and identified obvious cases of third-party-owned installations located on public property. Using the capacity of these installations, we estimated how many commercial projects were third-party-owned systems serving public entities. We also used the July 31, 2013, *Application Activity and Remaining Capacity Report* from the System of Assurance of Net Metering Eligibility to estimate the total net metering capacity allocated to public entities in Massachusetts. As a large majority of the allocated capacity is for solar PV installations, allocated net metering capacity also is an indication of the scale of third-party-owned PV installations located on public property.

[5] It should be noted that the Customer Sector designation appears to have been interpreted by many project developers as the customer sector of the project owners instead of the property owners. This means many solar facilities sited on public property have been designated "commercial" instead of "public/non-profit." Part of the confusion by the applicants may be due to the use of the term "facility." In the Statement of Qualification Application, facility refers to the property at which the PV generator is installed. In contrast, in Massachusetts applications for net metering services and applications for a net metering cap allocation, the term facility refers to the generator itself, not the property on which the generator is installed.

2.3 Analysis

2.3.1 Distribution by Customer Sector

As previously mentioned, information about customer sectors was taken from DOER's SQA database. The database provides applicants with a range of options for self-designating the customer sector of their project. The Consulting Team aggregated these project sector types into four categories for this analysis:

- **Residential:** All residential systems, including multi-family,
- **Public/Non-Profit:** Projects owned by a public entity or non-profit,
- **Utility:** Projects that are limited to the statutory definition and allowance of utility-owned systems6, and
- **Commercial:** All remaining system sectors in the database.

The following sections present the results of an analysis of both the capacity distribution and number of systems in these categories for the SREC-I program.

2.3.1.1 Distribution Across Market Sector by Capacity: Status and Trends

Figure 1 shows the total capacity of installations participating in the SREC-I program through the Q2, 2013. As the figure shows, commercial systems comprise the majority of the capacity that has been installed under the SREC-I program (174.5 MW, 71%) with residential systems comprising the next largest capacity segment (36.8 MW, 15%).

Figure 1. SREC-I Program Installation Capacity (kW) By Customer Sector (DOER SQA Category)

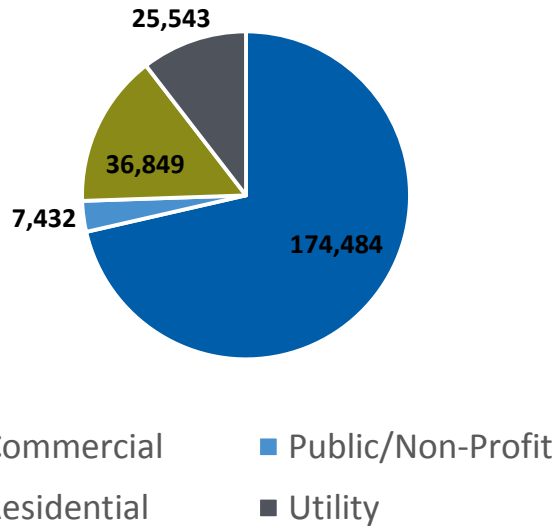


Table 1 shows the average system size for each market sectors. As the table shows, utility systems had the largest average system size, with typical system sizes of nearly 2 MW. As would be expected, residential systems have the smallest average size (6 kW)

[6] These utility owned systems do not serve an onsite load, nor are they eligible for net metering credits.

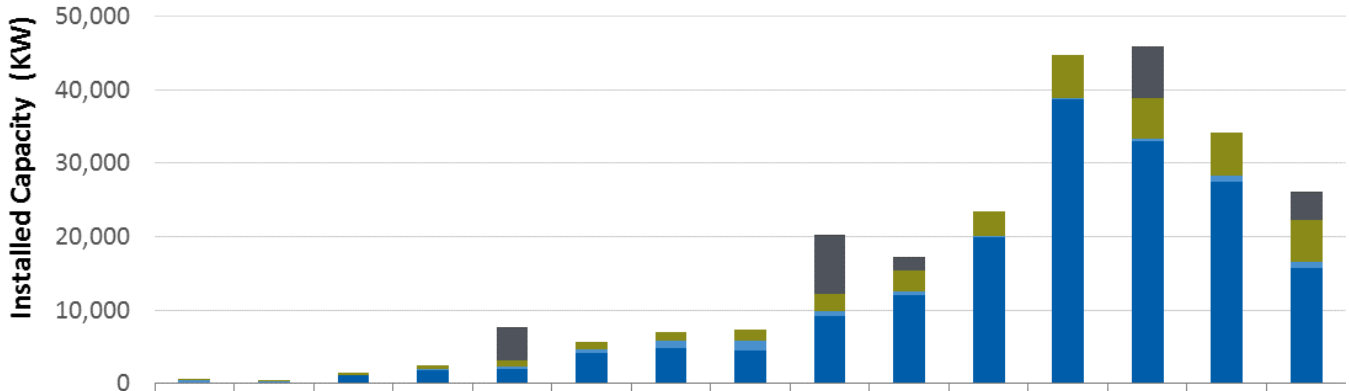
Table 1. System Average Capacities by Customer Sector

Systems Sector	Average System Size (kW)
Commercial	208.5
Public/Non-Profit	70.1
Residential	6.0
Utility	1,964.9

Temporal analysis of the SQA dataset indicated substantial growth occurred in the *residential* and *commercial* sectors installations during to the SREC-I program. Figure 2 shows the capacity installed by quarter, and Figure 3 shows the same data trend as a percentage of total installed capacity.

As the figure indicates, between 2010 and 2012, the *residential* sector capacity grew from a rate of about 50 kW per quarter (in Q1, 2010) to more than 5,000 kW per quarter during the last four quarters of the analysis. A similar increase in the *commercial* sector was observed, which grew from an installed capacity of 1,156 kW in Q2 2010 to a high of 38,735 kW in Q3 2012. Installations in the commercial category have declined from their 2012 quarterly highs. This could be due to a number of factors, such as seasonal factors, declining SREC market prices, uncertainty around net-metering availability, and issues related to the approach of the 400 MW cap. Utility scale solar PV installations did not experience a comparable level of growth to other reviewed sectors, however, this is due primarily to statutory limits in the quantity of utility-owned PV and the regulatory pathway for utility-scale projects.

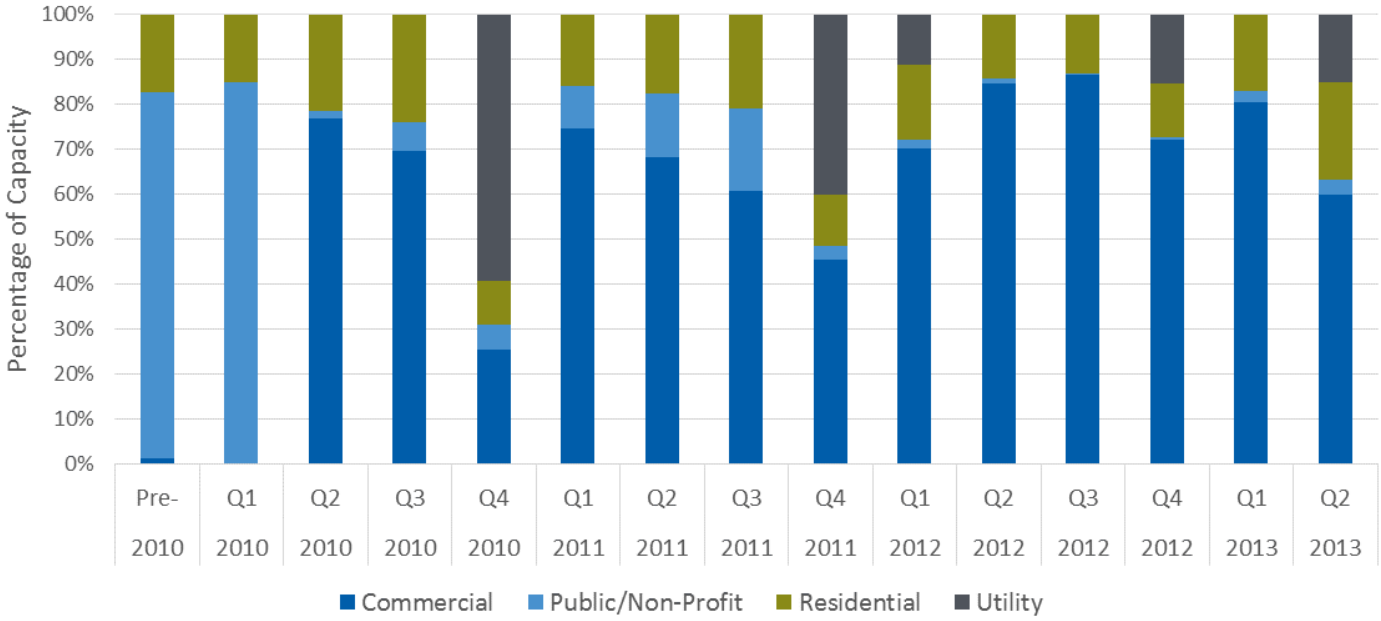
Figure 2. SREC-I Program Installation History by Customer Sector (DOER SQA Category)[7]



	Pre-2010	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Utility	-				4,540				8,100	1,929			7,081		3,894
Residential	94	52	320	609	744	886	1,226	1,533	2,333	2,846	3,330	5,873	5,471	5,827	5,703
Public/Non-Profit	441	294	28	158	422	532	993	1,344	626	363	246	109	271	795	812
Commercial	7		1,156	1,764	1,963	4,164	4,804	4,468	9,221	12,10	19,84	38,73	33,06	27,52	15,66

[7] Note: All time-related data in this analysis is by the system's listed commercial operations date.

