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CLEAN ENERGY
FINANCE AND INVESTMENT AUTHORITY

March 6, 2014

Energy and Technology Committee
Room 3900
Legislative Office Building
Hartford, CT 06106

Re: Submission of Progress Report on the Residential Solar Investment Program per Section 106 of Public Act 11-80

Dear Distinguished Members of the Energy & Technology Committee:

On behalf of the Clean Energy Finance and Investment Authority (CEFIA), I am pleased to enclose a Progress Report on CEFIA's Residential Solar Investment Program (RSIP).

Section 106 of Public Act 11-80 required CEFIA to establish a residential solar investment program that will result in a minimum of 30 MW of new residential solar PV installations in Connecticut by the end of 2022, while not expending more than one-third of the annual surcharge (System Benefits Charge) on electricity ratepayer bills that funds RSIP. As specified in the statute, CEFIA provides both up-front and performance-based incentives for the purchase and/or lease of qualifying residential PV systems. CEFIA designed the RSIP to provide a reasonable payback to the customer, foster the growth and development of the industry, and decrease incentives over time while encouraging competition in the marketplace in order to create a sustainable PV industry in Connecticut.

The Act requires CEFIA to submit a report on the progress made towards the goals. Attached you will find a copy of progress report of the RSIP by the Cadmus Group.

We are happy to report that we are ahead of schedule and under budget.

The RSIP is following Governor Malloy's and the Legislature's imperative for Connecticut's "green bank" to not only leverage the limited ratepayer resources we administer to attract more private capital investment, but to also reduce the market reliance on grants, rebates, and other subsidies and transition the market to innovative low-cost and long-term financing. . CEFIA is well ahead of schedule for meeting the 30 MW by 2022 goal, while spending less than the one-third of the annual Systems Benefits Charge – as I have said we are ahead of schedule and under budget.

While we work hard to deploy more clean energy, faster, while using ratepayer resources more efficiently, we are also reducing greenhouse gas emissions and creating jobs that support local economic development in our communities.

We appreciate your leadership and ongoing support in helping CEFIA achieve its mission.

Sincerely,

Bryan Garcia
President and CEO

Progress Report
CEFIA Residential Solar Investment Program

January 16, 2014

Clean Energy Finance and Investment Authority
845 Brook Street
Rocky Hill, CT 06067

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CADMUS

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Report delivered to CEFIA on 12/31/2013

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CADMUS

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1.0 Executive Summary

Cadmus, selected through a competitive RFP process and under contract to the Connecticut Clean Energy Finance and Investment Authority (CEFIA), has completed a statutorily required progress report of the Residential Solar Investment Program (RSIP).[1] The period being evaluated includes a 16-month period from the launch of the program in March 2012 through June 2013, the end of CEFIA's fiscal year 2013. This evaluation encompassed a thorough review of numerous program materials, tracking databases, and other materials to measure the RSIP's progress towards statutory goals related to installed capacity, customer payback, and other metrics.

CEFIA was established by Connecticut's General Assembly on July 1, 2011 through Public Act 11-80[2] as a quasi-public agency that supersedes the former Connecticut Clean Energy Fund (CCEF). CEFIA's mission is to help ensure Connecticut's energy security and community prosperity by realizing its environmental and economic opportunities through clean energy finance and investments. As the nation's first state "Green Bank," CEFIA leverages public and private funds to drive investment and scale-up clean energy deployment in Connecticut. For more information about CEFIA, please visit www.ctcleanenergy.com.

Public Act 11-80 required CEFIA to establish a residential solar investment program that will result in a minimum of 30 MW of new residential solar PV installations in Connecticut by the end of 2022, while not expending more than one-third of the annual surcharge (System Benefits Charge) on electricity ratepayer bills that funds RSIP.[3] As also specified in the statute, CEFIA provides estimated performance-based buy-down incentives (EPBB) and performance-based incentives (PBI) for the purchase and/or lease of qualifying residential PV systems. CEFIA designed the RSIP to provide a reasonable payback to the customer, foster the growth and development of the industry, and decrease incentives over time while encouraging competition in the marketplace in order to create a sustainable PV industry in Connecticut.

[1] PA 11-80, Section 106 (h) On or before January 1, 2014, and every two years thereafter for the duration of the program, the Clean Energy Finance and Investment Authority shall report to the joint standing committee of the General Assembly having cognizance of matters relating to energy on progress toward the goals identified in subsection (a) of this section.

[2] PA 11-80: http://www.cga.ct.gov/2011/act/pa/2011PA-00080-R00SB-01243-PA.htm

[3] PA 11-80, Section 106 (a) The Clean Energy Finance and Investment Authority established pursuant to section 16-245n of the general statutes, as amended by this act, shall structure and implement a residential solar investment program established pursuant to this section, which shall result in a minimum of thirty megawatts of new residential solar photovoltaic installations located in this state on or before December 31, 2022, the annual procurement of which shall be determined by the authority and the cost of which shall not exceed one-third of the total surcharge collected annually pursuant to said section 16-245n.

1.1 Key Benefits of the RSIP

The RSIP has led to significant growth in the installation of residential solar PV. As of June 30, 2013, CEFIA has:

- Approved or paid incentives for a total installed capacity of 10 MW, which is estimated to generate over 11,000 MWh of electricity for Connecticut residents annually. This is equivalent to supplying the electricity needs of approximately 1,300 average Connecticut homes.
- Disbursed $8.4 million in incentive payments to 1,419 Connecticut homeowners to purchase PV systems, with funds originating from the following two sources:
    - $4.7 million from funds collected through the System Benefit Charge (SBC[4]), representing 13%[5] of the $36 million of SBC funds collected by CEFIA during the 16 month period of this evaluation
    - $3.7 million from Regional Greenhouse Gas Emissions Initiative (RGGI) auction proceeds transferred to CEFIA by Connecticut's Department of Energy and Environmental Protection (DEEP)[6]
- Provided transparent insight into the RSIP through a range of outreach avenues such as weekly Market Watch reports, installer training sessions, and regular e-mail communications to solar PV installers and other stakeholders

The typical system supported by the RSIP is approximately 7 kilowatts (kW), at a cost of approximately $4.80/Watt, or $33,600. After all incentives, this translates to a $1.93/Watt out-of-pocket cost for customers, or $13,500. Most customers receiving an EPBB will recoup this investment in 11-12 years.

1.2 Progress Toward RSIP Statutory Goals

Section 106 of Public Act 11-80 established several goals for the RSIP, and Cadmus measured the RSIP's substantial progress toward these goals, as shown in Table 1.

[4] The System Benefit Charge is a small charge added to the electric bills of Connecticut customers of Connecticut Investor Owned Utilities (IOUs), Connecticut Light and Power (a Northeast Utilities Company) and United Illuminating.

[5] This 13% is less than the statutory one-third expenditure limit for SBC funds applied to RSIP, per PA 11-80. If RGGI funds had not been available, as described below, and all of the incentives had been funded by the SBC, the $8.4 million would have represented 23% of the SBC funds.

[6] See Section 3.2.7 of this report. RGGI is a regional market-driven program to reduce greenhouse gas emissions.

Table 1. RSIP Progress Toward Statutory Goals

RSIP Statutory Goal	Progress Achieved Through June 30, 2013
Fund installation of 30 MW by 2022	10 MW in completed, in progress or approved projects in the first 16 months
Achieve reasonable customer payback periods	Expected simple payback of 11-12 years for EPBB
Use one-third or less of collected SBC revenues	$36M in SBC funds collected and $8.4M in RSIP incentives disbursed[7], of which $4.7M originated from SBC, representing 13% of SBC funds devoted to RSIP incentives for the study period[8]
Identify barriers and support training for workforce development	Responsibility for workforce development has shifted to the Connecticut Energy Workforce Development Consortium (CTEWDC) but CEFIA is continuing two initiatives, E-Houses and support of community college programs, both begun by CCEF

CEFIA is currently on track to meet, or exceed, the statutory goals of the RSIP, as outlined in Table 1.

