Evaluation of DC Sustainable Energy Utility FY2020 Programs

FINAL

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SUBMITTED TO:
District of Columbia Department of Energy and Environment

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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 2020 (FY2020) programs.

In FY2020, the commercial sector represented 85% of tracked electric and gas savings across the DCSEU portfolio. This was largely driven by three custom programs, in particular the Retrofit Custom program (Table 1).

EVALUATION METHODOLOGY

For the FY2020 evaluation, we completed the following activities:

Gross Savings Verification	Process Evaluation and Net Savings Estimation
• Tracking database review • Desk reviews • Virtual on-site visits • Billing analysis	• Surveys with participating customers

We targeted a subset of 14 programs for evaluation: seven commercial programs, three multifamily programs, three residential programs, and one solar program (Table 1). The NMR team selected the programs for the FY2020 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 FY2020.

Table 1: FY2020 Program Evaluation Summary

Sector	Program Name	Track Number	Percent of FY2020 Tracked Gross Electric & Gas Savings	FY2020 Evaluation	
				Gross Savings Verification	NTG Estimation & Process Evaluation
Solar	Solar PV Market Rate	7101PVMR	1.1%	✓	✓
	Low-income Solar Renewable Credit	7107SREC	0.0%		
	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	6.9%	✓	✓
	Small & Medium Business Rebates	7511SMRX	0.0%		
	Market Transformation Value	7512MTV	0.3%		✓
	Commercial Upstream - Lighting	7513UPLT	9.7%	✓	✓
	Retrofit - Commercial Custom	7520CUST	49.0%	✓	✓
	Market Opportunity - Commercial Custom	7520MARO	4.9%	✓	✓
	New Construction - Commercial Custom	7520NEWC	9.4%	✓	✓
	Pay for Performance	7520P4PX	4.5%	✓	✓
Low-income	Income Qualified Gas Efficiency Fund	4335IGEF	0.5%		
	Low-income Decarbonization Pilot	7415LIDP	0.0%		
	Income Qualified Efficiency Fund	7610IQEF	1.1%	✓	
	Low-income Multifamily Comprehensive	7612LICP	3.3%	✓	
	Low-income Prescriptive Rebate	7613LIRX	0.6%	✓	
	Retail Lighting Food Bank	7717FBNK	0.3%		
	Home Energy Conservation Kit – Low-income	7717HEKT	0.4%		
Residential	Retail Efficient Appliances	7710APPL	0.1%		✓
	Retail Heating and Cooling	7710HTCL	0.4%	✓	✓
	Retail Lighting	7710LITE	6.6%	✓	
	Nest Seasonal Savings	7710STAT	0.9%		
	Residential Midstream	7725RSUP	0.1%		
	Innovation - Market Rate	7915INMR	0.0%		

The NMR team assigned FY2020 programs that did not undergo an evaluation a default gross savings realization rate based on either (1) FY2020 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 FY2020 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 103% of the DCSEU tracked electric savings, the actual portfolio peak demand reduction is 95% of the DCSEU tracked peak demand reduction, and the actual portfolio gas savings is 100% of the DCSEU tracked gas savings.

Table 2: DCSEU FY2020 Portfolio-level Gross Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
Electric Savings (MWh)	101,515	103%	104,558
Peak Demand Savings (MW)	14.98	95%	14.24
Gas Savings (MMBtu)	188,221	100%	187,672

Table 3 displays the portfolio gross savings realization rates over the previous four 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	FY2020	FY2019	FY2018	FY2017
Electric Savings Realization Rate	103%	97%	99%	99%
Peak Demand Savings Realization Rate	95%	96%	105%	96%
Gas Savings Realization Rate	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 103%, the electric savings realization rate for DCSEU equals PECO and exceeds the 96% value for BG&E. At 95%, the demand savings realization rate for DCSEU is lower than both the 126% figure for PECO and the 100% value for BG&E.

Table 4: Comparison of Portfolio-level Realization Rates

Savings Type	DCSEU FY2020	PECO Energy Program Year 11[1]	Baltimore Gas & Electric 2019[2]
Electric Savings	103%	103%	96%
Peak Demand Savings	95%	126%	100%

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 less than 90% or greater than 110% for a small number of programs evaluated in FY2020, including the Upstream Lighting, Low-income Multifamily Comprehensive, and Low-income Prescriptive tracks. For these programs, the accuracy of tracked savings could be improved. We offer our resulting recommendations in the following section.

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[1] 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_evaluat or_swe_.aspx

[2] Verification of the 2019 Empower Maryland Energy Efficiency Program Impact and Cost-Effectiveness Evaluations. Itron, October 2, 2020. https://sites.google.com/view/empowermarylandevaluation/home

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

Sector	Program Name	Track	FY2020 Electric Savings (MWh)			FY2020 Peak Demand Savings (MW)			FY2020 Gas Savings (MMBtu)		
			Tracked	Realization Rate	Evaluated	Tracked	Realization Rate	Evaluated	Tracked	Realization Rate	Evaluated
Solar	Solar PV Market Rate	7101PVMR	1,720	103%	1,771	1.40	30%	0.41	-	-	-
	Low-income Solar Credit	7107SREC	20	102%	20	0.01	103%	0.01	-	-	-
Commercial	C&I RX - Equipment Replace	7511CIRX	11,808	109%	12,920	1.40	106%	1.48	(3,668)	109%	(4,011)
	Small & Medium Business	7511SMRX	-	-	-	-	-	-	-	-	-
	Market Transformation Value	7512MTV	507	108%	548	0.02	139%	0.03	(71)	107%	(76)
	Upstream – Lighting	7513UPLT	16,856	115%	19,432	2.29	112%	2.58	(5,478)	115%	(6,282)
	Retrofit - Commercial Custom	7520CUST	27,074	99%	26,732	3.52	97%	3.40	169,735	100%	169,940
	Market Opportunity - Custom	7520MARO	5,719	98%	5,622	0.95	102%	0.97	6,575	103%	6,804
	New Construction - Custom	7520NEWC	8,676	96%	8,324	2.09	97%	2.03	20,766	100%	20,764
	Pay for Performance	7520P4PX	6,851	100%	6,851	0.68	100%	0.68	663	100%	663
Low-income	Income Quali Gas Eff Fund	4335IGEF	-	-	-	-	-	-	2,484	100%	2,484
	Low-income Decarbonization	7415LIDP	-	-	-	-	-	-	-	-	-
	Income Qual Efficiency Fund	7610IQEF	570	100%	572	0.16	105%	0.17	3,757	101%	3,786
	Multifamily Comprehensive	7612LICP	3,244	98%	3,170	0.35	114%	0.40	6,471	101%	6,561
	Prescriptive Rebate	7613LIRX	1,051	112%	1,173	0.10	92%	0.09	(463)	107%	(496)
	Retail Lighting Food Bank	7717FBNK	811	100%	811	0.08	100%	0.08	(1,129)	100%	(1,129)
	Home Energy Cons Kit	7717HEKT	775	100%	775	0.06	100%	0.06	(653)	100%	(653)
Residential	Retail Efficient Appliances	7710APPL	133	100%	134	0.02	100%	0.02	105	100%	105
	Retail Heating and Cooling	7710HTCL	193	103%	198	0.05	100%	0.05	1,683	105%	1,767
	Retail Lighting	7710LITE	14,681	100%	14,681	1.67	100%	1.67	(14,935)	100%	(14,935)
	Nest Seasonal Savings	7710STAT	587	100%	587	0.11	100%	0.11	2,710	100%	2,710
	Residential Midstream	7725RSUP	238	100%	238	0.02	100%	0.02	(329)	100%	(329)
	Innovation - Market Rate	7915INMR	-	-	-	-	-	-	-	-	-
Portfolio			**101,515**	**103%**	**104,558**	**14.98**	**95%**	**14.24**	**188,221**	**100%**	**187,672**

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.[3]

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[3] 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	FY2020 Electric Savings (MWh)		FY2020 Peak Demand Savings (MW)		FY2020 Gas Savings (MMBtu)	
			Tracked	Evaluated	Tracked	Evaluated	Tracked	Evaluated
Solar	Solar PV Market Rate	7101PVMR	1,799	1,852	1.5	0.4	-	-
	Low-income Solar Credit	7107SREC	21	21	0.0	0.0	-	-
Commercial	C&I RX - Equipment Replace	7511CIRX	12,351	13,514	1.5	1.6	17	-
	Small & Medium Business	7511SMRX	-	-	-	-	-	-
	Market Transformation Value	7512MTV	530	573	0.0	0.0	-	-
	Upstream - Lighting	7513UPLT	17,631	20,326	2.5	2.8	-	-
	Retrofit - Commercial Custom	7520CUST	28,319	27,961	3.8	3.7	171,358	171,203
	Market Opportunity - Custom	7520MARO	5,982	5,880	1.0	1.1	7,983	8,023
	New Construction - Custom	7520NEWC	9,076	8,707	2.2	2.2	21,126	21,923
	Pay for Performance	7520P4PX	7,166	7,166	0.7	0.7	663	663
Low-income	Income Qualified Gas Efficiency Fund	4335IGEF	-	-	-	-	2,484	2,484
	Low-income Decarbonization	7415LIDP	-	-	-	-	-	-
	Income Qual Efficiency Fund	7610IQEF	596	598	0.2	0.2	3,914	3,944
	Multifamily Comprehensive	7612LICP	3,393	3,316	0.4	0.4	8,201	8,203
	Prescriptive Rebate	7613LIRX	1,100	1,227	0.1	0.1	-	-
	Retail Lighting Food Bank	7717FBNK	848	848	0.1	0.1	-	-
	Home Energy Cons Kit	7717HEKT	810	810	0.1	0.1	91	91
Residential	Retail Efficient Appliances	7710APPL	1,456	1,458	0.0	0.0	105	105
	Retail Heating and Cooling	7710HTCL	202	207	0.1	0.1	1,683	1,767
	Retail Lighting	7710LITE	14,039	14,039	1.8	1.8	-	-
	Nest Seasonal Savings	7710STAT	614	614	0.1	0.1	2,710	2,710
	Residential Midstream	7725RSUP	249	249	0.0	0.0	-	-
	Innovation - Market Rate	7915INMR	-	-	-	-	-	-
Portfolio			**106,183**	**109,368**	**16.1**	**15.3**	**220,335**	**221,117**

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Recommendations

Our evaluation of the FY2020 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. While DCSEU prescriptive savings estimates were reasonable, in aggregate, for the FY2020 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 most prescriptive programs.

- Apply project-specific efficiency levels and other inputs to improve the accuracy of tracked savings when feasible. DCSEU applied deemed values or ranges for efficiency levels, wattages, and other inputs to savings algorithms when site specific information was available. This issue was most prominent for commercial and low-income lighting projects where the DCSEU used default energy-efficient wattage assumptions when the actual wattage values were available. For PV systems, default values for inverter efficiency and locations were input rather than available site-specific data. In these cases, project-specific input values were available, which would improve the accuracy of tracked 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:

- Ensure that all references, assumptions, details, and baseline conditions for each project are provided and clearly laid out in project documentation.

- Each project should contain a narrative specifically related to baseline determination and associated inputs. This is particularly critical for projects where the baseline equipment is aged and/or performing significantly worse than originally designed.

- For large multi-measure projects, in particular lighting, consider organizing the projects by measure type. This could involve creating subfolders within the main project directory for each individual measure analysis and all relevant documentation used to perform the analysis.

- Consider requiring use of standard savings calculator tools for as many efficiency measures as possible. Customer-provided calculators do not always utilize appropriate algorithms or assumptions, nor do they always provide a clear indication of how the final ex-ante values were calculated. Employing standard calculators will yield clearer, more-reliable results and streamline SEU's processing of projects.

- For projects that employ energy modeling software to estimate savings, provide a narrative within the project documentation indicating how the output summaries from the modeling software were used to calculate ex-ante savings values.

- Require that applicants submit any calculations used to estimate annual hours-of-use for custom lighting measures. Applicants should also submit supporting documentation or other sources that indicate how the estimates were developed.

- Post-installation inspection reports should be more detailed, especially in situations where discrepancies were observed during the inspection. All information that is collected or confirmed during the site inspection should be clearly linked to the respective measure.

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

- Ensure that the savings from the Energy Summary Report document align with the final claimed savings.

- Consider requiring the Energy Summary Report to include an explanation describing which energy model output file(s) and documents contributed to the final claimed savings.

- Consider adding input variables in the DCSEU tracker to include both baseline and proposed energy usage. The savings should simply be the difference between the two scenarios with clear reference to the modeling output file.

- Consider undertaking further quality control regarding peak electric demand savings as some projects referenced total demand reduction instead of summer peak demand savings.

- Consider ways to expedite processing times for application pre-approval and rebate delivery and streamline application processes, where possible.

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

- Continue to include site-specific calculators for each project that show how ex-ante savings were estimated. The calculators could be improved by adding explanations regarding the workings of the calculators and the reasoning behind certain assumptions.

- Ensure that all references, assumptions, details, and baseline conditions for each project are provided and clearly laid out in project documentation. Each project should contain a narrative specifically related to baseline determination and associated inputs, particularly for efficiency measures involving HVAC equipment and heating/cooling plants.

- For lighting measures, consider developing a lighting workbook with assumptions referencing an index table. Referencing an index table would provide more consistency across projects and provide a clear itemized list of the lighting measures to reference against project documents.

- Consider including additional detail in the DCSEU tracker related to the various inputs used to calculate ex-ante savings values for lighting projects. In particular, we recommend providing more information on each facility's HVAC system in order to apply the appropriate waste heat factors within the lighting savings calculations. Additionally, unless there is substantial operating data indicating a site-specific lighting controls factor, energy savings resulting from lighting controls should be based on the deemed values found in the DC TRM.

For the CI RX Equipment Replacement program, we offer the following additional recommendation:

- To account for peak demand savings, the TRM should include a formula that calculates the summer peak demand coincidence factor based on load shapes recorded in the tracker. This adjustment could improve savings calculations for all measure types.

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

- Collect additional information at the time of purchase, including contact information and building type. Rather than relying solely on fixture type to determine hours of operation, the building type could improve the accuracy of estimated hours of operation. In addition, collect contact information for the end-use customers to facilitate follow-up outreach and evaluation.

- Consider conducting post-installation inspections or request that customers provide photos to more accurately estimate in-service rates for a sample of projects. Due to the upstream nature of the program, we understand that inspections are not currently performed.

- Ensure all projects have specification sheets provided for each unique lamp and fixture that is installed as part of the project.

- Consider offering upstream incentives for additional equipment types, such as HVAC equipment, VFDs, and motors.

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

- The evaluation team recommends that the SEU continue to utilize the Temperature and Time of the Week (TTOW) modeling algorithm whenever possible. The TTOW model is well supported by the literature and has been found to be a very accurate energy predictor when weather data is the only available independent variable.

- The effects of the COVID pandemic will continue to impact the P4P program for the next two or three years. Depending on when customers enter the program, their baseline or performance periods will include the 2020 calendar year. DCSEU properly handled the effects of the pandemic by examining data periods which were unaffected by the pandemic, or by including indicator variables to account for the impacts. DCSEU should continue to be mindful of the pandemic time periods as the P4P program continues.

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

- Consider adding an automated check in the tracking database to flag projects where the peak demand savings are unusually high. One potential flag could be to identify projects where the peak demand savings exceeds 300% of the average demand savings. This will alert SEU staff to potential data entry issues during the data entry process.

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

- Ensure that lighting installation locations and heating fuel types are recorded correctly so the appropriate hours of use and waste heat factors are applied.

- Calculate cooling and peak demand savings for projects with heat pumps where air sealing was performed.

For the Low-Income Prescriptive Rebate program we offer the following additional recommendations:

- Ensure that deemed prescriptive savings are rounded to the same decimal place across item codes.

- Ensure that the appropriate coincidence factors are utilized based on the location in which lighting measures are installed (multifamily in-unit versus common area).

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

- Ensure that measures are accurately characterized in the tracking data.

For the Retail Heating & Cooling program we offer the following recommendations:

- Ensure that home and product information from the rebate data, such as home type, heating/cooling type, and system size, are accurately recorded in the tracking data so the correct deemed savings are applied.

- Review program materials to identify opportunities to improve clarity on the application process, particularly for measures that are more likely to be self-installed.

In addition, based on feedback from the survey with participating commercial customers, we recommend that DCSEU continue to engage prior commercial participants with ongoing outreach, as engaged participants are more likely to undertake additional projects. In particular, 35% of commercial participants surveyed would like DCSEU to provide them with information on all available rebates, 28% would like to be notified when programs change, and 16% would like DCSEU to conduct an energy audit of their facility.

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 2020 (FY2020) 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 DC Sustainable Energy Utility's (DCSEU's) FY2020 final program tracking database in order 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.

In order to identify evaluation priorities and develop 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
- Virtual onsite inspections
- 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 FY2020 saving goals for DCSEU. While DCSEU contract performance is measured by first-year energy savings, a single year's impact is relatively small compared to the lifetime energy savings for measures that participants may install for 20+ years. Therefore, our evaluation approach for FY2020 estimates energy savings assuming a typical year under normal operating conditions.

The NMR team calculated FY2020 energy savings employing an approach that is consistent with prior evaluations. For prescriptive measures and custom measures where the DCSEU calculated 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, such as the Pay for Performance (P4P) program, 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 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. Some of the most important databases and documentation reviewed include the following:

- Project site information from the SEU tracker online portal. This application is an electronic record keeping, file storage, and savings calculation platform that the SEU utilizes across the portfolio.

- Rows from the SEU FY2020 tracking database associated with the project ID number. The tracking database contains less detail than the online portal, but the information it does have tends to match what is found in the online portal.

- Main analysis file(s). These are typically Excel files that include TRM-based calculations, custom calculations, or outputs from an energy modeling software.

- Pre- or post-installation site visit reports from the program implementation team

- Equipment specification sheets
- Invoices

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 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:

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

1.2.2.2 Custom Measures

Custom project analyses involved the review of calculations done by DCSEU and contractors to verify and modify the methods and equations used in the analysis based on engineering judgment and expertise. It also involved the verification of assumptions regarding system parameters and the adjustment of those calculations as necessary to provide a more accurate estimate of energy savings. The NMR team evaluated the custom measures 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:

- Reviewed project description, documentation, specifications, and tracking system data

- Reviewed engineering analyses for technical soundness, appropriate baselines, and appropriateness for the specific application

- Reviewed methods of determining demand (capacity) savings to ensure they are consistent with approved methods for determining peak load/savings

- Reviewed input data for appropriate baseline specifications and variables, such as weather data, bin hours, and total annual hours, and to confirm they are consistent with facility operation

- Considered and reviewed for interactive effects with affected systems

- Ensured the measure complies with program rules for eligibility and falls within the parameters outlined by the applicable energy code

- Adjusted for impacts of COVID by normalizing weather dependent measures to TMY3 or NOAA 30 year normal data, and normalizing 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 completed telephone 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.

1.2.4 Virtual Onsite Inspections

The NMR team conducted virtual onsite verifications for a sample of projects. The NMR team selected these projects either because they exhibit a high degree of savings uncertainty or to serve 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 virtual onsite 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. Virtual 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.

The NMR team also selected projects for virtual onsite visits in order to serve the broader QC purposes of the evaluation by ensuring that program savings are delivered across all programs. A portion of the virtual onsite visits were allocated to sampled multifamily projects to confirm that measures are installed and operating properly.

The NMR team completed the following tasks while conducting virtual onsite inspections:

- 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 Pay for Performance (P4P) program. 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 below.

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

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 heating- and cooling-degree days, or another explanatory variable describing the weather, directly into the models. Other variables that are often correlated with consumption include fuel prices, occupancy changes, and behavior changes (set-points, schedules, and frequency of use).

We analyzed changes in energy consumption records to estimate savings for P4P projects. Billing analysis is extremely useful for programs where the same premise installs multiple measures that have interactive effects, such as whole building programs. For other measures, or for situations where whole building billing analysis is not suitable (i.e., replace-on-burnout projects, analyses yielding poor R-squared statistics), 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 has impacted the customer's baseline data, the NMR team omitted the affected period and then look further back in time to ensure adequate baseline data is available. When COVID has impacted the post-project period, the affected period was removed. Depending on the specific project, removing data may result 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.