Figure 3. SREC-I Program Installation Percentage Capacity History by Customer Sector (DOER SQA Category)



2.3.1.2 Distribution Across Market Sector by Number of Installations: Status and Trends

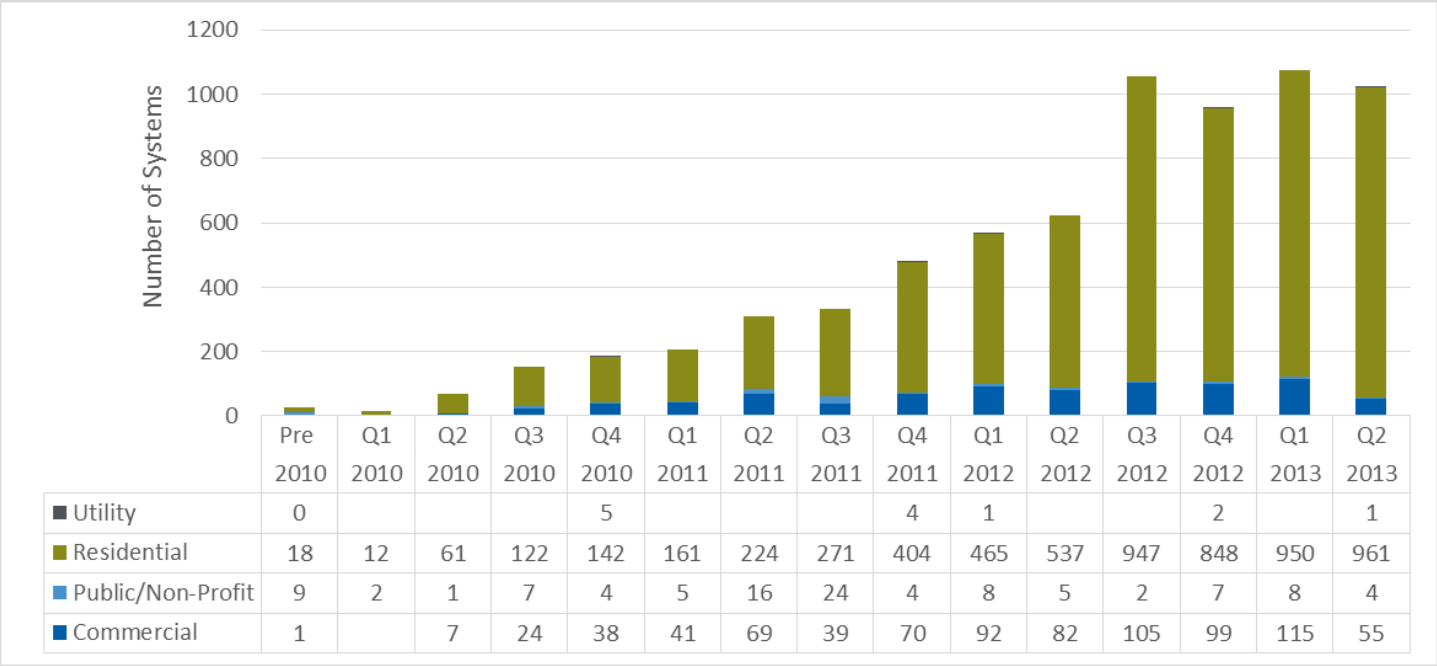
While commercial systems comprise the majority of capacity installed to date under the SREC-I program, the number of total residential systems far exceeds the number of systems in any other market sector. Table 2 shows total installations as of Q2 2013 by market sector. Residential systems made up 86.5% of all installations, while public/non-profit and utility systems together made up less than 2% of all installations.

Table 2. SREC- I Program Installations by Customer Sector thru Q2 2013

Customer Sector	# Installations	% of Installations
Residential	6,123	86.5
Commercial	837	11.8
Public/Non-profit	106	1.5
Utility	13	0.2
Total	**7,079**	100

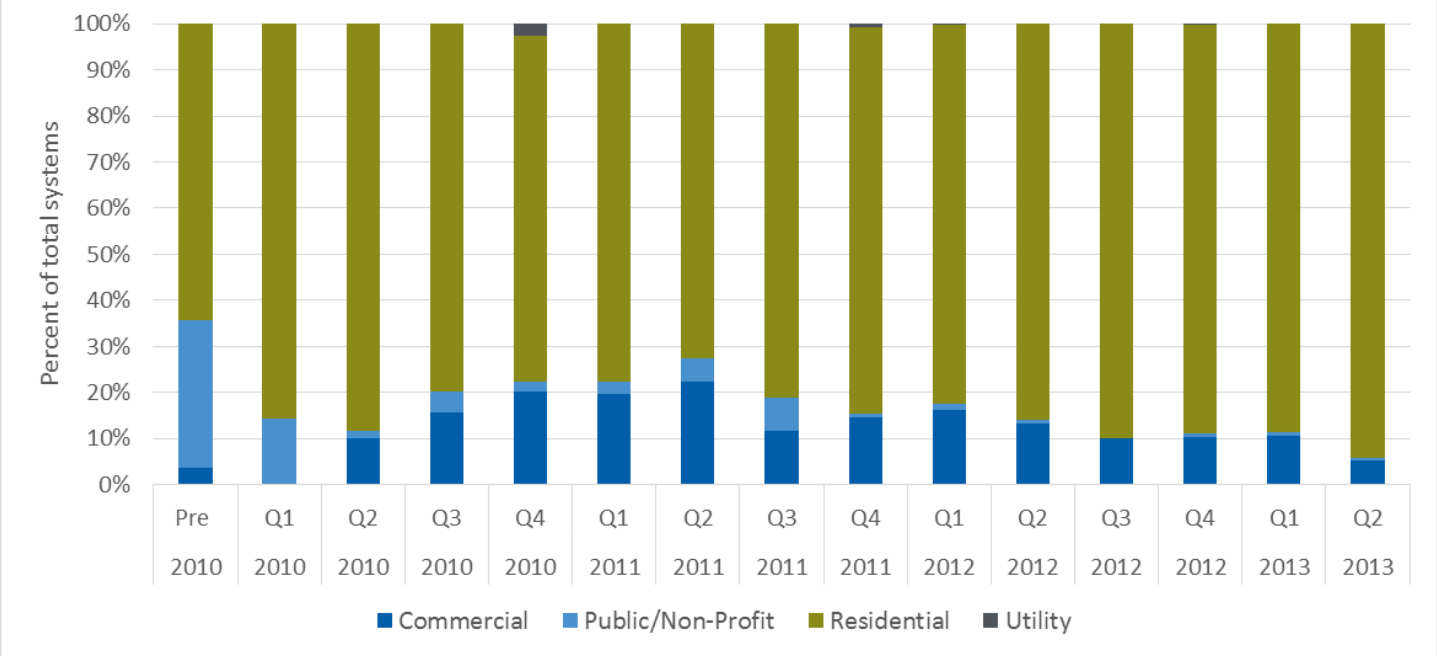
Figure 4 shows the number of SREC-I eligible systems by market sector and quarter while Figure 5 shows the relative percentage of total systems by quarter. As both graphs show, residential systems have been the dominant system type installed in Massachusetts throughout the SREC-I program.

Figure 4. Quarterly SREC-I Program Installations by Customer Sector



	Pre 2010	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Utility	0				5				4	1			2		1
Residential	18	12	61	122	142	161	224	271	404	465	537	947	848	950	961
Public/Non-Profit	9	2	1	7	4	5	16	24	4	8	5	2	7	8	4
Commercial	1		7	24	38	41	69	39	70	92	82	105	99	115	55

Figure 5. Quarterly Percentage of Total Systems Installed by Customer Sector



While residential systems have been the most predominant type by total number of systems over the course of the SREC-I program, the program also provided an opportunity for a diversity of project types in the state. As noted in Section 2.3.1.1 above, the majority of the capacity in the state is in the commercial sector. This suggests that both residential and commercial ratepayers were able to have significant participation in the SREC-I program.

2.3.2 Installation Size Distribution

The SREC-I program data set was also analyzed to determine the extent to which the program supported the development of a diverse solar market with respect to system size. In order to evaluate this question, system data was broken into the following bins:

- Utility system
- Residential Systems
- Public/Non-Profit < 250kW
- Public/Non-Profit 250-1,000kW
- Commercial less than 250kW
- Commercial 250-1000kW
- Commercial greater than 1000kW

As with the previous sections, this data is present by total capacity and number of systems in each system classification in the following two sections.

2.3.2.1 Installation Size Distribution by Installed Capacity: Status and Trends

Figure 6 shows the total capacity distribution by system size and classification of the SREC-I program through Q2 2013. As the figure indicates, large-scale commercial systems are the largest share (63 MW) of system capacity installed under the program. The next largest by capacity is the 250 kW to 1,000 kW commercial system classification (45 MW). The smallest segment by capacity is the 250 to 1,000 kW public/non-profit classification (956 kW).

Figure 6. SREC-I Program Installation Capacity (kW)
By Customer Sector and System Size (DOER SQA Category)

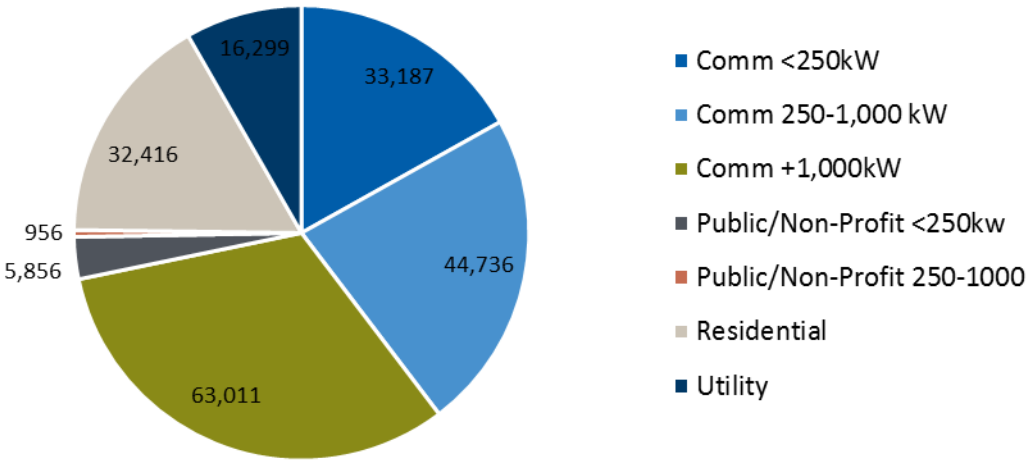
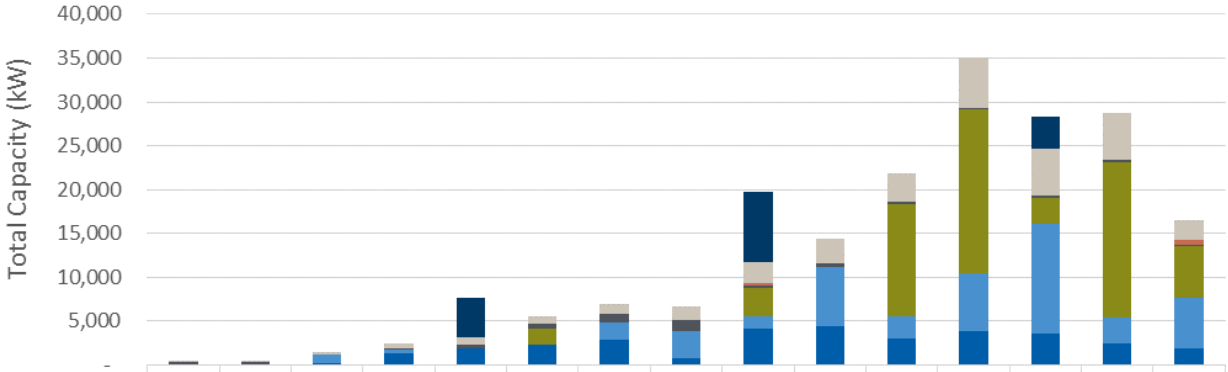