[7] Disbursal of incentives is presented here on a cash versus accrual, accounting basis.

[8] The other $3.7M of the $8.4M in RSIP incentives was provided from RGGI funds, as explained in Section 3.2.7. If RGGI funds had not been available, and all of the incentives had been funded by the SBC, the $8.4 million would have represented 23% of the SBC funds.

2.0 Introduction

The Connecticut Clean Energy Finance and Investment Authority (CEFIA) selected Cadmus through a competitive RFP process to evaluate the Residential Solar Investment Program (RSIP). The primary goal of this evaluation was to measure the RSIP's progress against statutory goals, as outlined in Section 106 of Public Act 11-80, over the study period from March 1, 2012 to June 30, 2013. This progress report documents the evaluation results, as measured by:

- Installed residential solar photovoltaic (PV) system capacity
- Average customer payback period
- Use of System Benefit Charge (SBC) funds
- Workforce development

Where possible, Cadmus also documented the RSIP's progress toward CEFIA's additional, internal goals.

To complete this evaluation, Cadmus reviewed a wide variety of data sources, including:

- Interviews with key CEFIA personnel involved in planning and implementing the RSIP
- Online application processing and Program tracking database (PowerClerk)[9]
- Program plan
- Written communications from CEFIA staff to solar PV installers and other stakeholders
- RSIP and CEFIA websites and related online content
- CEFIA accounting records

[9] PowerClerk is an online database provided by Clean Power Research. It is an implementation tool for regional renewable energy programs. For more information: http://www.cleanpower.com/products/powerclerk.

3.0 Program Summary

3.1 CEFIA Overview

3.1.1 Mission and Vision

CEFIA was created by the Connecticut legislature as part of Public Act 11-80, *An Act Concerning the Establishment of the Department of Energy and Environmental Protection and Planning for Connecticut's Energy Future*, and is the successor organization to the Connecticut Clean Energy Fund (CCEF). CEFIA aims to attract and deploy capital to:

- Finance the clean energy goals of Connecticut,
- Develop and implement strategies that lower the cost of clean energy,
- Reduce reliance on grants, rebates, and other subsidies, and
- Move toward innovative low-cost financing for clean energy deployment.

These goals support CEFIA's vision to help ensure Connecticut's energy security and community prosperity by realizing its environmental and economic opportunities through clean energy finance and investment.

3.1.2 Legislative Authority

CEFIA is led by a Board of Directors, comprised of 11 voting and two non-voting members, each with knowledge and expertise in matters related to the purpose of the organization. CEFIA is governed by its bylaws adopted August 3, 2011, revised September 29, 2011 and amended periodically. A joint-standing committee of CEFIA and the Connecticut Energy Efficiency Fund (CEEF) was established to coordinate programs and activities.

3.1.3 CEFIA's Green Bank Approach

One of CEFIA's primary goals is to grow the state's residential solar PV industry to a point where the market can operate subsidy-free, and instead be supported by innovative clean energy loan and lease products. CEFIA now provides support for long-term loan (CT Solar Loan and the Smart-E Loan) and lease (CT Solar Lease) financing products for solar PV installations. These products were launched after the period included in this evaluation, and will be discussed in a future progress report.

3.2 Residential Solar Investment Program

3.2.1 History and Background

RSIP was developed and is administered by CEFIA. It was approved by CEFIA's Board of Directors in February 2012 and was implemented on March 2, 2012. The program requires that a minimum of 30 MW of new residential solar PV be installed in Connecticut on or before December 31, 2022, at a reasonable payback to the customer. Through the program, CEFIA provides to residential customers, via solar PV installers, direct financial incentives in the form of expected performance-based buy-down

incentives (EPBB) and performance-based incentives (PBI) for the purchase and/or lease of qualifying residential PV systems.[10] In addition to administering the incentives, CEFIA also coordinates other activities associated with RSIP including coordination of incentives with CEFIA financing products, marketing, legal support, workforce development, technology, and evaluation, measurement and verification.

Prior to CEFIA's existence, the Connecticut Clean Energy Fund (CCEF) launched a multi-year residential solar program in late 2004, which has since been through several revisions and iterations, providing homeowners with the opportunity to own solar PV systems. In 2008, the CCEF launched a unique solar lease program that met with great success, including winning a State Leadership in Clean Energy Award from the Clean Energy States Alliance in 2012. This program was the predecessor to CEFIA's current lease program/product, CT Solar Lease, launched in July 2013. CEFIA's first lease program provided households with the opportunity to lease solar PV systems from installers or third-party financiers and benefit from a reduced monthly electric bill. Strong incentive support and program success over several years resulted in increased customer demand, followed by a depletion of incentive funds. With incentives having run out, at the same time as the first lease program ending, CEFIA was unable to provide incentives to meet demand, resulting in some local contractors moving to neighboring states or going out of business.

CEFIA designed the RSIP to foster sustained growth and development of the solar PV industry in Connecticut rather than the boom-bust cycles that have followed the ups and downs of incentive levels in the clean energy industry in the past. This approach will support the industry in the long-term, even in the absence of or with reduced incentives in the future. A mechanism to achieve this goal is the development and implementation of innovative clean energy financing products that makes the installation of clean energy technologies accessible to more households and businesses in Connecticut.

3.2.2 Statutory and CEFIA Organizational Goals

Table 2 outlines the statutory and CEFIA organizational goals for the RSIP in the short- and long-term. Please note that in several instances, CEFIA's organizational goals are beyond what is mandated by the statute.

[10] PA 11-80, Section 106 (b): The Clean Energy Finance and Investment Authority shall offer direct financial incentives, in the form of performance-based incentives or expected performance-based buydowns, for the purchase or lease of qualifying residential solar photovoltaic systems. For the purposes of this section, "performance-based incentives" means incentives paid out on a per kilowatt-hour basis, and "expected performance-based buydowns" means incentives paid out as a one-time upfront incentive based on expected system performance…

Table 2. Statutory and CEFIA Organizational Goals for RSIP

Metric	Statutory Goals	Internal Goal (Near Term)	Internal Goal (Long Term)
Installed Capacity	30 MW by end of 2022		50 MW by 2022
Customer Payback	"Reasonable"	Nine years	Five to seven years by 2022
RSIP Procurement	Less than one-third of SBC intake (~$100 M)		50% of statutory procurement target (~$50 M)
Cost Reduction		20%, $4.00/Watt Standard Testing Conditions	20-40%
Incentives Leveraged			4:1 leverage ratio
Customer Acquisitions			7,500 customers
Model Communities			Demonstrate communities with 5% residential solar PV system penetration
Energy-Efficiency Participation		Demonstrate cost-effectiveness	
Workforce Development	Identify barriers and support training		Increase the trained solar workforce in Connecticut
Public Awareness			Increase awareness of solar PV systems
Accessibility			Demonstrate that solar PV systems are accessible to all income levels

3.2.3 Transition From Subsidy to Low-Cost Financing and Credit Enhancement Model

CEFIA is supporting the transition from a subsidized marketplace to one supported by innovative, low-cost financing models by reducing, over time, the financial incentives that are offered. A short-term, first-year internal goal of the RSIP was to achieve a 20% reduction in the installed system cost (dollars per watt, or $/W),[11] which also lowers the dollar amount of participant incentives per system. Incentive levels are expected to be decreased steadily over the life of the RSIP as the market grows, prices fall, and project economics become less dependent on subsidies.

