DC Sustainable Energy Utility FY2021 Program Evaluation Report

FINAL

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SUBMITTED TO:
District of Columbia Department of Energy and Environment

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Table of Contents

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Executive Summary

NMR Group, EcoMetric Consulting, Demand Side Analytics, BluePath Labs, and Setty – collectively referred to as *the NMR team* – were contracted by the DC Department of Energy and Environment (DOEE) to evaluate the energy-efficiency and renewable energy programs implemented by the DC Sustainable Energy Utility (DCSEU). This report presents the results of the evaluation of the Fiscal Year 2021 (FY2021) programs.

In FY2021, the commercial sector represented 72% of tracked electric and gas savings across the DCSEU portfolio. This was largely driven by three custom commercial programs, in particular the Retrofit Custom program, as well as the commercial upstream lighting program (Table 1).

Evaluation Methodology

For the FY2021 evaluation, we completed the following activities:

Gross Savings Verification	Process Evaluation and Net Savings Estimation
• Tracking database review • Desk reviews • On-site visits • Billing analysis	• Surveys with participating customers • Interviews with solar developers

We targeted a subset of 14 programs for evaluation: eight commercial programs, three multifamily programs, five residential programs, and one solar program (Table 1). The NMR team selected the programs for the FY2021 evaluation because the programs represented a large share of portfolio savings, had not recently been evaluated, included a key measure of interest, and/or contributed to the DCSEU's performance benchmarks. See Section 1.5 for details of our sampling approach.

Appendix A provides descriptions for each of the program tracks offered by DCSEU in FY2021.

Table 1: FY2021 Program Evaluation Summary

Sector	Program Name	Track Number	Percent of FY2021 Tracked Gross Electric & Gas Savings	FY2021 Evaluation	
				Gross Savings Verification	NTG Estimation & Process Evaluation
Solar	Solar PV Market Rate	7101PVMR	6.0%	✓	✓
	Solar for All Community Renewable PV	7108CREF	n/a	✓	✓
	Solar for All Low-income Single-family PV	7109LISF	n/a	✓	
Commercial	C&I RX - Equipment Replacement	7511CIRX	4.0%	✓	✓
	Small & Medium Business Rebates	7511SMRX	>0.1%		✓
	Market Transformation Value	7512MTV	0.2%		✓
	Commercial Upstream - Lighting	7513UPLT	14.4%	✓	✓
	Retrofit - Commercial Custom	7520CUST	39.6%	✓	✓
	Market Opportunity - Commercial Custom	7520MARO	3.0%	✓	✓
	New Construction - Commercial Custom	7520NEWC	10.3%	✓	✓
	Pay for Performance	7520P4PX	0.9%	✓	
Low-income	Income Qualified Gas Efficiency Fund	4335IGEF	2.0%	✓	
	Implementation Contractor DI	7610ICDI	1.4%	✓	
	Income Qualified Efficiency Fund	7610IQEF	1.1%	✓	
	Low-income Multifamily Comprehensive	7612LICP	3.0%	✓	
	Low-income Prescriptive Rebate	7613LIRX	0.2%		
	Retail Lighting Food Bank	7717FBNK	2.1%	✓	
	Home Energy Conservation Kit – Low-income	7717HEKT	>0.1%		
Residential	Retail Efficient Appliances	7710APPL	0.1%		✓
	Retail Heating and Cooling	7710HTCL	0.6%		✓
	Retail Lighting	7710LITE	10.7%	✓	
	Nest Seasonal Savings	7710STAT	0.1%		
	Home Energy Conservation Kit – Market Rate	7710HEKT	0.1%		
	Innovation - Market Rate	7915INMR	0.0%		

The NMR team assigned FY2021 programs that did not undergo an evaluation a default gross savings realization rate based on either (1) FY2021 realization rates for similar programs or measures or (2) previous realization rates for the same program. Realization rates are the ratio of evaluated savings to tracked savings. See Section 4 for more details.

This report also includes the evaluation of two Solar For All programs administered by DCSEU that are funded outside of the Sustainable Energy Trust Fund. The evaluation approach and results for the Solar For All Low-income Single-family and Community Solar programs are described in Appendix C.

Evaluation Results

Table 2 displays the FY2021 tracked gross savings, realization rates, and evaluated savings for the DCSEU portfolio at the meter level. The NMR team estimates that the actual portfolio electric savings is 100% of the DCSEU tracked electric savings, the actual portfolio peak demand reduction is 104% of the DCSEU tracked peak demand reduction, and the actual portfolio gas savings is 100% of the DCSEU tracked gas savings.

Table 2: DCSEU FY2021 Portfolio-level Gross Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
Electric Savings (MWh)	99,633	100%	99,646
Peak Demand Savings (MW)	15.8	104%	16.4
Gas Savings (MMBtu)	119,018	100%	118,887

Table 3 displays the portfolio gross savings realization rates over the previous five years. Overall, the realization rates have remained fairly stable, ranging from 97% to 103% for electric savings, from 95% to 105% for peak demand savings, and 93% to 100% for gas savings.

Table 3: DCSEU Portfolio-level Gross Savings Realization Rates by Year

Savings Type	FY2021	FY2020	FY2019	FY2018	FY2017
Electric Savings Realization Rate	100%	103%	97%	99%	99%
Peak Demand Savings Realization Rate	104%	95%	96%	105%	96%
Gas Savings Realization Rate	100%	100%	94%	94%	93%

Table 4 compares the electric and demand savings realization rates for the DCSEU portfolio to those from neighboring utilities, including PECO Energy in Pennsylvania and Baltimore Gas & Electric (BG&E) in Maryland. Each of these utilities serves a large city (Philadelphia for PECO and Baltimore for BG&E), as well as the surrounding, less urban, region. At 100%, the electric savings realization rate for DCSEU exceeds the 96% value for BG&E and is less than the 103% value for PECO. At 104%, the demand savings realization rate for DCSEU exceeds the 103% value for BG&E and is lower the 126% figure for PECO.

Table 4: Comparison of Portfolio-level Realization Rates[1]

Savings Type	DCSEU FY2021	PECO Energy Program Year 11[2]	Baltimore Gas & Electric 2020[3]
Electric Savings	100%	103%	96%
Peak Demand Savings	104%	126%	103%

Table 5 displays the tracked gross savings, realization rates, and evaluated savings at the meter-level for each program in the DCSEU portfolio. Most of the program-level realization rates range from 95% to 105%, indicating that SEU is accurately estimating savings for most programs. However, we found realization rates for peak demand savings of 14% for the Pay for Performance track and 134% for the Commercial Custom Retrofit track. Additional details concerning those realization rates can be found in Section 2. For these programs, the accuracy of tracked savings could be improved. We offer our resulting recommendations in the following section.

[1] While these comparisons are useful, it is important to note that these jurisdictions may calculate savings differently than DCSEU which may affect realization rates.
[2] Pennsylvania SWE Annual Report Act 129 Program Year 11. NMR Group, Demand Side Analytics, Brightline Group. May 25, 2021. http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx
[3] Verification of the 2020 Empower Maryland Energy Efficiency Program Impact and Cost-Effectiveness Evaluations. Itron, October 29, 2021. https://sites.google.com/view/empowermarylandevaluation/home

Table 5: DCSEU Gross Meter-level Program Realization Rates and Savings

Sector	Program Name	Track Number	FY2021 Electric Savings (MWh)			FY2021 Peak Demand Savings (MW)			FY2021 Gas Savings (MMBtu)		
			Tracked	Realization Rate	Evaluated	Tracked	Realization Rate	Evaluated	Tracked	Realization Rate	Evaluated
Solar	Solar PV Market Rate	7101PVMR	8,085	100%	8,076	1.98	101%	1.99	-	-	-
Commercial	C&I RX - Equipment Replacement	7511CIRX	5,853	105%	6,118	0.68	101%	0.68	(1,787)	103%	(1,848)
	Small & Medium Business	7511SMRX	51	105%	53	0.006	101%	0.006	(16)	103%	(16)
	Market Transformation Value	7512MTV	315	108%	340	0.04	139%	0.06	(92)	107%	(98)
	Upstream - Lighting	7513UPLT	21,389	106%	22,773	2.85	105%	2.99	(6,824)	106%	(7,230)
	Retrofit - Commercial Custom	7520CUST	22,479	93%	20,810	3.06	134%	4.09	105,135	100%	105,263
	Market Opportunity - Custom	7520MARO	498	100%	498	0.13	98%	0.13	12,255	98%	11,974
	New Construction - Custom	7520NEWC	8,258	100%	8,285	2.56	96%	2.48	19,273	102%	19,721
	Pay for Performance	7520P4PX	1,176	100%	1,176	0.53	14%	0.08	-	-	-
Low-income	Income Qual Gas Eff Fund	4335IGEF	3	101%	3	-	-	-	9,086	99%	8,999
	Implementation Contractor DI	7610ICDI	-	-	-	-	-	-	6,390	100%	6,390
	Income Qual Efficiency Fund	7610IQEF	1,133	101%	1,139	0.27	101%	0.27	1,185	100%	1,182
	Multifamily Comprehensive	7612LICP	3,890	99%	3,866	0.57	100%	0.57	484	109%	529
	Prescriptive Rebate	7613LIRX	386	100%	386	0.03	100%	0.03	(455)	101%	(460)
	Retail Lighting Food Bank	7717FBNK	4,718	100%	4,718	0.44	100%	0.44	-6,568	100%	(6,568)
	Home Energy Cons Kit - LI	7717HEKT	89	100%	89	0.01	100%	0.01	(1)	100%	(1)
Residential	Retail Efficient Appliances	7710APPL	139	100%	139	0.02	100%	0.02	73	100%	73
	Retail Heating and Cooling	7710HTCL	218	103%	224	0.07	100%	0.07	1,957	105%	2,055
	Retail Lighting	7710LITE	20,613	100%	20,613	2.35	100%	2.35	(21,070)	100%	(21,070)
	Nest Seasonal Savings	7710STAT	136	100%	136	0.13	100%	0.13	-	-	-
	Home Energy Cons Kit - MR	7710HEKT	196	100%	196	0.01	100%	0.01	(3)	100%	(3)
	Residential Midstream	7725RSUP	9	100%	9	-	-	-	(5)	100%	(5)
	Innovation - Market Rate	7915INMR	-	-	-	-	-	-	-	-	-
Portfolio			**99,633**	**100%**	**99,646**	**15.75**	**104%**	**16.41**	**119,018**	**100%**	**118,887**

Table 6 displays the modified gross tracked savings and evaluated savings at the generator-level for each program in the DCSEU portfolio. The modified gross generator-level savings are calculated by increasing gross meter-level electric savings by 4.6% and gross meter-level demand savings by 7.7% to adjust for line losses. In addition, modified gross gas savings are calculated from gross gas savings by excluding the cross-fuel interactive effects that reflect the increase or decrease in energy usage due to the installation of an energy-efficiency measure.[4]

[4] A common example is energy-efficient lighting: an LED bulb installed in conditioned space produces less waste heat than an incandescent bulb, which then reduces the energy consumption from cooling equipment but increases consumption from heating equipment. In this case, the cooling savings is a like-fuel interactive effect (the lighting and cooling equipment both use electricity), while the heating penalty is likely a cross-fuel interactive effect (the lighting uses electricity, while the heating equipment likely uses gas).

Table 6: DCSEU Modified Gross Generator-level Program Savings

Sector	Program Name	Track Number	FY2021 Electric Savings (MWh)		FY2021 Peak Demand Savings (MW)		FY2021 Gas Savings (MMBtu)	
			Tracked	Evaluated	Tracked	Evaluated	Tracked	Evaluated
Solar	Solar PV Market Rate	7101PVMR	8,456	8,447	2.13	2.14	-	-
Commercial	C&I RX - Equipment Replacement	7511CIRX	6,122	6,399	0.73	0.73	-	-
	Small & Medium Business	7511SMRX	53	56	0.01	0.01	-	-
	Market Transformation Value	7512MTV	329	355	0.05	0.07	-	-
	Upstream - Lighting	7513UPLT	22,373	23,820	3.06	3.22	-	-
	Retrofit - Commercial Custom	7520CUST	23,513	21,767	3.29	4.41	109,627	109,245
	Market Opportunity - Custom	7520MARO	521	521	0.14	0.14	12,263	11,980
	New Construction - Custom	7520NEWC	8,638	8,666	2.77	2.67	19,407	19,797
	Pay for Performance	7520P4PX	1,230	1,230	0.57	0.08	-	-
Low-income	Income Qual Gas Eff Fund	4335IGEF	3	3	-	-	9,086	8,999
	Implementation Contractor DI	7610ICDI	-	-	-	-	6,390	6,390
	Income Qual Efficiency Fund	7610IQEF	1,185	1,191	0.29	0.29	1,619	1,603
	Multifamily Comprehensive	7612LICP	4,069	4,044	0.61	0.61	1,731	1,731
	Prescriptive Rebate	7613LIRX	404	404	0.04	0.04	-	-
	Retail Lighting Food Bank	7717FBNK	4,935	4,935	0.47	0.47	-	-
	Home Energy Cons Kit - LI	7717HEKT	93	93	0.01	0.01	19	19
Residential	Retail Efficient Appliances	7710APPL	145	145	0.02	0.02	73	73
	Retail Heating and Cooling	7710HTCL	228	234	0.08	0.08	1,957	2,055
	Retail Lighting	7710LITE	21,560	21,560	2.53	2.53	-	-
	Nest Seasonal Savings	7710STAT	142	142	0.14	0.14	-	-
	Home Energy Cons Kit - MR	7710HEKT	205	205	0.01	0.01	42	42
	Residential Midstream	7725RSUP	10	10	0.00	0.00	-	-
	Innovation - Market Rate	7915INMR	-	-	-	-	-	-
Portfolio			**104,214**	**104,228**	**16.96**	**17.67**	**162,215**	**161,934**

Recommendations

Our evaluation of the FY2021 programs found that DCSEU expended the appropriate amount of effort and rigor on their savings calculations. In general, the documentation provided was sufficient, and the methods and assumptions were suitable. The evaluation team believes the DCSEU calculated energy savings with a reasonable degree of accuracy.

However, our evaluation yielded specific recommendations for most programs, as described below. We offer two general types of recommendations: to improve the accuracy of savings calculations and to improve program design and delivery. Because most of the evaluation effort focuses on verifying the DCSEU tracked savings, the savings accuracy recommendations represent the majority of our recommendations. To more easily distinguish between the two types of recommendations, we have bolded and italicized the program design and delivery recommendations.

While DCSEU prescriptive savings estimates were reasonable in aggregate for the FY2021 programs, the NMR team believes the DCSEU can continue to improve calculation methods and should prioritize improvements that offer the most cost-effective outcomes. The NMR team provides one recommendation that applies to multiple programs.

- Apply project- specific efficiency levels, fixture wattages, peak summer coincident demand factors, and other inputs to improve the accuracy of tracked peak demand savings when feasible. DCSEU applied deemed load shapes from the TRM to the custom project calculations. In these cases, project-specific input values could be used, which would improve the accuracy of tracked peak demand savings. DCSEU should examine how integrating site-specific information within the tracking system can be done efficiently when these data are already collected from customers.

For the Custom Retrofit program, we offer the following recommendations:

- Six of the thirty-one sampled projects were not retrofits or equipment replacements; rather, they were new construction or gut rehab projects. Consider including all new construction projects (i.e., those with theoretical baselines based on building energy code) in the Commercial New Construction program.
- Include a narrative within each project that describes the approach to estimating energy savings for all measures. Provide references to relevant spreadsheets and external sources of inputs for savings calculations.
- Consider adding a separate load shape peak demand value for air conditioning systems in school facilities. The “Commercial A/C” value is not appropriate for schools, which typically have limited operation over the summer (i.e., during most of the peak coincident period).

For the Commercial New Construction program, we offer the following recommendations:

- NMR recommends that SEU change their approach to estimating peak coincident demand savings for projects for which a building simulation model was developed. The outputs from most building simulation software includes only total load reduction by end-

use category. SEU then typically applies the "Commercial A/C" load shape value for peak coincident demand to calculate peak demand savings. NMR recommends determining a project-specific load shape (or coincidence factor) value for each project, based on the actual operating conditions of the facility.

- If TRM deemed load shape values are used to calculate peak demand savings, ensure that each measure involved in the project is assigned the most appropriate load shape value.

For the Market Opportunities program, we offer the following recommendations:

- Utilize Typical Meteorological Year weather data to weather-normalize the energy consumption of weather-dependent systems and measures in custom analyses.
- Ensure that all building systems that use electricity during the peak period (2:00 – 6:00 PM on non-holiday weekdays between June and August) are included in estimates of peak coincident demand savings for projects. Such systems typically include interior lighting, space cooling, heat rejection, and ventilation.
- ***Consider ways to make the application process more user-friendly and guide the customer through the steps of application submission and approval.*** *One participant reported difficulties with the application and thought the amount of the rebate did not justify the level of effort required.*

For the CIRX Equipment Replacement program, we offer the following recommendations:

- Project files should include a lighting specification sheet and/or certification (DLC or Energy Star) listing for every unique installed fixture type. Each specification sheet or certification listing should show the manufacturer, model number, fixture wattage and lumen output.
- Consider requiring program applicants to provide a full list of spaces within the facility that were affected by the project.

For the Commercial Upstream Lighting program, we offer the following recommendations:

- Project files should include a specification sheet and/or certification (DLC or Energy Star) listing for every unique installed fixture type. Each specification sheet or certification listing should show the manufacturer, model number, fixture wattage and lumen output.
- Consider requiring distributors to collect additional site-specific information at the time of sale, to be used in the energy savings calculations for each project. This should help in calculating more accurate energy consumption and savings estimates at the project level. Examples of additional inputs could include baseline fixture types and wattages, schedules (and associated hours of use and peak coincidence factor), heating fuel type, and facility and space type(s).
- Similarly, consider requiring distributors to collect contact information for the purchaser at the time of sale. Not only could it provide an opportunity for DCSEU to market additional savings opportunities to new commercial customers, but it would also improve the quality of the evaluation. The NMR team could only contact Commercial Upstream

Lighting participants who had contact information on file from participating in another DCSEU program, which biases the study results towards more highly engaged participants.

For the Pay for Performance program, we offer the following recommendations:

- Continue to leverage the existing modeling scripts and data analytics processes for the P4P program. The modeling continues to be robust, accurate and consistent with data science best practices.
- When accounting for anomalous events in the baseline or efficient time periods, ensure that the effects of these anomalous events are removed from all fuel savings including energy (kWh), demand (kW), and natural gas (MMBTU).

For the Solar PV Market Rate program, we offer the following recommendations:

- Peak demand savings should be calculated as the average load savings during peak period hours (2:00 – 6:00 PM on non-holiday weekdays between June and August). Provide the 8,760-hour spreadsheet output from the PV Watts tool that was used for ex ante savings.
- Ensure the proper module type is selected for each project in PV Watts, based on the efficiencies of the installed equipment.

For the Low-Income Multifamily Comprehensive program, we offer the following recommendations:

- Ensure that savings calculations are based on the appropriate hours of use and waste heat factors given the building heating fuel types and rooms in which lighting was installed.
- Ensure that any savings inputs used in calculations match those listed on supporting documentation.
- Review post-installation photos to ensure that savings inputs are derived from the appliance models installed.
- Review procedures for faucet aerator and ceiling exhaust fan peak demand calculations to ensure they are consistent across measures.

For the Income Qualified Efficiency Fund program, we offer the following recommendation:

- Ensure that savings inputs used in calculations match those listed in supporting documentation.

For the Retail Heating & Cooling program we offer the following recommendations based on feedback from participant surveys:

- ***Consider increasing the rebate amount for eligible equipment types where feasible.*** *When asked to suggest any changes DCSEU could make to the program, survey respondents most commonly cited increasing the rebate amount.*
- ***Identify opportunities to simplify the application process, in particular the paperwork that participants need to complete.*** *Although most participants were generally satisfied with the application process, some survey respondents reported that the application process was too lengthy and burdensome.*

For the Retail Efficient Appliances program, we offer the following recommendations based on feedback from participant surveys:

- ***Consider increasing the rebate amount and expanding the types of eligible equipment where feasible.*** *When asked to suggest any changes DCSEU could make to the program, survey respondents most commonly cited increasing the rebate amount and increasing the variety of eligible equipment.*

  Continue to offer education about savings from energy-efficient appliances so customers are prepared to choose an energy-efficient model when their current equipment fails. *Survey respondents rated energy efficiency and reduced energy bills as non-programmatic factors that exhibited little influence on their purchasing decision relative to more important factors such as product features and product reviews. Consequently, there appears to be an opportunity for DCSEU to increase awareness concerning the benefits of selecting energy-efficient models.*

Detailed results and recommendations can be found in each of the individual program sections.

Section 1 Methodology

This section provides an overview of the key activities the NMR team completed for the evaluation of the Fiscal Year 2021 (FY2021) programs, including the following:

- Program tracking data review
- Gross savings verification
- Net savings estimation
- Process evaluation

1.1 Program Tracking Data Review

The first evaluation task was to review DCSEU's FY2021 final program tracking database to assess evaluation priorities and identify key programs and measures. The NMR team leveraged the database for multiple tasks, including identifying programs for evaluation, developing the sample design, drawing samples for the desk reviews and surveys, and calculating savings.

To identify evaluation priorities and develop detailed sampling plans, the NMR team analyzed the tracking database to conduct a portfolio assessment of all programs. We assigned priorities based on the following metrics:

- Which programs and measures account for the largest share of portfolio savings?
- Which programs contain deep dive measures of interest?
- Which programs and measures have the most and least uncertainty around their estimated savings?
- Which programs and measures contribute to DCSEU performance benchmarks?
- How recently have programs and measures been evaluated?
- Which programs and measures are projected to expand or contract in the future?

1.2 Gross Savings Verification

The gross savings verification included the following tasks:

- Desk reviews
- Participant surveys
- On-site inspections (virtual and in-person)
- Billing analysis

1.2.1 COVID Impact

The ongoing COVID-19 pandemic has substantially altered energy consumption patterns in DC since March 2020. For businesses that closed or reduced operating hours, the pandemic typically leads to reduced energy usage. For residents who are home more often than before the pandemic due to unemployment or closed workplaces, the pandemic typically leads to increased energy usage. However, DC's net overall effect is likely a decrease in energy usage because C&I consumption exceeds residential consumption. In addition to impacting energy usage, the pandemic affects energy savings from the DCSEU programs, potentially in directions and magnitudes that are difficult to quantify.

Due to the uncertainty surrounding the pandemic's impact on DC energy usage and savings, the DOEE elected to maintain the contracted FY2021 saving goals for DCSEU. While DCSEU contract performance is measured by first-year energy savings, a single year's impact is relatively small on the lifetime energy savings for measures that participants may install for 20+ years. Therefore, our evaluation approach for FY2021 estimates energy savings assuming a typical year under normal operating conditions.

The NMR team calculated FY2021 energy savings employing an approach that is consistent with prior evaluations. For prescriptive measures and custom measures where the DCSEU calculates energy savings with an engineering algorithm approach we assumed standard operating hours and other inputs. For certain custom projects that rely on actual energy consumption we adjusted the savings calculations to reflect usage under normal operating conditions to the extent possible.

1.2.2 Desk Reviews

For the residential prescriptive programs, the desk reviews entailed a measure-level review of the Technical Reference Manual (TRM) savings algorithms for each key measure from the evaluated programs, covering the entire program tracking database. In addition, we reviewed supporting files for a sample of individual projects from the evaluated programs.

For the commercial and multifamily programs, the NMR team conducted a thorough review of detailed files for a sample of projects. Because custom projects are more complex than the prescriptive projects, the NMR team conducted a more detailed and comprehensive engineering analysis for the custom project file reviews.

1.2.2.1 Prescriptive Measures

For prescriptive measures from the residential, multifamily, and commercial programs, we assessed the accuracy and reasonableness of the savings parameters in accordance with the International Performance Measurement and Verification Protocol (IPMVP) Options A and B, utilizing savings algorithms set forth in the DCSEU TRM. In particular, the NMR team assessed the measure quantities, efficiency levels, and capacities. In addition, we re-created the savings calculations using the TRM algorithms to ensure that the savings listed in the tracking database are accurate. Lastly, we reviewed application forms, invoices, and other available documentation for a sample of projects. The NMR team conducted the following evaluation efforts for prescriptive measures:

- Confirm that the appropriate TRM algorithm is being applied correctly
- Verify key inputs into the algorithms
- Confirm that documentation supports the tracking database values
- Develop recommendations on how TRM assumptions can be improved

1.2.2.2 Custom Measures

Custom project analyses involve the review of calculations done by the DCSEU and contractors to verify and modify the methods and equations used in the analysis based on engineering judgment and expertise. It also involves the verification of assumptions regarding system parameters and the adjustment of those calculations as necessary to provide a more accurate estimate of energy savings. Custom measures will be evaluated in accordance with IPMVP Options A, B, or C using industry-standard methods, with input from the DCSEU TRM where applicable.

For custom projects, the NMR team completed the following activities during the savings calculation reviews:

- Review project description, documentation, specifications, and tracking system data
- Review engineering analyses for technical soundness, appropriate baselines, and appropriateness for the specific application
- Review methods of determining demand (capacity) savings to ensure they are consistent with approved methods for determining peak load/savings
- Review input data for appropriate baseline specifications and variables, such as weather data, bin hours, and total annual hours, and confirm they are consistent with facility operation
- Consider and review for interactive effects with affected systems
- Ensure the measure complies with program rules for eligibility and falls within the parameters outlined by the applicable energy code
- Adjust for impacts of COVID by normalizing weather dependent measures to TMY3 or NOAA 30-year normal data, and normalize non-weather dependent measures to measured and operational data prior to COVID or engineering estimates, if required

1.2.3 Participant Surveys

The NMR team conducted telephone and web surveys with a random sample of participants for selected programs to inform the gross savings verification, net-to-gross (NTG) estimation, and process evaluation tasks. These surveys had the following goals:

- Verify the installation of measures included in the program tracking database
- Ask questions to estimate free-ridership and spillover
- Obtain data on baseline equipment (if needed)
- Assess participants' satisfaction and feedback regarding their program experience
- Identify participation drivers and barriers

1.2.4 On-site Inspections

The NMR team conducted on-site verifications for a sample of projects. These projects were selected either because they exhibited a high degree of savings uncertainty or served the broader QC purposes of the evaluation. Savings uncertainty can come from a lack of project documentation or can be due to the nature of a project. Lighting projects and one-for-one equipment replacement projects tend to be more straight forward to review, with fewer parameters to verify. Therefore, most of the information can be gleaned from specifications, invoices, and operational hours. Projects that tend to be more holistic in scope (such as controls projects or new construction) can benefit greatly from on-site verification. Interviewing a facilities manager to learn how the equipment is operated is generally more accurate than referring to a building plan sequence of operations that may or may not have been implemented. Site inspections are also valuable because they allow evaluation team staff to view control panels, examine current settings, visually confirm installation, and work with customers to gather any trended data from building control systems.

Projects were also selected for on-site visits to serve the broader QC purposes of the evaluation by ensuring that program savings were delivered across all programs. A portion of the on-site visits were allocated to sampled multifamily projects to confirm that measures were installed and operating properly.

The type of inspection performed, whether in-person or virtual, for each project depended on any COVID-19 mandates in DC as well as individual facility restrictions.

During the on-site inspections, the NMR team:

- Confirmed measure installations and controls operations
- Collected information on baseline/pre-existing conditions
- Confirmed information on efficiency level, operating hours, equipment quantity, and operation
- Conducted an interview with the contact person

1.2.5 Billing Analysis

A meter-based billing regression analysis (IPMVP Option C) is effective where measures are higher impact, weather-sensitive, and have the potential for significant interactive effects. Meter based analysis is also the measurement and verification (M&V) method of choice for whole building programs, such as the P4P program. A regression analysis statistically correlates energy usage to one or more variables that change over time. A typical equation for a regression analysis using billing data and weather data is shown here.

$$Usage = \alpha * HDD + \beta * CDD + \theta$$

Where:

α = correlation coefficient for HDD

HDD = Heating Degree Days

β = correlation coefficient for CDD

CDD = Cooling Degree Days

θ = correlation constant

The NMR team incorporated weather-normalized consumption as the dependent variable and included heating- and cooling-degree days, or another explanatory variable describing the weather, directly in the model. The NMR team also considered other variables that are often correlated with consumption include fuel prices, occupancy changes, and behavior changes (set-points, schedules, and frequency of use).

A billing analysis is extremely useful for programs where the same premise installs multiple numbers of measures that have interactive effects, such as whole building programs. For other measures, or for situations where a whole building billing analysis is not suitable (i.e., replace-on-burnout projects or analyses yielding poor R-squared statistics), a billing analysis may be used to corroborate results produced by the engineering analysis.

COVID-19 has impacted energy usage at facilities in DC, causing customers to shut down or reduce operations. These changes to building operations will become evident in their energy usage data. If COVID had impacted the customer's baseline data, the NMR team omitted the affected period and then looked further back in time to ensure adequate baseline data was available. When COVID had impacted the post-project period, the affected period was removed. Depending on the specific project, removing data may have resulted in insufficient data to complete a reasonable billing analysis. In those situations, the NMR team leveraged alternate methods, such as engineering calculations or building simulations, to model the post-project period, and validate electricity, demand, and natural gas savings.

1.2.6 Realization Rate Calculation

Realization rates are the ratio of evaluated savings to tracked savings. Realization rates are typically calculated at the measure-level or project-level and applied to the appropriate tracked savings. After completing our savings analyses, we calculated a gross savings realization rate

for each program across the sampled projects. We then applied these realization rates to the tracked savings for each program and then summed across the entire portfolio.

For programs that did not undergo a gross savings verification, the NMR team assigned a default gross savings realization rate based on either (1) current realization rates for similar programs or measures or (2) previous realization rates for the same program.

1.3 Net Savings Estimation and Process Evaluation

In this section, we provide a description of the activities we executed to estimate net savings and conduct a process evaluation. The NMR team leveraged the participant surveys to estimate the NTG ratio and to collect data for the process evaluation. We also used the participant surveys to assist with gross savings verification.

1.3.1 Net Savings Estimation

The NMR team calculated net savings that were attributable to each program by multiplying the gross verified savings by the NTG ratio. This equation and general methodology were used for estimating both the net energy and net demand savings. The NMR team estimated net savings by multiplying the verified gross savings by the NTG ratio, as specified below:

Net Savings = Verified Gross Savings x NTG ratio

The NTG ratio is based on measurement of free-ridership and participant spillover rates. The NTG ratio is defined as follows:

NTG ratio = 1 – Free-ridership % + Participant Spillover %

We estimated free-ridership and spillover based on self-reports from participant surveys. We asked a series of questions related to the influence of program elements on participants' decision to install the measures, and we developed final savings-weighted average free-ridership and participant spillover values. The NMR team combined these estimates to develop an overall savings-weighted NTG estimate for each evaluated program.

Because commercial customers may have been involved in multiple projects with multiple measures within the same fiscal year, we asked free-ridership questions about the primary measure from the primary project. If a customer had multiple projects, we selected the project with the most savings, then, within that project, the measure with the most savings. This approach allowed us to provide NTG ratios at the measure-level when sample sizes are sufficient.

For programs that did not undergo net savings estimation, the NMR team assigned a default NTG ratio based on either (1) current NTG ratios for similar programs or measures or (2) previous NTG ratios for the same program. See Section 4.2 for more details.

1.3.1.1 Free-ridership

Free-ridership is the proportion of participants who would have implemented the program measure (a) within a specified period, (b) at the same efficiency level, and (c) in the absence of the program. The survey estimated free-ridership based on two key components:

- Intention or the expected behavior in the absence of the program
- The influence of various program elements on the decision to participate in the program

Each component produced scores ranging from 0% to 50%; the two components are summed to produce a total free-ridership score ranging from 0% (not a free rider) to 100% (complete free rider).

1.3.1.1.1 Intention

The intention component of the free-ridership score asked participants how the purchase decision would have been different in the absence of the program. The two key questions that determined the intention score are as follows:

Q1.If you had never learned you could receive information about and a $[XX] rebate for the [MEASURE] from DCSEU, which of the following best describes what you would have done? You would have...

1. *Delayed the purchase/installation of the [MEASURE] for at least one year*
2. *Not purchased/installed a new [MEASURE] at all*
3. *Purchased/installed a different [MEASURE] instead or scaled back the scope or efficiency*
4. *Purchased/installed the same [MEASURE] with the exact same scope and efficiency*

98. (Don't know)
99. (I'd rather not answer)

[ASK Q2 ONLY IF RESPONSE TO QUESTION 1=4: Purchased the same measure anyway]

Q2.If you had not received the $[XX] rebate from DCSEU, would you say you definitely would have, might have, or definitely would NOT have had enough money to purchase the exact same [MEASURE]?

1. *Definitely would have*
2. *Might have*
3. *Definitely would NOT have*

98. (Don't know)
99. (I'd rather not answer)

Table 7 indicates the possible intention scores a respondent could have received depending on their responses to these two questions. When asked the first question, if a respondent provided an answer of 1 or 2 (would postpone or cancel the purchase), the respondent received a free-ridership intention score of 0% (on a scale of 0% to 50%, where 0% is associated with no free-

ridership and 50% is associated with high free-ridership). If a respondent provided an answer of 3 (would have purchased a different measure without the incentive) or if they said they did not know or refused the question, the respondent received a free-ridership intention score of 25% (associated with moderate free-ridership). If the respondent provided an answer of 4 (would have purchased the same measure without program rebate), they were asked the second question before a free-ridership intention score can be assigned.

The second question asked the participants who had said they would have purchased the same measure without the program rebate whether they would have had sufficient funds available to cover the entire purchase. If the respondent provided an answer of 1 (definitely would have the funds), the respondent received a score of 50% (associated with high free-ridership). If the respondent provided an answer of 2 (might have had the funds available), they received a slightly lower free-ridership score of 37.5%. If the respondent provided an answer of 3 (definitely would not have the funds) or if they said they did not know or refused the question, the respondent received a free-ridership intention score of 25% (associated with moderate free-ridership).

Table 7: Free-ridership Intention Scoring

Question 1 Response	Question 2 Response	Free-ridership Intention Score (%)	Free-ridership Intention Level
1 or 2	Not asked	0%	Low
3, 98 (Don't Know), or 99 (Refused)	Not asked	25%	Moderate
4	3, 98 (Don't Know), or 99 (Refused)	25%	Moderate
4	2	37.5%	Moderate-High
4	1	50%	High

1.3.1.1.2 Influence

The influence component of the free-ridership score asked each respondent to rate how much of a role various program-related influence factors had on their decision to purchase the measure. Influence was scored using a scale from 1 to 5, in which 1 meant "it played no role at all" and 5 meant "it played a great role." The influence factors assessed were as follows:

- The financial incentive or rebate of $[REBATE]
- Information or recommendations provided by a DCSEU representative
- The results of any audits, energy modeling, or technical studies done through a program offered by DCSEU
- Information or recommendations provided by contractors or suppliers associated with the program
- Marketing materials or information about the program provided by DCSEU (email, direct mail, etc.)
- Previous experience with a DCSEU program

- Others (identified by the respondent)

Table 8 indicates the possible influence scores a respondent could have received depending on how they rated the influence factors above. For each respondent, the program influence was set equal to the maximum influence rating that a respondent reported across the various factors. For example, if the respondent provided a score of 5 (great role) to at least one of the influence factors, then the program was considered to have had a great role in their purchase decision and the influence component of free-ridership is set to 0% (not a free rider).

Table 8: Free-ridership Influence Scoring

Maximum Influence Rating	Influence Score (%)	Free-ridership Influence Level
5 - Program factor(s) highly influential	0%	Low
4	12.5%	Low-Moderate
3	25%	Moderate
2	37.5%	Moderate-High
1 - Program factor(s) not influential	50%	High
98 - Don't know, 99 - Refused	25%	Moderate

The intention and program influence scores for each respondent were summed to generate a free-ridership score ranging from 0% to 100%. A score of 0% free-ridership meant the participant was not a free rider, a score of 100% free-ridership meant the participant was a complete free rider, and a score between 0% and 100% meant the participant was a partial free rider.

1.3.1.2 Participant Spillover

Spillover is a reduction in energy consumption and/or demand caused by the presence of an energy-efficiency program, beyond the program-related gross savings of the participants and without financial assistance from the program. Participant spillover can manifest in participants who take actions beyond the program.

The participant survey estimated spillover for each respondent through questions about purchases of energy-efficient equipment outside of the DCSEU programs. In those situations, the survey asked about the equipment and the impact the program had on the decision.

For each equipment type the respondent reported purchasing without a program rebate, the survey asked about the extent of influence that earlier involvement in the program had on their decision. Influence was reported using a scale from 1 to 5, in which 1 meant "it played no role at all" and 5 meant "it played a great role." For each respondent, the program influence rating was converted to an influence score ranging from 0% to 100% (Table 9).

Table 9: Spillover Influence Scoring

Maximum Influence Rating	Influence Score (%)	Spillover Influence Level
Maximum rating of 1 (no influence)	0%	Low
Maximum rating of 2	25%	Low-Moderate
Maximum rating of 3	50%	Moderate
Maximum rating of 4	75%	Moderate-High
Maximum rating of 5 (great influence)	100%	High
Respondent does not know how much influence any factor had	50%	Moderate

We calculated the participant spillover rate as follows:

- Multiplied the estimated unit energy savings for each equipment type by the influence percentage to calculate the program-attributable energy savings. We leveraged the DCSEU TRM and/or program tracking data to estimate typical unit energy savings for each measure type.
- Summed program-attributable energy savings across all survey respondents to calculate the total spillover savings
- Divided the total spillover savings by the total tracked savings across all survey respondents to calculate the participant spillover rate

1.3.2 Process Evaluation

The NMR team fielded telephone and web surveys of a sample of participants to collect information about their program experience, including questions on topics such as the following:

- Program awareness and satisfaction
- Decision-making process
- Participation drivers and barriers
- Opportunities for program improvement
- Firmographic or demographic characteristics

Where email addresses were available, the NMR team sent sampled participants a notification of the survey by email in advance.

In addition to the general survey, the NMR team completed interviews with participating solar developers to inform the evaluation of the CREF program. Details of the survey results can be found in Appendix C.

1.4 PROGRAM SAVINGS OVERVIEW

In this section, we provide an overview of the FY2021 tracked gross savings by sector and program. Table 10 displays the percent of FY2021 tracked gross energy, electric, and gas savings by sector. The commercial sector programs contributed the most savings across each savings category.

Table 10: FY2021 Tracked Gross Savings Summary by Sector

Sector	Percent of FY2021 Tracked Savings		
	Total Energy Savings (MMbtu)	Electric Savings (MWh)	Gas Savings (MMbtu)
Commercial	72%	60%	108%
Low Income	10%	10%	9%
Residential	12%	21%	-16%
Solar	6%	8%	0%
Total	**458,965**	**99,633**	**119,018**

Table 11 displays the percent of FY2021 tracked overall energy, electric, and gas savings by program track. The commercial Custom Retrofit program contributed about 40% of the total energy portfolio savings. The next largest programs include the commercial Midstream Lighting program (14%), commercial New Construction program (10%), and the Retail Lighting program (11%).