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 the program-level savings across the entire portfolio.

For programs that do 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. See Section 4 for more details.

1.3 NET SAVINGS ESTIMATION AND PROCESS EVALUATION

In this section, we provide a description of the activities we undertook to estimate net savings and to conduct a process evaluation. The NMR team leveraged the participant surveys to estimate the NTG ratio and to collect data for the process evaluation.

1.3.1 Net Savings Estimation

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

$$\text{Net Savings} = \text{Verified Gross Savings} \times \text{NTG ratio}$$

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

$$\text{NTG ratio} = 1 - \text{Free-ridership \%} + \text{Participant Spillover \%}$$

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 their decision to install the measures and 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 be 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 has multiple projects, we selected the project with the most savings, then, within that project, the measure with the most savings. This approach allows us to provide NTG ratios at the measure-level when sample sizes are sufficient.

For programs that do 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 produces 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 asks participants how the purchase decision would have been different in the absence of the program. The two key questions that determine 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 provides an answer of 1 or 2 (would postpone or cancel the purchase), the respondent receives 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 provides 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 receives a free-ridership intention score of 25% (associated with moderate free-ridership). If the respondent provides an answer of 4 (would have purchased the same measure without program rebate), they are asked the second question before a free-ridership intention score can be assigned.

The second question asks 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 provides an answer of 1 (definitely would have the funds), the respondent receives a score of 50% (associated with high free-ridership). If the respondent provides an answer of 2 (might have had the funds available), they receive a slightly lower free-ridership score of 37.5%. If the respondent provides an answer of 3 (definitely would not have the funds) or if they said they did not know or refused the question, the respondent receives 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 asks each respondent to rate how much of a role various program-related influence factors had on their decision to purchase the measure. Influence is scored using a scale from 1 to 5, where 1 means "it played no role at all" and 5 means "it played a great role." The influence factors assessed are as follows:

- The financial incentive or rebate of $[REBATE]

- Information or recommendations provided to you 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 from contractors or suppliers associated with the program

- Marketing materials or information provided by DCSEU about the program (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 is set equal to the maximum influence rating that a respondent reports 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 is 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 NMR team summed the intention and program influence scores for each respondent to generate a free-ridership score ranging from 0% to 100%. A score of 0% free-ridership means the participant was not a free rider, a score of 100% free-ridership means the participant was a complete free rider, and a score between 0% and 100% means 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 these situations, the survey asked about the equipment participants purchased and the impact the program had on their decision to purchase that equipment.

For each equipment type the respondent reports purchasing without a program rebate, the survey asked about the extent of influence that earlier involvement in the program had on their decision. Influence is reported using a scale from 1 to 5, where 1 means "it played no role at all" and 5 means "it played a great role." For each respondent, the program influence rating is 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:

- Multiply 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.

- Sum program-attributable energy savings across all survey respondents to calculate the total spillover savings.

- Divide the total spillover savings by the total tracked project-level savings across all survey respondents to calculate the participant spillover rate.

1.3.2 Process Evaluation

The NMR team fielded a telephone survey with customers who participated in the residential programs and a telephone survey and web survey with customers who participated in the commercial programs. The surveys were completed with 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

The NMR team sent an advance notification of the survey by email to sampled participants whose email addresses were available.

1.4 PROGRAM SAVINGS OVERVIEW

In this section, we provide an overview of the FY2020 tracked savings by sector and program.

Table 10 displays the percent of FY2020 tracked overall energy, electric, and gas savings by sector. The commercial sector programs contributed the large majority of savings across each savings category. Note that the Efficient Products programs yielded negative gas savings due to the heating penalty associated with efficient lighting.

Table 10: FY2020 Tracked Gross Meter-Level Savings Summary by Sector

Sector	Percent of FY2020 Tracked Savings			
	Total Energy Savings (MMbtu)	Electric Savings (MWh)	Gas Savings (MMbtu)	Peak Demand Savings (MW)
Low-income	6.2%	6.6%	5.4%	5.1%
Residential	8.0%	15.4%	-5.5%	12.3%
Commercial	84.7%	76.3%	100.2%	73.1%
Solar	1.1%	1.7%	0.0%	9.4%
Total	**534,591**	**101,515**	**188,221**	**15.0**

Table 11 displays the percent of FY2020 tracked overall energy, electric, and gas savings by program track. The commercial Custom Retrofit program contributed about 49% of the total energy portfolio savings. The next largest programs include the Equipment Replacement program (7%), Commercial Upstream Lighting program (10%), Commercial New Construction program (9%), and the Retail Lighting program (7%).

Table 11: FY2020 Tracked Gross Meter-Level Savings Summary by Program

Sector	Program Name	Percent of FY2020 Tracked Savings			
		Total Energy Savings (MMbtu)	Electric Savings (MWh)	Gas Savings (MMbtu)	Peak Demand Savings (MW)
Commercial	C& I RX - Equipment Replacement	6.9%	11.6%	-1.9%	9.4%
	Small & Medium Business Rebates	0.0%	0.0%	0.0%	0.0%
	Market Transformation Value	0.3%	0.5%	0.0%	0.1%
	Commercial Midstream - Lighting	9.7%	16.6%	-2.9%	15.3%
	Retrofit - Commercial Custom	49.0%	26.7%	90.2%	23.5%
	Market Opportunities - Comm Custom	4.9%	5.6%	3.5%	6.4%
	New Construction - Comm Custom	9.4%	8.5%	11.0%	13.9%
	Pay for Performance	4.5%	6.7%	0.4%	4.6%
Low-income	Refresh the District	0.0%	0.0%	0.0%	0.0%
	LI Decarbonization Pilot	0.0%	0.0%	0.0%	0.0%
	Income Qualified Efficiency Fund	1.1%	0.6%	2.0%	1.1%
	Low Income MF Comprehensive	3.3%	3.2%	3.4%	2.3%
	Low Income Prescriptive Rebate	0.6%	1.0%	-0.2%	0.6%
	Retail Lighting Food Bank	0.3%	0.8%	-0.6%	0.5%
	Home Energy Conservation Kit – Low-income	0.4%	0.8%	-0.3%	0.4%
	Income Qualified Gas Efficiency Fund	0.5%	0.0%	1.3%	0.0%
Residential	Retail Efficient Appliances	0.1%	0.1%	0.1%	0.1%
	Retail Heating and Cooling	0.4%	0.2%	0.9%	0.3%
	Retail Lighting	6.6%	14.5%	-7.9%	11.1%
	Nest Seasonal Savings	0.9%	0.6%	1.4%	0.8%
	Residential Midstream	0.1%	0.2%	-0.2%	0.1%
	Innovation - Market Rate	0.0%	0.0%	0.0%	0.0%
Solar	Solar PV Market Rate	1.1%	1.7%	0.0%	9.4%
	Low-income Solar Renewable Energy Credit	0.0%	0.0%	0.0%	0.0%
Total		534,591	101,515	188,221	15.0

1.5 PROGRAM SAMPLING PLAN

In this section, we outline our sampling plan for the FY2020 evaluation activities.

1.5.1 Gross Savings Verification Sampling Plan

We applied a staggered impact evaluation approach, in which some programs will be evaluated annually and others will be evaluated less frequently, with default realization rates being applied in years without evaluation activities.

1.5.1.1 Commercial and Solar Programs

We allocated 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 FY2020 was lighting, which contributed approximately 37% of overall savings in FY2020. The NMR team oversampled for projects that contain lighting measure categories.

Table 12 lists the number of projects and sample sizes for desk reviews and virtual onsite inspections. All sampled projects included desk reviews, a portion of which will also include a follow-up interview with the customer to verify key input parameters. In addition, a nested sample of projects that underwent a desk review also received a virtual onsite inspection.

Table 12: Commercial Gross Savings Verification Sampling Plan

Program	FY2020 Participation (Projects)	Number Sampled for Desk Review Only	Number Sampled for Virtual Onsite + Desk Review	Total Number Sampled for Desk Reviews
C&I RX - Equipment Replacement	163	5	3	8
Pay for Performance*	14	4	0	4
Retrofit – Custom**	68	11	9	20
Market Opportunities – Custom***	30	6	3	9
Commercial Upstream Lighting	132	11	0	11
Solar PV Market Rate	6	3	0	3
Solar for All Community Renewable PV Energy****	134	5	0	5
New Construction - Custom	23	7	1	8
All Evaluated Commercial Programs	**570**	**52**	**16**	**68**

 * Only four of the 14 projects in the initial data included electric or natural gas savings.
 ** Only 62 of the 68 projects in the initial data included electric or natural gas savings.
 *** Only 29 of the 30 projects in the initial data included electric or natural gas savings.
 **** Only 99 of the 134 projects in the initial data included electric or natural gas savings.

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 ensures the largest projects are included in the sample. We allocated the number of sample points for each program to each sub-stratum based on each substratum's contribution to the program savings. The NMR team ensured that lighting measures are prominent in the sampled projects. Further details of the sampling plan for each program are provided in the individual program sections.

1.5.1.2 Residential and Low-income 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 & Low-income Gross Savings Verification Sampling Plan

Program	FY2020 Participation (Projects)	Number Sampled for Desk Review Only	Number Sampled for Virtual Onsite + Desk Review	Total Number Sampled for Desk Reviews
Retail Lighting	195,013*	10**	0	10
Retail Heating & Cooling	265	35**	0	35
Low-income Multifamily Comprehensive	40	8	3	11
Income Qualified Efficiency Fund	27	4	1	5
Low-income Prescriptive Rebate	15	6	1	7
Solar for All Low-income Single-family PV	210	5	0	5
All Evaluated Residential Programs	**195,570**	**68**	**5**	**73**

* Number of measures rather than projects for the Retail Lighting program.
** A sample of invoices/receipts and rebate forms were reviewed.

1.5.2 Net Savings Estimation and Process Evaluation Sampling Plan

In this section, we outline our sampling plan for the participant surveys that served the NTG estimation and process evaluation efforts (Table 14). Because the primary motivation for the FY2020 surveys was to estimate NTG, we targeted all non-low-income programs (all low-income programs are assigned a default NTG of 100%) with available customer contact information. At the 80% confidence level, the sample precision varies between ±17% and ±8% for each program. Due to the small number of FY2020 projects for several commercial programs, we do not estimate sample precision.

Given the small participant population for some of the commercial programs, the response rate for the surveys was reasonable – ranging from 17% for the Solar PV Market Rate program to 100% for the Market Transformation Value (MTV) program.

Table 14: FY2020 Participant Survey Sampling

Program	FY2020 Participation (Sites)	Number of Sites Contacted*	Number of Completed Surveys	Estimated Sample Precision
Solar PV Market Rate	6	6	1	n/a
C& I RX - Equipment Replacement	134	83	19	80% ± 14%
Market Transformation Value	7	4	4	n/a
Commercial Upstream - Lighting	735	228	39	80% ± 10%
Retrofit - Commercial Custom	97	35	13	80% ± 17%
Market Opportunities - Commercial Custom	44	22	7	n/a
New Construction - Commercial Custom	20	19	4	n/a
Pay for Performance	12	4	2	n/a
Retail Efficient Appliances	716	417	57	80% ± 8%
Retail Heating and Cooling	618	538	43	80% ± 9%
All Evaluated Programs	**2,389**	**1,357**	**189**	

*Number of sites contacted is lower than FY2020 participation for several reasons: customer contact information was not available for all sites, some sites participated in more than one project, and some sites were sampled for other evaluation activities.

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 eight commercial and solar programs selected for the FY2020 evaluation:

- Retrofit – Custom
- New Construction – Custom
- Market Opportunities – Custom
- CI RX – Equipment Replacement
- 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 FY2020, the program provided incentives for 68 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 FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Gas Savings	Percent of FY2020 Peak Demand Savings
HVAC	66%	19%	92%	22%
Appliances, Office Equipment, Refrigeration	<1%	1%	0%	1%
Comprehensive	8%	15%	5%	7%
Water Heating	2%	1%	2%	0%
Lighting	19%	54%	-1%	61%
Motors & Drives	5%	9%	3%	10%

For the FY2020 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
FY2020 Electric Savings (MWh)	27,074	98.7%	26,732
FY2020 Peak Demand Savings (MW)	3.52	96.7%	3.40
FY2020 Gas Savings (MMBtu)	169,735	100.1%	169,940

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 20 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 >20,000 MMBtu of total energy savings to the certainty stratum. We also created a large probability stratum for projects with total energy savings between 5,000 and 20,000 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 in order 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	FY2020 Participation	Number of Sampled Sites
Certainty	>20,000 MMBtu	51%	4	4
Large Probability	5,000 to 20,000 MMBtu	32%	8	6
Small Probability	≤5,000 MMBtu	17%	50	10
Zero Savings*	0 MMBtu	0%	6	0

*Six projects were listed in the SEU tracker with no savings associated with them. The NMR team assumes that these were potential projects, but ones in 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 20 selected sample sites, through which we calculated the evaluated savings. Nine of the 20 desk reviews employed additional information gathered from virtual onsite verifications (four from the Certainty stratum, three from the Large Probability stratum, and two from the Small Probability stratum). The virtual onsite 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 undoubtedly impacted energy consumption at most commercial facilities in 2020. As most of the calculations for this program did not involve actual metered data, the pandemic did not affect our analysis. The verified savings estimates reflect the energy savings that can be expected in a typical year; 2020 would not be considered such a year.

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. Figure 1 shows an example of the calculator for a heat recovery ventilator.

Figure 1: Example of Custom Savings Calculation

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 made adjustments to input variables such as hours of use (HOU) or equipment efficiencies if needed, based on the project documentation or virtual onsite visits. Savings calculations ultimately relied on the verified values. In some cases, the NMR team applied a differently 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
FY2020 Electric Savings (MWh)	27,074	98.7%	26,732	80% ± 0.9%
FY2020 Peak Demand Savings (MW)	3.52	96.7%	3.40	80% ± 1.2%
FY2020 Gas Savings (MMBtu)	169,735	100.1%	169,940	80% ± 0.1%

The program-level realization rates are 98.7% for electric savings, 96.7% for demand savings, and 100.1% for natural gas savings. The selected sample ultimately achieved ±0.9% precision for electric savings, ±1.2% precision for demand savings, and ±0.1% 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 onsite visits performed by our engineers.

Gas savings adjustments were minor, with overall verified savings within ±0.1% of ex-ante savings.

Electricity (kWh) savings adjustments were also minor, with overall verified savings within ±1.3% of ex-ante savings.

The majority of the demand savings adjustments are due to a single certainty stratum project (Project ID 20947). This project accounted for about 2.5% of the 3.3% reduction in the program's demand savings. This was a large, multi-site LED lighting replacement project. The evaluator made several minor adjustments to input variables, such as fixture wattage and fixture quantity, which amounted to a roughly 6.0% decrease in verified peak demand savings for the project.

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 13 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 19, the 13 Custom Retrofit program participants received the following scores:

- Less than one-quarter of participants (three of the 13 respondents) 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 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:
  - 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 (37.5%).
  - Seven of the 13 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 13 respondents is 35%.

Table 19: 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%	3
• 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%	2
	• Definitely would have had the funds	50%	7
Total		**35%**	**13**

Influence

Table 20 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 (4.0) and the rebate (3.8).

Table 20: 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	12	2	--	2	--	8	4.0
The rebate	13	3	1	--	1	8	3.8
Information or recommendation from a DCSEU representative	13	4	--	--	4	5	3.5
Information or recommendation from contractors or vendors associated with the program	10	3	1	1	4	1	2.9
The results of any audits, energy modeling, or technical studies done through a DCSEU program	13	4	2	2	2	3	2.8
Marketing materials or information provided by DCSEU	12	5	1	1	2	3	2.8

[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 21):

- Ten of the 13 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 respondent provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.

- Two respondents 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 13 respondents is 10%.

Table 21: 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%	10
4	12.5%	--
3	25%	1
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	2
Don't know OR Refused	25%	--
Total	**10%**	**13**

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 fundraisers helped raise additional project funds. Another respondent indicated that failing equipment introduced urgency into the purchasing 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 Custom Retrofit program was 48% (Table 22).

Table 22: FY2020 Free-ridership Rate for Custom Retrofit Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	44%	0%	100%
Free-ridership (savings-weighted)	48%	0%	100%

The FY2018 and FY2019 free-ridership rates were 56% and 30%, respectively. Given the small sample sizes for the three years, we recommend combining the results across all three years through a savings-weighted approach, shown in Table 23. We recommend using 48% as the free-ridership rate.

Table 23: FY2018-FY2020 Free-ridership Rate for Custom Retrofit Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2018	25	18%	56%
FY2019	8	8%	30%
FY2020	13	75%	48%
Weighted Average			**48%**

2.1.2.2 Participant Spillover

None of the respondents reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Custom Retrofit project. This resulted in a spillover rate of 0% for the Custom Retrofit program in FY2020. The spillover rate was also 0% in FY2019, while in FY2018, spillover savings represented 1% of tracked savings (Table 24). We recommend an average spillover rate of 0%, after rounding.

Table 24: FY2018-FY2020 Spillover Rate for Custom Retrofit Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2018	25	18%	1%
FY2019	8	8%	0%
FY2020	13	75%	0%
Weighted Average			**0%**

2.1.2.3 NTG Ratio

The savings-weighted NTG ratio for the Custom Retrofit program equals 52%, after rounding (Table 25).

Table 25: NTG Ratio for Custom Retrofit Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	48%	0%	52%

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 26).

Table 26: Custom Retrofit Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	6
Participating end user surveys – web	7
Total	**13**

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, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 5.0, on average.

- The NPS[4] for the Custom Retrofit program was 92.

- 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 (five of 13 respondents), and 11 respondents received assistance on their application from the DCSEU.

2.1.3.2 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 9.7, on average. The NPS for the program among participating end users was 92, a four-point increase from FY2019, where NPS was 88. Overall, nearly all respondents (12 of 13) were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. The other respondent was *passive*, rating their likelihood to recommend the program to someone else an 8.

- Participants rated their overall satisfaction with the program a 5.0, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2019, participants rated their average satisfaction a 4.5. Table 27 shows their satisfaction ratings in detail.

- Two respondents praised the program when asked for additional comments at the end of the survey. One expressed concern that the program could be ending and encouraged the DCSEU to continue offering the program.

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[4] 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 27: Participant Experience with the Custom Retrofit Program[1]

Feature	n[2]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**13**	**--**	**--**	**--**	**--**	**13**	**5.0**
The amount of the rebate, discount, or financial incentive	13	--	--	--	--	13	5.0
The preapproval process	8	--	--	--	--	8	5.0
The application process	11	--	--	--	1	10	4.9
Time to receive the rebate or incentive	11	--	--	--	1	10	4.9
The energy savings from your new equipment	12	--	--	1	1	10	4.8
The type of eligible equipment or projects	12	--	--	--	2	10	4.8
The information about the DCSEU offerings	12	--	--	1	--	11	4.8
The performance of the new equipment	13	--	--	1	2	10	4.7
The assistance from your contractor or vendor	12	--	--	2	2	8	4.5
The technical assistance you received from the DCSEU	14	--	1	1	3	9	4.4

[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." One respondent had not yet installed the measure. If n < 20, counts are shown.

Based on their experience, participants provided feedback on what they would change about the Custom Retrofit program. Four of 13 respondents suggested program changes: two respondents suggested that the program include additional types of equipment (chillers, boilers, and EV charging stations), and one respondent suggested increasing the rebate amount by 15% to 20%. Respondents also suggested that the program process rebates more quickly, require less information for project approval, and expand the number of participating contractors (one respondent, respectively). Most respondents (eight out of 13) did not suggest any changes based on their experience with the program.[5]

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 save money on energy costs (nine respondents) and advance a long-term strategic management plan (eight respondents). Even more participants reported realizing these benefits (11 and nine respondents, respectively [Table 28]). Six respondents implemented the measure in order to reduce operating or maintenance costs, while ten respondents reported realizing a reduction in operating or maintenance costs.

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[5] One respondent replied "Don't know" to this question.