[11] During the 16 months of the RSIP, nameplate installed costs for EPBB projects have fallen 15%. See Table 6 in Section 4.2. The scope of this evaluation does not include determination of how much of this cost reduction is directly attributable to any specific program or effort. However, CEFIA is working to identify key drivers of cost reduction for solar PV and programs such as the RSIP and Solarize Connecticut appear to play a role in reducing costs. For example, a report analyzing the Solarize Connecticut Phase I program indicates a cost reduction impact of between 20-30% for homeowners. See the report for details: http://solarizect.com/wp-content/uploads/2013/09/TheFinalReportSept172013.pdf.

CEFIA identifies key methods for reducing the installed cost ($/W), thus lowering the customer payback period, as follows:

1. Improved permitting, interconnection, and net metering processes and standards that reduce non-hardware or "soft" costs for solar PV installation
2. Innovative community-based customer acquisition strategies to lower costs through customer aggregation (e.g., the Solarize Connecticut Program[12])
3. Having well-defined criteria for installers, homeowners, and PV systems to qualify for the incentives offered under the RSIP.

CEFIA has leveraged almost $3 million of non-ratepayer resources to fund cost reduction efforts, including competing for and winning two U.S. Department of Energy SunShot Initiative Rooftop Solar Challenge grants to better understand and reduce solar PV "soft costs," contributing to winning a third federal grant to study mechanisms for reducing costs and increasing solar PV deployment in Connecticut, and attracting private foundation funds to add to CEFIA's investment in the Solarize Program.[13]

[12] http://solarizect.com

[13] CEFIA has competed for and won two U.S. Department of Energy SunShot Initiative Rooftop Solar Challenge grants to fund efforts to reduce solar PV "soft costs." The first grant, for $480,000, funded a Connecticut collaborative project led by CEFIA called "Sun Rise New England – Open for Business," with project results including a final report available at www.energizect.com/sunrisene. The second grant, for which Connecticut is receiving $360,000, is part of a larger $1.5 million grant funding a collaborative New England project called the "New England Solar Cost-Reduction Partnership," led by the Clean Energy States Alliance. CEFIA contributed to winning a third grant, led by Yale University, bringing $1.8 million to Connecticut for "Solar Energy Evolution Diffusion Study (SEEDS)" efforts to better understand and enable adoption of solar PV on a large scale. In addition to federal grants, CEFIA has attracted private foundation funds totaling $300,000, nearly matching its $400,000 investment in the Connecticut Solarize Program.

3.2.4 Eligibility Requirements for RSIP

CEFIA developed the following program requirements based on experience in the early years of the residential solar incentive program.

Projects

Projects seeking funding under the RSIP must meet the following key criteria:

- Must be installed on a one to four family home in the Connecticut Light & Power (CL&P) or United Illuminating Company (UI) service territory. In addition, outside of the CL&P and UI service territories, through an agreement with the Connecticut Municipal Electric Energy Cooperative (CMEEC), CEFIA will provide administrative and technical support (including system design review) to solar PV projects for which CMEEC provides incentives.
- Must be new and grid-tied. Incentives are not available for used equipment or new PV systems that were partially or completely installed prior to receiving written approval from CEFIA. CEFIA considers the expansion of existing PV systems on a case-by-case basis.
- Must comply with applicable federal, state, and local laws, regulations, codes, licensing, and permit and inspection requirements, including the Connecticut Building Code and the National Electric Code.
- All applicable components must use commercially available PV technologies as listed on the California Energy Commission (CEC) website.
- All components must be Underwriter's Laboratory (UL) listed (or equivalent) where applicable.
- All systems must conform to the kW size and load limits, which is per address, not per homeowner or meter.

Homeowners

Homeowners seeking funding under the RSIP must be CL&P or UI customers and agree to:

- Work with a contractor or third-party system owner approved[14] by CEFIA as eligible to participate in the RSIP
- Complete an energy assessment through participation in CEEF's Home Energy Solutions Program, or by having the assessment performed by a Building Performance Institute (BPI)-certified contractor, Certified Energy Manager, or Professional Engineer.

[14] CEFIA reviews each contractor and third party owner to ensure compliance with the RSIP requirements but does not endorse contractors beyond ensuring eligibility to participate in the RSIP. CEFIA maintains a list of eligible contractors at: http://www.energizect.com/residents/find-a-professional.

- Install a CEFIA-approved, web-based kWh monitoring device to track system performance.
- Install a CEFIA-approved, revenue grade meter to verify system performance.[15]

Contractors

Contractors must be approved by CEFIA and meet the following criteria to become eligible for participation in the RSIP:

- Have at least one permanent employee or subcontractor that holds an E-1 license.
- Have at least one permanent employee that holds the North American Board of Certified Energy Practitioners (NABCEP) Entry Level Passing Score Achievement Certificate, or has a full NABCEP certification.
- Carry at least $1 million in general liability insurance.
- Provide verifiable evidence of financial solvency and health in the form a bank letter or credit reference.
- Provide a copy of a standard contract or sales agreement.
- Provide a five-year workmanship warranty to homeowners, covering all components of the generating equipment against breakdown or degradation in electrical output of not more than 10% of the original rated electrical output, and covering the full costs of labor and repair for replacing defective components or systems.

Third-Party System Owners

Third-party owners must be approved by CEFIA and meet the following criteria to participate in the program:

- Use an eligible contractor to install solar PV systems receiving RSIP incentives.
- Carry at least $1 million in general liability insurance.
- Provide verifiable evidence of financial solvency and health in the form of a bank letter or credit reference.
- Provide copies of a standard contract or lease sales agreement, energy services agreement, or power purchase agreement. Contracts must include warranty provisions, including energy production and workmanship.

3.2.5 Expected Performance-Based Buy-Down Incentives

Through the EPBB, CEFIA effectively provides a rebate, paid to the installer upon completion of a project, which is then passed on to the homeowner, thus lowering the total cost of their solar PV

[15] As a condition of participating in the RSIP, homeowners transfer the rights of Renewable Energy Credit (REC) ownership to CEFIA. CEFIA, in turn, tracks the amount of renewable energy produced from each system, registers the RECs on the New England Power Pool Generation Information System (NEPOOL GIS) system, and sells the RECs to buyers seeking to comply with Connecticut's Class I RPS regulations.

installation. The incentive is calculated on a per-Watt basis, up to 10 kW, based on the system's PVUSA Test Conditions (PTC) rating as opposed to the standard test conditions (STC) or nameplate rating.[16] The incentive calculation also takes into account the design factor of the system to account for shading and orientation. Systems incentivized under steps 1 and 2 are de-rated by multiplying the percent of optimal production by the PTC rating. Step 3 systems that are designed to meet at least 87% of optimal production receive the listed dollar per watt incentive; incentives for systems with a design factor below 87% of optimal are reduced accordingly. The first 60% or 70%[17] of the incentive is dispersed following delivery of the equipment to the homeowner, and the remaining incentive after the PV system is installed and has passed all inspections. The EPBB is designed to support local installers and homeowners that want to own their solar PV system. Only PV systems that are owned by the homeowner are eligible to receive the EPBB.

The EPBB was designed so that incentive levels would be reduced in a series of steps. During the period of this evaluation, the incentives have progressed from step 1 to step 3, with step 3 providing the lowest incentive levels. For each step, CEFIA has provided a higher dollars-per-Watt incentive for the first 5 kW of installed capacity, and a lower incentive for additional, installed capacity greater than 5 kW and less than 10 kW.

EPBB incentives are not provided for capacity beyond 10 kW, and are only available up to the PV capacity necessary to meet the home's load. The system can still have a capacity that is larger than necessary for the load; however, no incentives will be provided for this extra capacity.