Table 11: FY2021 Tracked Gross Savings Summary by Program

Sector	Program Name	Percent of FY2021 Tracked Savings		
		Total Energy Savings (MMbtu)	Electric Savings (MWh)	Gas Savings (MMbtu)
Commercial	C& I RX - Equipment Replacement	4%	6%	-2%
	Small & Medium Business Rebates	0%	0%	0%
	Market Transformation Value	0%	0%	0%
	Commercial Midstream – Lighting	14%	21%	-6%
	Retrofit -Commercial Custom	40%	23%	88%
	Market Opp - Comm Custom	3%	1%	10%
	New Constr - Comm Custom	10%	8%	16%
	Pay for Performance	1%	1%	0%
Low-Income	Income Qualified Gas Efficiency Fund	2%	0%	8%
	Implementation Contractor DI	1%	0%	5%
	Income Qualified Efficiency Fund	1%	1%	1%
	Low Income MF Comprehensive	3%	4%	0%
	Low Income Prescriptive Rebate	0%	0%	0%
	Retail Lighting Food Bank	2%	5%	-6%

Sector	Program Name	Percent of FY2021 Tracked Savings		
		Total Energy Savings (MMbtu)	Electric Savings (MWh)	Gas Savings (MMbtu)
	Home Energy Conservation Kit - Low Income	0%	0%	0%
Residential	Retail Efficient Appliances	0%	0%	0%
	Home Energy Conservation Kit - Market Rate	0%	0%	0%
	Retail Heating and Cooling	1%	0%	2%
	Retail Lighting	11%	21%	-18%
	Nest Seasonal Savings	0%	0%	0%
	Innovation - Market Rate	0%	0%	0%
Solar	Solar PV Market Rate	6%	8%	0%
Total		458,965	99,633	119,018

1.5 Program Sampling Plan

In this section, we outline our sampling plan for the FY2021 evaluation activities.

1.5.1 Gross Savings Verification Sampling Plan

In this section, we outline our evaluation sample design for the gross savings verification. Throughout this five-year evaluation period, we applied a staggered impact evaluation approach, in which some programs were evaluated annually and others less frequently, with default realization rates being applied in years without evaluation activities.

1.5.1.1 Commercial and Solar Programs

We allocate the rigor of evaluation methods by end-use on a rotating annual schedule, with annual deep dives into specific measures of interest or high uncertainty. The deep dive measure of interest for FY2021 was lighting, which contributed approximately 37% of overall savings in FY2021. The NMR team oversampled for projects that contain lighting measure categories.

Table 12 lists the number of projects and the final sample sizes for desk reviews and on-site inspections. All sampled projects included desk reviews, a portion of which also included a follow-up interview with the customer to verify key input parameters. In addition, a nested sample of projects that undergo a desk review also received an on-site inspection (either virtual or in-person).

Table 12: Commercial Gross Savings Verification Sampling Plan

Program	FY2021 Participation (Projects)	Number Sampled for Desk Review Only	Number Sampled for Site Visit* + Desk Review	Total Number Sampled for Desk Reviews
C&I RX - Equipment Replacement	58	8	6	14
Pay for Performance	1	1	0	1
Retrofit – Custom	60**	21	10	31
Market Opportunities – Custom	7	3	2	5
Commercial Upstream Lighting	138	21	0	21
Solar PV Market Rate	5	4	0	4
Solar for All Community Renewable PV Energy	23	9	0	9
New Construction - Custom	30	10	4	14
All Evaluated Commercial Programs	**322**	**77**	**22**	**99**

*The site visits were a combination of virtual and in-person visits. The type of visit for each project depended on DC mandates and individual facility restrictions related to the COVID-19 pandemic.

**The tracking database shows two additional projects with zero savings. Similar to past years, these were assumed to be projects that were in progress, but not finalized at the end of the program year.

Given the anticipated homogenous makeup of the sample selected for each program, we assumed a coefficient of variation (Cv) of 0.5 for most programs. However, prior realization rates for the CIRX, PVMR, and CREF programs suggest lower Cv's were appropriate. The final sample precision varied between 80% ± 8% and 80% ± 17% at the program level, and the overall sample precision was 90% ± 7% across all evaluated programs.

The NMR team stratified each program based on key measure types split into certainty and probability sites based on total savings (MMBtu). The certainty cutoff ensured the largest projects were included in the sample. Utilizing the Dalenius-Hodges method, we allocated the number of sample points for each program to each substratum based on each substratum's contribution to the program savings. The NMR team ensured that lighting measures were prominent in the sampled projects.

1.5.1.2 Residential, Retail, and Low-income Multifamily Programs

Table 13 provides the number of residential projects and the sample sizes for desk reviews and virtual on-site inspections. Further details of the sampling plan for each program are provided in the individual program sections.

Table 13: Residential Gross Savings Verification Sampling Plan

Program	FY2021 Participation (Projects)	Number Sampled for Desk Review Only	Number Sampled for Site Visit + Desk Review	Total Number Sampled for Desk Reviews
Retail Lighting	272,904*	10**	0	10
Retail Lighting Food Bank	92,512*	10**	0	10
Low-income Multifamily Comprehensive	45	21	3	24
Income Qualified Gas Efficiency Fund	19	14	1	15
Income Qualified Efficiency Fund	14	10	1	11
Low-Income Multifamily Implementation Contractor DI	1	1	0	1
Solar for All Low-income Single-family PV	122	8	0	8
All Evaluated Residential Programs	**365,617**	**74**	**5**	**79**

* Number of measures rather than projects for the retail lighting programs.
** A sample of invoices will be reviewed.

For the Retail Lighting and Retail Lighting Food Bank Programs, we reviewed a sample of ten invoices from the largest manufacturers involved in each program.

We allocated desk reviews among the four low-income multifamily programs in proportion to their contribution to overall energy savings as well as prior evaluations results. For each of the sampled projects, we reviewed all of the whole-building measures as well as the in-unit measures for a sample of housing units. The sampling plan for each program was as follows:

- Desk reviews for the 24 projects with the highest energy savings from the Low-income Multifamily Comprehensive Program, which represented 89% of the FY2021 savings from all 45 projects.
- Desk reviews for the 15 projects with the highest energy savings from the Income Qualified Gas Efficiency Fund Program, which represented 98% of FY2021 savings from all 19 projects.
- Desk reviews for the 11 projects with the highest energy savings from the Income Qualified Efficiency Fund Program, which represented 99% of the FY2021 savings from all 14 projects.
- A desk review for the one Low-Income Multifamily Implementation Contractor Direct Install project completed in FY2021.

For the Solar for All Low-income Single-family PV Program, we randomly sampled eight projects stratified by installation vendor.

1.5.2 Net Savings Estimation and Process Evaluation Sampling Plan

In this section, we outline our final sampling plan for the participant surveys that served the gross savings verification, NTG estimation, and process evaluation efforts (Table 14). Because the primary motivation for the surveys was to estimate NTG, we targeted all non-low-income programs (which were assigned a default NTG of 100%) with available customer contact information. At the 80% confidence level, the estimated sample precision varied between ±19% and ±8% for each program. Due to the small number of FY2021 projects for several commercial programs, we did not estimate sample precision.

Rather than contact individual participants for the Community Renewables program (CREF), we interviewed five solar developers who installed solar projects through the program (not shown in table).

Given the small participant population for some of the commercial programs, the response rate for the surveys was reasonable – ranging from 10% for Retail Efficient Appliances to 60% for Solar PV Market Rate.

Table 14: FY2021 Participant Survey Sampling

Program	FY2021 Participation (Sites)	Number of Sites Contacted	Number of Completed Surveys	Calculated Sample Precision
Solar PV Market Rate	10	5	3	n/a
C& I RX - Equipment Replacement	58	36	12	80% ± 19%
Market Transformation Value	7	7	2	n/a
Commercial Upstream - Lighting	715	219	35	80% ± 11%
Retrofit - Commercial Custom	58	29	8	n/a
Market Opportunities - Commercial Custom	7	6	2	n/a
New Construction - Commercial Custom	31	16	5	n/a
Small and Medium Business	9	6	2	n/a
Retail Efficient Appliances	803	656	70	80% ± 8%
Retail Heating and Cooling	648	619	72	80% ± 8%
All Evaluated Programs	**2,346**	**1,599**	**211**	**90% ± 8%**

Section 2 Commercial & Solar Programs

In this section, we present a brief program summary, as well as the methodology, findings, and recommendations from our evaluation of each of the nine commercial and solar programs selected for the FY2021 evaluation:

- Retrofit – Custom
- New Construction – Custom
- Market Opportunities – Custom
- CIRX – Equipment Replacement
- Small & Medium Business Rebates
- Commercial Upstream Lighting
- Pay for Performance
- Market Transformation Value
- Solar PV Market Rate

2.1 RETROFIT – CUSTOM (7520CUST)

The Custom Retrofit Program provides incentives to owners of large buildings to replace equipment in their building with more efficient equipment or make operational changes to their facility that would result in energy savings. The program offers incentives for a variety of equipment types, including lighting, chillers, boilers, heat pumps, steam systems, insulation, refrigeration, and various building or equipment controls. Through this program, DCSEU provides technical assistance to help decision makers design, scope, and fund their projects. Funding is available through a traditional rebate structure, where participants are paid flexible amounts per project, but also through partnerships with lenders in the District who may finance up to 100% of a project's cost.

DCSEU staff provide project support from inception, when possible. Account managers focus on relationship building, especially for large federal accounts. DCSEU provides input on measure implementation. The economic/lifecycle analysis provided by DCSEU staff allows customers to make informed decisions on their projects. As a custom program, DCSEU staff are able to tailor the financial and technical assistance provided to each project with a focus on the long-term customer experience. Quality assurance is implemented for custom projects on a monthly basis. As the program matures and these relationships are cultivated, custom projects find their way to DCSEU, so less outreach is required.

With a limited marketing budget, the program marketing efforts have been focused on supporting customers and disseminating best practices and technologies. For larger customers, DCSEU may participate in engineering meetings and planning. The program formed cohorts with customers, which meet on a quarterly basis to discuss topics, measures, and lessons learned. The cohorts provide a platform for customers to share and gain insights on energy-efficiency measures with their peers. To introduce customers to new technologies, DCSEU holds brown bag meetings to introduce and vet new energy-efficiency technologies.

In FY2021, the program provided incentives for 60 projects. Table 15 provides the breakdown of tracked savings by measure type. The bulk of total energy savings and total electric savings come from the HVAC and lighting measures.

Table 15: Custom Retrofit Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Gas Savings	Percent of FY2021 Peak Demand Savings
HVAC	67.3%	24.4%	98.7%	28.9%
Appliances, Office Equipment, Refrigeration	1.6%	1.8%	1.5%	1.2%
Comprehensive	3.5%	3.9%	3.3%	13.0%
Water Conservation	0.5%	0.1%	0.8%	0.1%
Lighting	23.8%	62.4%	-4.3%	47.9%
Motors & Drives	3.1%	7.3%	0.1%	8.7%
Other	0.1%	0.2%	0.0%	0.1%

For the FY2021 Custom Retrofit program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.1.1 Gross Savings Verification

Table 16 shows the tracked savings, realization rate, and evaluated savings for the Custom Retrofit program.

Table 16: Custom Retrofit Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	22,479	93%	20,810
FY2021 Peak Demand Savings (MW)	3.06	134%	4.09
FY2021 Gas Savings (MMBtu)	105,135	100%	105,263

2.1.1.1 Sampling

Due to the heterogeneous makeup of the program, we assumed a coefficient of variation (C_v) of 0.5 for our initial sample design. With a precision target of ±15% at 80% confidence, this required a selection of 15 unique sample sites at a minimum. The final sample included 31 unique sample sites. The NMR team designed the sampling plan using stratified random sampling to ensure the evaluation included a diverse mix of measure types. We created a certainty stratum, which ensured that we reviewed the largest projects from the program. The NMR team assigned projects with >10,000 MMBtu of total energy savings to the certainty stratum. We also created a Large Probability stratum for projects with total energy savings

between 2,000 and 10,000 MMBtu, and a Small Probability stratum for the remaining projects. We randomly sampled projects from each of the probability strata. The evaluation team created these strata to capture as much gross savings as possible with the limited number of sample points. Strategically dividing the sample into size strata ensured that the evaluation team reviewed as many larger projects as possible, while still allowing a random selection of smaller projects. Table 17 presents the final sample for the Custom Retrofit program.

Table 17: Custom Retrofit Sampling Plan

Stratum	Stratum Criteria	Percent of Program Energy Savings	FY2021 Participation*	Number of Sampled Sites
Certainty	>10,000 MMBtu	63%	3	3
Large Probability	2,000 to 10,000 MMBtu	19%	10	8
Small Probability	≤2,000 MMBtu	18%	47	20

*Two projects were listed in the SEU tracker with no savings associated with them. The NMR team assumes that these were potential projects, but ones for which no energy savings were achieved or were possible.

2.1.1.2 Methodology

The NMR team conducted a desk review for each of the 31 selected sample sites, through which we calculated the evaluated savings. Ten of the 31 desk reviews employed additional information gathered from on-site verifications (three from the Certainty stratum, five from the Large Probability stratum, and two from the Small Probability stratum). The on-site inspections involved verification of equipment types, operating hours, capacities, quantities, and other parameters via interviews with facility representatives and visual observation.

The NMR team analyzed each project using one of two evaluation methodologies:

- For measures that exist in the TRM, desk reviews used algorithms and assumptions presented in the TRM as a reference for analysis, making methodological adjustments as appropriate for the site-specific information provided. TRM assumptions were overwritten with site-specific data when reliable information was provided to justify the change.
- For measures that did not exist in the TRM, engineers reviewed all submitted documentation and determined the suitability of the equations and assumptions used to calculate the tracked savings. If equations or assumptions were deemed unsuitable, the NMR team overrode them with more appropriate inputs.

The COVID-19 pandemic certainly impacted energy consumption at most commercial facilities in 2020 and 2021. As most of the calculations for this program did not involve actual metered data, the impacts of the pandemic did not affect our analysis. The verified savings estimates reflect the energy savings that can be expected in a typical year of operation.

The NMR team employed a custom savings calculator designed to facilitate the savings calculations. The custom calculator used the SEU's online tracker site to look up project-specific

inputs based on project number for reported electric, demand, and natural gas savings. The online tracker is an electronic record keeping, file storage, and savings calculation platform that the SEU utilizes across the portfolio. The savings are calculated within the tracker based on the provided inputs. The NMR team's custom calculator allows for manual input of savings algorithms and provides a table that compares inputs between those used in the tracked savings, those used in the TRM (if applicable), and those deemed appropriate by the evaluating engineer.

During the desk review process, our engineers created a custom calculation for each project within the sample. We reviewed all available project documentation and assessed the method of savings analysis used by the DCSEU. If we agreed with the methodology of the analysis, we relied on the same algorithms and verified the inputs. We reviewed each input variable to determine whether it was accurate. We adjusted input variables such as hours of use (HOU) or equipment efficiencies if needed, based on the project documentation or virtual on-site visits. Savings calculations ultimately relied on the verified values. In some cases, the NMR team applied a different methodology to calculate savings, using site specific input variables.

2.1.1.3 Results

The program-wide impact evaluation results for the Custom Retrofit Program are shown in Table 18. The findings that contributed to the realization rates are detailed in the text that follows.

Table 18: Custom Retrofit Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	22,479	93%	20,810	80% ± 3.3%
FY2021 Peak Demand Savings (MW)	3.06	134%	4.09	80% ± 3.2%
FY2021 Gas Savings (MMBtu)	105,135	100%	105,263	80% ± 2.3%

The program-level realization rates are 93% for electric savings, 134% for demand savings, and 100% for natural gas savings. The selected sample ultimately achieved ±3.3% precision for electric savings, ±3.2% precision for demand savings, and ±2.3% precision at the 80% confidence level for gas savings.

The evaluation team concluded that significant review went into the custom savings calculations. The documentation provided was thorough, and the methods and assumptions used were suitable.

SEU utilized a calculation method prescribed in their online tracker portal for custom projects. The NMR team calculated savings within the tracker based on the provided inputs. The documentation for the input variables was not consistently included in the project files, though the NMR team was able to locate them in the SEU tracker. However, the SEU tracker was missing inputs for some projects; therefore, the NMR team could not always reproduce savings using equations and assumptions from the DCSEU TRM or the Mid Atlantic TRM. As needed, the NMR team performed independent engineering calculations for such projects based on the

inputs verified from the project files, supplemented by telephone interviews or virtual on-site visits performed by our engineers.

Electricity (kWh) savings adjustments were also generally minor, except for one project, which was the primary driver of the program kWh savings realization rate:

- One Large Probability stratum project (ID 23994) was found to have inappropriately calculated annual kWh savings as well as natural gas savings. The ex ante savings estimates appear to have been based on total modeled MMBtu for baseline and proposed periods, along with percentage breakdown of site energy consumption by end-use (measure). Then, most MMBtu savings allocated to each measure were converted to kWh savings. We did this for all measures, including a boiler measure for which a large electric savings estimate is not appropriate. The evaluator's verified savings estimates are based on the outputs from the building energy model. The boiler measure achieved significant natural gas savings but carries an electric penalty. While the overall energy savings (MMBtu) realization rate is close to 100%, the adjustment had a massive impact on the individual electric energy and natural gas realization rates. The kWh savings realization rate for the project is 1% and the natural gas realization rate is 4,959%.

Table 19: Project ID 23994 Evaluation Results

Savings Type	**Reported**	**Verified**	**Realization Rate**
Electric kWh	425,729	3,274	1%
Natural gas MMBtu	29	1,438	4,959%
Total energy MMBtu	1,482	1,449	98%

The program's peak demand savings realization rate is primarily driven by one project, the largest electric savings project in the sample:

- Certainty stratum project ID 22757 was found to have inappropriately calculated total connected load savings, from which peak demand savings were estimated. The connected load savings estimate appears to have been calculated based on total kWh savings generated from the fixture replacements divided by total hours in a year. From there, the estimate was multiplied by the 'Commercial Indoor Lighting – Blended' load shape value for summer kW:

  Peak kW savings = connected load savings x summer kW load shape value

  = (6,542,395 kWh / 8,760 hours) x 57.82%

  = 746 kW x 57.82%

  = 431.3 kW

  This is not an appropriate method for calculating total connected load savings. Verified peak demand savings were calculated as the sum of connected load savings for all fixture replacements. Peak coincidence factors were applied to each line item of the

calculation spreadsheet based on the specific schedule for the fixtures. The resulting realization rate for the project is 281%.

The overall verified natural gas savings are within 0.2% of ex ante savings; however, there were two projects in the sample that saw significant adjustments:

- Certainty stratum project 19315 yielded a 92% realization rate for natural gas savings. The project is a large steam trap replacement. Ex ante savings were calculated using the VEIC steam trap calculator tool. The tool was generally used correctly, however, NMR found that the single value for latent heat of vaporization used was not appropriate. The value should also vary based on pressure. These adjustments are reflected in the evaluator's verified savings.
- Large Probability stratum project (ID 23994) yielded a very high realization rate (281%). The cause of this is described above in the electric kWh savings adjustment section.

2.1.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from eight web and telephone surveys completed with participating Custom Retrofit program customers.

2.1.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 20, the eight Custom Retrofit program participants received the following scores:

- One respondent reported they would have canceled the implementation of the measure in the absence of the program. We assigned this respondent a low free-ridership intention score (0%).
- One respondent was not sure what they would have done in the absence of the program. We assigned this respondent a moderate free-ridership intention score (25%).
- The remaining participants said they would have purchased the same measure in the absence of the program:
    - One respondent said they were not sure whether they would have had the funds to purchase the measure in the absence of the program. We assigned them a moderate free-ridership intention score (25%).
    - Two respondents said they might have had the funds available to purchase the measure in the absence of the program. We assigned them a moderate-high free-ridership intention score (38%).

- Three respondents reported that they definitely would have had the funds to cover the entire cost of the measure in the absence of the program, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score across all eight respondents is 34%.

Table 20: Free-ridership Intention Scoring for Custom Retrofit Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents[1]
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	1
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	1
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	1
	• Might have had the funds	38%	2
	• Definitely would have had the funds	50%	3
Total		**34%**	**8**

Influence

Table 21 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Custom Retrofit program features with the highest average ratings include previous experience with a DCSEU program (4.3) and the rebate (3.8).

Table 21: Influence of DCSEU Program Features for Custom Retrofit Program

Features	n[1]	1 Played no Role at All	2	3	4	5 Played a Great Role	Average Rating
Previous experience with a DCSEU program	6	--	--	2	--	4	4.3
The rebate	6	1	--	1	1	3	3.8
Information or recommendation from a DCSEU representative	6	1	1	1	--	3	3.5
The results of any audits, energy modeling, or technical studies done through a DCSEU program	5	1	1	1	1	1	3.0
Information or recommendation from contractors or vendors associated with the program	5	1	1	2	--	1	2.8
Marketing materials or information provided by DCSEU	5	2	1	0	1	1	2.6

[1] Sample sizes exclude those who said, “Not applicable” or “I’m not sure.”

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 22):

- One-half of the participants (four of the eight Custom Retrofit program respondents) indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- One-quarter of the participants (two out of eight respondents) provided a maximum rating of 4, so we assigned them a free-ridership influence score of 13%.
- One respondent indicated that the program features were not applicable to their decision, so we assigned them a free-ridership influence score of 50%.
- One respondent was not sure about the influence of the program features on their decision, so we assigned them a free-ridership influence score of 25%.

The overall free-ridership influence score across all eight respondents is 13%.

Table 22: Free-ridership Influence Scoring for Custom Retrofit Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - Program feature played a great role	0%	4
4	13%	2
3	25%	--
2	38%	--
1 - Program feature played no role OR Not applicable	50%	1
Don't know OR Refused	25%	1
Total	**13%**	**8**

When asked if any other factors played a great role in influencing them to implement the measure through the Custom Retrofit program, one respondent reported that sustainability was a core value of their organization. Another respondent indicated that energy savings and a desire to improve their systems influenced them to participate, and a third respondent further emphasized their relationship with DCSEU as influencing their decision.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 47% and the average weighted free-ridership rate for the Custom Retrofit program was 44% (Table 23).

Table 23: FY2021 Free-ridership Rate for Custom Retrofit Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	47%	0%	100%
Free-ridership (savings-weighted)	44%	0%	100%

The FY2018 free-ridership rate was 56%, the FY2019 free-ridership rate was 30%, and the FY2020 free-ridership rate was 48%. Given the small sample sizes for the four years, we recommend combining the results across all four years through a savings-weighted approach, shown in Table 24. We recommend using 47% as the free-ridership rate.

Table 24: FY2018-FY2021 Free-ridership Rate for Custom Retrofit Program

	Sample Size	Percent of Sampled Energy Savings[1]	Free-ridership Rate
FY2018	25	17%	56%
FY2019	8	7%	30%
FY2020	13	71%	48%
FY2021	8	4%	44%
Weighted Average	**54**	**100%**	**47%**

[1] Does not sum to 100% due to rounding.

2.1.2.2 Participant Spillover

One respondent reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Custom Retrofit project. This participant rated the program's influence on their decision to install six refrigerated display cases a 2 on a 1 to 5 scale, in which 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 25%.

Table 25: Spillover Influence Scores for Custom Retrofit Program

Influence Rating	Assigned Influence Score (%)	Spillover Measures	Count of Respondents
Rating of 2 (some influence)	25%	Refrigerated display cases	1
Rating of 3	50%	-	--
Rating of 4	75%	--	--
Rating of 5 (great influence)	100%	--	--
Respondent does not know how much influence	50%	-	-

We estimated the savings associated with the refrigerated display cases by assigning them the savings value for the average commercial reach-in refrigerator with glass doors.[5] We then divided that estimate by the cumulative tracked savings across all eight survey respondents to calculate the spillover rate. This resulted in a savings-weighted spillover rate of 9% for the Custom Retrofit program in FY2021 (Table 26).

Table 26: FY2021 Spillover Rate for Custom Retrofit Program

	Average	Minimum	Maximum
Spillover Rate	9%	0%	101%

[5] https://trm.veic.org/dcseu/contents/characterizations/1086/commercial-reach-in-refrigerators-and-freezers

The spillover rate was 0% in both FY2019 and in FY2020, while in FY2018, spillover savings represented 1% of tracked savings (Table 27). We recommend an average spillover rate of 1%, after rounding.

Table 27: FY2018-FY2021 Spillover Rate for Custom Retrofit Program

	Sample Size	Percent of Sampled Energy Savings[1]	Spillover Rate
FY2018	25	17%	1%
FY2019	8	7%	0%
FY2020	13	71%	0%
FY2021	8	4%	9%
Weighted Average	**54**	**100%**	**1%**

[1] Does not sum to 100% due to rounding.

2.1.2.3 NTG Ratio

The savings-weighted NTG ratio for the Custom Retrofit program equals 54%, after rounding (Table 28).

Table 28: NTG Ratio for Custom Retrofit Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	47%	1%	54%

2.1.3 Process Evaluation

For the process evaluation of the Custom Retrofit program, the NMR team completed telephone and web surveys with program participants (Table 29).

Table 29: Custom Retrofit Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	5
Participating end user surveys – web	3
Total	**8**

2.1.3.1 Key Findings

These were the key findings from the process evaluation of the Custom Retrofit program:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.3, on average.
- The NPS[6] for the Custom Retrofit program was 50.
- DCSEU staff are critical to encouraging program engagement; Custom Retrofit program participants most often heard about the program first from a DCSEU staff member or account manager (three of eight respondents), and six respondents received assistance on their application from the DCSEU.
- Program participants who had visited the DCSEU website found it fairly useful. On a scale from 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," Custom Retrofit program participants rated it a 3.8, on average. When asked how the website could be improved, two of the five respondents requested more up-to-date information and an explainer on local government regulations as it relates to program activity.

2.1.3.2 Program Satisfaction

Program satisfaction is generally high, though not as high as observed in FY2020:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," FY2021 participants rated their likelihood to recommend the program to someone else an 8.9 on average. While still high, it is almost a point lower than FY2020's average score of a 9.7. The NPS for the program among participating end users was 50, a 42-point decrease from FY2020, where NPS was 92. Overall, five of the eight respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. Two respondents were *passives*, rating their likelihood to recommend the program to someone else an 8. The other respondent was a *detractor*, rating their likelihood to recommend the program to someone else a 5.
- Participants rated their overall satisfaction with the program a 4.3, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2020, participants rated their average satisfaction a 5.0, on average. Table 30 shows their satisfaction ratings in detail.
- When asked for additional comments at the end of the survey, one respondent indicated they would prefer an email invitation to complete the program feedback survey rather than multiple phone calls. The survey was offered via both phone and web; this respondent was initially invited to participate via the email address DCSEU had on file, but it is possible they did not receive the invitation to the web survey.

[6] The NPS is a well-established measure of customer loyalty. Using a scale of 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," respondents are asked how likely they are to recommend the program to someone else. Respondents are then grouped as promoters (score 9-10), passives (7-8), and detractors (0-6). The NPS is calculated by subtracting the percentage of detractors from the percentage of promoters and is presented as a whole number.

Table 30: Participant Experience with the Custom Retrofit Program

Feature	n[1]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**8**	**--**	**1**	**1**	**1**	**5**	**4.3**
The inspection of your project by the DCSEU, if applicable	5	--	--	--	1	4	4.8
The performance of the new equipment	8	--	--	1	--	7	4.8
The energy savings from your new equipment	7	--	--	--	2	5	4.7
The application process	7	--	--	--	3	4	4.6
The assistance from your contractor or vendor	7	--	--	1	1	5	4.6
Time to receive the rebate or incentive	8	--	1	--	1	6	4.5
The information about the DCSEU offerings	6	--	--	1	1	4	4.5
The preapproval process	7	--	1	--	3	3	4.1
The type of eligible equipment or projects	7	--	--	3	--	4	4.1
The amount of the rebate, discount, or financial incentive	8	--	1	2	1	4	4.0
The technical assistance you received from the DCSEU	4	--	--	2	--	2	4.0

[1] Sample sizes vary because results exclude those who said, “Not applicable” or “I’m not sure.”

Based on their experience, five of the eight participants provided feedback on what they would change about the Custom Retrofit program (Table 31). Two respondents suggested increasing the rebate amount. When asked by how much the rebate should be increased, one of these respondents recommended that the rebate cover at least 10% of installation and equipment costs and the other noted that small businesses need higher rebates. Two respondents suggested improving the inspection process; one respondent suggested that the inspection process provide more information on how the rebates relate to current legislation and the other respondent recommended aligning the process to match newer building codes.[7] The following suggestions were mentioned by one respondent each: simplifying the application process, speeding up the pre-approval process, and including additional types of equipment such as gas-powered restaurant equipment.[8] Three respondents indicated they would not change anything about the program.

[7] Though they gave suggestions for improvements, the respondents rated their satisfaction with the inspection program a 5 and 4, respectively.
[8] After September 30, 2021, the DCSEU discontinued gas rebates and incentives for certain projects in line with District policy and the Clean Energy DC plan. If these changes were applicable to restaurant equipment, the DCSEU

Table 31: Suggested Changes to the Custom Retrofit Program

Suggested Change	Count of Respondents (n=5)[1]
Increase the rebate amount	2
Improve the inspection process	2
Speed up the pre-approval process	1
Include additional types of equipment	1
Simplify the program application process	1

[1] Does not sum to 5; multiple responses allowed.

2.1.3.3 Program Experience

When asked why they implemented the measure through the Custom Retrofit program, participants most commonly cited a desire to reduce operating or maintenance costs (eight respondents), save money on energy costs (seven respondents), and advance a long-term strategic management plan (six respondents), as shown in Table 32. When asked what benefits their company realized as a result of their participation in the program, the most common responses include saving money on energy costs (eight respondents), advancing long-term strategic management plan (six respondents), and reducing operating or maintenance costs (five respondents). Notably, while all eight respondents hoped to reduce operating or maintenance costs by participating in the Custom Retrofit program, only five respondents reported realizing a reduction in these costs following the project.

Table 32: Custom Retrofit Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=8)[1]	
	Reason for Participation	Benefits Realized
Reduce operating or maintenance costs	8	5
Save money on energy costs	7	8
Advance long-term strategic management plan	6	6
Install more reliable equipment	6	4
Save money on equipment installation	4	4
Improve work environment	3	3
Improve production or productivity	1	2
Promote positive public relations	--	1

[1]Counts sum to greater than eight because multiple responses were allowed.

The majority (five of eight respondents) reported facing no hurdles when deciding whether or not to implement the measure through the program. One participant cited difficulties collecting documentation for the pre-approval process and another participant was unsure of the energy savings potential (Table 33). One respondent was not sure if they faced a hurdle. The two

may not be able to act on this respondent's suggestion. (DCSEU. "Start a Project." https://www.dcseu.com/commercial-and-multifamily/start-a-project. Accessed May 9, 2022)

respondents who cited specific hurdles both indicated that DCSEU provided clear communication and directions to help them overcome barriers to participation.

Table 33: Hurdles Faced by Custom Retrofit Program Participants

Hurdle/Barrier	Count of Respondents (n=2)
Difficulties collecting documentation for pre-approval	1
Unsure of energy savings potential	1

All respondents reported receiving assistance on their Custom Retrofit program applications from either a DCSEU staff member (six respondents) and/or a third-party vendor or contractor (four respondents). On a scale from 1 to 5, in which 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.0, on average. In FY2020, all respondents received assistance with their applications and rated the ease of completing them a 4.3, on average.

2.1.3.4 Program Awareness

Most of the participants (seven out of eight) learned about the Custom Retrofit program before they began implementing their project. One respondent learned about the program after they began implementing the project but before it was completed (Table 34).

Table 34: Awareness of Custom Retrofit Program

When Respondent Learned about the Financial Incentives/Assistance	Count of Respondents (n=8)
Before planning the project	3
After planning the project, but prior to implementing	4
After implementing the project, but prior to completing	1

Two respondents indicated that their organizations moved forward with their project before submitting their application to the program. One of these respondents explained that they needed time to submit the application through the program application system and the other respondent noted that they first needed to complete energy efficiency in a project.

Three respondents first heard about the Custom Retrofit program from a DCSEU staff person or account manager, and two respondents first heard about the program from a colleague or industry peer. Table 35 shows how program respondents heard about the program.

Table 35: Sources of Custom Retrofit Program Awareness

Source of Program Awareness	Count of Respondents (n=8)	
	Where Participants First Heard of Program	Other Sources of Participant Awareness[1, 2]
DCSEU staff or account manager	3	3
A colleague or industry peer	2	3
The DCSEU website	1	4
A DCSEU mailing or email	1	2
A contractor	1	3
Prior experience with DCSEU	1	--
DCSEU social media (Facebook, Twitter, etc.)	--	1
A distributor	--	3
DCSEU online advertisement	--	1
A vendor	--	3
DCSEU meeting	--	1

[1] Counts sum to greater than eight because multiple responses were allowed.
[2] Two respondents had not heard about the program anywhere else.

Over one-half of respondents (five of eight) had visited the DCSEU website to look for information on DCSEU financial or technical assistance for an energy-efficiency or renewable energy project. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 3.8, on average, for the information provided on the DCSEU's website. The two respondents who rated the website a 3 or below were asked how the DCSEU could make the website information more useful. Respondents requested more up-to-date information about DCSEU's relationship with local government and the impact of current legislation on the program.

2.1.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the Custom Retrofit program:

- Six of the 31 sample projects were not retrofits or equipment replacements; rather, they were new construction or gut rehab projects. Consider including all new construction projects (i.e., those with theoretical baselines based on building energy Code) in the NEWC program.
- Include a narrative within each project that describes the approach to estimating energy savings for all measures. Provide references to relevant spreadsheets and external sources of inputs for savings calculations.
- Consider adding a separate load shape peak demand value for air conditioning systems in school facilities. The "Commercial A/C" value is not appropriate for schools, which typically have limited operation over the summer (i.e., during most of the peak coincident period).

- Consider using site- or project-specific estimates or calculations of peak summer coincident demand savings. Peak demand savings for most, if not all, CUST projects are based on TRM deemed load shape values.

2.2 NEW CONSTRUCTION – CUSTOM (7520NEWC)

The new construction program provides incentives to building owners who build new facilities that exceed energy code standards. Through this program, DCSEU provides technical assistance to help decision makers design, scope, and fund their projects. New construction projects cover a multitude of building systems, including lighting; HVAC; building controls; building envelope elements, such as insulation and windows; and plug loads, such as icemakers, refrigerators, and freezers. Most of the buildings applying for funding also seek LEED certification.

Program staff focus on the long-term customer experience and aim to provide technical assistance during the project design phase. The DCSEU's role in these projects is primarily to provide guidance and direction. Account managers cultivate customer relationships, which enables DCSEU to be brought in early on projects. As the program has matured and these relationships have developed, custom projects find their way to DCSEU, so less outreach is required.

With a limited marketing budget, outreach efforts for the Commercial New Construction program have been focused on supporting customers and disseminating best practices and technologies. To introduce customers to new technologies, DCSEU holds brown bag meetings with interested stakeholders to introduce and vet new energy-efficiency technologies. The DCSEU also collaborates with other DC government programs to spread the word about this program. Customers may be directed to the DCSEU program from the DC Department of Regulatory Affairs (DCRA), the DC Department of Energy and Environment (DOEE), or the DC PACE program.

In FY2021, the program provided incentives for 30 projects. Table 36 provides the breakdown of tracked savings by measure type. Most of the total energy savings and total electric savings came from HVAC and lighting measures.

Table 36: New Construction Custom Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Gas Savings	Percent of FY2021 Peak Demand Savings
HVAC	61.8%	39.3%	94.7%	72.9%
Lighting	27.7%	47.1%	-0.7%	21.5%
Motors & Drives	2.4%	4.1%	0.0%	0.9%
Water Heating	3.6%	2.2%	5.7%	-0.2%
Appliances, Office Equipment, & Refrigeration	2.0%	3.1%	0.3%	1.4%
Solar PV	2.5%	4.2%	0.0%	3.6%

For the FY2021 New Construction Custom program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.2.1 Gross Savings Verification

Table 37 shows the tracked savings, realization rate, and evaluated savings for the program. The electric savings realization rate was 100%, the demand savings realization rate was 96%, and the natural gas savings realization rate was 100%.

Table 37: New Construction Custom Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	8,258	100%	8,285
FY2021 Peak Demand Savings (MW)	2.57	96%	2.48
FY2021 Gas Savings (MMBtu)	19,273	102%	19,721

2.2.1.1 Sampling

Due to the heterogeneous makeup of the program, we assumed a C_v of 0.5 for our initial sample design. With a precision target of ±20% at 80% confidence, this required a selection of eight unique sample sites at a minimum. The final sample size was 14 unique sites. The NMR team designed the sampling plan utilizing a stratified random sample to ensure the evaluation included a diverse mix of measure types. We created a certainty stratum, which ensured that we reviewed the largest projects from the program. The NMR team assigned projects that had more than 5,000 MMBTU of total energy savings to the certainty stratum. We also created a large probability stratum for projects with total energy savings between 2,000 and 5,000 MMBtu, and a small probability stratum for the remaining projects. We randomly sampled projects from each of the probability strata. Table 38 presents the final sample for the program.

Table 38: New Construction Custom Sampling Plan

Stratum	Stratum Criteria	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Sites
Certainty	>5,000 MMBtu	24%	2	2
Large Probability	2,000 to 5,000 MMBtu	41%	6	5
Small Probability	<2,000 MMBtu	35%	22	7

2.2.1.2 Methodology

The NMR team conducted a desk review for each of the selected sample sites, through which we calculated the evaluated savings. Four of the desk reviews used additional information

gathered via a virtual on-site verification. Each project was analyzed using one of two evaluation methodologies:

- For the majority of new construction projects, the NMR team reviewed the modeling inputs from building simulation software, such as Trane TRACE, and building systems against available construction and design documents. The NMR team compared the HVAC and lighting systems to the information provided in the project documentation and checked the systems against applicable building codes to confirm that they were more efficient than code minimums by the claimed amount.
- The NMR team also employed a custom savings calculator to aggregate the savings derived from building models. For lighting measures that provided detailed information on individual lighting fixtures, such as HOU, location, and wattages, the NMR team created the savings calculations using the custom calculator. For the FY2021 evaluation, the NMR team performed on-site verifications for one project from within the Certainty stratum, two projects from within the Large Probability stratum, and one project from within the Small Probability stratum. During the virtual on-site visits, the NMR team verified that the efficiencies, capacities, and quantities of the installed equipment matched the inputs for these systems in the simulation models. The NMR team also confirmed the date of the building construction documents to ensure that the correct code baselines were applied.

The measures included in the sampled projects were lighting, space heating, air conditioning, motor efficiency, ventilation, comprehensive building-wide savings, hot water conservation, refrigeration, water flow fixtures, and solar PV.

2.2.1.3 Results

The program-wide impact evaluation results are shown in Table 39. The findings that contributed to deviations in the realization rates are described in the text that follows.

Table 39: New Construction Custom Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	8,258	100%	8,285	80% ± 0.1%
FY2021 Peak Demand Savings (MW)	2.57	96%	2.48	80% ± 13.3%
FY2021 Gas Savings (MMBtu)	19,273	102%	19,721	80% ± 1.5%

The program-level realization rates are 100% for electric savings, 96% for demand savings, and 102% for natural gas savings. The selected sample ultimately achieved a ±0.1% precision at 80% confidence for electric savings, ±13.3% precision for demand savings, and ±1.5% precision for gas savings.