Table 28: Custom Retrofit Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=13)[1]	
	Reason for Participation	Benefits Realized
Save money on energy costs	9	11
Advance long-term strategic management plan	8	9
Install more reliable equipment	6	7
Reduce operating or maintenance costs	6	10
Increase safety and/or security	3	2
Improve work environment	2	3
Promote positive public relations	2	0
Improve production or productivity	1	2
Don't know	2	0

[1] Percentages sum to greater than 100% because some respondents provided more than one reason for implementation or benefit realized.

Four of the 13 respondents reporting facing at least one hurdle when deciding whether or not to implement the measure through the program (Table 29). Participants most commonly cited internal approval lead time and a lack of funds available for investment (two respondents, respectively). Three respondents said that the program did not help them overcome barriers to participation, while one respondent said direct funding from the program alleviated the need for capital spending.

Table 29: Hurdles Faced By Custom Retrofit Program Participants

Hurdle/Barrier	Count of Respondents (n=4)[1]
Internal lead time	2
Lack of funds available for investment	2
Other priorities for capital spending	1
Lack of financing	1
Amount of management time to oversee projects	1
The economy	1
Internal staff lacked expertise about energy savings options	1
Equipment availability	1

[1] Counts sum to greater than 4 because some respondents provided more than one reason.

All 13 respondents reported receiving assistance on their Custom Retrofit program applications from a DCSEU staff member (11 respondents) and/or a third-party vendor or contractor (five respondents). On a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.3, on average. In FY2019, most of the participants surveyed (six of the eight respondents) had completed their own applications and rated the ease of completing them a 4.3, on average.

2.1.3.4 Program Awareness

Most of the participants (11 out of 13) learned about the Custom Retrofit program before they began implementing their project. One respondent learned about the program after they began implementing the project and another heard about it after completing the project (Table 30).

Table 30: Awareness of Custom Retrofit Program

When Respondent Learned about the Financial Incentives/Assistance	Count of Respondents (n=13)
Before planning the project	5
After planning the project, but prior to implementing	6
After implementing the project, but prior to completing	1
After completing the project	1

When asked why their organizations moved forward with their project before submitting their application to the program, participants reported that they needed to complete work for an unplanned equipment failure (two respondents) or needed to move forward with an internal schedule (one respondent).[6]

Over one-third of respondents (five of 13) first heard about the Custom Retrofit program from a DCSEU staff person or account manager, followed by a colleague or industry peer (four of 13). Table 31 shows all of the ways program respondents heard about the program.

Table 31: Sources of Custom Retrofit Program Awareness

Source of Program Awareness	Count of Respondents (n=13)	
	Where Participants First Heard of Program	Where Participants Overall Heard of Program[1]
DCSEU staff or account manager	5	8
A colleague or industry peer	4	5
The DCSEU website	1	4
A DCSEU mailing or email	1	4
A vendor	--	4
A contractor	--	2
A conference, trade show, or fair	--	2
Other (prior experience with DCSEU)	1	--
Don't know	1	2

[1] Counts sum to greater than 13 because some respondents provided more than one response.

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[6] Of the four respondents who moved forward with the project before engaging with DCSEU, one respondent was unsure why they submitted their application after starting the project.

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Over one-half of respondents (seven of 13) had visited the DCSEU website before. On a scale of 1 to 5, where 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.

2.1.4 Recommendations

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

- Ensure that all references, assumptions, details, and baseline conditions for each project are provided and clearly laid out in project documentation. Assumptions and variables used in ex-ante savings calculations should reflect those descriptions. For example, a steam reduction measure should include the steam tables referenced in the calculations; a pump system replacement that includes calculations for varying load, total dynamic head, etc., should have a manufacturer-provided pump curve provided with the documentation.

- Each project should contain a narrative specifically related to baseline determination and associated inputs (e.g., efficiencies). This is particularly critical for projects where the baseline equipment is aged and/or performing significantly worse than originally designed. Inputs should not solely be based on equipment nameplate/manufacturer ratings or rough estimates.

- Where possible, for large multi-measure projects, consider organizing the projects by measure type. This could involve creating subfolders within the main project directory for each individual measure analysis and all relevant documentation used to perform the analysis.

  o This recommendation is perhaps most critical with large lighting projects, which can have dozens (up to 80+ per project) of individual line items in the SEU tracker. This leads to confusion when attempting to reconcile the information from the tracker line items with project documentation.

- Consider requiring use of standard savings calculator tools for as many efficiency measures as possible. Customer-provided calculators do not always utilize appropriate algorithms or assumptions, nor do they always provide a clear indication of how the final ex-ante values were calculated. Employing standard calculators will yield clearer, more-reliable results and streamline SEU's processing of projects.

  o This recommendation could be implemented relatively easily for lighting measures. A standard calculator tool could be developed and used in multiple commercial programs where lighting projects are common. The calculator would pull in TRM algorithms and source tables for prescriptive measures but would be flexible enough to be used for custom measures. Such a calculator is successfully used in many other jurisdictions throughout the country.

- For projects that use energy modeling software to estimate savings, provide a narrative within the project documentation indicating how the output summaries from the modeling

software were used towards calculating ex-ante savings values. The evaluation team observed that there are often discrepancies between these two sources.

- Require that applicants submit any calculations used to estimate annual hours-of-use for custom lighting measures. Applicants should also submit supporting documentation or other sources (i.e., posted schedules) that indicate how the estimates were developed.

- Post-installation inspection reports should be more detailed, especially in situations where discrepancies were observed during the inspection (i.e., equipment quantities have changed, measures have been removed from the scope). All information that is collected or confirmed during the site inspection should be clearly linked to the respective measure being incentivized through DCSEU.

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 FY2020, the program provided incentives for 23 projects. Table 32 provides the breakdown of tracked savings by measure type. The bulk of total energy savings and total electric savings reside with HVAC and lighting measures.

Table 32: New Construction Custom Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Gas Savings	Percent of FY2020 Peak Demand Savings
HVAC	53%	37%	76%	72%
Lighting	25%	44%	-2%	26%
Motors & Drives	1%	2%	<1%	-2%
Water Heating	17%	12%	24%	1%
Appliances, Office Equipment, & Refrigeration	3%	4%	1%	2%
Solar PV	<1%	1%	0%	1%

For the FY2020 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 33 shows the tracked savings, realization rate, and evaluated savings for the program. The electric savings realization rate was 95.9%, the demand savings realization rate was 97.4%, and the natural gas savings realization rate was 100.0%.

Table 33: New Construction Custom Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	8,676	95.9%	8,324
FY2020 Peak Demand Savings (MW)	2.09	97.4%	2.03
FY2020 Gas Savings (MMBtu)	20,766	100.0%	20,764

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. 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 1,000 and 5,000 MMBtu, and a small probability stratum for the remaining projects. We randomly

sampled projects from each of the probability strata. Table 34 presents the final sample for the program.

Table 34: New Construction Custom Sampling Plan

Stratum	Stratum Criteria	Percent of Program Energy Savings	FY2020 Participation	Number of Sampled Sites
Certainty	>5,000 MMBtu	40%	3	3
Large Probability	1,000 to 5,000 MMBtu	55%	13	4
Small Probability	<1,000 MMBtu	5%	7	1

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. One of the desk reviews used additional information gathered via a virtual onsite verification. Each project was analyzed using one of two evaluation methodologies:

- The NMR team modeled the majority of new construction projects using a building simulation software, such as EQuest. For these types of projects, the NMR team reviewed the modeling inputs 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 FY2020 evaluation, the NMR team performed a virtual onsite verification for one project from within the Large Probability stratum. During the virtual onsite, the NMR team verified that the efficiencies, capacities, and quantities of the 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 and hot water conservation, refrigeration, and water flow fixtures.

2.2.1.3 Results

The program-wide impact evaluation results are shown in Table 35. The findings that contributed to deviations in the realization rates are described in the text that follows.

Table 35: New Construction Custom Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	8,676	95.9%	8,324	80% ± 1.8%
FY2020 Peak Demand Savings (MW)	2.09	97.4%	2.03	80% ± 2.1%
FY2020 Gas Savings (MMBtu)	20,766	100.0%	20,764	80% ± 0.0%

The program-level realization rates are 95.9% for electric savings, 97.4% for demand savings, and 100.0% for natural gas savings. The selected sample ultimately achieved a ±1.8% precision at 80% confidence for electric savings, ±2.1% precision for demand savings, and ±0.0% 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.

Seven of the eight sampled new construction projects had a total energy realization rate that was roughly 100%. The last sampled project had a total energy realization rate of 80%, due to the project's electric savings. The NMR team's verification uncovered two project-level errors that resulted in electric, demand, or gas realization rates less than or greater than 100%. The findings for these two projects are described below.

- The ex-ante electric and demand savings for one project (Project 19269) appeared to have been significantly overstated due to two HVAC measures within the project:
  - One measure did not account for post-installation heating consumption of heat pumps.
  - The other measure did not account for post-installation system usage at all.
- One project appears to have reported the total kW load reduction – not summer peak load reduction – as the ex-ante peak kW savings (Project ID 19733).

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 four 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 36, the four New Construction program participants received the following scores:

- One participant would have cancelled the implementation of the project in the absence of the program, so we assigned a free-ridership influence score of 0%.

- One participant was not sure what they would have done in the absence of the program, so we assigned a moderate free-ridership intention score (25%).

- The other 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 36: 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%	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 have had the funds	50%	2
Total		**31%**	**4**

Influence

Table 37 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 the rebate (4.4) and information or recommendations from contractors or vendors associated with the program (3.8).

Table 37: 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
The rebate	4	1	--	--	--	3	4.4
Information or recommendation from contractors or vendors associated with the program	4	1	--	--	1	2	3.8
Previous experience with a DCSEU program	3	1	--	--	1	1	3.3
The results of any audits, energy modeling, or technical studies done through a DCSEU program	3	1	--	1	--	1	3.0
Information or recommendation from a DCSEU representative	3	1	--	1	--	1	3.0
DCSEU marketing materials or program information	4	1	--	3	--	--	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 38).

- Three of the 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 fourth respondent provided a maximum rating of 1 for the program features, so we assigned them a free-ridership influence score of 50%.

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

Table 38: 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%	3
4	12.5%	--
3	25%	--
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	1
Don't know OR Refused	25%	--
Total	**13%**	**4**

When asked if any other factors played a great role in influencing them to implement the measure through the New Construction program, two respondents mentioned that the efficiency and/or design of the measure had 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 each project. The average unweighted free-ridership rate was 44% and the average weighted free-ridership rate for the New Construction program was 63% (Table 39).

Table 39: FY2020 Free-ridership Rate for New Construction Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	44%	0%	100%
Free-ridership (savings-weighted)	63%	0%	100%

The FY2018 free-ridership rate was 61%. Given the low sample sizes for both years, we recommend combining the results through a savings-weighted approach, shown in Table 40. We recommend an average free-ridership rate of 62%.

Table 40: FY2018 & FY2020 Free-ridership Rate for New Construction Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2018	6	55%	61%
FY2020	4	45%	63%
Weighted Average			**62%**

2.2.2.2 Participant Spillover

While one of the four respondents reported purchasing and installing energy-efficient products after completing their New Construction project, this respondent reported receiving a rebate or other financial incentive for that project. This resulted in a spillover rate of 0% for the New Construction program. However, in FY2018, spillover savings represented 7% of tracked savings

for the respondents. Therefore, we recommend an average spillover rate of 4%, as shown in Table 41.

Table 41: FY2018 & FY2020 Spillover Rate for New Construction Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2018	6	55%	7%
FY2020	4	45%	0%
Weighted Average			**4%**

2.2.2.3 NTG Ratio

The savings-weighted NTG ratio for the New Construction program equals 42%, after rounding (Table 42).

Table 42: NTG Ratio for New Construction Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	62%	4%	42%

2.2.3 Process Evaluation

For the process evaluation of the New Construction program, the NMR team completed telephone and web surveys with program participants (Table 43).

Table 43: New Construction Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	2
Participating end user surveys – web	2
Total	**4**

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, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 5.0, on average.

- Although participants reported high satisfaction with the application process (4.7 on a scale from 1 to 5, where 1 is "not at all satisfied" and 5 is "very satisfied"), participants rated the ease of completing the application less favorably (a 3.5 on a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy"). Two of the four respondents consider the application process too lengthy and offered suggestions to improve it, such as requiring less information and streamlining the process. Two of the four respondents also suggested speeding up the pre-approval process and the time it took to receive rebates.

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 an 8.3, on average.

- 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." Table 44 shows their satisfaction ratings in detail.

Table 44: 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	**4**	**--**	**--**	**1**	**1**	**2**	**4.3**
The application process	3	--	--	--	1	2	4.7
The amount of time it took to receive the rebate or financial incentive	4	--	--	--	1	1	4.5
The preapproval process	2	--	--	--	1	1	4.4
The inspection of your project by the DCSEU	4	--	1	--	--	3	4.3
The type of eligible equipment or projects	4	--	--	--	4	--	4.0
The amount of the rebate, discount, or financial incentive	4	--	--	1	2	1	4.0
The energy savings from your new equipment	3	--	--	--	3	--	4.0
The performance of the new equipment	3	--	--	--	3	--	4.0
The assistance from your contractor or vendor	2	--	--	--	2	--	4.0
The information about DCSEU offerings	4	--	1	1	1	1	3.5
The technical assistance you received from the DCSEU	2	--	--	1	1	--	3.5

[1] 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.

Based on their experience, participants provided feedback on what they would change about the New Construction program (Table 45). Respondents suggested that the program speed up processing times for the pre-approval and the rebate and move program processes online (two respondents, respectively). One respondent suggested that the program add more types of equipment, specifying that any component that contributes to a building's energy-efficiency should be included. One respondent did not suggest any changes to the program.

Table 45: Suggested Changes to the New Construction Program

Suggested Change	Count of Respondents (n=4)[1]
Speed up the rebate processing	2
Speed up the pre-approval processing	2
Have a completely web-based process	2
Require less information for project approval	1
Ensure that the quoted rebate is the same as the actual rebate	1
Include additional types of equipment	1
Expand the number of participating contractors and/or vendors	1
Allow greater flexibility in project timeline	1
Improve navigability of the website	1
No change	1

2.2.3.3 Program Experience

When asked why they implemented the measure through the New Construction program, participants most commonly cited a desire to advance their long-term strategic energy management plan and save money on energy costs (three respondents, respectively). Notably, only one respondent reported realizing energy savings; however, due to the nature of the program (new construction), the respondent may be an outside architect or engineer who only designs buildings or that buildings were not yet fully operational at the time of the survey. Three respondents reported a reduction in operating or maintenance costs as a result of participating in the New Construction program (Table 46).

Table 46: New Construction Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=4)[1]	
	Reason for Participation	Benefits Realized
Advance long-term strategic energy management plan	3	2
Save money on energy costs	3	1
Reduce operating or maintenance costs	2	3
Install more reliable equipment	2	2
Save money on equipment installation	1	1
Improve work environment	1	--
Increase safety/security	1	--
Improve production or productivity	1	1
Don't know	--	1

[1] Count of respondents sum to greater than 2 because some respondents provided more than one reason for implementation or benefit realized.

Two of the four participants reported facing at least one hurdle when deciding whether or not to participate in the New Construction program (Table 47). Both respondents cited the amount of management time needed to oversee projects. These respondents were not sure whether the program had helped them overcome these barriers. The other two respondents did not report experiencing any barriers to participating in the New Construction program.

Table 47: Hurdles Faced by New Construction Program Participants

Hurdle or Barrier	Count of Respondents (n=4)[1]
Amount of management time to oversee projects	2
Rebate application process was challenging	1
Organization hesitant to replace existing working equipment	1
Incremental cost for more efficient equipment was higher than expected	1
Other priorities for capital spending	1
No barriers/hurdles	2

[1] Counts sum to greater than 4 because some respondents provided more than one reason.

All four participants received assistance on their New Construction program application; three respondents received assistance from a third-party contractor or vendor, and one received assistance from DCSEU staff. On a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 3.5, on average. When asked what they would change about the application, respondents suggested reducing the amount of time needed to complete the application (two respondents), streamlining the process, clarifying up front what information is required, and automating the application response (one respondent each).

2.2.3.4 Program Awareness

New Construction program participants first heard about the program from a colleague or industry peer (two respondents), a distributor, or DCSEU staff or account manager (one respondent each). Other sources of program awareness included the DCSEU website and program vendors. One of the respondents suggested that the DCSEU could consider publicly recognizing and promoting individual program participants as a strategy to increase awareness about the program.

Three of the four respondents recalled visiting the DCSEU website. On a scale from 1 to 5, where 1 is not at all useful and 5 is very useful, respondents 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:

- New Construction projects are provided with an Energy Summary Report document that provides the final savings value. For some projects, a conversion is done from ASHRAE 90.1 2007 baselines used in the energy model to ASHRAE 90.1 2010 baselines. Although most projects' claimed savings for each measure match the values in the Energy Reports Summary, the NMR team found that some projects had inconsistent values between the claimed savings and the Energy Summary Report.

- Consider requiring the Energy Summary Report to include an explanation describing which energy model output file(s) and documents contributed to the final claimed savings. It should be clear which energy model output file(s) were used for the savings and why specific categories were included or excluded from the total savings.

- Consider adding input variables in the DCSEU tracker to include both baseline and proposed energy usage. The savings should simply be the difference between the two scenarios with clear reference to the modeling output file. One project was found to include a major error where the baseline was input into the tracker as the total savings and the Energy Reports Summary document (Baseline minus Proposed) did not equal the savings that was typed into the cell. Documents did not align and it was not clear how the final values were derived.

- Consider undertaking more quality control regarding the demand savings. Some projects referenced total demand reduction instead of summer peak demand savings.

- Consider ways to expedite processing times for application pre-approval and rebate delivery and streamline application processes, where possible.

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 FY2020, the program provided incentives for 30 projects. Table 48 provides the breakdown of tracked savings by measure type. The bulk of total energy savings and total electric savings reside with the lighting and HVAC measures.

Table 48: Market Opportunities Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Gas Savings	Percent of FY2020 Peak Demand Savings
HVAC	38%	15%	106%	24%
Appliances, Office Equipment, & Refrigeration	2%	3%	<1%	3%
Water Heating	4%	0%	15%	0%
Lighting	48%	71%	-21%	60%
Motors & Drives	8%	11%	0%	14%

For the FY2020 Market Opportunities program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.3.1 Gross Savings Verification

Table 49 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 98.3%, the demand realization rate was 101.9%, and the gas realization rate was 103.5%.

Table 49: Market Opportunities Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	5,719	98.3%	5,622
FY2020 Peak Demand Savings (MW)	0.95	101.9%	0.97
FY2020 Gas Savings (MMBtu)	6,575	103.5%	6,804

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 nine 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, which ensured that we reviewed the largest projects. The NMR team assigned projects with more than 2,500 MMBTU in total energy savings to the certainty stratum. We also had a large and small probability stratum from which we drew a random sample. The large probability stratum included non-certainty projects with total energy savings between 750 and 2,500 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 50 presents the final sample.

Table 50: Market Opportunities Sampling Plan

Stratum	Stratum Criteria	Percent of Program Energy Savings	FY2020 Participation	Number of Sampled Sites
Certainty	>2,500 MMBtu	52%	3	3
Large Probability	750 to 2,500 MMBtu	28%	6	3
Small Probability	<750 MMBtu	20%	21	3

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. Three of the nine desk reviews employed additional information gathered from virtual onsite verifications (two from the Certainty stratum and one from the Large Probability stratum). The virtual onsite 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. Figure 2 shows an example of the calculator used for a variable frequency drive (VFD).

Figure 2: Example of Custom Savings Calculation

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 made adjustments to variables, such as HOU or equipment efficiencies, that we were able to find 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 51. The findings that contributed to the realization rates are described in the text that follows.

Table 51: Market Opportunities Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	5,719	98.3%	5,622	80% ± 0.3%
FY2020 Peak Demand Savings (MW)	0.95	101.9%	0.97	80% ± 0.4%
FY2020 Gas Savings (MMBtu)	6,575	103.5%	6,804	80% ± 0.9%

The program-level realization rates are 98.3% for electric savings, 101.9% for demand savings, and 103.5% for natural gas savings. The selected sample ultimately achieved a ±0.3% precision for electric savings, ±0.4% for demand savings, and ±0.9% 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.