Figure 7 shows the quarterly installations by system size and sector under the SREC-I program, while Figure 8 shows the relative percentage of total quarterly capacity installed in each size classification. As the graphs indicate, large

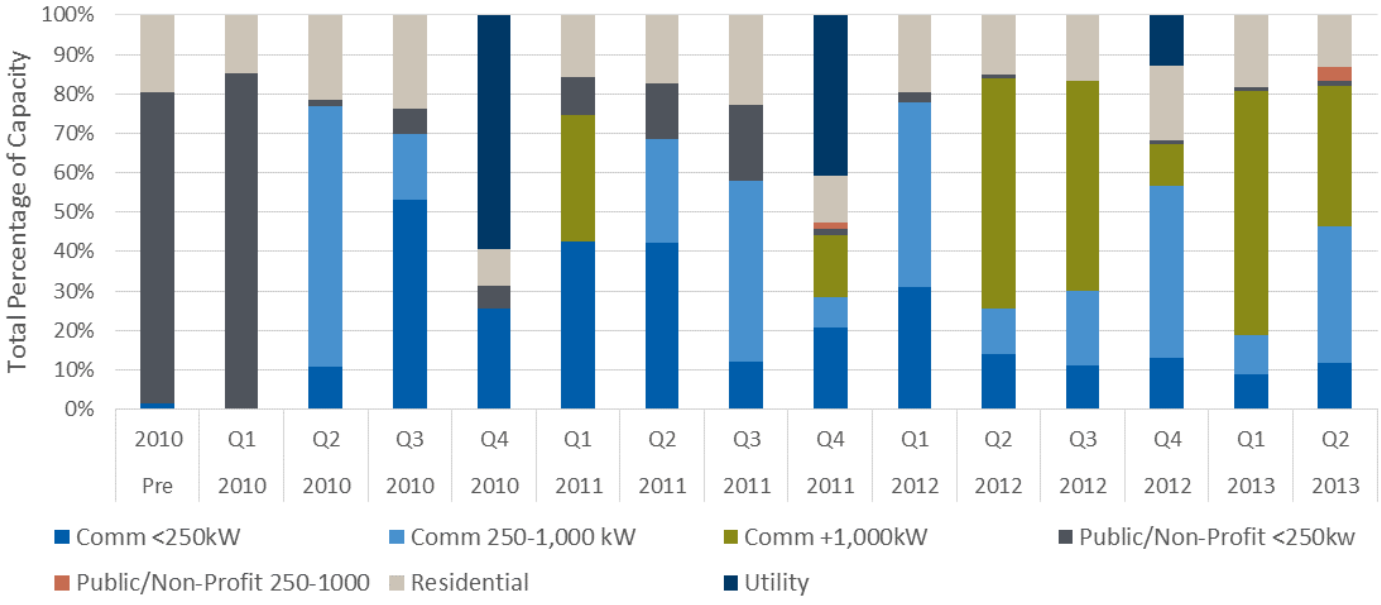
commercial PV systems have been a major driver of market growth starting in early 2012. Prior to this, megawatt-scale commercial PV systems were far less prevalent.

Figure 7. Quarterly SREC-I Program Capacity by System Size



	2010 Pre	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Utility	-				4,540				8,100				3,659		
Residential	94	52	320	604	732	878	1,220	1,524	2,321	2,841	3,298	5,809	5,339	5,237	2,146
Public/Non-Profit 250-1000	-								346						610
Public/Non-Profit <250kw	380	294	28	158	422	532	993	1,302	277	363	246	109	257	293	202
Comm +1,000kW	-					1,801			3,169		12,809	18,653	3,004	17,717	5,858
Comm 250-1,000 kW	-		983	425			1,843	3,070	1,508	6,754	2,526	6,607	12,396	2,937	5,687
Comm <250kW	7		163	1,339	1,963	2,363	2,948	816	4,091	4,489	3,039	3,892	3,635	2,490	1,952

Figure 8 Quarterly Percentage of Total Systems Capacity by Customer and System Size

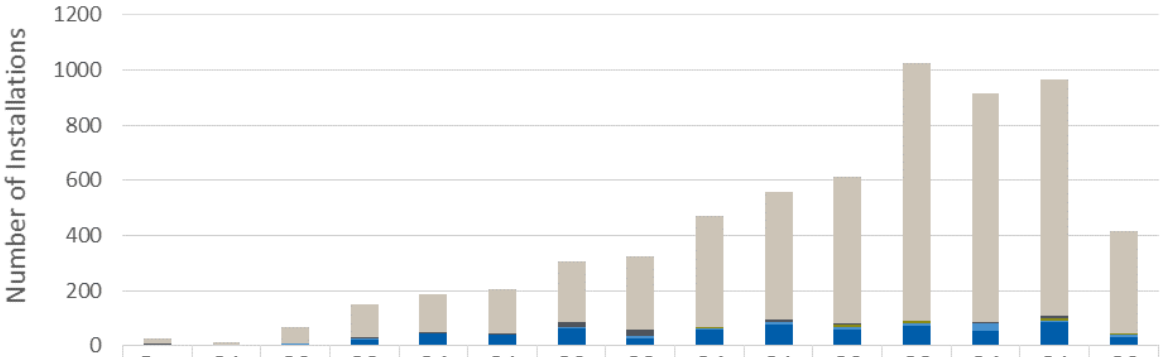


Over the course of the SREC-I program, a diverse range of system sizes have been installed by a range of customer types. The mix of system capacity by installation size has changed over the course of the program with the majority of the limited capacity installed during the early years of the program coming from systems smaller than 1 MW. The data indicates that the market shifted during 2012, when a significant proportion of total state-wide capacity started to be installed in MW-scale commercial systems.

2.3.2.2 Installation Size Distribution by Number of Installations: Status and Trends

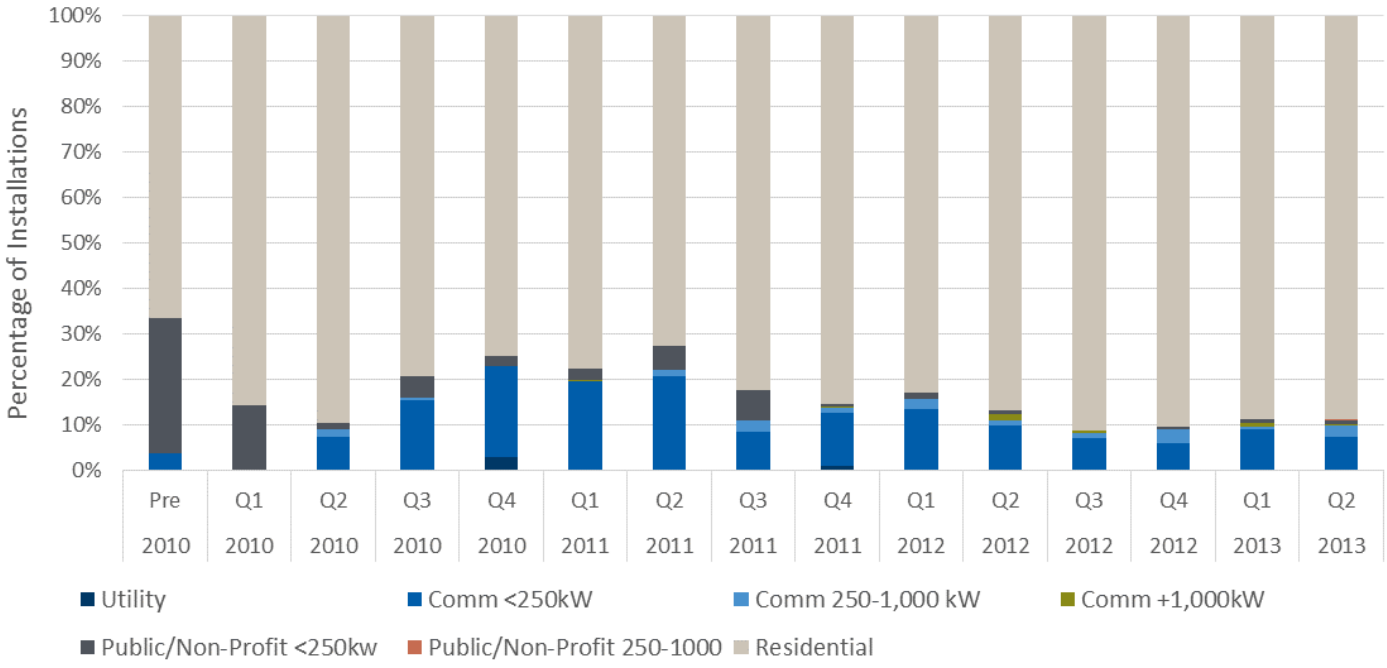
As mentioned in the previous section, the majority of systems installed under the SREC-I program were in the residential classification. Figure 9 and Figure 10, respectively, show the quarterly distribution of systems by size and sector over the course of the program to date. It is notable that 25 systems in the megawatt scale commercial classification were interconnected between Q1 2012 and Q2 2013, yet as mentioned in the previous section, these few systems account for a significant proportion of the capacity installed during that period.