The evaluation team concluded that significant review went into the new construction models and calculations. The documentation provided was thorough, and the methods and assumptions used were suitable.

Thirteen of the 14 sampled new construction projects had a total energy realization rate that was roughly 100% ±1%. The last sampled project had a total energy realization rate of 157%, due to the project's natural gas savings. The finding for this project is described below.

- Small Probability stratum project 14599 did not report any natural gas savings. There is a note in the project page on VEIC's Tracker site explaining that this was intentional since "DCSEU will not provide incentives for gas measures for this year." The statement seems to be referring to the DC SEU's guidance in FY2022 that natural gas savings cannot be claimed for fuel-switching measures. Given that ID 14599 is a FY2021 project, the evaluator has deemed the natural gas savings that were found to be achieved via the space heating measure as eligible savings and has included them in verified savings for the project.

Peak coincident demand savings adjustments were generally related to application of coincidence factors (load shape values) for Small Probability stratum projects. Prominent examples of this type of adjustment are described below:

- Three projects (ID 14599, ID 16511, and ID 20641) took place at K-12 schools. Ex ante peak demand savings for HVAC measures were calculated based on the TRM deemed "Commercial A/C" load shape value of 57.82%. This value does not reflect the operation of most K-12 schools during the peak coincident demand period (non-holiday weekday afternoons from 2:00-6:00 PM, June through August), as there is limited occupancy while students are gone for the summer. In verified savings calculations, the evaluator used coincidence factor values from the Pennsylvania TRM, for the Philadelphia region (this was the most similar to Washington, DC, in terms of effective full load cooling hours). These values were generally around 18%, so this adjustment resulted in decreased savings for the projects.
- One project (ID 19802) was found to have used the incorrect deemed load shape value in calculating peak demand savings for the ventilation measure. The ex ante calculation was based on the "Commercial A/C" load shape value of 57.8%. The more appropriate load shape value is the 'Commercial Ventilation motor' load shape value of 88.3%. This adjustment resulted in an increase in savings for the ex post.

2.2.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from five web and telephone surveys completed with participating New Construction program customers.

2.2.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 40, the five New Construction program participants received the following scores:

- Two of the five respondents reported they would have installed the measure but scaled back the scope or efficiency of the project by a moderate amount, so we assigned them a moderate free-ridership intention score (25%).
- The other three participants said they would have purchased the same measure in the absence of the program:
    - One participant said they might have had the funds available to purchase the measure in the absence of the program. We assigned them a moderate-high free-ridership intention score (38%).
    - Two participants said they definitely would have had the funds to implement the same measure in the absence of the program, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score for the four respondents is 31%.

Table 40: Free-ridership Intention Scoring for New Construction Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	--
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	2
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	38%	1
	• Definitely would have had the funds	50%	2
Total		**38%**	**5**

Influence

Table 41 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The New Construction program features with the highest average ratings include previous experience with a DCSEU program (4.0) and the results of any audits, energy modeling, or technical studies done through a DCSEU program (4.0).

Table 41: Influence of DCSEU Program Features for New Construction Program

Features	n[1]	1 Played no role at all	2	3	4	5 Played a great role	Average Rating
Previous experience with a DCSEU program	5	1	--	--	1	3	4.0
The results of any audits, energy modeling, or technical studies done through a DCSEU program	4	1	--	--	--	3	4.0

Features	n[1]	1 Played no role at all	2	3	4	5 Played a great role	Average Rating
Information or recommendation from a DCSEU representative	5	--	1	1	1	2	3.8
The rebate	5	2	--	--	--	3	3.4
DCSEU marketing materials or program information	5	1	1	1	--	2	3.2
Information or recommendation from contractors or vendors associated with the program	4	2	--	--	--	2	3.0

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 42).

- Four of the five New Construction program participants indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- The fifth respondent provided a maximum rating of 4.0 for the program features, so we assigned them a free-ridership influence score of 13%.

The overall free-ridership influence score across all five respondents is 3%.

Table 42: Free-ridership Influence Scoring for New Construction Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - Program feature played a great role	0%	4
4	12.5%	1
3	25%	--
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**3%**	**5**

When asked if any other factors played a great role in influencing them to implement the measure through the New Construction program, one respondent, a non-profit, mentioned that the cost savings through the program had a great impact on their decision because it helped them focus more of their funds on the organization's mission.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with each project. The average unweighted

free-ridership rate was 40% and the average weighted free-ridership rate for the New Construction program was 36% (Table 43).

Table 43: FY2021 Free-ridership Rate for New Construction Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	40%	25%	63%
Free-ridership (savings-weighted)	36%	25%	63%

The FY2018 free-ridership rate was 61% and the FY2020 free-ridership rate was 63%. Given the low sample sizes for all three years, we recommend combining the results through a savings-weighted approach, shown in Table 44. We recommend an average free-ridership rate of 53%.

Table 44: FY2018, FY2020, & FY2021 Free-ridership Rate for New Construction Program

	Sample Size	Percent of Sampled Energy Savings[1]	Free-ridership Rate
FY2018	6	37%	61%
FY2020	4	30%	63%
FY2021	5	32%	36%
Weighted Average	15	**100%**	**53%**

[1] Does not sum to 100% due to rounding.

2.2.2.2 Participant Spillover

None of the five respondents reported purchasing and installing energy-efficient products after completing their New Construction project. This resulted in a spillover rate of 0% for the FY2021 New Construction program. The spillover rate for FY2020 was also 0%. However, in FY2018, spillover savings represented 7% of tracked savings for the respondents. Therefore, we recommend an average spillover rate of 3%, as shown in Table 45.

Table 45: FY2018, FY2020, & FY2021 Spillover Rate for New Construction Program

	Sample Size	Percent of Sampled Energy Savings[1]	Spillover Rate
FY2018	6	37%	7%
FY2020	4	30%	0%
FY2021	5	32%	0%
Weighted Average	**15**	**100%**	**3%**

[1] Does not sum to 100% due to rounding.

2.2.2.3 NTG Ratio

The savings-weighted NTG ratio for the New Construction program equals 50%, after rounding (Table 46).

Table 46: NTG Ratio for New Construction Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	53%	3%	50%

2.2.3 Process Evaluation

For the process evaluation of the New Construction program, the NMR team completed two telephone surveys and three web surveys with program participants (Table 47).

Table 47: New Construction Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	2
Participating end user surveys – web	3
Total	**5**

2.2.3.1 Key Findings

The key findings from the process evaluation of the New Construction program were as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their overall satisfaction with the program overall a 4.4, on average.
- When asked for their main reasons for participating in the New Construction program, participants most frequently cited a desire to save money on energy costs (five respondents), advance their long-term strategic energy management plan (three respondents), and save money on energy costs (three respondents). Notably, while two respondents had hoped to save money on their equipment installation by participating in the program, neither respondent reported realizing these savings.
- None of the five respondents reported experiencing any barriers to participating in the New Construction program.

2.2.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.2, on average. In FY2020, participants rated their likelihood to recommend the program to someone else an 8.3, on average.
- Participants rated their overall satisfaction with the program a 4.4, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2020, participants rated their overall satisfaction a 4.3, on average. Table 48 shows their satisfaction ratings in detail.

Table 48: Participant Experience with the New Construction Program

Feature	n[1]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**5**	**--**	**--**	**--**	**3**	**2**	**4.4**
The technical assistance you received from the DCSEU	4	--	--	--	1	3	4.8
The inspection of your project by the DCSEU	4	--	--	--	1	3	4.8
The preapproval process	3	--	--	--	1	2	4.7
The amount of the rebate, discount, or financial incentive	5	--	--	1	--	4	4.6
The performance of the new equipment	5	--	--	--	2	3	4.6
The type of eligible equipment or projects	4	--	--	1	--	3	4.5
The application process	5	--	--	1	1	3	4.4
The amount of time it took to receive the rebate or financial incentive	5	--	--	1	1	3	4.4
The energy savings from your new equipment	5	--	--	--	3	2	4.4
The assistance from your contractor or vendor	3	--	--	1	--	2	4.3
The information about DCSEU offerings	4	--	1	1	--	2	3.8

[1] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure."

Based on their experience, participants provided feedback on what they would change about the New Construction program (Table 49). Three respondents suggested changes.[9] The respondent who suggested that the program simplify the application process asked for clearer instructions. The respondent who suggested improving the inspection process asked that DCSEU contact participants about additional programs and incentives.

[9] One respondent did not have any suggested changes to the program, and another respondent was not sure how the program could improve.

Table 49: Suggested Changes to the New Construction Program

Suggested Change	Count of Respondents (n=3)[1]
Simplify the program application process or form	1
Give more detailed instructions or examples on application form	1
Provide more technical assistance or education regarding energy-saving options	1
Improve the inspection process	1
Allow greater flexibility in project timeline	1

[1] Does not sum to 3; multiple responses allowed.

2.2.3.3 Program Experience

When asked why they implemented the measure through the New Construction program, respondents most commonly cited a desire to save money on energy costs (five respondents), advance a long-term strategic energy management plan (three respondents), and save money on energy costs (three respondents) (Table 50). When asked what benefits their company realized because of their participation in the program, the most common responses include saving money on energy costs (four respondents), advancing long-term strategic management plan (four respondents), and reducing operating or maintenance costs (three respondents). Notably, none of the respondents reported realizing equipment installation savings or improved production or productivity.

Table 50: New Construction Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=5)[1]	
	Reasons for Participation	Benefits Realized
Save money on energy costs	5	4
Advance long-term strategic energy management plan	3	4
Reduce operating or maintenance costs	3	3
Install more reliable equipment	2	2
Save money on equipment installation	2	--
Improve work environment	2	1
Promote positive public relations	1	1
Improve production or productivity	1	--
To meet LEED standards	1	1
Increase safety/security	--	1

[1] Count of respondents sum to greater than five; multiple responses allowed.

None of the five respondents reported experiencing any barriers to participating in the New Construction program.

Four of the five participants received assistance on their New Construction program application. Two respondents received assistance from a DCSEU staff member, one respondent received assistance from a third-party contractor or vendor, and one respondent received assistance

from an architect. On a scale from 1 to 5, in which 1 is “very difficult” and 5 is “very easy,” respondents rated the ease of completing the application a 3.6, on average, a slight increase from the FY2020 average rating of 3.5. None of the respondents provided suggestions for improving the application process.

2.2.3.4 Program Awareness

New Construction program respondents first heard about the program from a colleague or industry peer (three respondents) or a DCSEU staff or account manager (two respondents).

Three of the five respondents recalled visiting the DCSEU website. On a scale from 1 to 5, in which 1 is not at all useful and 5 is very useful, respondents rated the usefulness of the information on the DCSEU website a 4.0, on average. In FY2020, participants rated the usefulness of the information on the DCSEU website a 3.3, on average.

2.2.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the New Construction program:

- NMR recommends that VEIC change their approach to estimating peak coincident demand savings with projects for which a building simulation model was developed. The outputs from most building simulation software includes only total load reduction by end-use category. VEIC then typically applies the “Commercial A/C” load shape value for peak coincident demand to calculate peak demand savings for the measures. NMR recommends determining a project-specific load shape (or coincidence factor) value for each project, based on the actual operating conditions of the facility.
- Consider adding a separate load shape peak demand value for air conditioning systems in school facilities. The “Commercial A/C” value is not appropriate for schools, which typically have limited operation over the summer (i.e., during most of the peak coincident period).
- If TRM deemed load shape values are used to calculate peak demand savings, ensure that each measure involved in the project is assigned the most appropriate load shape value.

2.3 MARKET OPPORTUNITIES – CUSTOM (7520MARO)

The Market Opportunities program provides incentives to owners of large buildings who replace equipment in their building with more efficient equipment or make operational changes to their facility that would result in energy savings. The program offers incentives for a variety of equipment types, including lighting, chillers, boilers, heat pumps, steam systems, insulation, refrigeration, and various building or equipment controls. Through this program, DCSEU provides technical assistance to help decision makers design, scope, and fund their projects. Funding is available through a traditional rebate structure where participants are paid per unit of energy saved.

In FY2021, the program provided incentives for 7 projects. Table 51 provides the breakdown of tracked savings by measure type. The bulk of total energy savings and total electric savings reside with the HVAC, refrigeration, and lighting measures.

Table 51: Market Opportunities Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Gas Savings	Percent of FY2021 Peak Demand Savings
HVAC	70.1%	-13.4%	91.6%	38.1%
Appliances, Office Equipment, & Refrigeration	26%	62.5%	8.4%	38.5%
Water Heating	1.7%	0.0%	0.0%	0.0%
Lighting	0.6%	37.5%	-0.1%	17.4%
Motors & Drives	1.6%	13.5%	0.0%	6.0%

For the FY2021 Market Opportunities program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.3.1 Gross Savings Verification

Table 52 shows the tracked savings, realization rate, and evaluated savings for the Market Opportunities program. Overall, the evaluation found the tracked savings to be calculated with a high degree of accuracy. The electric realization rate was 98%, the demand realization rate was 100%, and the gas realization rate was 98%.

Table 52: Market Opportunities Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	498	100%	498
FY2021 Peak Demand Savings (MW)	0.130	98%	0.128
FY2021 Gas Savings (MMBtu)	12,255	98%	11,972

2.3.1.1 Sampling

Due to the heterogeneous makeup of the program, we assumed a C_v of 0.5 for our initial sample design. With a precision target of ±20% at 80% confidence, this required a selection of five unique sample sites. The NMR team designed the sampling plan using stratified random sampling to ensure the evaluation included a diverse mix of savings magnitudes and measure types. We created a certainty stratum to ensure we reviewed the largest projects. The NMR team assigned projects with more than 1,000 MMBTU in total energy savings to the certainty stratum. We also created a probability stratum from which we drew a random sample. The large probability stratum included non-certainty projects (i.e., total energy savings less than 1,000 MMBtu). Stratifying by size allowed the evaluation team to capture as much of the gross energy and fuel savings as possible with the limited number of sample points allocated to the program. Table 53 presents the final sample.

Table 53: Market Opportunities Sampling Plan

Stratum	Stratum Criteria	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Sites
Certainty	>1,000 MMBtu	93%	3	3
Probability	<1,000 MMBtu	7%	4	2

2.3.1.2 Methodology

The NMR team conducted a desk review for each of the selected sample sites, through which we calculated the evaluated savings. Two of the five desk reviews employed additional information gathered from virtual on-site verifications (both from the Certainty stratum). The virtual on-site inspections involved verification of equipment types, operating hours, capacities, quantities, and other parameters via interviews with facility representatives and visual observation.

The NMR team analyzed each project using one of two evaluation methodologies:

- For measures that exist in the TRM, desk reviews applied algorithms and assumptions presented in the TRM as a reference for analysis, making methodological adjustments as appropriate for the site-specific information provided. The NMR team overwrote the TRM assumptions with site-specific data when enough information was provided to justify the change.
- For measures that did not exist in the TRM, engineers reviewed all submitted documentation and determined the suitability of the equations and assumptions used to calculate the tracked savings. If the NMR team deemed equations or assumptions unsuitable, we overrode them with more appropriate inputs.

The NMR team employed a custom savings calculator to facilitate the savings calculations. The custom calculator used the SEU's tracked savings database to look up project-specific inputs based on project number for reported electric, demand, and natural gas savings. The calculator allows for manual input of savings algorithms and provides a table that compares inputs

between those used in the tracked savings, those used in the TRM (if applicable), and those deemed appropriate by the evaluating engineer.

During the desk review process, our engineers created a calculator for each project within the sample. The engineer reviewed all available project documentation and assessed the method of analysis. If we agreed with the methodology of the analysis, then we relied on the same algorithms. We reviewed each variable to determine whether it was accurate. We also adjusted variables, such as the peak coincidence factor, that we found throughout the project documentation. Savings calculations ultimately relied on the verified values.

2.3.1.3 Results

The program-wide impact evaluation results for the Market Opportunities Program are shown in Table 54. The findings that contributed to the realization rates are described in the text that follows.

Table 54: Market Opportunities Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	498	100%	498	80% ± 0.0%
FY2021 Peak Demand Savings (MW)	0.130	98%	0.128	80% ± 0.6%
FY2021 Gas Savings (MMBtu)	12,255	98%	11,972	80% ± 0.0%

The program-level realization rates are 100% for electric savings, 98% for demand savings, and 98% for natural gas savings. The selected sample ultimately achieved a ±0.0% precision for electric savings, ±0.6% for demand savings, and ±0.0% for gas savings with an 80% confidence level.

The evaluation team concluded that significant review went into the custom savings calculations. The documentation provided was thorough, and the methods and assumptions used were suitable. The evaluation team believes these analyses were handled with the correct amount of rigor and that the tracked energy savings were calculated with a high degree of accuracy.

Projects with a prescribed calculation method used the SEU online tracking application. The tracking application is an electronic record keeping, file storage, and savings calculation platform that the SEU utilizes across the portfolio. The savings are calculated within the tracker based on the provided inputs. The sources of the inputs were not always provided in the project documentation, though the NMR team was able to locate the inputs in the online tracker for most projects. As needed, the NMR team performed independent engineering calculations for such projects based on the inputs verified from the project files, SEU tracker, and supplemented by virtual site visits performed by our engineers.

There were no major adjustments made to electric kWh savings for the sample projects.

We made only one significant adjustment to peak electric demand savings. The project ID was 18256. The project was a gut renovation of an office building, with measures related to all major

building systems. Ex ante peak demand savings were estimated for interior lighting, space cooling, and ventilation measures. The evaluator found that no peak demand savings were estimated for the heat rejection measure, which is a system that operates during the peak summer period. The verified savings incorporate an estimate for this system. The adjustment resulted in a decrease in savings (since the heat rejection peak demand savings are negative) for the project and an 88% realization rate.

There were two minor adjustments made to gas savings. The projects that had the largest effect on the program realization rate included:

- Certainty stratum project ID 14808 included a boiler installation measure. The evaluator deemed the overall approach for ex ante savings calculations to be appropriate and thorough, but the results were not weather-normalized. NMR's analysis used TMY weather data for a Washington, DC, weather station, as opposed to actual weather data for 2016-17 that was used in ex ante savings calculations. This adjustment resulted in a slight decrease in natural gas savings and a 97% realization rate.
- Certainty stratum project ID 22136 involved installation of energy-efficient refrigerated cases in a grocery store. NMR deemed the ex ante savings approach and estimates to be appropriate and accurate. There just appears to have been a data entry error for the natural gas savings. The calculation spreadsheet yields 1,068 MMBtu savings, but ex ante reported 1,028 MMBtu. This adjustment resulted in a slight increase in savings and a 104% realization rate.

2.3.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from two web and telephone surveys completed with participating Market Opportunities program customers.

2.3.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 55, the two Market Opportunities program participants received the following scores:

- One respondent installed the measure but reported scaling back the scope or efficiency by a small amount. We assigned this respondent a moderate free-ridership intention score (25%).
- The second respondent said they would have purchased the same measure in the absence of the program and definitely would have had the funds to cover the cost of the measure, so we assigned them a high free-ridership intension score (50%).

The overall free-ridership intention score for both respondents is 38%.

Table 55: Free-ridership Intention Scoring for Market Opportunities Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	--
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	1
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	38%	--
	• Definitely would have had the funds	50%	1
Total		**38%**	**2**

Influence

Table 56 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." Four Market Opportunities program features had average ratings of 4.0: previous experience with a DCSEU program; the results of any audits, energy modeling, or technical studies done through the program; information or recommendations from contractors or vendors; and DCSEU marketing materials.

Table 56: Influence of DCSEU Program Features for Market Opportunities Program

Features	n[1]	1 Played no role at all	2	3	4	5 Played a great role	Average Rating
Previous experience with a DCSEU program	2	--	--	--	2	--	4.0
The results of any audits, energy modeling, or technical studies done through a program offered by DCSEU	2	--	--	1	--	1	4.0
Information or recommendation from contractors or vendors associated with the program	1	--	--	--	1	--	4.0
DCSEU program marketing materials about the program	1	--	--	--	1	--	4.0
Information or recommendation from a DCSEU representative	2	--	--	1	1	--	3.5
The rebate	2	1	--	--	1	--	2.5

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 57):

- One of the two Market Opportunities program respondents indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- The other respondent provided a maximum rating of 4, so we assigned them a free-ridership influence score of 13%.

The overall free-ridership influence score for both respondents is 6%.

Table 57: Free-ridership Influence Scoring for Market Opportunities Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - Program feature played a great role	0%	1
4	13%	1
3	25%	--
2	38%	--
1 - Program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**6%**	**2**

Neither respondent cited any other factor as playing a great role in influencing them to implement the measure through the Market Opportunities program.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 44% and the average weighted free-ridership rate for the Market Opportunities program was 54% (Table 58).

Table 58: FY2021 Free-ridership Rate for Market Opportunities Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	44%	25%	63%
Free-ridership (savings-weighted)	54%	25%	63%

The FY2019 and FY2020 free-ridership rates were both 36%. Given the small sample sizes for the three years, we recommend combining the results through a savings-weighted approach, shown in Table 59. We recommend an average free-ridership rate of 37%.

Table 59: FY2019-FY2021 Free-ridership Rate for Market Opportunities Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2019	12	15%	36%
FY2020	7	80%	36%
FY2021	2	5%	54%
Weighted Average	**21**	**100%**	**37%**

2.3.2.2 Participant Spillover

Neither of the two FY2021 respondents reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Market Opportunities project. This resulted in a spillover rate of 0% for the Market Opportunities program in FY2021. However, in FY2019, spillover savings represented 14% of tracked savings for the respondents (Table 60). Therefore, we recommend an average spillover rate of 2%.

Table 60: FY2019-FY2021 Spillover Rate for Market Opportunities Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2019	12	15%	14%
FY2020	7	80%	0%
FY2021	2	5%	0%
Weighted Average	**21**	**100%**	**2%**

2.3.2.3 NTG Ratio

The savings-weighted NTG ratio for the Market Opportunities program equals 65%, after rounding (Table 61).

Table 61: NTG Ratio for Market Opportunities Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	37%	2%	65%

2.3.3 Process Evaluation

For the process evaluation of the Market Opportunities program, the NMR team completed two telephone surveys with program participants (Table 62).

Table 62: Market Opportunities Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	2

2.3.3.1 Key Findings

These were the key findings from the process evaluation of the Market Opportunities program:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.5, on average. One respondent reported having difficulties with the application and the amount of effort involved in participating in the program compared to the amount of the rebate. Despite these challenges, this respondent said they would be extremely likely to recommend the program to a friend.
- The information provided on the DCSEU website has a high potential impact as both respondents reported visiting the DCSEU website.

2.3.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 10, on average. In FY2020, participants rated their likelihood to recommend the program to someone else a 9.4, on average.
- Participants rated their overall satisfaction with the program a 4.5, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2020, participants rated their average satisfaction a 4.4. Table 63 shows their satisfaction ratings in detail.

Table 63: Participant Experience with the Market Opportunities Program

Feature (n=2)	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**--**	**--**	**--**	**1**	**1**	**4.5**
The inspection of your project by the DCSEU, if applicable	--	--	--	--	2	5.0
The performance of the new equipment	--	--	--	--	2	5.0
The amount of the rebate, discount, or financial incentive	--	--	--	1	1	4.5
The energy savings from your new equipment	--	--	--	1	1	4.5
The technical assistance you received from the DCSEU	--	--	--	1	1	4.5
The application process	--	--	1	--	1	4.0
The information about the DCSEU offerings	--	--	1	--	1	4.0
The type of eligible equipment or projects	--	--	--	2	--	4.0
The preapproval process	--	--	1	--	1	4.0
Time to receive the rebate or incentive	--	1	--	--	1	3.5

One respondent rated their satisfaction with “Time to receive the rebate or incentive” less than a value of 3, saying that the whole process took far too long.

Based on their experience, participants provided feedback on what they would change about the Market Opportunities program. One respondent suggested simplifying the program application process and another suggested improving the inspection process and including additional types of equipment outside of electrical equipment.

2.3.3.3 Program Experience

When asked why they implemented the measures through the Market Opportunities program, both participants cited advancing a long-term strategic management plan, installing more reliable equipment, reducing operating costs, saving money on energy costs, saving money on equipment installation, promoting positive public relations, and improving production or productivity. The complete list of reasons participants gave for participating in the program are presented below (Table 64). Of the seven reasons cited by both participants, both participants indicated realizing benefits in six areas.

Table 64: Market Opportunities Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=2)[1]	
	Reason for Participation	Benefits Realized
Advance long-term strategic management plan	2	2
Install more reliable equipment	2	2
Reduce operating or maintenance costs	2	1
Save money on energy costs	2	2
Save money on equipment installation	2	2
Promote positive public relations	2	2
Improve production or productivity	2	1
Improve work environment	1	2
Increase safety and/or security	1	1

[1] Counts sum to greater than two because multiple responses were allowed.

Only one of the two respondents reported facing a hurdle when determining whether or not to implement the measure through the Market Opportunities program. This respondent reported that the program's payback helped them overcome this hurdle.

One respondent reported receiving assistance on their Market Opportunities program applications from a third-party vendor or contractor. The other respondent completed the application on their own. On a scale from 1 to 5, in which 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 2, on average. One respondent was not convinced that the rebate was worth the application process. In FY2020, participants rated the ease of completing the application a 4.4, on average.

2.3.3.4 Program Awareness

One respondent learned about the Market Opportunities program before they started planning their project. The other respondent learned about the program after they started planning, but before they started implementing the project. Both respondents first engaged with the DCSEU before their organization began implementing the project.

Respondents first heard about the Market Opportunities programs from a DCSEU online advertisement (one respondent) and a DCSEU mailing or email (one respondent). When asked where else they heard about the program, respondents mentioned vendors (two respondents), a newspaper, radio, or television ad (two respondents), a conference, trade show, or fair (one respondent), a DCSEU online advertisement, and on DCSEU social media (Facebook, Twitter, etc.). Table 65 shows how program respondents heard about the program.

Table 65: Sources of Market Opportunities Program Awareness

Source of Program Awareness	Count of Respondents (n=2)	
	Where Participants First Heard of Program	Where Participants Heard of Program Overall [1]
A DCSEU online advertisement	1	1
A DCSEU mailing or email	1	--
A newspaper, radio, or television ad	--	2
A vendor	--	2
A conference, trade show, or fair	--	1
DCSEU social media (Facebook, Twitter, etc.)	--	1

[1] Counts sum to greater than two because multiple responses were allowed.

Both respondents had visited the DCSEU website before. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 3.5 for the information presented on the DCSEU financial or technical assistance for an energy-efficiency or renewable energy project. The one respondent who rated the website a rating of 3 or below was asked how the DCSEU could make the website information more useful. This respondent suggested that the DCSEU make the website more user-friendly and clearly convey that an application has been submitted and/or approved. In FY2020, respondents gave an average rating of 4.4 for the information provided on the DCSEU's energy saving programs.

2.3.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the MARO program:

- Each of the sampled projects used TRM deemed load shape values in ex ante peak demand savings calculations. Consider determining and using site-specific coincidence factors based on the actual operation of the building systems and facility.
- Utilize TMY weather data for weather-normalizing energy consumption of weather-dependent systems and measures in custom analyses.
- Ensure that all building systems that use electricity during the peak period (2:00 – 6:00 PM on non-holiday weekdays between June and August) are included in estimates of peak coincident demand savings for projects. Such systems typically include interior lighting, space cooling, heat rejection, and ventilation.
- Consider ways to make the application process more user-friendly and guide the customer through the steps of application submission and approval. One respondent reported having difficulties with the application and the amount of effort involved in participating in the program compared to the amount of the rebate. Despite these challenges, this respondent said they would be extremely likely to recommend the program to a friend.
- .

2.4 CIRX - EQUIPMENT REPLACEMENT (7511CIRX)

The C&I RX Equipment Replacement program, also known as Business Energy Rebates (BER), provides rebates to small-to-medium sized businesses and institutions. The program offers prescriptive incentives for lighting, HVAC, compressed air, refrigeration, food service, and vending equipment. Rebates require written pre-approval and are provided for facility improvements that result in a permanent reduction in electric and/or natural gas energy usage (persisting for a minimum of five years). The DCSEU provides per-unit rebates of up to $5 per bulb for screw-in LEDs, $50 per fixture for more advanced interior lighting, $60 per fixture for exterior lighting, $10-$20 per sensor for lighting controls, $350 for an efficient reach-in refrigerated case, and $750 for qualified commercial kitchen equipment. Other measures are rebated based on the size and efficiency of the equipment, with all rebates capped at 100% of the participant cost. Updates to the program offerings and incentive amounts are made on a quarterly basis to better address demand and to highlight specific measures for customers.

Savings were accrued and incentives were provided for 58 unique projects in FY2021. Table 66 shows the measure types contributing savings to the program during FY2021. The FY2021 program year saw more than 97% of combined energy savings from lighting.

Table 66: CIRX Equipment Replacement Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings (MMBtu)	Percent of FY2021 Electric Savings (MWh)	Percent of FY2021 Gas Savings (MMBtu)	Percent of FY2021 Peak Demand Savings (MW)
Lighting	97%	98%	100%	97%
Motors & VFDs	3%	2%	0%	3%
Appliances, Office Equipment, & Refrigeration	<1%	<1%	0%	<1%

For the FY2021 CIRX Equipment Replacement program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.4.1 Gross Savings Verification

Table 67 displays the tracked savings, realization rate, and evaluated savings for the CIRX Equipment Replacement program. The electric savings realization rate equals 105%, the peak demand realization rate equals 101%, and the natural gas savings realization rate equals 103%.

Table 67: CIRX Equipment Replacement Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	5,853	105%	6,118
FY2021 Peak Demand Savings (MW)	0.68	101%	0.68
FY2021 Gas Savings (MMBtu)	-1,787	103%	-1,848

2.4.1.1 Sampling

Given the homogenous makeup of the program, we assumed a C_v of 0.5 for our initial sample design. With a precision target of ±20% at 80% confidence, this required a selection of at least nine unique sample sites. In the end, we selected fourteen total sample sites. We employed stratified random sampling with ratio estimation for the prescriptive project selection.

We allocated the number of sample points across three strata (certainty, large probability, and small probability projects) based on each stratum's contribution to the program savings. The certainty stratum included projects with energy savings greater than 1,500 MMBtu. The NMR team categorized projects with between 500 and 1,500 MMBtu of energy savings as large probability, while we categorized projects with under 500 MMBtu savings as small probability. Randomly sampling from the two probability groups enabled us to balance between capturing projects with a larger contribution to the program savings while still allowing space for smaller projects. Table 68 presents the final sample for the CIRX Equipment Replacement Program.

Table 68: CIRX Equipment Replacement Sampling Plan

Substratum	Energy Savings (MMBtu)	Percent of Energy Savings	FY2021 Participation (Projects)	Number of Sampled Projects
Certainty	3,621	20%	2	2
Large Probability	8,825	49%	8	5
Small Probability	5,737	32%	48	7

The selected sample included 13 lighting retrofit projects and one VFD project; note that the entire population of projects from the program only included four non-lighting projects. The

sampled projects accounted for about 58% of the total energy savings for the program's population.

2.4.1.2 Methodology

The NMR team conducted a desk review for each of the sampled projects to determine the evaluated savings. The NMR team did not review any custom analyses for this program as all the projects were prescriptive. The desk reviews relied on algorithms and assumptions presented in the TRM. When project files provided more accurate site-specific information, the NMR team overwrote TRM assumptions with site-specific data.

Six of the fourteen desk reviews employed additional information gathered from virtual on-site verifications (two from the Certainty stratum, two from the Large Probability stratum, and two from the Small Probability stratum). The virtual on-site inspections involved verification of equipment types, operating hours, quantities, and other parameters via interviews with facility representatives and visual observation.

To facilitate the prescriptive lighting savings calculations, the NMR team constructed our own lighting savings calculator. The calculator used SEU's reported savings database to look up project-specific inputs, such as basic customer information, facility type, location of installed lighting, and installed fixture details and quantities. Heating fuel type, air conditioning, and schedule designation for each space was based on the TRM, with minor deviations subject to engineering judgment based on available project documentation. For example, the TRM assumes 68% of buildings utilize fossil fuel space heating. However, space heating type differs depending on the building and location of installations. The NMR team adjusted this assumption to reflect the heating fuel type when known and to show no heat in the case of exterior or parking garage fixtures.

Each project utilized its own calculator file, and an engineer reviewed the automatically loaded data for accuracy and completeness. We then reviewed project files and adjusted the deemed values if site-specific information was supported by sufficient project documentation, such as invoices, specifications, or email correspondence. These adjustments often included changes to installed fixture and/or lamp wattage values, which we checked against the provided product cut-sheets.

2.4.1.3 Results

The program-wide impact results of the CIRX Equipment Replacement Program are shown in Table 69. The findings that contribute to the realization rates are discussed in the text that follows.

Table 69: CIRX Equipment Replacement Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	5,853	105%	6,118	80% ± 3.6%
FY2021 Peak Demand Savings (MW)	0.68	101%	0.68	80% ± 4.6%
FY2021 Gas Savings (MMBtu)	-1,787	103%	-1,848	80% ± 3.9%

The program-level electric savings realization rate is 105%, the program-level demand savings realization rate is 101%, and the program-level gas savings realization rate is 103%. The sampled project-specific realization rates ranged from 77% to 196%. The selected sample ultimately achieved a ±3.6% precision at the 80% confidence level for electric savings.

Project files generally did not contain savings calculations or spreadsheets; however, based on the evaluator's attempt at recreating the ex ante analyses, it appeared that ex ante savings values are based on site-specific fixture quantities and TRM-deemed values for all other inputs.

The largest contributor to the sampled project-specific electric and peak demand savings realization rates was post-installation fixture wattages. All ex ante savings calculations utilized TRM-deemed values for post-installation wattages based on fixture type (screw-based, linear lamp, high/low bay, etc.). The evaluation team applied wattages that reflected the actual installed fixture, with values coming from specification sheets and DLC listings. The specific fixtures installed had actual wattages varying by about ±20% from the TRM-deemed values; however, they tended to be lower than the TRM-deemed values. This resulted in higher ex post savings and therefore realization rates greater than 100% for nine of the fourteen sampled projects.

Two projects accounted for the largest project-level variation in post-installation fixture wattages (Project ID 21734 yielded a 125% realization rate for electric savings; Project ID 23624 yielded a 77% realization rate for electric savings).

One other significant factor affecting the savings realization rates was the operating schedule. NMR found during a site visit that the light fixtures involved in Project 23174 operate continuously (24 hours per day, seven days per week), for an estimated total of 8,760 hours per year. This estimate is significantly higher than the value used in ex ante calculations (4,171 hours per year). This change also affected peak demand savings, as the verified schedule meant adjusting the coincidence factor to 1.00. This project yielded a 196% realization rate for kWh savings and a 161% realization rate for peak kW savings.

The natural gas realization rate equaled 103%. The largest contributor to this realization rate was the increased heating penalty associated with higher electric savings, as the two savings measurements are related. The higher the electric savings are for a lighting project, the larger

the associated gas penalty will be as the heating system must produce more heat to compensate for the lack of heat dissipating from more efficient lights.

2.4.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from 12 web and telephone surveys completed with participating CIRX Equipment Replacement program customers.

2.4.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 70, the 12 CIRX Equipment Replacement program participants received the following scores:

- Two of the 12 respondents reported they would have canceled the purchase of the measure in the absence of the program. We assigned these respondents a low free-ridership intention score (0%).
- Two of the 12 respondents said they would have implemented the measure but scaled back the scope or efficiency by a moderate amount. Two respondents were not sure what they would have done in the absence of the program. We assigned these four respondents a moderate free-ridership intention score (25%).
- The remaining six participants said they would have purchased the same measure in the absence of the program and definitely would have had the funds to cover the entire cost of the measure in the absence of the program, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score across all 12 respondents is 33%.

Table 70: Free-ridership Intention Scoring for CIRX Equipment Replacement Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	2
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	4
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	38%	--
	• Definitely would have had the funds	50%	6
Total		**33%**	**12**

Influence

Table 71 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The CIRX Equipment Replacement program features with the highest average ratings include information or recommendations provided by contractors or vendors associated with the program (4.5) and the rebate (3.9).

Table 71: Influence of DCSEU Program Features for CIRX Equipment Replacement Program

Features	n[1]	1 Played no Role at all	2	3	4	5 Played a Great Role	Average Rating
Information or recommendations from contractors or vendors associated with the program	11	--	1	--	3	7	4.5
The rebate	12	--	1	4	2	5	3.9
The results of any audits, energy modeling, or technical studies done through a DCSEU program	9	2	--	2	2	3	3.4
Previous experience with a DCSEU program	11	4	--	--	3	4	3.3
Information or recommendation from a DCSEU representative	11	4	1	3	1	2	2.6
Marketing materials or information provided by DCSEU	12	7	2	1	1	1	1.9

[1] Sample sizes exclude those who said, “Not applicable” or “I’m not sure.”

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 72):

- Nearly all CIRX Equipment Replacement program participants (ten out of 12 respondents) indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- Two respondents provided a maximum rating of 4, so we assigned them a free-ridership influence score of 13%.

The overall free-ridership influence score across all 12 respondents is 2%.

Table 72: Free-ridership Influence Scoring for CIRX Equipment Replacement Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Countof Respondents
5 - Program feature played a great role	0%	10
4	13%	2
3	25%	--
2	38%	--
1 - Program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**2%**	**12**

When asked if any other factors played a great role in influencing them to implement the measure through the CIRX Equipment Replacement Retrofit program, two respondents cited a desire to achieve energy efficiency throughout their building or organization.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 35% and the average weighted free-ridership rate for the CIRX Equipment Replacement program was 25% (Table 73).

Table 73: FY2021 Free-ridership Rate for CIRX Equipment Replacement Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	35%	0%	63%
Free-ridership (savings-weighted)	25%	0%	63%

The FY2018 free-ridership rate was 35% and the FY2020 free-ridership rate was 30%. Given the small sample sizes for the three years, we recommend combining the results from both years through a savings-weighted approach, shown in Table 74. We recommend an average free-ridership rate of 31%.

Table 74: FY2018, FY2020, & FY2021 Free-ridership Rate for CIRX Equipment Replacement Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2018	39	44%	35%
FY2020	19	34%	30%
FY2021	12	22%	25%
Weighted Average	**70**	**100%**	**31%**

2.4.2.2 Participant Spillover

One of the 12 respondents reported installing energy-efficient or renewable energy equipment at a DC location after implementing the project through the CIRX Equipment Replacement program. While this respondent indicated that the project did not receive a financial incentive or rebate, they rated the program's influence on their decision a 1 on a 1 to 5 scale, in which 1 means "no influence at all" and 5 means "great influence." Therefore, we assigned this respondent a spillover influence score of 0%. This resulted in a spillover rate of 0% for the CIRX Equipment Replacement Program (Table 75).

Table 75: FY2021 Spillover Rate for the CIRX Equipment Replacement Program

	Average	Minimum	Maximum
Spillover Rate	0%	0%	0%

In FY2018, spillover savings represented 1% of tracked savings for the respondents. In FY2020, spillover savings represented 0% of tracked savings for respondents.[10] Given the sample sizes for the two years, we recommend combining the results from both years through a savings-weighted approach, shown in Table 76. Therefore, we recommend a spillover rate of 1% for FY2021.

