845 Brook Street
Rocky Hill, Connecticut 06067

300 Main Street, 4th Floor
Stamford, Connecticut 06901

T: 860.563.0015
F: 860.563.4877
www.ctcleanenergy.com

CLEAN ENERGY
FINANCE AND INVESTMENT AUTHORITY

Solar Home and Jobs Opportunity Act:

Delivering Ratepayer Benefits through the Renewable Portfolio Standard

A proposal to the Energy & Technology Committee
February 10, 2015

In support of Governor Malloy's proposed legislation regarding the Solar Home Renewable Energy Credit (SHREC), the Connecticut Green Bank (Green Bank) engaged Sustainable Energy Advantage (SEA) to provide a thorough analysis of the recommended policy. SEA is an independent national authority on renewable energy policy and markets, and has advised the decision-making of 40 governmental entities over 15 years.

Results:

- Over the life of the SHREC program it will provide substantial savings to Connecticut ratepayers. SHREC will save ratepayers an estimated $68[1] million in Class I RPS Compliance Costs.[2]

- SHREC will allow the solar market to continue to grow, resulting in the investment of over $1.0 billion[3] and the achievement of Governor Malloy's 300 MW target.

- SHREC will produce cleaner, cheaper, and more reliable energy for Connecticut while creating jobs and supporting local economic development.[4]

Methodology:

Green Bank asked SEA to estimate the costs and benefits that the SHREC program would incur from its interactions with the RPS market. SEA then compared results under a range of scenarios and conditions. Green Bank assisted the SEA analysis by projecting residential PV deployment in the current policy environment, a total of 90.8 MW from 2015 by 2022. SEA evaluated two alternative scenarios for the Green Bank – a Low SHREC Targets case that ramps up to 160 MW, and a High SHREC Targets case that would reach 250 MW. For each of these scenarios, SEA estimated the net present value of the stream of REC payments under a variety of REC price forecasts.

[1] Under future Class I REC price estimates from the Department of Energy & Environmental Protection draft Integrated Resource Plan

[2] The savings in times of high-price RECs are much greater than the loss risks in times of low-price RECs.

[3] Installed costs of $4.25/W

[4] The greatest savings will probably come in the first five years. Whether SHREC prices are higher or lower than market Class I REC prices depends on how much Class I renewable generation becomes available in the New England RPS market.

Sustainable Energy Advantage, LLC

10 Speen Street, 3rd Floor, Framingham, MA 01701 • Tel: 508.665.5850 • Fax: 508.665.5858 • bgrace@seadvantage.com • www.seadvantage.com

Memorandum

To: Mackey Dykes, Bryan Garcia, Brian R. Farnen, and Dale Hedman

From: Bob Grace, Dan von Allmen and Jason Gifford

Date: January 20, 2015

Re: Solar Home Renewable Energy Credit (SHREC) program

1 Introduction

The Connecticut Green Bank (CGB)[1] engaged Sustainable Energy Advantage, LLC (SEA)[2] to conduct a quantitative analysis investigating a proposed expanded residential solar incentive program, modeled after and adapted from Connecticut's successful ZREC program, referred to as the Solar Home Renewable Energy Credit (SHREC) program.[3] This memorandum describes, for two hypothetical SHREC program targets and designs, SEA's projections of:

- the cost per renewable energy credit (REC) compared to several key benchmarks including the $55 per MWh Alternative Compliance Payment (ACP), projected Class I RPS market REC prices (as developed by SEA and from DEEP's draft Integrated Resources Plan), and a projection of Small ZREC prices; and
- Total ratepayer costs per year, and on a net-present-value (NPV) basis, compared to a continuation of the current residential solar policy approach (business-as-usual).

2 Policy Background:

Current Residential Solar Program: Section 106 of Public Act 11-80 authorized the CGB to establish and implement a declining incentive program to support 30 MW of residential solar photovoltaic (PV) installations in Connecticut over 10 years. In combination with other finance programs, this Residential Solar Investment Program (RSIP) has succeeded well ahead of schedule, with 50 MW of incentives (as of November 24, 2014) having been approved and soon to be installed by 2015. The Connecticut residential solar market has roughly doubled in size annually over the last few years, even as incentive levels have declined.

[1] The Connecticut Clean Energy Finance and Investment Authority, CEFIA, was recently renamed as the CGB.
[2] See Appendix A for background on SEA.
[3] See Appendix B for CGB's SHREC legislative proposal.

This RSIP supports residential solar incentives through a combination of rebate and performance-based payments. Specifically, it provides a Homeowner Performance-Based Incentive (HOPBI) as a $ per Watt upfront cost reduction to contractors on behalf of homeowners who purchase a solar system (paid once a performance test is met), and a Performance-Based Incentive (PBI) for 3rd-party owners of systems leased to homeowners (or for solar PV energy supplied to homeowners under power purchase agreements) with little or no upfront costs, consisting of payments for 6 years based on actual system performance. In exchange for providing the incentive, CGB receives the Class I RECs, which it resells into the market over time at market prices to fund CGB programs in future years.

The incentives provided by CGB are funded through an allocation of system benefit charges (SBC) to the RSIP. At this juncture, the current level of residential solar growth in Connecticut cannot be sustained through the level of SBC collections available. CGB is barely able to make its authorized incentive budget stretch to support the quantity targeted, as various programmatic limits are being reached. Recently, Governor Malloy announced his plan to expand Connecticut's residential solar market by ten times the original 30MW RSIP minimum goal by 2020. Even with progressively lower incentives, the current SBC-funding approach is inadequate to meet the Governor's goals.

CT ZREC Program: Under Sections 107, 108 and 110 of Public Act 11-80, Connecticut Light & Power Company ("CL&P") and The United Illuminating Company ("UI"), the states' electric distribution companies (EDCs), are required to procure Class I RECs under 15-year contracts with owners or developers of renewable energy projects in Connecticut. Through these ZREC (Zero Emission Renewable Energy Credit, open to solar, wind and hydro) and LREC (Low Emission Renewable Energy Credit, open to fuel cells, biomass plants, and ZREC-eligible projects) programs, whose prices are determined through competitive procurements run annually by the EDCs, project developers can rely on a known REC revenue stream sufficient to attract low-cost financing commensurate with reduced revenue risk. The EDCs can resell ZRECs and LRECs procured into the RPS Class I market, passing along the positive or negative difference between price paid and market price to customers. The ZREC program, which has been almost exclusively supplied by solar projects under large, medium or small[4] ZREC categories, has been successful to date in leading to development of solar projects in Connecticut, at reduced ZREC prices in successive procurement rounds, and (while there has been some project attrition), allowing projects to successfully attract financing.

3 Proposed SHREC Program

In the context of the inadequacy of the current SBC-funded approach to maintain the scale of Connecticut's rapidly growing residential solar sector (and its associated jobs), and the Governor's desire to expand the residential solar sector further, CGB is investigating, and plans to propose in the next legislative session, a Solar Home Renewable Energy Credit (SHREC) program. The SHREC program, similar in some respects to the current ZREC program, builds on and succeeds the Section 106 program. The SHREC program envisioned by CGB would allow CGB to monetize a 15-year stream of RECs from residential solar systems through sale of the RECs under 15-year fixed-price REC sales agreements to Connecticut's EDCs at prices sufficient to support the program plus CGB's overhead. CGB could take the net present value of the expected known payment streams from the EDCs into

[4] Large and Medium ZREC classes have contract prices determined through competitive procurement. The small ZREC program, open to projects under 100 kW, has its contract determined be based on the average price of awarded bids for Medium ZREC projects (100 – 250 kW) plus ten percent (10%).

account in establishing a new set of incentives. In doing so, CGB could fund a continuation of the successful grant and PBI structure of the SBC-funded program without requiring SBC funds. Under the proposed SHREC program, CGB would continue to monetize the value of all RECs produced by the residential installations, freeing residential customers from the administrative burden of doing so and in return for the up-front assurance of an incentive (through the HOPBI or PBI). RECs would be sold to EDCs as SHRECs for 15 years, and then sold into RPS markets at the going market price thereafter.

One benefit of this approach is that the program, leveraged by CGB's financing programs, could fund its incentives through financing of the known REC revenue stream (securitization). In addition, CGB could increase the scale of the RSIP to one limited by the RPS policy rather than statutory budget constraints. Further, such a program would encourage channeling RPS expenditures to in-state investments. In sum, CGB's objectives are to create a policy to achieve residential solar photovoltaic market scale and system affordability, in line with Connecticut's overall policy agenda. One important difference between the proposed SHREC program and the current RSIP is that under the SHREC program CGB would not accumulate funds from resale of RECs to reinvest in additional installations or other programs during the term of the SHREC sale to EDCs, since those funds would be used (e.g., via securitization) to fund the RSIP installation incentives.

3.1 Business-as-Usual and SHREC Policy Targets:

CGB projects that a business-as-usual (BAU) approach to the RSIP, funded by ongoing SBC collections, would expand the RISP by 90.8 MW by 2022, for a cumulative residential solar penetration of 140MW, less than half of the Governor's goal. CGB asked SEA to evaluate two alternative SHREC program targets and associated schedules commencing in 2015, a Low SHREC Targets case which would ramp up to 160 MW of additional residential solar installations by 2022 (for a cumulative residential solar penetration of 210 MW), and a High SHREC Targets case ramping up to 250 MW by 2022, with cumulative residential solar installations totaling 300 MW – achieving Governor Malloy's residential solar goal. The annual build-out schedule under BAU and SHREC policy cases is summarized in Table 1, showing the quantity funded in each year and the quantity installed in each year, reflecting a typical RSIP delay between funding and installation.