Custom 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.

The adjustments made to electric savings for this program are generally minor. The projects with adjustments that had the biggest impact on the program realization rate included the following:

- Ex-ante calculations for one project (Project ID 18052) appeared to use TRM-deemed values for post-installation fixture wattages, based on fixture type. The evaluation team's calculations used wattages that reflected the actual installed fixture, with values coming from specification sheets and DLC listings. The specific fixtures installed had actual wattages that were significantly lower than the TRM values; therefore, verified kWh savings are higher than ex-ante.

- One multi-measure project (Project ID 17015) included adjustments to electric kWh savings for space heating and VFD measures:

  o The ex-ante space heating calculations appeared to use an incorrect value for baseline efficiency related to the VRF system.

  o The evaluator verified that the VFD savings calculations were performed correctly, but there appeared to be discrepancies around the motor sizes and kWh savings values used between the tracking database and project calculation files.

- Ex-ante calculations for one project (Project ID 17042) appeared to use TRM-deemed values for post-installation fixture wattages, based on fixture type. The evaluation team's calculations used wattages that reflected the actual installed fixture, with values coming from specification sheets and DLC listings. The specific fixtures installed had actual wattages that were significantly lower than the TRM values; therefore, verified kWh savings are higher than ex-ante. The evaluator also made a slight adjustment to the lighting controls factor.

There were no significant adjustments made to peak electric demand savings. The project that had the largest effect on the demand savings realization rate was a Certainty stratum lighting project (Project ID 17042). The ex-ante savings appeared to use TRM-deemed values for post-installation fixture wattages, based on fixture type. The evaluation team's calculations used wattages that reflected the actual installed fixture, with values coming from specification sheets and DLC listings. The specific fixtures installed had actual wattages that were slightly lower than the TRM values; therefore, verified kWh savings are higher than ex-ante. The project's demand savings realization rate is 102%.

There were no significant adjustments made to gas savings. The projects that had the largest effect on the program realization rate included:

- Certainty stratum Project ID 17042. This is a lighting project for which no gas penalty (due to HVAC interactive effects) calculation was provided in project files. The evaluator's verified savings value differed from the one listed in the tracking database, but no calculation file could be located in the submitted project files; therefore, the evaluator was

unable to determine the source of the discrepancy. The project's gas savings realization rate is 106%.

- Certainty stratum Project ID 15741. This is a boiler replacement project. Ex-ante savings calculations used 82% for the baseline thermal efficiency. The evaluator could not identify a source for this value. Ex-post calculations assume 80% baseline plant efficiency - this is a commonly used value for the type and age of the system involved, especially when there is uncertainty about the actual efficiency. The project's gas savings realization rate is 106%.

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 seven 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 52, the seven Market Opportunities program participants received the following scores:

- One of the seven respondents 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 this respondent a low free-ridership intention score (0%).

- One respondent installed the measure but reported scaling back the scope or efficiency by a moderate amount. 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:

  o One respondent said they might have had the funds available to purchase the measure in the absence of the program. We assigned a moderate-high free-ridership intention score (37.5%).

  o Four of the seven 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 seven respondents is 38%.

Table 52: 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%	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%	1
	• Definitely would have had the funds	50%	4
Total		**38%**	**7**

Influence

Table 53 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 1 means it "played no role at all" and 5 means it "played a great role." The Market Opportunities program features with the highest average ratings include previous experience with a DCSEU program (4.2) and information or recommendations from a DCSEU representative (3.6).

Table 53: 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	6	1	--	--	1	4	4.2
Information or recommendation from a DCSEU representative	7	2	--	1	--	4	3.6
Information or recommendation from contractors or vendors associated with the program	6	2	--	1	2	1	3.0
The rebate	7	3	--	--	2	2	3.0
The results of any audits, energy modeling, or technical studies done through a program offered by DCSEU	6	2	--	1	2	1	3.0
DCSEU program marketing materials about the program	6	2	2	--	2	--	2.3

[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 54):

- Four of the seven 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%.

- One respondent provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.

- One respondent provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.

- One respondent 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 seven respondents is 14%.

Table 54: 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%	4
4	12.5%	1
3	25%	--
2	37.5%	1
1 - Program feature played no role OR Not applicable	50%	1
Don't know OR Refused	25%	--
Total	**14%**	**7**

When asked if any other factors played a great role in influencing them to implement the measure through the Market Opportunities program, one respondent reiterated a desire to save energy by implementing the measure.

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 52% and the average weighted free-ridership rate for the Market Opportunities program was 36% (Table 55).

Table 55: FY2020 Free-ridership Rate for Market Opportunities Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	52%	13%	100%
Free-ridership (savings-weighted)	36%	13%	100%

The FY2019 free-ridership rate was also 36%. Given the small sample sizes for the two years, we recommend combining the results from both years through a savings-weighted approach, shown in Table 56. As the free-ridership rate for both years was 36%, we recommend using 36% as the free-ridership rate.

Table 56: FY2019-FY2020 Free-ridership Rate for Market Opportunities Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2019	12	15%	36%
FY2020	7	85%	36%
Weighted Average			**36%**

2.3.2.2 Participant Spillover

One of the seven FY2020 respondents reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Market Opportunities project.[7] This respondent reported that the program had no influence on their decision to install these energy-efficient products. This resulted in a spillover rate of 0% for the Market Opportunities program. However, in FY2019, spillover savings represented 14% of tracked savings for the respondents (Table 57). Therefore, we recommend an average spillover rate of 2%.

Table 57: FY2019-FY2020 Spillover Rate for Market Opportunities Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2019	12	15%	14%
FY2020	7	85%	0%
Weighted Average			**2%**

2.3.2.3 NTG Ratio

The savings-weighted NTG ratio for the Market Opportunities program equals 66%, after rounding (Table 58).

Table 58: NTG Ratio for Market Opportunities Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	36%	2%	66%

2.3.3 Process Evaluation

For the process evaluation of the Market Opportunities program, the NMR team completed telephone and web surveys with program participants (Table 59).

Table 59: Market Opportunities Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	4
Participating end user surveys – web	3
Total	**7**

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[7] Another respondent said they were in the process of updating their HVAC system, but since the install was not yet complete, we did not assign them a spillover rate.

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, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.4, on average.

- DCSEU staff are critical to encouraging program engagement. Program participants most often heard about the program first from a DCSEU staff member or account manager (four of seven respondents), and five respondents received assistance on their application from the DCSEU.

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 9.4, 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 FY2019, participants rated their average satisfaction a 4.6. Table 60 shows their satisfaction ratings in detail.

Table 60: Participant Experience with the Market Opportunities Program[1]

Feature	n[2]	1 Not at all Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**7**	**--**	**--**	**1**	**2**	**4**	**4.4**
The energy savings from your new equipment	7	--	--	--	2	5	4.7
The performance of the new equipment	7	--	--	1	--	6	4.7
The assistance from your contractor or vendor	5	--	--	--	2	3	4.6
The technical assistance you received from the DCSEU	5	--	--	--	2	3	4.6
The application process	5	--	--	--	3	2	4.4
The information about the DCSEU offerings	7	--	--	--	5	2	4.3
The type of eligible equipment or projects	7	--	--	1	4	2	4.1
The preapproval process	4	--	--	--	4	--	4.0
Time to receive the rebate or incentive	5	--	1	--	2	2	4.0
The amount of the rebate, discount, or financial incentive	7	1	1	--	3	2	3.6

[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 time it took to receive the rebate as a 2 indicated that the application process was too lengthy.

- Both respondents who rated their satisfaction with the amount of the rebate as a 1 or a 2 indicated that the rebate amount was too small.

Based on their experience, participants provided feedback on what they would change about the Market Opportunities program. Four of seven respondents suggested program changes. Three participants suggested increasing the rebate level; in particular, respondents hoped to see increases ranging from 15% to 25%. One respondent observed that high rebates increase the return on investment (ROI) and make it easier for projects to be approved. Respondents also requested that the program include additional types of equipment, expand the number of participating contractors, and allow greater flexibility on the project timeline.[8] One respondent

[8] The participant who requested that the program include additional types of equipment suggested transformers, network protectors, compressors, rooftop units, and air handling units. The site in question was a healthcare facility.

indicated that the program could be improved by adding an online application process. The other three respondents did not suggest any changes based on their experience with the program.[9]

2.3.3.3 Program Experience

When asked why they implemented the measures through the Market Opportunities program, participants most commonly cited a desire to advance a long-term strategic management plan, install more reliable equipment, and reduce operating costs (six respondents, respectively). Six of seven respondents reported saving money on energy costs after participating in the program (Table 61).

Table 61: Market Opportunities Program Participants' Motivation for Participation and Benefits Realized

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

[1] Count of respondents sum to greater than 7 because some respondents provided more than one reason for implementation or benefit realized.

Only one of the seven respondents reported facing a hurdle when deciding whether or not to implement the measure through the Market Opportunities program. This respondent reported that the program's flexibility with the project timeline helped them overcome internal delays to project approval.

Five respondents reported receiving assistance on their Market Opportunities program applications from a DCSEU staff member and one respondent received assistance from a third-party vendor or contractor.[10] On a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.4, on average. In FY2019, participants rated the ease of completing the application a 4.0, on average.

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[9] One respondent replied "don't know" to this question.
[10] One respondent refused to respond.

2.3.3.4 Program Awareness

Most of the participants (five out of seven) learned about the Market Opportunities program before they began implementing their project, while two participants learned about the program after they began implementing their project. One of those participants did not engage with the DCSEU until after the project was complete, indicating that they had to adhere to an internal schedule for project completion.

Participants first heard about the Market Opportunities programs from DCSEU staff or account managers (two respondents) and the DCSEU website (two respondents). When asked where they had also heard about the program, respondents mentioned contractors (three respondents), followed by the DCSEU website, DCSEU mailing or email, and a colleague or industry peer (two respondents each). Table 62 shows all of the ways program respondents heard about the program.

Table 62: Sources of Market Opportunities Program Awareness

Source of Program Awareness	Count of Respondents (n=7)	
	Where Participants First Heard of Program	Where Participants Heard of Program Overall [1]
DCSEU staff or account manager	2	3
The DCSEU website	2	2
A contractor	1	3
A conference, trade show, or fair	1	1
A DCSEU mailing or email	--	2
A colleague or industry peer	--	2
A vendor	--	1
Don't know	1	1

[1] Count of respondents sum to greater than 7 because some respondents provided more than one response.

Over one-third of respondents (five of seven) had visited the DCSEU website before. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," 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:

- Continue to include site-specific calculators that are used to evaluate savings. This could be improved by adding some explanation on the workings of the calculators and variable breakdowns.

- Ensure that all references, assumptions, details, and baseline conditions for each project are provided and clearly laid out in project documentation. Each project should contain a narrative specifically related to baseline determination and associated inputs, particularly for efficiency measures involving HVAC equipment and heating/cooling plants.

- For lighting measures, consider developing a lighting workbook with assumptions referencing an index table. Referencing an index table would provide more consistency

across projects and provide a clear itemized list of the lighting measures to reference against project documents.

- Consider requiring a detailed statement for lighting inputs into the DCSEU tracker that provides explanation for final savings values. Specifically, natural gas penalties for LED lighting were not defined for some projects. We recommend providing more information on the HVAC systems for calculating the effects of LED lights on heating and cooling loads. Additionally, control savings should apply a standardized savings factor referenced from a source like ASHRAE or the TRM.

- For the projects with several dozen measures, add a brief explanation for each savings value input used in the tracker and a source reference to provide a more efficient quality control and review process.

2.4 CI RX - 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 163 unique projects in FY2020. Table 63 shows the measure types contributing savings to the program during FY2020. The FY2020 program year saw nearly 100% of combined energy savings from lighting.

Table 63: CIRX Equipment Replacement Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings (MMBtu)	Percent of FY2020 Electric Savings (MWh)	Percent of FY2020 Gas Savings (MMBtu)	Percent of FY2020 Peak Demand Savings (MW)
Appliances, Office Equipment, & Refrigeration	<1%	<1%	0%	<1%
Water Heating	<1%	0%	<1%	0%
Lighting	100%	100%	100%	100%

For the FY2020 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 64 displays the tracked savings, realization rate, and evaluated savings for the CIRX Equipment Replacement program. The electric savings realization rate equals 109%, the peak demand realization rate equals 106%, and the natural gas savings realization rate equals 109%.

Table 64: CIRX Equipment Replacement Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	11,808	109%	12,920
FY2020 Peak Demand Savings (MW)	1.40	106%	1.48
FY2020 Gas Savings (MMBtu)	-3,668	109%	-4,011

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 eight unique 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 2,500 MMBtu. The NMR team categorized projects with between 500 and 2,500 MMBtu of energy savings as large probability, while we categorized projects with under 500 MMBtu savings as small probability. Randomly sampling from the two groups enabled us to balance between capturing projects with a larger contribution to the program savings while still allowing space for smaller projects. Table 65 presents the final sample for the CIRX Equipment Replacement Program.

Table 65: CIRX Equipment Replacement Sampling Plan

Substratum	Energy Savings (MMBtu)	Percent of Energy Savings	FY2020 Participation (Projects)	Number of Sampled Projects
Certainty	5,336	15%	2	2
Large Probability	17,950	49%	21	3
Small Probability	13,336	36%	140	3

The selected sample included all lighting retrofit projects; note that the entire population of projects from the program only included five non-lighting projects. The sampled projects accounted for about 21% 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.

Three of the eight desk reviews employed additional information gathered from virtual onsite verifications (two from the Certainty stratum and one from the Large Probability stratum). The virtual onsite 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. The NMR team also removed interactive effects for underground parking garages as they are assumed to not be heated. Additionally, one project was found to be a new construction project that included occupancy sensors. The NMR team reviewed the relevant energy code and adjusted the energy savings to reflect the sensors being required by code. We then used the calculator to map site-specific inputs to the appropriate TRM baseline and installed wattages, coincidence factors (CF), waste heat factors, and controls savings factors.

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 66. The findings that contribute to the realization rates are discussed in the text that follows.

Table 66: CIRX Equipment Replacement Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	11,808	109%	12,920	80% ± 6.2%
FY2020 Peak Demand Savings (MW)	1.40	106%	1.48	80% ± 4.9%
FY2020 Gas Savings (MMBtu)	-3,668	109%	-4,011	80% ± 6.4%

The program-level electric savings realization rate is 109%, the program-level demand savings realization rate is 106%, and the program-level gas savings realization rate is 109%. The sampled project-specific realization rates ranged from 85% to 122%. The selected sample ultimately achieved a ±6.2% 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 ±33% 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 six of the eight sampled projects.

Two small probability stratum projects accounted for the largest project-level variation in post-installation fixture wattages (Project ID 19222 yielded a 122% realization rate for electric savings; Project ID 19653 yielded an 85% realization rate for electric savings).

The natural gas realization rate equaled 109%. 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.

2.4.2 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 19 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 67, the 19 CIRX Equipment Replacement program participants received the following scores:

- One-quarter of participants (five of the 19 respondents) 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%).

- Eight respondents said they would have implemented the measure but scaled back the scope or efficiency and one respondent was not sure what they would have done in the absence of the program. We assigned these nine respondents a moderate free-ridership intention score (25%).

- The remaining five 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 19 respondents is 25%.

Table 67: 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%	5
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	9
• 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%	5
Total		**25%**	**19**

Influence

Table 68 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 the rebate (4.4) and information or recommendations provided by contractors or vendors associated with the program (4.1).

Table 68: 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
The rebate	19	--	1	2	4	12	4.4
Information or recommendation from contractors or retailers associated with the program	16	2	1	--	4	9	4.1
Previous experience with a DCSEU program	12	2	--	2	--	8	4.0
Information or recommendation from a DCSEU representative	13	5	--	1	2	5	3.2
The results of any audits, energy modeling, or technical studies done through a DCSEU program	13	4	--	2	4	3	3.2
Marketing materials or information provided by DCSEU	14	5	1	1	4	3	2.9

[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 69):

- Nearly all of the CIRX Equipment Replacement program participants (18 out of 19 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 respondent provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.

The overall free-ridership influence score across all 19 respondents is 2%.

Table 69: 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%	18
4	12.5%	--
3	25%	--
2	37.5%	1
1 - Program feature played no role OR Not applicable	50%	--
Don't know OR Refused	25%	--
Total	**2%**	**19**

When asked if any other factors played a great role in influencing them to implement the measure through the CIRX Equipment Replacement Retrofit program, one respondent cited the energy-efficiency of the new lights and the fact that they would not have to deal with toxic waste disposal for the replaced products. Another respondent said that benchmarking played a great role, and a third respondent implemented the measure to comply with licensure requirements for their business.

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 27% and the average weighted free-ridership rate for the CIRX Equipment Replacement program was 30% (Table 70).

Table 70: FY2020 Free-ridership Rate for CIRX Equipment Replacement Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	27%	0%	63%
Free-ridership (savings-weighted)	30%	0%	63%

The FY2018 free-ridership rate was 35%, which was the last time net savings was estimated for the CIRX Equipment Replacement program. Given the small sample sizes for the two years, we recommend combining the results from both years through a savings-weighted approach, shown in Table 71. We recommend an average free-ridership rate of 32%.

Table 71: FY2018 & FY2020 Free-ridership Rate for CIRX Equipment Replacement Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2018	39	43%	35%
FY2020	19	57%	30%
Weighted Average			**32%**

2.4.2.2 Participant Spillover

Six of the 19 respondents reported installing energy-efficient or renewable energy equipment at a DC location after implementing the project through the CIRX Equipment Replacement program. Five of the respondents indicated that these projects did not receive a financial incentive or rebate. Two of the respondents rated the program's influence on their decision a 1 on a 1 to 5 scale, where 1 means "no influence at all" and 5 means "great influence." The other three participants rated the program's influence on their decision a 3 or 4. Based on those ratings, we assigned them spillover influence scores of 50% and 75% (as shown in Table 72).

Table 72: Spillover Influence Scores for CIRX Equipment Replacement Program

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

We estimated the savings associated with these lighting 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 19 survey respondents to calculate the spillover rate for the program. This resulted in a spillover rate of 0% for the CIRX Equipment Replacement program, after rounding (Table 73).[11]

Table 73: FY2020 Spillover Rate for the CIRX Equipment Replacement Program

	Average	Minimum	Maximum
Spillover Rate	0%	0%	13%

In FY2018, spillover savings represented 1% of tracked savings for the respondents. Given the sample sizes for the two years, we recommend combining the results from both years through a

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[11] The spillover was 0.25%, which we used when calculating the savings-weighted spillover for FY2018 and FY2020 in Table 74.

savings-weighted approach, shown in Table 74. Therefore, we recommend a spillover rate of 1% for FY2020.

Table 74: FY2018 & FY2020 Spillover Rate for CIRX Equipment Replacement Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2018	39	43%	1%
FY2020	19	57%	0%
Weighted Average			**1%**

2.4.2.3 NTG Ratio

The savings-weighted NTG ratio for the CIRX Equipment Replacement program equals 69%, after rounding (Table 75).

Table 75: NTG Ratio for CIRX Equipment Replacement Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	32%	1%	69%

2.4.3 Process Evaluation

For the process evaluation of the CIRX Equipment Replacement program, the NMR team completed telephone and web surveys with program participants (Table 76).

Table 76: CIRX Equipment Replacement Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	11
Participating end user surveys – web	8
Total	**19**

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, where 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[12] for the CIRX Equipment Replacement program was 84.

- The top two reasons participants cited for participating in the CIRX Equipment Replacement program were financial: saving money on energy costs (18 out of 19

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[12] 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.

respondents) and reducing operating or maintenance costs (15 out of 19). Among participants who cited barriers to program participation (three respondents), financing issues and a higher-than-expected incremental cost for more efficient equipment were the most common hurdles.

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 9.7, on average. The NPS for the program among participating end users was 84. Most of the respondents (16 of 19) were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. The other three respondents were *passives*, rating their likelihood to recommend the program to someone else an 8.

- Participants rated their overall satisfaction with the program a 4.7, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 77 shows their satisfaction ratings in detail.