Table 76: FY2018, FY2020, & FY2021 Spillover Rate for CIRX Equipment Replacement Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2018	39	44%	1%
FY2020	19	34%	0%
FY2021	12	22%	0%
Weighted Average	**70**	**100%**	**1%**

2.4.2.3 NTG Ratio

The savings-weighted NTG ratio for the CIRX Equipment Replacement program equals 70%, after rounding (Table 77).

Table 77: NTG Ratio for CIRX Equipment Replacement Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	31%	1%	70%

2.4.3 Process Evaluation

For the process evaluation of the CIRX Equipment Replacement program, the NMR team completed nine telephone and three web surveys with program participants (Table 78).

[10] The spillover rate for FY2020 was 0.25%, which we used when calculating the weighted savings in Table 76.

Table 78: CIRX Equipment Replacement Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	9
Participating end user surveys – web	3
Total	**12**

2.4.3.1 Key Findings

The key findings from the process evaluation of the CIRX Equipment Replacement program are as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.6, on average.
- The NPS for the CIRX Equipment Replacement program was 83.
- The top two reasons participants cited for participating in the CIRX Equipment Replacement program were financial: saving money on energy costs (11 out of 12 respondents) and reducing operating or maintenance costs (ten out of 12 respondents).

2.4.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.6, on average. The NPS for the program among participating end users was 83. Most of the respondents (ten of twelve) were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. The other two respondents were *passives*, rating their likelihood to recommend the program to someone else an 8.
- Participants rated their overall satisfaction with the program a 4.6, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 79 shows their satisfaction ratings in detail.

Table 79: Participant Experience with the CIRX Equipment Replacement Program

Feature	n[1]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**12**	**--**	**--**	**--**	**5**	**7**	**4.6**
The performance of the new equipment	11	--	--	--	1	10	4.9
The energy savings from your new equipment	11	--	--	--	2	9	4.8
The amount of time it took to receive the rebate	12	--	--	1	2	9	4.7
The assistance from your contractor or vendor	11	--	--	--	3	8	4.7
The inspection of your project by the DCSEU	7	--	--	--	2	5	4.7
The technical assistance you received from the DCSEU	6	--	--	--	2	4	4.7
The application process	11	--	--	1	3	7	4.5
The preapproval process	10	--	--	1	3	6	4.5
The amount of the rebate, discount, or financial incentive	12	--	--	2	4	6	4.3
The type of eligible equipment or projects	9	--	--	2	3	4	4.2
The information about DCSEU offerings	11	--	--	5	--	6	4.1

[1] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure."

Based on their experience, six participants provided feedback on what they would change about the CIRX Equipment Replacement program (Table 80) [11] Respondents most commonly suggested providing additional information (three respondents); two of those respondents would like to know more about the qualified equipment and one respondent requested to be informed of any new program offerings via email. Two respondents suggested increasing the rebate amount; one of those respondents suggested the rebate should reduce initial costs by 33% and the other respondent would like to receive 25% back instead of 10%. Other suggestions mentioned by one respondent each included adding additional equipment types, such as non-DLC items, and simplifying the application process. Five of the twelve respondents indicated that they would not change anything about the program.

[11] Five respondents did not suggest any changes to the program, and one respondent said, "I'm not sure."

Table 80: Suggested Changes to the CIRX Equipment Replacement Program

Suggested Change	Count of Respondents (n=6)[1]
Provide additional information	3
Increase the rebate level	2
Include additional types of equipment	1
Simplify the program application process	1

[1] Count is greater than 12 because multiple responses were allowed.

2.4.3.3 Program Experience

When asked why they implemented the measure through the CIRX Equipment Replacement program, participants most commonly cited a desire to save money on energy costs (11 of the 12 respondents), reduce operating or maintenance costs (10 respondents), and install more reliable equipment (nine respondents) (Table 81). Notably, only eight respondents reported saving money on energy costs and only six respondents said they installed more reliable equipment, fewer than the number of participants who participated in the program in order to realize those benefits.

Table 81: CIRX Equipment Replacement Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=12)[1]	
	Reason for Participation	Benefits Realized
Save money on energy costs	11	8
Reduce operating or maintenance costs	10	10
Install more reliable equipment	9	6
Save money on equipment installation/purchase	9	9
Advance long-term strategic management plan	9	9
Improve work environment	6	8
Improve production or productivity	4	3
Increase safety and/or security	4	6
Promote positive public relations	4	4
Cost saving for the Clean River Initiative	1	--

[1] Count is greater than 12 because multiple responses were allowed.

Seven respondents reported facing no barriers or hurdles when deciding to participate in the program. The five respondents who faced a hurdle each mentioned a different barrier to participation, as shown in Table 82. The respondent who said that the payback period was too long would have preferred a payback period of less than two years.

Table 82: Hurdles Faced by CIRX Equipment Replacement Program Participants

Hurdle/Barrier	Count of Respondents (n=5)
Incremental cost for efficient equipment was higher than expected	1
Unsure of energy savings potential	1
The rebate amount was too low	1
Supply challenges due to the pandemic	1
Payback period was too long	1

Most of the respondents (11 of the 12) reported receiving assistance on their CIRX Equipment Replacement applications from a third-party contractor or vendor (eight respondents) and/or a DCSEU staff member (three respondents). One respondent completed the application themselves. On a scale from 1 to 5, in which 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.3, on average.

2.4.3.4 Program Awareness

Two-thirds of the participants (eight out of 12) learned about the CIRX Equipment Replacement program before they began planning their project. Three respondents learned about the program after they began planning but prior to implementing the project, and one respondent learned of the program after they started implementing but prior to completing the project (Table 83).

Table 83: Awareness of CIRX Equipment Replacement Program

When Respondent Learned about the Financial Incentives/Assistance	Count of Respondents (n=12)
Before planning the project	8
After planning the project, but prior to implementing	3
After implementing the project, but prior to completing	1
After completing the project	--

Nine of the twelve respondents first engaged with the DCSEU *before* their organization began implementing the project, while two respondents first engaged with the DCSEU after the project began. Two respondents reported that they first engaged with the DCSEU after the project began, but before it was complete.[12]

Respondents most commonly first heard about the CIRX Equipment Replacement program from a vendor (four respondents), followed by the DCSEU website (two respondents) or a colleague or industry paper (two respondents). Table 84 shows all of the ways program respondents heard about the program.

[12] One respondent did not know when they first engaged with DCSEU on their CIRX Equipment Replacement project.

Table 84: Sources of CIRX Equipment Replacement Program Awareness

Source of Program Awareness	Where Participants First Heard of Program (n=12)	Where Participants Overall Heard of Program (n=11)[1,2]
A vendor	4	3
The DCSEU website	2	2
A colleague or industry peer	2	6
DCSEU staff or account manager	1	2
A DCSEU mailing or email	1	2
A newspaper, radio, or television ad	1	1
Google search	1	--
A contractor	--	5
A distributor	--	4
DCSEU online advertisement	--	1
A conference, trade show, or fair	--	1
Trade publication	--	1
Energy benchmark company	--	1

[1] Sums to greater than 12 because multiple responses were allowed.
[2] One respondent had not heard about the program anywhere else.

Three-quarters of respondents (nine of 12) reported visiting the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 3.9 for the information provided on the DCSEU's website. The three respondents who rated the website a 3 or below were asked how the DCSEU could make the website information more useful. One respondent suggested improving the website navigation, one respondent suggested providing more specific information about the equipment covered by the program, and one respondent suggested providing energy reduction ideas for tenants, such as using more LED bulbs.

2.4.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the CIRX program:

- Project files for all CIRX projects should include a specification sheet and/or certification (DLC or Energy Star) listing for every unique installed fixture type. Each specification sheet or certification listing should show the manufacturer, model number, fixture wattage and lumen output.
- Consider collecting and using additional site-specific information in the energy savings calculations for each project. This should help in calculating more accurate energy consumption and savings estimates at the project level. Examples of additional inputs could include energy efficient fixture wattages, baseline fixture types and wattages, schedules (and associated hours of use and peak coincidence factor), and heating fuel type.
- Consider requiring program applicants to provide a full list of spaces within the facility that were affected by the project.

2.5 SMALL & MEDIUM BUSINESS REBATES (7511SMRX)

The Small & Medium Business Rebates program provides rebates to small-to-medium sized business and institution (under 10,000 square feet). The program offers prescriptive rebates for lighting, HVAC, refrigeration, food service, and vending equipment. Rebates are the same as the 7511CIRX program, but the incentives are slightly higher for the qualifying small and medium businesses.

For the FY2021 Small & Medium Business Rebates program, we completed the following evaluation activities:

- Net Savings Estimation
- Process Evaluation

2.5.1 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from two web and telephone surveys completed with participating Small and Medium Business Rebates program customers.

2.5.1.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

One Small and Medium Business Rebate participant would have delayed the implementation of the measure for at least one year and the other participant would have cancelled the implementation of the measure altogether. We assigned them both a free-ridership influence score of 0% (Table 85). The overall free-ridership intention score for the two Small and Medium Business Rebate program respondents is 0%.

Table 85: Free-ridership Intention Scoring for Small and Medium Business Rebate Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	2
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	--
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	37.5%	--
	• Definitely would have had the funds	50%	--
Total		**0%**	**2**

Influence

Table 86 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Small and Medium Business Rebate program features with the highest average ratings include the rebate (5.0) and previous experience with a DCSEU program (5.0).

Table 86: Influence of DCSEU Program Features for Small and Medium Business Rebate Program

Features	n[1]	1 Played no Role at All	2	3	4	5 Played a Great Role	Average Rating
The rebate	2	--	--	--	--	2	5.0
Previous experience with a DCSEU program	2	--	--	--	--	2	5.0
Information or recommendation from a DCSEU representative	2	--	--	1	--	1	4.0
The results of any audits, energy modeling, or technical studies done through a DCSEU program	2	1	--	--	--	1	3.0
Information or recommendation from contractors or vendors associated with the program	2	1	--	1	--	--	2.0
DCSEU marketing materials or program information	2	1		1	--	--	2.0

[1] Sample sizes exclude those who said, “Not applicable” or “I’m not sure.”

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 87). Both Small and Medium Business Rebate program respondents indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.

Table 87: Free-ridership Influence Scoring for Small and Medium Business Rebate Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - Program feature played a great role	0%	2
4	12.5%	--
3	25%	--
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	--
Don’t know OR Refused	25%	--
Total	**0%**	**2**

When asked if any other factors played a great role in influencing them to implement the measure through the Small and Medium Business Rebate program, one respondent cited care and concern for the environment.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. The average free-ridership score for the Small and Medium Business Rebate program was 0% (Table 88).

Table 88: Free-ridership Rate for Small and Medium Business Rebate Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	0%	0%	0%
Free-ridership (savings-weighted)	0%	0%	0%

2.5.1.2 Participant Spillover

Neither respondent reported installing energy-efficient or renewable energy equipment after completing their Small and Medium Business Rebate program project. This resulted in a spillover rate of 0% for FY2021.

2.5.1.3 NTG Ratio

The savings-weighted NTG ratio for the Small and Medium Business Rebate program equals 100% (Table 89).

Table 89: NTG Ratio for Small and Medium Business Rebate Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	0%	0%	100%

2.5.2 Process Evaluation

For the process evaluation of the Small and Medium Business Rebates program, the NMR team completed one web survey and one phone survey with program participants.

Table 90: Small and Medium Business Rebates Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	1
Participating end user surveys – web	1
Total	**2**

2.5.2.1 Key Findings

These were the key findings from the process evaluation of the Small and Medium Business Rebates program:

- On a scale from 1 to 5, in which 1 is “not at all satisfied” and 5 is “very satisfied,” the respondents rated their satisfaction with the program overall as a 4.5, on average. Both respondents also said they were likely to recommend the Small and Medium Business Rebates program to someone else.
- All respondents reported engaging with the Small and Medium Business Rebates program to install more reliable equipment, save money on equipment installation, and save money on energy costs.
- Respondents indicated that they realized all benefits they expected as well as additional benefits through engaging with the program.
- Both respondents reported visiting the DCSEU website, but the information available on the website received a rating of 2.5, on average.

2.5.2.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.5, on average. The NPS for the program among participating end users was 100. Both respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth.
- The participants rated their overall satisfaction with the program as a 4.5, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 91 shows the satisfaction ratings in detail.

Table 91: Participant Satisfaction with the Small and Medium Business Rebates Program

Feature	n[1]	Rating
Your experience overall	**2**	**4.5**
The amount of time it took to receive the rebate or financial incentive	2	4.5
The type of eligible equipment	2	4.5
The application process	2	4.5
The amount of the rebate, discount, or financial incentive	2	4.5
The energy savings from your new equipment	2	4.5
The performance of the new equipment	2	4.5
The inspection of your project by the DCSEU	1	4.0
The assistance from your contractor or vendor	1	4.0
The information about the DCSEU offerings	2	3.5
The technical assistance you received from DCSEU	2	3.5
The preapproval process	2	3.5

[1] Sample sizes vary because results exclude those who said, "Not applicable" or "I'm not sure."

Based on their experience, the respondents provided feedback on what they would change about the Small and Medium Business Rebate program. One respondent suggested improving the inspection process by having a third-party manage the process from start to finish. One respondent indicated they would not change anything about the program.

2.5.2.3 Program Experience

When asked why they implemented the measure through the Small and Medium Business Rebates program, both participants indicated a desire to install more reliable equipment, save money on equipment installation, and save money on energy costs (Table 32). When asked what benefits their company realized through participation in the program, both respondents mentioned the four most common responses , including installing more reliable equipment, saving money on energy costs, saving money on equipment installation/purchase, and reducing operating or maintenance costs.

Table 92: Small and Medium Business Rebates Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=2)[1]	
	Reason for Participation	Benefits Realized
Install more reliable equipment	2	2
Save money on energy costs	2	2
Save money on equipment installation/purchase	2	2
Reduce operating or maintenance costs	1	2
Improve production or productivity	1	2
Increase safety/security	1	1
Improve work environment	1	1
Promote positive public relations	1	1
Advance long-term strategic energy management plan	1	1

[1]Counts sum to greater than two because multiple responses were allowed.

One respondent reported facing at least one hurdle when deciding whether or not to implement the measure through the program. This respondent listed lack of funds available for investment and equipment availability. When asked if the program had helped them overcome these hurdles, the respondent was unsure.

Both respondents reported receiving assistance on the Small and Medium Business Rebates application from either a DCSEU staff member or a third-party contractor or vendor. On a scale from 1 to 5, in which 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 2.5, on average.

2.5.2.4 Program Awareness

Both respondents learned about the Small and Medium Business Rebates program before they started planning their project and their organization first engaged with DCSEU before beginning to implement their project.

One respondent first heard about the program from a contractor while the other respondent cited a conference, trade show, or fair. Respondents reported also hearing about the program from a DCSEU mailing or email, a DCSEU staff member or account manager, and a colleague or industry peer (each mentioned by one respondent).

Both participants indicated they had visited the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," the respondents rated the information on the DCSEU website a 2.5, on average. The respondent who gave the lower rating explained that the website is difficult to navigate and finding the information they were looking for was a challenge.

2.6 UPSTREAM LIGHTING (7513UPLT)

The Upstream Lighting program provides instant rebates (i.e., discounts) to customers purchasing lighting equipment through qualified distributors. Through this program, customers can purchase lightbulbs from any one of 12 participating distributors for a discounted rate. As it has matured, the program has adjusted discounts to align with market conditions. Available lamp types include Energy Star 2.0 certified LED directional, omnidirectional, and decorative bulbs, as well as DLC certified linear LED tubes.

These Instant Business Rebates support DCSEU's midstream work in the commercial sector. By drawing on the motivation for higher yields in the distribution channels, the program drives increased numbers of efficient products to showroom floors. The structure of this program allows for closer and more efficient tracking of product purchases. The distributors provide information on sales directly to the DCSEU, enabling a higher level of quality control. This allows the DCSEU to adjust the incentives more frequently to match the conditions of the changing market.

For the FY2021 Upstream Lighting program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.6.1 Gross Savings Verification

Table 93 shows the tracked savings, realization rate, and evaluated savings for the Upstream Lighting program. The electric savings realization rate was 106%, the demand savings realization rate was 105%, and the gas savings realization rate was 106%.

Table 93: Upstream Lighting Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	21,389	106%	22,773
FY2021 Peak Demand Savings (MW)	2.85	105%	2.99
FY2021 Gas Savings (MMBtu)	-6,824	106%	-7,230

2.6.1.1 Sampling

Given the homogenous makeup of the program, the NMR team assumed a C_v of 0.5 for our initial sample design. With a precision target of ±20% at 80% confidence, this required a selection of at least 16 unique sample sites. The final sample size was 21 unique sites. We employed stratified random sampling with ratio estimation for the prescriptive project selection.

We allocated the number of sample points across three substrata (certainty, large probability, and small probability projects) based on each substratum's contribution to the program savings. The certainty strata cut off was set at 2,000 MMBtu. The NMR team automatically selected projects that had total energy savings above 2,000 MMBtu into the sample, while we randomly sampled projects below that threshold. We also created a large probability stratum for projects with total energy savings between 1,000 and 2,000 MMBtu, and a small probability stratum for

the remaining projects. We randomly sampled projects from each of the probability strata. Table 94 presents the final sample for the Upstream Lighting program.

Table 94: Upstream Lighting Sampling Plan

Stratum	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Sites
Certainty	16%	3	3
Large Probability	22%	12	4
Small Probability	62%	123	14

2.6.1.2 Methodology

The NMR team conducted a desk review for 21 of the 138 total projects to calculate the evaluated savings. These calculations relied on algorithms and assumptions presented in the TRM. When information in the project files deviated from the TRM, the NMR team overwrote these assumptions with site-specific data.

To calculate the prescriptive lighting savings, we employed our own lighting savings calculator. The calculator utilized DCSEU's savings database to look up project-specific inputs, such as basic customer information, facility type, location of installed lighting, and installed bulb/fixture numbers and quantities, which our engineers reviewed for correctness and completeness. Assumed values from the TRM included hours of operation, prescriptive wattages, waste heat factors, in-service rate, percent of lighting in heated spaces, and fossil fuel and electric waste heat factors. The NMR team applied values from the TRM based on the type of bulb or fixture and the installation location (indoor versus outdoor). Hours of operation were based on the LED category of the bulb or fixture.

The NMR team then reviewed supporting project documentation, such as invoices, spec sheets, or email correspondence and adjusted the deemed values if site-specific information was provided.

2.6.1.3 Results

The program-wide impact evaluation results for the Upstream Lighting Program are shown in Table 95. The findings that contributed to the realization rates are described in the text that follows.

Table 95: Upstream Lighting Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	21,389	106%	22,773	80% ± 1.4%
FY2021 Peak Demand Savings (MW)	2.85	105%	2.99	80% ± 1.3%
FY2021 Gas Savings (MMBtu)	-6,824	106%	-7,230	80% ± 1.3%

The program-level electric and demand savings realization rates are 106% and 105%, respectively. The largest contributor to the sampled project-specific electric realization rates exceeding 100% was adjustments to post-installation fixture wattages. All ex ante savings

calculations utilized TRM-deemed values for post-installation wattages based on fixture type (screw-based, linear lamp, high/low bay, etc.). The evaluation team applied wattages that reflected the actual installed fixture, with values coming from specification sheets and DLC listings. The specific fixtures installed had actual wattages varying by about ±25% from the TRM-deemed values; however, they tended to be lower than the TRM-deemed values. This resulted in higher ex post savings and project realization rates greater than 100% for seventeen of the 21 sampled projects.

The natural gas realization rate equaled 106%. The largest contributor to this realization rate was the increased heating penalty associated with higher electric savings, as the two values are related. The higher the electric savings are for a lighting project, the larger the associated gas penalty will be as the heating system must produce more heat to compensate for the lack of heat dissipating from more efficient lights.

2.6.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from 35 web and telephone surveys completed with participating Commercial Upstream Lighting program customers.

2.6.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 96, the 35 Commercial Upstream Lighting program participants received the following scores:

- Nearly one-fifth of participants (17%) reported they would have delayed the purchase of the LEDs by at least one year or canceled the purchase in the absence of the program. We assigned these respondents a low free-ridership intention score (0%).
- Approximately one-third of participants (34%) said they would have purchased a smaller quantity of LEDs in the absence of the program. When asked how many LEDs they would have purchased in the absence of the program, four of the 11 respondents said they would have only purchased a small portion of the LEDs, six said they would have purchased a moderation portion, and one said they would have purchased a large portion. We assigned these 11 respondents a moderate free-ridership intention score (25%).
- The remaining participants said they would have purchased the exact same quantity of LEDs in the absence of the program:
    - Six percent of respondents said they definitely would not have had the funds available to purchase the LEDs in the absence of the program, or that they did not

know or would rather not answer the question about the availability of the funds. We assigned them a moderate free-ridership intention score (25%).

- Nine percent of respondents said they might have had the funds available to purchase the LEDs in the absence of the program. We assigned them a moderate-high free-ridership intention score (37.5%).
- One-third of respondents (34%) reported that they definitely would have had the funds to cover the entire cost of the LEDs in the absence of the program, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score across all 35 respondents is 30%.

Table 96: Free-ridership Intention Scoring for Commercial Upstream Lighting Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Percent of Respondents[1]
• Delayed the purchase of the LEDs for at least one year OR • Cancelled the purchase of the LEDs altogether	• Not Asked	0%	17%
• Purchased a smaller quantity of LEDs OR • Don't know OR • I'd rather not answer	• Not Asked	25%	34%
• Purchased the exact same quantity of LEDs	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	6%
	• Might have had the funds	37.5%	9%
	• Definitely would have had the funds	50%	34%
Total		**30%**	**35**

[1] Percentages sum to greater than 100% due to rounding.

Influence

Table 97 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Commercial Upstream Lighting program features with the highest

average ratings include the rebate (3.8) and information or recommendations from contractors or distributors associated with the program (3.8).

Table 97: Influence of DCSEU Program Features for Commercial Upstream Lighting Program

Features	n[1]	1 Played no role at all	2	3	4	5 Played a great role	Average Rating
The rebate[2]	33	15%	3%	15%	21%	45%	3.8
Information or recommendations from contractors or distributors associated with the program	32	19%	--	9%	22%	50%	3.8
Previous experience with a DCSEU program[2]	30	27%	7%	10%	7%	50%	3.5
Information or recommendation from a DCSEU representative	28	39%	7%	7%	21%	25%	2.9
DCSEU marketing materials about the program[2]	30	43%	13%	10%	17%	17%	2.5

[1] Sample sizes exclude those who said, “Not applicable” or “I’m not sure.”
[2] Percentages do not sum to 100% due to rounding.

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 98):

- Over four-fifths of Commercial Upstream Lighting program respondents (83%) indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- Six percent of respondents provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.
- Three percent of respondents provided a maximum rating of 3, so we assigned them a free-ridership influence score of 25%.
- Six percent of respondents provided a maximum rating of 1, so we assigned them a free-ridership influence score of 50%.
- Three percent of respondents were not sure about the influence of the program features on their decision to implement the measure, so we assigned them a free-ridership influence score of 25%.

The overall free-ridership influence score across all 35 respondents is 5%.

Table 98: Free-ridership Influence Scoring for Commercial Upstream Lighting Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Percent of Respondents[1]
5 - Program feature played a great role	0%	83%
4	12.5%	6%
3	25%	3%
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	6%
Don't know OR Refused	25%	3%
Total	**5%**	**35**

[1] Percentages sum to greater than 100% due to rounding.

Fourteen respondents named at least one non-program factor that played a great role in influencing them to purchase LEDs through the program (Table 99). Respondents most often mentioned saving money (four respondents), time saved replacing bulbs (four respondents), and energy savings (three respondents). Three respondents also mentioned the goal of reducing energy consumption in compliance with local regulations. Respondents also mentioned a commitment to sustainability, the ease of participating in the program, and local building code regulations as factors in their decision to purchase LEDs through the Commercial Upstream Lighting Program (one respondent each).

Table 99: Non-Program Factors Influencing Purchase of LEDs through the Commercial Upstream Lighting Program

Other Factor Influencing Purchase Decision	Count of Respondents (n=14)[1]
Saving money	4
Labor savings (LEDs last longer)	4
Energy savings	3
Reducing energy consumption in compliance with DC regulations	3
Sustainability/for the environment	1
Ease of participation	1
Building code regulations	1

[1] Multiple responses allowed; results exclude those who reported that there were no other factors with a great impact on their decision.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. In FY2021, both the average unweighted free-ridership rate and the average weighted free-ridership rate for the Commercial Upstream Lighting program were 35% (Table 100).

Table 100: FY2021 Free-ridership Rate for Commercial Upstream Lighting Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	35%	0%	100%
Free-ridership (savings-weighted)	35%	0%	100%

The FY2019 free-ridership rate was 30% and the FY2020 free-ridership rate was 28%. We recommend combining the results from the three years through a savings-weighted approach, shown in Table 101. We recommend an average free-ridership rate of 32%.

Table 101: FY2019-FY2021 Free-ridership Rate for Upstream Lighting Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2019	48	35%	30%
FY2020	39	22%	28%
FY2021	35	43%	35%
Weighted Average	**122**	**100%**	**32%**

2.6.2.2 Participant Spillover

Four of the 35 respondents (11%) reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Commercial Upstream Lighting project. One participant (3%) reported that the program had some influence on their decision to update the building's existing pneumatic controls of VAV dampers to DDC (Table 25). The participants rated the program's influence on their decision a 5 on a 1 to 5 scale, in which 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 100%, respectively.

Table 102: Spillover Influence Scores for Commercial Upstream Lighting Program

Influence Rating	Assigned Influence Score (%)	Spillover Measures	Count of Respondents
Rating of 2 (some influence)	25%	-	-
Rating of 3	50%	-	-
Rating of 4	75%	--	--
Rating of 5 (great influence)	100%	Updating pneumatic controls of VAV dampers to DDC	1
Respondent does not know how much influence	50%	-	-

The NMR team used building science models to estimate the average savings associated with updating the controls in a commercial building of a similar square footage, usage, and number of VAV boxes specified by the respondent (700). We then divided that estimate by the cumulative tracked savings across all 35 survey respondents to calculate the spillover rate. This resulted in a spillover rate of 2% for the Commercial Upstream Lighting program (Table 26).

Table 103: FY2021 Spillover Rate for Commercial Upstream Lighting Program

	Average	Minimum	Maximum
Spillover Rate	2%	0%	60%

Spillover savings represented 5% of tracked savings in FY2019 and 1% of tracked savings in FY2020 for the respondents. Given the small sample sizes for the three years, we recommend combining the results from all years through a savings-weighted approach, shown in Table 104. Therefore, we recommend an average spillover rate of 3%.

Table 104: FY2019-FY2021 Spillover Rate for Commercial Upstream Lighting Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2019	48	35%	5%
FY2020	39	22%	1%
FY2021	35	43%	2%
Weighted Average	**122**	**100%**	**3%**

2.6.2.3 NTG Ratio

The savings-weighted NTG ratio for the Commercial Upstream Lighting program equals 71%, after rounding (Table 105).

Table 105: NTG Ratio for Commercial Upstream Lighting Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	32%	3%	71%

2.6.3 Process Evaluation

For the process evaluation of the Commercial Upstream Lighting program, the NMR team completed 34 telephone surveys and one web survey with program participants (Table 106). As contact information was only available for Commercial Upstream Lighting participants who participated in another DCSEU program, results may be biased towards more highly engaged program participants who have undertaken more than one energy-efficiency upgrade at their DC property.[13]

Table 106: Commercial Upstream Lighting Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	34
Participating end user surveys – web	1

[13] The NMR team was able to find some participant contact information from other publicly available sources, so the sample frame was not entirely composed of Commercial Upstream Lighting participants that had also participated in another program.

Stakeholder	Completed
Total	**35**

2.6.3.1 Key Findings

The key findings from the process evaluation of the Commercial Upstream Lighting program are as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.6, on average.
- The NPS[14] for the Commercial Upstream Lighting program was 74.
- Commercial Upstream Lighting program participants realized financial benefits through participation in the program: 97% saved money on operating or maintenance costs and 94% saved money on energy costs.

2.6.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, in which 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.4, on average, which is the same likelihood as in FY2020. The NPS for the program among participating end users was 74, which is the same NPS as FY2020. Overall, 80% of respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. Two respondents were *passives*, rating their likelihood to recommend the program to someone else an 8. The other two respondents were *detractors*, rating their likelihood to recommend the program to someone else a 5.
- Participants rated their overall satisfaction with the program a 4.6, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Satisfaction levels are slightly lower than FY2020, when respondents rated their overall satisfaction a 4.8, on average. Table 107 shows satisfaction ratings in detail.

[14] The NPS is a well-established measure of customer loyalty. Using a scale of 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," respondents are asked how likely they are to recommend the program to someone else. Respondents are then grouped as promoters (score 9-10), passives (7-8), and detractors (0-6). The NPS is calculated by subtracting the percentage of detractors from the percentage of promoters and is presented as a whole number.

Table 107: Participant Experience with the Commercial Upstream Lighting Program[1]

Feature	n[2]	1 Not at all satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**34**	**--**	**--**	**3%**	**32%**	**65%**	**4.6**
The performance of the new equipment	34	--	--	9%	12%	79%	4.7
The assistance of the distributor you purchased the LEDs from	30	--	--	3%	23%	73%	4.7
The assistance from your contractor or vendor	26	--	--	4%	23%	73%	4.7
The technical assistance you received from the DCSEU	16	--	--	1	7	22	4.7
The amount of the rebate, discount, or financial incentive	34	--	3%	12%	29%	56%	4.4
The energy savings from your new equipment	33	--	3%	6%	39%	52%	4.4
The type of eligible equipment or projects	33	--	3%	24%	30%	42%	4.1
The information about the DCSEU offerings	33	--	--	21%	24%	55%	4.3

[1] Some rows do not sum to 100% due to rounding.
[2] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure." If n < 20, counts are shown instead of percentages.

Respondents who rated their satisfaction with program features less than a 3 were asked to provide additional context.

- One respondent who rated their satisfaction with the type of eligible equipment or projects as a 2 explained that it took too much time to complete the application and the application process was unclear.
- One respondent who rated their satisfaction with the amount of the rebate as a 2 said that the amount was too low.
- One respondent who rated their satisfaction with the energy savings from their new equipment as a 2 said that they have not yet seen a return on investment.

Based on their experience, participants provided feedback on what they would change about the Commercial Upstream Lighting program (Table 108). Nearly two-thirds of respondents (63%) indicated they would not change anything about the program. The most common suggestion (20% of respondents) was to increase the rebate amount; in particular, respondents suggested rebate increases ranging from 10% to 20% as well as increasing the rebate for lighting management systems. Respondents also suggested increasing program awareness and visibility (9%) and including additional types of equipment (6%); one respondent cited difficulty finding products that exceeded the program's required energy standards and the other

respondent would like to see other equipment types, including appliances and HVAC, included in the upstream program. The respondent who suggested the program offer higher quality equipment reported that the LEDs they received through the program had not lasted very long.

Table 108: Suggested Changes to the Commercial Upstream Lighting Program

Suggested Change	Percent of Respondents (n=35)[1]
Increase the rebate level	20%
Increase program awareness and visibility	9%
Include additional types of equipment	6%
Simplify the program application process	3%
Give more detailed instructions or examples on application form	3%
Offer higher quality equipment	3%
Conduct annual energy audits of buildings	3%
Extend the length of time that equipment is eligible	3%
No change	63%

[1] Percentages sum to greater than 100% because multiple responses were allowed.

2.6.3.3 Program Experience

When asked why they purchased LEDs through the Commercial Upstream Lighting program, all respondents cited a desire to save money on energy costs (100%) and to reduce operating and maintenance costs (94%). As shown in Table 109, respondents also mentioned advancing a long-term strategic energy management plan (86%), and to save money on equipment installation (66%).

When asked what benefits their company realized through their participation in the program, the most common responses include reducing operating or maintenance costs (97%), saving money on energy costs (94%), and advancing a long-term strategic energy management plan (89%). In nearly every category, respondents reported realizing more benefits than they had foreseen when deciding to participate in the program (e.g., 40% of respondents purchased LEDs through the program to increase safety or security at their company, while 57% of respondents reported realizing this benefit after participating).

Table 109: Commercial Upstream Lighting Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=35)[1]	
	Reason for Participation	Benefits Realized
Save money on energy costs	100%	94%
Reduce operating or maintenance costs	94%	97%
Advance long-term strategic energy management plan	86%	89%
Save money on equipment installation	66%	83%
Install more reliable equipment	57%	77%
Promote positive public relations	57%	57%
Improve work environment	51%	63%
Increase safety/security	40%	57%
Improve production or productivity	37%	46%

[1] Percentages sum to greater than 100% because multiple responses were allowed.

Most respondents (86%) did not face any hurdles when deciding whether or not to purchase LEDs through the program. Of the four respondents who faced least one hurdle, two respondents indicated that the payback period was too long (Table 110). One respondent who indicated that the payback period was too long noted that their organization looks for a payback period of two years. Other hurdles, each mentioned by one respondent, included difficulty finding warm-color lighting or American-made manufacturers. One respondent mentioned a challenging application process and requested that participation could be made "easier and faster;" however, as the Commercial Upstream Lighting program offers instant discounts, it was not clear to which program process the respondent was referring. Two of the four respondents who cited specific hurdles indicated that the program helped them overcome these barriers to participation. The other two respondents who faced hurdles were not sure if the program helped to overcome these barriers to participation.

Table 110: Hurdles Faced by Commercial Upstream Lighting Program Participants

Hurdle/Barrier	Count of Respondents (n=4)[1]
Payback period is too long	2
Rebate application process was challenging	1
Finding warm lighting	1
Finding American manufacturers	1

[1] Counts sum to greater than four because multiple responses were allowed.

2.6.3.4 Program Awareness

More than three-quarters of respondents (77%) were aware they had participated in the Commercial Upstream Lighting program prior to taking the survey. While some of these respondents may not have been aware of DCSEU's involvement, 91% of survey respondents recalled learning that the discount was available before purchasing the LEDs (Table 111).

Table 111: Awareness of Commercial Upstream Lighting Program Rebate Availability

When Respondent Learned about the Rebate	Percent of Respondents (n=34)
Before purchasing LEDs	91%
While purchasing LEDs	3%
After purchasing LEDs	3%
Don't know	3%

Over one-quarter of participants reported first learning about the program from a vendor[15] (26%), a DCSEU staff or account manager (17%), a contractor (11%), or a colleague or industry peer (11%). Table 112 shows how program respondents heard about the program.

Table 112: Sources of Commercial Upstream Lighting Program Awareness

Source of Program Awareness	Where Participants First Heard of Program	Where Participants Overall Heard of Program[1]
A vendor	26%	51%
A DCSEU staff or Account Manager	17%	20%
A contractor	11%	37%
A colleague or industry peer	11%	31%
A DCSEU mailing or email	9%	34%
DCSEU website	9%	40%
A distributor	6%	46%
A building industry association	3%	11%
Previous work with DCSEU	3%	--
A conference, trade show, or fair	--	17%
A DCSEU online advertisement	--	11%
A newspaper, radio, or television ad	--	9%
US DOE	--	3%
Don't know	6%	--

[1] Three respondents had not heard about the program anywhere else.

Nearly two-thirds of the 35 respondents (63%) reported visiting the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave a rating of 4.6, on average, for the information provided on the DCSEU website.

[15] Some participants may be unclear on the role of their distributor and referred to them as a "vendor" in the survey.

2.6.3.5 Upstream Measures

All commercial survey respondents were asked to identify other types of energy-efficient equipment, besides LEDs, that DCSEU should consider offering instant discounts through distributors. Two-thirds of respondents (67%) suggested some type of non-lighting equipment.[16] Table 113 shows all equipment types identified by at least two respondents. General requests for HVAC equipment were the most popular request (37%), followed by laundry, kitchen, and/or commercial refrigeration appliances (28%) and motors or motor controls (22%). Some respondents appeared to consider equipment suitable for instant rebates, while others may have been thinking about any equipment they would like to see covered by a DCSEU program.

Table 113: Equipment Suggested for Instant Discounts Through Distributors

Equipment Type	Percent of Respondents (n=46)[1]
HVAC equipment	37%
Appliances (laundry, kitchen, and/or commercial refrigeration)	28%
Motors or motor controls	22%
Variable frequency drives	15%
Chillers	13%
Boilers	13%
Solar panels	9%
Pumps	9%
Water heating equipment	7%
Electric vehicle charging equipment	7%
Window or wall air conditioner	7%
Water-saving equipment	7%
Heat pumps	2%
Other[2]	24%

[1] Percentages sum to greater than 100% because multiple responses were allowed.
[2] The following items were also mentioned by own respondent each: large machinery, thermostats, air compressors, cooling towers, security alarms, energy management system, green roofing materials, water fountains, occupancy sensors, portable generators, window treatments including blinds or window tinting, and bulb, battery, and oil recycling.

2.6.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the Upstream Lighting program:

- Project files for all CIRX projects should include a specification sheet and/or certification (DLC or Energy Star) listing for every unique installed fixture type. NMR found that four sample projects were missing either a specification sheet, a certification listing, or both. Each specification sheet or certification listing should show the manufacturer, model number, fixture wattage and lumen output.

[16] The six respondents who requested no other equipment except additional lighting rebates wanted more program-eligible options, including garage lighting, LED drivers, and ballasts.

- Consider using actual fixture wattages for energy efficient fixtures in energy savings calculations.
- Consider requiring distributors to collect additional site-specific information at the time of sale, to be used in the energy savings calculations for each project. This should help in calculating more accurate energy consumption and savings estimates at the project level. Examples of additional inputs could include baseline fixture types and wattages, schedules (and associated hours of use and peak coincidence factor), heating fuel type, and facility and space type(s).
- Similarly, consider requiring distributors to collect contact information for the purchaser at the time of sale. Not only could it provide an opportunity for DCSEU to market additional savings opportunities to new commercial customers, but it would also improve the quality of the evaluation. The NMR team could only contact Commercial Upstream Lighting participants who had contact information on file from participating in another DCSEU program, which biases the study results towards more highly engaged participants.

2.7 PAY FOR PERFORMANCE (7520P4PX)

The Pay for Performance (P4P) track focuses on C&I existing buildings undergoing complex, multi-measure efficiency projects, including those with behavioral or operational changes. Projects with these types of measures are challenging to analyze with traditional prescriptive or spreadsheet savings calculations.

Incentives are paid based on pre- and post-project metered data, where actual energy saved is determined using multivariate linear regression of AMI (electric) or monthly (natural gas) meter data. The program utilizes the Temperature and Time of Week (TTOW) algorithm developed by Lawrence Berkeley National Laboratory (LBNL).[17] The TTOW model produces a piecewise estimate of hourly or sub-hourly interval meter data based on energy usage, outdoor air temperature, an occupancy indicator variable, and 167 hours of the week indicator variables. The baseline period usage data is fit with a baseline model. The baseline model is then compared to the actual customer usage during the evaluation period to determine the savings.

In FY2021, the program only appeared to have claimed savings and provided incentives for one project. Table 114 presents the summary of tracked savings for the one project in FY2021. The savings for the program during FY2021 originated from temperature reset, pump control automation, and start time optimization.