Table 1: Illustration and Comparison of BAU and SHREC Program Scale

	MW Approved & Funded			MW Installed		
Year	BAU	Low SHREC Targets	High SHREC Targets	BAU	Low SHREC Targets	High SHREC Targets
2015[5]	3.9	8.8	15.2	1.0	2.3	4.0
2016	9.1	19.0	31.8	5.2	11.5	19.6
2017	10.5	20.4	33.2	9.4	19.3	32.2
2018	12.0	21.9	34.7	10.9	20.8	33.6
2019	13.6	23.5	36.3	12.4	22.3	35.1
2020	15.3	25.2	38.0	14.0	23.9	36.8
2021	17.1	27.0	39.8	15.7	25.6	38.5
2022	9.5	14.4	20.8	15.1	23.7	34.8
2023				7.0	10.6	15.3
Total MW	90.8	160.0	250.0	90.8	160.0	250.0

For purposes of this analysis, CGB calculated a projected incentive level for HOPBI and PBI incentives for each year of the analysis for BAU and SHREC policy cases. The size of the incentive is a function of (declining) installed cost, the changing projected avoided utility retail rate value over time, and the Federal Investment Tax Credit (ITC), and was established to produce a positive difference between the NPV of the levelized cost of energy (LCOE) of the solar installation and the NPV of utility retail avoided cost. The average HOPBI incentive for a 7.0 kW system projected by CGB applicable to each year's installations is shown in Table 2.[6]

Table 2: Projected HOPBI Incentive

	HOPBI Incentive ($/kW Installed)
2015	$607.50
2016	$516.38
2017	$860.63
2018	$688.50
2019	$550.80
2020	$440.64
2021	$330.48
2022	$247.86

[5] CGB operates on a fiscal year basis while this analysis is performed on a calendar year basis. The quantities shown for 2015 reflect an assumed commencement of the program part-way through the year, while subsequent years prior to the final year reflecting continuous deployment throughout the year, and the final year reflecting the remaining installations established funded in one year but installed at a later date.

[6] For comparison, the current Step 5 RISP HOPBI is $685.71 per kW.

The PBI incentive changes over time to provide a comparable level of incentive. Note that the incentive levels falls over time with falling installed cost and projected[7] utility electric rates, but jumps upward after 2016 to reflect the need for greater incentive when the ITC drops from 30% to 10% of installed cost.[8]

CGB also developed a projection of CGB overhead, summarized in Table 3, which is sensitive to the scale of the program (i.e. the program has scale economies, with lower overhead per MWh for more residential solar installations).

Table 3: Levelized CGB Overhead, $/MWh

	BAU	Low SHREC Targets	High SHREC Targets
Levelized Overhead Cost	$ 20.04	$ 8.38	$ 5.36

3.2 Calculation of SHREC Payments for Each Vintage Year:

As an input to SEA's analysis, CGB estimated a SHREC payment level sufficient to cover the cost of the incentive, plus CGB overhead and securitization interest and calculated at a 4.5% annual interest rate. Specifically, CGB established a declining schedule of SHREC payments for each vintage year[9] as equivalent to the incentive payment *at a programmatic* level, plus levelized overhead plus levelized securitization interest. In setting a declining SHREC payment rate while incentive payments increase following the reduction in ITC, there is some implicit cross-subsidization (entirely internal to the CGB) between vintage years, allowing the market to continue at a sustainable growth rate in the face of the ITC change. Otherwise, SHREC vintage payments would increase in 2017 like the incentive values.

4 Results

To assess the impacts of the proposed SHREC program, SEA compared:

- the cost per SHREC with several key benchmarks including the $55 per MWh Alternative Compliance Payment (ACP), projected Class I RPS market REC prices (as developed by SEA and from DEEP's draft Integrated Resources Plan), and a projection of Small ZREC prices; and
- Total ratepayer costs per year, and on a net-resent-value (NPV) basis, compared to a continuation of the current residential solar policy approach (business-as-usual).

Key assumptions underlying this analysis, including residential PV system installed costs and performance, avoided utility retail rates, market Connecticut Class I prices, Small ZREC prices, and costs of financing underlying SHREC securitization, are summarized in Appendix C.

[7] The projection is described in Appendix C.

[8] Under current law, after December 31, 2016, the Federal ITC will fall from 30% to 10% of installed cost for commercial installations, including 3rd-party owned residential systems, and will be eliminated for installations owned by residential homeowners. Extension of the ITC would reduce the costs shown herein.

[9] The vintage year is the year of installation. SHREC payment rates represent a 15-year stream of fixed incentive payment per MWh which is held constant at the rate paid in the year of installation; installations in each successive year receive a different SHREC payment.

In assessing the ratepayer cost impacts of alternative SHREC target futures, it is necessary to compare them to the business-as-usual case described earlier. Because the volumes are different in each case, SEA constructed a model of total RPS compliance costs. Class I RPS compliance costs to ratepayers are either hedged through policy procurement mechanisms[10] – such as long-term contracts under Project 150, certain programs established under Public Act 11-80 (Section 127, LREC/ZREC), long-term contracts entered into pursuant to Public Act 13-303 (Section 6, Section 7, Section 8)[11] and the SHREC program – or assumed to be purchased at spot market REC process. Figure 1 and Figure 2 depict the volumes of Class I RECs that are either assumed hedged or purchased at market prices, under 160 MW and 250 MW Target SHREC cases respectively. Under the BAU case, the shaded area representing the SHREC layer is replaced by RECs purchased from the market. When comparing BAU to SHREC policy cases, the actual costs of hedged RECs purchased net out.

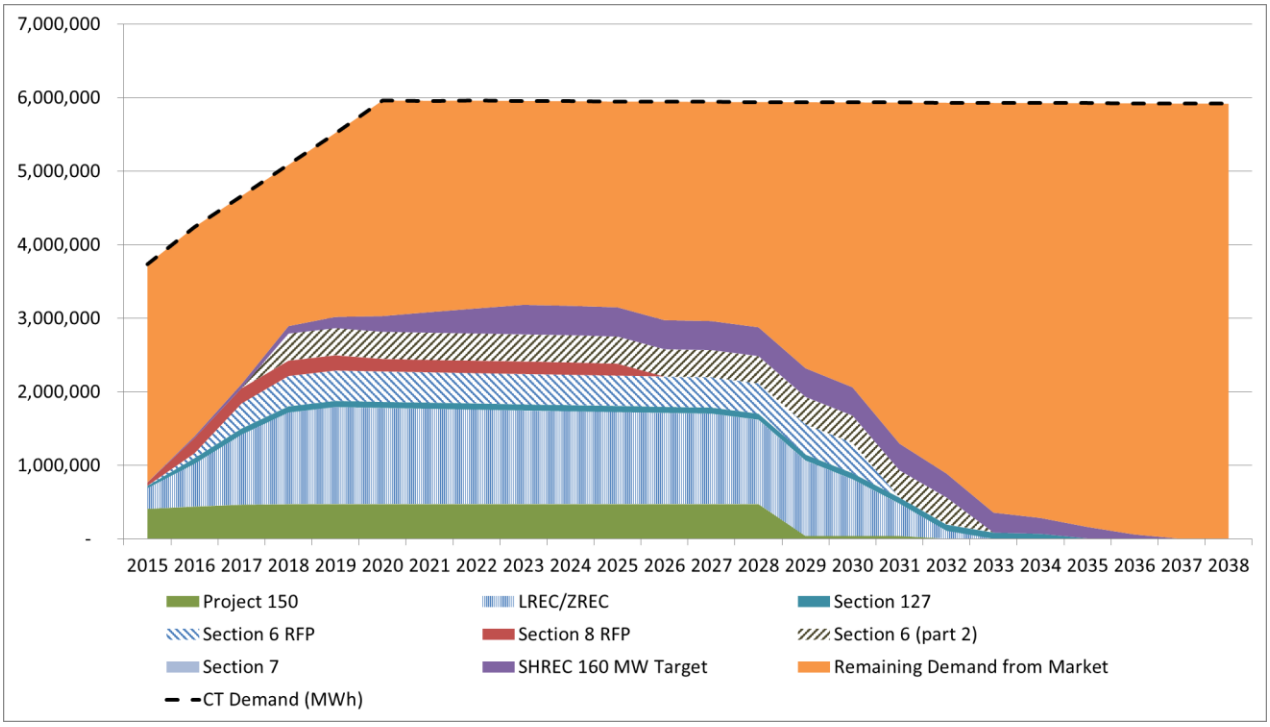


Figure 1: Volume of Class I RECs Hedged and at Market, with 160 MW SHREC Targets

[10] These policies typically provide for EDCs to purchase RECs at fixed price, resell them short-term into the market at then-current market prices, and pass the positive or negative difference through to distribution ratepayers. In aggregate, the total cost to ratepayers associated with that volume of RECs is effectively hedged so long as competitive suppliers and standard service suppliers purchase RECs at market prices and set electricity prices to customers based on these costs.

[11] This analysis has assumed current Section 6 and Section 8 contracting, future Section 6 procurement up to the maximum amount authorized under statute, but no explicit Section 7 contracting. If DEEP procures additional Class I RPS supply pursuant to Section 7, as foreshadowed in the 2014 draft IRP, then the amount depicted as hedged in this analysis would increase.

