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CONNECTICUT GREEN BANK

Memo

To: Connecticut General Assembly – Energy & Technology Committee

From: Bryan Garcia (President & CEO)

Cc Board of Directors of the Connecticut Green Bank, Brian Farnen (General Counsel and CLO), Matt Macunas (Manager and Legislative Liaison), Dale Hedman (Managing Director of Statutory & Infrastructure Programs), Eric Shrago (Managing Director of Operations), and Selya Price (Associate Director of Infrastructure Programs)

Date: January 11, 2019

Re: Progress report on the Connecticut Green Bank Residential Solar Investment Program

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Overview

This memo provides an update on progress toward the goals of the Connecticut Green Bank (Green Bank) Residential Solar Investment Program (RSIP). This program was first legislatively enabled through Section 106 of Public Act No. 11-80[1] and more recently updated by Public Act No. 15-194[2] and Public Act No. 16-212[3], amending the CT General Statutes at Section 16-245ff[4]. The Green Bank is providing progress updates on the following provisions of Section 16-245ff:

> (4)(b) The Connecticut Green Bank, established pursuant to section 16-245n, shall structure and implement a residential solar investment program established pursuant to this section that shall support the deployment of not more than three hundred megawatts[5] of new residential solar photovoltaic installations located in this state on or before (1) December 31, 2022, or (2) the deployment of three hundred megawatts of residential solar photovoltaic installation, in the aggregate, whichever occurs sooner, provided the bank shall not approve direct financial incentives under this section for more than one hundred megawatts of new qualifying residential solar photovoltaic systems, in the aggregate, between July 2, 2015, and April 1, 2016. The procurement and cost of such program shall be determined by the bank in accordance with this section.

[1] PA 11-80: https://www.cga.ct.gov/2011/ACT/Pa/pdf/2011PA-00080-R00SB-01243-PA.pdf, "An Act Concerning the Establishment of the Department of Energy and Environmental Protection and Planning for Connecticut's Energy Future"
[2] PA 15-194: https://www.cga.ct.gov/2015/act/pa/pdf/2015PA-00194-R00HB-06838-PA.pdf, "An Act Concerning the Encouragement of Local Economic Development and Access to Residential Renewable Energy"
[3] PA 16-212: https://www.cga.ct.gov/2016/act/pa/pdf/2016PA-00212-R00SB-00366-PA.pdf, "An Act Concerning Administration of the Connecticut Green Bank, the Priority of the Benefit Assessments Lien under the Green Bank's Commercial Sustainable Energy Program and the Green Bank's Solar Home Renewable Energy Credit Program,"
[4] https://www.cga.ct.gov/2017/pub/chap_283.htm#sec_16-245ff
[5] All solar PV capacity units in this progress report are provided in direct current (DC). The performance of PV modules and arrays are generally rated according to their maximum DC power output (watts).

(4)(d)(3) provide incentives that decline over time and will foster the sustained, orderly development of a state-based solar industry;[6]

(4)(j) On or before January 1, 2017, and every two years thereafter for the duration of the program, the Connecticut Green Bank 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 (b) of this section.

In addition to reporting on CT General Statute Section 16-245ff (4)(b), the Green Bank is providing updates on RSIP progress in deploying residential solar PV in low-to-moderate income households. We also provide considerations in the transition of the residential solar PV market to a post-RSIP market where there is a public policy requirement to ensure that local state-based residential solar PV contractors are a viable and thriving economic development industry.[7]

RSIP Progress toward 300 MW

As of December 31, 2018, 31,222 projects totaling 244.6 MW (DC) of residential solar PV have been approved through the RSIP, or 81.5% of the 300 MW (DC) public policy goal under Section 16-245ff.

As the Green Bank supports the market in meeting the installed capacity goal of the public policy through declining incentives offered through the RSIP, it now turns its focus to achieving the public policy objective of fostering the sustained, orderly development of a state-based solar industry as the compensation structure for residential ratepayers shifts from net metering to a tariff that assures a reasonable rate of return for participating residential ratepayers.

RSIP Progress

As previously reported in 2017, between July 2, 2015 and April 1, 2016, 5632 projects or 43.8 megawatts[8] (MW) were approved. This was less than the time-based 100 MW deployment cap required by PA 15-194.

[6] Section 16-245ff (4)(d): The Connecticut Green Bank shall develop and publish on its Internet web site a proposed schedule for the offering of performance-based incentives or expected performance-based buydowns over the duration of any such solar incentive program. Any such direct financial incentives shall only apply to the first twenty kilowatts of direct current of the qualifying residential solar photovoltaic system. Such schedule shall: (1) Provide for a series of solar capacity blocks the combined total of which shall be a maximum of three hundred megawatts and projected incentive levels for each such block; (2) provide incentives that are sufficient to meet reasonable payback expectations of the residential consumer and provide such consumer with a competitive electricity price, taking into consideration the estimated cost of residential solar installations, the value of the energy offset by the system, the cost of financing the system, and the availability and estimated value of other incentives, including, but not limited to, federal and state tax incentives and revenues from the sale of solar home renewable energy credits; **(3) provide incentives that decline over time and will foster the sustained, orderly development of a state-based solar industry;** (4) automatically adjust to the next block once the board has issued reservations for financial incentives provided pursuant to this section from the board fully committing the target solar capacity and available incentives in that block; and (5) provide comparable economic incentives for the purchase or lease of qualifying residential solar photovoltaic systems or power purchase agreements from such systems. The Connecticut Green Bank may retain the services of a third-party entity with expertise in the area of solar energy program design to assist in the development of the incentive schedule or schedules. The Department of Energy and Environmental Protection shall review and approve such schedule. Nothing in this subsection shall restrict the Connecticut Green Bank from modifying the approved incentive schedule to account for changes in federal or state law or regulation or developments in the solar market when such changes would affect the expected return on investment for a typical residential solar photovoltaic system by ten per cent or more. Any such modification shall be subject to review and approval by the department.

[7] Based on provision (4)(d), in particular (4)(d)(3) of Section 16-245ff, pertaining to fostering the sustained, orderly development of a state-based solar industry.

[8] All solar PV capacity units in this progress report are provided in direct current (DC). The performance of PV modules and arrays are generally rated according to their maximum DC power output (watts).

As of December 31, 2018, a total of 31,222 or 244.6 MW of RSIP projects had been approved for incentives, representing 81.5% of the legislative target of 300 MW. Of the total, 26% are homeowner owned projects, incentivized with Expected Performance Based Buydowns (EPBBs) (i.e., one-time, upfront rebates), and 74% are third party owned projects (i.e., leases and power purchase agreements), incentivized with Performance Based Incentives (PBIs) (i.e., incentives provided on a per kWh basis, quarterly over six years for electricity produced through leases and power purchase agreements). While the EPBB and PBI are administered differently and over different time periods, they are, as required by statute, economically comparable on a net present value basis.