Table 114: P4P Program Tracked Savings by Project

Project ID	Electric Energy Savings (MWh)	Peak Demand Savings (MW)	Gas Savings (MMBTU)
18135	1,175.6	0.532	0
Total	**1,175.6**	**0.532**	**0**

For the FY2021 P4P program, we completed the following evaluation activities:

- Gross Savings Verification

2.7.1 Gross Savings Verification

Table 115 shows the tracked savings, realization rate, and evaluated savings for the P4P program. The realization rates are 100% for electric and 14% for peak demand.

Table 115: P4P Program Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	1,176	100%	1,176
FY2021 Peak Demand Savings (MW)	0.532	14%	0.076
FY2021 Gas Savings (MMBtu)	0	N/A	0

[17] Price, P. et al. *Using Whole-Building Electric Load Data in Continuous or Retro-Commissioning*. Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division. July 2011.

2.7.1.1 Sampling

Due to the small number (one) of participants in the P4P program during FY2021, the evaluation team verified a census of the projects. If participation in the P4P program increases in future years, a sampling strategy may be employed.

2.7.1.2 Methodology

The NMR team conducted a desk review for each project, through which we calculated the evaluated savings. The goal of the desk reviews was to confirm the inputs used to model the customer energy usage and to validate the modeled savings estimates independently. The NMR team analyzed each project by following the process outlined below:

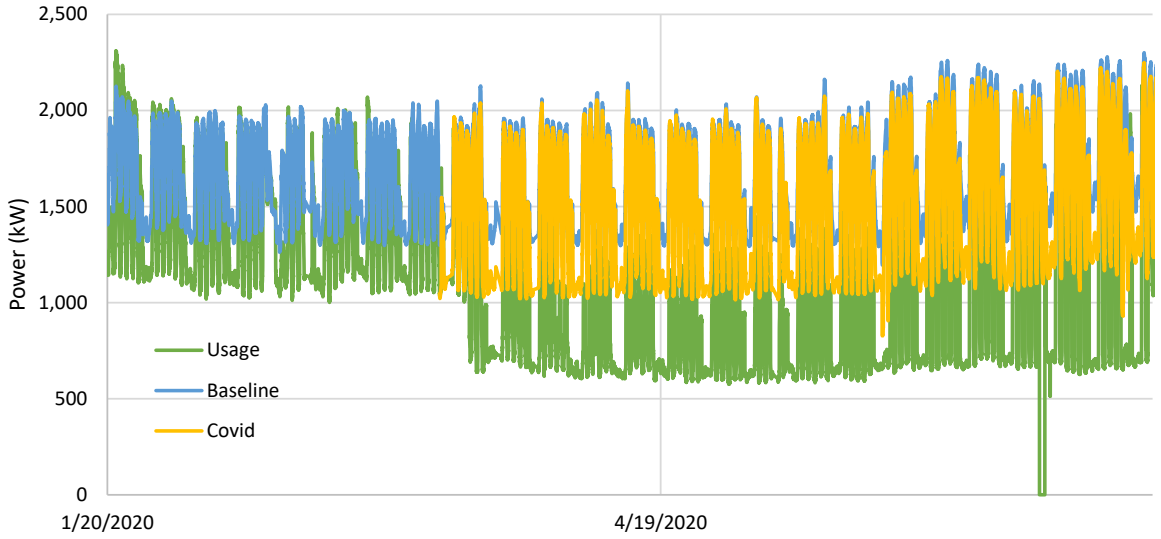
- The evaluation team reviewed the source code of the energy model for each project to ensure that the data supplied was appropriately pulled and analyzed. The NMR team also examined the model outputs to ensure they were consistent with expectations and were consistent with the summary values included in the project documentation.
- The NMR team ran parallel independent models using the same TTOW model algorithm. The independent model was used to validate that the modeled energy usage was accurate and consistent with the prescribed modeling methodology.

During 2020 and 2021, the COVID-19 pandemic caused numerous businesses to shut down or alter their operations. The P4P program is uniquely affected by operational changes since the program savings are calculated by examining the customers usage data. The timing for the one P4P project required the SEU to compensate for the effect of the pandemic. Not accounting for the pandemic would have resulted in overpredicting the savings considerably for the project. The SEU built algorithms to model the performance period usage in the absence of the pandemic. Projecting the baseline usage can be done using two methods.

1. Independent Variables. Including an independent variable that shows the level of impact that shutdowns have on operations. Good independent variables include occupancy, open hours, sales, or production.
2. Performance Model. Develop a performance period model from usage data that was in the performance period, but prior to the shutdown. The performance period model projected during the shutdown provides an estimate of the non-shutdown usage.

The savings for projects affected by shutdowns are calculated as the difference between the baseline model and the performance model. Figure 1 shows how the performance period for project 18135 was modeled to account for the impacts of the pandemic. The evaluation team reviewed the performance period models and found them to be accurate and appropriate.

Figure 1: Models Used for Project 18135



2.7.1.3 Results

The program-wide impact evaluation results for the program are shown in Table 116. The findings that contributed to deviations in the realization rates are described in the text that follows. The evaluation team utilized a census approach for the P4P program.

Table 116: P4P Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence[18]
FY2021 Electric Savings (MWh)	1,175.6	100%	1,175.6	NA
FY2021 Peak Demand Savings (MW)	0.532	14%	0.076	NA
FY2021 Gas Savings (MMBtu)	0	N/A	0	NA

The program-level realization rates are 100% for electric savings, and 14% for demand savings. There were no natural gas savings in FY2021. The evaluation team concluded that SEU developed and implemented the modeling and savings calculations correctly. The model developed by the SEU is robust, includes several valuable control checks, and has some built-in flexibility to handle varying customer data intervals.

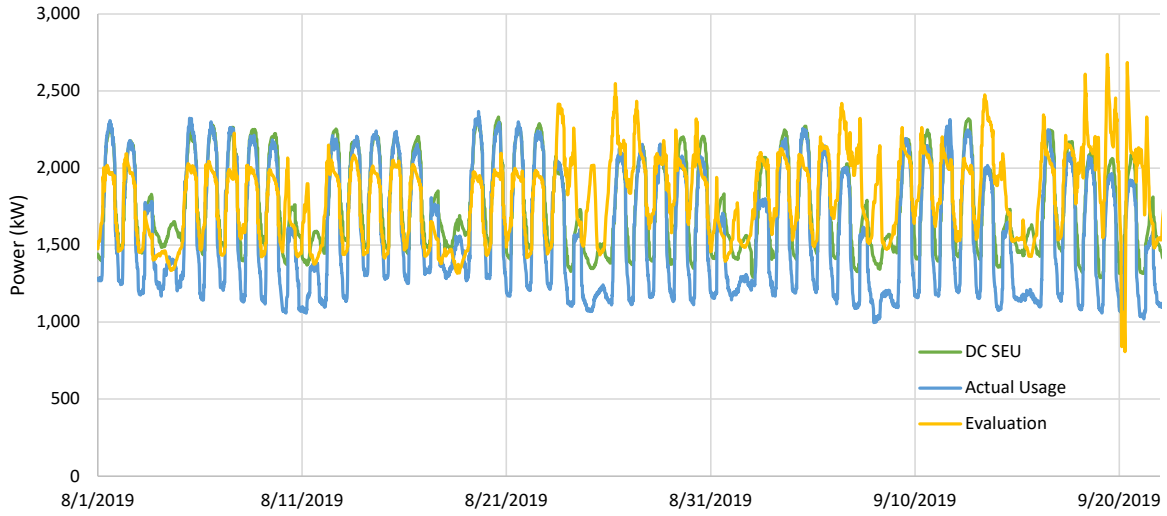
The evaluation team reviewed the model source code developed by SEU. The model code uses an open-source programming language (Python) and transparent packages, such as pandas.[19] The modeling code does use proprietary modules and files, such as weather data, which could

[18] The evaluation completed a census of projects within the P4P Program during CY2021, so confidence and precision estimates are not necessary.
[19] Pandas is the data analytics library for the python computing language. It contains many routines and modules for large scale data manipulation. https://pandas.pydata.org/

not be used by the evaluation team since the files reside on internal SEU servers. The evaluation team expected this type of coding because it is necessary to deploy code broadly across an organization, and it did not impede the evaluation team's review. The evaluation team independently gathered weather data and confirmed that SEU collects and uses it properly.

After the NMR team reviewed the model code, we developed independent models of the energy savings. The evaluation team also utilized the TTOW algorithm. The evaluation team developed independent estimates to confirm and validate that the SEU savings estimates were reasonable. Figure 2 shows a snapshot for the reviewed project containing the customer's actual hourly usage, the evaluation team's baseline model, and the SEU's model used in the ex ante savings. The evaluation team and SEU models both match customer usage well.

Figure 2: SEU and Evaluation Team Baseline Models with Customer Usage for Project 18135



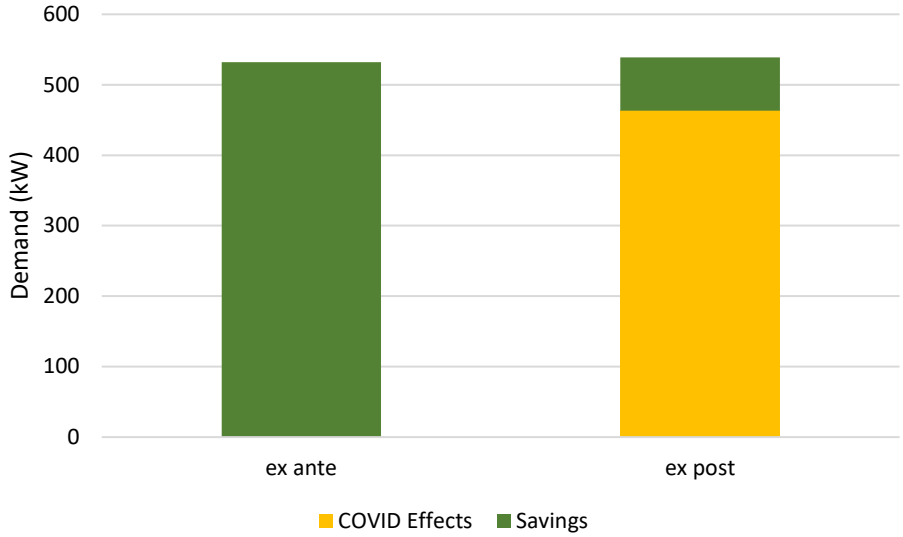
Once the baseline model was developed, the SEU used an identical approach to model the building usage prior to the COVID-19 pandemic. The customer building was notably impacted by the effects of the pandemic, so the savings from reduced operation must be excluded from the verified savings. The SEU properly applied the modeling algorithms to the pre-COVID period and subtracted the COVID impacts from the claimed project savings.

Annual kWh savings estimates calculated by the evaluation team were within the fractional savings uncertainty bounds at the 90% confidence level of the SEU savings estimates, indicating statistically similar results for electric savings.

The evaluation team also evaluated the peak demand savings claimed by the SEU. The evaluation team calculated the verified peak demand savings, removing the effects of COVID, by subtracting the pre-COVID modeled usage from the baseline modeled usage. This is the exact method the SEU used to determine the energy (kWh) savings. In addition, the evaluation team only considered the average demand during the months of June to August, on weekdays, from 2:00 – 6:00 PM in the afternoon.

The ex ante savings appear to have been calculated using similar time windows, but the pre-COVID model was not included in the ex ante peak demand calculation. Including the effects of the pre-COVID model reduced the ex post peak demand savings. Figure 3 shows the ex ante and ex post calculation of peak demand savings for project 18135.

Figure 3. Peak Demand for Project 18135



2.7.1.4 Key Findings

The evaluation team found that the modeling for the P4P program was consistent with COVID related methods utilized in previous years. The evaluation team agrees with these algorithms and approaches to determining savings when COVID related shutdowns are applicable.

The evaluation team also determined that the peak demand savings for the one P4P project in FY2021 did not account for the effects of COVID. The evaluation team utilized the pre-COVID model developed by the SEU, in conjunction with the baseline model, to determine the ex post peak demand savings. Including the effects of COVID reduced the ex post demand savings for project 18135.

2.7.2 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the P4P program:

- Continue to leverage the existing modeling scripts and data analytics processes for the P4P program. The modeling continues to be robust, accurate and consistent with data science best practices.
- When accounting for anomalous events in the baseline or efficient time periods, ensure that the effects of anomalous events are removed from all fuel savings including energy (kWh), demand (kW), and natural gas (MMBTU).

2.8 MARKET TRANSFORMATION VALUE (7512MTV)

The Market Transformation Value (MTV) program provides rebates to large businesses and institutions for lighting upgrades. The program offers prescriptive incentives for lighting. The DCSEU provides per-unit rebates for screw-in LEDs, advanced interior lighting, exterior lighting, and installation of lighting controls. The program completed seven unique projects during FY2021.

For the FY2021 MTV program, we completed the following evaluation activities:

- Net Savings Estimation
- Process Evaluation

2.8.1 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from two web and telephone surveys completed with participating Market Transformation Value program customers.

2.8.1.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 85, the two Market Transformation Value program participants received the following scores:

- One participant would have delayed the implementation of the measure for at least one year, so we assigned them a free-ridership influence score of 0%.
- The other respondent would have installed the measure with the exact same scope and efficiency and said they might have had the funds to cover the entire cost of the measure in the absence of the program. We assigned a moderate-high free-ridership intention score (37.5%).

The overall free-ridership intention score for the two respondents is 13%.

Table 117: Free-ridership Intention Scoring for Market Transformation Value Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	1
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	--
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	37.5%	1
	• Definitely would have had the funds	50%	--
Total		**13%**	**2**

Influence

Table 86 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The MTV program features with the highest average ratings include the rebate (5.0) and information or recommendation from a DCSEU representative (5.0).

Table 118: Influence of DCSEU Program Features for Market Transformation Value Program

Features	n[1]	1 Played no Role at All	2	3	4	5 Played a Great Role	Average Rating
The rebate	2	--	--	--	--	2	5.0
Information or recommendation from a DCSEU representative	2	--	--	--	--	2	5.0
Information or recommendation from contractors or vendors associated with the program	2	--	--	--	1	1	4.5
The results of any audits, energy modeling, or technical studies done through a DCSEU program	2	1	--	--	--	1	3.0
DCSEU marketing materials or program information	1	--		1	--	--	3.0
Previous experience with a DCSEU program	1	1	--	--	--	--	1.0

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 87). Both MTV program respondents indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.

Table 119: Free-ridership Influence Scoring for Market Transformation Value Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - Program feature played a great role	0%	2
4	12.5%	--
3	25%	--
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**0%**	**2**

When asked if any other factors played a great role in influencing them to implement the measure through the Market Transformation Value program, one respondent said that new measures were installed for safety considerations at their facility.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with

the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 6% and the average weighted free-ridership rate for the Market Transformation Value program was 15% (Table 88).

Table 120: Free-ridership Rate for Market Transformation Value Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	13%	0%	25%
Free-ridership (savings-weighted)	20%	0%	25%

The FY2020 free-ridership rate was 15%. Given the low sample sizes for both years, we recommend combining the results through a savings-weighted approach, shown in Table 121. We recommend an average free-ridership rate of 16%.

Table 121: FY2020-FY2021 Free-ridership Rate for Market Transformation Value Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership rate
FY2020	4	80%	15%
FY2021	2	20%	20%
Weighted Average	**6**	**100%**	**16%**

2.8.1.2 Participant Spillover

Neither respondent reported installing energy-efficient or renewable energy equipment after completing their Market Transformation Value project. This resulted in a spillover rate of 0% for FY2021. The spillover rate for FY2020 was 0%, after rounding. Therefore, we recommend an average spillover rate of 0%, as shown in Table 122.

Table 122: FY2020-FY2021 Spillover Rate for Market Transformation Value Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2020	4	20%	0%
FY2021	2	80%	0%
Weighted Average	**6**	**100%**	**0%**

2.8.1.3 NTG Ratio

The savings-weighted NTG ratio for the Market Transformation Value program equals 84%, after rounding (Table 89).

Table 123: NTG Ratio for Market Transformation Value Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	16%	0%	84%

2.8.2 Process Evaluation

For the process evaluation of the MTV program, the NMR team completed two telephone surveys with program participants (Table 90).

Table 124: Market Transformation Value Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	2
Total	**2**

2.8.2.1 Key Findings

The key findings from the process evaluation of the Market Transformation Value program are as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 5.0, on average.
- Both respondents indicated they were "extremely likely" to recommend the program to someone else.
- Respondents reported numerous reasons for engaging with the Market Transformation Value program and both participants indicated that they realized all expected benefits as well as additional benefits through engaging with the program.
- Both respondents reported experiencing difficulties with participating in the program, citing a lengthy waiting period and communication challenges with DCSEU; each respondent ultimately received assistance from program staff.

2.8.2.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 10.0, on average, an increase from the FY2020 average rating of 8.3. The NPS for the program among participating end users was 100. Both respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth.
- Participants rated their overall satisfaction with the program a 5, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2020, respondents gave the same average rating. Table 125 shows their satisfaction ratings in detail.

Table 125: Participant Experience with the Market Transformation Value Program

Feature	n	Average Rating
Your experience overall	**2**	**5.0**
The inspection of your project by the DCSEU	2	5.0
The technical assistance you received from the DCSEU	2	5.0
The application process	2	5.0
The amount of time it took to receive the rebate or financial incentive	2	5.0
The information about DCSEU offerings	2	5.0
The type of eligible equipment or projects	2	5.0
The assistance from your contractor or vendor	2	5.0
The energy savings from your new equipment	2	4.5
The amount of the rebate, discount, or financial incentive	2	4.5
The performance of the new equipment	2	4.5
The preapproval process	2	4.5

Based on their experience, participants provided feedback on what they would change about the MTV program. Respondents requested that the program increase the rebate amount, simplify the program application, and provide additional information about other savings opportunities available from DCSEU. The participant who provided feedback about the application noted they had to get help from both the DCSEU and a contractor to complete the program application form.

2.8.2.3 Program Experience

When asked why they implemented the measure through the MTV program, both respondents said that they wanted to save money on energy costs, install more reliable equipment, reduce operating and maintenance costs, save money on equipment installation, advance a long-term strategic energy management plan, and increase safety/security, as shown in Table 126. When asked what benefits their company realized through their participation in the program, both respondents reported that in nearly every category their organization realized the benefits they expected and more (e.g., only one respondent expected to promote positive public relations, but two respondents reported realizing this benefit after participating).

Table 126: Market Transformation Value Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=2)[1]	
	Reason for Participation	Benefits Realized
Save money on energy costs	2	2
Install more reliable equipment	2	2
Reduce operating or maintenance costs	2	2
Save money on equipment installation	2	2
Advance long-term strategic energy management plan	2	2
To increase safety/security	2	2
Promote positive public relations	1	2
Improve work environment	1	2
Improve production or productivity	1	2
To replace old or failing equipment	1	--

[1] Count of respondents sum to greater than 2 because multiple responses were allowed.

Both participants reported facing one hurdle when deciding whether or not to participate in the MTV Program. One participant indicated that communicating with DCSEU was a challenge and the other participant indicated that the length of the process and the overall waiting time was a hurdle. Both respondents indicated that program helped them overcome their hurdles. Both respondents received assistance on their MTV applications from a DCSEU staff member and one respondent also received assistance from a third-party contractor or vendor. On a scale from 1 to 5, in which 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.0, on average, which is the same average rating respondents gave on the ease of completing the application in FY2020.

2.8.2.4 Program Awareness

One participant reported first hearing about the program through the DCSEU website. The other participant heard about the program from a colleague or industry peer. Both respondents also recalled hearing about the program from a DCSEU staff member or account manager. Table 35 shows how program respondents heard about the program.

Table 127: Sources of Market Transformation Value Program Awareness

Source of Program Awareness	Count of Respondents (n=2)	
	Where Participants First Heard of Program	Other Sources of Participant Awareness[1, 2]
The DCSEU website	1	1
A colleague or industry peer	1	--
DCSEU staff or account manager	--	2
A DCSEU mailing or email	--	1
A newspaper, radio, or television ad	--	1
Google search	--	1

[1] Counts sum to greater than two because multiple responses were allowed.

One respondent learned about the Market Transformation Value program before they started planning their project, while the other respondent learned about the program after they started planning but before they started implementing the project. Both respondents first engaged with DCSEU before their organization began to implement the project.

Both participants indicated they had visited the DCSEU website. On a scale from 1 to 5, in which 1 is not at all useful and 5 is very useful, respondents rated the usefulness of the information on the DCSEU website a 4.5, on average, which is 0.5 higher than the average rating participants gave in FY2020.

2.9 SOLAR PV MARKET RATE (7101PVMR)

The Solar Photovoltaic Market Rate (PVMR) Program provides incentives to buildings that install solar panels that produce local electricity to reduce their consumption from the electric grid. This program was established to help DC meet its Renewable Portfolio Standard renewable energy capacity goals. Moving forward, the program is aiming to achieve the DCSEU performance benchmark and address the needs of the solar market by serving as a low or no cost technical assistance center for solar installations. This effort will supplement the Solar for All program, which provides assistance for solar projects in low-income single-family homes and community solar projects.

Due to budget constraints, DCSEU did not set up the solar program as an independent program. The program falls under the custom and new construction tracks, and projects are diverted to the solar track to facilitate renewable capacity tracking.

Both Pepco and DCSEU must sign off on submitted projects before they may be installed or funded. Pepco vets the project for interconnection compatibility and DCSEU reviews the scope of work, spec sheets, and other documentation. DCSEU analyzes projects using NREL's PV Watts tool and a custom load shape is created for each project. Once both organizations approve the project, DCSEU inspects the installation and Pepco provides proof of interconnection before a rebate is issued.

In FY2021, the program provided incentives for five projects and claimed 8,085 MWh of electric savings and 1.98 MW of peak demand reduction. For the FY2021 Solar PV Market Rate program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.9.1 Gross Savings Verification

Table 128 shows the tracked savings, realization rate, and evaluated savings for the program. No gas savings are claimed for this program as it is entirely comprised of solar panel installations, and no interactive effects are present. The NMR team found the electric savings realization rate to equal 100%, while the demand savings realization rate equals 101%.

Table 128: PV Market Rate Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	8,085	100%	8,076
FY2021 Peak Demand Savings (MW)	1.98	101%	1.99

2.9.1.1 Sampling

Due to the heterogeneous makeup of the program, the PVMR program sample design employed stratified random sampling. The NMR team created a certainty stratum, which ensured that we reviewed the largest project from the program. The NMR team assigned projects with more than 5,000 MMBtu of total energy savings to the certainty stratum. There was

a single certainty stratum project that represented 75% of the program savings. The NMR team assigned the remaining projects to the probability stratum, from which we drew a random sample (Table 129). We randomly selected three of the four projects for review in the FY2021 evaluation.

Table 129: PV Market Rate Sampling Plan

Stratum	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Sites
Certainty	75%	1	1
Probability	25%	4	3

2.9.1.2 Methodology

The NMR team conducted desk reviews for the four sampled projects, through which we calculated the evaluated savings for the program. No virtual or on-site visits were performed.

The NMR team used the National Renewable Energy Laboratory (NREL) PV Watts Calculator[20] to calculate the energy savings. The PV Watts tool relies on several key inputs, including the following:

1. **Site Address –** The location (address or latitude/longitude) of the solar PV installation
2. **DC System Size** – The direct current (DC) power output of the system
3. **Module Type** – The type of solar panels. Either standard, premium, or thin film.
4. **Array Type** – Fixed, one-axis tracking, or two-axis tracking
5. **System Losses** – Estimate of real-world system losses
6. **Tilt** – Roof angle where the panels are installed
7. **Azimuth** – Direction panels face away from true north
8. **DC to AC Size Ratio** – Inverter AC output compared to solar array DC output
9. **Inverter Efficiency** – DC to AC conversion efficiency
10. **Ground Coverage Ratio** – How close together the panels are placed

During the desk review process, our engineers reviewed all available project documentation for consistency. Project drawings, spec sheets, and invoices often supplied more accurate project information, including specific inverter efficiency values, exact site addresses, installation locations (such as rooftop), or a DC to AC Size Ratio. Regardless, for each project, the NMR team created an updated PV Watts model utilizing project documentation to verify the reported savings or provide more accurate savings calculations.

[20] https://pvwatts.nrel.gov/

2.9.1.3 Results

The program-wide impact evaluation results for the PVMR program are shown in Table 130. The findings that contributed to the realization rates are detailed in the text that follows.

Table 130: PV Market Rate Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	8,085	100%	8,076	80% ± 0.05%
FY2021 Peak Demand Savings (MW)	1.98	101%	1.99	80% ± 0.10%

The program-level realization rates are 100% for electric savings and 101% for demand savings. The selected sample ultimately achieved a ±0.05% precision at 80% confidence for electric savings and ±0.10% precision for demand savings.

The NMR team could not fully recreate the ex ante savings estimates in some cases. These slight discrepancies (less than 2%) are likely related to installation addresses. NMR found that some of the projects evaluated did not use the correct installation address for the panels in PV Watts (the general city of Washington, DC, versus actual installation address). Updating the PV Watts model to the actual address led to a slight increase in energy and peak demand savings as PV Watts obtains weather data based on the address input by the user. The savings also saw a slight increase due to site specific inverter efficiencies being input in PV Watts software instead of an assumed value of 96% (which is the PV Watts default inverter efficiency).

The evaluation team has leveraged the PV Watts solar calculator for evaluations in other jurisdictions and vetted its accuracy and reliability. The tool also projects estimated energy production relative to typical meteorological year (TMY3) data,[21] providing the DCSEU with a weather normalized generation estimate.

The primary cause for the peak demand savings realization rate equaling 101% is an adjustment to module type for project ID 18634. Ex ante savings are based on selection of "Standard" module type. As the solar cell efficiency is 19% for the installation, the module type should be "Premium." This adjustment resulted in a kWh savings realization rate for the project of 102% and a peak demand savings realization rate of 113%.

2.9.2 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from three web and telephone surveys completed with participating Solar PV Market Rate program customers.

2.9.2.1 Free-ridership

We estimated free-ridership based on the following two factors:

[21] https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 131, the three Solar PV Market Rate program participants received the following scores:

- One respondent would have delayed the installation of the solar PV system for at least one year. We assigned them a low free-ridership intention score (0%).
- One respondent would have installed the solar PV system but would have scaled back the scope or efficiency in the absence of the program, so we assigned them a moderate free-ridership intention score (25%).[22]
- The third respondent would have purchased the same measure in the absence of the program. As this respondent reported that they definitely would have had the funds to cover the entire cost of the solar PV system in the absence of the program, we assigned them a high-free-ridership intention score (50%).

Table 131: Free-ridership Intention Scoring for Solar PV Market Rate Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the of the measure altogether	• Not Asked	0%	1
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	1
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	--
	• Might have had the funds	37.5%	--
	• Definitely would	50%	1

[22] When asked by how much they would have scaled back the scope or efficiency of the solar PV system in the absence of the program, this respondent was not sure.

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Count of Respondents
	have had the funds		
Total		**25%**	**3**

Influence

Table 41 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Solar PV Market Rate program features with the highest average ratings were previous experience with a DCSEU program (4.0) and information or recommendation from a DCSEU representative (3.7).

Table 132: Influence of DCSEU Program Features for Solar PV Market Rate Program

Features	n[1]	1 Played no role at all	2	3	4	5 Played a great role	Average Rating
Previous experience with a DCSEU program	3	--	--	1	1	1	4.0
Information or recommendation from a DCSEU representative	3	--	1	--	1	1	3.7
DCSEU marketing materials or program information	3	--	1	1	1	--	3.0
The rebate	2	--	--	2	--	--	3.0
The results of any audits, energy modeling, or technical studies done through a DCSEU program	2	--	1	--	1	--	3.0
Information or recommendation from contractors or vendors associated with the program	2	--	1	--	1	--	3.0

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the program features (Table 133).

- One Solar PV Market Rate program participant indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- One respondent provided a maximum rating of 4 for the program features, so we assigned them a free-ridership influence score of 12.5%.
- The third respondent provided a maximum rating of 3 for the program features, so we assigned them a free-ridership influence score of 25%.

The overall free-ridership influence score across all three respondents is 13%.

Table 133: Free-ridership Influence Scoring for Solar PV Market Rate Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Count of Respondents
5 - program feature played a great role	0%	1
4	12.5%	1
3	25%	1
2	37.5%	--
1 - program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**13%**	**3**

When asked if any other factors played a great role in influencing them to implement the measure through the Solar PV Market Rate program, one respondent cited the Renewable Portfolio Standard (RPS) credits available in the District of Columbia and another respondent pointed to a corporate goal of reducing greenhouse gas emissions and improving their GRESB score.[23]

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the total energy savings associated with the solar PV system installation. The average unweighted free-ridership rate was 38% and the average weighted free-ridership rate for the Solar PV Market Rate program was 57% (Table 134).

Table 134: FY2021 Free-ridership Rate for Solar PV Market Rate Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	38%	25%	63%
Free-ridership (savings-weighted)	57%	25%	63%

The FY2018 free-ridership rate was 0%, the FY2019 free-ridership rate was 49%, and the FY2020 free-ridership rate was 63%. Given the small sample sizes for each of the four years, we recommend combining the results across years through a savings-weighted approach. This approach produces a free-ridership rate of 55% (Table 135).

[23] The Global Real Estate Sustainability Benchmark (GRESB) score is an overall measure of Environmental, Social, Governance (ESG) performance to guide financial investors.

Table 135: FY2018-FY2021 Free-ridership Rate for Solar PV Market Rate Program

	Sample Size	Percent of Sampled Energy Savings[1]	Free-ridership rate
FY2018	2	2%	0%
FY2019	5	14%	49%
FY2020	1	5%	63%
FY2021	3	80%	57%
Weighted Average	**11**	**100%**	**55%**

[1] Does not sum to 100% due to rounding.

2.9.2.2 Participant Spillover

Two of the three respondents reported installing energy-efficient or renewable energy equipment at a DC location after completing their Solar PV Market Rate project; however, both respondents reported that the projects received a rebate from DCSEU or another organization. This resulted in a spillover rate of 0% for the FY2021 Solar PV Market Rate program. The spillover rates for the Solar PV Market Rate program in FY2018, FY2019, and FY2020 were also 0%.

2.9.2.3 NTG Ratio

The savings-weighted NTG ratio for the Solar PV Market Rate program equals 45%, after rounding (Table 136).

Table 136: FY2018-FY2021 NTG Ratio for Solar PV Market Rate Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	55%	0%	45%

2.9.3 Process Evaluation

For the process evaluation of the Solar PV Market Rate program, the NMR team completed a web survey with three program participants.

Table 137: Solar PV Market Rate Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – web	3

2.9.3.1 Key Findings

These were the key findings from the process evaluation of the Solar PV Market Rate program:

- On a scale from 1 to 5, in which 1 is “not at all satisfied” and 5 is “very satisfied,” the participants rated their satisfaction with the program overall as a 4.7, on average. One of the three participants also said they were “extremely likely” to recommend the Solar PV Market Rate program to someone else.

- Participants reported having equipment difficulties and/or delays during the installation of their solar PV systems. The program feature with the lowest satisfaction rating was the performance of the new equipment, which participants rated a 3.7, on average.
- All respondents reported engaging with the Solar PV Market Rate program to advance long-term strategic energy goals.

2.9.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is “extremely unlikely” and 10 is “extremely likely,” participants rated their likelihood to recommend the program to someone else an 8.3, on average. In FY2020, the NMR team surveyed one participant, who rated their likelihood to recommend the program to someone else a 10.
- The participants rated their overall satisfaction with the program as a 4.7, on average, where 1 is “not at all satisfied” and 5 is “very satisfied.” In FY2020, the participant rated their average satisfaction a 5. Table 138 shows the satisfaction ratings in detail.

Table 138: Participant Satisfaction with the Solar PV Market Rate Program

Feature	n[1]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**3**	**--**	**--**	**--**	**1**	**2**	**4.7**
The information about DCSEU offerings	3	--	--	--	1	2	4.7
The type of eligible equipment or projects	3	--	--	--	1	2	4.7
The inspection of your project by the DCSEU	3	--	--	--	1	2	4.7
The application process	3	--	--	--	1	2	4.7
The technical assistance you received from the DCSEU	3	--	--	--	1	2	4.7
The amount of time it took to receive the rebate	3	--	--	--	1	2	4.7
The assistance from your contractor or vendor	2	--	--	--	1	1	4.5
The energy savings from your new equipment	3	--	--	1	--	2	4.3
The amount of the rebate, discount, or financial incentive	3	--	--	--	2	1	4.3
The preapproval process	3	--	--	--	2	1	4.3
The performance of the new equipment	3	--	--	2	--	1	3.7

[1] Sample size varies because results exclude those who said, “Not applicable” or “I’m not sure.”

When asked if there were any aspects of the Solar PV Market Rate program they would change, one participant suggested increasing the rebate level and one participant recommended providing more detailed instructions or examples on the application form as well as including storage equipment among eligible equipment. One participant reported having no suggested changes.

2.9.3.3 Program Experience

When asked why they implemented solar through the Solar PV Market Rate program, all three participants indicated a desire to advance long-term strategic energy plans (Table 139). Two respondents wanted to save money on energy costs, two wanted to reduce operating or maintenance costs, and two wanted to help the environment by reducing greenhouse gas emissions and their organization's carbon footprint. The respondents reported realizing many of these benefits following participation in the program; however, two of the respondents may not have achieved the equipment or cost savings they were hoping for from the program.

Table 139: Solar PV Market Rate Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=3)[1]	
	Reason for Participation	Benefits Realized
Advance long-term strategic energy management plan	3	3
Reduce GHG emissions/carbon footprint	2	2
Reduce operating or maintenance costs	2	2
Save money on energy costs	2	1
Promote positive public relations	1	1
Install more reliable equipment	1	--
Save money on equipment installation	1	--

[1] Multiple responses allowed.

The Solar PV Market Rate program participants all reported having issues with the installation or performance of the solar system or with the contractor who installed it. One participant cited needing additional telemetry equipment for their project, which delayed the installation process. One participant noted having trouble getting the solar PV system to function properly and needed the assistance of the contractor to remedy the issue. The final participant indicated that challenges during the COVID-19 pandemic had caused delays in the installation process.

2.9.3.4 Program Awareness

Two respondents learned about the Solar PV Market Rate program before they started planning their project and one respondent learned about it after they started planning, but before they started implementing their project. All three respondents indicated that their organization first engaged with DCSEU before beginning to implement their project.

Two respondents first heard about the program from a DCSEU staff member or account manager. One respondent was not sure where they first heard about the program. Table 84 shows how program respondents heard about the program.

Table 140: Sources of Solar PV Market Rate Program Awareness

Source of Program Awareness	Where Participants First Heard of Program (n=3)	Where Participants Overall Heard of Program (n=3)[1]
The DCSEU website	2	3
A colleague or industry peer	--	2
A vendor	--	1
DCSEU staff or account manager	--	1
A DCSEU mailing or email	--	1
A contractor	--	1
A distributor	--	1
DCSEU online advertisement	--	1
A conference, trade show, or fair	--	1
Don't know	1	--

[1] Count sums to greater than three because multiple responses were allowed.

All three respondents indicated they had visited the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," the respondents rated the information on the DCSEU website a 4.3, on average.

2.9.4 Recommendations

Based on the findings of our evaluation, we offer the following recommendations for the Solar PV Market Rate program:

- Peak demand savings should be calculated as the average load savings during peak period hours (2:00 – 6:00 PM on non-holiday weekdays between June and August). Provide the 8,760-hour spreadsheet output from the PV Watts tool that was used for ex ante savings.
- Ensure the proper module type is selected for each project in PV Watts, based on efficiencies of the installed equipment.
- Continue using site-specific values for system loss percentage and DC-to-AC ratio. This results in more accurate savings estimates for ex ante.

Section 3 Low-Income and Residential Programs

In this section, we present a brief program summary, as well as the methodology, findings, and recommendations from our evaluations of each of the eight residential and low-income programs selected for the FY2021 evaluation:

- Retail Lighting
- Retail Heating and Cooling
- Retail Efficient Appliances
- Income Qualified Efficiency Fund
- Income-Qualified Gas Efficiency Fund
- Low-income Multifamily Comprehensive
- Low-income Lighting Food Bank
- Implementation Contractor Direct Install

3.1 RETAIL LIGHTING (7710LITE)

The Retail Lighting initiative is an upstream program that works to increase availability and sales of LED bulbs in the District of Columbia. Partnering with retailers and manufacturers, DCSEU offers rebates for these technologies installed in DC homes and businesses and provides educational materials to raise consumer awareness of these products.

This program targets lighting manufacturers and retailers to reach residents and small businesses. The manufacturers and retailers are provided incentives on a per-bulb basis. In FY2021, the Retail Lighting initiative offered rebates for qualifying ENERGY STAR LED lightbulb purchases, including screw-base LEDs, LED fixtures, and recessed LED downlights. Working with area distributors, DCSEU also offered lighting rebates to District contractors and businesses for these products at the time of purchase.

This initiative is implemented by DCSEU, and the Energy Federation Incorporated (EFI) provides support for incentive payment and data tracking. EFI is responsible for compiling and verifying manufacturer invoices and processing payments. The manufacturers work with stores to gather sales reports to submit along with their invoice requests.

For the FY2021 Retail Lighting program, we completed the following evaluation activity:

- Gross Savings Verification

3.1.1 Gross Savings Verification

Table 141 displays the tracked savings, realization rate, and evaluated savings for the Retail Lighting program. The evaluation team calculated a realization rate of 100% for electric, peak demand, and gas savings.

Table 141: Retail Lighting Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	20,613	100%	20,613
FY2021 Peak Demand Savings (MW)	2.35	100%	2.35
FY2021 Gas Savings (MMBtu)	-21,070	100%	-21,070

3.1.1.1 Methodology

We reviewed rebate forms, invoices, and summary files to verify that the quantities and general measure descriptions in these documents matched the quantities and descriptions listed in the tracking database. In addition, we verified that the savings algorithms from the TRM were applied correctly for all 272,904 measures that represent 100% of FY2021 program energy savings. The NMR team used deemed wattage values and prescriptive inputs to calculate electric, demand, and gas savings.

3.1.1.2 Results

The NMR team calculated a realization rate of 100% for electric, demand, and gas savings for all Retail Lighting measure types, including screw-base LEDs, LED fixtures, and recessed LED downlights (Table 142).

Table 142: Retail Efficient Lighting Savings and Realization Rates by Measure Type

	FY2021 Electric Savings Realization Rate	FY2021 Peak Demand Savings Realization Rate	FY2021 Gas Savings Realization Rate
LED Screw-base Bulbs	100%	100%	100%
LED Lighting Fixtures	100%	100%	100%
Recessed LED Downlights	100%	100%	100%
Total	**100%**	**100%**	**100%**

3.2 RETAIL LIGHTING FOOD BANK (7717FBNK)

The Retail Lighting Food Bank Initiative supplies screw-base LEDs to low-income households in the District of Columbia area that receive goods from participating food banks. The DCSEU provided LEDs after verifying that the household is located in the DC area and conducting a short survey with the client to determine the appropriate number of bulbs needed.

For the FY2021 Retail Lighting Food Bank program, we completed the following evaluation activity:

- Gross Savings Verification

3.2.1 Gross Savings Verification

Table 143 displays the tracked savings, realization rate, and evaluated savings for the Retail Lighting Food Bank program. The evaluation team calculated a realization rate of 100% for electric, peak demand, and gas savings.