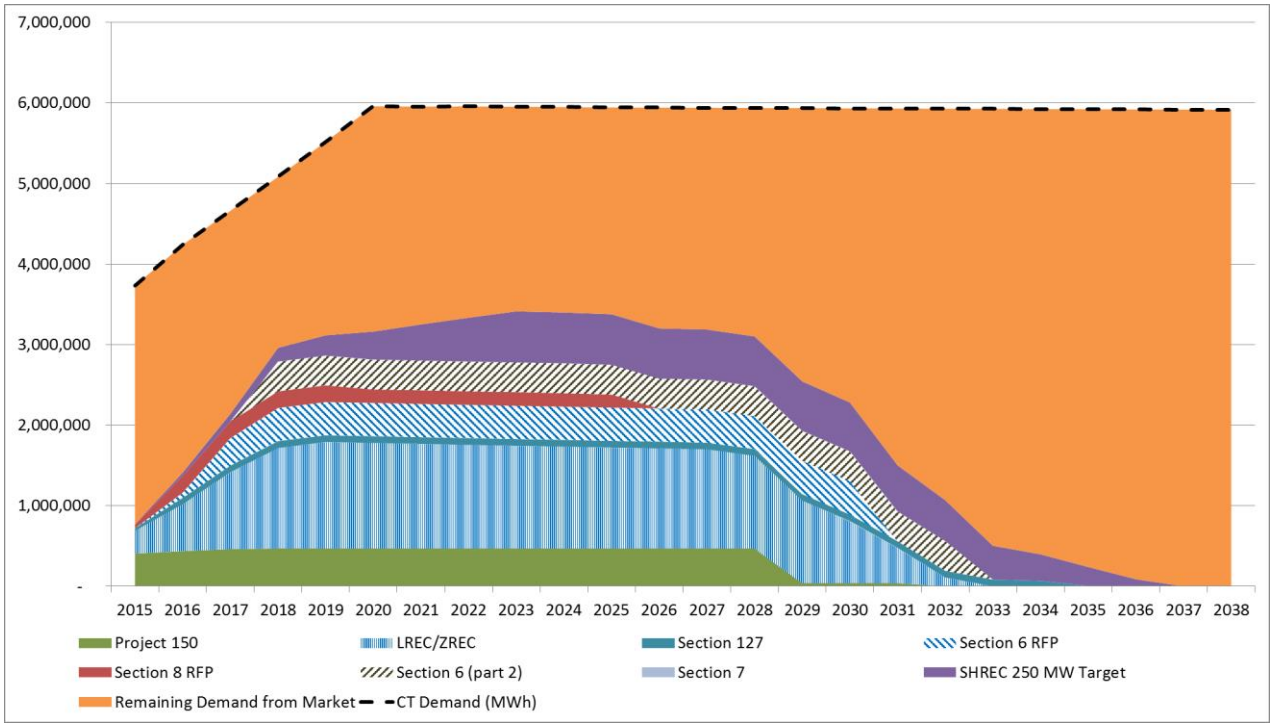


Figure 2: Volume of Class I RECs Hedged and at Market, with 250 MW SHREC Targets

SHREC Prices:

SHREC prices for each vintage year of solicitations (reflecting FY 2016-2022 which captures SHREC sales during CY 2015-2022) were calculated as described above to cover the cost of up-front HOPBI and PBI incentives, CGB overhead and securitization interest cost at the aggregate programmatic level. These values are shown in Figure 3 and Figure 4 below, and the weighted average of all SHREC prices is shown in Table 5. These values can be compared directly to various benchmarks. They are also used to calculate total program costs to ratepayers.

Figure 3 and Figure 4 compare projected SHREC prices for each vintage year with forecasts of the CT Class I ACP ($55/MWh) and three forecasts of Class I REC prices described earlier, for the 160 MW and 250 MW SHREC targets, respectively. As can be seen, SHREC prices by design decline in each year. The SHREC prices for the 160 MW cases are slightly higher per MWh than for the 250 MW due primarily to scale economies of CGB overhead costs. In addition, the SHREC program would produce progressively larger savings over time relative to the Class I ACP. Substantial savings are also shown relative to the Class I REC assumptions in the recently released CT Draft IRP for most vintages prior to 2025, for roughly the first half of the SCHREC term for each vintage. Thereafter, the IRP's spot price is projected to follow a declining cost of entry for new onshore wind and fall below the SHREC prices. SHREC prices are projected to be moderately more costly than market Class I RECs after the first seven years of the analysis when compared to SEA's more supply-robust assumptions.[12]

[12] Note that SEA's 'Base Supply Case' assumes that Cape Wind has a 65% probability of success. It also assumes adequate supply at an on-shore wind-dominated cost of entry. Subsequent information suggests that Cape Wind is unlikely to move forward. In contrast, the December 2014 Draft IRP assumes that REC prices will track the ACP until 2024 before tracking the on-shore wind cost of entry. Without Cape Wind, it may be reasonable to expect spot Class I REC prices to fall somewhere between these cases.

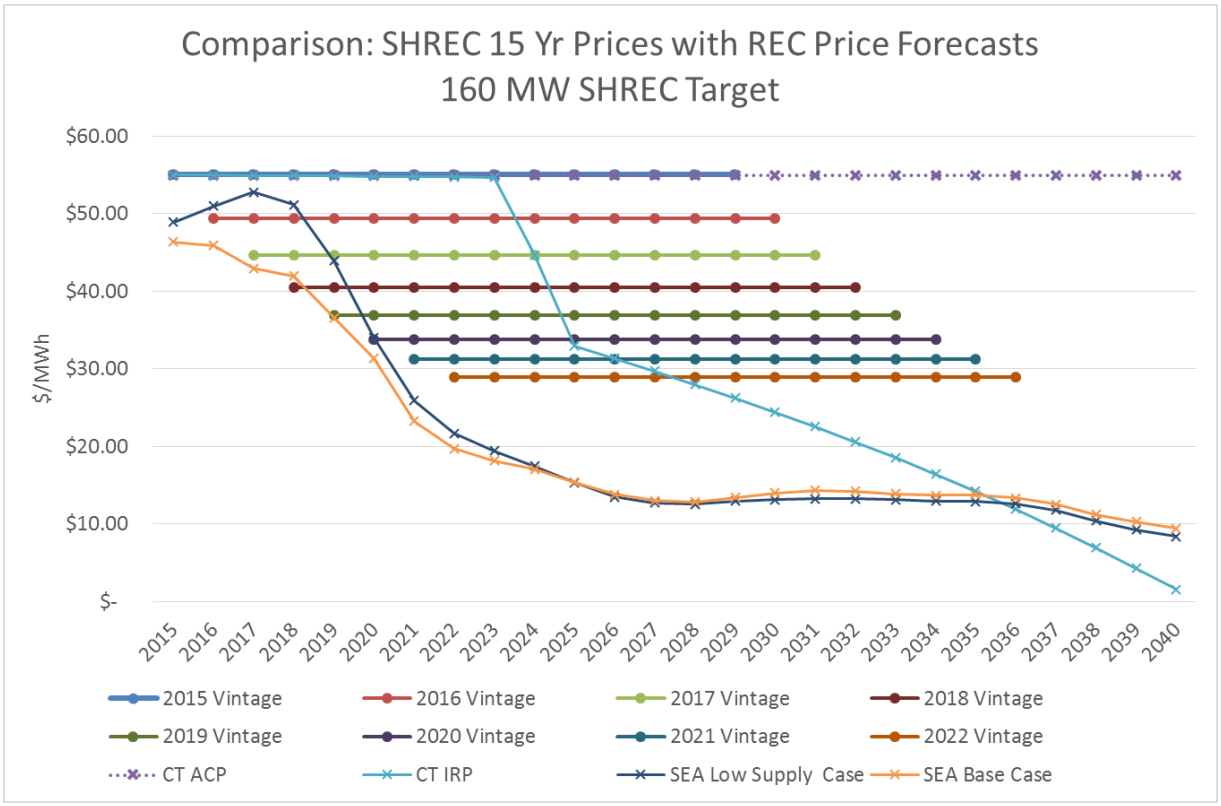


Figure 3: Comparison of SHREC Prices under 160 MW Targets to Class I Price Forecasts

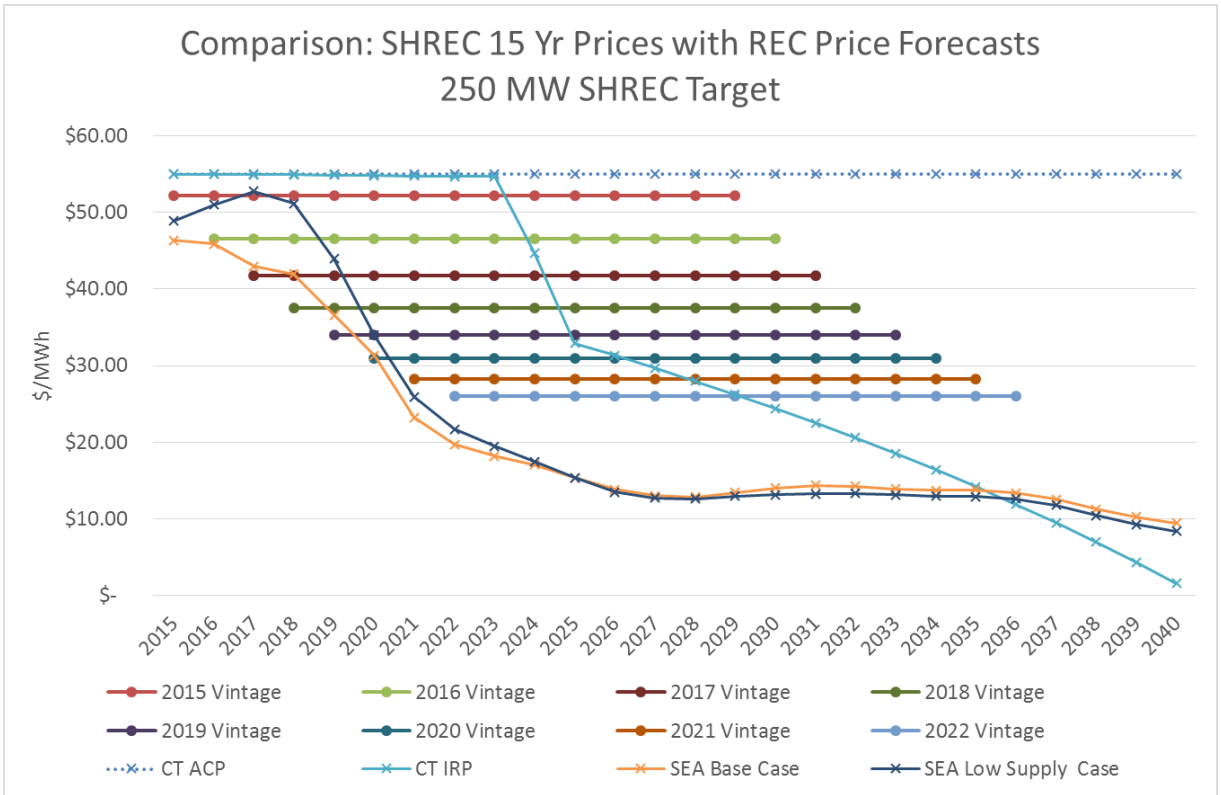


Figure 4: Comparison of SHREC Prices under 250 MW Targets to Class I Price Forecasts

In addition, the projected SHREC prices associated with each vintage year was compared to SEA's projections (described earlier) of costs associated with each vintage year for the current Small ZREC program (as if extended through 2022 to match the proposed SHREC program duration). The comparison is shown in Figure 5. As can be seen, the proposed SHREC program appears able to deliver RECs usable for Class I Compliance at a substantially lower per-REC price than the Small ZREC program. Also note that the proposed setting of SHREC prices on a programmatic basis allows for a smoother profile for SHREC prices over time, supporting a stable and robust residential market insulated from the potential for substantial contraction in the face of the drop in the Federal ITC after 2016.