Table 1 below summarizes RSIP benefits since program inception, including projects approved from March 2012 through December 31, 2018. The fleet of almost 245 MW of RSIP projects is anticipated to produce over 278 million kWh of electricity annually or nearly 7 million MWh over the 25-year project lifetimes. Total job-years created are 12,116, of which 4,823 are direct and 7,294 are indirect and induced.[9] Nearly 3.9 million tons of carbon dioxide emissions will be avoided over the project lifetimes. [10]

Table 1. RSIP Benefits for Projects Approved CY 2012-2018

CY	# Projects	Capacity Approved (kW STC)	Expected Annual Generation (kWh)	Expected Lifetime Generation (MWh)	Direct Jobs Created	Indirect and Induced Jobs Created	Total Jobs Created	Lifetime Tons CO2 Avoided
2012	791	5,524	6,291,288	157,282	157	252	409	89,074
2013	1,464	10,405	11,849,056	296,226	272	438	710	166,563
2014	4,496	33,373	38,005,179	950,129	857	1,381	2,238	540,139
2015	7,039	54,137	61,651,028	1,541,276	1,383	2,227	3,610	880,316
2016	5,660	44,942	51,179,919	1,279,498	855	1,297	2,152	711,902
2017	4,528	35,996	40,991,781	1,024,795	489	639	1,128	552,337
2018	7,244	60,195	68,550,336	1,713,758	810	1,059	1,870	923,316
TOTAL	**31,222**	**244,572**	**278,518,587**	**6,962,965**	**4,823**	**7,294**	**12,116**	**3,863,647**

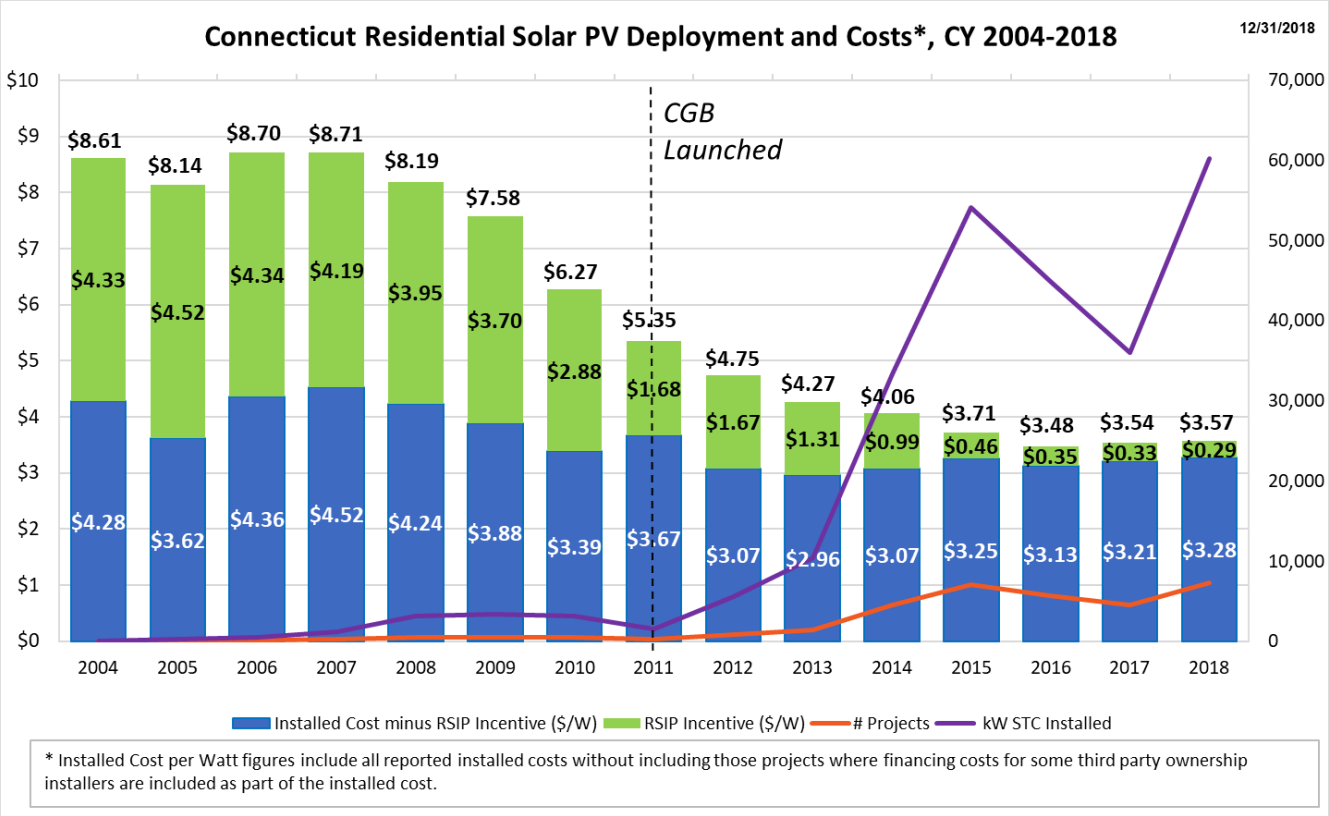
In addition to the above benefits of over 278 million kWh of solar energy expected to be produced annually by nearly 245 MW of solar PV projects approved through RSIP, this solar PV capacity can help meet peak load demand. Though solar PV does not coincide exactly with the system peak, solar PV provides significant load reduction during the hours the sun is shining and provides savings during the system peak. For examples, behind-the-meter distributed solar PV reduced New

[9] Jobs methodology was developed by Navigant Consulting for the Connecticut Green Bank in consultation with the Department of Economic and Community Development – https://www.ctgreenbank.com/wp-content/uploads/2018/03/CGB_DECD_Jobs-Study_Fact-Sheet.pdf. It should be noted that a tax revenue methodology was also developed by Navigant Consulting for the Connecticut Green Bank in consultation with the Department of Revenue Services – https://www.ctgreenbank.com/wp-content/uploads/2018/09/CGB-Eval-Tax-Methodology-7-24-18.pdf

[10] Air emissions methodology developed by the Connecticut Green Bank in consultation with the US Environmental Protection Agency and the Department of Energy and Environmental Protection – https://www.ctgreenbank.com/wp-content/uploads/2018/01/CGB-Eval-IMPACT-091917-Bv2.pdf. It should be noted that a public health methodology was also developed by the Connecticut Green Bank in consultation with US Environmental Protection Agency, Department of Public Health, and Department of Energy and Environmental Protection – https://www.ctgreenbank.com/wp-content/uploads/2018/03/CGB-Eval-PUBLICHEALTH-1-25-18-new.pdf. These numbers are also referenced in the Green Bank Comprehensive Annual Financial Report for fiscal year ended June 30, 2018, available at: https://www.ctgreenbank.com/wp-content/uploads/2018/10/Green-Bank-CAFR_2018.pdf, table 147, report p. 233.