Table 77: 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	**19**	**0**	**0**	**0**	**4**	**15**	**4.7**
The performance of the new equipment	18	0	0	0	4	14	4.8
The preapproval process	13	0	0	0	4	9	4.7
The inspection of your project by the DCSEU	11	0	0	0	3	8	4.7
The energy savings from your new equipment	17	0	0	2	3	12	4.6
The technical assistance you received from the DCSEU	9	0	0	0	4	5	4.6
The assistance from your contractor or vendor	12	0	0	0	6	6	4.5
The information about DCSEU offerings	18	0	0	2	7	9	4.4
The type of eligible equipment or projects	17	0	1	1	6	9	4.4
The application process	15	0	0	2	7	6	4.3
The amount of time it took to receive the rebate	17	1	1	0	7	8	4.2
The amount of the rebate, discount, or financial incentive	19	0	0	5	7	7	4.1

[1] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure." One respondent had not yet installed the measure. If n < 20, counts are shown.

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 as a 2 was disappointed that some of the bulbs they were interested in (e.g., MR16 and 18-watt triple prong tube lights) were not eligible.

- One respondent rated their satisfaction with the amount of time it took to receive the rebate a 1 because it took too long to receive the rebate. The respondent who rated their satisfaction a 2 said that it took too long to complete the application process.

Later in the survey, one respondent whose contractor collected the incentive through the program noted that they would have preferred to receive the rebate directly.

Based on their experience, participants provided feedback on what they would change about the CIRX Equipment Replacement program (Table 78). Respondents most commonly suggested increasing the rebate amount (by 20% or providing increased subsidies for LEDs) and adding

additional equipment types, such as HVAC equipment and additional types of bulbs [13] (two respondents, respectively). Other suggestions mentioned by more than one respondent included speeding up the pre-approval process and shifting the program processes online. Eight of the 19 participants did not suggest any changes based on their experience with the program.

Table 78: Suggested Changes to the CIRX Equipment Replacement Program

Suggested Change	Count of Respondents (n=19)[1]
The rebate amount	2
Have a completely web-based online process	2
Include additional types of equipment	2
Speed up the pre-approval of project	2
Speed up the rebate processing	1
Simplify the program application process	1
Require less information for project approval	1
Give more detailed instructions or examples on application form	1
Ensure that the quoted rebate is the same as the actual rebate	1
Include service in the program	1
No change	8

[1] Count of respondents is greater than 19 because some respondents provided more than one response.

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 (18 of the 19 respondents), reduce operating or maintenance costs (15 respondents), and advance a long-term strategic management plan (14 respondents). Thirteen respondents reporting saving money on equipment installation (Table 79). Six respondents implemented the measure in order to promote positive public relations, while five respondents reported realizing that goal; one respondent noted they were able to include program participation in marketing materials.

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[13] The respondent specified "MR16 and 18-watt triple prong tube light (in a number of sizes)." It was unclear if they were referring to LED replacements for these bulbs or CFLs.

Table 79: CIRX Equipment Replacement Program Participants' Motivation for Participation and Benefits Realized

Reason/Benefit	Count of Respondents (n=19)[1]	
	Reason for Participation	**Benefits Realized**
Save money on energy costs	18	18
Reduce operating or maintenance costs	15	15
Advance long-term strategic management plan	14	11
Save money on equipment installation	12	13
Install more reliable equipment	8	10
Improve work environment	8	9
Increase safety and/or security	6	6
Promote positive public relations	6	5
Improve production or productivity	4	2
Replace obsolete equipment	1	--

[1] Percentages sum to greater than 100% because some respondents provided more than one reason for implementation or benefit realized.

Almost three-quarters of the respondents (14 of 19) reported facing no barriers or hurdles when deciding to participate in the program. Of the three respondents who reporting facing a barrier or hurdle, the most frequently cited barrier was a higher-than-expected incremental cost for more efficient equipment (two respondents).[14] Respondents also cited a lack of financing and other priorities for capital spending, a lack of clarity about their project's energy-savings potential, a long internal lead time, and challenges with the rebate application process. One respondent indicated that the program provided assistance by being responsive to any questions that arose.

Most of the respondents (16 of the 19) reported receiving assistance on their CIRX Equipment Replacement applications from a third-party contractor or vendor (13 respondents) and/or a DCSEU staff member (four respondents). One respondent completed the application themselves and two others received assistance from colleagues. On a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.1, on average.

2.4.3.4 Program Awareness

More than two-thirds of the participants (13 out of 19) learned about the CIRX Equipment Replacement program before they began planning their project. Five respondents learned about the program after they began planning the project and another reported learned of it after completing the project (Table 80).

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[14] Two participants responded, "I don't know," when asked if they had faced any hurdles to deciding whether to implement the measure through the program.

Table 80: Awareness of CIRX Equipment Replacement Program

When Respondent Learned about the Financial Incentives/Assistance	Count of Respondents (n=19)
Before planning the project	13
After planning the project, but prior to implementing	5
After implementing the project, but prior to completing	--
After completing the project	1

Thirteen of the 19 respondents first engaged with the DCSEU *before* they began implementing the project, while three respondents first engaged with the DCSEU after the project began. One respondent reported that they did not engage with the DCSEU until after the project was complete. [15] When asked why their organizations moved forward with their project before submitting their application to the program, participants pointed to time or resource constraints at their organization, the need to move forward with an internal schedule, and the time needed to submit an application through the program application system.[16]

Respondents first heard about the CIRX Equipment Replacement program from a vendor (six respondents) or a contractor (five respondents), followed by a colleague or industry peer (three respondents). Table 81 shows all of the ways program respondents heard about the program.

Table 81: Sources of CIRX Equipment Replacement Program Awareness

Source of Program Awareness	Count of Respondents (n=19)	
	Where Participants First Heard of Program	Where Participants Overall Heard of Program[1]
A vendor	6	9
A contractor	5	5
A colleague or industry peer	3	8
A distributor	1	2
The DCSEU website	1	6
DCSEU staff or account manager	--	4
A DCSEU mailing or email	--	2
DCSEU online advertisement	--	1
A newspaper, radio, or television ad	--	1
Other (DC Council Proceedings)	1	1
Other (From customer's utility)	1	1
Don't know	1	1

[1] Counts sum to greater than 19 because some respondents provided more than one response.

Three-quarters of respondents (14 of 19) had visited the DCSEU website before. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.6 for the information provided on the DCSEU's energy saving programs.

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[15] Two respondents responded, "I don't know," when asked when they first engaged with DCSEU on their CIRX Equipment Replacement project.
[16] Of the four respondents who moved forward with the project before engaging with DCSEU, one respondent was unsure why they submitted their application after starting the project.

2.4.4 Recommendations

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

- Site-specific equipment information, such as installed fixture wattage, should be used rather than relying on the assumptions created by the measure code to calculate the wattage difference. Energy efficient wattage was updated from TRM assumed values to the wattage of the actual fixture installed for all sampled projects.

- To account for peak demand savings, the TRM should include a formula that calculates the summer peak demand coincidence factor based on load shape recorded in the Tracker. This issue arose in all sampled projects and could improve savings calculations for all measure types.

2.5 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 light bulbs 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 FY2020 Upstream Lighting program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.5.1 Gross Savings Verification

Table 82 shows the tracked savings, realization rate, and evaluated savings for the Upstream Lighting program. The electric savings realization rate was 115.3%, the demand savings realization rate was 112.4%, and the gas savings realization rate was 114.7%.

Table 82: Upstream Lighting Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	16,856	115.3%	19,432
FY2020 Peak Demand Savings (MW)	2.29	112.4%	2.58
FY2020 Gas Savings (MMBtu)	-5,478	114.7%	-6,282

2.5.1.1 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 11 unique sample 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 1,250 MMBtu. The NMR team automatically selected projects that had total energy savings above 1,250 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 500 and 1,250 MMBtu, and a small probability stratum for the remaining projects. We randomly sampled projects from each of the probability strata. Table 83 presents the final sample for the Upstream Lighting program.

Table 83: Upstream Lighting Sampling Plan

Stratum	Percent of Program Energy Savings	FY2020 Participation	Number of Sampled Sites
Certainty	14%	4	4
Large Probability	50%	36	3
Small Probability	36%	92	4

2.5.1.2 Methodology

The NMR team conducted a desk review for 11 of the 132 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.

2.5.1.3 Results

The program-wide impact evaluation results for the Upstream Lighting Program are shown in Table 84. The findings that contributed to the realization rates are described in the text that follows.

Table 84: Upstream Lighting Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	16,856	115.3%	19,432	80% ± 5.7%
FY2020 Peak Demand Savings (MW)	2.29	112.4%	2.58	80% ± 4.9%
FY2020 Gas Savings (MMBtu)	-5,478	114.7%	-6,282	80% ± 5.8%

The program-level electric and demand savings realization rates are 115.3% and 112.4%, 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 ±35% 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 nine of the 11 sampled projects.

The natural gas realization rate equaled 114.7%. 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.

2.5.2 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 39 web and telephone surveys completed with participating Commercial Upstream Lighting program customers.

2.5.2.1 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 85, the 39 Commercial Upstream Lighting program participants received the following scores:

- Nearly one-quarter of participants (23%) 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%).

- More than two-fifths of participants (44%) 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:

   o 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%).

   o One-quarter of respondents (26%) 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 39 respondents is 27%.

Table 85: 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 measure for at least one year OR • Cancelled the purchase of the measure altogether	• Not Asked	0%	23%
• Purchased a less efficient measure or different product instead OR • Don't know OR • I'd rather not answer	• Not Asked	25%	44%
• 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%	26%
Total		**27%**	**39**

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

Influence

Table 86 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 (4.3) and information or marketing materials from a DCSEU representative (4.1).

![NMR Group, Inc. logo]

Table 86: 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	38	5%	8%	5%	16%	66%	4.3
Information or recommendation from a DCSEU representative	37	14%	--	5%	30%	51%	4.1
Previous experience with a DCSEU program	34	18%	6%	9%	18%	50%	3.8
DCSEU program marketing materials about the program	36	31%	6%	31%	17%	17%	2.8
Information or recommendation from contractors or retailers associated with the program	34	41%	9%	12%	18%	21%	2.7

[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):

- Over four-fifths of Commercial Upstream Lighting program respondents (82%) 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%.

- Thirteen 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 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 39 respondents is 4%.

Table 87: 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%	82%
4	12.5%	13%
3	25%	--
2	37.5%	--
1 - Program feature played no role OR Not applicable	50%	3%
Don't know OR Refused	25%	3%
Total	**4%**	**39**

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

Thirteen respondents named at least one non-program factor that played a great role in influencing them to purchase LEDs through the program (Table 88). Respondents most often mentioned support for energy efficiency from their organization's leadership and/or the community (five respondents).[17] Respondents also cited a commitment to sustainability (three respondents) and an interest in saving money and energy (three respondents, respectively) as factors having a great role in their purchase. One respondent was influenced by the longer effective useful life (EUL) of LEDs, meaning that maintenance staff would need to change bulbs at the facility less often.

Table 88: Non-Program Factors Influencing Purchase of LEDs through the Commercial Upstream Lighting Program

Other Factor Influencing Purchase Decision	Count of Respondents (n=13)[1]
Internal or institutional support for energy efficiency	5
Sustainability	3
Saving money	3
Energy savings	3
Time savings (facility maintenance)	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 FY2020, the average unweighted free-ridership rate was 30% and the average weighted free-ridership rate for the Commercial Upstream Lighting program was 28% (Table 89).

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[17] Specifically, one respondent from a government agency cited a federal mandate to conserve energy.

Table 89: FY2020 Free-ridership Rate for Commercial Upstream Lighting Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	30%	0%	100%
Free-ridership (savings-weighted)	28%	0%	100%

The FY2019 free-ridership rate was 30%. We recommend combining the results from both years through a savings-weighted approach, shown in Table 90. We recommend an average free-ridership rate of 29%.

Table 90: FY2019-FY2020 Free-ridership Rate for Upstream Lighting Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership Rate
FY2019	48	61%	30%
FY2020	39	39%	28%
Weighted Average			**29%**

2.5.2.2 Participant Spillover

Nearly one-fifth of the 39 respondents (18%) reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Commercial Upstream Lighting project. Two participants (5%) reported that the program had some influence on their decision to install additional LEDs (Table 91). The participants rated the program's influence on their decision a 4 and a 5 on a 1 to 5 scale, where 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 75% and 100%, respectively.

Table 91: 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%	LEDs	1
Rating of 5 (great influence)	100%	LEDs	1
Respondent does not know how much influence	50%	-	-

We estimated the savings associated with the LEDs by assigning them the average per unit savings for LEDs from the FY2020 program tracking database. We then divided that estimate by the cumulative tracked savings across all 39 survey respondents to calculate the spillover rate. This resulted in a spillover rate of 1% for the Commercial Upstream Lighting program (Table 92).

Table 92: FY2020 Spillover Rate for Commercial Upstream Lighting Program

	Average	Minimum	Maximum
Spillover Rate	1%	0%	1,121%

In FY2019, spillover savings represented 5% of tracked savings for the respondents. Given the small sample sizes for the two years, we recommend combining the results from both years through a savings-weighted approach, shown in Table 93. Therefore, we recommend an average spillover rate of 3%.

Table 93: FY2019-FY2020 Spillover Rate for Commercial Upstream Lighting Program

	Sample Size	Percent of Sampled Energy Savings	Spillover Rate
FY2019	48	61%	5%
FY2020	39	39%	1%
Weighted Average			**3%**

2.5.2.3 NTG Ratio

The savings-weighted NTG ratio for the Commercial Upstream Lighting program equals 74%, after rounding (Table 94).

Table 94: NTG Ratio for Commercial Upstream Lighting Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	29%	3%	74%

2.5.3 Process Evaluation

For the process evaluation of the Commercial Upstream Lighting program, the NMR team completed telephone and web surveys with program participants (Table 95). 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.[18]

Table 95: Commercial Upstream Lighting Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	32
Participating end user surveys – web	7
Total	**39**

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[18] 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.

2.5.3.1 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, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.8, on average.

- The NPS[19] for the Commercial Upstream Lighting program was 74.

- Commercial Upstream Lighting program participants realized financial benefits through participation in the program: 90% saved money on energy costs and 85% saved money on operating or maintenance costs.

2.5.3.2 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 9.4, on average. The NPS for the program among participating end users was 74. Overall, 82% of respondents were *promoters* – that is, these participating end users may actively promote the program to other potential participants by word of mouth. FY2019 participants were more likely to recommend the program than FY2020 participants; in FY2019, the NPS was 83.

- Participants rated their overall satisfaction with the program a 4.8, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Satisfaction levels are on par with those found in FY2019. Table 96 shows their satisfaction ratings in detail.

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[19] 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 96: 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	**38**	**0%**	**0%**	**3%**	**11%**	**87%**	**4.8**
The assistance from your contractor or vendor	27	0%	0%	0%	11%	89%	4.9
The assistance of the distributor you purchased the LEDs from	37	0%	0%	0%	11%	89%	4.9
The performance of the new equipment	37	0%	0%	0%	16%	84%	4.8
The energy savings from your new equipment	35	0%	0%	3%	23%	74%	4.7
The amount of the rebate, discount, or financial incentive	34	0%	3%	6%	29%	62%	4.5
The technical assistance you received from the DCSEU	14	--	1	1	3	9	4.4
The type of eligible equipment or projects	37	0%	0%	11%	38%	51%	4.4
The information about the DCSEU offerings	34	0%	6%	6%	32%	56%	4.4

[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 amount of the rebate as a 2 said that the rebate was too small.

- One respondent rated their satisfaction with the technical assistance they received from the DCSEU as a 2, saying that they wrote to the DCSEU "at least twice and received no response."

- Two respondents rated their satisfaction with the information about DCSEU offerings a 2. They requested additional communication from the DCSEU and increased visibility of program offerings.

Based on their experience, participants provided feedback on what they would change about the Commercial Upstream Lighting program (Table 97). Eight percent of respondents suggested increasing the rebate amount; in particular, respondents suggested increasing the rebate amount by 20%, standardizing the rebate amount across bulb types, and offsetting the installation cost. Respondents also suggested that the program offer more technical assistance and/or education

(8%) and additional types of equipment (5%).[20] However, more than one-half of respondents (59%) did not suggest any changes based on their experience with the program.

Table 97: Suggested Changes to the Commercial Upstream Lighting Program

Suggested Change	Percent of Respondents (n=39)[1]
The rebate amount	8%
Offer more technical assistance or education	8%
Include additional types of equipment	5%
Increase the rebate eligibility window	3%
Increase the cap on program-eligible purchases	3%
Offer more reliable equipment	3%
Improve program awareness and visibility	3%
No change	59%
Don't know	10%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

2.5.3.3 Program Experience

When asked why they purchased LEDs through the Commercial Upstream Lighting program, participants most commonly cited a desire to save money on energy costs (87%), reduce operating or maintenance costs (77%), advance a long-term strategic energy management plan (74%), and to save money on equipment installation (72%) (Table 98). More than half of respondents also purchased the LEDs because they wanted to install more reliable equipment (54%) and promote positive public relations (51%).

When asked what benefits their companies realized after participating in the Commercial Upstream Lighting Program, participants most often reported saving money on energy costs (90%), a reduction in operating or maintenance costs (85%), and advancement of their long-term strategic energy management plan (79%). In fact, participants reported realizing more benefits in nearly every category than they had foreseen when deciding to participate in the program (e.g., 36% of respondents purchased LEDs through the program in order to increase safety or security at their company, while 46% of respondents reported realizing this benefit after participating).

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[20] When asked to specify what additional equipment the program should offer, respondents named equipment types outside the program's scope: solar panels, inverters, window treatments, and "anything that saves energy."

Table 98: Commercial Upstream Lighting Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=39)[1]	
	Reason for Participation	Benefits Realized
Save money on energy costs	87%	90%
Reduce operating or maintenance costs	77%	85%
Advance long-term strategic energy management plan	74%	79%
Save money on equipment installation	72%	74%
Install more reliable equipment	54%	64%
Promote positive public relations	51%	49%
Improve work environment	44%	54%
Improve production or productivity	38%	41%
Increase safety/security	36%	46%
Benefit the environment/reduce carbon footprint	3%	--
Marketing	--	6%
Other	8%	6%
Don't know	3%	3%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

One-quarter of participants reporting facing at least one hurdle when deciding whether or not to purchase LEDs through the program (Table 99). The respondent who indicated that the payback period was too long noted that the company required a payback period of five years. Four of these ten participants reported that the rebate helped them overcome barriers to participation, while three indicated that the program did not help, and the other respondents were not sure.

Table 99: Hurdles Faced By Commercial Lighting Program Participants

Hurdle/Barrier	Count of Respondents (n=10)[1]
Lack of funds available for investment	2
Internal approval lead time	2
Equipment availability	1
Respondent leases the space	1
Existing equipment is functional	1
Payback period is too long	1
The economy	1
Amount of time needed by vendor to install the equipment	1
Don't know	2

[1] Counts sum to greater than 10 because some respondents provided more than one reason.

2.5.3.4 Program Awareness

More than three-quarters of respondents (79%) were aware they had participated in the Commercial Upstream Lighting program prior to taking the survey. Of those respondents, 87% reported learning about the program before purchasing the LEDs (Table 100).

Table 100: Awareness of Commercial Upstream Lighting Program Rebate Availability

When Respondent Learned about the Rebate	Percent of Respondents (n=31)[1]
Before purchasing LEDs	87%
While purchasing LEDs	6%
After purchasing LEDs	3%
Don't know	3%

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

Nearly one-quarter of participants reported first learning about the program from a distributor (23%), contractors (13%), vendors[21] (13%), DCSEU mailing or emails (10%), and DCSEU staff or account managers (10%). Table 101 shows all of the ways program respondents heard about the program; distributors (46%), vendors (44%), and colleagues or industry peers (41%) are the most common sources of program marketing.