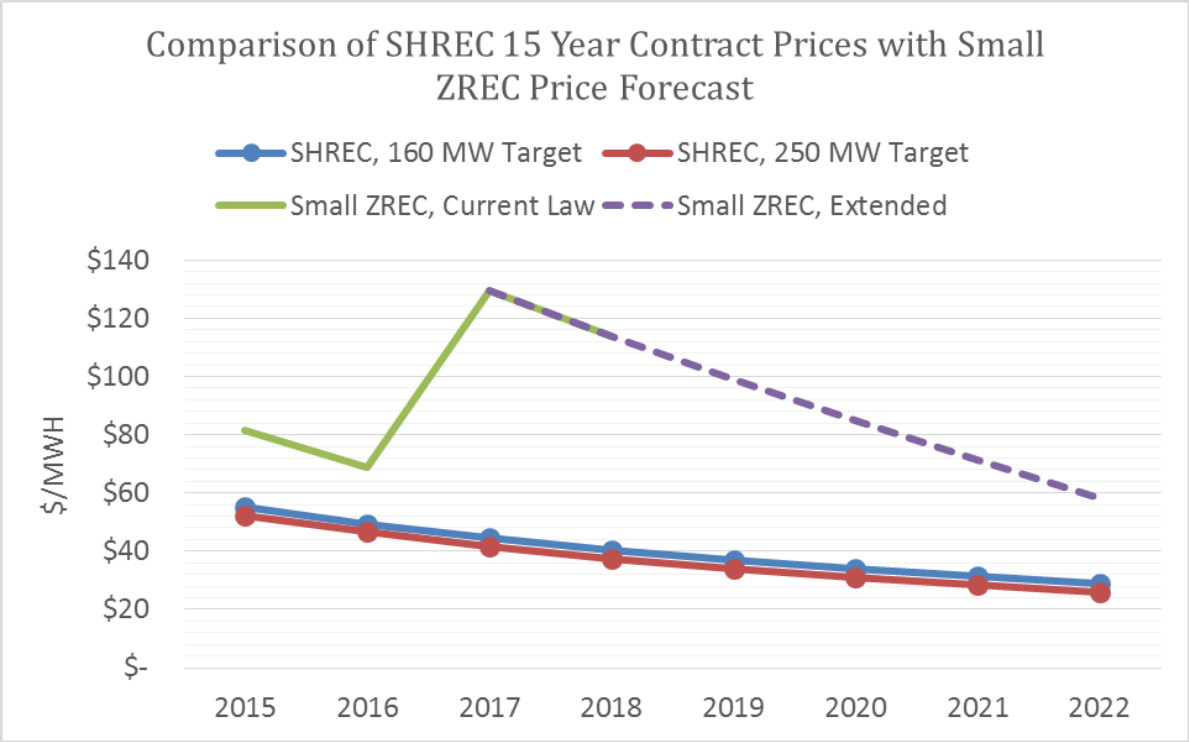


Figure 5: Comparison of SHREC Prices to Small ZREC Prices

Total Policy Cost to Ratepayers:

The components of the total policy cost to ratepayers between the SHREC policy cases and the BAU situation are summarized in Table 4. This description highlights that the cost to ratepayers is dependent on the market price of RECs.

Table 4: Components of Analysis of Total Policy Cost

Figure 6: Component	BAU	SHREC Policy Case
Upfront Incentive (PBI & HOPBI)	✓ from SBC	n/a: included in calculation of required SHREC price
CGB Overhead	✓ from SBC	n/a: included in calculation of required SHREC price
Securitization Interest	N/A	n/a: included in calculation of required SHREC price
Market-Priced RECs from each installation, Yrs 1-15	✓ Ratepayers have to pay market price for the associated volumes of RECs*	n/a
SHRECs from each installation, Yrs 1-15	n/a	✓
Market-Priced RECs from each installation, Yrs 16-25	✓ Ratepayers have to pay market price for the associated volumes of RECs*	✓ Ratepayers have to pay market price for the associated volumes of RECs*

** = CGB receives market-priced revenues from periodic sale of RECs. For years 1-15, this revenue is accounted for separately. Thereafter it is assumed to be small and ignored.*

Figure 7 and Figure 8 show the results of calculations of total cost to ratepayers of the SHREC policy at 160 MW and 210 MW target levels compared to the BAU scenario, under each of the four Class I REC price forecasts. Consistent with Table 4 above, these projections account for SBC collections (in the BAU case), REC and SHREC payments, CGB overhead, and the cost of securitization. The different volumes involved confound comparisons on a per-REC basis, so these results are presented as the differences in the sum of RPS compliance and SBC cost for clarity. The weighted average SHREC price under 160 MW and 250 MW target scenarios are shown in Table 5.

Table 5: Weighted Average SHREC Price ($/MWh)

160 MW Target Case					250 MW Target Case			
Year	**$/MWh**	**Year**	**$/MWh**		**Year**	**$/MWh**	**Year**	**$/MWh**
2015	$55.08	2026	$37.08		2015	$52.24	2026	$34.42
2016	$52.66	2027	$37.08		2016	$49.81	2027	$34.42
2017	$49.13	2028	$37.08		2017	$46.28	2028	$34.42
2018	$46.29	2029	$37.08		2018	$43.45	2029	$34.42
2019	$44.08	2030	$36.94		2019	$41.28	2030	$34.26
2020	$41.96	2031	$36.13		2020	$39.20	2031	$33.40
2021	$40.00	2032	$34.91		2021	$37.28	2032	$32.11
2022	$38.35	2033	$33.46		2022	$35.67	2033	$30.59
2023	$37.08	2034	$32.12		2023	$34.42	2034	$29.20
2024	$37.08	2035	$30.86		2024	$34.42	2035	$27.91
2025	$37.08	2036	$30.09		2025	$34.42	2036	$27.13

Figure 7: Annual Ratepayer Cost/(Savings), 160 MW SHREC Targets vs. BAU, Various REC Prices