England wholesale power costs during a heat wave from July 1 to July 7, 2018[11], and ISO New England reported that the Thanksgiving midday peak "typically seen from ovens and family gatherings was curtailed this year because of the installation of rooftop solar in Connecticut and New England states."[12]

The following chart provides historical perspective on Connecticut's residential solar PV market from 2004 through 2018, based on projects incentivized through RSIP from 2012-2018 and before that through the Connecticut Clean Energy Fund (CCEF), the Green Bank's predecessor organization. The average RSIP incentive has been dramatically reduced as shown by the upper/green portion of the bars in the chart, while the average installed cost minus the RSIP incentive shown in the lower/blue portion of the bars have stayed roughly stable. Comparing 2004 to 2018, the average installed cost decreased 58% from $8.61/W to $3.57/W and the average RSIP incentive decreased 93% from $4.33/W to $0.29/W, while deployment increased over 470,000% from 12.7 kW in 2004 to 60.2 MW in 2018. Incentives were reduced most steeply with the inception of the Green Bank in 2011, 83% from $1.68/W in 2011 to $0.29/W in 2018 (as compared to 61% from 2004 to 2011). At the same time, installed costs decreased 33% from $5.35/W to $3.57/W and deployment grew over 3700% from 1.6 MW in 2011 to 60.2 MW in 2018.



Note that deployment had declined in 2016 and 2017 due to several factors including a decrease in electricity rates from July through December 2016 and nationwide flattening/slowdown in the residential solar PV market due to structural changes in the third-party ownership landscape, with major companies struggling with profitability and customer acquisition costs, resulting in business

[11] http://isonewswire.com/updates/2018/7/17/heat-wave-recap-reliable-operations-through-holiday-heat-hum.html, https://pv-magazine-usa.com/2018/07/25/heavy-lifting-by-behind-the-meter-solar-power-in-new-england-heatwave/, https://www.solarreviews.com/news/rooftop-solar-saves-new-englanders-30m-1-week-083118/

[12] https://www.theday.com/local-news/20181224/greenhouse-gas-emissions-continue-to-decline-in-new-england

model changes, market exits, and bankruptcies. In Connecticut, SolarCity reduced annual deployment significantly starting in 2016 when they stopped offering power purchase agreements and focused exclusively on selling homeowner-owned projects, NRG withdrew from doing residential solar PV projects in the state, and several companies went into bankruptcy including Sungevity, One Roof, and Sun Edison. The Connecticut market rebounded strongly by 2018 with several large, national companies (i.e., Sunnova, Sunrun, Vivint, PosiGen, and SunPower) filling the gap left by those who exited the market, along with strong participation by regional and local companies including Trinity Solar, Ross Solar (a ConEdison Solutions Company), Sunlight Solar, RGS Energy, C-TEC Solar, Aegis Solar Energy, Earthlight Technologies, EcoSmart Home Services, and other companies.

At the current pace of submissions and approvals, the Green Bank estimates that RSIP will reach 300 MW sometime in Q4 2019 depending on end-of-program volume.

Table 2 provides RSIP cost and incentive data by calendar year and incentive type, for projects with cost data in PowerClerk[13]. The incentive for an RSIP project has decreased from an average of 35% of project cost in 2012 to an average of 8% in 2018 (10% for an EPBB project and 7% for a PBI). Associated with the incentive reduction, Table 2 shows that the ratio of the installed cost minus RSIP incentive to the RSIP incentive increased from a ratio of nearly 2-1 in 2012 to over 11-1 in 2018, reflecting increasingly efficient leveraging of RSIP funds to deploy higher levels of solar PV.

Table 2. RSIP Cost and Incentive Data for Projects Approved CY 2012-2018[14]

CY Approved	Incentive Type	# Projects	Capacity (kW STC)	Average Installed Cost minus RSIP Incentive ($/W)	Average RSIP Incentive ($/W)	Average of Installed Cost ($/W)	Incentive as % of Installed Cost	Installed Cost minus RSIP Incentive/ RSIP Incentive Leverage Ratio
2012 Total		**603**	**4,209**	**$3.07**	**$1.67**	**$4.75**	**35%**	**1.8**
2013 Total		**1,021**	**7,460**	**$2.96**	**$1.31**	**$4.27**	**31%**	**2.3**
2014 Total		**2,936**	**22,402**	**$3.07**	**$0.99**	**$4.06**	**24%**	**3.1**
2015 Total		**4,034**	**31,929**	**$3.25**	**$0.46**	**$3.71**	**12%**	**7.0**
2016	EPBB	1,101	9,549	$3.34	$0.43	$3.77	11%	7.8
	PBI	3,572	27,783	$3.06	$0.32	$3.39	10%	9.4
2016 Total		**4,673**	**37,332**	**$3.13**	**$0.35**	**$3.48**	**10%**	**9.0**
2017	EPBB	1,253	10,833	$3.21	$0.40	$3.61	11%	8.0
	PBI	3,147	24,201	$3.20	$0.30	$3.51	9%	10.5
2017 Total		**4,400**	**35,033**	**$3.21**	**$0.33**	**$3.54**	**9%**	**9.6**
2018	EPBB	1,366	12,320	$3.38	$0.38	$3.76	10%	8.9
	PBI	2,352	18,833	$3.22	$0.24	$3.46	7%	13.2
2018 Total		**3,718**	**31,153**	**$3.28**	**$0.29**	**$3.57**	**8%**	**11.2**
Grand Total		**21,385**	**169,518**	**$3.18**	**$0.53**	**$3.71**	**14%**	**6.0**

Table 2 also provides insight into installed costs which decreased from 2012 to 2016 but which increased slightly in recent years, from 2016 to 2018. In 2018 in particular, key cost drivers that have contributed to this increase are:

[13] PowerClerk is the Green Bank's incentive application and document management system for RSIP. For information about PowerClerk, see https://www.cleanpower.com/products/powerclerk/. PBI projects approved after August 15, 2017, when RSIP launched the updated PowerClerk II system, do not report cost data until project completion, hence a lag in cost reporting for PBI projects as compared to EPBB projects (which report cost data at incentive application). The number of projects with cost data reported thus far for CY 2017 and 2018 is therefore a smaller number than those approved for incentives in 2017 and 2018.

[14] Average system cost per Watt figures include all reported installed costs without including those projects where financing costs for some third-party ownership installers are included as part of the system cost.