Table 143: Retail Lighting Food Bank Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	4,718	100%	4,718
FY2021 Peak Demand Savings (MW)	0.44	100%	0.44
FY2021 Gas Savings (MMBtu)	-6,568	100%	-6,568

3.2.1.1 Methodology

We reviewed rebate forms, invoices, and summary files to verify that the quantities and general measure descriptions in these documents matched the quantities and descriptions listed in the tracking database. In addition, we verified that the savings algorithms from the TRM were applied correctly for all 92,512 measures representing 100% of FY2021 program energy savings. The NMR team used deemed wattage values and prescriptive inputs to calculate electric, demand, and gas savings.

3.2.1.2 Results

The NMR team calculated a realization rate of 100% for electric, demand, and gas savings for screw-base LEDs, the only Retail Lighting Food Bank measure in FY2021.

Table 144: Retail Lighting Food Bank Savings and Realization Rates by Measure Type

	FY2021 Electric Savings Realization Rate	FY2021 Peak Demand Savings Realization Rate	FY2021 Gas Savings Realization Rate
LED Screw-base Bulbs	100%	100%	100%
Total	**100%**	**100%**	**100%**

3.3 RETAIL HEATING & COOLING (7710HTCL)

In FY2021, the DCSEU partnered with local retailers and contractors to promote rebates for thermostats (advanced and setback), efficient boilers and furnaces, efficient water heaters, heat pumps (ductless mini-split and air source), and Energy Star central AC. Customers could submit rebates by mail, email, or by filling out an online rebate form. Through partner agreements with advanced thermostat manufacturers, the DCSEU verified the number of active thermostats by ZIP code.

For the FY2021 Retail Heating & Cooling program, we completed the following evaluation activities:

- Net Savings Estimation
- Process Evaluation

3.3.1 Net Savings Estimation

The NMR team calculated the NTG ratio, composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from 72 web and telephone surveys completed with participating Retail Heating and Cooling program customers.

3.3.1.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 145, the 72 Retail Heating and Cooling program participants received the following scores:

- One-quarter of participants (21%) reported they would have delayed the measure purchase by at least one year or canceled the purchase in the absence of the program. We assigned these respondents a low free-ridership intention score (0%).
- One-quarter of participants (25%) said they would have purchased a less efficient measure or a different product altogether in the absence of the program. We assigned these respondents a moderate free-ridership intention score (25%).
- The remaining participants said they would have purchased the same measure in the absence of the program.
    - Eight percent of respondents said they might have had the funds available to purchase the measure in the absence of the program. We assigned them a moderate-high free-ridership intention score (37.5%).
    - The remaining participants (46%) reported they definitely would have had the funds to cover the entire cost of the measure, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score across all 72 respondents is 32%.

Table 145: Free-ridership Intention Scoring for Retail Heating and Cooling Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Percent of Respondents[1]
• Delayed the purchase of the measure for at least one year OR • Cancelled the purchase of the measure altogether	• Not Asked	0%	21%
• Purchased a less efficient measure or different product instead OR • Don't know OR • I'd rather not answer	• Not Asked	25%	25%
• Purchased the measure with the exact same efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	0%
	• Might have had the funds	37.5%	8%
	• Definitely would have had the funds	50%	46%
Total		**32%**	**72**

[1] Percentages sum to greater than 100% due to rounding.

Influence

Table 146 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Retail Heating and Cooling program features with the highest average ratings include the rebate (3.7) and information or recommendations from contractors or retailers associated with the program (2.8).

Table 146: Influence of DCSEU Program Features for Retail Heating and Cooling Program

Features	n[1]	1 Played no Role at All[2]	2	3	4	5 Played a Great Role	Average Rating
The rebate	72	13%	10%	18%	14%	46%	3.7
Information or recommendation from contractors or retailers associated with the program	69	30%	12%	26%	16%	16%	2.8
DCSEU program marketing materials about the program	55	51%	4%	15%	20%	11%	2.4
Previous experience with a DCSEU program	50	58%	6%	12%	6%	18%	2.2

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."
[2] Percentages sum to greater than 100% due to rounding.

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 147):

- One-half of Retail Heating and Cooling program respondents (53%) indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- Over one-fifth of respondents (21%) provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.
- Fifteen percent of respondents provided a maximum rating of 3, so we assigned them a free-ridership influence score of 25%.
- Three percent of respondents provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.
- Nine percent of respondents (28%) provided a maximum rating of 1, so we assigned them a free-ridership influence score of 50%.

The overall free-ridership influence score across all 72 respondents is 12%.

Table 147: Free-ridership Influence Scoring for Retail Heating and Cooling Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Percent of Respondents
5 - Program feature played a great role	0%	53%
4	12.5%	21%
3	25%	15%
2	37.5%	3%
1 - Program feature played no role OR Not applicable	50%	9%
Don't know OR Refused	25%	--
Total	**12%**	**72**

Twenty respondents named at least one non-program factor that played a great role in influencing them to purchase the rebated measure (Table 148). Respondents most often mentioned choosing products based on their smart features or smart home compatibility (seven respondents); these respondents had all purchased advanced thermostats.

Table 148: Non-program Factors Influencing Purchase of Retail Heating and Cooling Program Measure

Other Factor Influencing Purchase Decision	Count of Respondents (n=20)[1]
Smart features	7
Energy efficiency and/or sustainability	5
Space or size considerations	4
Additional rebate provided by installation company	2
Reduced energy bills	1
Product research or online reviews	1
Desire for newest technology	1
Prior experience with other energy-efficiency programs	1
Savings from installing solar panels	1

[1] Multiple responses allowed; results exclude those who reported that there were no other factors with a great impact on their decision.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 44% and the average weighted free-ridership rate for the Retail Heating and Cooling program was 45% (Table 149).

Table 149: Free-ridership Rate for Retail Heating and Cooling Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	44%	0%	100%
Free-ridership (savings-weighted)	45%	0%	100%

Table 150 shows free-ridership by measure. The sample size for central air conditioners (n=4), water heater replacement (n=3), and ductless mini-split heat pumps (n=2) were too small to calculate measure-level free-ridership. Free-ridership for advanced thermostats in FY2021 was 44%, compared to 62% estimated in FY2020.

Table 150: Free-Ridership by Measure for Retail Heating and Cooling Program

Free-ridership (weighted)	Average	Minimum	Maximum
Advanced thermostat (n=46)	44%	0%	100%
Air source heat pump (n=6)	39%	13%	63%
Boiler replacement (n=6)	56%	25%	88%
Furnace replacement (n=5)	34%	25%	50%

3.3.1.2 Participant Spillover

Nearly one-third of respondents (32%) reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Retail Heating and Cooling project. Six of these participants reported that the program had some influence on their decision to purchase one or more energy-efficient products (Table 151).

Participants rated the program's influence on their decision to install the energy-efficient products on a 1 to 5 scale, in which 1 means "no influence at all" and 5 means "great influence":

- Four respondents who reported installing LEDs or a smart thermostat rated the program's influence on their decision a 2. Based on that rating, we assigned them a spillover influence score of 25%.
- Two participants who reported installing LEDs or an advanced power strip (APS) rated the program's influence on their decision a 4, so we assigned them a spillover influence score of 75%.
- Two participants who reported installing a clothes washer or a water heater rated the program's influence on their decision a 5, so we assigned them a spillover influence score of 100%.

Table 151: Spillover Influence Scores for Retail Heating and Cooling Program

Influence Rating	Assigned Influence Score (%)	Spillover Measures	Count of Respondents[1]
Rating of 2 (some influence)	25%	LEDs (3) and smart thermostat (1)	4
Rating of 3	50%	-	-
Rating of 4	75%	LEDs and advanced power strip	2
Rating of 5 (great influence)	100%	Clothes washer and water heater	2
Respondent does not know how much influence	50%	-	-

[1] Multiple responses allowed.

We estimated the savings associated with these measures and applied the spillover influence scores to estimate the total spillover savings. We then divided that estimate by the cumulative tracked savings across all 72 survey respondents to calculate the spillover rate. This resulted in a spillover rate of 3% for the Retail Heating and Cooling program (Table 152).

Table 152: Spillover Rate for Retail Heating and Cooling Program

	Average	Minimum	Maximum
Spillover Rate	3%	0%	95%

3.3.1.3 NTG Ratio

The savings-weighted NTG ratio for the Retail Heating and Cooling program equals 58%, after rounding (Table 153).

Table 153: NTG Ratio for Retail Heating and Cooling Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	45%	3%	58%

3.3.2 Process Evaluation

For the process evaluation of the Retail Heating and Cooling program, the NMR team completed telephone surveys with 72 program participants. For each unique participant in FY2021, the NMR team identified the measure with the highest savings ("primary measure") and asked the respondent to consider that measure when responding to the survey.[24] The proportion of primary measures among survey respondents is similar to the proportion of measures that received a rebate through the Retail Heating and Cooling Program in FY2021 (Table 154).

Table 154: Retail Heating and Cooling Program Evaluation Activity

Primary Measure	% of Survey Respondents	% of FY2021 Program Participation
Smart thermostat	64%	59%
Boiler replacement	8%	5%
Air source heat pump	8%	5%
Furnace replacement	7%	6%
Central air conditioning	6%	9%
Water heater replacement	4%	7%
Ductless mini-split heat pump	3%	5%
Setback thermostat	--	3%
Heat pump water heater	--	1%

3.3.2.1 Key Findings

The key findings from the process evaluation of the Retail Heating and Cooling program are as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.5, on average.
- The NPS[25] for the Retail Heating and Cooling program was 85.
- Participants who suggested changes to the program most often pointed to the rebate amount (35%) and the application process (25%). On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with both program features a 4.3 on average.
- Most participants learned about the availability of the rebate while they were making the decision (43%) or before they had decided to purchase the measure (38%), emphasizing

[24] According to the program tracking data, 83% of Retail Heating and Cooling program participants received a rebate for one measure, while 14% received a rebate for two measures. Four percent of participants received a rebate for three or more measures during FY2021.

[25] The NPS is a well-established measure of customer loyalty. Using a scale of 0 to 10, in which 0 is "extremely unlikely" and 10 is "extremely likely," respondents are asked how likely they are to recommend the program to someone else. Respondents are then grouped as promoters (score 9-10), passives (7-8), and detractors (0-6). The NPS is calculated by subtracting the percentage of detractors from the percentage of promoters and is presented as a whole number.

the importance of increasing program awareness among the market actors who influence the purchasing decision. Indeed, participants most often reported learning about the program through the DCSEU website (42%).

3.3.2.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.3, on average. The NPS for the program among participating end users was 85, which represents a four-point increase from FY2020. Overall, 88% of respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. Five respondents were passives and two were detractors.
- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their overall satisfaction with the program a 4.5, on average. Table 155 shows their satisfaction ratings in detail.

Table 155: Participant Experience with the Retail Heating and Cooling Program[1]

Feature	n[2]	1 Not at All Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**70**	**--**	**4%**	**6%**	**21%**	**69%**	**4.5**
The performance of the measure	71	--	--	6%	17%	77%	4.7
The variety of eligible equipment	61	2%	3%	7%	23%	66%	4.5
Energy savings from new equipment	65	--	2%	18%	23%	57%	4.4
The rebate amount	68	1%	4%	11%	24%	59%	4.3
The application process	70	3%	--	13%	33%	51%	4.3
Time it took to receive rebate	69	0%	4%	7%	38%	51%	4.3
Information on the DCSEU website	67	4%	1%	9%	36%	49%	4.2

[1] May not sum to 100% due to rounding.
[2] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure."

Respondents who rated their satisfaction with program features less than a 3 were asked to provide additional context:

- The two of the four respondents who rated their satisfaction with their overall experience either a 1 or 2 said that it was overly complicated to collect and submit the necessary documentation. One respondent had difficulty obtaining approval from their

neighborhood preservation department and another respondent had a bad experience with the contractor who installed the measure.

- Three respondents rated their satisfaction with the variety of eligible equipment either a 1 or a 2. One respondent indicated the equipment they wanted was not eligible, another respondent explained that the eligible items were constantly changing on the website, and the third respondent stated that not enough equipment is eligible for the rebate.
- All four respondents who rated their satisfaction with the rebate amount a below a 3 indicated they want to see a rebate that covers a higher percentage of the cost of the measure.
- Two respondents rated their satisfaction with the application process a 1 or 2. Both respondents found the application process to be lengthy and burdensome. One respondent indicated the website was hard to navigate and noted that they had to send paperwork multiple times. Another respondent explained that it took too long to receive the rebate.
- Two of the three respondents who rated their satisfaction with the amount of time it took to receive a rebate either a 1 or a 2 indicated that their rebate checks took several months to arrive. One respondent reported frustration with the amount of time it took to satisfy the paperwork requirements.

Based on their experience, participants provided feedback on what they would change about the Retail Heating and Cooling program (Table 156). The rebate amount (32%) and application process (26%) were the most commonly suggested program changes. Seventeen percent of respondents suggested decreasing the time it takes to receive the rebate, seven respondents (10%) suggested increasing the program's publicity to improve awareness, and 6 respondents (8%) suggested increasing the variety of eligible equipment. Other suggestions (3%) mentioned by one respondent each included better coordination with DC government and being able to pick up the rebate in person. Nearly one-fifth of respondents (18%) indicated that they would not change anything about the program.

Table 156: Suggested Changes to the Retail Heating and Cooling Program

Program Feature	Percent of Respondents (n=72)[1]
The rebate amount	32%
The application process	26%
The amount of time it took to receive the rebate	17%
Program visibility/publicity	10%
The variety of eligible equipment	8%
The program website	3%
Other	3%
Not sure	6%
No change	18%

[1] Percentages do not sum to 100% because multiple responses were allowed.

Respondents who purchased a smart thermostat (n=46), a ductless mini-split heat pump (n=2), or an air source heat pump (n=6) were asked whether they would recommend the technology to

someone else. Based on their experience, 91% of respondents said they were "very likely" to recommend the technology and 7% said they were "somewhat likely" to recommend the technology to someone else. One respondent indicated that they were neither likely nor unlikely to recommend the technology. Respondents who purchased an air source heat pump seemed to be slightly less likely to enthusiastically recommend the technology (one of six selected "neither unlikely nor likely" and one selected "somewhat unlikely", as compared only one of 46 advanced thermostat who selected a response other than "very likely"), though the sample size was too small to draw any conclusions.

3.3.2.3 Program Experience

Participants were asked to report their reasons for purchasing the primary measure for which they received a rebate through the program (Table 157). Three-fifths (60%) of all respondents purchased the measure to save energy. Almost half (49%) of respondents purchased the measure to save money on bills. Respondents also cited a desire to use technology to moderate temperature in their home (44%) and to improve comfort or temperature in their homes (43%). Twenty-eight (39%) respondents purchased the measure to help the environment.

Table 157: Retail Heating and Cooling Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=72)[1]
To save energy	60%
To save money on bills	49%
To use technology to moderate temperature in my home[2]	44%
Improve comfort or temperature	43%
To help the environment	39%
Replace older or failing unit	31%
Increased capacity and/or performance	18%
Due to home remodeling or renovation	11%
Existing unit stopped working or broke	7%
It was time to replace the unit	6%
Installed it in a new home	6%
It was recommended by a contractor	6%
Existing unit was too expensive to repair	4%
To have a secondary unit – not a replacement	4%
To reduce humidity	1%
Other	8%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.
[2] This response option was only available for respondents who installed a smart thermostat as the primary measure (n=26).

3.3.2.4 Program Awareness

As shown in Table 158, more than three-quarters of respondents learned about the Retail Heating and Cooling rebate before making the decision to purchase the measure (38%) or while they were making the decision to purchase the measure (43%). One-fifth of respondents (19%) reported learning about the rebate after making the decision to purchase the measure.

Table 158: Awareness of Retail Heating and Cooling Program Rebate Availability

When Respondent Learned About the Rebate	Percent of Respondents (n=72)
Before respondent decided to purchase the measure	38%
While responded was deciding to purchase the measure	43%
After respondent had already decided to purchase the measure	19%

Participants most often heard about the Retail Heating and Cooling program rebate from the DCSEU website (42%), a contractor (21%), or from a colleague, friend, or family member (13%). Respondents also indicated that they had heard about the program through conducting internet research (11%) and via signs in store indicating the availability of DCSEU rebates (6%) (Table 159).

Table 159: Awareness of the Retail Heating and Cooling Program

Source of Program Awareness	Percent of Respondents (n=72)[1]
The DCSEU website	42%
A contractor	21%
A colleague, friend, or family member	13%
Internet research	11%
Signs in store indicating DCSEU rebates available	6%
DCSEU online advertisement	6%
A retail store employee	3%
Retailer's website	3%
Manufacturer's website	1%
Prior program knowledge	1%
Non-DCSEU social media	1%
Information that came with the equipment purchase	1%
Don't know	4%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

Nine of every ten respondents (90%) reported visiting the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.1 for the information provided on the DCSEU's energy saving programs. The one respondent who rated it a 1 explained that it was difficult to identify rebates.

3.3.2.5 Application Installation Experience

All of the Retail Heating and Cooling respondents (100%) reported that the measure for which they received the rebate was installed at the time of the survey. Nearly half of respondents indicated that a contractor (46%) installed the measure while another 46% revealed they installed the measure themselves. The remaining respondents reported that the measure was either installed by someone in the household (4%) or by a representative from the retailer (4%).

3.3.3 Recommendations

Based on the findings from our evaluation, we offer the following recommendations for the Retail Heating and Cooling program:

- Consider increasing the rebate amount for eligible equipment types where feasible. When asked to suggest any changes DCSEU could make to the program, survey respondents most commonly cited increasing the rebate amount. Notably, 46% of survey respondents reported that the rebate "played a great role" in program participation and 83% of survey respondents identified the rebate as an important (4 or 5 on the 5-point scale) positive influence in program participation.
- Identify opportunities to simplify the application process, in particular the paperwork that participants need to complete. Although most participants were generally satisfied with the application process, some survey respondents reported that the application process was too lengthy and burdensome. As one example, a survey respondent found the website difficult to navigate and needed to submit paperwork multiple times.

3.4 RETAIL APPLIANCES (7710APPL)

In FY2021, the Retail Efficient Appliances program offered mail-in and online rebates for qualifying refrigerators, clothes washers, clothes dryers, dishwashers, and dehumidifiers. The DCSEU partnered with local retailers and contractors to promote these rebates.

For the FY2021 Retail Appliances program, we completed the following evaluation activities:

- Net Savings Estimation
- Process Evaluation

3.4.1 Net Savings Estimation

The NMR team calculated the NTG ratio, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from 70 web and telephone surveys completed with participating Retail Efficient Appliances program customers.

3.4.1.1 Free-ridership

We estimated free-ridership based on the following two factors:

- Intention or the expected behavior in absence of the program; and
- The influence of various program elements on the decision to participate in the program.

Intention

As shown in Table 160, the 70 Retail Efficient Appliances program participants received the following scores:

- Three percent of participants reported they would have delayed the measure purchase by at least one year or canceled the purchase in the absence of the program. We assigned these respondents a low free-ridership intention score (0%).
- Nearly one-third of participants (30%) said they would have purchased a less efficient measure or a different product altogether in the absence of the program. An additional 4% of respondents were not sure what they would have done in the absence of the program. We assigned these respondents a moderate free-ridership intention score (25%).
- The remaining participants said they would have purchased the same measure in the absence of the program.
    - Six percent of respondents said they might have had the funds available to purchase the measure in the absence of the program. We assigned them a moderate-high free-ridership intention score (37.5%).
    - The remaining participants (61%) reported they definitely would have had the funds to cover the entire cost of the measure in the absence of the program, so we assigned them a high free-ridership intention score (50%).

The overall free-ridership intention score across all 70 respondents is 40%.

Table 160: Free-ridership Intention Scoring for Retail Efficient Appliances Program

Intention in the Absence of the Program	Funds Available to Cover the Entire Cost	Assigned Free-ridership Intention Score (%)	Percent of Respondents[1]
• Delayed the installation of the measure for at least one year OR • Cancelled the installation of the measure altogether	• Not Asked	0%	3%
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	30%
• Installed the measure with the exact same scope and efficiency	• Definitely would not have had the funds OR • Don't know OR • I'd rather not answer	25%	0%
	• Might have had the funds	37.5%	6%
	• Definitely would have had the funds	50%	61%
Total		**40%**	**70**

[1] Percentages sum to greater than 100% due to rounding.

Influence

Table 161 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, in which 1 means it "played no role at all" and 5 means it "played a great role." The Retail Efficient Appliances program features with the highest average ratings include the rebate (2.7) and DCSEU program marketing materials (2.3)

Table 161: Influence of DCSEU Program Features for Retail Efficient Appliances Program

Features	n[1]	1 Played no Role at All[2]	2	3	4	5 Played a Great Role	Average Rating
The rebate	68	37%	7%	18%	22%	16%	2.7
DCSEU program marketing materials about the program	64	48%	13%	16%	9%	14%	2.3
Previous experience with a DCSEU program	58	64%	2%	7%	12%	16%	2.1
Information or recommendation from contractors or retailers associated with the program	62	63%	10%	6%	11%	10%	2.0

[1] Sample sizes exclude those who said, "Not applicable" or "I'm not sure."
[2] Percentages do not sum to 100% due to rounding.

The NMR team assigned each respondent a free-ridership influence score based on the highest rating they provided for any of the above program features (Table 162):

- One-third of Retail Efficient Appliances program respondents (34%) indicated that at least one program feature played a great role in their decision, so we assigned them a free-ridership influence score of 0%.
- Over one-quarter of respondents (27%) provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.
- Ten percent of respondents provided a maximum rating of 3, so we assigned them a free-ridership influence score of 25%.
- Seven percent of respondents provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.
- About one-fifth of respondents (21%) provided a maximum rating of 1, so we assigned them a free-ridership influence score of 50%.

The overall free-ridership influence score across all 70 respondents is 19%.

Table 162: Free-ridership Influence Scoring for Retail Efficient Appliances Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Percent of Respondents[1]
5 - Program feature played a great role	0%	34%
4	12.5%	27%
3	25%	10%
2	37.5%	7%
1 - Program feature played no role OR Not applicable	50%	21%
Don't know OR Refused	25%	--
Total	**19%**	**57**

[1] Percentages do not sum to 100% due to rounding.

Thirty-one respondents named at least one non-program factor that played a great role in influencing them to purchase the rebated measure (Table 163). Respondents most often mentioned limitations or requirements on the size or type of equipment appropriate to their space (ten respondents), product features (ten respondents), and online research or product reviews (six respondents).

Table 163: Non-program Factors Influencing Purchase of Retail Efficient Appliances Program Measure

Other Factor Influencing Purchase Decision	Count of Respondents (n=31)[1]
Space limitations or requirements	10
Product features	10
Online research/product reviews	6
Energy efficiency	3
Brand recognition	3
Sale price provided by the retailer	2
Product was in stock/available for delivery	1
Reduced energy bills	1

[1] Multiple responses allowed; results exclude those who reported that there were no other factors with a great impact on their decision.

For each respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. We calculated both unweighted and savings-weighted free-ridership values, where we applied a weight based on the measure with the most tracked total energy savings associated with their project. The average unweighted free-ridership rate was 60% and the average weighted free-ridership rate for the Retail Efficient Appliances program was 56% (Table 164).

Table 164: Free-ridership Rate for Retail Efficient Appliances Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	60%	0%	100%
Free-ridership (savings-weighted)	56%	0%	100%

Table 165 shows free-ridership by measure. Refrigerators had the highest free-ridership rate (70%), followed by clothes washers (67%).

Table 165: Free-ridership Rate by Measure for Retail Efficient Appliances Program

Free-ridership (weighted)	Average	Minimum	Maximum
Refrigerator (n=21)	70%	25%	100%
Clothes washer (n=19)	67%	38%	100%
Clothes dryer (n=20)	46%	0%	100%
Dehumidifier (n=10)	47%	0%	100%

Table 166 shows the retail cost for each type of appliance as recorded by participant applications. We calculated the rebate as the percentage of the average retail price. For example, refrigerators, the measure category with the highest free-ridership rate, were also the most expensive appliance; FY2021 rebates provided a 4% to 6% discount, on average, of the total cost of the appliance. The relatively high level of free-ridership for appliances may be partially driven by the fact that rebates represent a small portion of the total cost.

Table 166: Prices and Rebate Amounts for the Retail Efficient Appliances Program

Primary Measure	n	Tracking Dataset	Application Data		Rebate Range (%)
		FY2021 Rebate Amount	Average Retail Price	Median Retail Price	
Clothes washer	349	$75 - $100	$848	$800	9% - 12%
Clothes dryer	322	$75 - $200	$894	$850	8% - 22%
Refrigerator	289	$75 - $100	$1,698	$1,618	4% - 6%
Dehumidifier	110	$25 - $35	$221	$219	11% - 16%

3.4.1.2 Participant Spillover

One-quarter of respondents (26%) reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Retail Efficient Appliances project. Three of those participants (4%) reported that the program had some influence on their decision to purchase the energy-efficient product (Table 167). The participants who reported installing a clothes washer and LEDs rated the program's influence on their decision a 2 on a 1 to 5 scale, in which 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 25%. The participant who installed a clothes dryer rated the program's influence on their decision a 4; we assigned them a spillover influence score of 75%.[26] The third participant reported installing LEDs and rated the program's influence on their decision a 5; we assigned them a spillover influence score of 100%.

[26] The participant who reported installing a clothes dryer had received a rebate for a clothes washer, and the participant who reported installing a clothes washer had received a rebate for a clothes dryer. We checked these participants' names and addresses in the FY2021 tracking data to make sure they did not receive a rebate for these measures through the Retail Efficient Appliances Program.

Table 167: Spillover Influence Scores for Retail Efficient Appliances Program

Influence Rating	Assigned Influence Score (%)	Spillover Measures	Count of Respondents
Rating of 2 (some influence)	25%	Clothes washer, LEDs	2
Rating of 3	50%	-	-
Rating of 4	75%	Clothes dryer	1
Rating of 5 (great influence)	100%	LEDs	1
Respondent does not know how much influence	50%	-	-

We estimated the savings associated with these measures (assuming they were ENERGY STAR) and applied the spillover influence scores to estimate the total spillover savings. We then divided that estimate by the cumulative tracked savings across all 70 survey respondents to calculate the spillover rate for the program. This resulted in a spillover rate of 6% for the Retail Efficient Appliances program (Table 168).

Table 168: Spillover Rate for Retail Efficient Appliances Program

	Average	Minimum	Maximum
Spillover Rate	6%	0%	218%

3.4.1.3 NTG Ratio

The savings-weighted NTG ratio for the Retail Efficient Appliances program equals 50%, after rounding (Table 169).

Table 169: NTG Ratio for Retail Efficient Appliances Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	56%	6%	50%

3.4.2 Process Evaluation

For the process evaluation of the Retail Efficient Appliances program, the NMR team completed telephone surveys with 70 program participants. For each unique participant in FY2021, the NMR team identified the measure with the highest savings ("primary measure") and asked the respondent to consider that measure when responding to the survey.[27] The proportion of primary measures among survey respondents is similar to the proportion of measures that received a rebate through the Retail Efficient Appliances Program in FY2021 (Table 170).

[27] According to program tracking data, over two-thirds of Retail Efficient Appliances program participants (69%) received a rebate for one appliance, while 27% received rebates for two appliances. Four percent of participants received a rebate for three or more appliances in FY2021.

Table 170: Retail Efficient Appliances Program Survey Completes by Measure

Primary Measure	% of Survey Respondents	% of FY2021 Program Participation
Refrigerator	30%	27%
Clothes dryer	29%	30%
Clothes washer	27%	33%
Dehumidifier	14%	10%

3.4.2.1 Key Findings

The key findings from the process evaluation of the Retail Efficient Appliances program are as follows:

- On a scale from 1 to 5, in which 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.7, on average.
- The NPS[28] for the Retail Efficient Appliances program was 79.
- Nearly half of participants (46%) reported purchasing their appliance to replace an older or failing unit.
- Half of participants (50%) indicated they had learned about the availability of the rebate while they were deciding to purchase the measure, emphasizing the importance of program advertising at the point of sale. Respondents most commonly learned about the program from the DCSEU website (24%), a retail store website (20%), from a colleague, friend, or family member (16%), or from a sign in a store indicating DCSEU rebates are available (16%).

3.4.2.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, in which 0 is "extremely unlikely" and 10 is "extremely likely," participants rated their likelihood to recommend the program to someone else a 9.3, on average. The NPS for the program among participating end users was 79, a 7-point decrease from FY2020, where NPS was 86. Overall, 83% of respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. Eight respondents were *passives* and three respondents were *detractors*.
- Participants rated their overall satisfaction with the program a 4.7, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 171 shows their satisfaction ratings in detail.
- When asked if they had any additional comments at the close of the survey, three participants praised the program's offerings and the DCSEU in general. Of the remaining

[28] The NPS is a well-established measure of customer loyalty. Using a scale of 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," respondents are asked how likely they are to recommend the program to someone else. Respondents are then grouped as promoters (score 9-10), passives (7-8), and detractors (0-6). The NPS is calculated by subtracting the percentage of detractors from the percentage of promoters and is presented as a whole number.

five participants who provided additional comments, two suggested increasing program awareness through increased advertising, two participants would've liked to provide program feedback closer to the date of purchase, and one participant suggested making the application process more clear.

Table 171: Participant Experience with the Retail Efficient Appliances Program[1]

Feature	n[2]	1 Not at All Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**70**	**0%**	**0%**	**4%**	**17%**	**79%**	**4.7**
The performance of the measure	68	0%	0%	4%	13%	82%	4.8
The application process	70	0%	1%	6%	23%	70%	4.6
Time it took to receive rebate	68	0%	3%	12%	24%	62%	4.4
Energy savings from the new appliance	52	0%	0%	14%	21%	65%	4.5
The rebate amount	70	0%	1%	16%	19%	64%	4.5
The variety of eligible equipment	58	3%	2%	12%	19%	64%	4.4
Information on the DCSEU website	63	0%	5%	11%	32%	52%	4.3

[1] Some rows do not sum to 100% due to rounding.
[2] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure."

Respondents who rated their satisfaction with program features less than a 3 were asked to provide additional context.

- The respondent who rated their satisfaction with the rebate amount a 2 reported that the rebate was too low.
- The three respondents who rated their satisfaction with the variety of eligible equipment a 1 or 2 indicated that the appliance they purchased alongside the rebated measure did not qualify for a rebate as expected (one respondent) and that the list of eligible products is too limited (two respondents).
- The three respondents who rated their satisfaction with the information available about eligible equipment on the DCSEU website a 2 reported that it was difficult to compare and assess (one respondent), the website was not clear (one respondent), and the website was difficult to navigate (one respondent).

Based on their experience, participants provided feedback on what they would change about the Retail Efficient Appliances program (Table 172). The rebate amount (33%), variety of eligible equipment (26%), and application process (10%) were the most commonly suggested program changes. Nine percent of respondents suggested increasing the program's publicity to improve awareness. Seven percent of respondents requested a quicker turnaround for the rebate, with one of these respondents specifying that having options for how they can receive

their rebate (e.g., direct deposit or the picking up the rebate in person) would be a nice feature. Four percent of respondents suggested improving the program website. Other suggestions (3%) mentioned by one respondent each included providing the rebate as a direct deposit and clarifying what products are eligible. One-fifth of respondents (20%) indicated that they would not change anything about the program.

Table 172: Suggested Changes to the Retail Efficient Appliances Program

Program Feature	Percent of Respondents (n=70)[1]
The rebate amount	33%
The variety of eligible equipment	26%
The application process	10%
Program visibility/publicity	9%
Faster rebate turnaround	7%
The program website	4%
Other	3%
Not sure	7%
No change	20%

[1] Percentages do not sum to 100% because multiple responses were allowed.

3.4.2.3 Program Experience

Participants were asked to report their reasons for purchasing the appliances (Table 173). Nearly one-half of respondents (46%) reported purchasing the appliance to replace an older or failing unit, followed by a desire to replace the unit (21%) or because an existing unit stopped working or broke (19%). Seventeen percent of respondents indicated purchasing an appliance to save energy. Additionally, helping the environment (14%) and reducing humidity (14%) were the next most common reasons participants purchased an appliance.

Table 173: Retail Efficient Appliances Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=70)[1]
Replace older or failing unit	46%
It was time to replace the unit	21%
Existing unit stopped working or broke	19%
To save energy	17%
To help the environment	14%
To reduce humidity	14%
Increased capacity and/or performance	13%
Due to home remodeling or renovation	13%
To save money on bills	9%
Installed in a new home	6%
Existing unit was too expensive to repair	6%
To have a secondary unit – not a replacement unit	1%
To improve comfort or temperature	1%
Other	3%

[1] Percentages sum to greater than 100% because multiple responses were allowed.

3.4.2.4 Program Awareness

One half of participants (50%) reported that they first learned they could obtain a rebate from the program while they were deciding to purchasing the appliance, while just under one third of respondents (30%) learned about the availability of the rebate before deciding to purchase the appliance (Table 174).

Table 174: Awareness of Retail Efficient Appliances Program Rebate Availability

When Respondent Learned About the Rebate	Percent of Respondents (n=70)
While respondent was deciding to purchase the measure	50%
Before respondent decided to purchase the measure	30%
After respondent had already decided to purchase the measure	17%
Don't know	3%

When asked how they heard about the rebate, participants most often cited the DCSEU website (24%), a retailer website (20%), and a colleague, friend, or family member (16%). Sixteen percent of participants learned about the rebate from an in-store sign indicating available DCSEU rebates and fourteen percent heard about the rebate from a retail store employee. Respondents also indicated they had heard about the program through internet research (9%) or via a DCSEU mailing or email (3%) (Table 175).

Table 175: Awareness of the Retail Efficient Appliances Program

Source of Program Awareness	Percent of Respondents (n=70)[1]
The DCSEU website	24%
Retailer website	20%
A colleague, friend, or family member	16%
Signs in store indicating DCSEU rebates available	16%
Retail store employee	14%
Internet research	9%
A DCSEU mailing or email	3%
DCSEU online advertisement	1%
Other	1%

[1] Percentages sum to greater than 100% because multiple responses were allowed.

Almost three-quarters of respondents (74%) reported visiting the DCSEU website. On a scale of 1 to 5, in which 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.3 for the information provided on the DCSEU's energy saving programs.

3.4.2.5 Appliance Installation Experience

All but one of the respondents (99%) reported that the measure for which they received the rebate was installed at the time of the survey. The respondent who did not have the measure currently installed reported having the measure installed previously and was unsure as to why it was removed.

Almost one-half of respondents (49%) reported having their rebated appliance installed by a representative from the retailer. Nearly one-third of respondents (31%) indicated that they installed the appliance themselves. The remaining respondents had their appliance installed by a contractor (17%), or someone else in their household (3%).

On a scale of 1 to 5, in which 1 is “very difficult” and 5 is “very easy,” the 24 respondents who installed the appliance themselves or indicated that someone else in their household installed the appliance rated the ease of installation a 4.8, on average.

3.4.3 Recommendations

Based on the findings from our evaluation, we offer the following recommendations for the Retail Efficient Appliances program:

- Consider increasing the rebate amount and expanding the types of eligible equipment where feasible. When asked to suggest any changes DCSEU could make to the program, survey respondents most commonly cited increasing the rebate amount and increasing the variety of eligible equipment. Survey respondents reported that the availability of the rebate was the greatest influence on program participation and 83% of survey respondents identified the rebate as an important (4 or 5 on the 5-point scale) positive influence in program participation. Similarly, 83% of survey respondents reported satisfaction with the variety of eligible equipment available through the program. However, of all the participant experience survey questions, some survey respondents selected the “not at all satisfied” option only in the variety of eligible equipment question.
- Continue to offer education about savings from energy-efficient appliances so customers are prepared to choose an energy-efficient model when their current equipment fails. Survey respondents scored energy efficiency and reduced energy bills as non-programmatic factors that influenced purchasing decisions relatively low compared to other factors (e.g., product features, product reviews). Consequently, there appears to be an opportunity for DCSEU to increase awareness concerning the benefits of choosing energy-efficient equipment.

3.5 INCOME QUALIFIED EFFICIENCY FUND (7610IQEF)

The Income Qualified Efficiency Fund (IQEF) program provides financial support to projects that increase energy efficiency in buildings, neighborhoods, and communities. This program allotted funding to DCSEU approved contractors to implement projects that resulted in significant energy savings and passed the resulting monetary benefits on to low- and moderate-income residents in the District of Columbia. A total of 14 energy-efficiency projects were funded at DC multifamily properties, shelters, or clinics in FY2021.

Table 176 provides the breakdown of tracked savings by measure type. Combined, indoor LED fixtures, boilers, and furnaces accounted for over one-half (61%) of program-level energy savings.

Table 176: Income Qualified Efficiency Fund Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Peak Demand Savings	Percent of FY2021 Gas Savings
Indoor LED Fixtures	32%	48%	25%	<-1%[29]
Boilers/Furnaces	29%	3%	-	84%
LED downlights	13%	20%	12%	<-1%
Cooling	10%	14%	54%	-
Thermostats	5%	0.2%	-	16%
Linear LEDs	4%	6%	4%	<-1%
Pin Base LEDs	3%	5%	3%	<-1%
Outdoor LED Fixtures	1%	2%	-	-
Screw Base LEDs	1%	1%	1%	<-1%
Other	1%	1%	1%	<-1%

*Other includes heat pumps, LED exit signs, and occupancy sensors.

For the FY2021 Income Qualified Efficiency Fund program, we completed the following evaluation activity:

- Gross Savings Verification

3.5.1 Gross Savings Verification

Table 177 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the Income Qualified Efficiency Fund program.

Table 177: Income Qualified Efficiency Fund Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	1,133	101%	1,139	80% ± 0.2%

[29] Lighting gas savings are negative because of the heating penalty for efficient lighting.

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Peak Demand Savings (MW)	0.269	101%	0.270	80% ± 0.2%
FY2021 Gas Savings (MMBtu)	1,185	100%	1,182	80% ± 0.1%

3.5.1.1 Methodology

We conducted a desk review for each sampled project. We reviewed spec sheets and other supporting documentation to verify that measure quantities, descriptions, and other key inputs matched those utilized in savings calculations. For measures that existed in the TRM, desk reviews used algorithms and assumptions presented in the TRM as a reference for analysis, making methodological adjustments as appropriate for the site-specific information provided. For measures that did not exist in the TRM, we reviewed all submitted documentation and determined the suitability of the equations and assumptions used to calculate the tracked savings. If equations or assumptions were deemed unsuitable, the NMR team overrode them with more appropriate inputs. In addition, we conducted an on-site verification visit at one sampled project.

3.5.1.2 Sampling Plan

We conducted desk reviews for the 11 projects with the most energy savings. For the IQEF program, these 11 projects represented 99% of the tracked energy savings from all 14 projects that participated in the program in FY2021.

3.5.1.3 Results

Table 178 displays the realization rates for the measures installed at the 11 sampled projects. Most measures achieved realization rates of 100% in all applicable savings categories. Linear LEDs achieved electric and gas realization rates of 109% because the quantity of LEDs used in savings calculations at one project was lower than the quantity listed in the supporting documentation.