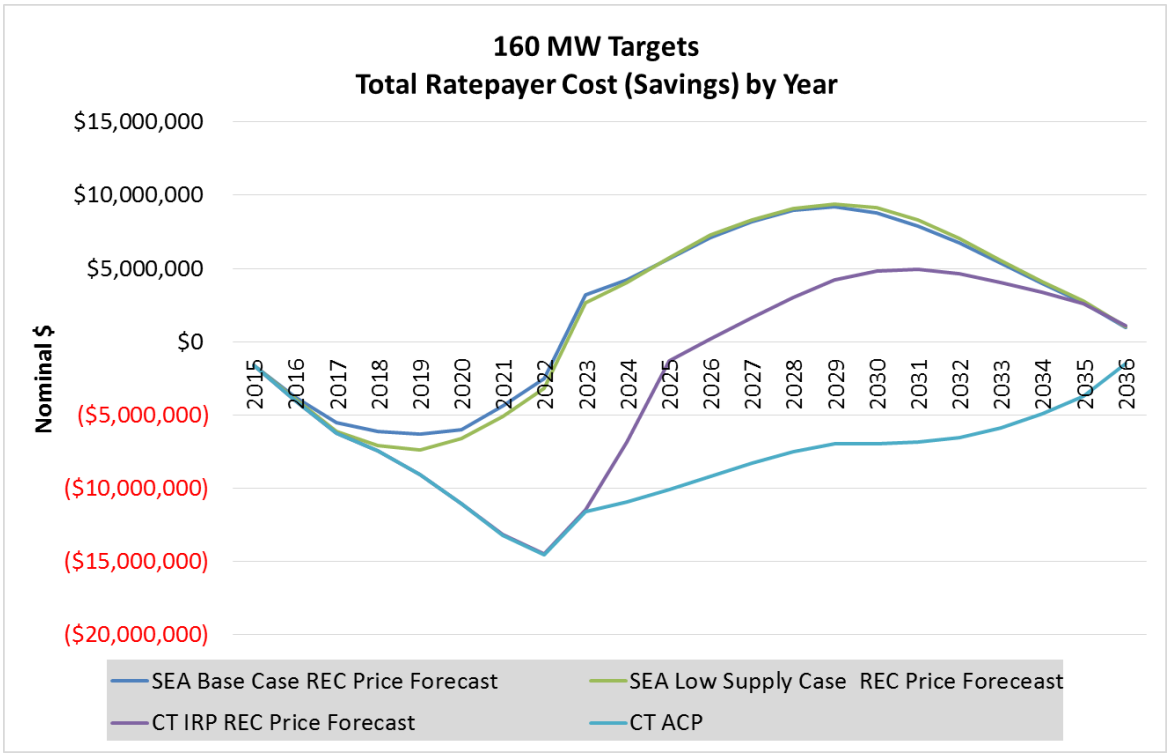
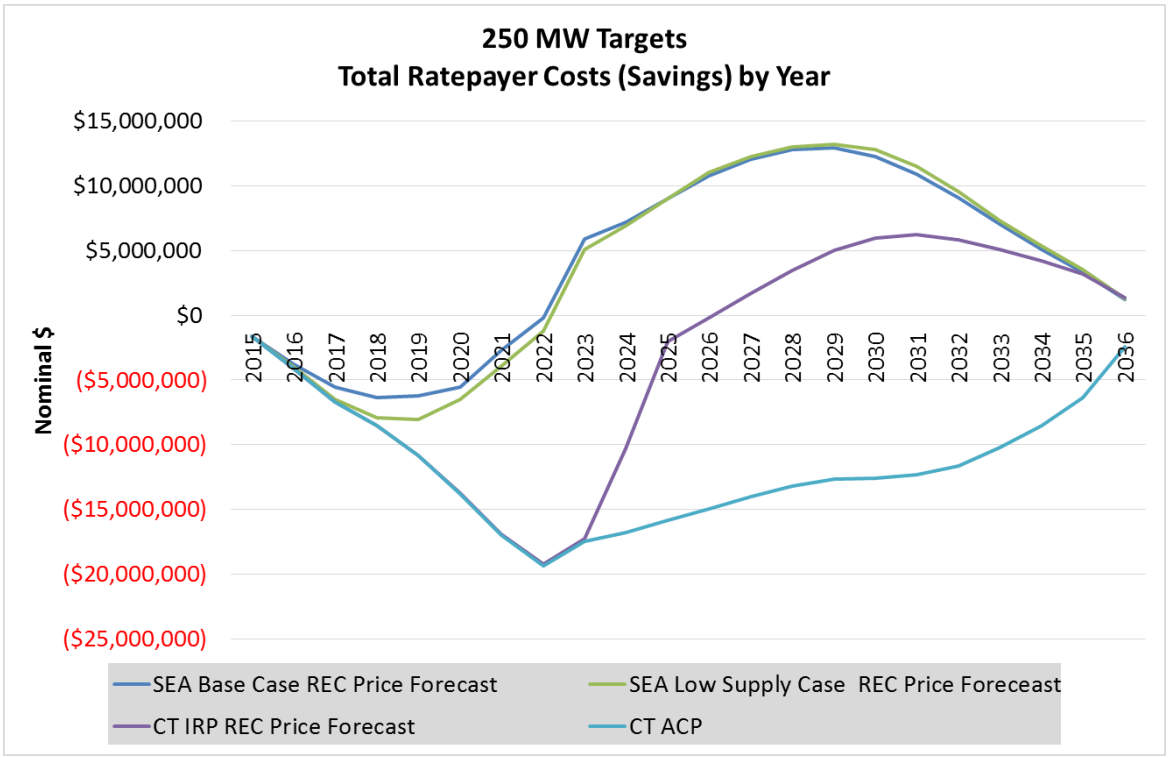


Figure 8: Annual Ratepayer Cost/(Savings), 250 MW SHREC Targets vs. BAU, Various REC Prices



As can be seen from these figures, the SHREC program, in addition to delivering more RECs from in-state sources with their commensurate economic benefits (not analyzed in this memo), delivers ratepayer savings in the earlier years. The quantity and duration is longer the higher the alternative REC price assumed, and highest compared to the ACP level which would apply under conditions of shortage.[13] Under futures in which Class I REC price decreases markedly – in which supply keeps up with demand in a regional basis and REC prices are dictated by the cost of entry in a competitive market, SHRECs may for the later years cost more than market REC prices. The balance of these factors is considered further below on a net present value basis. But for market REC prices at, or anywhere near the ACP… or for that matter, at any price materially above the weighted average SHREC prices shown in Table 5, SHRECs would continue to produce ratepayer savings.

One other important distinction between the BAU and SHREC policy cases is that, under BAU, CGB receives Class I REC revenue from resale over time of RECs from supported installations at market REC prices. These funds are available to be reinvested in more residential installations or other programs. In contrast, under the SHREC program, these RECs are monetized at known revenue, and securitization of these funds augments the SBC funding source.[14] So a true comparison must consider this accumulation of funds as well. These figures are shown below alongside aggregate costs or savings on a NPV basis.

Summary Statistics on a Net Present Value Basis:

To summarize and compare the resulting costs or savings to ratepayers shown in Figure 7 and Figure 8 above, the net present value (NPV) of these results was calculated using two alternative discount rates: 3% (nominal) per year, a value commonly used to reflect a 'societal' perspective, and 4.5% (nominal) per year, the assumed cost of securitization interest for CGB. The NPV costs or savings to ratepayers is shown under each of the four REC price forecasts, in addition to the NPV of REC revenue sales coming back to CGB in the BAU case. Figure 9 presents results using a 3% discount rate, and Figure 10 presents results using the 4.5% discount rate.

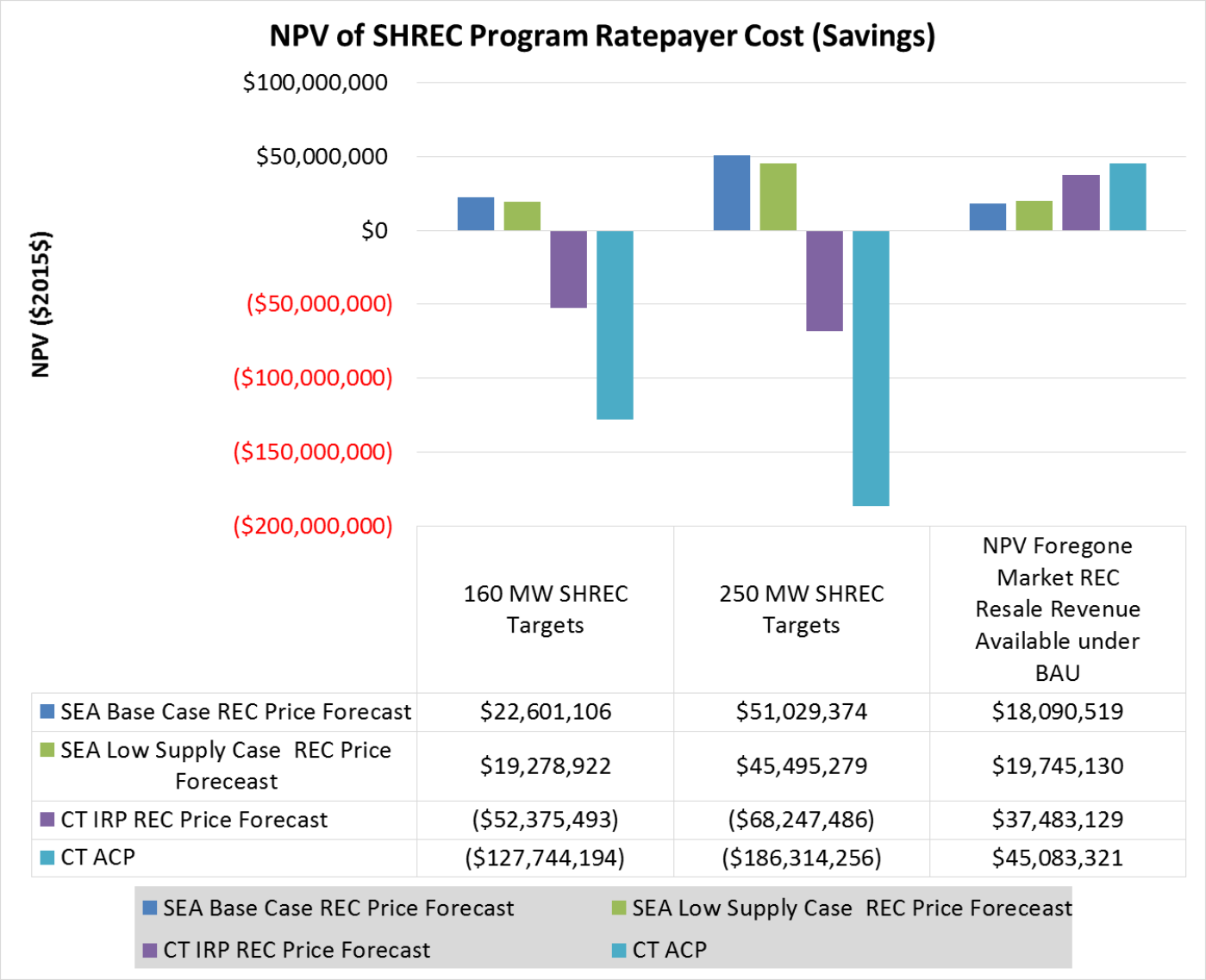
As can be seen, at 3% discount rate, in the two lower REC price futures, there would be a net cost to ratepayers under the SHREC program of NPV $19. 3 to $22.6 million (160 MW targets) or $45.5 to $51.0 million (250 MW targets), not accounting for the other benefits of allowing for expansion of the residential PV market and its commensurate economic benefits to Connecticut (the calculation of which are beyond the scope of this memo). In these cases, the NPV of $18.1 - $19.7 million would accumulate back to CGB for REC sales under the BAU scenario are foregone. In contrast, under the two higher REC cost cases – the CT draft IRP and ACP alternative futures, there are savings to ratepayers under the SHREC program of a far greater magnitude: NPV $51.4 to $112.6 million (160 MW targets) or $66.4 to $162.3 million (250 MW targets). In these cases, the quantity of REC resale revenue accruing to CGB under the BAU scenario that is foregone is $33.8 to $40.3 million, far smaller than the savings realized.