- Import tariffs on modules/cells, inverters, and steel/racking – these tariffs are scheduled to increase for inverters and steel in January 2019 (from 10% to 25%) unless trade negotiations with China result in changes to the current import tariff schedule. Related to the import tariffs are challenges around uncertainty in availability of equipment.
- Increased customer acquisition and other soft costs such as infrastructure upgrades (note however that the cost of infrastructure upgrades is not captured in installed cost numbers and are borne by either contractors and/or customers outside of the RSIP installed cost data being captured).
- Increased financing, labor and insurance costs.
- RSIP installers explained to the Green Bank that solar PV companies were absorbing cost increases for some time and had to start passing some of these costs onto customers in order to stay in business. That said, contractors still absorb to various degrees (depending on the company) unexpected costs of installation (e.g., infrastructure upgrades, electrical upgrades) to help projects move forward.

Other factors that can affect costs or the economics of solar PV projects in the near future, include but are not limited to:

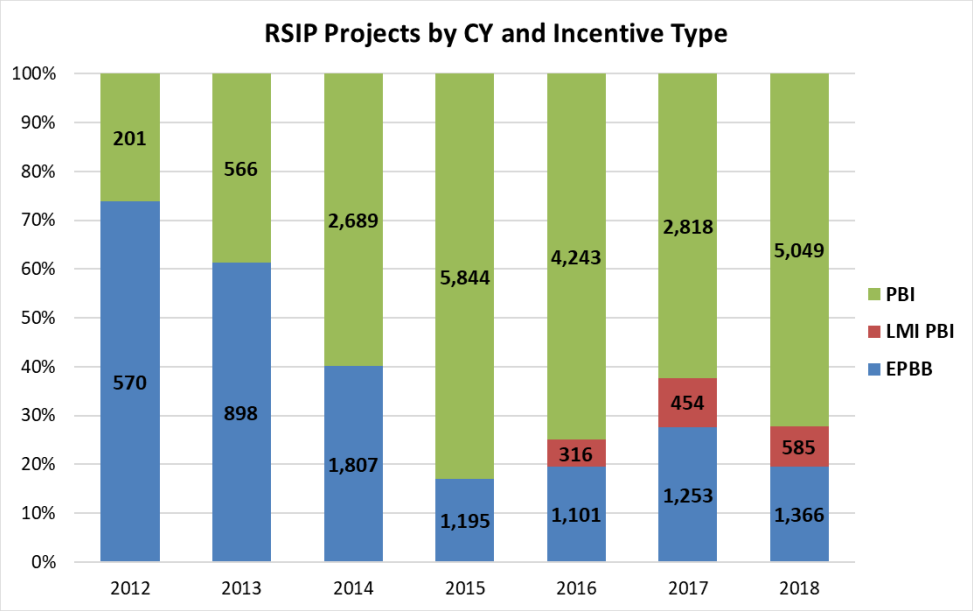
- The federal Investment Tax Credit is scheduled to ramp down from the current tax credit of 30% to 26% in 2020, then 22% in 2021, to 0% in 2022 for residential, homeowner-owned projects and 10% from 2022 onward for third party owned projects.
- Property tax exemptions are being fought by a handful of CT municipalities looking for new revenue streams, in particular for solar PV projects that are third party owned.

Expanding Adoption in Low-to-Moderate Income Households

While solar PV adoption was strong among residential households generally through 2015, to ensure that the benefits of solar were being shared equally among all income classes and to correct for natural market failures, the Green Bank devised and successfully implemented a strategy to increase adoption specifically among low-to-moderate income (LMI) households from 2016 onward. LMI households have higher energy burdens (percentage of income spent on household energy costs) than upper-income households, so solar PV and energy efficiency projects can help significantly alleviate this burden and provide greater energy security for these families.

Through a public-private partnership with PosiGen Solar, the Green Bank established a “Solar for All” initiative to expand deployment of residential solar PV among LMI households. The Green Bank supported the partnership through an investment in PosiGen’s Connecticut solar lease fund, along with a higher RSIP incentive[15] for projects serving low and moderate income-verified customers, and collaboration on Solarize-style marketing campaigns. The following chart shows the number of RSIP projects that received the higher LMI PBI, as well as PBI (non-LMI) and EPBB incentives, with the stacked bars representing the percentage of projects in each year. From 2012 to 2018, third party owned projects, including PBI and LMI PBI, have grown in market share from 26.1% in 2012 to 72.3% of projects in 2017, 80.5% of projects in 2018, and 73.5% of all RSIP projects since 2012. LMI PBI projects made up 5.6%, 10.0%, and 8.4% of all projects in 2016, 2017 and 2018 respectively, or 4.4% for RSIP overall.

[15] The LMI incentive is only offered as a PBI incentive based on research indicating that LMI customers are less able to fully utilize the ITC based on lower tax liability. The base LMI PBI in the current Step 14 is 2.57 times higher than the PBI.



While only a small percentage of RSIP projects utilized the higher LMI PBI incentive, adoption of residential solar PV in LMI communities has increased significantly since the Solar for All initiative launched. From 2016-2018, nearly half of all RSIP customers lived in census tracts with average median income (AMI) of 100% or less.

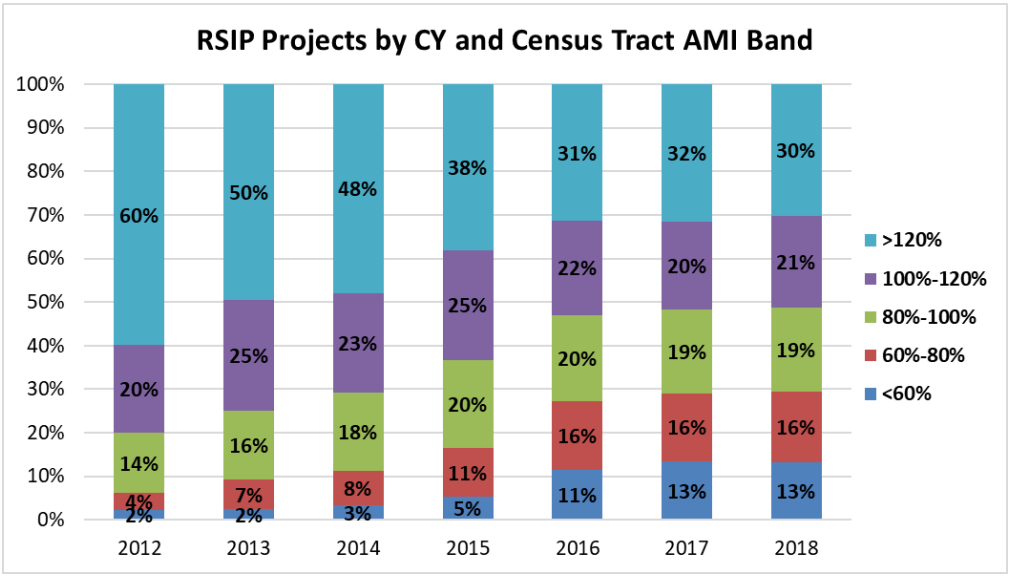


Table 3 below provides a comparison of approved RSIP projects by census tract income bands as a percentage of the number of owner-occupied households in the respective income bands. The data indicate that the highest market penetration is 4.5% in the <60% (lowest income band) and the lowest market penetration is 3.3% in the >120% (highest income band). The 60-80% income band has the next highest market penetration at 4.0%. Table 4 provides another, similar perspective on LMI market penetration based on the distribution of all RSIP projects among income bands as compared to the distribution of owner-occupied housing units among income bands. While only 7.1% of owner-occupied housing units belong to homeowners in the <60% income band, a higher percentage, namely 8.9% of all RSIP projects were deployed by homeowners in this lowest income band (i.e., the lowest income band group was responsible for more than their share of solar PV