Figure 9. Quarterly SREC-I Installations by Customer and System Size



	Pre 2010	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Residential	18	12	61	120	140	160	223	268	403	464	532	936	829	859	368
Public/Non-Profit 250-1000	0								1						1
Public/Non-Profit <250kw	8	2	1	7	4	5	16	22	2	8	5	2	5	7	3
Comm +1,000kW	0					1			2		8	5	1	9	2
Comm 250-1,000 kW	0		1	1			5	8	5	12	8	12	27	6	10
Comm <250kW	1		5	23	38	40	63	27	55	75	59	71	53	86	30
Utility	0				5				4				1		

Figure 10 Quarterly Percentage of Total System Installations by Customer and System Size



2.3.3 Diversity in Installation Type

Promoting solar PV across a variety of installation types, including existing roofs, was important to promoting diverse solar PV development and maximizing benefits realized by the program. Capacity installed per installation type category is considered in Figure 11. Roof-mounted installations comprise the majority of installed capacity, but ground-mounted installations come in a close second, making up 46% of total capacity representing a significant minority of the capacity. Frequency of rooftop installations was much higher compared to ground-mounted installations, as seen in Figure 12. Installations utilizing a mixture of ground and roof-mounted, and carport awnings were negligible during the program.

Figure 11. SREC-I Program Installation Capacity (kW) By Type

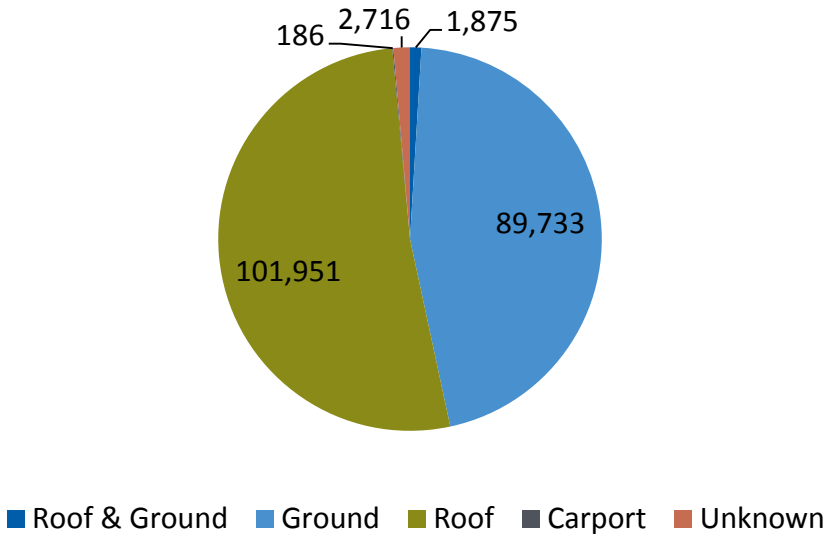


Figure 12. SREC-I Total Installations by Type

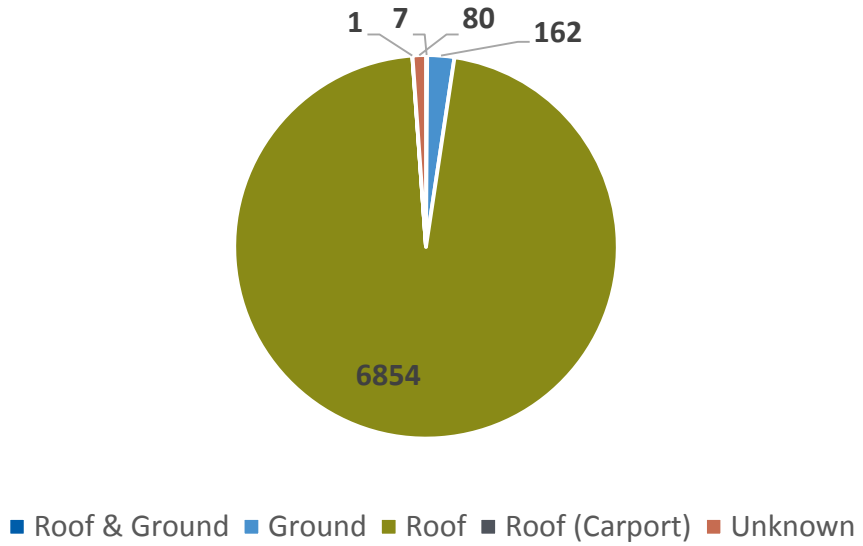
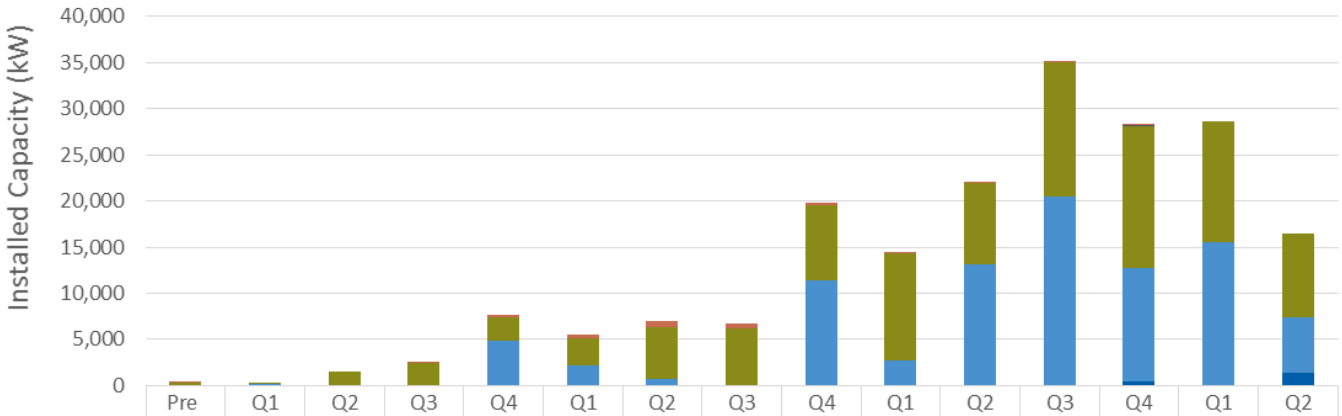


Figure 13 shows the quarterly capacity installed under the SREC-I program by installation type. As the figure indicates, ground-mounted systems have become a more significant proportion of the total capacity installed as part of the program during recent years.

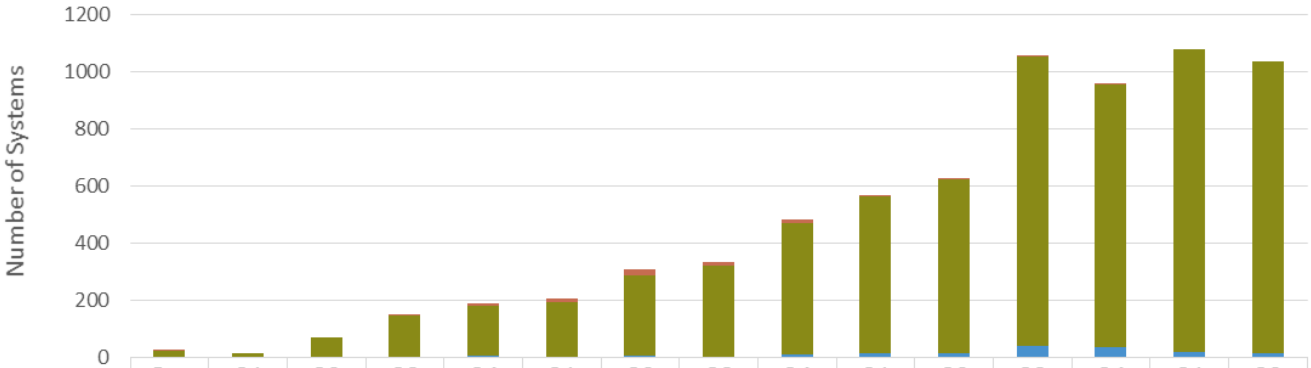
Figure 13. SREC-I Program Historical Capacity Installed By Installation Type



	Pre 2010	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Unknown	172			138	251	487	698	505	313	109	17	26	1		
Carport	-												186		
Roof	203	232	1,494	2,381	2,580	2,844	5,577	6,208	8,071	11,580	8,730	14,579	15,362	13,071	9,038
Ground	107	113		6	4,826	2,242	729		11,428	2,758	13,171	20,466	12,231	15,594	6,062
Roof & Ground	-												511	10	1,354

Figure 14 shows the total number of systems installed by installation types by quarter. As the graph shows, roof-mounted systems have been the majority of total installed systems throughout the SREC-I program.

Figure 14. SREC-I Program Historical Number of Systems Installed By Installation Type



	Pre 2010	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011	Q1 2012	Q2 2012	Q3 2012	Q4 2012	Q1 2013	Q2 2013
Unknown	6			5	7	12	22	13	9	3	1	1	1		
Carport													1		
Roof	21	13	69	147	174	191	282	321	463	549	609	1012	919	1060	1024
Ground	1	1	0	1	8	4	5	0	10	14	14	40	34	19	11
Roof & Ground												1	3	1	2

While the majority of systems installed under the SREC-I program have been roof-mounted, the total capacity installed under the program has been relatively evenly distributed across both roof- and ground-mounted systems. This indicates that the solar market developed under the SREC-I program has included a diversity of system types.

2.3.4 Program Participation by Commonwealth Residents, and Public and Private Entities: Status and Trends

Growth in accessibility to and participation in the SREC-I program by Commonwealth residents and public and private entities is also a primary indicator of DOER's objective to cultivate solar development across varied sectors. As described, the majority of PV capacity installed under the program fell under the *commercial* market sector.

An increase in residential-sector installations was also observed. However, these indicators are limited as they do not identify the entity that benefits from the energy generated by the PV installation.

To further evaluate accessibility and participation, the Consulting Team considered factors that expanded access to the SREC-I program to Commonwealth residents and entities, as well as additional data sources that indicate the level of private versus public participation in the solar PV market as a whole.

Market developments contemporary to the SREC-I program contributed to increased access to the solar PV market and benefits resulting from the SREC-I program, including the expansion of alternatives to traditional solar PV financing. The introduction of third-party ownership models to the Massachusetts solar PV market expanded access to benefits derived from the SREC-I program to additional Commonwealth residents and public entities. With these options, local residents and public entities could install solar PV without an initial capital investment. Although third-party ownership is not delineated in the SQA dataset, other evidence supports the conclusion that private financing of projects sited on public

and private property contributed to growth in the *commercial* and *residential* sectors. Further, using complementary data obtained via the System of Assurance of Net Metering Assurance, it can be inferred that energy benefits derived from solar PV installed via third-party contracts were often retained by public entities and, therefore, benefited Massachusetts ratepayers.