CEFIA provides additional incentives for projects that incorporate major system components that were manufactured or assembled in Connecticut (a 5% incentive bonus) and a 10% bonus if the components were manufactured or assembled in a distressed municipality, as defined by the United States Department of Housing and Urban Development, or targeted investment community, as designated by the Connecticut Department of Economic and Community Development (DECD). EPBB incentive levels since inception of RSIP, steps 1 through 3, are listed in Table 3.

[16] PTC is an alternative PV module rating scheme that differs from Standard Test Conditions (STC) used for module "nameplate" values. The PTC rating, which is generally lower than the STC rating, is recognized to be a more realistic measure of PV output because the test conditions better reflect real-world conditions. The PTC rating is used by programs in California, Connecticut, and elsewhere as the basis of incentive calculations. PTC refers to PVUSA Test Conditions, which were developed to test and compare PV systems as part of the PVUSA or Photovoltaics for Utility Systems Applications (formerly Photovoltaics for Utility Scale Applications) project. PTC are defined as 1,000 Watts per square meter solar irradiance, 20 degrees Celsius *air* temperature, and wind speed of 1 meter per second at 10 meters above ground level. STC are based on 25 degrees Celsius *cell* temperature. The PTC rating differs in that its test conditions of ambient temperature and wind speed will result in a PV cell temperature of about 50 degrees Celsius, instead of the 25 degrees Celsius assumed for STC. Consequently, for crystalline silicon PV systems with a power degradation due to temperature of -0.5% per degree Celsius, the PV module PTC power rating is generally about 88% of the PV module STC or nameplate rating.

[17] In Steps 1 and 2, a 60% milestone payment was provided upon equipment delivery. This was changed to 70% beginning in Step 3.

Table 3. EPBB Incentive Levels since Inception of RSIP ($/W)[18]

Step	EPBB Incentive ≤ 5 kW	EPBB Incentive > 5 kW and ≤ 10 kW
1	$2.450	$1.250
2	$2.275	$1.075
3	$1.750	$0.550

3.2.6 Performance-Based Incentives

The PBI supports third-party financiers who work with homeowners who want to lease their PV system. Similar to the EPBB, the PBI decreases over the life of the program. However, unlike the EPBB, CEFIA bases the PBI incentive on the kWh output of the PV system, rather than the kW capacity. CEFIA began the program by offering $0.30 per kWh and has reduced the incentive levels in steps as for EPBB. Projects that incorporate major system components that are manufactured or assembled in Connecticut receive an additional 5% incentive, while those from a distressed municipality or strategic investment community receive an additional 10% incentive.

Unlike the EPBB, which CEFIA pays upfront at the completion of the project, the PBI is disbursed quarterly over six years. By disbursing the incentive payments over time, CEFIA does not require a large upfront source of funds. The PBI incentive levels since inception of RSIP are listed in Table 4.

Table 4. PBI Incentive Levels since Inception of RSIP ($/kWh)[19]

Step	PBI Incentive ≤ 10 kW
1	$0.300
2	$0.300
3	$0.225

3.2.7 Funding and Incentive Levels

The EPBB and the PBI incentive budget totaled approximately $12 million during the study period[20] and CEFIA disbursed $8.4M in RSIP incentives. Of the $8.4M in disbursed incentives, $4.7M were funded by SBC income, with the remainder funded through an allocation of funds from Regional Greenhouse Gas Initiative (RGGI) auction proceeds.[21]

RGGI is a cooperative market-based regulatory program among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and

[18] This does not include incentive adders, such as the 5% adder for using CT-manufactured equipment.
[19] This does not include incentive adders, such as the 5% adder for using CT-manufactured equipment.
[20] Based on one third of total SBC income between March 2012 and June 2013.
[21] CEFIA obtained permission from CT DEEP, on May 3, 2013, to allocate $3.7M in auction proceeds to RSIP incentives.

reduce carbon dioxide emissions from the power sector.[22] In Connecticut, RGGI is implemented and auction proceeds are distributed as provided in:

- Section 22a-200c of the Connecticut General Statutes, "Implementation of Regional Greenhouse Gas Initiative. Regional Greenhouse Gas account. Auctioning of allowances"[23]
- Section 22a-174-31 of the Regulations of Connecticut State Agencies[24]

If the RSIP meets its internal goals, CEFIA will achieve over 50 MW of residential solar, over a 10-year period, using less than half of the allowable incentives, while working toward achieving a payback period between five and seven years for residential customers.

CEFIA designed the level of incentives for each step based on a target capacity, associated dollar amount to be disbursed, and the final cost to the customer. The target capacity and incentive level for each incentive step are approved by the CEFIA Board of Directors (BOD) and the incentive level is also approved by the Commissioner of DEEP before it becomes official. Beginning in Step 2, CEFIA structured the target capacity as a "Race to the Rooftop", in which a portion is allotted to EPBB projects, a portion to PBI projects, and the remaining portion is reserved to be allotted to whichever incentive structure reaches its target capacity first. For this reason the EPBB and PBI incentives do not always move from Step to Step on the same date.

Once approximately 50% of the target capacity for a particular step has been subscribed, CEFIA begins designing and planning for the next incentive step. Because CEFIA tracks and reviews RSIP costs on a regular basis, changes in cost (such as cost reductions) can be and are considered when determining an appropriate incentive level for the next step. During the planning phase, CEFIA also solicits input from solar PV installers, another source of information about current market conditions and trends.

Once CEFIA proposes and gets approval of the new incentive level(s) from the CEFIA BOD and DEEP, CEFIA announces the new incentive level(s) to installers. CEFIA sends an e-mail to all installers at least two weeks in advance of the effective date of the new incentive level(s) to provide information including a deadline submission date for the current incentive level and the beginning date for the new incentive levels and capacity targets.

Along with seeking input from installers before the new incentive level is finalized, the official notification is also preceded by earlier communications with installers to let them know what the anticipated, new incentive level(s) will be, so that installers are not surprised when the official announcement is released. Additionally, installers and other stakeholders can stay informed about developments around incentive levels by monitoring the Market Watch reports on the EnergizeCT

[22] See http://www.rggi.org for more information about RGGI.
[23] http://www.cga.ct.gov/2012/sup/chap446c.htm#Sec22a-200c.htm
[24] http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/22a-174-31.pdf

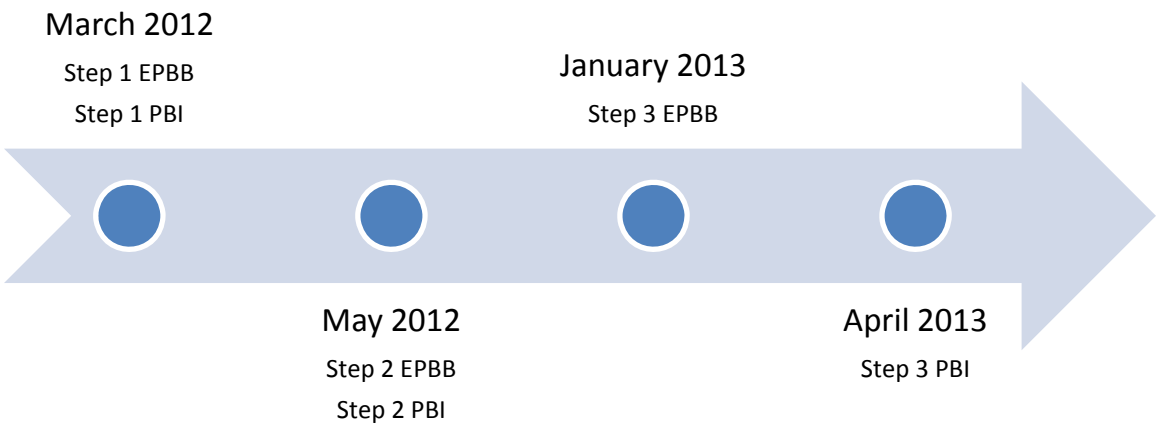
website and the CEFIA Board of Director meeting minutes on the CEFIA website.[25] Because the PBI is dispersed over six years, funds will be allotted for the five years after all steps have been completely subscribed.