Table 178: Income Qualified Efficiency Fund Realization Rates by Measure Type

Measure Category*	FY2021 Electric Savings Realization Rate	FY2021 Peak Demand Savings Realization Rate	FY2021 Gas Savings Realization Rate
Indoor LED Fixtures	100%	100%	100%
Boilers/Furnaces	100%	-	100%
LED downlights	100%	100%	100%
Cooling	100%	100%	-
Thermostats	100%	-	100%
Linear LEDs	109%	114%	109%
Pin Base LEDs	100%	100%	100%
Outdoor LED Fixtures	100%	-	-
Screw Base LEDs	100%	100%	100%
Other	100%	100%	100%
Total	**101%**	**101%**	**100%**

*Sampled measures only.

3.5.1.4 Recommendations

Based on the findings of our analysis, we offer the following recommendation for the Income Qualified Efficiency Fund program:

- Ensure that savings inputs used in calculations match those listed in supporting documentation.

3.6 INCOME QUALIFIED GAS EFFICIENCY FUND (4335IGEF)

The Income Qualified Gas Efficiency Fund (IGEF) program provides financial support to projects that increase natural gas efficiency upgrades for low- and limited-income residents of affordable, multifamily housing in the District of Columbia. This program, in partnership with Washington Gas, allotted funding to DCSEU approved contractors to implement projects that resulted in significant energy savings and passed the resulting monetary benefits on to low- and moderate-income residents in the District of Columbia. A total of 19 energy-efficiency projects were funded at DC multifamily properties in FY2021.

Table 179 provides the breakdown of tracked savings by measure type. Combined, boilers, furnaces, and water heaters accounted for nearly all (99%) of program-level energy savings.

Table 179: Income Qualified Gas Efficiency Fund Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Gas Savings
Boilers	76%	-	76%
Water Heating	22%	-	22%
Furnaces	1%	-	1%
Other*	1%	100%	1%

*Other includes windows, air sealing, programmable thermostats, and low flow water fixtures.

For the FY2021 Income Qualified Gas Efficiency Fund program, we completed the following evaluation activity:

- Gross Savings Verification

3.6.1 Gross Savings Verification

Table 180 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the Income Qualified Gas Efficiency Fund program.

Table 180: Income Qualified Gas Efficiency Fund Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	2.7	100%	2.7	80% ± 0.0%
FY2021 Peak Demand Savings (MW)	0.0	n/a	0.0	n/a
FY2021 Gas Savings (MMBtu)	9,086	99%	8,999	80% ± 0.3%

3.6.1.1 Methodology

We conducted a desk review for each sampled project. We reviewed spec sheets and other supporting documentation to verify that measure quantities, descriptions, and other key inputs matched those utilized in savings calculations. For measures that existed in the TRM, desk reviews used algorithms and assumptions presented in the TRM as a reference for analysis, making methodological adjustments as appropriate for the site-specific information provided. For measures that did not exist in the TRM, we reviewed all submitted documentation and determined the suitability of the equations and assumptions used to calculate the tracked savings. If equations or assumptions were deemed unsuitable, the NMR team overrode them with more appropriate inputs. In addition, we conducted an on-site verification visit at one sampled project.

3.6.1.2 Sampling Plan

We conducted desk reviews for the 15 projects with the most energy savings. For the IGEF program, the top 15 projects represented 98% of the tracked energy savings from all 19 projects that participated in the program in FY2021.

3.6.1.3 Results

Table 181 displays the realization rates for the measures installed at the 15 sampled projects. Water heaters, furnaces, and other measures achieved realization rates of 100% in all applicable savings categories. Boilers achieved gas realization rates of 99% because we found that the equipment efficiencies utilized in savings calculations at four projects differed from the efficiencies listed on the AHRI certificates for these models. We recalculated savings using the AHRI verified efficiencies which reduced savings slightly because, overall, the verified efficiencies were slightly lower than the ones used in the original estimates.

Table 181: Income Qualified Gas Efficiency Fund Realization Rates by Measure Type

Measure Category	FY2021 Electric Savings Realization Rate	FY2021 Peak Demand Savings Realization Rate	FY2021 Gas Savings Realization Rate
Boilers	-	-	99%
Water Heating	-	-	100%
Furnaces	-	-	100%
Other*	100%	-	100%

*Other includes windows, air sealing, programmable thermostats, and low flow water fixtures.

3.6.1.4 Recommendations

Based on the findings of our analysis, we offer the following recommendation for the Income Qualified Gas Efficiency Fund program:

- Ensure that any savings inputs used in calculations match those listed on supporting documentation.

3.7 LOW-INCOME MULTIFAMILY COMPREHENSIVE (7612LICP)

The Low-income Multifamily Comprehensive (LICP) program provides custom technical services and incentives for energy-efficiency improvements to low-income multifamily projects – specifically, new construction, substantial renovation, and redevelopment housing. In FY2021, ECMs included in-unit and common area lighting, heating and cooling systems, low flow water fixtures, domestic hot water systems, appliances, solar PV, VFD motor controls, ventilation equipment, thermostats, and air sealing.

In FY2021, the program provided incentives for 45 projects. Table 182 provides the breakdown of tracked savings by measure type. Combined, lighting (50%) and heat pumps (16%) accounted for nearly two-thirds of program-level savings.

Table 182: Low-income Multifamily Comprehensive Program Savings Contributions

Measure Type	Percent of FY2021 Combined Energy Savings	Percent of FY2021 Electric Savings	Percent of FY2021 Peak Demand Savings	Percent of FY2021 Gas Savings
Lighting	50%	62%	47%	<-1%[30]
Heat Pumps	16%	17%	27%	-
Low flow water fixtures	8%	6%	2%	16%
Cooling	7%	7%	13%	-
Furnaces	5%	-	-	41%
Water Heating	5%	-	-	34%
Appliances	4%	4%	3%	1%
Other*	5%	5%	7%	9%

*Other includes solar PV, VFD motor controls, ventilation equipment, thermostats, and air sealing.

[30] Lighting gas savings are negative because of the heating penalty for efficient lighting.

For the FY2021 LICP program, we completed the following evaluation activity:

- Gross Savings Verification

3.7.1 Gross Savings Verification

Table 183 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the LICP program.

Table 183: Low-income Multifamily Comprehensive Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	3,890	99%	3,866	80% ± 0.6%
FY2021 Peak Demand Savings (MW)	0.6	100%	0.6	80% ± 0.3%
FY2021 Gas Savings (MMBtu)	484	109%	529	80% ± 18.0%

3.7.1.1 Methodology

We conducted a desk review for each sampled project. We reviewed spec sheets and other supporting documentation to verify that measure quantities, descriptions, and other key inputs matched those utilized in savings calculations. For measures that existed in the TRM, desk reviews used algorithms and assumptions presented in the TRM as a reference for analysis, making methodological adjustments as appropriate for the site-specific information provided. For measures that did not exist in the TRM, we reviewed all submitted documentation and determined the suitability of the equations and assumptions used to calculate the tracked savings. If equations or assumptions were deemed unsuitable, the NMR team overrode them with more appropriate inputs. In addition, we conducted on-site verifications for three sampled projects.

3.7.1.2 Sampling Plan

We conducted desk reviews for the 24 projects with the most energy savings. For the LICP program, these projects represented 89% of the tracked energy savings from all 45 projects that participated in the program in FY2021.

3.7.1.3 Results

Table 184 displays the realization rates for the measures installed at the 24 sampled projects. Heat pumps and cooling achieved realization rates of 100% in all applicable savings categories. The findings that contributed to the realization rates for other measures are detailed in the text that follows.

Table 184: Low-income Multifamily Comprehensive Realization Rates by Measure Type

Measure Category*	FY2021 Electric Savings Realization Rate	FY2021 Peak Demand Savings Realization Rate	FY2021 Gas Savings Realization Rate
Lighting	98%	100%	65%
Heat Pumps	100%	100%	-
Low flow water fixtures	99%	102%	90%
Cooling	100%	100%	-
Furnaces	-	-	105%
Water Heating	-	-	57%
Appliances	110%	95%	151%
Other**	100%	108%	100%

*Sampled measures only.
**Other includes solar PV, VFD motor controls, ventilation equipment, thermostats, and air sealing.

Lighting

- Tracked savings calculations for lighting installed in closets at four projects assumed two to four hours of use per day. We recalculated savings using 0.6 hours per day, an assumption from the Pennsylvania TRM for lighting installed in residential closets.[31] The NMR team believes 0.6 is more realistic for residential closets and has utilized this assumption in past evaluations of DC multifamily projects. The reduction in HOU resulted in lower savings for these lightbulbs.
- Tracked savings calculations for lighting installed at four projects heated with electric heat pumps employed gas waste heat factors. We recalculated savings using electric waste heat factors, which reduced electric savings but also eliminated the gas heating penalty associated with these lighting measures. This adjustment is the driving force for the lighting gas realization rate of 65%.
- Tracked savings for lighting installed in common areas at two projects had been calculated using in-unit waste heat factors. We recalculated savings using common area waste heat factors, which had a small, positive impact on savings for these lighting measures.
- Tracked savings calculations for three lighting models employed a wattage value different from that listed on the supporting documentation. The correct wattages for these models were higher; therefore, verified savings for these models were higher.

Low Flow Water Fixtures

- At one project in which low flow showerheads and faucet aerators had been installed, a high efficiency gas water heater had also been installed. Tracked savings calculations for the low flow fixtures utilized the water heater efficiency listed in the TRM, which is

[31] https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/technical-reference-manual/

lower than that of the new, high efficiency gas water heater. We recalculated savings for these low flow fixtures using the efficiency of the new water heater, resulting in lower verified gas savings.

- Tracked savings for faucet aerators at one project with an electric water heater had been calculated using a GPM different from that listed on supporting documentation. Because the correct GPM was higher, verified savings were lower for the faucet aerators at this project.
- At three projects we were able to replicate tracked electric savings for all faucet aerators using the TRM algorithms and assumptions. However, when using the TRM algorithms and assumptions for peak demand savings at these projects, we were only able to replicate tracked savings for some of these fixtures. When our peak demand savings estimates differed from tracked savings estimates, they were higher. Therefore, the peak demand realization rate for low flow water fixtures (102%) exceeds 100%.

Furnaces

- The gas realization rate for furnaces (105%) is greater than 100% because the furnaces installed at one project had been calculated using an AFUE of 95%; however, an AFUE of 96% was listed on the spec sheet for the model installed.

Water Heating

- The gas realization rate for water heaters (57%) is less than 100% because water heater savings per apartment at one project had been multiplied by an incorrect number of apartments: 152 instead of 17.

Appliances

- We identified four projects where refrigerator savings had been based on a model other than the model that we observed in post-installation inspection photos. In most cases the refrigerators installed were more efficient than the models on which tracked savings calculations had been based, which had a positive effect on the electric and peak demand realization rates.
- Twelve clothes washers and dryers were installed in a common area laundry room at a 152-unit new construction project. Tracked savings calculations for these appliances assumed 5.7 wash cycles per week: typical usage for a single-family household. We recalculated savings assuming 3.4 wash cycles per day for multifamily laundry appliances based on a 2008 DOE commercial clothes washer rulemaking.[32]
- Three of the four projects that included clothes dryers were heated with electricity. However, tracked savings for these projects included gas penalties. We removed these gas penalties which increased the gas realization rate for appliances.

[32] https://www1.eere.energy.gov/buildings/publications/pdfs/corporate/commercial_appliances_report_12-09.pdf

Other

- We were able to replicate tracked electric savings for all ceiling exhaust fans using the TRM algorithms and assumptions. However, when using the TRM algorithms and assumptions for peak demand savings, we were only able to replicate tracked savings for some of these exhaust fans. When our peak demand savings estimates differed from tracked savings estimates, they were higher. Therefore, the peak demand realization rate for other measures (108%) exceeds 100%.

3.7.2 Recommendations

Based on the findings of our analysis, we offer the following recommendations for the Low-income Multifamily Comprehensive program:

- Ensure that savings calculations are based on the appropriate HOU and waste heat factors given the building heating fuel types and rooms in which lighting was installed.
- Ensure that any savings inputs used in calculations match those listed on supporting documentation.
- Calculate savings utilizing site-specific inputs as opposed to TRM defaults where available.
- Review post-installation photos to make sure that savings inputs are derived from the appliance models installed.
- Review procedures for faucet aerator and ceiling exhaust fan peak demand calculations to ensure they are consistent across measures.

3.8 LOW-INCOME MULTIFAMILY IMPLEMENTATION CONTRACTOR DIRECT INSTALL (7610ICDI)

The Low-income Multifamily Implementation Contractor Direct Install (ICDI) initiative is promoted to property owners, property managers, and developers of low-income multifamily residents in the District of Columbia. It covers 100% of the costs (products and direct installation) and hires implementation contractors to perform the direct installation of energy efficient measures.

For the FY2021 ICDI program, we completed the following evaluation activity:

- Gross Savings Verification

3.8.1 Gross Savings Verification

During FY2021 one Low-Income Multifamily Implementation Contractor Direct Install project was completed. We conducted a desk review for this project, which included the installation of efficient gas boilers at a low-income multifamily property. Table 185 shows that the ICDI program achieved a realization rate of 100% for gas savings.

Table 185: Low-income Multifamily Implementation Contractor Direct Install Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	0	n/a	0
FY2021 Peak Demand Savings (MW)	0	n/a	0
FY2021 Gas Savings (MMBtu)	6,390	100%	6,390

Section 4 Default Realization Rates and Net-to-Gross Values

This section provides a description of the process to assign default realization rates and NTG values for programs that the NMR team did not select for the FY2021 evaluation.

4.1 Default Realization Rates

As described in Section 1.5, the FY2021 evaluation verified the gross savings for 13 programs. To assign default realization rates for the nine programs that the NMR team did not evaluate for FY2021, we reviewed previous realization rates for these DCSEU programs, as well as the calculated FY2021 realization rates for other programs. Because realization rates can change over time as measure offerings and markets evolve, we opted to apply the FY2020, FY2019, FY2018, or FY2017 realization rate for the same program or the FY2021 realization rate from similar programs or similar measures if they exist.

Table 186 lists each of the nine programs that did not undergo gross savings verification in FY2021, the source of the realization rate, and the default realization rate values.

Table 186: FY2021 Default Realization Rates

Sector	Program Name	Source for Default Realization Rate	Default Realization Rates		
			Electric Savings	Peak Demand Savings	Gas Savings
Commercial	Market Transformation Value (7512MTV)	FY2020 Evaluation	108%	139%	107%
	Small & Medium Business Rebates (7511SMRX)	7511CIRX Evaluation	105%	101%	103%
Low-income	Low-income Prescriptive Rebates (7613LIRX)	FY2018 Evaluation	100%	100%	101%
	Home Energy Conservation Kit - Low-income (7717HEKT)	100% Assumption	100%	100%	100%
Residential	Retail Efficient Appliances (7710APPL)	FY2017 Evaluation	100%	100%	100%
	Nest Seasonal Savings (7710STAT)	TRM savings updated based on FY2018 & FY2019 evaluations	100%	100%	100%
	Residential Upstream (7725RSUP)	FY2020 Evaluation for Retail Lighting	100%	100%	100%
	Home Energy Conservation Kit – Market Rate (7710HEKT)	100% Assumption	100%	100%	100%
	Retail Heating & Cooling (7710HTCL)	FY2020 Evaluation	103%	100%	105%

4.2 NET-TO-GROSS REVIEW

The NMR team estimated NTG values for ten FY2021 programs. For the low-income programs where a NTG value was not estimated, we assumed a 100% NTG value, which is a common assumption for low-income programs. For other programs, we based NTG on the most recently available DCSEU NTG estimates from FY2020, FY2019, FY2018, FY2014, or FY2013, if available. For programs where NTG was not previously estimated (and for recently launched programs), the NMR team derived NTG values from similar programs. Table 187 presents the recommended NTG estimates for these FY2021 programs.

Table 187: Recommended Default FY2021 NTG Estimates

Sector	Program Name	Track Number	NTG Value	Source
Solar	Low-income Solar Renewable Credit	7107SREC	100%	Assumed
Commercial	Pay for Performance	7511SMRX	74%	FY2020
Low-income	Income Qualified Gas Efficiency Fund	4335IGEF	100%	Assumed
	Income Qualified Efficiency Fund	7610IQEF	100%	Assumed
	Low-income Multifamily Comprehensive	7612LICP	100%	Assumed
	Low-income Prescriptive Rebate	7613LIRX	100%	Assumed
	Low-income Decarbonization Pilot	7415LIDP	100%	Assumed
	Retail Lighting Food Bank	7717FBNK	100%	Assumed
	Home Energy Conservation Kit - Low-income	7717HEKT	100%	Assumed
Residential	Retail Lighting	7710LITE	51%	FY2013
	Nest Seasonal Savings	7710STAT	100%	FY2018 & FY2019 evaluations
	Residential Upstream	7725RSUP	51%	Same as Retail Lighting

To inform the derived FY2021 NTG estimates, the NMR team reviewed the previous DCSEU NTG values and examined NTG results from other Mid-Atlantic and Northeastern jurisdictions. When we were not able to locate NTG studies for similar programs, we provided assumed values. Table 188 compares the most recent DCSEU NTG estimates with the NTG values from other jurisdictions. The table also includes the evaluation team's assumed estimates, which we used when NTG studies for comparable programs were not available. Overall, the DCSEU NTG estimates are aligned with those in other areas, which suggests that the recommended NTG values included in Table 188 are reasonable values for FY2021.

Table 188: DCSEU NTG Values Compared to Other Jurisdictions

Sector	Track	Initiative	DCSEU NTG	Year Assessed	Benchmark NTG	Benchmark Source Program Administrator (Program Year)
Solar	7101PVMR	Solar PV Market Rate	45%	FY2021	--	--
	7108CREF	Solar for All Community Renewable PV	100%	Assumed	--	--
Commercial	7511SMRX	Small and Medium Business Rebates	100%	FY2021	Lighting: 64%-77% Prescriptive: 44%-54%	PA First Energy Companies (2018-2019)[a]
					77%	PA PECO (2019-2020)[b]
					Lighting: 72% Equipment: 63%	PA PPL (2020-2021)[k]
					88%	EmPOWER Maryland (2020)[d]
	7511CIRX	C&I RX - Equipment Replacement	70%	FY2021	Lighting: 64%-77% Prescriptive: 44%-54%	PA First Energy Companies (2018-2019)[a]
					77%	PA PECO (2019-2020)[b]
					Lighting: 72% Equipment: 63%	PA PPL (2020-2021)[k]
					88%	EmPOWER Maryland (2020)[d]
	7512MTV	Market Transformation Value	84%	FY2021	Lighting: 64%-77% Prescriptive: 44%-54%	PA First Energy Companies (2018-2019)[a]
					77%	PA PECO (2019-2020)[b]
					Lighting: 77% Equipment: 56%-77%	PA PPL (2019-2020)[c]
					88%	EmPOWER Maryland (2020)[d]
	7513UPLT	Commercial Upstream Lighting	71%	FY2021	62%	PA PPL (2019-2020)[c]
					94% A-line LEDs 88% Other LEDs	PA Duquesne (2020-2021)[l]
					80%	EmPOWER Maryland (2020)[d]
	7520CUST	Retrofit - Custom	54%	FY2021	Lighting: 64%-80% Custom: 53%-84%	PA First Energy Companies (2019-2020)[f]
					60%	EmPOWER Maryland (2020)[d]
					61%	PA PPL (2020-2021)[k]
					60%	PA PECO (2019-2020)[b]
	7520MARO	Market Opportunities - Custom	65%	FY2021	Lighting: 66%-85% Custom: 37%-56%	PA First Energy Companies (2016-2017)[g]
					60%	EmPOWER Maryland (2020)[d]

Sector	Track	Initiative	DCSEU NTG	Year Assessed	Benchmark NTG	Benchmark Source Program Administrator (Program Year)
Multifamily					66%	PA PPL (2019-2020)[c]
					60%	PA PECO (2019-2020)[b]
	7520NEWC	New Construction - Custom	50%	FY2021	Small: 33% Large: 48%	PA PECO (2019-2020)[b]
	7520P4PX	Pay for Performance	74%	FY2020	n/a	--
	7610IQEF	Income Qualified Efficiency Fund	100%	Assumed	45%	PA Duquesne (2017-2018)[h]
	7612LICP	Low-income Multifamily Comprehensive	100%	Assumed	Large: 93% Small: 92%	PA PECO (2018-2019)[d]
	7613LIRX	Low-income Prescriptive Rebate	100%	Assumed	45%	PA Duquesne (2017-2018)[h]
Efficient Products	7710APPL	Retail Efficient Appliances	50%	FY2021	90%-222%	PA PECO (2019-2020)[b]
					50%-65%	PA First Energy Companies (2019-2020)[f]
					31%	EmPOWER Maryland (2020)[d]
					61%	PA Duquesne (2019-2020)[i]
	7710HTCL	Retail Heating and Cooling	58%	FY2021	81%-100%	PA PECO (2019-2020)[b]
					51%-55%	PA First Energy Companies (2019-2020)[f]
					60%	EmPOWER Maryland (2020)[d]
					64%	PA PPL (2016-2017)[j]
	7710LITE	Retail Lighting	51%	FY2013	Standard LED: 51% Specialty LED: 46%	PA PECO (2017-2018)[d]
					23%-31%	PA First Energy Companies (2018-2019)[a]
					19%	EmPOWER Maryland (2020)[d]
					Standard LED: 43% Specialty LED: 43%	PA Duquesne (2017-2018)[h]
					83%	PA PPL (2016-2017)[j]
	7717FBNK	Retail Lighting Food Bank	100%	Assumed	--	--
	7717HEKT	Home Energy Conservation Kit - Low-income	100%	Assumed	100%	PA PPL (2019-2020, assumed)[c]
					100%	PA Duquesne (2019-2020, assumed)[i]
					100%	PA First Energy Companies (2018-2019, assumed)[a]
	7725RSUP	Residential Upstream	51%	Retail Lighting	Standard LED: 51% Specialty LED: 46%	PA PECO (2017-2018)[h]
					23%-31%	PA First Energy Companies (2018-2019)[a]

Sector	Track	Initiative	DCSEU NTG	Year Assessed	Benchmark NTG	Benchmark Source Program Administrator (Program Year)
					19%	EmPOWER Maryland (2020)[d]
					Standard LED: 43% Specialty LED: 43%	PA Duquesne (2017-2018)[h]
					83%	PA PPL (2016-2017)[j]

[a] ADM Associates and Tetra Tech. November 15, 2019. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 10 (June 1, 2018-May 31, 2019). Prepared for Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, West Penn Power.
[b] Guidehouse. February 15, 2021. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 11 (June 1, 2019-May 31, 2020). Prepared for PECO.
[c] The Cadmus Group. February 15, 2021. Annual Report to the Pennsylvania Public Utility Commission Phase III of Act 129 Program Year 11 (June 1, 2019 – May 31, 2020) for Pennsylvania Act 129 of 2008 Energy Efficiency and Conservation Plan. Prepared for PPL Electric Utilities.
[d] Guidehouse. October 29, 2021. Overview Memo - Calendar Year 2020 Deliverables. Submitted to: Sheldon Switzer and Trey Greiser (BGE); David Pirtle and Joe Cohen (Pepco and Delmarva Power); Diane Rapp and Lisa Wolfe (PE); Jennifer Raley (SMECO); Joe Loper (Loper Energy); Dan Hurley and Amanda Best (MD PSC); and other EmPOWER stakeholders.
[e] Navigant, A Guidehouse Company. November 15, 2019. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 10 (June 1, 2018-May 31, 2019). Prepared for Duquesne Light Company.
[f] ADM Associates and Tetra Tech. February 16, 2021. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 11 (June 1, 2019-May 31, 2020). Prepared for Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, West Penn Power.
[g] Navigant Consulting. November 15, 2017. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 8 (June 1, 2016-May 31, 2017). Prepared for Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, West Penn Power.
[h] Navigant Consulting. November 15, 2018. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 9 (June 1, 2017-May 31, 2018). Prepared for Duquesne Light Company.
[i] Guidehouse, Inc. February 15, 2021. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 11 (June 1, 2019-May 31, 2020). Prepared for Duquesne Light Company.
[j] The Cadmus Group. November 15, 2017. Annual Report to the Pennsylvania Public Utility Commission Phase III of Act 129 Program Year 8 (June 1, 2016-May 31, 2017) for Pennsylvania Act 129 of 2008 Energy Efficiency and Conservation Plan. Prepared for PPL Electric Utilities.
[k] The Cadmus Group. November 15, 2021. Annual Report to the Pennsylvania Public Utility Commission Phase III of Act 129 Program Year 12 (June 1, 2020 – May 31, 2021) for Pennsylvania Act 129 of 2008 Energy Efficiency and Conservation Plan. Prepared for PPL Electric Utilities.
[l] Guidehouse. November 15, 2021. Final Annual Report to the Pennsylvania Public Utility Commission, Phase III of Act 129 Program Year 12 (June 1, 2020-May 31, 2021). Prepared for Duquesne Light Company.

Appendix A Program Descriptions

This appendix provides a description for each of the program tracks offered by DCSEU in FY2021.

A.1 Commercial Sector

7520CUST - Retrofit – Commercial Custom

The Custom Retrofit program offers incentives to owners of large buildings to install energy-efficient equipment or make operational changes to their facility that result in energy savings. The program focuses on retrofit projects where the equipment is being replaced prior to the end of its life. Incentives are offered for a variety of equipment types, including lighting, chillers, boilers, heat pumps, steam systems, insulation, refrigeration, and various building or equipment controls. Through this program, the DCSEU offers technical assistance to help decision makers design, scope, and fund their projects. Rebates are paid on a traditional per-unit of energy saved basis.

7520MARO - Market Opportunities – Commercial Custom

The Market Opportunity Custom program focuses on retrofit projects where equipment is at the end of its life. It offers incentives to large building owners who update equipment to energy-efficient options or update operational controls to achieve energy savings. This track includes measures in lighting, HVAC, and various commercial/residential appliances. Key objectives of the incentive are to offset the costs of adding energy-efficient equipment beyond the current energy code; provide comprehensive technical services to help decision makers design, scope, and fund their projects; and share the economic benefits with the customer. Funding is available through a traditional rebate structure where participants are paid per unit of energy saved.

7520NEWC - New Construction – Commercial Custom

This program focuses on construction of new buildings or facilities that exceed energy code standards. The New Construction Track covers a large range of new construction measures, including lighting; HVAC; building controls; building envelope elements, such as insulation and windows; and plug loads, such as icemakers, refrigerators, and freezers. DCSEU provides technical assistance in the design stage to help decision makers design, scope, and fund their projects. The key features of the incentive structure are to offset the incremental costs of adding more energy-efficient equipment than the current code requires, provide comprehensive technical services during design stage, and share the economic benefits with the customer.

7520P4PX - Pay for Performance

The P4P program launched in FY2019 to incentivize complex, multi-measure energy-efficiency projects that are not covered under existing program tracks. It focuses on existing commercial and industrial buildings, which implement multiple measures simultaneously or behavioral or operational changes where it is difficult to estimate savings. This may include re-/retro-commissioning, upgrades to the building controls, or fault detection. Incentives are paid based on pre- and post- project metered data where actual energy saved is determined using multivariate linear regression of AMI (PEPCO) or monthly (WGL) meter data.

7511CIRX - C&I RX – Equipment Replacement

The Business Energy Rebate (BER) initiative provides small- to medium-sized businesses located in DC with a comprehensive set of services and financial incentives to help them transition to more energy-efficient equipment. The initiative provides prescriptive incentives for lighting, refrigeration, HVAC, compressed air, and food service and vending equipment. Rebates require written pre-approval and are given for facility improvements that result in a permanent reduction in electrical and/or natural gas energy usage persisting for a minimum of five years.

The initiative is implemented through individual contractors selected by the participant. The DCSEU Account Managers generate leads based on prior years' participation or interest. Customers can also call the DCSEU or visit the DCSEU website. Contractors are also trained on how to upsell energy-efficient equipment.

7511SMRX - Small & Medium Business Rebates

This track is for Small Businesses, under 10,000 square feet. The DCSEU has been offering higher incentives to them as part of an ongoing campaign. The measures offered are the same as 7511CIRX, but with slightly higher incentives.

7512MTV – Market Transformation Value

The T12 MTV initiative targets small- to medium-sized businesses (less than 10,000 square feet or less than 5,000 kWh/month). While larger customers can participate, they are encouraged to participate in an appropriate Custom track. MTV provides upgrades for old, inefficient equipment. The DCSEU staff interview applicants to determine incentive levels needed to move viable projects forward.

DCSEU staff and Certified Business Enterprise (CBE) contractors are responsible for outreach to potential participants. The CBE contractors install eligible equipment, and DCSEU staff inspect 100% of the projects prior to release of the financial incentive.

7513UPLT – Commercial Upstream

The Commercial Upstream/Midstream Lighting Program provides customers with point-of-purchase rebates when they buy qualified lighting products from participating distributors. Through this program, customers can receive rebates for ENERGY STAR 2.0 certified LED directional, omnidirectional, and decorative bulbs, as well as DLC certified linear LED tubes. This program format enables closer and more efficient tracking of product purchases. Distributors provide sales information directly to DCSEU, enabling higher levels of quality control. It also means that incentives can be adjusted more frequently "behind the scenes." In this way, the DCSEU can ensure that incentives more closely match changing conditions in the market. The DCSEU piloted this approach in FY2017 with lighting distributors.

A.2 SOLAR SECTOR

7101PVMR – Solar PV Market Rate

The PV Market Rate program provides incentives to buildings that install solar panels to reduce their consumption from the electric grid. The DCSEU works directly with contractors to identify potential properties. At the start of a project, the contractor submits project information (the Interconnection Application Agreement) to Pepco and the DCSEU. Pepco reviews the form and checks for completeness, determines circuit impact and operating conditions, and requests amendments to the contractor, as needed. Upon Pepco approval of this form, Pepco sends an "Approval to Install" notification to the contractor. Concurrently, the DCSEU checks the income qualification materials, scope of work, spec sheets, and other materials, and generates a work order. With Pepco's approval and a work order from DCSEU in hand, the contractor can begin installation. Once the project is completed, the DCSEU schedules an inspection with the contractor. As of FY2015, proof of interconnection from Pepco is required for DCSEU to issue payment to the contractor.

The program contributes to electricity and natural gas savings, installed renewable energy capacity, the formation of green jobs, and low-income spending and savings. It also helps meet the DCSEU performance benchmark and address the needs of the solar market by serving as a low or no cost technical assistance center for solar installations.

A.3 LOW-INCOME SECTOR

4335IGEF - Income Qualified Gas Efficiency Fund

Washington Gas is partnering with the DCSEU to provide funding for natural gas efficiency upgrades for low- and limited-income residents of affordable multifamily housing in the District of Columbia. These projects consist of natural gas saving measures on old, inefficient equipment that can now be replaced with this available funding. These projects are classified as retrofits.

7610ICDI - Implementation Contractor Direct Install

The Low Income Multi Family (LIMF) Implementation Contractor Direct Install (ICDI) initiative provides specific services and products to LIMF community residents of the District of Columbia. The initiative is promoted to property owners, property managers, developers, architects, and engineers and is designed to serve a wide variety of energy efficiency needs. The ICDI initiative, initially launched as the Property Manager Direct Install (PMDI) initiative in April of 2012, covers 100 percent of the costs (products and direct installation) and hires implementation contractors to perform the direct installation rather than having the property managers install the equipment.

7612LICP - Low-income Multifamily Comprehensive

The Low-income Multifamily Comprehensive program is designed to support low-income multifamily housing, specifically new construction or gut-rehab, in the installation of energy-efficient measures, and allows DCSEU to provide technical expertise and funding. Each project is independently evaluated, and specific energy conservation measures (ECM) are chosen depending on the project's needs. Some of these ECMs will include measures affecting the

thermal envelope (air and thermal barriers, doors, and windows), domestic hot water systems, in-unit and common area lighting, appliances, and controls.

The initiatives work with developers and owners of low-income multifamily projects constructing, redeveloping, or rehabilitating affordable housing projects. The initiatives provide custom technical services and incentives for energy-efficiency improvements to low-income multifamily projects.

7610IQEF - Income Qualified Efficiency Fund

The Income Qualified Efficiency Fund program is designed to serve low-income multifamily housing, shelters, and approved clinics. Funding and priority are competitively awarded to approved contractors for energy-efficiency projects that generate significant energy savings and pass the associated financial benefits on to low-income DC residents. Efficiency measures that maximize energy savings, reach a large number of low-to-moderate income residents, and/or assist residents who face a loss of heating or air conditioning due to inoperable equipment receive priority. Supported measures include domestic hot water systems, lighting, appliances, controls, and measures improving the thermal envelope.

7613LIRX - Low-income Prescriptive Rebate

The Low-income Prescriptive Rebate program provides financial support for lighting installations in low-income multifamily housing and low-income shelters and clinics. Approved installations must be EnergyStar or DLC qualified. Projects tracked under 7613 LI RX are generally focused on specific end uses. 7613LIRX is focused on in-unit and common area lighting. The initiatives work with developers and owners of low-income multifamily projects who are constructing, redeveloping, or rehabilitating affordable housing projects. The initiatives provide custom technical services and incentives for energy-efficiency improvements to low-income multifamily projects.

7415LIDP - Low Income Decarbonization Pilot

In FY 2020, the DCSEU operator received funding from the District Department of Energy & Environment (DOEE) to implement the Low Income Decarbonization Pilot (LIDP) program. The goal of the LIDP was to obtain data on the total costs, benefits, challenges, resident impact, and cost effectiveness of beneficial electrification (BE) and other forms of decarbonization from installing BE measures in income-qualified homes. The DCSEU Pilot Team also sought to derive best practices – from the pilot and from its own substantial experience in delivering services to the low-income residential market – to guide building owners and other interested stakeholders considering beneficial electrification. The Pilot Team also expected the results to help the DCSEU examine consumer pros and cons from switching to BE from fossil fuel sources for heating, ventilation, and air conditioning (HVAC) equipment and appliances.

The pilot's primary purpose was to replace fossil fuel measures with high efficiency electric equipment and appliances. A secondary purpose was to ensure the participating homes became more functional, comfortable, and safe for their occupants. Participants could be either owners or renters of single-family dwellings (detached houses or rowhouses), or renters in low-rise multifamily buildings with four or fewer units.

7717FBNK - Retail Lighting Food Bank

The Food Bank Energy Efficient Lighting Distribution initiative provides LED lighting to low-income households in DC that receive goods from participating food banks. The DCSEU provides LEDs to these residents after verifying that their household is located in the District and conducting a short survey with the client to determine the appropriate number of bulbs needed.

7717HEKT - Home Energy Conservation Kit – Low-income

The Home Energy Conservation Kit – Low-income program sends energy conservation kits to low-income District residents. The only measures in this track are home energy conservation kits, which include an Advanced Power Strip, a Faucet Aerator, and six LEDs. They offer low-income DC residents a free, easy way to implement energy saving measures.

A.4 RESIDENTIAL SECTOR

7710APPL - Retail Efficient Appliances

The Retail Efficient Appliances program offers mail-in and online rebates for qualifying refrigerators, clothes washers, clothes dryers, heat pumps, air conditioners, boilers, furnaces, thermostats, and other products. Under this initiative, DCSEU partners with local retailers and contractors to promote these rebates, providing rebate forms in retail stores when possible.

7710LITE - Retail Lighting

The Retail Efficient Lighting program coordinates with lighting retailers and manufacturers to increase the availability of LEDs and offer them at lower prices for District residents and small businesses. This initiative works to educate customers on the benefit of LED lights and increase awareness as LEDs are less familiar to residents than CFLs or incandescent bulbs. Retailers and manufacturers are provided incentives on a per-bulb basis. The initiative is implemented by DCSEU with EFI providing support for incentive payment and data tracking. EFI is responsible for compiling and verifying manufacturer invoices and processing payments. Manufacturers submit invoices to EFI for payment and work with stores to gather sales reports that they submit along with the invoice requests.

7710HTCL - Retail Heating and Cooling

The Retail Heating and Cooling program works with contractors in the District to install heating and cooling equipment in residential applications. Measures include advanced and programmable thermostats (not smart thermostats), central air conditioners, domestic hot water heaters, boilers, furnaces, and ductless and air-source heat pumps. The only measure that does not require a contractor to install is a smart thermostat. Smart thermostats have their install verification through a confirmation with the manufacturer that the thermostat is connected to the internet and actively working.

7710STAT - Nest Seasonal Savings

Residents who install Nest thermostats can enroll in the Nest Thermostat Seasonal Savings program to garner additional energy savings.

7725RSUP – Residential Upstream

The Residential Upstream program is used to track residential, efficient lighting projects purchased through electrical distributors. Participating electrical distributors buy down the price of the lighting products and offer a point-of-sale rebate to their customers. After sale, they submit documentation to the DCSEU for reimbursement on the products.

A.5 SOLAR FOR ALL

7109LISF - Solar for All Low-income Single-family PV

Solar for All aims to provide low-income DC residents with the benefits of solar electricity. The program was established by the Renewable Portfolio Standard (RPS) act of 2016, which is funded by the Renewable Energy Development Fund (REDF). Upon enrolling in the Solar for All program, an installed system will offset the homeowner's electricity costs by about $500 per year or more. Renters who meet income requirements are eligible for the program if they agree to the terms and conditions. Once a homeowner is qualified, the system is installed at no cost and is fully funded by the DCSEU through the Solar for All program. The Solar for All program operates on a first-come, first-served basis and fulfillment is dependent upon funding availability.

7108CREF - Solar for All Community Renewable PV

In addition to installing solar directly on income-qualified single-family homes, the DCSEU is also working with solar developers to install large community renewable energy facilities (CREFs), or community solar, on structures around the District as part of the Solar for All program. Once installed and operational, these systems can provide electricity bill credits to save income-qualified District residents up to 50% off their electricity bill each year. This allows residents who live in multifamily buildings or whose roofs are not suitable for solar to access savings from Solar for All.

Appendix B Additional Survey Findings

B.1 Residential Programs Survey – Demographics

Nearly all residential survey respondents reported owning their own home: 93% of Retail Efficient Appliance program participants and 96% of Retail Heating and Cooling participants. Nearly one-half of Retail Efficient Appliances program participants (47%) and Retail Heating and Cooling program participants (46%) live in a single-family attached home. Overall, program participants are more likely to live in a single-family home (attached or detached) than the average DC resident (Table 189). This participation pattern is mostly driven by homeownership, as homeowners, rather than renters, are more likely to purchase HVAC equipment and appliances for their homes.

Table 189: Home Type of Residential Program Participants

Type of Home	Census Estimates[1]	Percent of Respondents[2]	
		Retail Efficient Appliances (n=70)	Retail Heating and Cooling (n=72)
Single-family attached	24%	47%	46%
Single-family detached	12%	26%	19%
Apartment/condo with 2-4 units	10%	--	14%
Apartment/condo with 5-9 units	7%	9%	1%
Apartment/condo with 10 to 19 units	10%	3%	4%
Apartment/condo with 20+ units	37%	14%	15%
Other	--	1%	--

[1] ACS 2019 five-year estimates (Census data).
[2] Percentages do not sum to 100% due to rounding.

Table 190 shows the year that the residential program participants' homes were built. Participants reported having older homes than the average DC home; 50% of Retail Efficient Appliances program participants and 56% of Retail Heating and Cooling participants have homes built before 1940, compared to 35% of DC residents.