The Consulting Team analyzed the MassCEC's PTS and identified approximately 270 commercial PV installations (of 470 total installations, or 57%) that it believes are third-party owned. Attribution of assumed third-party ownership was limited to systems where the listed owner organization is known to develop third-party projects in the Commonwealth, and the analysis focused on installations with a capacity in excess of 100 kW DC that were in service and actively participating in the SREC-I program.

Similarly, a review of the residential PV installations in the MassCEC's PTS dataset suggests a similar, but more pronounced, trend. Of nearly 5,600 systems participating in the SREC-I program, nearly 2,800 are believed to be third-party owned (52%).[8]

These trends demonstrate that growth specific to third-party financing was occurring at a similar rate to the solar PV market overall. While self-qualified responses have likely attributed these installations to the *commercial* sector in the SQA dataset, benefits derived from these projects may reach public/non-profit entities, as well as homeowners, in addition to their listed commercial proponents.

Data from the System of Assurance of Net Metering Eligibility, which tracks the recipient of energy generated instead of the system's owner, shows that public entities were identified as the Host Customer Entity—or direct recipient of net metering credits—for 31% of projects interconnected to the grid as of July 31, 2013. Further, public Host Customer Entities represented 86% of capacity seeking to secure a cap allocation, and nearly all are owned by a third-party entity. While both numbers for the private and public caps includes other technologies, a majority is solar PV and, thus, indicates a majority of such credits are accruing to public entities. As most PV installations in the *commercial* sectors will receive both net metering services and SRECs, it can be inferred that a majority of the SREC-I benefits will accrue to public entities.

2.4 Conclusions

The results of this evaluation suggest that the SREC-I program was successful in cultivating diversity in solar PV installations and the customer sectors that are benefiting from both the program incentives and the energy generated. Market trends demonstrated that a majority of capacity was large-scale facilities installed in the commercial and public/non-profit sectors, but the majority of systems were small, residential-scale installations. Further, installations comprised an even mix between roof- and ground-located facilities, which indicates existing roof stock is being utilized under the program.

Concurrent to the SREC-I program, incentives such as the MassCEC rebates, federal and state tax incentives, and virtual net metering further amplified the resulting impacts and enabled strong growth in Massachusetts' solar PV market. Additionally, the introduction of third-party financing options into the Massachusetts market widened access to solar PV

[8] For the purposes of this analysis, the Consulting Team reviewed the production tracking system (PTS) dataset for commercial systems, defined as systems with a capacity greater than 100 KW DC, participating in the SREC-I program, and in service at the time of this analysis. Likewise, the analysis of residential facilities was limited to those with a capacity equal to or less than 10 KW DC, identified as participating in the SREC-I program, and in service at the time of this analysis.

and the benefits generated by such installations. Overall, strong participation across sectors in the SREC-I program, along with the ten-fold growth in residential installed capacity, reinforces the fact that access to the benefits of the SREC-I program has impacted multiple sectors.

A significant challenge to maintaining future market diversity under the SREC-II program will occur when any of the available incentives, such as the federal investment tax credit or the net metering caps, are exhausted.

3 Sustainable Solar PV Market Development

Through the SREC-I program, DOER sought to support a sustainable solar PV market in Massachusetts with long-term growth potential. Central to this objective was DOER's effort to promote market growth at the same time that the program's available incentives declined.

3.1 Evaluation Approach

To determine if the DOER was successful in supporting the growth of a sustainable solar PV market, the Consulting Team began by considering trends which could indicate that the SREC-1 program was contributing to sustainable long-term growth of the solar PV market in Massachusetts. These trends include the development of infrastructure and businesses to install and maintain solar PV systems that would continue to operate and install new capacity within the Commonwealth in the absence of incentives. Key temporal indicators of these characteristics are continued market growth concurrent to reduced incentives, which indicates reduced dependence on incentives, and continued growth in the absence of solar-specific incentives (that is, Class I RPS parity).

The following key characteristics were identified to measure the SREC-I program's capacity to support the adoption and diffusion of solar PV while reducing dependence on incentives over time:

- Growth in market participation (quantity of installations and cumulative capacity),
- Growth in jobs supported by the market,
- Observed market growth concurrent with declining incentives, and
- Observed reduction to installed costs.

As Massachusetts is a part of a much larger national and international solar PV market, it can be assumed that its market will be influenced by external forces outside the program administrator's ability to influence the sustainability of the solar PV market. For instance, Massachusetts is subject to and has little impact on global module prices and federal incentive levels. Likewise, the effect of regional market improvements on the larger solar PV market and supply chain may be limited. However, a well-designed and managed regional effort could be anticipated to take advantage of external market conditions and federal incentives to support this objective. In this way, evolution of the market in Massachusetts also contributes to the sustainability of the larger national and worldwide markets.

Key data considered for this evaluation included:

- Growth in the quantity, and total capacity, of PV installations as reviewed under Section 2.1 of this report.
- Trends in job growth related to the PV market as reported by the Massachusetts Clean Energy Center's 2012 *Clean Energy Industry Report*.[9]
- Trends in SREC spot market prices that indicate a lower, or higher, dependence on state subsidies. The history of SREC market spot prices was derived from two sources:
    - SREC Trade (http://srectrade.com/srec_prices.php)
    - Knollwood Energy (www.knollwoodenergy.com/markets/ma_srec_program)

[9] See: http://images.masscec.com.s3.amazonaws.com/uploads/attachments/101/MassCEC_Industry-Rpt-12_web.pdf

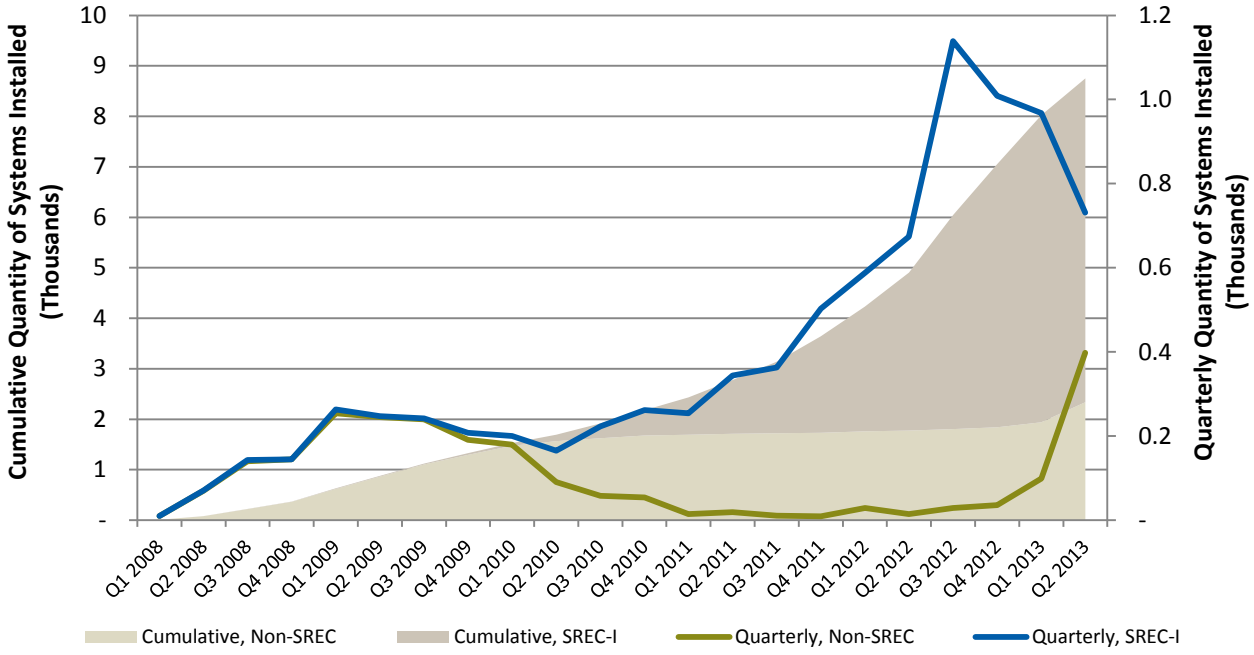
- Trends in the Alternative Compliance Payment (ACP) levels set by the DOER.
- Trends in incentives provided by MassCEC to SREC-I participants.
- Trends in installed PV price as reported in the *Task 1 Report: Evaluation of Current Solar Costs and Needed Incentive Levels across Sectors,* with consideration for the possible impacts of the SREC-I program on those trends.

3.2 Analysis

3.2.1 Growth in the Quantity and Total Capacity of Installations

PV installation capacity increased ten-fold during the SREC-I program, as described in Section 2.1 of this report. Figure 15 shows substantial growth in the quantity of solar PV installations from Q1, 2008, through Q2, 2013, particularly between Q2, 2011, through Q4, 2012. Figure 16 shows the growth in solar PV capacity installed over the same period.