Timeline of Historical RSIP Incentive Changes

The RSIP went into effect on March 2, 2012 for both the EPBB and PBI, and CEFIA dispersed Step 1 funding for each from March 2, 2012 to May 18, 2012 before moving to Step 2.

On January 4, 2013, the EPBB shifted to Step 3, where it remained as of June 30, 2013 for all participants with the exception of those projects participating in the Solarize Phase I Program, who received Step 2 incentive levels for Solarize projects with contracts signed by January 14, 2013. The PBI progressed to Step 3 on April 1, 2013 and remained at that level as of June 30, 2013. The timeline of these incentive changes is shown in Figure 1.

Figure 1. Timeline of RSIP Incentive Changes



[25] The EnergizeCT website came online in January 2013 to consolidate information about Connecticut energy programs and resources in one place. As of January 2013, information on the RSIP, including the Market Watch Report, was available on both the CEFIA website and the EnergizeCT website. As of December 2013, most RSIP information on the CEFIA website has been removed; the CEFIA website now points to the EnergizeCT website for all RSIP information excepting a contractor portal on the CEFIA website. However, CEFIA-specific information, such as all CEFIA Board materials, still resides on the CEFIA website.

3.2.8 Transparency

Transparency and reporting is specifically identified as a priority in the RSIP Program Plan. CEFIA achieves this transparency in several ways: regular website updates on the market status, providing installer trainings on how to use the RSIP and associated tools and resources, notifying stakeholders of any program changes as soon as possible, and making resources and information about RSIP available to stakeholders through several avenues.

Information Available on the CEFIA Website

The CEFIA website (http://www.ctcleanenergy.com) directs visitors to the www.EnergizeCT.com website to learn more about the RSIP.[26] EnergizeCT provides an overview of the program and its goals, high-level steps for homeowners who are interested in participating, and an overview of incentives for different project configurations (third party-owned versus homeowner-owned system). The program page also describes the basic specifications for sites that are eligible to participate, such as orientation, roof tilt, shading, and more. Lastly, the program page describes several financing options, including CEFIA's CT Solar Lease, CT Solar Loan, and the Smart-E Loan. Links are provided for each financing product/program.

The "Incentives" page of the EnergizeCT website includes a spreadsheet of all the residential PV projects participating in the program which, according to the website, is updated monthly. This information is publicly available, easy to locate, and easily digestible for the various stakeholders using this data to inform decision making.

The EnergizeCT website also provides a weekly RSIP Market Watch Report, which gives an overview of residential PV installations over varying timeframes and progress towards regulatory and organizational goals, such as total installed residential capacity. The Market Watch Report also includes tables of aggregate data about the total number of incentive applications received, costs of incentives, and various cost and production averages. One table includes these metrics for the current incentive step, and another table shows the combined historical program data. Lastly, the Report provides estimates of the program's impact on the environment, job creation, and workforce development.

The EnergizeCT website provides information that is accessible to homeowners who are new to the subject matter and are interested in installing a solar PV system. The RSIP webpages outline high-level steps for the process, which include first having an energy-efficiency audit performed, then selecting an Eligible Contractor, and finally having the PV system installed. The site notes that the RSIP incentives pass through the installer. The RSIP webpages provide a link to the list of Eligible Contractors, with the

[26] The EnergizeCT website came online in January 2013 to consolidate information about Connecticut energy programs and resources in one place. As of January 2013, information on the RSIP, including the Market Watch Report, was available on both the CEFIA website as well as on the EnergizeCT website. As of December 2013, most RSIP information on the CEFIA website has been removed; the CEFIA website now points to the EnergizeCT website for all RSIP information excepting a contractor portal on the CEFIA website. However, CEFIA-specific information, such as all CEFIA Board materials, still resides on the CEFIA website.

contact information and utility area served for each installer. Homeowners could use this information to find a local installer or perform background research on potential installers, or they could use a spreadsheet of residential solar PV installations in Connecticut (provided on the website along with the Market Watch Report) to determine which installers are the most experienced in the state, or which has the lowest installation costs.

The CEFIA website houses a contractor portal, where RSIP forms and information are available through a login interface. Additionally, this page gives contractors a brief overview of the EPBB and PBI, the application to become an Eligible Contractor, and links to available financing options, including CEFIA's CT Solar Loan, Smart-E Loan, CT Solar Lease.

The EnergizeCT website provides numerous resources for installers to learn about the RSIP and how it functions. The spreadsheet of individual installations shows which areas in the state are developing most quickly, as well as which installers are installing projects and at what cost.

Data Available for Stakeholder Decision Making

The publicly available spreadsheet includes individual project-level information, detailing whether the project received the EPBB or PBI, the date the incentive was applied for, and the date the project was completed, in addition to listing the interconnecting utility, facility location, installer, system financing, system size, system costs, installation cost per watt, estimated annual production, and total amount of incentive approved. As of a given week, a stakeholder could view and analyze data on all the installed capacity under the EPBB and PBI, find the highest volume installers in their area, and estimate the cost of installing a PV system based on the cost of other PV systems in the area.

Clarity of Incentive Level Information

The EnergizeCT website provides basic information about the EPBB and PBI incentives. The website is missing information regarding the full calculation of incentives for the EPBB and PBI, previous incentive levels (it only shows the current incentive levels), and how incentive levels are determined. The RSIP incentives page and installer training materials outline a simplified version of the EPBB incentive calculation, which omits inverter efficiency factors. It is unclear whether installers and homeowners know exactly what their rebate would be until after their PV system information is entered in PowerClerk. Information on recommended and approved incentive levels for each step is documented in the meeting minutes of CEFIA's Board of Directors and posted on the CEFIA website, though there is not a summary of historical incentive levels available online at this time.

3.2.9 Stakeholder Communication

This section summarizes CEFIA's communication strategy for several relevant stakeholder groups.

Connecticut Residents

While CEFIA provides ample program resources to all stakeholders through the various avenues discussed above, it mostly relies upon the more customer facing installer community to deliver the program to consumers. CEFIA primarily communicates news or announcements about the program to its

group of registered Eligible Contractors via e-mail, then relies on those parties to inform interested residential customers of program changes or updates. CEFIA does promote other stories about solar PV through earned media stories, to generate interest in the technology.

Installers

CEFIA has communicated clearly and regularly with installers, contractors, and third-party system owners starting prior to the launch of RSIP. From January 2012 through June 2013, CEFIA sent 36 e-mail blasts to its registered Eligible Contractors, providing updates on incentive levels and dates that incentive changes can be expected, changes in the requirements for Eligible Contractors, how to request incentive payments, how to use PowerClerk, and more. The correspondence is clear and thorough, and in addition to a wealth of resources CEFIA distributes through email, they also encourage contractors to reach out to CEFIA staff with questions about the RSIP. As mentioned previously, in addition to receiving updates via e-mail, installers can monitor the Market Watch Reports and Board of Directors meeting minutes from the CEFIA website to track when these changes in incentive levels may be happening.

Each new Eligible Contractor participates in a one-hour training that familiarizes them with the RSIP. The training covers the two incentive structures, and walks through PowerClerk and the necessary application paperwork, as well as the various financial tools available to Eligible Contractors, such as the CT Solar Lease, CT Solar Loan, and Smart-E Loan programs.