[13] We note that the recent termination of Cape Wind power purchase agreements increases the likelihood that such conditions will apply in some years, compared to the Draft IRP or SEA Base Case which assume Cape Wind operation.

[14] For purposes of this analysis, we have not assumed SBC funds were used for the SHREC policy; in practice CGB would likely utilize both securitized SHREC revenues and SBC funds.

Under the 4.5% discount rate, the magnitudes of the NPV figures are slightly lower, but the nature of the conclusions holds.[15]

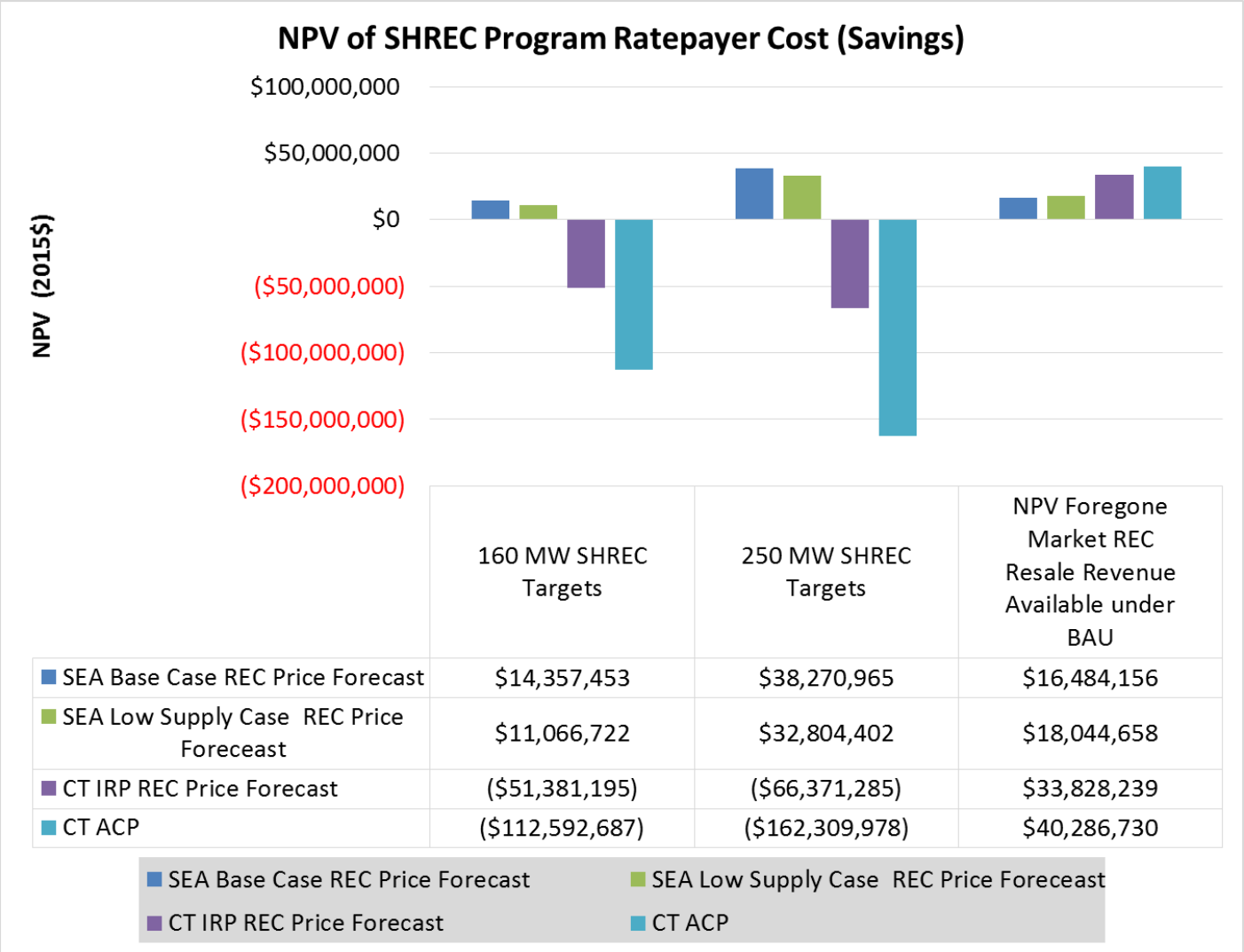
Figure 9: NPV Total Ratepayer Cost/(Savings), CGB REC Sale Revenue, 3% Discount Rate (2015 $)



	160 MW SHREC Targets	250 MW SHREC Targets	NPV Foregone Market REC Resale Revenue Available under BAU
SEA Base Case REC Price Forecast	$22,601,106	$51,029,374	$18,090,519
SEA Low Supply Case REC Price Foreceast	$19,278,922	$45,495,279	$19,745,130
CT IRP REC Price Forecast	($52,375,493)	($68,247,486)	$37,483,129
CT ACP	($127,744,194)	($186,314,256)	$45,083,321

[15] The analysis under different discount rates suggests that the qualitative nature of the results is not highly sensitive to the discount rate chosen.

Figure 10: NPV Total Ratepayer Cost/(Savings), CGB REC Sale Revenue, 4.5% Discount Rate (2015 $)



	160 MW SHREC Targets	250 MW SHREC Targets	NPV Foregone Market REC Resale Revenue Available under BAU
SEA Base Case REC Price Forecast	$14,357,453	$38,270,965	$16,484,156
SEA Low Supply Case REC Price Foreceast	$11,066,722	$32,804,402	$18,044,658
CT IRP REC Price Forecast	($51,381,195)	($66,371,285)	$33,828,239
CT ACP	($112,592,687)	($162,309,978)	$40,286,730

5 Conclusions

The potential costs of the CGB's proposed SHREC program were estimated and compared to a range of relevant benchmarks. Based on this analysis, we make the following findings:

- Over its life, the proposed SHREC program is expected to save ratepayers as much as NPV $186 million (in 2015 dollars) compared to Class I RPS compliance at the ACP.
- Substantial lifetime NPV savings are projected over a wide range of projected future Class I market REC prices, spanning Class I REC prices ranging from below the DEEP's draft IRP Class I REC price projections up to the ACP, and in general, at any REC prices above the weighted average SHREC price calculated herein. The program can provide these savings while simultaneously allowing substantial expansion of the residential solar PV market without requiring a separate source of increased incentive funding, realizing increased in-state economic benefits (relative to regional market Class I REC purchases).[16]

[16] Analysis of such benefits is beyond the scope of this memorandum.

- SHREC prices are projected to be moderately more costly than market Class I RECs after the first few years of the analysis when compared to more supply-robust regional REC assumptions, which presumes adequate Class I supply availability over the analysis period with priced trending toward the cost of entry of land-based wind assuming a material degree of regional transmission cost allocation to ratepayers (i.e. not reflected in the REC prices). Particularly in the face of the recent termination of the Cape Wind power purchase agreements by National Grid and Northeast Utilities, there is reasonable probability that such sustained supply-robust assumptions will not be maintained in all years, resulting in periodic price spikes towards the ACP which would increase the likelihood of SHREC savings.
- The SHREC program appears able to offer materially lower cost per REC than the current Small ZREC program, both over its current life and thereafter. Further, it can be crafted in a manner that can insulate the residential solar market from a price spike, in the event of expiration of the current 30% Federal ITC, that might otherwise lead to a contraction of the residential market, and avoid the expected increase in small ZREC prices prompted by the same ITC expiration.
- In the next five years, the probability is quite low that in any year the SHREC price would be higher than the market Class I REC price trend; thus the probability of annual RPS compliance cost savings during that period is quite high.
- After roughly five years (2019/2020), under the lowest-cost market REC price futures considered, the annual SHREC prices could exceed market Class I REC prices, but even under such forecasts, the aggregate savings persist through roughly 2022 before the SHREC program would be shown to have net positive costs compared to the market REC price forecast.
- In the 10-year and longer timeframe, the magnitude of savings in higher REC price futures substantially outweighs the degree of cost in the low REC price futures (under which aggregate ratepayer cost of RPS compliance is lower, substantially mitigating any SHREC price premium). Under a wide range of reasonably probably market Class I REC price futures, the proposed SHREC appears to provide a valuable hedge to Connecticut ratepayer Class I RPS compliance costs at the expected SHREC prices.
- Finally, this analysis contains an additional element of conservatism which suggests that the outcome for Connecticut ratepayers could be further improved. This analysis assumes that the EDCs periodically resell the SHRECs that they purchase in the market as Connecticut Class I RECs, passing along to distribution customers a credit or charge calculated as the difference between the SHREC price and the Connecticut Class I market REC price. Connecticut Class I REC prices are capped at $55 per MWh, while REC prices in Massachusetts[17] may approach a materially higher ACP under conditions of shortage ($67.21 per MWh in 2015, continuing to escalate with inflation). So, if Connecticut EDCs resell SHRECs as Massachusetts Class I RECs during times of regional shortage, the direct ratepayer benefits could be greater.

[17] RECs from behind-the-meter generation are not uniformly eligible for use for compliance with other state RPS requirements; however, Massachusetts allows such RECs from Connecticut and other New England states.

Appendix A: Sustainable Energy Advantage, LLC

Sustainable Energy Advantage, LLC has been a national leader on the analysis of renewable energy policy and markets for over 15 years, supporting the decision-making of nearly 200 clients, including 40 governmental entities. By providing market, policy, strategic and financial analysis and support, SEA helps its clients develop wholesale and retail renewable electricity businesses and projects; public policies and incentive programs; and market infrastructure. SEA focuses exclusively on surmounting the barriers to and tapping the potential of clean, renewable energy sources. As a result, the SEA team can bring an unparalleled level of focus, knowledge, experience, expertise, insight and credibility to the challenges faced by our clientele. SEA is known and respected widely as an independent analyst, a reputation earned through the firm's ability to identify and assess all stakeholder perspectives, conduct analysis that is objective and valuable to all affected, and provide advice and recommendations that are in touch with market realities and dynamics.