Table 101: Sources of Commercial Upstream Lighting Program Awareness

Source of Program Awareness	Where Participants First Heard of Program	Where Participants Overall Heard of Program
A distributor	23%	46%
A contractor	13%	38%
A vendor	13%	44%
A DCSEU mailing or email	10%	33%
DCSEU staff or Account Manager	10%	36%
A colleague or industry peer	8%	41%
A DCSEU online advertisement	3%	10%
A conference, trade show, or fair	3%	21%
Utility bill insert	3%	3%
Trade magazine article	3%	3%
DCSEU website	--	31%
A newspaper, radio, or television ad	--	5%
DCSEU social media	--	3%
Don't know	13%	--

More than two-fifths of the 39 program participants (62%) reported visiting the DCSEU website. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.4 for the information provided on the DCSEU's energy saving programs.

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[21] Some FY2020 participants may be unclear on the role of their distributor and referred to them as a "vendor" in the survey.

2.5.3.5 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. Nearly one-half of all respondents (41 of 89 commercial survey respondents) suggested some type of equipment. Table 102 shows all equipment types identified by at least two respondents. [22] HVAC equipment was the most popular request (37%), followed by appliances (20%), VFDs (17%), and motors (15%).

Table 102: Equipment Suggested for Instant Discounts Through Distributors

Equipment Type	Percent of Respondents (n=41)[1]
HVAC equipment	37%
Appliances	20%
Variable frequency drives	17%
Motors	15%
Solar panels	7%
Occupancy sensors	2%
Chillers	2%
Cooling towers	2%

[1] Percentages sum to greater than 100 because some respondents provided more than one reason. Equipment types that were only suggested by one respondent are not shown in the table.

2.5.4 Recommendations

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

- If possible, gathering information about the building type at the time of the lighting purchase could be helpful to determine hours of operation, instead of relying solely on fixture type for HOU.

- Inquire with customers about conducting post-installation inspections and providing photos to ensure the fixtures and bulbs purchased are installed, leading to more accurate savings calculations. Due to the upstream nature of the program, inspections are not currently performed (or the information is not provided). There is currently an assumed in-service rate of 97%; however, if inspections were performed this value would be more accurate for each project.

- Use site-specific information if available, such as the efficient bulb/fixture wattage, rather than relying on the TRM assumptions. For all sampled projects, the efficient wattage had to be updated from TRM values based on Item Code and Measure Description to the wattage of the actual fixture installed/purchased.

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[22] Respondents also requested instant discounts for the following equipment types: automation systems, ballasts, blowers, boilers, computer equipment, DOAS units, EV chargers, hot water converters, HVAC controls, mechanical equipment, pipe insulation, RTU/AHU, solar shades, steam traps, and water heating equipment.

- Ensure all projects have spec sheets provided for each model number and fixture. Five out of the 11 projects we evaluated had some spec sheets missing, so the evaluator had to search for them on Google or manufacturer websites.

- Request that participating distributors collect contact information for Commercial Upstream Lighting program participants. While it will improve data collection for future process evaluations, the main benefit will be to provide DCSEU with contact information of site managers who could be interested in additional energy savings opportunities through other DCSEU programs.

- Consider providing instant rebates for additional equipment types, such as HVAC equipment, appliances, VFDs, and motors.

2.6 PAY FOR PERFORMANCE (7520P4PX)

The Pay for Performance (P4P) track focuses on C&I existing buildings that are 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).[23] 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 FY2020, there were 14 total project IDs listed in the tracking database; however, the program only appeared to have claimed savings and provided incentives for four projects. Table 103 presents the breakdown of tracked savings for each project in FY2020. The majority of the savings for the program during FY2020 originated from scheduling, temperature setpoint optimization, equipment control upgrades, and other ongoing building commissioning and retro-commissioning measures.

Table 103: P4P Program Tracked Savings by Project

Project ID	Electric Energy Savings (MWh)	Peak Demand Savings (MW)	Gas Savings (MMBTU)
14249	4,691	0.36	0
14794	147	0.15	0
17056	726	0.05	0
18946	1,288	0.13	663
Total	**6,851**	**0.68**	**663**

[23] 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.

For the FY2020 P4P program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.6.1 Gross Savings Verification

Table 104 shows the tracked savings, realization rate, and evaluated savings for the P4P program. The realization rates are 100% for electric, peak demand, and natural gas savings.

Table 104: P4P Program Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	6,851	100%	6,851
FY2020 Peak Demand Savings (MW)	0.68	100%	0.68
FY2020 Gas Savings (MMBtu)	663	100%	663

2.6.1.1 Sampling

Due to the small number of participants in the P4P program during FY2020, 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.

2.6.1.2 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 FY2020, the COVID-19 pandemic caused numerous businesses to shut down operations. The P4P program is uniquely affected by customer shutdowns since the program savings are calculated by examining the customers usage data. The timing for two of the P4P projects 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 these projects. For both projects, 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 3 shows an example for project 14794 of how the performance period 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 3: Models Used for Project 14794
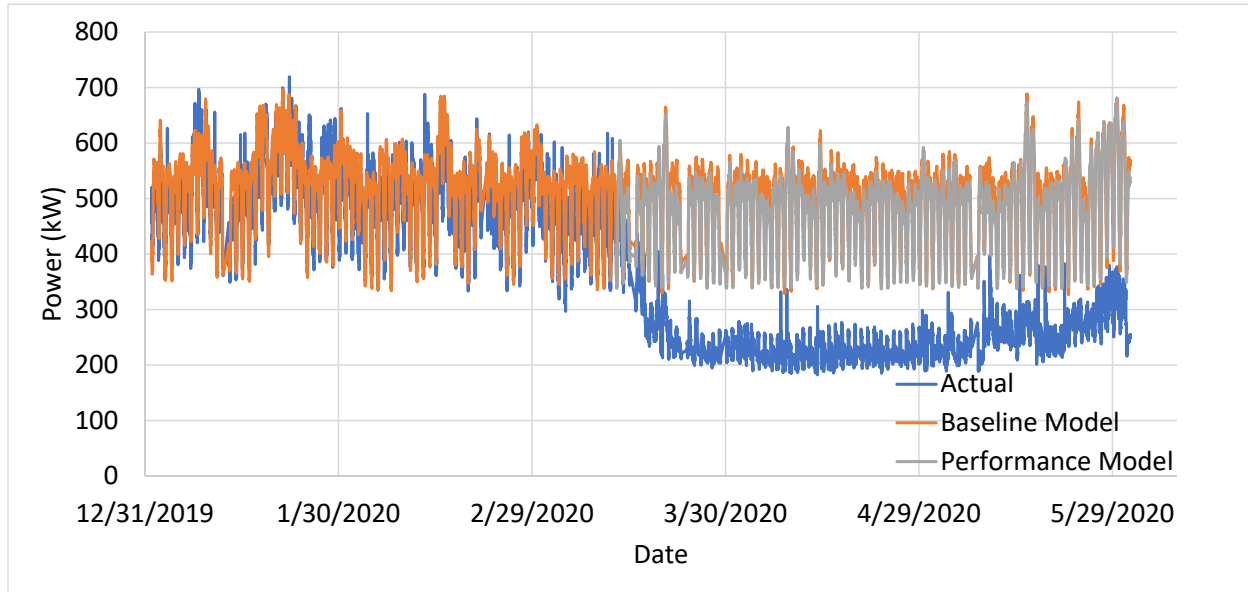
2.6.1.3 Results

The program-wide impact evaluation results for the program are shown in Table 105. 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 105: P4P Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	6,851	100%	6,851	n/a - census
FY2020 Peak Demand Savings (MW)	0.68	100%	0.68	n/a - census
FY2020 Gas Savings (MMBtu)	663	100%	663	n/a - census

The program-level realization rates are 100% for electric savings, 100% for demand savings, and 100% for natural gas savings. The evaluation team concluded that the 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 the SEU. The model code uses an open-source programming language (python) and transparent packages, such as pandas.[24] The modeling code does use proprietary modules and files, such as weather data, which could 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 4 shows a snapshot for one of the reviewed projects 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 and are nearly identical. The large spikes and dips in customer usage are indications of non-routine events, which TTOW do not explain. Future work on modeling can focus on including independent variables that help identify and explain non-routine events.

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[24] 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/

Figure 4: SEU and Evaluation Team Baseline Models with Customer Usage for Project 17056
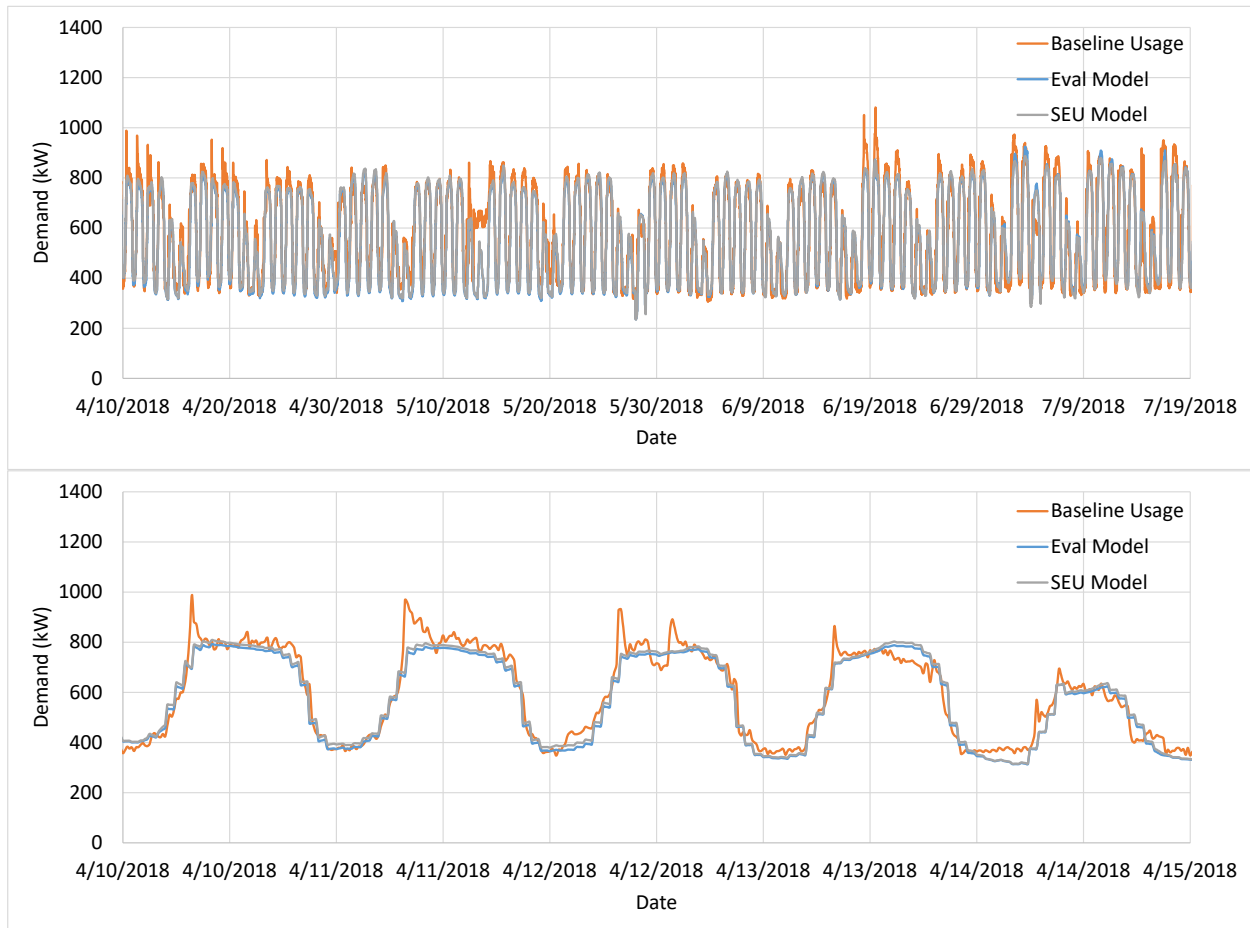
Once the baseline model was developed, the evaluation team then calculated the savings for each project by comparing the modeled baseline usage to the customer's actual usage during the evaluation periods. Given the similarity in baseline model results, the SEU and evaluation team cumulative savings estimates were consistent. Figure 5 shows the SEU and evaluation team cumulative summation (CUSUM) savings estimates for Project 17056. The calculations follow the same pattern and are very similar throughout the evaluation period for this project. The other three reviewed projects showed similar results.

Figure 5: CUSUM Electric Savings for Project 17056
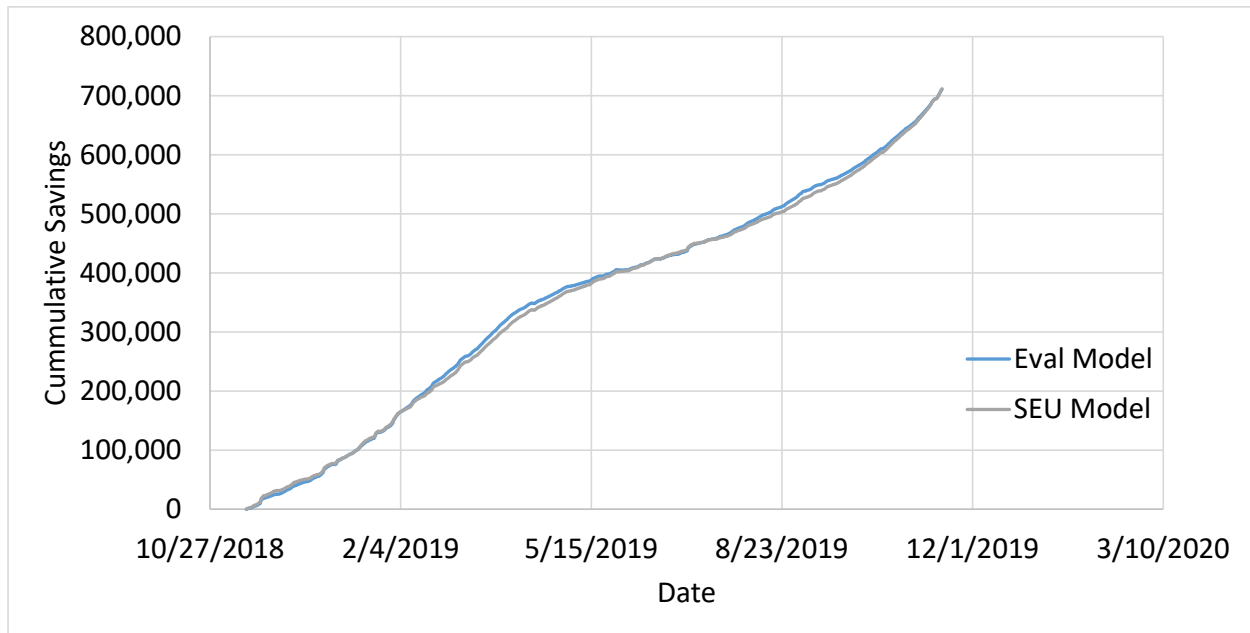
The evaluation team completed the above review steps for each of the four projects in the program during FY2020. Savings estimates calculated by the evaluation team were within the fractional savings uncertainty bounds at the 90% confidence level of the SEU savings estimates, indicating statistically similar results for electric savings (Figure 6).

Figure 6: SEU and Evaluation Team Electric Savings by Project
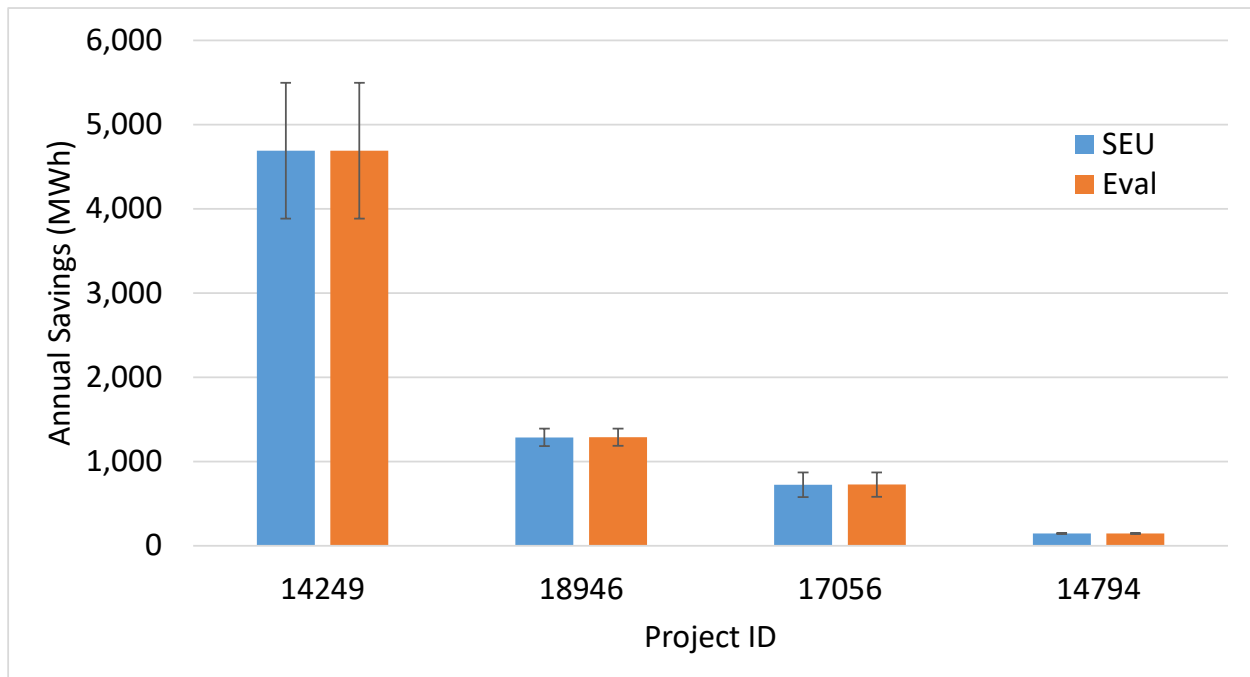
The evaluation team also verified the peak demand savings claimed by the SEU and found them to be accurate. One project, Project ID 18946, also claimed natural gas savings. Because interval natural gas data was not available, the SEU utilized monthly billing records. The evaluation team verified that the monthly regression model was calculated correctly for this project.

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 two surveys (one web and one telephone survey) completed with participating Pay for Performance 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 106, the two Pay for Performance program participants received the following scores:

- One participant was not sure what they would have done in the absence of the program, so we assigned a moderate free-ridership intention score (25%).

- The other respondent 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 a high free-ridership intention score (50%).

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

Table 106: Free-ridership Intention Scoring for Pay for Performance 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	37.5%	--
	• Definitely would have had the funds	50%	1
Total		**38%**	**2**

Influence

Table 107 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 1 means it "played no role at all" and 5 means it "played a great role." The Pay for Performance program features with the highest average ratings include previous experience with a DCSEU program, information or recommendation from a DCSEU representative, and marketing materials or program information from the DCSEU (5.0, respectively).

Table 107: Influence of DCSEU Program Features for Pay for Performance 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	5.0
Information or recommendation from a DCSEU representative	2	--	--	--	--	2	5.0
DCSEU marketing materials or program information	1	--	--	--	--	1	5.0
The rebate	2	--	--	--	1	1	4.5
The results of any audits, energy modeling, or technical studies done through a DCSEU program	2	--	--	--	1	1	4.5
Information or recommendation from contractors or vendors associated with the program	2	--	--	--	2	--	4.0

[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 108). Both of the Pay for Performance 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 108: Free-ridership Influence Scoring for Pay for Performance 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**

Participants did not name any other factors that played a great role in influencing them to implement the measure through the Pay for Performance 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 38% and the average weighted free-ridership rate for the Pay for Performance program was 26% (Table 109).

Table 109: Free-ridership Rate for Pay for Performance Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	38%	25%	50%
Free-ridership (savings-weighted)	26%	25%	50%

2.6.2.2 Participant Spillover

Neither of the two respondents indicated that they had purchased and installed energy-efficient products for which they did not receive a rebate after completing their Pay for Performance project. This resulted in a spillover rate of 0% for the Pay for Performance program.

2.6.2.3 NTG Ratio

The savings-weighted NTG ratio for the Pay for Performance program equals 74%, after rounding (Table 110).