deployments). By comparison, 40.2% of all owner-occupied housing units belonged to homeowners in the >120% income band, but these homeowners accounted for only 36.6% of all RSIP projects. These numbers show that LMI market penetration is beyond parity with respect to income bands, that LMI customers will go solar if they have the means, and that the LMI market is a key growth market for the long-term sustainability of the residential solar industry.

Table 3. RSIP Projects by Income Band as % of Owner-Occupied Households

Census Tract Income Level (AMI)	# Projects	Total Owner Occupied 1- 4 Unit Households	% of Households
<60%	2,759	60,769	4.5%
60%-80%	4,007	99,220	4.0%
80%-100%	5,931	165,331	3.6%
100%-120%	6,934	187,463	3.7%
>120%	11,347	345,311	3.3%
Total	30,978	858,094	3.6%

Table 4. Distribution of RSIP Projects by Income Band versus Distribution of Owner-Occupied Households by Income Band

Census Tract Income Band (AMI)	# Projects (cumulative)	% Project Distribution (cumulative)	Total Owner Occupied 1- 4 Unit Households	% Distribution Owner Occupied 1- 4 Unit Households
<60%	2,759	8.9%	60,769	7.1%
60%-80%	4,007	12.9%	99,220	11.6%
80%-100%	5,931	19.1%	165,331	19.3%
100%-120%	6,934	22.4%	187,463	21.8%
>120%	11,347	36.6%	345,311	40.2%
Total	30,978	100.0%	858,094	100.0%

Lastly, to complement the Green Bank's internal efforts to expand deployment to the LMI market, the Green Bank has received federal funding and is part of a U.S. Department of Energy (DOE) SunShot Initiative grant award, led by the Clean Energy States Alliance, to further develop and disseminate throughout the country successful strategies and informative research to help other states in serving the LMI market.

Sustained Orderly Development in a post-RSIP Market

CT General Statutes section 16-245ff (4)(d)(3) provides that incentives are to decline over time and **will foster the sustained, orderly development of a state-based solar industry.** The goal of sustained orderly development supports the state's goal of reducing greenhouse gas emissions to 80% below 2001 levels by 2050 and supports the state's economic development goals. Public Act 15-194 - An Act Concerning the Local Encouragement of Local Economic Development and Access to Residential Renewable Energy, which expanded RSIP from 30 to 300 MW - is written as a local economic development and clean energy policy, leveraging the Class I Renewable Portfolio

Standard to support local job creation and state revenues through corporate, individual, and sales taxes.

The Green Bank interprets achieving sustained orderly development to mean that adoption of residential solar PV will continue at a rate of approximately 50 MW per year, the average over the last few years. The Green Bank comments here on several key factors (among many) that will be important for the long-term sustainability of the solar PV industry, including: (1) future market support in terms of compensation (i.e., from net metering to tariff-based public policy) as well as other support mechanisms (e.g., reducing the cost of capital for financing), (2) continued effort to reduce costs, in particular soft costs, (3) clean energy deployment viewed holistically as part of grid modernization, electrification of heating, cooling and transportation, and commercialization and deployment of complementary technologies such as energy storage and energy efficiency.

Future Market Support

"An Act Concerning Connecticut's Energy Future," PA 18-50 passed in the 2018 legislative session, prescribing sweeping changes to the state's clean energy programs. Section 7 of the Act specifies that the current net metering policy of compensating solar PV at the avoided retail electricity rate will end when RSIP ends. Through Docket No. 18-08-33, the Green Bank has been a participant in the subsequent dialogues at the Public Utilities Regulatory Authority (PURA) on the design and implementation of the residential tariff compensation structure and rates that are intended to replace both current net metering and RSIP. The impact on the residential solar PV market will depend on whether the future tariff structure and compensation level (i.e., tariff rates assuring a reasonable rate of return) will provide sufficient support to continue a similar rate of deployment as in recent years, as well as provide for a smooth transition to a post-RSIP compensation structure. The transition will be important to get right from the perspectives of contractors, third party system owners (and their investors), and customers to ensure that the economics of investing in solar PV still make sense for all parties. It also requires that enough time is provided to adjust sales and marketing approaches and financing constructs, particularly in the case of third party owned projects which have historically been 74% of RSIP projects.

Despite PA 18-50 specifying that PURA should begin proceedings on Section 7 tariff development in September 2019, PURA recognized the need to begin as soon as possible (possibly in recognition that RSIP could end in late 2019 and because of the complexity of the policy). PURA began work in June 2018 on implementation of the new tariff structure with Docket 18-06-15, PURA Review of the Implementation Requirements of Section 7 of Public Act 18-50, followed in August 2018 by Docket 18-08-33, PURA Implementation of Section 7. The Green Bank has participated actively in both dockets along with many other stakeholders[16] to weigh in on the structure, compensation levels, and timing of both the final tariff as well as the possibility of an interim tariff. The final tariff for residential solar PV is specified by PA 18-50 to allow for two options: (1) a buy-all, sell-all/credit-all (BASA or BACA)[17] tariff rate fixed over 20 years, or (2) a netting option based on daily, sub-daily or real-time netting, sometimes called use-buy-sell since this option can allow for some self-consumption by a homeowner. The interim tariff is specified as an option that does not have any structural limitations.

[16] Stakeholders that have participated in docket 18-08-33 include the CT Green Bank, DEEP, Eversource Energy, United Illuminating, the Office of Consumer Counsel, Solar Connecticut and member contractors, Sunrun, Vivint, the CT Fund for the Environment, Acadia Center and others.

[17] Whether the tariff is designed as sell-all or credit-all would likely affect whether tariff compensation is taxable by the IRS, so the Green Bank has encouraged the seeking of an IRS ruling to clarify this before a compensation rate is set; however, requesting such a ruling comes at a high cost and it can take close to a year to get an answer. In the meantime, it is thought that a BACA structure is likely not taxable as credits would be included on utility bills; however, a credit structure would not allow compensation tariffs to be assignable to third parties.