SEA's services, practice areas and experience include the following:

- ***Renewable Energy Public Policy Analysis, Development and Implementation.***
- ***Market Analysis and Quantitative Modeling.***
- ***Financial Modeling & Advisory Services.***
- ***Strategy Development.***
- ***Renewable Energy Supply & Procurement***.
- ***Business Infrastructure Development***.
- ***Transaction Facilitation, Contract Development and Negotiation Support***.
- ***Due Diligence***
- ***Green Power Product Development and Pricing***

For more information, see www.seadvantage.com.

Appendix B: SHREC Legislative Proposal

Raised Bill No. ____

January Session, 2015 Solar Home and Jobs Opportunity Act

AN ACT CONCERNING SOLAR HOMES AND JOBS

Section 1. Section 16-245ff of the general statutes is repealed and the following is substituted in lieu thereof (Effective July 1, 2015):

(a) The Connecticut Green Bank established pursuant to section 16-245n shall structure and implement a residential solar investment program established pursuant to this section, which shall result in a minimum of 300 megawatts of new residential solar photovoltaic installations located in this state on or before December 31, 2022, the procurement and cost of which shall be determined by the bank in accordance with this section.

(b) The Connecticut Green Bank 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. The bank shall consider willingness to pay studies and verified solar photovoltaic system characteristics, such as operational efficiency, size, location, shading and orientation, when determining the type and amount of incentive.

(c) The Connecticut Green Bank shall develop and publish on its 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. Such schedule shall: (1) Provide for a series of solar capacity blocks the combined total of which shall be a minimum of 300 megawatts and projected incentive levels for each such block; (2) provide incentives that are sufficient to provide the residential 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. 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. 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 twenty per cent or more.

(d) The Connecticut Green Bank shall establish and periodically update program guidelines, including, but not limited to, requirements for systems and program participants related to: (1) Eligibility criteria; (2) standards for deployment of energy efficient equipment or building practices as a condition for receiving incentive funding; (3) procedures to provide reasonable assurance that such reservations are made and incentives are paid out only to qualifying residential solar photovoltaic systems demonstrating a high likelihood of being installed and operated as indicated in application materials; and (4) reasonable protocols for the measurement and verification of energy production.

(e) The Connecticut Green Bank shall maintain on its web site the schedule of incentives, solar capacity remaining in the current block and available funding and incentive estimators.

(f) Funding for the residential performance-based incentive program and expected performance-based buydowns (i) may include up to one-third of the moneys collected annually under the surcharge specified in section 16-245n; (ii) may include revenue from the solar home renewable energy credit program; and (iii) may be supplemented by federal funding as may become available.

(g) The Connecticut Green Bank 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.

(h) 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 (a) of this section.

(i) Commencing on January 1, 2016, and within the period established in section 2 of this act, the Connecticut Green Bank and the electric distribution companies shall file with the Public Utilities Regulatory Authority for its approval a master purchase agreement for the purchase by the electric distribution companies of solar home renewable energy credits produced by eligible residential customer-sited generating projects over the duration of the purchase agreement. The master purchase agreement shall have a term of fifteen years.

(j) For purposes of this section, solar home renewable energy credits means renewable energy credits owned by the Connecticut Green Bank which are produced by eligible residential customer-sited generating projects. For purposes of this section, eligible residential customer-sited generating projects means solar photovoltaic projects which receive funding from the Connecticut Green Bank, are certified by the authority as Class I renewable energy sources, as that term is defined in subsection (20) of section 16-1 of the general statutes, that emit no pollutants, are less than twenty kilowatts in size, are located on the customer side of the revenue meter of one-to-four-family homes and serve the distribution system of the electric distribution company.

(k) The production of a megawatt hour of electricity from an eligible residential customer-sited generating project with an approved incentive from the Connecticut Green Bank on or after January 1, 2015, shall create one solar home renewable energy credit. A solar home renewable energy credit shall have an effective life covering the year in which the credit was created and the following calendar year. The obligation of the electric distribution companies to purchase solar home renewable energy credits pursuant to the Master Purchase Agreement shall be apportioned to electric distribution companies based on their respective distribution system loads at the commencement of the master purchase agreement period, as determined by the authority.

(l) Notwithstanding subdivision (1) of subsection (h) of section 16-244c, an electric distribution company may retire the solar home renewable energy credits it procures through the master purchase agreement to satisfy its obligation pursuant to section 16-245a.

Sec. 2. (NEW) (Effective from passage):

a) To develop the master purchase agreement described in section 1 of this act, the Connecticut Green Bank and each electric distribution company shall negotiate in good faith the final terms of the draft master purchase agreement. After thirty days, any party may request the assistance of the Public Utilities Regulatory Authority to resolve any outstanding issues. No such master agreement may become effective without approval of the authority.

(b) To carry out the purposes of section 1 of this act, the Connecticut Green Bank and the electric distribution companies shall, not later than one hundred eighty days after July 1, 2015, negotiate and develop the master purchase agreement and submit such agreement to the authority for its approval. The authority shall hold a hearing that shall be conducted as an uncontested case, in accordance with the provisions of chapter 54, to approve, reject or modify an application for approval of the master purchase agreement.

(c) The purchase price of solar home renewable energy credits shall be determined by the Connecticut Green Bank and shall not exceed the lesser of the price of small zero-emission renewable energy credit projects for the preceding year or the alternative compliance payment pursuant to section 16-245(k) of the general statutes.

(d) The electric distribution companies shall be entitled to recover their reasonable costs and fees prudently incurred of complying with the master purchase agreement through a reconciling component of electric rates as determined by the authority. Nothing in this section shall preclude the resale or other disposition of energy or associated renewable energy credits purchased by the electric distribution companies, provided the distribution company shall net the cost of payments made to projects under the master purchase agreement against the proceeds of the sale of energy or renewable energy credits and the difference shall be credited or charged to distribution customers through a reconciling component of electric rates as determined by the authority that is nonbypassable when switching electric suppliers.

Appendix C: Key Assumptions

In support of this analysis, several key assumptions were utilized, summarized as follows:

PV Systems: SEA developed a range of forecasts of projected installed cost for residential solar installations in Connecticut. The forecasts were informed by (i) historic installed cost data from Connecticut and other relevant states; (ii) a survey of recent, publically-available installed cost trend forecasts; (iii) system size typical of the current Connecticut residential solar fleet; and (iv) a breakdown of installed cost components, based on Connecticut residential solar data from the last 12 months. Each component of cost was projected at an appropriate index representing either SEA's projected module cost trend or an inflation index.[18] The PV installed cost trends developed by SEA for this analysis is shown in Figure 11 below.

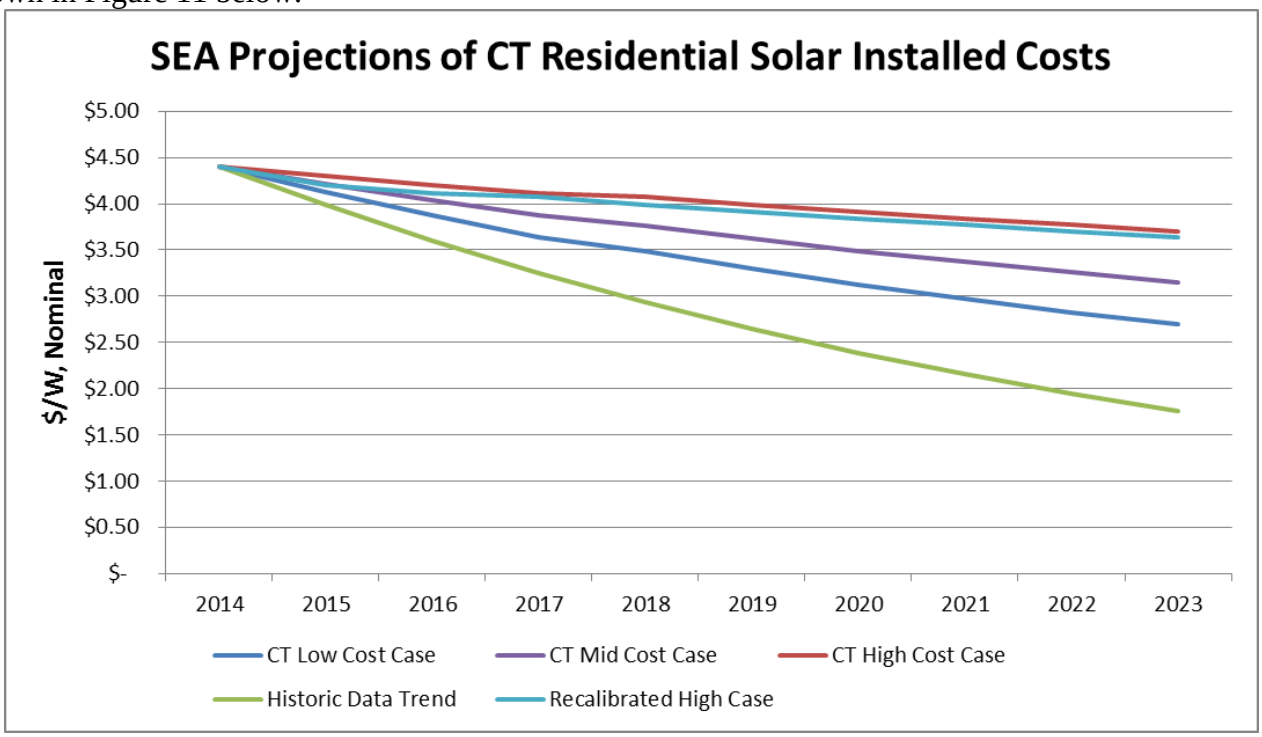


Figure 11: Projections of Installed Cost

After consultation with CGB, the CT High Cost Case was selected for use in this analysis, with a minor modification (referred to in Figure 11 as the Recalibrated High Case) to recalibrate the trend based on the most recent cost data available to CGB for early 2015 residential PV installations.[19] SEA considers this projection to be conservative. The historic trend for module costs and installed costs has been decreasing at a greater rate, costs typically decline to a modest degree as the industry achieves scale economies, and CGB is exerting effort to reduce soft costs via the D.O.E. Sunshot Initiative (e.g., permitting costs), and Solarize Connecticut (e.g., customer acquisition cost). As a result, there are many reasons to believe that ultimate cost to ratepayers will be lower, and savings to ratepayers higher, than projected in this memo.