Figure 15. Number of Solar PV Systems Installed, by SREC Eligibility[10]

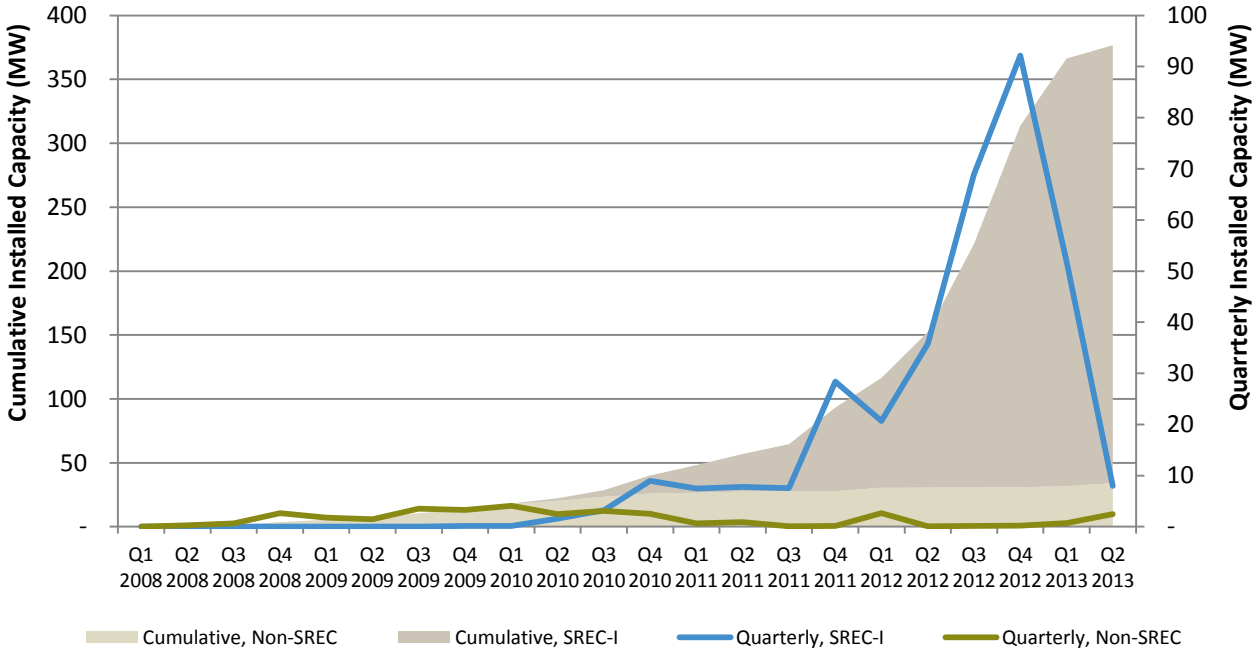


Note that, in both Figure 15 and Figure 16, the increase in the number of systems not participating in the SREC-I program during Q1, 2013, may be misleading, as data cross-referenced from DOER's SQA dataset most probably have not have been integrated into the PTS at the time of this analysis. A review of the data from Q1, 2013, and Q4, 2012, revealed that the percent of systems that did not report whether they would, or would not, participate in the SREC-I program were 10% and 3%, respectively. In comparison, 57% of systems lacked a qualifier in this category in Q2, 2013, and those systems are included with systems electing not to participate in the SREC-I program. However, with the

[10] Commonwealth Solar, Commonwealth Solar II, Commonwealth Solar Stimulus, and Non-Renewable Energy Trust Funded Facilities.

clarification and ultimate expansion of SREC-I beyond 400 MW, it is feasible that the growth indicated should also be attributed to incentives received by participants in the SREC-I program.

Figure 16. Solar PV Capacity (KW DC) Installed, by SREC Eligibility10



The most recent pace of growth is unlikely to be sustainable in the future. For example, if the future market grew at the same rate experienced under the program, approximately 2,000 MW of solar PV would be installed in 2014. This would exceed the 1,200 MW target proposed for a forthcoming SREC-II program. However, the SREC-I program may act to jumpstart a sustainable market with lower rates of growth. Concurrent with high installation and capacity growth in 2011 and 2012, investments in market infrastructure were made to meet increased demand for technical skills and market capacity that corresponded to the SREC-I program, which will in turn support expansion under SREC-II.

3.2.2 Jobs in the Solar PV Market: Status and Trends

Driven by and concurrent with the SREC-I program, significant investments were made to support job growth and development in the solar PV and peripheral markets. A key indicator of the market's continued growth, and its long-term stability, is that jobs created coinciding with incentive programs are retained as incentives declined.

According to the Massachusetts Clean Energy Center's *2012 Clean Energy Industry Report*,[11] jobs in renewable energy grew by 26% between 2011 and 2012, far exceeding the Commonwealth's average job growth rate of 1.2%. Businesses focusing on solar PV constituted 68.5% of renewable energy firms in Massachusetts, according to the *2011 Clean Energy Industry Report*.[12] A solar PV-specific breakout of jobs is not available; however, it is likely that solar PV was a significant contributor to the renewable energy job growth.

[11] http://www.masscec.com/content/2012-clean-energy-industry-report
[12] http://www.masscec.com/content/2011-massachusetts-clean-energy-industry-report

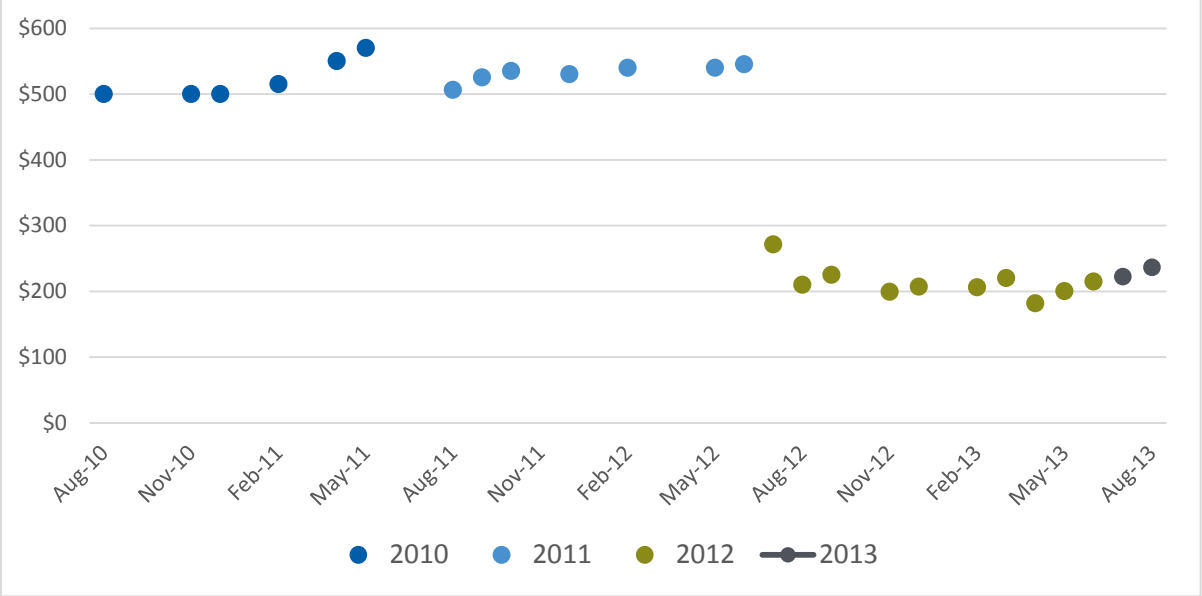
Expectations for job impacts are also discussed in the Task 4 report's Jobs and Economic Development Impact (JEDI) analysis and in the Task 3B report's projected jobs analysis.

3.2.3 Market Growth Concurrent with Declining Incentive Levels: Status and Trends

Coinciding with solar PV market growth, available incentives declined between 2010 and 2012. As shown in Figure 17, spot market prices for SRECs remained between $500 and $600 until mid-2012, as reported by SREC Trade. Quarterly SREC prices, shown in

Table 3, also declined by about approximately 50% in 2012, as tracked by Knollwood Energy.

Figure 17. Spot Market SREC Prices



Source: SREC Trade: http://srectrade.com/srec_prices.php

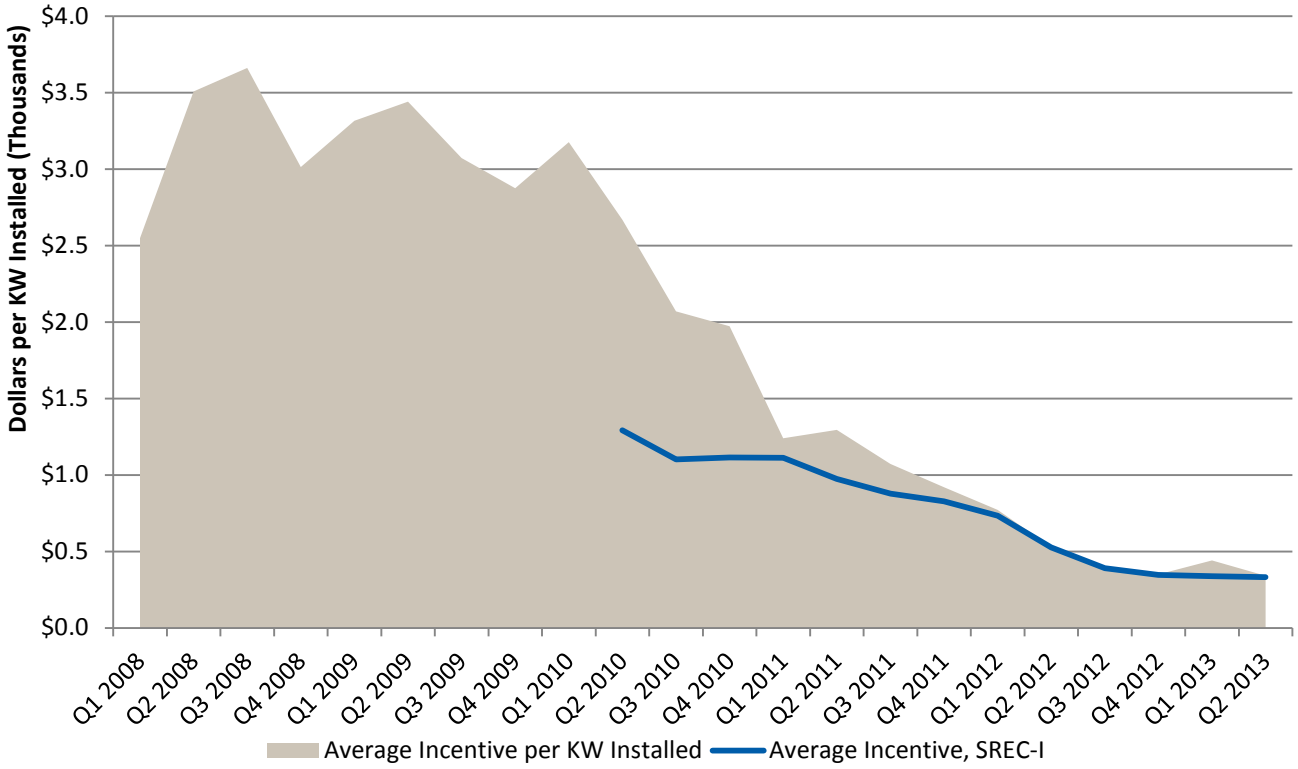
Table 3. Quarterly SREC Prices Reported by Knollwood Energy

	2010	2011	2012
First quarter	$580	$539	$292
Second quarter	$580	$539	$212
Third quarter	$580	$541	$211
Fourth quarter	$580	$541	$207

Source: Knollwood Energy: **http://www.knollwoodenergy.com/markets/ma_srec_program**

Due to the strong growth in solar PV installations, the supply of SRECs began to exceed demand, and spot prices dropped by about one-half. This drop, however, did not appear to slow growth in installation during 2012. As shown above, Q3 and Q4 of 2012 experienced the highest installation levels. Additional reductions in available incentives—including adjustments to the ACP discussed further under Section 5.2.1, reductions in available MassCEC rebates discussed below and shown in Figure 18, and fluctuations in the availability of net metering services discussed in section 4.2.3—resulted in only minimal and temporary adjustments to market growth.