List of Program Collateral

CEFIA has provided the following program collateral:

- Sent 36 e-mail blasts pertaining to RSIP to installers from January 2012 through June 2013
- Provided one-hour trainings for all new Eligible Contractors
- Held periodic check-ins and updates for Eligible Contractors
- Provided weekly Market Watch Report
- Provided CEFIA Board of Directors meeting minutes and meeting materials
- Provided periodic press releases

3.2.10 Workforce Development

CEFIA has supported solar education and workforce development programs that promote a high quality, Connecticut-based solar PV workforce,[27] though separate organizations have taken on primary responsibility for clean energy workforce development in the state since 2011. CEFIA continues to

[27] PA 11-80, Section 106(g): The Clean Energy Finance and Investment Authority shall identify barriers to the development of a permanent Connecticut-based solar workforce and shall make provision for comprehensive training, accreditation and certification programs through institutions and individuals accredited and certified to national standards.

conduct training for RSIP contractors as described in Section 3.2.9 Stakeholder Communication, and this section describes the progress of other workforce development initiatives which CEFIA still supports.

CCEF formerly played an active role in the state's workforce development programs. Since 2011, the majority of Connecticut's clean energy workforce development initiatives have been consolidated under other organizations, as CEFIA focuses on its unique strategic mission to deploy financing and make clean energy more accessible and affordable to consumers. Primary implementation of energy workforce development programs in Connecticut is under the banner of GetIntoEnergyCT.com, the website of the Connecticut Energy Workforce Development Consortium (CTEWDC), a public-private partnership of representatives from energy-related businesses, government, and academia. The CTEWDC is chaired by the major electric distribution utilities in Connecticut (Northeast Utilities and United Illuminating) in collaboration with the Connecticut Business and Industry Association (CBIA). CEFIA is a member of the Consortium, along with over 50 other state partners, associations, employers, and educational institutions.

Additionally, CEFIA carried forward two former workforce development initiatives of CCEF:

- Providing funding and strategy support to community colleges and other workforce development organizations across the state in support of furthering solar education. This initiative was begun by CCEF and completed by CEFIA in early 2013.
    - CEFIA has provided approximately $600,000 in funding, through a competitive solicitation, to 4 of the 12 community colleges in Connecticut, as well as to The WorkPlace, the University of New Haven, and the local chapters of the National Electrical Contractors Association (NECA) and International Brotherhood of Electrical Workers (IBEW).
    - These entities have used CEFIA's funding to train staff and to develop continuing education coursework and tracks, for marketing efforts to attract students, and to purchase teaching supplies. The primary focus of the grants is for equipment needs for solar thermal and solar photovoltaic training courses. Secondary funding opportunities included instructor training, curriculum development, and institution accreditation.
- Jointly supporting, with the Connecticut Energy Efficiency Fund, the establishment of E-Houses at the remaining 12 technical high schools statewide; CCEF had previously committed to supporting construction of E-Houses at 6 technical high schools in Connecticut.
    - E-Houses are 16 foot by 20 foot "laboratories", assembled by construction trade students, that incorporate solar PV, solar thermal, weatherization, and energy efficiency technologies and are used as training sites for the students and subsequent classes. At the end of the E-House implementation project, approximately one-third of all technical high school students will have worked on the E-Houses.
    - The E-House implementation plan includes training and professional development for instructors.

- CEFIA's total program budget for the 12 E-Houses is $395,000. Each technical high school receives between $18,500 and $40,000 to implement the E-House at their facility. The agreement between the schools and CEFIA runs through 2015; however, the day to day management of the implementation of the E-House projects is conducted by United Illuminating (UI) on behalf of the Energy Efficiency Fund, through an agreement between CEFIA and UI.
- As of June 30, 2013, one of the E-Houses had been completed under CEFIA's commitment; bringing the total in Connecticut to four (three had been completed under CCEF's commitment).

4.0 RSIP Achievements

4.1 Installed Capacity Goal

CEFIA uses PowerClerk as the primary repository for program data. Cadmus accessed PowerClerk for a variety of the data used in this report, including for calculating the installed capacity from both EPBB and PBI funded projects. In addition, CEFIA provided accounting data on incentives paid during the study period. Table 5 summarizes the total nameplate capacity supported by the RSIP during the study period. This total includes completed projects, projects approved for incentives by CEFIA, and projects in progress. The incentive amounts shown in Table 5 reflect actual incentive payments made by CEFIA during the study period. This includes full incentive payments for completed projects, as well as milestone payments, either 60% or 70% of the incentive total,[28] made for projects that have delivered equipment to the site (though installation, interconnection, or other tasks may still be in process). The incentives paid also do not reflect future PBI payments, which will be made over time. As a result, Table 5 reflects payments made during the study period but not necessarily the full cost of incentives provided to the 1,419 projects, totaling 10MW, completed or approved within the study period.

Table 5. Summary of Total RSIP Installed Capacity and Incentive Payments

	Number of Projects	Nameplate Capacity (kW)	Incentive Paid
EPBB	999	7,047	$8,345,696
PBI	420	2,938	$96,628
Total	**1,419**	**9,985**	**$8,442,324**

The total installed nameplate capacity approved or completed as of June 30, 2013 is 9,985 kW. This puts CEFIA at nearly one-third of the goal of 30MW by the end of 2022, in the first 16 months of the program. If this trend continues, CEFIA should meet or exceed this goal well in advance of the statutory target date. In addition to being on target to meet or exceed this installed capacity goal, RSIP projects included in this study period are expected to generate approximately 11,000 MWh annually, enough to meet the electricity needs of approximately 1,300 typical Connecticut homes.[29]

4.2 Customer Payback

Using data from PowerClerk and the Market Watch reports, Cadmus compiled typical system characteristics for each incentive step for both EPBB and PBI. We used these typical system

[28] In Steps 1 and 2, a 60% milestone payment was provided upon equipment delivery. This was changed to 70% beginning in Step 3.

[29] U.S. DOE Energy Information Administration (EIA) estimates monthly average electricity consumption for Connecticut households to be 730 kWh. http://www.eia.gov/electricity/sales_revenue_price/xls/table5_a.xls

characteristics, combined with the relevant assumptions listed in the tables below, to calculate a variety of customer-focused financial metrics, including:

- ***Simple Payback:*** number of years of operation for the owner to recover the undiscounted, invested capital (i.e., break-even point). Simple payback is only calculated for EPBB projects, since upfront capital expenditures by the customer are not required for PBI projects.
- ***Internal Rate of Return (IRR):*** a discount rate that, when applied to a project, yields a net present value of zero. It is meant to show the expected growth rate of a particular investment. The IRR also shows what the equivalent interest rate would be, if the customer decided to spend the same amount of money as they spent on the PV system in another way (e.g., savings bond, mutual fund). An IRR higher than the interest rate on another investment shows that the PV system generates more income than the alternative investment for the customer.
- ***Net Present Value (NPV):*** the difference between the present value of cash inflows and cash outflows. The present value is the discounting of future cash: a dollar today is worth more than a dollar tomorrow. A positive NPV indicates that the income (e.g., avoided energy costs) exceeds the costs (e.g., maintenance) over the life of the system.
- ***Levelized Cost of Energy (LCOE):*** the sum of the present value of future cash outflows and the initial investment, divided by the kWh produced over the life of a project. This analysis allows for comparison of renewable energy projects (with no fuel costs) to traditional electricity generation. Projects with a LCOE lower than the rate the customer would otherwise pay will generate a positive value to the customer.

Table 6 summarizes the typical system characteristics and key assumptions used in the analysis of EPBB funded projects.