A few highlights of the tariff development process are provided here - legislators are encouraged to view PURA docket materials directly for more information[18]:

- There is disagreement among stakeholders on what the structure, compensation levels and timing should be for both the final as well as a potential interim tariff.
- Clarity is needed on the legal and legislative intent of the interim tariff and whether it can bridge the gap between the end of RSIP and implementation of the new tariff or whether it can only be offered in parallel to RSIP.
- The utility companies do not yet have the metering nor the billing capabilities to allow for all netting options specified by the legislation, and it would likely take more than 6 months (or in some cases, for Eversource Energy, multiple years) to be able to implement the daily or sub-daily netting options.
- DEEP developed a spreadsheet model to enable calculation of tariff rates based on cost recovery plus a reasonable rate of return – using 10 percent as the default rate of return in the model, based on the best publicly available data at the time.[19]
- Stakeholders submitted proposals on the interim tariff to PURA in December 2018 and are hoping for a decision or next steps in January 2019.

In addition to supporting adequate and sustainable compensation policy for solar energy, the Green Bank has continued to support and help transform the residential solar PV market through program administration, financing, marketing and educational initiatives, and strategic partnerships, for example by:

- Continuing to support over 50 eligible installers and third-party system owners, ranging from large, national companies to regional players and small, local businesses that provide for a strong, diverse state industry.
- Continuing to offer the Smart-E loan[20] through local community banks and credit unions that can be used to finance installation of residential solar PV, renewable thermal technologies, energy efficiency, alternative fuel vehicles, energy storage and other measures, including health and safety (e.g., asbestos, lead, mold).
- Continuing to collaborate with stakeholders such as Solar Connecticut (the state's solar PV industry association), the Renewable Energy and Efficiency Business Association (REEBA), the Connecticut Technical High School System, and SmartPower - a nonprofit leading Solarize campaigns in communities throughout the state.
- Addressing consumer protection by collaborating with the Connecticut Department of Consumer Protection, the Office of Consumer Counsel, and the Office of the Attorney General to address consumer complaints and contractor issues. For examples, state officials issued a joint press release on Earth Day in 2015 offering consumer protection advice to homeowners considering the purchase or lease of solar PV[21], and the Green

[18] https://www.ct.gov/pura/

[19] DEEP's tariff model calculates the internal rate of return using a similar methodology to Solar Power Rocks which looks at "the cost of paying for a 5-kW system with cash, reduced within the first year by tax credits and other incentives, then estimate[s] annual electricity savings, SREC sales, and other ongoing incentives", https://solarpowerrocks.com/2017-state-solar-power-rankings/. DEEP also referenced Vivint, which includes states with a 10+ percent IRR among those with the "Highest Investment Return", https://www.vivintsolar.com/blog/top-states-for-solar. It should be noted that the Connecticut Green Bank asked a Yale University economist (Kenneth Gillingham) to calculate the rate of return for the RSIP over the last several years and it was determined that 10.1 - 11.3 % was the average rate of return from 2017-2018.

[20] https://ctgreenbank.com/programs/smart-e-loans/

[21] https://www.ftc.gov/system/files/documents/public_comments/2016/06/00190-128452.pdf, or https://portal.ct.gov/DCP/News-Releases-from-the-Department-of-Consumer-Protection/2015-News-Releases/On-Earth-Day-State-Officials-Offer-Advice-on-Solar-Energy-Promotions-and-Installation

Bank meets with the Department of Consumer Protection on a quarterly basis to address current issues and complaints.

- The Green Bank collaborates with the Clean Energy States Alliance (CESA)[22] to develop resources on solar PV consumer protection and related topics, in addition to participating as an active member in CESA's clean energy market transformation programs and projects.
- Participating in the ISO New England Distributed Generation Forecast Working Group[23].
- Updating the GoSolarCT.com web site to better support consumers of solar PV with a trusted source of information.
- Continuing improvement of RSIP customer and contractor experience and program efficiency by upgrading to an enhanced PowerClerk system for incentive application processing and increasing analytic capabilities in the Locus data monitoring platform.

Solar PV Cost Reduction Efforts

A second area of ongoing importance for the long-term sustainability of the solar PV industry is reduction of costs, in particular non-hardware or soft costs. Recognizing that hardware costs were steadily decreasing but soft costs were remaining high, the Green Bank participated in multiple U.S. Department of Energy (DOE) funding opportunities over the past 7 years, as the lead organization as well as in collaboration with other organizations on projects led by the Clean Energy States Alliance (CESA). Earlier efforts including two rounds of the DOE Rooftop Solar Challenge which focused on improvement of municipal solar PV permitting as well as barriers to solar PV adoption resulting from zoning regulations or interconnection rules and processes. Resources developed through these efforts can be found at www.energizect.com/sunrisene. As required by PA 15-194 Sec. 3(f) and in partnership with the Office of Education and Data Management, the Green Bank held 7 (2 more than required) residential solar PV system training seminars for municipal code officials around the state between October and December 2015. These seminars covered best practices and resources on solar PV permitting, as well as technical content on solar PV system equipment, design and National Electric Code requirements. In addition to the trainings, municipalities were supported in adopting best practices for solar PV permitting. The Green Bank continues to collaborate with municipalities and the Office of the State Building Inspector as opportunities arise.

Recent efforts have included participation in the DOE SunShot Prize Competition and the DOE-funded SolSmart grant. When the SunShot Prize: Race to 7-day Solar, a national competition intended to reduce the time it takes to "go solar" across the country, ended in FY18, the Connecticut Permit to Plug-in Challenge team was among the last two teams standing. The team, comprised of the Green Bank, the investor-owned utilities, solar installers, and municipalities, earned an award of distinction for their multi-pronged strategic approach to reducing solar installation times, which relied on detailed project tracking and evaluation. The competition enabled the team to create resources that walked residents through the permit to plug-in process[24], further standardized aspects of municipal solar permitting processes, and supported utility interconnection improvements for solar PV. The Connecticut Permit to Plug-in Challenge team reported the installation of 1,501 systems in 49 participating municipalities covering 141 different zip codes. The median total time from permit to plug-in was 89 days, with 78.6% of total installed capacity in the competition completing in 56 days or less. The Green Bank was a DOE-funded SolSmart technical advisor contract winner – funding from this award provided resources for further consulting support to municipalities on solar PV permitting and zoning improvements to earn SolSmart certifications for solar-friendliness. These resources have also enabled greater safety for firefighters through training

[22] https://www.cesa.org/
[23] https://www.iso-ne.com/committees/planning/distributed-generation/
[24] http://www.gosolarct.com/1-Get-Into-Solar/Whats-Involved-From-Paperwork-to-Panels

sessions coordinated by the Green Bank team on fire safety considerations where solar PV is present.