[18] For inflation, we used CPI All Urban Customers (1982=1.00) from EIA Annual Energy Outlook 2014.
[19] The 2015 cost per Watt was set to equal the average of the most recent data, while the trend matched SEA's CT High Cost Case.

PV systems were assumed to have an average size of 7 kW (dc), a 16% year 1 capacity factor relative to the nameplate DC rating, and to have a system production degradation rate of 0.5% per year.

Avoided Utility Retail Rates: The value of retail rates avoided by production from residential solar installations was determined by trending current CL&P and UI rates by appropriate indices.[20] The projection started with projected 2015 rates for each utility based on current transmission and distribution rate cases with orders pending, and recent generation standard service rate cases. Individual charges were trended as summarized in Table 6.

Table 6: Trend Assumptions for Projecting Avoided Residential Retail Rates

Category	Rate Component	Trending Assumption
Generation	G	SEA's Renewable Energy Market Outlook base case wholesale energy price trajectory
G-FMCC	G-FMCC	Inflation
Transmission	T	EIA AEO 2014 Northeast Transmission
Distribution	D	Inflation+1.5%
D-FMCC	FMCC DELIVERY CHARGE (Proposed - Weighted Average)	Inflation
Public Benefits Charges	SBC, COMPETITIVE TRANSITION ASSESSMENT, CONSERVATION CHARGE, CONSERVATION ADJUSTMENT MECHANISM, RENEWABLE ENERGY	Constant

The projected weighed average residential avoided retail rates are shown in Figure 12, based on an 80%/20% weighting of CL&P to UI.

[20] Customer charges are not avoidable.

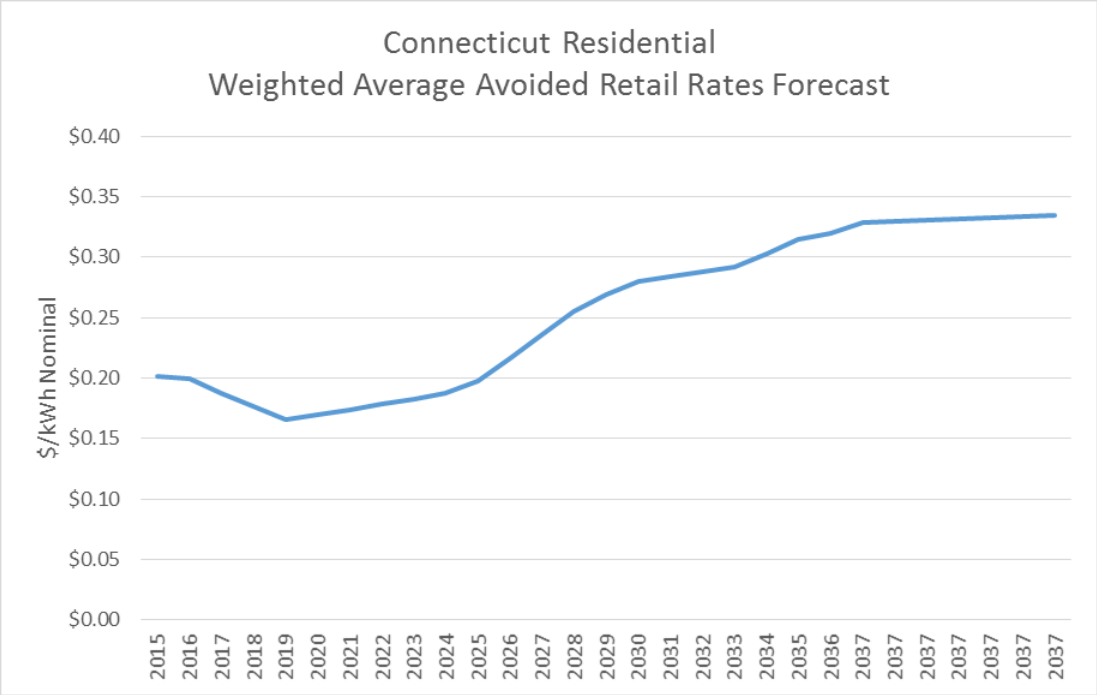


Figure 12: Avoided Utility Retail Rates, $/kWh[21]

Market Class I REC Prices: The SHREC prices calculated in this analysis are compared to various forecasts of market Class I REC prices; in addition, comparative calculations of ratepayer impacts and REC resale funds available to CGB also require market REC price forecasts. The benchmark forecasts used herein include two sets of Connecticut Class I REC prices forecasted by SEA as part of SEA's most recent New England Renewable Energy Market Outlook (REMO)[22] proprietary subscription-based market fundamentals service (Base Supply and Low Supply Case forecasts, presented on a 3-year rolling average basis); the Class I forecasts in DEEP's recently released draft Integrated Resource Plan[23]; and the Class I RPS Alternative Compliance Payment (ACP). These forecasts are shown in Figure 13.

[21] Note that the drop in projected retail rates tracks the forward market expectation of relief of natural gas pipeline constraints contributing to current elevated electricity generation prices.

[22] These forecasts were developed in December 2014 as part of SEA's REMO 2014#3 briefing. A High Supply Case was omitted from this analysis following the termination of Cape Wind power purchase agreements by Northeast Utilities and National Grid in early January 2015.

[23] Developed based on consultation with IRP consultants.

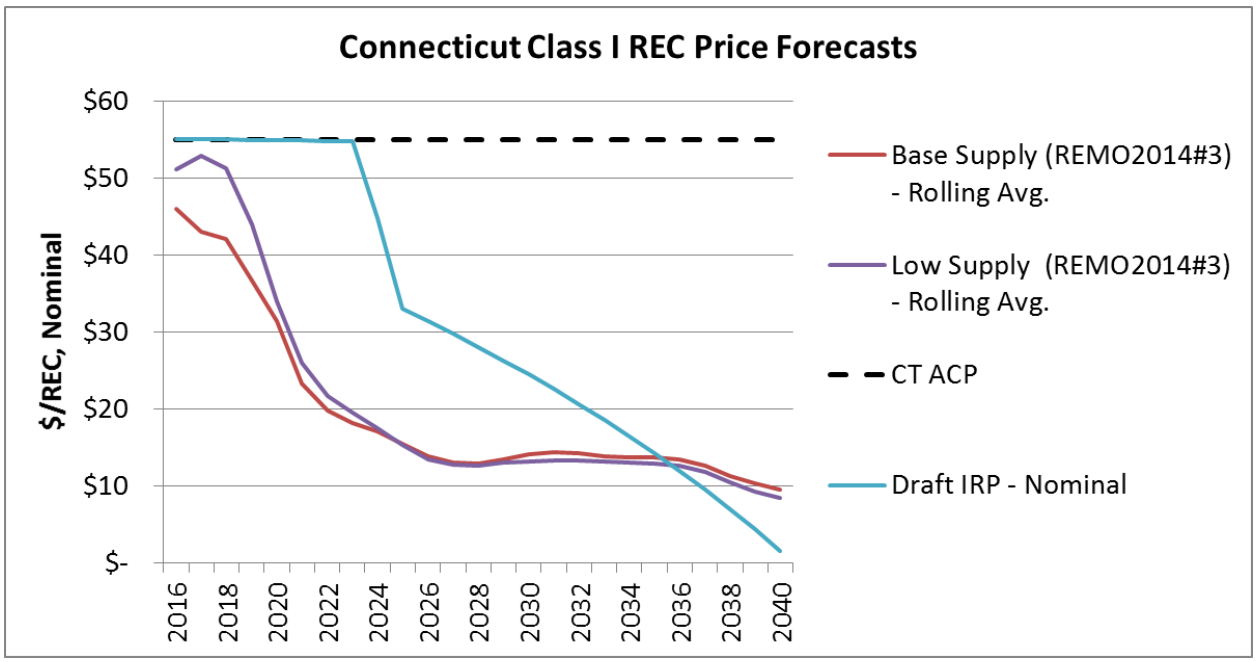


Figure 13: Connecticut Class I REC Price Benchmarks

Small ZREC Price Forecasts: In October of 2014, SEA developed a forecast of weighted average Small ZREC program prices through the end of installations under the current program (projected to occur in 2019) and beyond (assuming a continuation of the program using the corresponding installed cost trend), shown in Figure 14.[24]

Year	Small ZREC Price Forecast, $/MWh for Installation in Year Shown	
2015	$	81.58
2016	$	68.59
2017	$	129.46
2018	$	113.97
2019	$	99.14
2020	$	84.93
2021	$	71.31
2022	$	58.26

Figure 14: Small ZREC Price Forecast

Financing: The cost of financing by CGB to securitize SHREC payments to fund upfront incentives was assumed to be at a 4.5% annual interest rate.

[24] For comparison, CL&P announced on October 29, 2014 the Year 3 Small ZREC tariff rate, which equals 110% * Contracted Price for Medium ZRECs, is $80.97 per ZREC. The Year 2 CL&P Small ZREC Price was $103.01, and the Year 1 price was $164.22. More recently UI announced its Year 3 Small ZREC price as $84.04 per ZREC. UI's Year 2 price was $112.54/ZREC, and the Tear 1 price was $148.89 price.