Figure 18. MassCEC Capacity-Based Incentives For All Solar PV Systems and SREC-I Participating Systems



SREC prices are driven by a supply-demand relationship established by DOER in the SREC-I program. As the supply exceeded demand in 2012, the decline in SREC prices in effect constituted a market correction. Installation growth continued in 2012, and even as the substantially lower SREC rate indicates the values prior to 2011, they appear to be sufficiently high to grow the market. Of course, the supply-demand formula is expected to correct, and developers may be anticipating higher SREC prices in the future, so not too much should be read into this trend. Nonetheless, DOER's consistent annual reduction of the ACP rate, discussed further in Section 5.2.1, also suggests that the market's dependence on state incentives has decreased.

Rebates through the Commonwealth Solar II program, managed by MassCEC, continue to be available for residential and small commercial PV installations. As shown in Table 4 and Figure 18, the average rebate level dropped by over 73% during the SREC-I program, while the rate of installations increased.

Table 4. Commonwealth Solar II Average Rebates

Year	Rebate ($/kW)
2010	$1,256
2011	$915
2012	$465
2013	$342

3.2.4 Installed Cost Reduction

The Massachusetts solar market has seen a significant decline in installed costs over the course of the SREC-I program. Residential installed costs during the first quarter of 2009 were nearly $7.80 per watt, and by Q1 2013 prices had declined to an average of $4.66 per watt. Commercial scale PV systems have shown similar price trends.

These cost declines have mirrored costs declines in other nationally-prominent solar markets and are largely driven by significant decreases in global PV module costs. While the Massachusetts SREC-I program is likely too small to influence global market module prices, the growth of the Massachusetts market has likely driven a reduction in non-module installed soft costs. Several studies have noted the correlation between larger market sizes and reduced system soft costs.[13]

Additionally, the Massachusetts Clean Energy Center has developed the Solarize Mass program, a nationally significant initiative that has substantially lowered residential PV soft costs. This community-based customer aggregation program has repeatedly demonstrated an ability to achieve installed costs below market-average prices by reducing installer customer acquisition cost.[14] The Solarize Mass program structure has also been adopted in Connecticut by the Connecticut Clean Energy Finance and Investment Authority (CEFIA).[15]

3.3 Conclusions

During the SREC-I program, growth rates observed in the quantity and capacity of solar PV installations continued, or increased, despite decreasing incentive levels, demonstrating that the program did contribute to the development of a sustainable solar PV market in the Commonwealth. Over the past three years, both SREC prices and Commonwealth Solar rebates declined by nearly 50% while installations grew, further suggesting a reduced dependence on state incentives. Another way to look at this is that the solar PV market in Massachusetts is moving toward a market that would be sustainable in the absence of further incentives, due in large part to the SREC-I program as demonstrated by the concurrent growth in installations in the face of shrinking incentives.

Additionally, the increased level of installations made possible under SREC-I program also contributed to increased demand for skilled labor in the solar PV market. These factors, compounded with additional incentives available for training, enabled short-term job growth in the Massachusetts. This observed job growth may prove to be permanent, provided the market remains consistent in growth rate and participation levels.

Long-term growth potential depends on a number of factors outside the control of the program administrators, these include the availability of incentives, as well as PV module and equipment costs and supply chains. Under the proposed SREC-II program, DOER will need to adjust the program to address any significant changes in the broader national and international markets in order to ensure long-term stability in the Massachusetts solar PV market. The SREC-I program, when considered in this context, can be viewed as a jumpstart to a much larger Massachusetts market with the potential for sustainability.

[13] Source: www.nrel.gov/docs/fy12osti/53347.pdf, www.nrel.gov/docs/fy13osti/56806.pdf
[14] Source: http://images.masscec.com/uploads/attachments/Create%20Basic%20page/Solarize%20Massachusetts%20Pilot%20Overview.pdf
[15] Source: www.ctcleanenergy.com/YourCommunity/SolarizeCT/tabid/629/Default.aspx

4 Smooth Transition from Capacity-based Rebates

One key challenge presented by the adoption of the SREC-I program was ensuring a smooth transition from upfront, capacity-based rebate programs to the production-based, market-priced SREC. In addition to managing unfamiliarity and uncertainty introduced by market-pricing, DOER also was tasked with providing confidence to solar stakeholders that future SREC revenues would be available as the program matured.

4.1 Evaluation Approach

To assess the transition, the Consulting Team considered what efforts and attributes were necessary, and desired by stakeholders, to deliver a smooth transition from upfront, rebate-only incentives provided by MassCEC to the production-based market approach implemented via the SREC-I program. The transition effort, and support, would be expected to demonstrate one or more of the following attributes over time:

- Consistent market growth in the quantity and capacity of systems installed,
- Smooth phase-out in the capacity-based incentives, and
- Continuity in market growth.

Market growth and Commonwealth Solar rebate history are covered in a previous section of this report. Findings related to these topics are reviewed within the context of transition from rebate to production-based savings. To explore the issue of continuity in the market program history is reviewed with respect to events that impacted growth, whether they were under DOER influence or not.

4.2 Analysis

4.2.1 Growth in the Number of Installed Systems and Capacity

Overall, solar PV market growth remained consistent—in both capacity and quantity of installations developed each quarter—through the transition from upfront, capacity-based incentives to the SREC-I program. Growth trends observed for these two metrics are detailed in section 3.2.1. Two notable events at the start and nearing the end of the SREC-I program did result in market reactions and temporary corrections in growth.

The rate of growth of solar PV systems fell sharply as the SREC-I program replaced the capacity-based rebates in 2010, as demonstrated in Figure 15. Because new installed capacity also fell during this period (Figure 16), it can be inferred that the growth rate for all market sectors, including commercial and residential, was flat.

More recently, while the quantity of capacity seeking an SREC-I SQA jumped sharply, pending the resolution of which projects would be qualified under SREC-I before it reached 400 MW, the installation growth rates declined in 2013 as solar PV capacity that was qualified for the SREC-I program approached the 400 MW SREC-I program cap.

4.2.2 Smooth Phase-out of Rebate-only Incentives

As discussed in section 3, and shown in Table 4, rebates provided through Commonwealth Solar II declined by over 72% from 2010 to 2012. Despite the reduction, the quantity of residential PV installations, which the rebate targeted, continued to increase.

In late 2009, the cap established for the Commonwealth Solar I program was exceeded due to oversubscription (this was prior to the availability of the SREC-I program in 2010). In response, MassCEC, in coordination with DOER, continued to provide rebates to residential installations, but it reduced or curtailed rebates available to large-scale installations not sited on public property. Federal American Recovery and Reinvestment Act (ARRA) funds also helped bridge the gap between the capacity-based rebate programs and the new SREC-I program.

4.2.3 Continuity in Market Growth

On the whole, the solar PV market grew substantially under the SREC-I program. In a number of instances, market growth was either delayed or enhanced by DOER rule changes or external market forces. These events led at times to a market expansion that was less smooth than it otherwise might have been. The timing of many of the events listed here can be seen to correlate with changes in the pace of development shown earlier, for instance, in Figure 13.

- As noted above, the Commonwealth Solar rebate program reached its program cap prior to the start of the SREC-I program, resulting in a lag during when commercial and utility scale installations were without any state incentives.

- Market growth began slowly in 2010 as market participants adjusted to the post-rebate program for commercial installations. Only 1,845 kW of capacity was installed under the SREC-I program in the first two quarters of 2010. For the year, not enough SRECs were produced to meet demand.

- In early 2010 a lawsuit was filed by TransCanada Power Marketing against the Administration challenging certain aspects of the Green Communities Act, including geographic preferences under long-term contracting and carve-out provisions. Until it was resolved, the legal uncertainty created in the SREC-I program may have contributed to lower development in the new project pipeline. By June 2010, the lawsuit was resolved between DOER and TransCanada, in part by allowing retail energy suppliers to apply the lower Class I ACP rate to compliance shortfalls for the portion of compliance requirements associated with load under pre-SREC-I retail contracts for the duration of those contracts. In effect, the settlement reduced the compliance requirements in 2010 by roughly 40%.[16]

- Legislation signed by the governor in August 2010 increased the maximum project capacity from 2 MW to 6 MW. This enabled development of larger projects and contributed to rapid expansion in the program starting in Q4 2011.

- Rapid growth in capacity in the last half of 2011 was due in part to the expiration of the U.S. Treasury 1603 cash grant program at the end of 2011.[17]

- In the initial SREC-I regulations, DOER retained discretion to reduce the ACP by up to 10% in any year. As illustrated in Figure 19, DOER implemented a modest but sudden drop in the ACP in January 2011 with minimal notice and no stakeholder comment period. This change resulted in a temporary slowing of the market in 2011. At the time, stakeholders had anticipated that potential ACP decreases would be linked to underlying project cost movement and be provided with forewarning. The drop had been unanticipated and temporarily shook

[16] Source: www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/historical-development-of-the-rps-solar-carve-out.html

[17] Bird, Lori, Heeter, Jenny, Kreycik, Claire (November 2011). "Solar Renewable Energy Certificate (SREC) Markets: Status and Trends". National Renewable Energy Laboratory.

investor confidence. A slowdown in development resulted. Subsequently, on August 2, 2011, DOER presented and later adopted a proposed fixed 10-year forward schedule for the SREC-I ACP rate. Stakeholders commenting on the change underscored that the prior process of setting the SREC-I ACP annually, with the potential for as much as a 10% annual reduction, created an inherent regulatory risk and uncertainty surrounding future SREC ceiling prices. The new fixed schedule represented welcome mitigation to this uncertainty, providing added stability and restoring confidence in the marketplace. The resulting uptick in development activity shortly thereafter underscored the value of this predictability to smooth industry growth in a post-rebate environment.