Table 190: Year Home Built of Residential Program Participants

Year Home Built	Census Estimates[1]	Percent of Respondents[2]	
		Retail Efficient Appliances (n=70)	Retail Heating and Cooling (n=72)
2010 or later	7%	--	3%
2000 to 2009	8%	7%	13%
1990 to 1999	3%	1%	1%
1980 to 1989	4%	7%	1%
1970 to 1979	7%	6%	3%
1960 to 1969	11%	1%	4%
1950 to 1959	13%	9%	1%
1940 to 1949	12%	10%	7%
Before 1940	35%	50%	56%
Don't know/Refused	--	9%	--

[1] ACS 2019 five-year estimates (Census data).
[2] Percentages do not sum to 100% due to rounding.

Table 191 shows the size of the residential program participants' homes in square feet. Most of the respondents (69% of Retail Efficient Appliances program participants and 72% of Retail Heating and Cooling participants) reported that their homes were 2,000 square feet or less.

Table 191: Square Footage of Residential Program Participants' Homes

Square Footage	Percent of Respondents[1]	
	Retail Efficient Appliances (n=70)[1]	Retail Heating and Cooling (n=72)
Less than 500 square feet	3%	3%
500 to 1,000 square feet	13%	17%
1,001 to 1,500 square feet	20%	26%
1,501 to 2,000 square feet	33%	26%
2,001 to 2,500 square feet	14%	10%
2,501 to 3,000 square feet	3%	3%
More than 3,000 square feet	9%	13%
Don't know/Refused	6%	3%

[1] Percentages do not sum to 100% due to rounding.

As shown in Table 192, the majority of participants in the Retail Efficient Appliances and the Retail Heating and Cooling program reported having a graduate or professional degree (74% and 65%, respectively) or a Bachelors' degree (16% and 33%, respectively). The share of participants with a graduate or professional degree is substantially greater than the DC population as a whole.

Table 192: Educational Attainment of Residential Program Participants

Highest Level of Education Completed	Census Estimates[1]	Percent of Respondents	
		Retail Efficient Appliances (n=70)	Retail Heating and Cooling (n=72)[1]
Graduate or professional degree	34%	74%	65%
Bachelors' degree	26%	16%	33%
Some college, no degree	16%	4%	1%
Refused	--	6%	--

[1] ACS 2019 one-year estimates (Census data); 8% of DC residents have no degree.
[2] Percentages do not sum to 100% due to rounding.

Most respondents (98%) reported having a household income greater than the LIHEAP-eligibility threshold for a household of their size, while 2% of respondents reported a household income less than the threshold.[33] Nearly two-thirds of Retail Efficient Appliance program participants (63%) and 68% of Retail Heating and Cooling program participants identified as white. Sixteen percent and 10% of Retail Efficient Appliance program participants identified as Black or African American and Asian, respectively. One-tenth of Retail Efficient Appliance and Retail Heating and Cooling program participants (10%) identified Asian (Table 193). When compared to Census estimates of the population in Washington, DC, white residents are overrepresented as program participants.

Table 193: Race of Residential Program Participants

Race of Respondent	Census Estimates[1,2]	Percent of Respondents	
		Retail Efficient Appliances (n=70)	Retail Heating and Cooling (n=72)
White	46%	63%	68%
Black or African American	46%	16%	11%
Asian	5%	10%	10%
Biracial or multiracial	3%	1%	1%
Other	1%	--	3%
Refused	--	10%	7%

[1] Percentages do not sum to 100% due to rounding.
[2] ACS 2019 one-year estimates (Census data).

Nine percent of Retail Efficient Appliances program participants and 6% of Retail Heating and Cooling program participants identified as Hispanic or Latino. While respondents most commonly reported that English was the primary language spoken in their home (93% of Retail

[33] https://doee.dc.gov/liheap

Efficient Appliance respondents and 94% of Retail Heating and Cooling respondents), other respondents reported primarily speaking Spanish (2%), Mandarin (1%), Cantonese (1%), Vietnamese (1%), Serbian (1%), or Italian (1%) at home.

B.2 COMMERCIAL PROGRAMS SURVEY

B.2.1 Respondent Roles

Table 194 shows the people involved in the decision to participate in the DCSEU program. Senior leadership, facilities mangers, property managers, and technical specialists (architects, engineers, designers, and electricians) were the most common people involved in the organization's decision to participate in the program.

Table 194: People Involved in Decision to Participate in the Program

	Percent of Respondents (n=69)	
Decision-Maker	Ultimate Decision Maker	Involved in Decision[1]
Senior leader/manager	28%	62%
Facilities or Property Manager	25%	52%
Architect/Engineer/Designer/Electrician	19%	42%
Owner	9%	19%
Energy manager	7%	16%
Board of Directors	6%	12%
President/CEO/Executive Director	3%	10%
CFO/Accounting	1%	4%
Contractor/Distributor/Vendor	1%	17%
Staff members or committee	1%	3%

[1] Does not sum to 100%; multiple responses accepted. "Involved in Decision" column includes the ultimate decision-maker.

B.2.2 Engagement with DCSEU

Nearly one-third of respondents described their business organization as being "fully engaged" (30%) with DCSEU, while another 36% said that they were "engaged with DCSEU but could probably do more" (Table 195). In addition, approximately two-thirds of C&I program respondents (65%) indicated that their organization had plans for energy-efficient or renewable energy improvements in the next two years. All of these respondents (100%) said they would consider involving DCSEU in their future plans.

Table 195: Participant Engagement with DCSEU

Engagement Level	Percent of Respondents (n=69)[1]
Fully engaged with DCSEU	30%
Engaged with DCSEU but could probably do more	36%
Rarely engaged with DCSEU because we have little need	28%
Rarely engaged with DCSEU because ROI is too low	1%
Don't know	4%

[1] Does not sum to 100% due to rounding.

When asked how DCSEU could assist respondents in meeting their organizations' future energy needs, respondents most often requested that DSCEU inform them when programs or rebates change (22%) and provide information on all rebate opportunities (19%). Table 196 shows all responses provided by commercial program participants overall and by their level of engagement with DCSEU. Some respondents encouraged DCSEU to continue on the same track, such as continuing to offer rebates (17%) and programs (9%); one respondent praised DCSEU's open sharing of information. Other suggestions included requests for DCSEU to conduct an energy audit (10%), providing additional technical support (9%), and increasing outreach to customers about the program offerings (9%). Outreach suggestions included training classes, increased advertisements and promotional emails, and having DCSEU staff follow-up with program participants to discuss additional opportunities.

The most common request among all participants, regardless of engagement with DCSEU, was for more information on available rebates and any changes to the program offerings. Participants who reported they rarely engage with DCSEU or were unsure of their business relationship with DCSEU were, not surprisingly, more likely than more engaged participants to say they did not need anything from DCSEU (48% compared to 12 to 14%). These participants may be less aware of DCSEU's program offerings and may not be aware of additional opportunities for engagement.

Table 196: Ways DCSEU Can Meet Future Energy Needs by Customer Engagement Level[1]

DCSEU action	Overall (n=69)	Engagement with DCSEU: Fully engaged (n=21)	Could do more (n=25)	Rarely engages/don't know (n=23)
Inform us when programs or rebates change	**22%**	14%	28%	22%
Provide information on all rebates	**19%**	5%	28%	22%
Continue offering rebates	**17%**	14%	28%	9%
Increase rebate amounts	**10%**	14%	12%	4%
Visit facility for an energy audit	**10%**	10%	12%	9%
Continue offering programs	**9%**	10%	12%	4%
Provide additional technical support	**9%**	10%	16%	--
Increase outreach about available programs	**9%**	5%	8%	12%
Educate contractors about programs	**3%**	--	4%	4%
Streamline application process	**1%**	--	--	4%
Speed up rebate payment	**1%**	--	--	4%
Other[34]	**13%**	19%	16%	4%
Do not have any needs	**25%**	14%	12%	48%
Don't know	**16%**	14%	16%	17%

[1] Does not sum to 100%; multiple responses accepted.

Four-fifths of all respondents (80%) reported that they had heard of the Building Energy Performance Standards enacted by the District.[35] Of those respondents aware of the Building Performance Standards, nearly two-thirds considered themselves either "very familiar" (47%) or "mostly familiar" (15%) with the standards.

B.2.3 Impact of COVID-19

The NMR team asked respondents to describe how their organization and its operations had been impacted by the COVID-19 crisis. Some respondents focused on the pandemic's impact on their energy use, while others gave broader responses about the overall effect on their business operations. Most of the respondents (88%) provided a response, as shown in Table 197.[36] Nearly all of these respondents reported that their business or organization had been negatively impacted – some gravely – by a reduction in business traffic, tourism, and/or the number of students on campus. Nearly one-third of respondents (30%) reported experiencing a reduction in revenue or financial hardship or a reduction in building occupancy (28%), which more than likely resulted in a loss of revenue. One respondent reported that their building was

[34] Other responses included suggestions to simplify program materials for a non-technical audience, engage with new construction projects to install energy-efficient equipment up front and avoid the need for retrofits, offer more rebates for commercial HVAC applications, offer more pay for performance programs, make programs easier to navigate, provide more information on rebates for air handlers, and provide more guidance for customers about the intersection between program requirements and current legislation.
[35] https://doee.dc.gov/service/building-energy-performance-standards-beps
[36] The other respondents said they were not sure or opted not to respond to the question.

currently at 20% occupancy, compared to 100% before the pandemic. Approximately one in ten respondents (11%) reported that their business had shut down altogether at least once in the past two years.

Approximately one-third of respondents (30%) reported increased costs for energy consumption and/or mitigation expenses, such as personal protective equipment (PPE), additional sanitation or janitorial services, and upgraded air cleaning/HVAC equipment. Some respondents (16%) reported layoffs, a reduction in services due to decreased staff, hiring challenges, and/or disruptions to employee work schedules to accommodate social distancing or remote work. One participant reported that their organization invested in new office equipment to enable a successful transition to a hybrid work environment. Businesses that could not operate remotely (e.g., health care facilities and other essential service providers) noted challenges in keeping staff and clients safe while continuing to fulfill their organization's mission.

Respondents also had difficulties running their businesses in light of supply chain challenges and the cost of inflation (11%). While some respondents described reduced utility bills due to diminished occupancy (5%), managers of residential properties noted that utility bills had increased because their tenants were home more often. One manager of a residential facility reported that the pandemic had changed their business strategy, noting that their organization was planning for larger residential units to accommodate home offices, more outdoor recreational facilities and increased outdoor programming at their properties. Only one respondent reported that they were not affected by the crisis.

Table 197: Impact of COVID-19 on Participants' Organization

Impact of COVID-19	Percent of Respondents (n=61)[1]
Increased costs	30%
Reduced revenue/financial hardship	30%
Reduction in building occupancy	28%
Staffing challenges	16%
Business closures/reduction in services	11%
Supply chain issues/increased inflation	11%
Reduction in energy use	5%

[1] Does not sum to 100%; multiple responses allowed.

B.2.4 Commercial Program – Firmographics

Nearly three-quarters of the respondents (74%) said their organizations owned their space (Table 198).

Table 198: Organizational Tenure at Facility Participating in C&I Program

Facility Tenure	Percent of Respondents (n=69)
Own	74%
Manage	12%
Lease	7%
Don't know/Refused	7%

Nearly one-third of respondents (32%) described their organization as a non-profit, and half of all respondents described their organization as a for-profit business serving either the commercial sector (26%) or both commercial and residential sectors (25%). Table 199 describes the organization types represented in the survey.

Table 199: Type of Organization

Organization Type	Percent of Respondents (n=69)[1]
Non-profit organization	32%
For-profit business – commercial sector	26%
For-profit business – commercial/residential sector	25%
For-profit business – residential sector	7%
Federal government institution	3%
For-profit business – government sector	1%
Condo association	1%
District institution	3%
Don't know/Refused	1%

[1] Does not sum to 100% due to rounding.

The most common types of business activities conducted at the facilities that implemented a project through the DCSEU were housing or lodging (32%) and office or professional (30%). Table 200 describes the primary business activities across the facilities represented in the survey.

Table 200: Primary Business Activity at Participating Facility

Primary Business Activity	Percent of Respondents (n=69)[1]
Housing/Lodging	32%
Office/Professional	30%
Health care	4%
Education	9%
Religious worship	4%
Municipal government	7%
Food sales or service	4%
Retail	4%
Transportation	3%
Other	1%
Don't know/Refused	4%

[1] Does not sum to 100% because some respondents reported having mixed-use facilities.

Over one-third of respondents (38%) reported that less than ten employees worked at the location where the organization implemented a project through the DCSEU. Table 201 describes the number of employees at locations represented in the survey.

Table 201: Number of Employees at Facility

Number of Employees	Percent of Respondents (n=69)[1]
Less than 10	38%
11 to 20	12%
21 to 50	6%
51 to 100	9%
101 to 250	13%
251 to 500	7%
501 to 1,000	3%
1,001 to 2,000	3%
2,001 to 3,000	--
More than 3,000	6%
Don't know/Refused	4%

[1] Does not sum to 100% due to rounding.

Square footage of facilities differed widely across organizations represented by the survey; over half of respondents (53%) indicated that their facilities were large, ranging from approximately 100,000 square feet to over one million square feet (Table 202).

Table 202: Size of Facility in Square Feet

Square Footage	Percent of Respondents (n=69)[1]
Less than 1,000	1%
1,000 to 1,999	1%
2,000 to 2,999	1%
3,000 to 4,999	--
5,000 to 9,999	1%
10,000 to 14,999	3%
15,000 to 24,999	6%
25,000 to 49,999	10%
50,000 to 99,999	9%
100,000 to 199,999	17%
200,000 to 499,999	22%
500,000 to 749,000	3%
750,000 to less than 1 million	4%
More than 1 million	7%
Don't know/Refused	13%

[1] Does not sum to 100% due to rounding.

Appendix C Solar For All Evaluations

In this section, we describe the methodology and results of the evaluation of the Solar for All Low-Income Single-Family (LISF) program and Solar for All Community Renewables program.

C.1 Low-Income Single-Family

The LISF initiative is a Solar for All program that strives to deliver sustainable energy services to low-income, single-family homes within the District of Columbia. This program aims to provide 100 low-income single-family homes with the benefits of solar technology each year. Participating developers agree to design projects that will lower household electricity costs by 50% or more with at least a 15-year commitment.

The LISF program, as part of DCSEU's Solar for All Program, allows low-income residents access to the energy and money saving benefits of solar energy. Participants receive a credit back on their monthly electricity bill. Participating households must provide proof of income to be eligible for these benefits.

In FY2021, the LISF program provided incentives for 122 projects and claimed 0.51 MW of generation capacity. We completed the following evaluation activity:

- Gross Savings Verification

C.1.1 Gross Savings Verification

Table 203 shows the tracked savings, realization rate, and evaluated savings for the LISF program. No gas savings were claimed for this program as it is entirely composed of solar panel installations, and no interactive effects are present. The electric savings program-level realization rate is 124%, while the capacity realization rate is 103%.

Table 203: LISF Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	668	124%	825
FY2021 Max. Generation Capacity (MW)	0.51	103%	0.52

C.1.1.1 Sampling

Due to the homogeneous makeup of the program, we randomly selected two LISF projects from each of the four participating contractors. Table 204 displays the participating contractors, their FY2021 participation, and the number of sampled projects.

Table 204: LISF Sampling Plan

Contractor	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Projects
Greenscape Environmental Services, Inc.	34%	39	2

Contractor	Percent of Program Energy Savings	FY2021 Participation	Number of Sampled Projects
WDC Solar, Inc.	31%	34	2
Solar Solution LLC	29%	41	2
Ipsun Solar	6%	8	2

C.1.1.2 Methodology

The NMR team conducted desk reviews for the eight sampled projects. We gathered key values from project documents, such as invoices, project plan drawings, equipment spec sheets, and post-installation inspection forms. The NMR team used these inputs to calculate evaluated energy savings.

We used the NREL PV Watts Calculator[37] to calculate the energy savings. The PV Watts tool relies on several key inputs, including the following:

1. **Site Address** – The location (address or latitude/longitude) of the solar PV installation
2. **DC System Size** – The direct current (DC) power output of the system
3. **Module Type** – The type of solar panels (standard, premium, or thin film)
4. **Array Type** – Fixed, one-axis tracking, or two-axis tracking
5. **System Losses** – Estimate of real-world system losses
6. **Tilt** – Angle at which the panels are installed
7. **Azimuth** – Direction panels face away from true north
8. **DC to AC Size Ratio** – Ratio of the inverter's AC rated size to the array's DC rated size
9. **Inverter Efficiency** – DC to AC conversion efficiency
10. **Ground Coverage Ratio** – Ratio of module surface area to the area of the ground or roof occupied by the array

PV Watts uses these inputs to orient the site and calculate the electricity generation. The NMR team used the PV Watts hourly data to calculate the energy savings.

We gathered variables, such as DC and AC system size, module type, array type, tilt, azimuth, and inverter efficiency from the project documentation. When we could not find a project-specific input, we used the NREL PV Watts default value.

The evaluation team has leveraged the PV Watts solar calculation for evaluations in other jurisdictions and vetted its accuracy and reliability. The tool projects estimated energy production relative to TMY3 data, providing a weather-normalized generation estimate.

C.1.1.3 Results

The program-wide impact evaluation results are shown in Table 205. The program-level realization rates are 124% for electric savings and 103% for capacity. Realization rates are greater than 100% because the NMR team calculated savings using the PV Watts Calculator with site-specific inputs. In contrast, we understand that tracked savings values were determined using the Small Scale Residential Solar PV System TRM characterization. The TRM

[37] https://pvwatts.nrel.gov/

lists deemed electricity savings for solar installations in capacity increments of 500 watts and dictates that systems be mapped to the closest, smaller system size. Therefore, calculating savings based on the actual system size resulted in greater energy savings and generation capacity.

Table 205: LISF Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	668	124%	825	±6.1% @ 80%
FY2021 Max. Generation Capacity (MW)	0.51	103%	0.52	±4.5% @ 80%

C.2 COMMUNITY RENEWABLES

The CREF initiative is a Solar for All program that strives to deliver sustainable energy services to residential, commercial, and industrial institutions. Community solar provides the benefits of solar technology to residents who traditionally would not be able to take advantage of solar power, such as renters, residents in multifamily buildings, or those with rooftops that need repairs.

CREF installations are community solar projects that provide direct benefits to residents through virtual net metering. Individuals or entities that subscribe to a CREF PV system receive credits on their electricity bill for their portion of the electricity the PV system generates. PV installations are not located on individual residences; they are located offsite and can be sited on multifamily buildings, universities, commercial buildings and elsewhere. CREF site hosts may also receive benefits for hosting the community solar installation, such as lease payments and/or a new roof. Solar developers who act as contractors for the program submit applications for CREF solar installations through a competitive Request for Proposal (RFP) process each fiscal year.

For the FY2021 CREF program, we completed the following evaluation activities:

- Gross Savings Verification
- Influence Assessment
- Process Evaluation

C.2.1 Gross Savings Verification

Table 206 shows the tracked savings, realization rate, and evaluated savings for the CREF program. No gas savings are claimed for this program as it is entirely comprised of solar panel installations, and no interactive effects are present. The electric savings program-level realization rate was found to equal 101%, while the capacity realization rate equals 99%.

Table 206: CREF Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2021 Electric Savings (MWh)	7,683	101%	7,777
FY2021 Max. Generation Capacity (MW)	5.00	99%	4.95

C.2.1.1 Sampling

Due to the heterogeneous makeup of the program, the CREF program sample design employed stratified random sampling. We allocated the number of sample points across three substrata (certainty, large probability, and small probability projects) based on each substratum's contribution to the program savings. The certainty strata cut off was set at 800 MWh. All projects above that threshold were included in the sample. The NMR team placed projects that had total energy savings between 200 and 800 MWh in the large probability stratum, while we placed projects below 200 MWh in the small probability stratum. The NMR team randomly selected projects from within each of the two probability strata.

Table 207: CREF Sampling Plan

Stratum	Percent of Database Energy Savings	FY2021 Participation	FY2021 Participation	Number of Sampled Sites
Certainty	28%	2	3	3
Large Probability	30%	6	6	3
Small Probability	42%	12	23	3

C.2.1.2 Methodology

The NMR team conducted desk reviews for the nine sampled projects, through which we calculated the evaluated savings. The NMR team gathered important data values from verified project documents, such as invoices, project plan drawings, equipment spec sheets, and post-installation inspection forms.

The NMR team used the NREL PV Watts Calculator[38] to calculate the energy savings. The PV Watts tool relies on several key inputs including the following:

1. **Site Address –** The location (address or latitude/longitude) of the solar PV installation
2. **DC System Size** – the direct current (DC) power output of the system
3. **Module Type** – the type of solar panels. Either standard, premium, or thin film.
4. **Array Type** – Fixed, one-axis tracking, or two-axis tracking
5. **System Losses** – Estimate of real-world system losses
6. **Tilt** – Roof angle where the panels are installed
7. **Azimuth** – Direction panels face away from true north
8. **DC to AC Size Ratio** – Inverter AC output compared to solar array DC output
9. **Inverter Efficiency** – DC to AC conversion efficiency
10. **Ground Coverage Ratio** – How close together the panels are placed

The NMR team determined variables such as DC system size, module type, array type, tilt, azimuth, and inverter efficiency using the project documentation. When a project-specific input could not be found, the NMR team used the NREL PV Watts default value. PV Watts uses the input data to orient the site and calculate the electricity generation. The NMR team used the PV

[38] https://pvwatts.nrel.gov/

Watts hourly data to calculate the electricity savings. We attempted to visually confirm the installation of each PV system using Google Earth;[39] however, depending on the vintage of Google Earth images, this was not always possible.

C.2.1.3 Results

The program-wide impact evaluation results are shown in Table 208. The findings that contributed to the realization rates are detailed in the text that follows.

Table 208: CREF Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2021 Electric Savings (MWh)	7,683	101%	7,777	80% ± 0.27%
FY2021 Max. Generation Capacity (MW)	5.00	99%	4.95	80% ± 0.24%

The program-level realization rates are 101% for electric savings and 99% for generation capacity. The selected sample ultimately achieved a ±0.27% precision at 80% confidence for electric savings and ±0.24% precision for generation capacity.

NMR used the PV Watts online calculator tool for estimating verified savings. The evaluation team has leveraged the PV Watts solar calculator for evaluations in other jurisdictions and vetted its accuracy and reliability. The tool also projects estimated energy production relative to TMY3 data,[40] providing the DCSEU with a weather normalized generation estimate.

The implementer utilized NREL's System Advisor Model (SAM) tool for determining ex ante savings. The SAM tool seems to have PV Watts built into it, which led NMR to assume that savings results should be the same as what are generated by PV Watts directly; however, NMR could not fully recreate ex ante savings for every project. The discrepancies are likely due to a few inputs: The NMR team found that some of the projects evaluated did not use the correct installation address for the panels in PV Watts (the general city of Washington, DC, versus actual installation address). Updating the address led to a slight increase in energy savings and generation capacity as PV Watts obtains weather data based on the address input by the user. The savings also saw a slight increase due to site specific inverter efficiencies being input in PV Watts software instead of an assumed value of 96% (which is the PV Watts default inverter efficiency). The other main cause of increased verified savings is the module efficiency – ex ante savings calculations tended to use "standard" nominal efficiency (15% to 19%), while the actual efficiencies of the systems involved in the sampled projects tended to be "premium" (>19%).

The electric savings and generation capacity realization rates are most heavily impacted by the two Certainty stratum projects. Despite NMR using all of the same inputs as were used in the ex ante for both projects, savings differed slightly. Realization rates were 101% for kWh and 98% for capacity for project ID 22072, and 102% for kWh and 97% for capacity for project ID 22074.

[39] https://www.google.com/earth/
[40] https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

C.2.2 Influence Assessment and Process Evaluation

C.2.2.1 Key Findings

These were the key findings from the net savings review and process evaluation of the Solar for All Community Renewable Energy Facility (CREF) program:

- Solar developers are critical messengers for the CREF program. According to the five interviewed developers, only two out of fourteen site owners had heard of the CREF program before working with the developer.
- While over half of the 14 sites in these developers' CREF portfolios would have completed a solar installation without the CREF program, nearly all of them would have been unable to direct all, or even some, of the project's electricity to low-income customers.
- According to solar developers, both site hosts and solar developers find the program beneficial. Site hosts receive lease payments and may also receive a new roof, carport, or structure remediation. Solar developers receive program funding and technical assistance from DCSEU throughout the process.
- Some developers appreciate not having to handle subscriber management; however, others expressed frustration that DOEE could not provide the site hosts an estimate of how many of their eligible residents had signed up for Solar for All, an important program benefit for many site hosts.
- The program timeline is tight and not necessarily compatible with the realities of solar development. In some cases, the pressures afforded by the program accelerated the project development timeline. Solar developers appreciated the flexibility and assistance offered by DCSEU program staff; however, some expressed a preference for modified program schedules, such as an earlier RFP release date or a rolling application cycle.
- Some of the developers attributed project delays to Pepco and requested additional assistance from DCSEU and DOEE in navigating the interconnection and inspection process.

C.2.2.2 Influence Assessment

The NMR team targeted interviews with at least four of the six solar developers involved in the FY2021 CREF program (Table 209). We completed five interviews. These five developers worked with fourteen site hosts in FY2021; some site hosts had multiple projects on their property.[41]

[41] The sites were identified using the FY2021 tracking data. After interviews began, the NMR team learned that some of these sites included projects installed primarily in previous fiscal years, as some CREF installations are multi-year projects. However, as the developers gave us insights into those site hosts' motivations and experiences with the program, we included all fourteen of these site hosts in this summary.

Table 209: Community Renewable Energy Facility Program Evaluation Activity

Stakeholder	Completed
Solar developer Interviews	5

According to the five interviewed solar developers, nine of the 14 site hosts would have moved forward with a solar installation without CREF (Table 210). While the developers thought it was likely that all nine of the projects would have proceeded as planned, seven of those nine projects likely happened more quickly due to CREF, due to the pressures of meeting program milestones. According to one developer, the other two projects were hampered by burdensome program requirements and likely progressed more slowly than they would have otherwise.

Table 210: Solar Installation in the Absence of CREF

Indicator	Number of Site Hosts (n=14)
Site would have moved forward with solar without CREF	9
Site would not have moved forward with solar without CREF	5

Low-income residents who may have been eligible to receive Solar for All Community Solar benefits live on site at 11 of the 14 sites (Table 211). The developers considered it likely that the residency of the eligible customers motivated those site hosts to participate in the program. However, even property owners without low-income residents on site were motivated to participate by a desire to give back to the community. Participating in CREF offers site hosts a marketing opportunity as well as a philanthropic outlet.

Table 211: Presence of Low-Income Residents at CREF Sites

Indicator	Number of Site Hosts (n=14)
Residents on-site are eligible to apply for Solar for All credits	11
No low-income residents on site	3

Without funding through the CREF program, the developers estimated that the solar installations at five of the 14 projects would not have moved forward at all (Table 212). Two of the projects that would have moved forward without CREF support likely would have been scaled back and therefore generated less electricity. For some of these sites, the CREF funding enabled remediation projects or new roof installations critical to the solar installation. For sites that would have installed a similar amount of solar without CREF program funding, the developers indicated they would have maximized the system size whether it was a CREF project or a net-metered project. For net-metered projects that do not go through the CREF program, these developers would recommend that clients install the largest system size allowable under local regulations and sell the electricity to market-rate customers.

Table 212: Impact of CREF on Size and Feasibility of Solar Installations

Indicator	Number of Site Hosts (n=14)
Solar would *not* have been installed without CREF	5
The solar installation would have been scaled back without CREF	2
Solar would have been installed at a similar scale without CREF	7

According to developers, the electricity generated at six of the fourteen sites would not have been directed to low-income customers at all without the CREF program – either because the installation would not have been possible without CREF funding, or it would not have been financially feasible to develop the project without selling the electricity to market-rate subscribers. Seven of the 14 sites likely would have directed some of the electricity to low-income customers, but far less than under CREF. One developer indicated the electricity generated at their FY2021 site would have been directed to low-income customers, but it was unclear whether the full amount would have been dedicated. It does not seem likely that a solar installation could donate electricity on the scale enabled by the CREF program and remain financially feasible. As one of the respondents explained, while their business model directs the company to donate 20% of the electricity generated by an installation to low-income customers, they need to sell 80% to market-rate subscribers on a typical project to make it financially feasible.

Table 213: Electricity Directed to Low-Income Customers in Absence of CREF

Indicator	Number of Site Hosts (n=14)
Site would not have directed *any* electricity to LI customers	6
Site would have directed a small portion of electricity to LI customers	7
Site would have directed an unspecified amount of electricity to LI customers	1

In summary, while some solar installations would have likely proceeded had they not received program support, the program was instrumental in directing the electricity generated at these sites to low-income customers. In the absence of the CREF program, we do not believe it would have been feasible for any of these solar projects to supply all of the solar electricity to low-income customers. Moreover, for developers that would have been able to donate a portion of the electricity to low-income customers, the CREF program takes on the administrative burden of subscriber management. In the coming years, as other incentives appear poised to decline and market conditions continue to fluctuate, the CREF program may become more important in the development of new community solar installations.

Based on this qualitative assessment of the influence of the CREF program, the NMR team recommends a NTG ratio of 100%.

C.2.2.3 Process Evaluation

The NMR team asked the five developers about their experience with the program.

(a) Program Benefits for Developers

When asked why they got involved with the Community Renewable Energy Facility program, all five developers considered the program's goal to expand clean energy while benefiting low-income subscribers in alignment with their own mission. Four of the developers cited the financial benefits as one of the primary benefits their company receives through the program. According to the respondents, the upfront payments through the program made many projects possible and can reduce the financial risk of investing in the project. As one developer explained, their company's multi-year experience with the program and having the government as a funding source through the program is an intangible benefit that assists in securing lenders and tax equity partners during the financing process.

Other benefits cited by developers include subscriber recruitment, which can be costly and time intensive (one respondent); program assistance with interconnection and working with Pepco (two respondents); and program staff assistance with projects (two respondents). Specifically, one developer compared their experience with CREF to projects they had completed outside the program and noted that program staff provided a helpful sounding board for working through challenges. Another developer applauded the program for creating jobs for District residents.

One respondent offered the following praise for the program:

> *The program is a win all around. The residents are getting the benefit of 50% off their electricity and the property is getting the benefit of the lease payments or a new roof. The program design allows for projects to proceed that may not otherwise, due to high upfront costs of construction.*

(b) Marketing and Outreach to Site Hosts

Four of the five respondents indicated that their site hosts for FY2021 projects were not aware of the CREF program before planning their solar installation (12 of 14 site hosts). When asked about program awareness in general, two of the respondents whose clients include affordable housing developers indicated that many of those developers are already aware of the CREF program. Another respondent indicated that their clients heard of the program through word of mouth.

The respondents described how they identify potential sites and market the program to their customers. Some of the participating developers focus on certain customer types, such as condominium associations or multifamily affordable housing developers. One respondent credits their company's efforts to network in local real estate and energy communities with building a client base. Two of the developers reported utilizing satellite imagery and public records to identify suitable properties with roof space or open land.

For one developer, it was not necessary to market CREF because their customers, affordable housing developers, were already knowledgeable about the program. Two of the five respondents said they talk about CREF to all of their solar customers and let the customer decide. For properties with low-income residents on site, some property owners were attracted by the prospect of supporting a program that could benefit their eligible residents, while other site hosts saw participating in the program to publicly demonstrate their commitment to community engagement.

According to the developers, all site hosts receive lease payments for the solar energy system. Depending on the project, some site hosts also receive new roofs or carports. One of the respondents posited that sites that required extensive remediation prior to the solar installation may also benefit from improved living conditions in the building. Furthermore, one developer expressed a desire to provide additional energy-saving benefits to the site hosts, perhaps by coordinating with other DCSEU programs, but felt limited by the tight project schedule needed to satisfy program milestone requirements.[42]

(c) Program Administration

All four respondents who brought up program communication indicated that program staff were helpful, responsive, and knowledgeable. As noted previously, several respondents noted that check-ins were productive and helped facilitate successful project implementation. However, one of the five respondents found the overall program administration to be cumbersome.

Most of the developers indicated that they had a good understanding of program processes. However, some respondents identified areas that could use additional clarity:

- **Program coordination with Pepco**. One developer requested additional clarity on efforts taken by DCSEU or DOEE, if any, to advocate for the solar developers during the interconnection and permitting process.
- **The number of eligible residents receiving solar credits.** Site hosts with low-income residents are interested in learning whether their tenants have signed up for Solar for All, but the solar developers are unable to provide this information because DOEE manages the subscription process.
- **The language around Certified Business Enterprises (CBE).** One developer was unclear whether the program requirement that CBEs retain the money was incompatible with their organization's funding mechanisms or if they had misunderstood the guidelines.[43] The developer explained that while they are a CBE, and hire CBE subcontractors, the funds can flow to investors or equipment during the project and the developer is unclear on the applicability of the program guidelines to this scenario.
- **The logic behind the milestone payment structure.** A developer with experience beyond the program questioned why developers working with CREF were subject to multiple deadlines, compared to the experience of developers in the residential program.[44]
- **Communication of program decisions.** One respondent felt that while the program requirements were clear on paper, the DOEE decision-making process was opaque.

[42] Program staff may be reluctant to become involved with the site host in the early stages of the project due to the competitive nature of the CREF selection process.
[43] During the FY2021 RFP process, DCSEU awarded additional points to bidders with CBE status in order to fulfill a goal to distribute 38% of funds to CBEs. https://www.dcseu.com/Media/Default/docs/rfp/FY21/dcseu-sfa-rpf-responses.pdf
[44] While it was not specified by the interviewee, the developer may have been referring to the DCSEU low-income single family (LISF) Solar for All program. https://www.dcseu.com/solar-for-all

Four of the five developers found the program eligibility requirements to be appropriate, though with some caveats. One respondent indicated that the program timing limited the types of projects eligible for the program and a second respondent described the difficulty in obtaining a signed contract with a site host before learning whether the site would be accepted into the program.

One of the developers, who did not plan to continue participating in the program, found the incentives insufficient, given the complexity of the program and the milestone requirements. Another respondent described the competing pressures of the CREF program timeline and other solar incentives; waiting for CREF funding could mean losing out on several months of solar generation or forfeiting tax credits, which could make the project financially unfeasible. Another developer encouraged the program to monitor the incentive amount in response to market conditions, noting that while interconnection is becoming more costly, the value of tax incentives and Solar Renewable Energy Credits (SRECs) may decline in coming years. A third respondent agreed, citing the importance of the program in light of these developments; without the CREF incentive, it would be harder for them to give away a portion of the energy generated by their non-program solar installations for free to residents in affordable housing.

(d) Program Challenges

The five solar developers interviewed identified a number of program challenges and opportunities for improvement:

- **The program timeline is incompatible with the realities of the solar development industry.** Two respondents suggested a year-round, rolling application cycle to more easily accommodate projects that fit the eligibility criteria. One respondent recognized that such a change would not drive new solar installations but would direct more energy to low-income residents in the District.[45] The other respondent observed that it was difficult to retain employees due to downtime caused by the cyclical nature of the program funding cycle.
- **The scale of the CREF program provides DCSEU and DOEE leverage in negotiations with Pepco, but there is considerable room for improvement.** Two respondents noted that DCSEU and DOEE are able to get Pepco's attention on behalf of the solar developers; with solar electricity being generated at a large scale, the program has "purchasing power" that individual developers as private firms cannot accomplish. According to the respondents, the program's efforts in this area have been generally helpful. However, Pepco's actions and inconsistent information cause delays and increase expenses for the solar developers, and another respondent wondered if DCSEU and DOEE were doing everything possible to provide assistance. The respondent suggested DC impose financial penalties on Pepco for failing to meet its contractual obligations to the CREF developers and the low-income Solar for All recipients of CREF solar generation. The DC Office of the Attorney General and the

[45] Program staff indicated that program guidelines have changed since the inception of the program to allow existing solar projects to participate in the CREF program.

Office of the People's Council filed a complaint against Pepco.[46] The company has received negative media attention recently in light of complaints from developers, consumers, and the DOEE that Pepco is undercounting solar generation from community solar projects and failing to provide timely credits to subscribers.[47]

- **The milestone payment structure is untenable for some developers.** One respondent objected to having to acquire the equipment and pay for it in full before receiving the associated milestone payment because such a funding mechanism does not provide assistance to companies in need of funding. This respondent also suggested that program incentives should be tied to the amount of solar installed, rather than the performance of the system, as project delays or weather conditions are outside of their control.

The team asked developers to discuss any challenges resulting from the COVID-19 pandemic. Four of the five developers cited COVID-related supply chain disruptions as a significant issue that contributed to project delays and increased costs. As one respondent noted, most of the equipment is project-specific and they order what they need for the project and are unable to keep extra in stock. This respondent suggested lengthening the project timeline to help absorb any delays.

Another respondent noted the government shutdowns and periods of remote work caused disruptions across the industry, while another said they felt very little impact as they were considered essential workers in the construction industry.

One respondent indicated that it was particularly burdensome to take photos of their own sites to verify installation, suggesting that relying on information from online portals would have verified that the panels were installed and functioning. However, the developer recognized that was likely a unique situation in response to COVID-19 protocols and did not expect to have to do so again after program inspections resumed.

(e) Overall Program Experience

Most of the respondents were enthusiastic about the program and were invested in the mission. Two of the developers predicted that their participation would increase in future program cycles and two other respondents predicted they would participate at roughly the same level as in FY2021. The fifth respondent indicated that their company planned to discontinue participation in the program.

One of the respondents considers the program to be a model for community solar:

> *When we work in other regions, we point to the DC CREF program as a really strong program. It is one of the best programs in the country providing solar to low- and*

[46] In March 2022, the DC Attorney General filed a complaint against Pepco alleging that the utility has systematically mishandled community solar projects. https://oag.dc.gov/release/ag-racine-takes-enforcement-action-against-pepco
[47] Fenston, Jacob. March 24, 2022. "Pepco 'systematically mishandling' solar projects, says D.C. attorney general." NPR WAMU 88.5. https://www.npr.org/local/305/2022/03/24/1088512106/pepco-systematically-mishandling-solar-projects-says-d-c-attorney-general. Accessed May 9, 2022.

moderate-income customers. It solves a lot of challenges of community solar and provides the most benefits to participants.

C.2.3 Recommendations

Based on the findings of our analysis, we offer the following recommendations:

- Provide the output summary from SAM or PV Watts that shows all input values used for calculating ex ante savings.
- Continue using site-specific values for system loss percentage and DC-to-AC ratio. This results in more accurate savings estimates for the ex ante scenario.
- Providing electricity that benefits their eligible low-income residents is an important program feature for many site hosts. If possible, DOEE should provide estimates of subscribed residents for each CREF site to quantify this benefit for interested developers and property owners.
- Consider upcoming changes in the solar market and the declining value of SRECs when setting program incentives for subsequent years.
- Streamline the interconnection process with Pepco and provide additional assistance to developers in navigating the relationship between Pepco and the CREF program, such as by advocating for the developers during the interconnection and permitting process whenever possible.
- Consider methods of easing the program timeline for participating developers, such as releasing the RFP earlier and/or accepting applications throughout the program year.