Table 110: NTG Ratio for Pay for Performance Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	26%	0%	74%

2.6.3 Process Evaluation

For the process evaluation of the Pay for Performance program, the NMR team completed telephone and web surveys with two program participants (Table 111).

Table 111: Pay for Performance Program Evaluation Activity

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

2.6.3.1 Key Findings

The key findings from the process evaluation of the Pay for Performance program are as follows:

- On a scale from 1 to 5, where 1 is "not at all satisfied" and 5 is "very satisfied," the two participants rated their satisfaction with the program overall a 5.0, on average.

- Both respondents said they were highly likely to recommend the Pay for Performance program to someone else.

- Satisfaction with the rebate, while still high, was one of the program features with the lowest satisfaction rate (a 4.0, on average). While one respondent suggested increasing the rebate, the other respondent credited the availability of the rebate with getting their organization's upper management on board with the energy-efficiency improvement.

2.6.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," both participants rated their likelihood to recommend the program to someone else a 10.

- Participants rated their overall satisfaction with the program a 5.0, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 112 shows their satisfaction ratings in detail.

Table 112: Participant Experience with the Pay for Performance Program

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

[1] 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.

Based on their experience, participants provided feedback on what they would change about the Pay for Performance program. One participant suggested that the program increase the incentive, though they did not specify by how much.

2.6.3.3 Program Experience

When asked why they implemented the measure through the Pay for Performance program, both participants cited a desire to install more reliable equipment; reduce operating, maintenance, and energy costs; and advance a long-term strategic management plan. However, after participating, only one of the respondents reported experiencing increased equipment reliability or energy savings (Table 113).

Table 113: Pay for Performance 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	1
Reduce operating or maintenance costs	2	2
Save money on energy costs	2	1
Advance long-term strategic energy management plan	2	2
Improve production or productivity	1	1
Improve work environment	1	1
Promote positive public relations	1	1
Save money on equipment installation	--	1

[1] Count of respondents sum to greater than 2 because some respondents provided more than one reason for implementation or benefit realized.

One participant reported that upper management did not see the benefit of energy efficiency; the rebate helped them overcome this hurdle. The other respondent did not face any hurdles when deciding whether to implement the measure through the program.

Both respondents reported that a DCSEU staff member helped them complete their Pay for Performance applications. On a scale from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.5, on average.

2.6.3.4 Program Awareness

Both participants learned about the Pay for Performance program and engaged with the DCSEU before they started planning their project. Participants reported first learning about the Pay for Performance program though DCSEU staff or account managers and colleagues. One of the participants also recalled hearing about the program at a conference, trade show, or fair. Neither of the respondents could recall visiting the DCSEU website.

2.6.4 Recommendations

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

- The evaluation team recommends that the SEU continue to utilize the TTOW modeling algorithm whenever possible. The TTOW model is well supported by the literature and has been found to be a very accurate energy predictor when weather data is the only available independent variable.

- The effects of the COVID pandemic will continue to impact the P4P program for the next two or three years. Depending on when customers enter the program, their baseline or performance periods will include the 2020 calendar year. The SEU properly handled the effects of the pandemic by examining data periods that were unaffected by the pandemic, or by including indicator variables to account for the impacts. The SEU should continue to be mindful of the pandemic time periods as the P4P program continues.

2.7 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 FY2010.

For the FY2020 MTV program, we completed the following evaluation activities:

- Net Savings Estimation
- Process Evaluation

2.7.1 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 four web and telephone surveys completed with participating Market Transformation Value program customers.

2.7.1.1 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 114, the four Market Transformation Value program participants received the following scores:

- Three participants would have delayed the implementation of the measure for at least one year, so we assigned them a free-ridership influence score of 0%.

- One participant was not sure what they would have done in the absence of the program, so we assigned a moderate free-ridership intention score (25%).

The overall free-ridership intention score for the four respondents is 6%.

Table 114: 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%	3
• 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 have had the funds	50%	--
Total		**6%**	**4**

Influence

Table 115 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 (4.8) and previous experience with a DCSEU program (3.5).

Table 115: 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	4	--	--	--	1	3	4.8
Previous experience with a DCSEU program	4	1	--	--	2	1	3.5
The results of any audits, energy modeling, or technical studies done through a DCSEU program	2	--	--	1	1	--	3.5
Information or recommendation from contractors or vendors associated with the program	4	1	--	--	3	--	3.3
DCSEU marketing materials or program information	4	--	2	1	--	1	3.0
Information or recommendation from a DCSEU representative	4	--	2	1	1	--	2.8

[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 116). All four of the 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 116: 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%	4
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%**	**4**

Participants did not name any other factors that played a great role in influencing them to implement the measure through the MTV 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 6% and the average weighted free-ridership rate for the MTV program was 15% (Table 117).

Table 117: Free-ridership Rate for Market Transformation Value Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	6%	0%	25%
Free-ridership (savings-weighted)	15%	0%	25%

2.7.1.2 Participant Spillover

One of the four respondents purchased and installed energy-efficient products for which they did not receive a rebate after completing their MTV project (Table 118). The participant rated the program's influence on their decision a 4 on a 1 to 5 scale, where 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 75%.

Table 118: Spillover Influence Scores for Market Transformation Value 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%	LEDs	1
Rating of 5 (great influence)	100%	--	--
Respondent does not know how much influence	50%	-	-

We estimated the savings associated with the LEDs by assigning them the average per unit savings for LEDs from the FY2020 program tracking database. We then divided that estimate by the cumulative tracked savings across all four survey respondents to calculate the spillover rate. This resulted in a spillover rate of 0% for the MTV program (Table 119), after rounding.

Table 119: Spillover Rate for Market Transformation Value Program

	Average	Minimum	Maximum
Spillover Rate	0%	0%	4%

2.7.1.3 NTG Ratio

The savings-weighted NTG ratio for the MTV program equals 85%, after rounding (Table 120).

Table 120: NTG Ratio for Market Transformation Value Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	15%	0%	85%

2.7.2 Process Evaluation

For the process evaluation of the MTV program, the NMR team completed telephone and web surveys with program participants (Table 121).

Table 121: Market Transformation Value Program Evaluation Activity

Stakeholder	Completed
Participating end user surveys – phone	1
Participating end user surveys – web	3
Total	**4**

2.7.2.1 Key Findings

The key findings from the process evaluation of the MTV program are as follows:

- On a scale from 1 to 5, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 5.0, on average.

- Satisfaction with the rebate, while still high, was one of the program features with the lowest satisfaction ratings (a 4.3, on average). One respondent credited the availability of the rebate with helping their organization overcome a lack of funding for investment in energy-efficiency projects.

2.7.2.2 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 an 8.3, on average.

- Participants rated their overall satisfaction with the program a 5, on average, where 1 is "not at all satisfied" and 5 is "very satisfied." Table 122 shows their satisfaction ratings in detail.

Table 122: Participant Experience with the Market Transformation Value Program

Feature	n[1]	1 Not at All Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**4**	**--**	**--**	**--**	**--**	**4**	**5.0**
The inspection of your project by the DCSEU	4	--	--	--	1	3	4.8
The technical assistance you received from the DCSEU	3	--	--	--	1	2	4.7
The application process	4	--	--	--	2	2	4.5
The amount of time it took to receive the rebate or financial incentive	4	--	--	--	2	2	4.5
The energy savings from your new equipment	4	--	--	--	2	2	4.5
The information about DCSEU offerings	4	--	--	--	3	1	4.3
The type of eligible equipment or projects	4	--	--	1	1	2	4.3
The amount of the rebate, discount, or financial incentive	4	--	--	1	1	2	4.3
The assistance from your contractor or vendor	4	--	--	1	2	1	4.0
The performance of the new equipment	4	--	--	1	2	1	4.0
The preapproval process	3	--	--	--	3	--	4.0

[1] 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.

Based on their experience, participants provided feedback on what they would change about the MTV program. One of the respondents suggested expanding the number of participating contractors and/or vendors.

2.7.2.3 Program Experience

When asked why they implemented the measure through the MTV program, all four participants said that they wanted to save money on energy costs, install more reliable equipment, and reduce operating and maintenance costs. All four respondents reported that they saved money on energy costs and equipment installation after participating in the program (Table 123).

Table 123: Market Transformation Value Program Participants' Motivation for Participation and Benefits Realized

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

[1] Count of respondents sum to greater than 2 because some respondents provided more than one reason for implementation or benefit realized.

All four participants reported facing at least one hurdle when deciding whether or not to participate in the MTV Program (Table 124). One participant indicated that, by offering the rebate, the program helped their organization overcome the lack of funds available for investment. The program did not assist the other three respondents in overcoming their barriers to participation.[25]

Table 124: Hurdles Faced by Market Transformation Value Program Participants

Hurdle or Barrier	Count of Respondents (n=4)[1]
Lack of funds available for investment	1
Amount of management time to oversee projects	1
Organization hesitant to replace existing working equipment	1
Unsure of energy savings potential	1
Amount of time needed by vendor to install equipment	1
Internal approval lead time	1
Equipment availability	1

[1] Counts sum to greater than 4 because some respondents provided more than one reason.

All four 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

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[25] Two respondents said that the program did not help and the fourth respondent was not sure whether the program helped overcome the barrier.

from 1 to 5, where 1 is "very difficult" and 5 is "very easy," respondents rated the ease of completing the application a 4.0, on average.

2.7.2.4 Program Awareness

Each of the four MTV participants first heard about the program from different sources: the DCSEU website, DCSEU staff or account managers, a vendor, or a colleague or industry peer. One respondent also recalled hearing about the program from a DCSEU mailing or email. Three of the four respondents recalled visiting the DCSEU website. On a scale from 1 to 5, where 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.

2.8 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 FY2020, the program provided incentives for six projects and claimed 1,720 MWh of electric savings and 1.40 MW of peak demand reduction. For the FY2020 Solar PV Market Rate program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

2.8.1 Gross Savings Verification

Table 125 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 103%, while the demand savings realization rate equals 30%.

Table 125: PV Market Rate Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	1,720	103%	1,771
FY2020 Peak Demand Savings (MW)	1.40	30%	0.41

2.8.1.1 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 2,000 MMBtu of total energy savings to the certainty stratum. There was a single certainty stratum project that represented 44% of the program savings. The NMR team assigned the remaining projects to the probability stratum, from which we drew a random sample (Table 126). We randomly selected two of the three projects for review in the FY2020 evaluation.

Table 126: PV Market Rate Sampling Plan

Stratum	Percent of Program Energy Savings	FY2020 Participation	Number of Sampled Sites
Certainty	44%	1	1
Probability	56%	5	2

2.8.1.2 Methodology

The NMR team conducted desk reviews for the three sampled projects, through which we calculated the evaluated savings. No virtual onsite visits were performed.

The NMR team used the National Renewable Energy Laboratory (NREL) PV Watts Calculator[26] 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

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

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.

2.8.1.3 Results

The program-wide impact evaluation results for the PVMR program are shown in Table 127. The findings that contributed to the realization rates are detailed in the text that follows.

Table 127: PV Market Rate Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	1,720	103%	1,771	80% ± 0.8%
FY2020 Peak Demand Savings (MW)	1.40	30%	0.41	80% ± 1.3%

The program-level realization rates are 103% for electric savings and 30% for demand savings. The selected sample ultimately achieved a ±0.8% precision at 80% confidence for electric savings and ±1.3% precision for demand savings.

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, D.C., 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,[27] providing the DCSEU with a weather normalized generation estimate.

The primary cause for the peak demand savings realization rate equaling 30% is one of the probability stratum sample projects (Project ID 18485). The project's ex-ante savings value is 1,099 kW. The evaluator verified a savings value roughly 9% of the ex-ante value – 97 kW – which is in line with both the ex-ante kWh savings value and the PV system size. The evaluator believes the ex-ante peak demand savings value (1,099 kW) listed in the tracking database was entered in error. The evaluator reviewed the remaining entries in the tracking database and did not observe a similar issue with any other project. Therefore, the ex-ante peak demand savings value for Project ID 18485 was deemed to be an outlier, and the poor project realization rate was not extrapolated to the remaining projects in the program population. The difference between the

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

evaluated savings and the SEU claimed savings for Project ID 18485 was subtracted from the calculated program total *after* the realization rate extrapolation.

2.8.2 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 one web survey completed with a participating Solar PV Market Rate program customer.

2.8.2.1 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 128, the one Solar PV Market Rate program participant 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 128: 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%	--
• 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%	1
Total		**50%**	**1**

Influence

Using a 1 to 5 scale, where 1 means it "played no role at all" and 5 means it "played a great role," the Solar PV Market Rate program participant rated the information provided by contractors or vendors associated with the program a 4.[28] The NMR team assigned the respondent a free-ridership influence score based on the highest rating they provided for any of the program features (Table 129). As the respondent provided a maximum rating of 4 for one of the program features, we assigned them a free-ridership influence score of 12.5%.

Table 129: 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%	--
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	**13%**	**1**

For the respondent, we summed the free-ridership intention score and the free-ridership influence score to yield a cumulative free-ridership rate. The free-ridership of the Solar PV Market Rate respondent was 63% (Table 130).

Table 130: FY2020 Free-ridership Rate for Solar PV Market Rate Program

	Average	Minimum	Maximum
Free-ridership	63%	0%	63%

The FY2019 free-ridership rate was 49%, and the FY2018 free-ridership rate was 0%. Given the small sample sizes for each of the three years, we recommend combining the results across years through a savings-weighted approach. This approach produces a free-ridership rate of 38% (Table 131).

[28] The respondent did not consider the other program features to be applicable to their project. These other program features include the financial incentive; information or recommendations provided by a DCSEU representative; the results of any audits, energy modeling, or technical studies done through a program offered by the DCSEU; and marketing materials or information provided by the DCSEU about the program.

Table 131: FY2018-FY2020 Free-ridership Rate for Solar PV Market Rate Program

	Sample Size	Percent of Sampled Energy Savings	Free-ridership rate
FY2018	2	24%	0%
FY2019	5	68%	49%
FY2020	1	8%	63%
Weighted Average			**38%**

2.8.2.2 Participant Spillover

The respondent did not purchase and install any energy-efficient products for which they did not receive a rebate after completing their Solar PV Market Rate project. This resulted in a spillover rate of 0% for the FY2020 Solar PV Market Rate program. The spillover rate for the Solar PV Market Rate program in FY2018 and FY2019 were also 0%.

2.8.2.3 NTG Ratio

The savings-weighted NTG ratio for the Solar PV Market Rate program equals 62%, after rounding (Table 132).

Table 132: FY2018-FY2020 NTG Ratio for Solar PV Market Rate Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	38%	0%	62%

2.8.3 Process Evaluation

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

2.8.3.1 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, where 1 is "not at all satisfied" and 5 is "very satisfied," the participant rated their satisfaction with the program overall as a 5. This participant also said they were "extremely likely" to recommend the Solar PV Market Rate program to someone else.

- Solar vendors appear to play a critical role for Solar PV Market Rate program; however, there are opportunities for DCSEU to engage the customer directly.

2.8.3.2 Program Satisfaction

Program satisfaction is high:

- On a scale from 0 to 10, where 0 is "extremely unlikely" and 10 is "extremely likely," the participant rated their likelihood to recommend the program to someone else a 10. In FY2019, participants rated their likelihood to recommend the program to someone else a 9.6, on average.

- The participant rated their overall satisfaction with the program as a 5, where 1 is "not at all satisfied" and 5 is "very satisfied." In FY2019, participants rated their average satisfaction a 4.8. Table 133 shows the satisfaction ratings in detail.

Table 133: Participant Experience with the Solar PV Market Rate Program[1]

Feature	Rating (n=1)
Your experience overall	**5**
The performance of the new equipment	5
The information about the DCSEU offerings	5
The inspection of your project by the DCSEU	5
The assistance from your contractor or vendor	4
The energy savings from your new equipment	4

The respondent indicated that, while they had worked with DCSEU closely on other projects, the vendor was responsible for the application, rebate, and communication with DCSEU for this project. As such, the respondent could not comment on some of the Solar PV Market Rate program features they did not experience firsthand.

The respondent reported first hearing about the program from their vendor but had also learned about it from DCSEU staff members and resources, including the website. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," the respondent rated the information on the DCSEU website a 5.

When asked if there were any aspects of the Solar PV Market Rate program they would change, the participant suggested increasing the rebate level to ensure the customer is also receiving value from the program, alongside the solar vendor.

2.8.3.3 Program Experience

When asked why they implemented the measure through the Solar PV Market Rate program, the participant cited a desire to reduce operating or maintenance costs, save money on equipment installation and energy costs, promote positive public relations, advance the organization's long-term strategic energy management plan, and be good stewards of the environment. The participant reported realizing many of those benefits, as well as an improved work environment.

The Solar PV Market Rate program participant did not report any issues with the installation or performance of the solar system or with the contractor who installed it.

2.8.4 Recommendations

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

- Consider adding an automated check in the PVMR tracking data to flag projects where the peak demand savings are unusually high. One potential flag would be to identify projects where the peak demand savings exceeds 300% of the average demand savings.[29] This will alert SEU staff to potential data entry issues during the project entry process.

- Consider using the precise equipment inverter efficiency when estimating savings with PVWatts. The PVWatts tool includes defaults for most of the technical parameters required to run the calculator. The evaluation team updated the inverter efficiency for all three of the reviewed projects, resulting in small changes to the verified savings.

- Input the exact address into PVWatts rather than the zip code. Make sure the address is correct and that the address where the project is installed is being used. All the projects had the project address provided but most have other addresses listed as well, such as a customer billing address.

- For Solar PV Market Rate participants who are first-time DCSEU program participants, DCSEU should engage with the end-user and promote other program offerings to capture additional savings opportunities.

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[29] Average demand is equivalent to annual energy savings, in kWh, divided by 8,760 hours.

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 six residential and low-income programs selected for the FY2020 evaluation:

- Retail Lighting
- Retail Heating and Cooling
- Retail Efficient Appliances
- Income Qualified Efficiency Fund
- Low-income Multifamily Comprehensive
- Low-income Prescriptive Rebate

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 FY2020, 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 FY2020 Retail Lighting program, we completed the following evaluation activity:

- Gross Savings Verification

3.1.1 Gross Savings Verification

Table 134 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 134: Retail Lighting Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	14,681	100%	14,681
FY2020 Peak Demand Savings (MW)	1.7	100%	1.7
FY2020 Gas Savings (MMBtu)	-14,935	100%	-14,935

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 195,013 measures that represent 100% of FY2020 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 135).

Table 135: Retail Efficient Lighting Savings and Realization Rates by Measure Type

	FY2020 Electric Savings Realization Rate	FY2020 Peak Demand Savings Realization Rate	FY2020 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 HEATING & COOLING (7710HTCL)

In FY2020, 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.

Table 136 displays the ECMs included in FY2020 and their contribution to tracked savings. The majority of total energy savings are derived from advanced thermostats (51%), gas boilers (17%), and gas furnaces (14%).

Table 136: Retail Heating & Cooling Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Peak Demand Savings	Percent of FY2020 Gas Savings
Advanced Thermostats	51%	64%	49%	46%
Gas Boilers	17%	-	-	24%
Gas Furnaces	14%	-	-	19%
Water Heaters	8%	4%	1%	10%
Ductless Mini Split Heat Pumps	5%	17%	11%	-
Air Source Heat Pumps	2%	8%	13%	-
Energy Star Central AC	2%	7%	26%	-
Setback Thermostats	1%	1%	-	1%

For the FY2020 Retail Heating & Cooling program, we completed the following evaluation activities:

- Gross Savings Verification
- Net Savings Estimation
- Process Evaluation

3.2.1 Gross Savings Verification

Table 137 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the Retail Heating & Cooling program.

Table 137: Retail Heating and Cooling Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	193	102%	198	±5.5% @ 80%
FY2020 Peak Demand Savings (MW)	0.05	100%	0.05	±6.1% @ 80%
FY2020 Gas Savings (MMBtu)	1,683	105%	1,767	±5.3% @ 80%

3.2.1.1 Methodology

We reviewed rebate forms and invoices to verify that the quantities and measure descriptions in these documents matched the quantities and descriptions listed in the tracking database. For thermostats, we validated the home type (single family, multifamily, or unknown), heating type (electric or gas), and cooling type (presence of AC) gathered from customers' online rebate forms. For heating and cooling equipment, we validated savings inputs, including BTU/hr, AFUE, SEER,

EER, and HSPF from online and mail-in rebate forms. In addition, we verified that the prescriptive inputs and savings algorithms from the TRM were applied correctly for sampled measures.