- Other perturbations that impacted the transition related to the availability or value of other incentives; these included a period in 2011 when virtual net metering applicability to locations without pre-existing load was questioned and clarified, and a DPU adjustment to net metering qualification rules in 2012 under DPU Docket 11-11.

4.3 Conclusions

The SREC-I program was designed to replace a successful, but fund-limited, solar rebate program and sustain market expansion to meet a goal of installing 250 MW of solar by 2017. The SREC-I program easily met and exceeded the governor's goal in 2013, four years ahead of schedule. Although the program by itself cannot claim complete credit for the rapid growth, it is likely that without the program the governor's goal would not have been met. Without the additional incentive SRECs provided on top of federal tax and grant benefits, many, if not all of the commercial scale installations that drove market growth, would not have been financially feasible.

Although the SREC-I program did initially experience slow growth due to a number of the factors discussed above and then had stronger than expected growth starting in the last half of 2011, compared to solar RPS programs in other states the Massachusetts market for SRECs has been relatively stable. The supply-sensitive obligation formula of SREC-I contributed to preventing a persistent oversupply, with no crashing SREC prices and slowdowns in development such as was experienced in New Jersey's SREC market. The auction mechanism also contributed to the lower price variability in Massachusetts.

SREC legislation recently passed in New Jersey increased the purchase requirements for SRECs by almost a factor of three (from 560,000 in the 2014 program year to 1,633,394). Even with this unprecedented increase, some commenters suggest that the New Jersey market will remain oversupplied with SRECs.[18]

Clearly, there are some lessons to be learned from these discontinuities and their impacts (some of which have already been internalized by DOER in subsequent program design elements). As shown in the figures presented earlier in this report, installations did not really take off until the second half of 2011, but thereafter, in a period of relative stability, the growth rate of installations and capacity increased materially.

Going forward, lessons from the SREC-I program can be applied to the forthcoming SREC-II program to sustain a more stable market. It is clear, based on experience with the first phase of the SREC-I program, that SREC-II should maintain flexibility to adjust program details to meet changing market conditions. In addition to installed cost fluctuations, factors

[18] SREC Trade, NJ Governor Christie Signs Bill to Increase Solar Requirements , July 23, 2012. (www.srectrade.com/blog/srec-markets/nj-governor-christie-signs-bill-to-increase-solar-requirements)

such as the availability of net metering and the federal investment tax credit will impact the market. The ability to adjust incentives accordingly under SREC-II may act as a buffer against such shocks.

Clarity on future ACP rates, SREC factors, and auction floor prices that investors can rely on will add to market confidence required by investors under SREC-II. Improved transparency for progress in reaching the new SREC-II capacity cap will also help alleviate volatility in the market. Up-to-date application levels available on a frequent, if not real time, basis will allow market participants to better gauge market conditions and make prudent choices.

5 Minimize Ratepayer Impact

In addition to promoting continued investment in solar PV in the Commonwealth, the DOER sought to minimize impacts to ratepayer resulting from the SREC-I program. In part, DOER established the market-based mechanism of the SREC-I program to promote continued solar PV market growth by requiring that load-serving entities procure SRECs and attempting to bracket the potential cost through a combination of (1) a fixed price auction capable of providing some reliability to the low-end of revenues that developers and investors could expect, and (2) an alternative compliance payment to cap ratepayer exposure. Learning from experiences such as Spain's runaway solar feed-in tariff, DOER further strategically limited the initial SREC-I program to 400 MW in order to limit ratepayer exposure.

It should be noted that at the time of this evaluation, estimating the overall impact of the SREC-I program to ratepayers is not possible. As the compliance obligation to the Massachusetts' load-serving entities must extend to the end of the full opt-in period for the last qualified facility in 2023, a complete picture of ratepayer impacts will not be available until a decade into the future.

5.1 Evaluation Approach

To consider the effectiveness of the SREC-I program in minimizing ratepayer impact, the Consulting Team identified the following attributes the program would be expected to exhibit over time:

- Program design and modifications that limit and reduce the potential impact to ratepayers,
- Reduced incentives within a period of market growth, and
- Actual ratepayer impacts at, or lower than, originally projected ratepayer impacts, and towards the lower end of the range of the possible ratepayer impacts.

To explore the ratepayer impact issue, the SREC-I program was reviewed for elements of program design and modifications that minimized the impacts. In addition, SREC market price and volume history, which together determine ratepayer impacts, was compared to original expectations when the program was launched. As actual SREC prices paid by buyers are not publically available, this assessment relied on published spot market prices that were publically available.

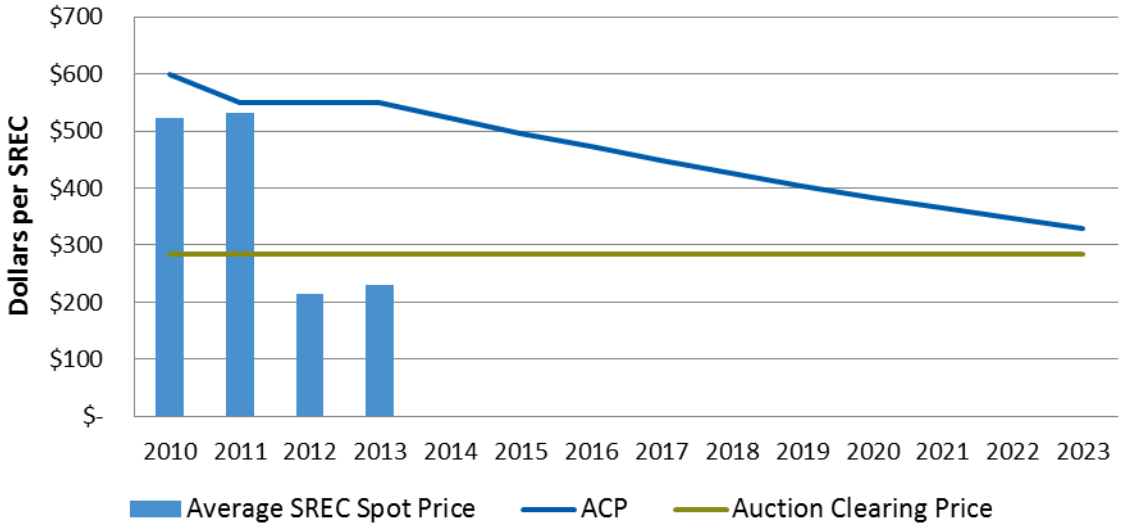
5.2 Analysis

5.2.1 Program Design and Modifications to Reduce Potential and Realized Ratepayers Impacts

Two key elements of the design of the SREC-I program were the program cap, which limited participation to 400 MW capacity, and the Alternative Compliance Payment (ACP). While the 400 MW cap was increased marginally to accommodate qualified projects that fell outside the cap during the transition to the SREC-II program,[19] the ACP, as shown in Figure 19, was adjusted annually and is scheduled to be continuously adjusted during the next decade. The ACP represents the maximum upward boundary any SRECs purchaser could anticipate paying in a given compliance year.

[19] See: http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/regulatory-proceedings-for-rps-and-aps.html.

Figure 19. Alternative Compliance Payment (ACP) and Auction Floor vs. SREC Average Annual Spot Market Price



5.2.2 Reduced incentives within a period of market growth

As shown in Figure 19, average annual SREC spot market prices dropped by roughly 50% in 2012. This drop is due largely to the oversupply of SRECs in the market, but it may also be attributable to the falling cost and SREC revenue needs of new solar PV installations. It is notable that spot prices fell below the opt-in fixed-price auction price floor of $285 ($300 less a 5% fee to cover auction administration costs).

While surpluses and a lack of impetus for load-serving entities to buy SRECs beyond the present compliance year from the fixed price action (the first of which did not clear in July of 2013) contributed to this dynamic, another contributing factor is the possibility that solar PV costs will continue to decline such that solar PV installations *might* be viable in the future with SREC payments below the floor.

As discussed in prior sections of this report, even with the substantially lower prices the overall market grew. Thus market growth was maintained while reducing ratepayer impact.

5.2.3 Actual ratepayer impacts at, or lower than, originally projected ratepayer impacts

As noted above, actual prices paid for SRECs by buyers is not publically available. Table 5 below estimates the ratepayer impacts to date using reported spot market prices. As actual contract prices for SRCECs should be lower than the spot market price, these values represent an upper bound on ratepayer impact estimates. For comparison, a hypothetical impact based on the ACP rate and auction floor prices are also demonstrated.

Table 5. Ratepayer Impact Comparison

Year	Volume (MWh)	Spot Price ($/MWh)	Spot Market Total Ratepayer Impact ($m)	Auction Floor ($/MWh)	Ratepayer Impact at Auction Price ($m)	ACP ($/MWh)	Ratepayer Impact at ACP Rate ($m)
2010	34,164	$ 523	$ 17.9	$285.00	$9.7	$600	$20.5
2011	78,577	$ 532	$ 41.8	$285.00	$22.4	$550	$43.2
2012	81,559	$ 213	$ 17.4	$285.00	$23.2	$550	$44.9
2013	189,297	$ 230	$ 43.5	$285.00	$53.9	$550	$104.1
Total	383,597		$ 120.5		$109.3		$212.7

Table 5 shows that the ratepayer impact over the first three years of the program was lower than the hypothetical impact if SRECs had sold at the ACP rate. The total ratepayer impact will not be known until the conclusion of the SREC-I program when PV installations participating in the program are no longer claiming SRECs. Prices between now and that time may vary significantly.

5.3 Conclusions

The ratepayer impact resulting from the SREC-I program over the first three years is much lower than if SREC prices had been near the ACP level, and it is still lower than the cost that would result of SREC prices were at the auction floor. This lower than estimated level of impact occurred even as the market grew rapidly starting in the last half of 2011.

Despite these early positive indicators, it is not possible at the time of this evaluation to estimate the full impact to ratepayers associated with the SREC-I program. As obligations will continue well into the future, the full ratepayer impacts will need to be evaluated at the close of the program. One challenge for DOER going forward will be in balancing SREC supply with demand after the capacity target has been reached. Small variations in supply or demand could push market prices lower toward the auction floor, or higher toward the ACP cap. The resulting price variability could make it difficult for market participants to predict future SREC prices. However, an auction banking provision should help maintain market balance during this phase of the SREC-1 program.