Table 6. Typical System Characteristics and Key Assumptions for EPBB Projects

	EPBB			
	Step 1	Step 2	Step 3	Escalation
Nameplate Rating (kW)	6.54	7.17	7.13	
CEC PTC Rating (kW)	5.91	6.47	6.50	
CSI Rating (kW)	5.23	5.52	5.56	
Design Factor	91.9%	88.8%	89.6%	
Modified Design Factor[30]	N/A	N/A	93.9%	
Nameplate Installed Cost ($/W)	$5.30	$4.38	$4.48	
Cost/ Watt-PTC Pre-Incentive ($/W)	$5.94	$4.81	$4.85	
Cost/Watt-PTC Post-Incentive ($/W)	$3.59	$2.69	$3.32	
Average Incentive ($/W-PTC)	$2.35	$2.12	$1.53	
Estimated Production (kWh/yr)	7,952	8,389	8,449	
Estimated Production (kWh/kW)	1,216	1,170	1,186	
Degradation (%/yr)	0.50%	0.50%	0.50%	
Federal ITC (% project cost)	30%	30%	30%	
Useful Life of System (years)	25	25	25	
RSIP Avoided Cost to Customer ($/kWh)	$0.152	$0.157	$0.151	2.99%
O&M Costs per kW per Year	$20	$20	$20	2.99%

Each project has an expected annual energy generation (production) that accounts for the specific equipment, azimuth, tilt and orientation. Cadmus based the energy generation indicated for each incentive step in Table 6 above on an average of these project-level energy generation estimates.

An important distinction between EPBB projects and PBI projects is their tax treatment. EPBB projects receive an upfront incentive payment, which decreases the Federal Investment Tax Credit (ITC) for these projects. While a typical Step 3 EPBB project has an ITC basis of $3.32/W ($4.85/W cost minus a $1.53/W incentive), a Step 2 PBI project has an ITC basis of $5.26/W, or a $0.58/W higher potential ITC.

For the PBI, there are two primary models:

- **Power Purchase Agreement:** In the case of a power purchase agreement (PPA), the customer signs a contract with a third party system installer/owner to purchase power over a long period of time (10 or 20 years, for example) at a fixed rate and escalation. In these cases, the customer may have a starting rate 5%-20% less than their current utility rate but the price will rise over time. So long as the rising PPA price remains below the prevailing utility rate, the customer will continue to save money.
- **Lease:** Though the lease is similar to a PPA, it is generally a fixed payment schedule that does not generally include an escalation. There are many variants on the leasing model but, for purposes of this report, we have modeled the lease payments as a fixed, non-escalating,

[30] In EPBB Step 3, CEFIA began treating design factors >87% as 100% for purposes of calculating incentives. This has the effect of increasing the overall average design factor.

payment on an energy generation (kWh) basis. Without escalation, the lease rate is generally higher than the starting PPA rate but still equal to, or lower than, the customer's prevailing utility rate.

A summary of the key assumptions used for PBI projects is included in Table 7.

Table 7. Typical System Characteristics and Key Assumptions for PBI Projects

	PBI-PPA			PBI-Lease		
	Steps 1 and 2	Step 3	Escalation	Steps 1 and 2	Step 3	Escalation
Nameplate Rating (kW)	7.14	6.58		7.14	6.58	
CEC PTC Rating (kW)	6.49	5.96		6.49	5.96	
CSI Rating (kW)	4.87	4.66		4.87	4.66	
Design Factor	79.2%	82.2%		79.2%	82.2%	
Modified Design Factor[31]	N/A	85.2%		N/A	85.2%	
Nameplate Installed Cost ($/W)	$4.83	$5.04		$4.83	$5.04	
Cost/Watt-PTC Pre-Incentive ($/W)	$5.26	$5.53		$5.26	$5.53	
Average Incentive ($/W-PTC)[32]	$1.83	$1.41		$1.83	$1.41	
Cost/ Watt-PTC Post-Incentive ($/W)	$3.43	$4.12		$3.43	$4.12	
Estimated Production (kWh/yr)	7,393	8,449		7,393	8,449	
Estimated Production (kWh/kW)	1,036	1,284		1,036	1,284	
Degradation (%/yr)	0.50%	0.50%		0.50%	0.50%	
Federal ITC (% project cost)	30%	30%		30%	30%	
Useful Life of System (years)	25	25		25	25	
Month Operational	5	4		5	4	
PPA/Lease Rate ($/kWh)	$0.146	$0.141	2.99%	$0.181	$0.174	0.00%
RSIP Avoided Cost to Customer ($/kWh)	$0.152	$0.154	2.99%	$0.152	$0.154	2.99%
O&M Costs per kW per Year	$20	$20	2.00%	$20	$20	2.00%

A complete list of assumptions is included in Appendix A.

[31] In PBI Step 3, CEFIA began treating design factors >87% as 100% for purposes of calculating incentives. This has the effect of increasing the overall average design factor.

[32] Incentive values expressed as $/W-PTC are for reference only for PBI. As noted above, PBI incentives are not paid on a PTC capacity basis.

As shown in Table 6 and Table 7, there are key differences in calculating the financial costs and benefits of the EPBB and PBI portions of the RSIP. PBI projects, for example, do not generally have an upfront payment from the customer, so we did not calculate simple payback; it is effectively immediate, assuming no initial payment is required and as long as the PPA or lease rate is less than the customer's utility rate (and assuming any extra utility fees have been integrated into the utility rate). Table 8 presents the LCOE for EPBB and PBI participants, along with other key economic metrics such as simple payback (EPBB only), IRR, and NPV. Where applicable, we have shown a range of discount rates from 2% to 8% and the impact these discount rates have on economic indicators.

Table 8. RSIP Customer Financial Results

Metric	Discount Rate	EPBB			PBI-PPA		PBI-Lease	
		Step 1	Step 2	Step 3	Steps 1&2	Step 3	Steps 1&2	Step 3
Simple Payback (year)		12	11	12	N/A	N/A	N/A	N/A
IRR and NPV								
IRR		9.1%	10.8%	8.9%	N/A	N/A	N/A	N/A
NPV @	2%	$14,628	$17,460	$15,535	$2,185	$1,796	$5,339	$5,540
NPV @	4%	$8,565	$10,988	$9,015	$1,707	$1,403	$3,617	$3,671
NPV @	6%	$4,303	$6,428	$4,433	$1,364	$1,122	$2,461	$2,425
NPV @	8%	$1,259	$3,163	$1,162	$1,115	$917	$1,675	$1,583
LCOE								
Total kWh produced		187,325	197,607	200,041	174,156	199,017	174,156	199,017
LCOE ($/kWh) @	2%	$0.10	$0.09	$0.10	$0.20	$0.21	$0.17	$0.18
LCOE ($/kWh) @	4%	$0.10	$0.09	$0.10	$0.20	$0.20	$0.17	$0.17
LCOE ($/kWh) @	6%	$0.10	$0.09	$0.10	$0.19	$0.20	$0.16	$0.17
LCOE ($/kWh) @	8%	$0.10	$0.09	$0.10	$0.19	$0.20	$0.16	$0.17

An interesting trend shown in Table 8 is in the relative economic benefit of customer and third party ownership models. In most cases, customers who have the ability to purchase their own PV systems, especially on a cash basis, have a better long-term economic outcome than customers who participate in the RSIP through a power purchase agreement or lease arrangement. Though the economics are generally favorable in the scenarios shown, customers participating in EPBB with lower discount rates tend to have the best economic returns (i.e., highest net present value). For example, 4% is a common discount rate applied to consumer investing decisions. A customer purchasing a typical (i.e., 7kW) PV system and receiving a Step 3 EPBB incentive would have a LCOE of $0.10/kWh, well below the competing utility rates, while a customer entering a PPA with the Step 3 PBI incentive would have a LCOE of $0.20/kWh. While both cases present a positive outcome, the direct ownership model provides better returns to the customer.