Finally, the Green Bank continues to work with municipalities on solar PV permitting and other municipal clean energy efforts through Sustainable CT[25], "a voluntary certification program to recognize thriving and resilient Connecticut municipalities. An independently funded, grassroots, municipal effort, Sustainable CT provides a wide-ranging menu of best practices. Municipalities choose Sustainable CT actions, implement them, and earn points toward certification." Sustainable CT provides a platform for achieving sustainability across a broad range of needs and connects municipalities to resources to help them achieve sustainability goals. The Green Bank provides technical and financial assistance for Sustainable CT[26] actions or action areas related to the following clean energy actions: (1) C-PACE, (2) municipal permitting, (3) supporting electric vehicle deployment, (4) increasing use of clean energy in municipal buildings, (5) implementing a community energy campaign targeting single-family households, and (6) benchmarking and providing financing for projects in multifamily buildings. Of the 22 municipalities certified, Green Bank programs and technical assistance helped 21 municipalities earn over 250 points in this year's first round of certifications.

Deployment of Solar PV in Combination with other Technologies

As more solar PV is deployed throughout Connecticut, the Green Bank and others including our utility partners are viewing clean energy deployment more holistically, in the context of grid modernization, electrification of heating, cooling and transportation, and commercialization and deployment of complementary technologies such as energy storage and energy efficiency.

Since the beginning of RSIP in 2012, it is a requirement to have an energy assessment performed in a home in order to access the solar PV incentive, preferably using the utility-administered Home Energy Solutions (HES)[27] assessment but with other options if needed. These energy assessments encourage customers to adopt energy efficiency measures along with solar PV – these measures might include insulation, upgrading to higher efficiency HVAC systems, adoption of heat pump hot water heaters, and electrification of space heating and cooling using air and ground source heat pumps.

An emerging market is residential solar plus energy storage. Over 100 RSIP projects approved in 2018 included battery storage systems. Battery storage provides backup power benefits for customers who are concerned about resiliency and increased energy independence, particularly during storms. Battery storage can also increase peak load reduction benefits to the grid by storing and making available solar energy when it is most needed. Commercially available battery storage systems based on lithium ion chemistry can be set up to cycle regularly to provide this load shifting functionality. Given that solar PV production generally peaks around midday to early afternoon, energy storage can save solar energy not needed to meet on-site load and use it later in the day during a household's greatest time of need, usually in the late afternoon or early evening. This alleviates demand put on the grid and potentially expensive and dirtier peaking plants that would otherwise be needed. Customer time of use rates can help incentivize cycling of battery systems to provide these peak load reduction benefits.

The Green Bank is collaborating with United Illuminating (UI) on a pilot project that aims to deploy solar PV as well as battery storage to reduce peak demand on two specific circuits in southwest

[25] https://sustainablect.org/
[26] https://ctgreenbank.com/SUSTAINABLECT/
[27] The HES assessment includes an energy audit with a blower door test as well as several on-site improvements like air and duct sealing, weather-stripping and water saving measures.

Connecticut. If enough peak load reduction is provided by the solar PV (and battery storage), UI may be able to avoid an upgrade to a specific substation. This pilot project helps illustrate another potential benefit of solar PV – the ability to provide location-specific benefits on a distribution system to help avoid traditional infrastructure capacity upgrades. This example also underscores the importance of looking at adoption of distributed energy resources such as solar PV and battery storage from a broader perspective, based on where and when these technologies can provide the greatest benefits. Section 7 of Public Act 18-50 directs PURA to evaluate these electric system benefits and to determine if and how locational benefits should be incentivized.

Similarly, approaching deployment of clean energy technologies in the residential market more holistically, the National Renewable Energy Laboratory (NREL) produced a report called "Solar Plus: A Holistic Approach to Distributed Solar PV"[28]. NREL's analysis illustrates that solar PV can provide more benefits when installed in combination with complementary technologies such as energy storage, controllable hot water heaters and air conditioning units, and home energy management systems. As RSIP reaches its statutory goal of 300 MW, the Green Bank encourages the state to support opportunities to deploy battery storage and other technologies in combination with existing and new solar PV installations to help meet the energy needs of customers more comprehensively while also providing greater benefits to the larger system and making energy cleaner, cheaper and more reliable for all customers. Technologies such as battery storage will also become more and more important for integration of solar energy into the grid as market penetration of solar energy increases to higher levels.

Recommendations

The Green Bank offers the following three recommendations to help ensure sustained orderly development of the Connecticut residential solar PV market in light of the transition to a post-RSIP market, as well as the state's broader economic and environmental context.

1. **Clarification of the Legal and Legislative Intent of PA 18-50, Section 7** - to provide guidance on whether an interim tariff structure can stay in place after RSIP ends. Implementation of an interim tariff structure is needed because the utility companies do not yet have the metering nor the billing capabilities to allow for all options specified by the legislation, and it would likely take 6 months or longer to implement the most expedient options (and for some options, for Eversource Energy, multiple years). It is critical to provide continuity between RSIP and the new, final tariff structure. A poor transition would result in the loss of economic development by companies leaving the state or at minimum shedding jobs thereby violating the public policy objective of fostering the sustained orderly development of a local state-based solar PV industry.

2. **Grid Modernization through Residential Solar PV and Complementary Technologies** – the Green Bank encourages the state to support opportunities to deploy clean energy technologies holistically and "cost effectively," in the context of grid modernization, electrification of heating, cooling and transportation, and commercialization and deployment of complementary technologies such as energy storage and energy efficiency in order to ensure that costs are minimized and benefits are maximized for all Connecticut ratepayers.

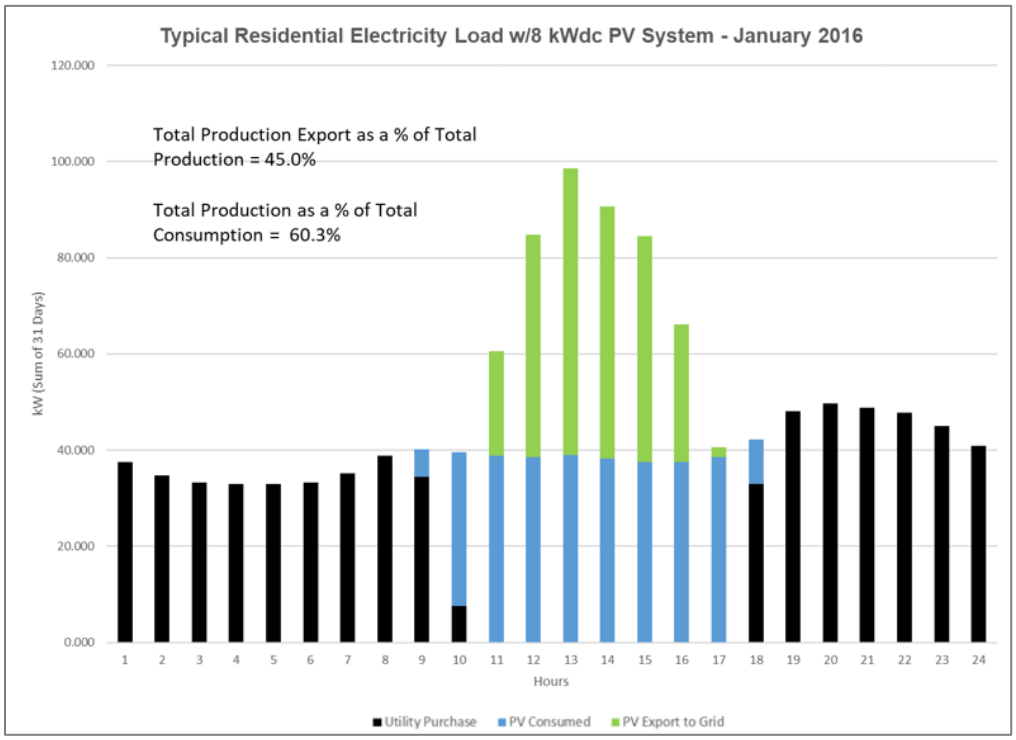
   For example, residential solar PV production and consumption graphs (produced by the Green Bank)[29] for January and July 2016 are provided below. In January 2016, 45% of PV