4.3 Use of System Benefit Charge Funds

According to CEFIA's accounting records, from March 2012 through June 2013, CEFIA collected $36,064,171 in system benefit charges (SBCs). During the same period, CEFIA paid $8,442,324 in incentives for completed and approved projects. Of this $8.4 million, $4.7 million of RSIP incentives were provided from SBC funds. Based on this, CEFIA used 13% of the SBC income to fund RSIP incentives during the study period covered by this evaluation, meeting its goal to spend less than one-third of the SBC income on RSIP incentives. As noted in section 1.1, the other $3.7 million of RSIP incentives were provided from RGGI funds.[33]

[33] CEFIA received $5,999,374 in RGGI allowance proceeds from March 14, 2012 through June 30, 2013. As of May 3, 2013, CEFIA obtained permission from DEEP to allocate $3,734,253 of RGGI allowance proceeds to incentives for residential solar PV projects provided through RSIP. If RGGI funds had not been available, as described below, and all of the incentives had been funded by the SBC, the $8.4 million would have represented 23% of the SBC funds.

Appendix A: Key Assumptions for Financial Analysis

Nameplate system size	Typical system STC or nameplate size installed since beginning of program through June 2013. System sizes determined by calculating the average nameplate sizes of projects for each incentive level (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, PBI Step 3). This information was drawn from PowerClerk.
PTC[34] system size	Typical system PTC size installed since beginning of program through June 2013. System sizes determined in two steps: 1) dividing the PowerClerk-generated PTC system size by the inverter efficiency for each project, then 2) calculating the average PTC size of projects for each incentive (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, PBI Step 3). This PTC and inverter efficiency information was drawn from PowerClerk.
Design Factor	Typical system design factor since beginning of program through June 2013, drawn from PowerClerk. Design factor determined by calculating the average design factor of projects for incentive levels (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, and PBI Step 3). The design factor was applied to these incentive levels.[35]

[34] PTC is an alternative PV module rating scheme that differs from Standard Test Conditions (STC) used for module "nameplate" values. The PTC rating, which is generally lower than the STC rating, is recognized to be a more realistic measure of PV output because the test conditions better reflect real-world conditions. The PTC rating is used by programs in California, Connecticut, and elsewhere as the basis of incentive calculations. PTC refers to PVUSA Test Conditions, which were developed to test and compare PV systems as part of the PVUSA or Photovoltaics for Utility Systems Applications (formerly Photovoltaics for Utility Scale Applications) project. PTC are defined as 1,000 Watts per square meter solar irradiance, 20 degrees Celsius *air* temperature, and wind speed of 1 meter per second at 10 meters above ground level. STC are based on 25 degrees Celsius *cell* temperature. The PTC rating differs in that its test conditions of ambient temperature and wind speed will result in a PV cell temperature of about 50 degrees Celsius, instead of the 25 degrees Celsius assumed for STC. Consequently, for crystalline silicon PV systems with a power degradation due to temperature of -0.5% per degree Celsius, the PV module PTC power rating is generally about 88% of the PV module STC or nameplate rating.

[35] Per 12/17/2013 conversation with Dale Hedman.

Modified Design Factor	Typical system modified design factor since beginning of program through June 2013. The modified design factor is determined in two steps: 1) each project with a design factor greater than 87% was rounded up to 100%-- all other projects remained at their starting design factor, and 2) by calculating the average modified design factor of projects. Note that this modified number, not the design factor, is used in the calculation for Step 3 EPBB and Step 3 PBI. The design factor information was drawn from PowerClerk, and the method for calculating the modified design factor was provided in communications from CEFIA.
Nameplate Installed Cost/W-STC	Typical cost to install a PV system since beginning of program through June 2013. Divided total nameplate project cost by Watts (STC) installed for each project, and then calculated average cost to install for each incentive level (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, and PBI Step 3). Total project cost and Watts installed are from PowerClerk.
Cost/Watt-PTC Pre-Incentive	Typical system cost to install (on a PTC basis) since beginning of program through June 2013. Divided total nameplate project cost by corrected PTC Watts installed for each project, and then calculated average cost to install for each incentive level (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, PBI Step 3).Total project costs are from PowerClerk, corrected PTC Watts calculated based on inverter efficiency information from PowerClerk.
Estimated Production (actual)	Typical system production. Individual production per project used as basis to calculate average per kW since beginning of program through June 2013. Calculated individually for each incentive level (EPBB Step 1, EPBB Step 2, EPBB Step 3, PBI Step 1, PBI Step 2, and PBI Step 3). This information was drawn from PowerClerk.
Degradation	0.50% per year. Number agreed to with CEFIA, based on CEFIA and Cadmus experience.
ITC	Homeowner (for EPBB incentives) and system owner (for PBI incentives) have the ability to fully monetize ITC in the first year of operation.
Depreciation	100% at 5 year Modified Accelerated Cost Recovery System (MACRS). Homeowner has no ability to use depreciation. System owner can fully use depreciation in year accrued.
EPBB Tax Impact	EPBB incentive decreases the ITC eligible basis of a project.

PBI Tax Impact	PBI incentive decreases the ITC and depreciation eligible basis of a project.
EPBB Limitation	For Step 3 only, the maximum incentive is 35% of the PTC cost of a project. Per 12/17/2013 conversation with Dale Hedman.
Loan	It is assumed that the system owner pays for the photovoltaic system outright, without using a loan
Avoided Cost of Electricity	Values obtained from the U.S. Department of Energy (DOE) Energy Information Administration (EIA) for residential electricity rates in Connecticut, using data from the months closest to the start of each RSIP Step. As the Connecticut utilities charge a fixed customer fee of approximately $16 per month, the EIA rates have been reduced by $0.02/kWh to account for the fact that this customer charge is billed regardless of net electricity consumption, so generation from the PV system does not offset the full residential rate.
Net metering	System output is less than on-site consumption on an annual basis
O&M	$20 per kW per year, consistent with NREL analysis (NREL link), escalating at 2%
PBI Incentive, Amount Paid	Total incentive paid to PBI project owners by CEFIA from beginning of program through June 2013. Information provided to Cadmus by CEFIA.
Incentives, PBI	Term of PBI incentive is six years. Step 1 and 2 are $0.30/kWh and Step 3 is $0.0225/kWh. The source for the $0.30/kWh incentive level information is "Rebate Level Changes by Program.xls" provided by CEFIA. The source for the Step 3 $0.0255/kWh incentive level is http://www.energizect.com/residents/programs/residential-solar-investment-program.

Incentives, EPBB	All incentives are divided into two groups: up to 5kW installed and above 5kW up to 10 kW installed. Up to 5kW receives a higher incentive that steps down for the next 5kW, and to zero above 10kW. The incentives for Step 1 are $2.45 up to 5 kW and $1.25 per watt greater than 5 kW, and up to 10 kW. The incentives for Step 2 are $2.275 up to 5 kW and $1.10 per watt greater than 5 kW, and up to 10 kW. The incentives for Step 3 are $1.75 up to 5 kW and $0.55 per watt greater than 5 kW, and up to 10 kW. The source for the incentive levels are "Rebate Level Changes by Program.xls" and an email from Ed Kranich on 12/4/2013.
Maximum Incentive Percent	The maximum incentive for a Step 3 project is 35% of the project cost. Any incentive above this level is not allowed. The source for this is http://www.energizect.com/residents/programs/residential-solar-investment-program.
Discount Rate	Applied discount rates of 2%, 4%, 6%, and 8% to calculations of NPV and LCOE.
Useful Life of System	25 years
Calendar Year and Project Year	For the sake of simplicity, the typical project begins operation on January 1, 2013.
Salvage Value	Equal to system removal value (no economic salvage value)
Accrual	Incentive payments, net metering proceeds, and costs are expensed when accrued
Law	No change in law or market structure