[28] https://www.nrel.gov/solar/solar-plus-holistic-approach.html

[29] Interval data for a typical residential customer in Connecticut came from Eversource Energy. Solar data is derived from NREL's PV Watts (https://pvwatts.nrel.gov) for a typical residential solar PV system in Connecticut that is 8 kW with a capacity factor of 12.53%.

production is exported to the grid (implying that 55% is used for on-site, household consumption) and about 60% of consumption is met by solar PV production. In July 2016, 37% of PV production is exported to the grid (63% is used for on-site consumption) and about 75% of consumption is met by solar PV production. On average throughout the year, about 50% of PV production is used on site and 50% is exported to the grid. These numbers demonstrate that solar PV provides significant benefit to the grid in reducing electricity demand throughout the year, as well as peak demand in months such as July. As previously noted, behind-the-meter distributed solar PV reduced New England wholesale power costs during a heat wave from July 1 to July 7, 2018[30], and ISO New England reported that the Thanksgiving midday peak "typically seen from ovens and family gatherings was curtailed this year because of the installation of rooftop solar in Connecticut and New England states."[31]

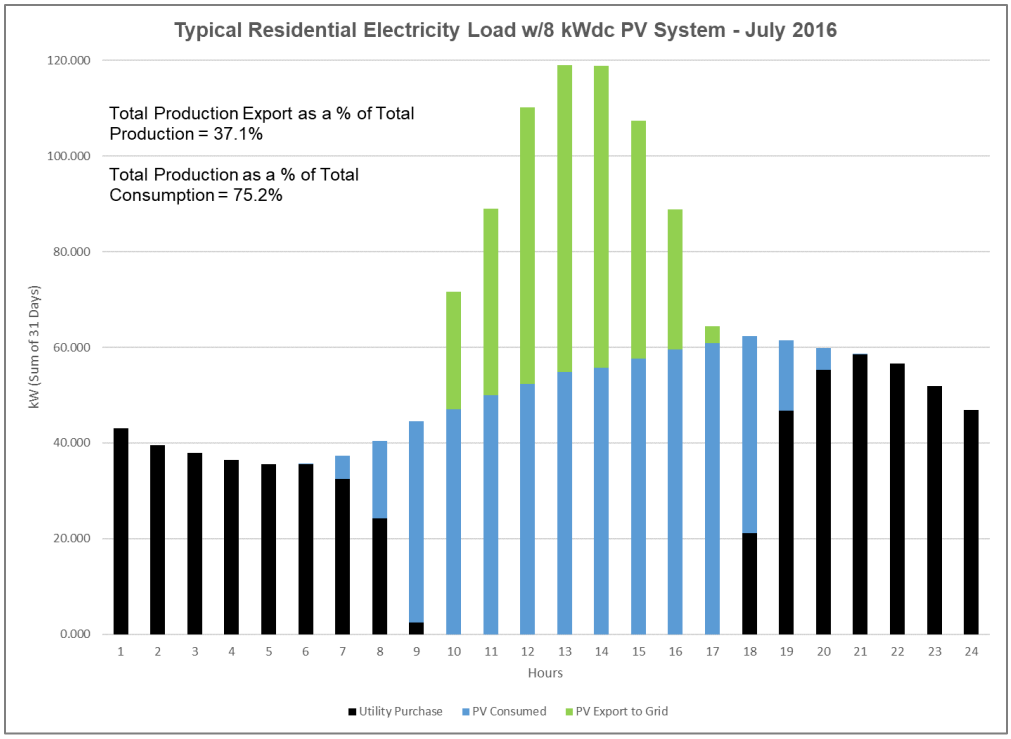
If a complementary technology such as battery storage is installed to store solar energy and dispatch it when the grid needs it the most (i.e., during summer and winter peak demand periods), grid and customer benefits will be further maximized. The Green Bank strongly recommends deployment of complementary technologies such as solar PV plus battery storage,[32] solar PV plus energy efficiency, solar PV plus heat pumps, and other combinations that maximize economic, energy and environmental benefits to all stakeholders.



[30] http://isonewswire.com/updates/2018/7/17/heat-wave-recap-reliable-operations-through-holiday-heat-hum.html, https://pv-magazine-usa.com/2018/07/25/heavy-lifting-by-behind-the-meter-solar-power-in-new-england-heatwave/, https://www.solarreviews.com/news/rooftop-solar-saves-new-englanders-30m-1-week-083118/

[31] https://www.theday.com/local-news/20181224/greenhouse-gas-emissions-continue-to-decline-in-new-england

[32] The Green Bank has submitted Partner and Technology Applications under the Electric Efficiency Partners Program to support enhanced demand-side management technologies that reduce demand, specifically peak demand.



3. **<u>Resource Value Framework</u>** – the Green Bank supports the use of methods and tools for bringing consistency and synergy to State of Connecticut policies in terms of valuing various energy resources. One key method being implemented by DEEP, which has the legislative authority to administer cost-effectiveness assessments for energy efficiency, is the use of the Resource Value Framework provided in the latest edition of the National Standard Practice Manual.[33] The Green Bank supports DEEP's reforms of energy efficiency "cost-effectiveness" screening using the Resource Value Framework, which seeks to value both energy and non-energy costs and benefits with respect to public policy in Connecticut. Consideration should be given to applying this same framework to cost-effectiveness evaluation of all distributed energy resources (e.g., solar PV, battery storage, demand response, etc.) so as to ensure that their individual and collective value toward grid modernization are appropriately and equitably valued.

[33] The National Standard Practice Manual has historically provided guidance on cost-effectiveness testing for energy efficiency technologies, https://nationalefficiencyscreening.org/national-standard-practice-manual/.