3.2.1.2 Sampling Plan

We conducted desk reviews for a sample of 35 Retail Heating & Cooling projects. The sample design employed stratified random sampling. First, we stratified the sample by delivery method (upstream and downstream). We further stratified the upstream stratum by month to minimize any potential bias resulting from seasonal purchase patterns. The distribution of measure types among the 35 sampled projects approximates the distribution of measure types across the HTCL program. The 35 sampled projects accounted for 34% of FY2020 program energy savings.

3.2.1.3 Results

Table 138 displays the realization rates for sampled measures. The following measure categories achieved realization rates of 100% in all applicable savings categories: gas boilers, gas furnaces, water heaters, air source heat pumps, and Energy Star central air conditioners.

The NMR team found that the home type, heating type, and/or cooling type had been recorded incorrectly in the tracking data for 29% of the 189 sampled advanced thermostats. The most prevalent error was recording unknown home types as multifamily homes. The NMR team assigned the deemed savings from the TRM for the corrected home type, heating type, and/or cooling type. Because deemed advanced thermostat savings from multifamily homes are less than deemed savings for unknown home types, this adjustment increased the advanced thermostat realization rates to 105% for electric, 101% for peak demand, and 108% for gas savings.

Similarly, the NMR team found that the heating type had been recorded incorrectly in the tracking data for three of the ten sampled setback thermostats. Customers' rebate forms for these three setback thermostats indicated that the homes were heated with gas; however, deemed savings for homes heated with electricity had been applied. The NMR team assigned deemed savings for homes heated with gas to these three setback thermostats, which reduced the setback thermostat electric realization rate to 40% and increased the gas realization rate to 144%.

The NMR team observed one additional recording error in the tracking data. For one sampled ductless mini split heat pump system, the rebate form indicated that it was a 22,000 BTU/hr system; however, deemed savings for a 32,000 BTU/hr system had been recorded in the tracking data. The NMR team assigned the deemed savings corresponding with 22,000 BTU/hr for this system, which decreased the ductless mini split heat pump electric and peak demand realization rates to 94%.

Table 138: Retail Heating and Cooling Realization Rates by Measure Type

Measure	FY2020 Electric Savings Realization Rate	FY2020 Peak Demand Savings Realization Rate	FY2020 Gas Savings Realization Rate
Advanced Thermostats	105%	101%	108%
Gas Boilers	-	-	100%
Gas Furnaces	-	-	100%
Water Heaters	100%	100%	100%
Ductless Mini Split Heat Pumps	94%	94%	-
Air Source Heat Pumps	100%	100%	-
Energy Star Central AC	100%	100%	-
Setback Thermostats	40%	-	144%
Total	102%	100%	105%

3.2.2 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 43 telephone surveys completed with participating Retail Heating and Cooling program customers.

3.2.2.1 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 139, the 43 Retail Heating and Cooling program participants received the following scores:

- Twelve 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-fifth of participants (19%) 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%).

- More than two-thirds of respondents (70%) reported they would have purchased the measure with the exact same efficiency in the absence of the program and 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 43 respondents is 40%.

Table 139: 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%	12%
• Purchased a less efficient measure or different product instead OR • Don't know OR • I'd rather not answer	• Not Asked	25%	19%
• 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%	0%
	• Definitely would have had the funds	50%	70%
Total		**40%**	**43**

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

Influence

Table 140 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 (2.8) and information or recommendations from contractors or retailers associated with the program (2.3).

Table 140: Influence of DCSEU Program Features for Retail Heating and Cooling Program

Features	n[1]	1 Played no Role at All	2	3	4	5 Played a Great Role	Average Rating
The rebate	43	44%	5%	12%	9%	30%	2.8
Information or recommendation from contractors or retailers associated with the program	42	57%	2%	17%	5%	19%	2.3
DCSEU program marketing materials about the program	41	56%	12%	10%	12%	10%	2.1
Previous experience with a DCSEU program	32	69%	-	9%	6%	16%	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 141):

- One-half of Retail Heating and Cooling program respondents (51%) 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%.

- Five percent of respondents provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.

- Fourteen percent of respondents provided a maximum rating of 3, so we assigned them a free-ridership influence score of 25%.

- Two percent of respondents provided a maximum rating of 2, so we assigned them a free-ridership influence score of 37.5%.

- Just over one-quarter 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 43 respondents is 19%.

Table 141: 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%	51%
4	12.5%	5%
3	25%	14%
2	37.5%	2%
1 - Program feature played no role OR Not applicable	50%	28%
Don't know OR Refused	25%	0%
Total	**19%**	**43**

Seventeen respondents named at least one non-program factor that played a great role in influencing them to purchase the rebated measure (Table 142). Respondents most often mentioned energy efficiency (four respondents). The four respondents who cited product features and three respondents who cited recommendations from friends or family purchased smart thermostats as their primary measure.

Table 142: Non-program Factors Influencing Purchase of Retail Heating and Cooling Program Measure

Other Factor Influencing Purchase Decision	Count of Respondents (n=17)[1]
Energy efficiency	4
Product features	4
Recommendations from friends or family	3
Reduced energy bills	3
Product research or online reviews	2
Increased comfort at home	2
Prior experience with the product	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 58% and the average weighted free-ridership rate for the Retail Heating and Cooling program was 56% (Table 143).

Table 143: Free-ridership Rate for Retail Heating and Cooling Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	58%	0%	100%
Free-ridership (savings-weighted)	56%	0%	100%

We estimated free-ridership by measure type and found free-ridership equals 62% for the 26 smart thermostat respondents. The sample sizes for the remaining measures were too low (≤5) to provide estimates.

3.2.2.2 Participant Spillover

Seven percent of respondents reported purchasing and installing energy-efficient products for which they did not receive a rebate after completing their Retail Heating and Cooling project. One of these participants reported that the program had some influence on their decision to purchase an energy-efficient product (Table 144). This participant reported installing one ENERGY STAR boiler and rated the program's influence on their decision a 4 on a 1 to 5 scale, where 1 means "no influence at all" and 5 means "great influence." Based on that rating, we assigned them a spillover influence score of 75%.

Table 144: Spillover Influence Scores for Retail Heating and Cooling 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%	Boiler	1
Rating of 5 (great influence)	100%	-	-
Respondent does not know how much influence	50%	-	-

We estimated the savings associated with this measure and applied the spillover influence scores to estimate the total spillover savings. We then divided that estimate by the cumulative tracked savings across all 43 survey respondents to calculate the spillover rate. This resulted in a spillover rate of 1% for the Retail Heating and Cooling program (Table 145).

Table 145: Spillover Rate for Retail Heating and Cooling Program

	Average	Minimum	Maximum
Spillover Rate	1%	0%	64%

3.2.2.3 NTG Ratio

The savings-weighted NTG ratio for the Retail Heating and Cooling program equals 45%, after rounding (Table 146).

Table 146: NTG Ratio for Retail Heating and Cooling Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	56%	1%	45%

3.2.3 Process Evaluation

For the process evaluation of the Retail Heating and Cooling program, the NMR team completed telephone surveys with 43 program participants. For each unique participant in FY2020, 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.[30] 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 FY2020 (Table 147).

Table 147: Retail Heating and Cooling Program Evaluation Activity

Primary Measure	% of Survey Respondents[1]	% of FY2020 Program Participation[2]
Smart thermostat	60%	62%
Central air conditioning system	12%	8%
Ductless mini-split heat pump	12%	6%
Water heater replacement	7%	4%
Furnace replacement	5%	7%
Boiler replacement	5%	6%

[1] Does not sum to 100% due to rounding.
[2] Does not sum to 100%; some measures from the program tracking database are not shown.

3.2.3.1 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, where 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[31] for the Retail Heating and Cooling program was 81.

- Participants who suggested changes to the program most often pointed to the rebate amount (26%) and application process (26%). On a scale from 1 to 5, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with these program features as a 4.2.

- Most participants learned about the availability of the rebate before they had made the decision to purchase the measure (28%) or while they were making the decision (42%), emphasizing the importance of increasing program awareness among the market actors who influence the purchasing decision. Indeed, participants most often reported learning about the program from their contractor (23%).

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[30] 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. Three percent of participants received a rebate for three or more measures during FY2020.

[31] 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.

3.2.3.2 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 9.3 on average. The NPS for the program among participating end users was 81. Overall, 84% of 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 4.6, where 1 is "not at all satisfied" and 5 is "very satisfied," on average. Table 148 shows their satisfaction ratings in detail.

Table 148: 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	**43**	**--**	**5%**	**2%**	**19%**	**74%**	**4.6**
The performance of the measure	42	--	--	--	26%	74%	4.7
The type of eligible equipment	33	--	3%	21%	9%	67%	4.4
The rebate amount	43	--	5%	23%	16%	56%	4.2
The application process	42	2%	5%	19%	19%	55%	4.2
Energy savings from new equipment	34	3%	--	18%	29%	50%	4.2
Time it took to receive rebate	42	--	7%	19%	31%	43%	4.1
Information on the DCSEU website	29	3%	7%	17%	17%	55%	4.1

[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 respondents who rated their satisfaction with their overall experience a 2 said that the rebate process was too difficult. Both respondents reported needing to exchange several emails and phone calls with DCSEU staff to receive the rebate. In particular, one respondent self-installed the measure (a smart thermostat) and could not provide a contractor's invoice to satisfy the application requirements.[32]

- The respondent who rated their satisfaction with the variety of eligible equipment a 2 indicated that one of the measures they purchased did not qualify for a rebate.[33]

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[32] The respondent did not indicate how the process was eventually resolved, though the Retail Heating and Cooling application specifies that the applicant can substitute a monthly energy report from the thermostat manufacturer for the contractor invoice to confirm installation.
[33] The respondent received a rebate for a furnace replacement through the program, and did not specify what type of equipment was purchased that was not eligible for an additional rebate.

- The two respondents who rated their satisfaction with the rebate amount a 2 said that the rebate amount was smaller than expected. One respondent purchased a central air conditioning system, and the other respondent received a rebate for a smart thermostat.

- The three respondents who rated their satisfaction with the application process a 1 or 2 found the application process to be lengthy and burdensome. One respondent reported contacting both the contractor and manufacturer in search of the technical information required by the application for the furnace replacement. Another respondent, also replacing a furnace, had difficulties finding the information on their own after the contractor declined to participate in the program, citing burdensome paperwork requirements. The third respondent needed to submit additional documentation for their boiler replacement and reported contacting DCSEU for assistance finding and uploading the information.

- The three respondents who rated their satisfaction with the amount of time it took to receive a rebate a 2 indicated that their rebate checks were delayed. In particular, one respondent ended up having to resubmit an application. One respondent noted that they would have preferred to receive a rebate in a different form than a mailed check but did not suggest an alternative.

Based on their experience, participants provided feedback on what they would change about the Retail Heating and Cooling program (Table 149). The rebate amount (26%) and application process (26%) were the most commonly suggested program changes. One-fifth of respondents (19%) suggested increasing the program's publicity in order to improve awareness. Seven percent of respondents requested that the program increase the variety of equipment eligible for the program. One-quarter of respondents (26%) did not suggest any changes.

Table 149: Suggested Changes to the Retail Heating and Cooling Program

Program Feature	Percent of Respondents (n=43)[1]
The rebate amount	26%
The application process	26%
Program visibility/publicity	19%
The variety of eligible equipment	7%
The program website	2%
Clarity of eligible equipment types	2%
No change	26%
Don't know	2%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

Respondents who purchased a smart thermostat (n=26) or a ductless mini-split heat pump (n=5) were asked whether they would recommend the technology to someone else. Based on their experience, 88% of smart thermostat purchasers said they were "very likely" to recommend the technology. Four of the five ductless mini-split heat purchasers said they were "very likely" (three respondents) or "somewhat likely" (one respondent) to recommend the technology to someone else.

3.2.3.3 Program Experience

Participants were asked to report their reasons for purchasing the primary measure for which they received a rebate through the program (Table 150). Two-fifths of all respondents (40%) wanted to use technology to moderate the temperature in their home.[34] Two-thirds of respondents purchased the measure to save energy or replace an older or failing unit (35%, respectively). Respondents also cited a desire to improve comfort or temperature in their homes (19%) and to save money on bills (12%).

Table 150: Retail Heating and Cooling Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=43)[1]
To use technology to moderate temperature in my home[2]	40%
To save energy	35%
Replace older or failing unit	35%
Improve comfort or temperature	19%
To save money on bills	12%
Increased capacity and/or performance	9%
Due to home remodeling or renovation	2%
To accommodate space and/or feature requirements in the home	2%
For health reasons/accommodations	2%

[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).

3.2.3.4 Program Awareness

Less than one-third of respondents (28%) reported learning about the Retail Heating and Cooling rebate before making the decision to purchase the measure, while 42% reported learning about it while they were making the decision to purchase the measure (Table 151).

Table 151: Awareness of Retail Heating and Cooling Program Rebate Availability

When Respondent Learned About the Rebate	Percent of Respondents (n=43)
Before respondent decided to purchase the measure	28%
While respondent was deciding to purchase the measure	42%
After respondent had already decided to purchase the measure	30%

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[34] This response option was only available to respondents whose primary measure was a smart thermostat; 65% of smart thermostat purchasers surveyed cited the desire to moderate the temperature in their home with technology as a reason for purchasing the measure.

Participants most often heard about the Retail Heating and Cooling program rebate from a contractor (23%); the DCSEU website (16%) or DCSEU mailing or email (14%); and/or from a colleague, friend, or family member (14%). Respondents also indicated that they had heard about the program through in-store program signage (9%) and newspaper, radio, or television ads (7%) (Table 152).

Table 152: Awareness of the Retail Heating and Cooling Program

Source of Program Awareness	Percent of Respondents (n=43)[1]
A contractor	23%
The DCSEU website	16%
A DCSEU mailing or email	14%
A colleague, friend, or family member	14%
Signs in store indicating DCSEU rebates available	9%
A newspaper, radio, or television ad	7%
A retail store employee	5%
Manufacturer's website	5%
Community group website or blog	5%
The electric utility	5%
DCSEU online advertisement	2%
Internet research	2%
Email from manufacturer	2%
Don't know	2%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

More than three-quarters of respondents (77%) reported visiting the DCSEU website. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.4 for the information provided on the DCSEU's energy saving programs. The respondent who rated it a 3 explained that they had difficulty finding program information or logging in from the DCSEU home page. When describing their satisfaction with the information available about eligible equipment on the DCSEU website, three respondents brought up concerns about outdated rebate amounts, a lack of clarity on eligible equipment, and difficulty navigating the website.

3.2.3.5 Application Installation Experience

All of the Retail Heating and Cooling participants (100%) reported that the measure for which they received the rebate was installed at the time of the survey. Nearly two-thirds of respondents indicated that a contractor (60%) or representative of the retailer (2%) installed the measure. The remaining respondents (37%) reported that the measure was self-installed (either by the respondent, someone in the household, or a friend).[35]

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[35] Smart thermostats (n=26) were the only measures in the survey that participants reported self-installing; 57% of smart thermostats were self-installed, while the remaining 43% were installed by professionals (contractors or representatives from the retailer).

3.2.4 Recommendations

Based on the findings from our evaluation, we offer the following recommendations for the Retail Heating and Cooling program:

- Ensure that home and product information based on rebate data (e.g., home type, heat/cool type, system size) are accurately recorded in the tracking data so the correct deemed savings are applied.

- Consider increasing the rebate amount for eligible equipment types where feasible.

- Review program materials to identify opportunities to improve clarity on the application process, particularly for measures that are more likely to be self-installed.

3.3 RETAIL APPLIANCES (7710APPL)

In FY2020, 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 FY2020 Retail Appliances 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, which is composed of free-ridership and participant spillover. We estimated free-ridership and participant spillover based on question responses from 57 telephone surveys completed with participating Retail Efficient Appliances 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 153, the 57 Retail Efficient Appliances program participants received the following scores:

- Two 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%).

- More than one-quarter of participants (28%) 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.

  o Five percent of respondents said they definitely would not have had the funds available to purchase the measure in the absence of the program or were not sure whether they would have had the funds available. We assigned them a moderate free-ridership intention score (25%).

  o Four 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%).

  o The remaining participants (58%) 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 57 respondents is 39%.

Table 153: 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%	2%
• Installed the measure but scaled back the scope or efficiency OR • Don't know OR • I'd rather not answer	• Not Asked	25%	32%
• 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%	5%
	• Might have had the funds	37.5%	4%
	• Definitely would have had the funds	50%	58%
Total		**39%**	**57**

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

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Influence

Table 154 displays the influence rating of various program features on participants' decision to install the measure, using a 1 to 5 scale, where 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 (2.9) and DCSEU program marketing materials (2.4)

Table 154: Influence of DCSEU Program Features for Retail Efficient Appliances Program

Features	n[1]	1 Played no Role at All	2	3	4	5 Played a Great Role	Average Rating
The rebate	55	27 %	15%	16%	22%	20%	2.9
DCSEU program marketing materials about the program	55	45%	9%	18%	15%	13%	2.4
Information or recommendation from contractors or retailers associated with the program	54	59%	7%	6%	4%	24%	2.3
Previous experience with a DCSEU program	47	79%	-	2%	-	19%	1.8

[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 155):

- Two-fifths of Retail Efficient Appliances program respondents (40%) 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%.

- Sixteen percent of respondents provided a maximum rating of 4, so we assigned them a free-ridership influence score of 12.5%.

- Fourteen 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 57 respondents is 19%.

Table 155: Free-ridership Influence Scoring for Retail Efficient Appliances Program

Maximum Influence Rating	Assigned Free-ridership Influence Score (%)	Percent of Respondents
5 - Program feature played a great role	0%	40%
4	12.5%	16%
3	25%	14%
2	37.5%	7%
1 - Program feature played no role OR Not applicable	50%	21%
Don't know OR Refused	25%	2%
Total	**19%**	**57**

Twenty respondents named at least one non-program factor that played a great role in influencing them to purchase the rebated measure (Table 156). Respondents most often mentioned limitations or requirements on the size or type of equipment allowed in their space (five respondents), online research or product reviews (four respondents), and recommendations from friends or family (three respondents).

Table 156: Non-program Factors Influencing Purchase of Retail Efficient Appliances Program Measure

Other Factor Influencing Purchase Decision	Count of Respondents (n=20)[1]
Space limitations or requirements	5
Online research/product reviews	4
Recommendation from friends or family	3
Energy efficiency	3
Brand recognition	2
Information or sale price provided by the retailer	2
Product was in stock/available for delivery	1
Purchased alongside matching appliance	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 59% and the average weighted free-ridership rate for the Retail Efficient Appliances program was 58% (Table 157).

Table 157: Free-ridership Rate for Retail Efficient Appliances Program

	Average	Minimum	Maximum
Free-ridership (unweighted)	59%	0%	100%
Free-ridership (savings-weighted)	58%	0%	100%

Table 158 shows free-ridership by measure. Refrigerators had the highest free-ridership rate (65%). The sample size for dehumidifiers (n=4) was too small to calculate measure-level free-ridership.

Table 158: Free-ridership Rate by Measure for Retail Efficient Appliances Program

Free-ridership (weighted)	Average	Minimum	Maximum
Clothes washer (n=19)	58%	0%	100%
Clothes dryer (n=19)	61%	25%	100%
Refrigerator (n=15)	65%	25%	100%

Table 159 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; FY2020 rebates provided a 3% 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 159: Prices and Rebate Amounts for the Retail Efficient Appliances Program

Primary Measure	Tracking Dataset		Application Data			Rebate Range (%)
	n	FY2020 Rebate Amount[1]	n[1]	Average Retail Price	Median Retail Price	
Clothes washer	363	$50 - $100	198	$785	$698	6% - 13%
Clothes dryer	325	$50 - $200	178	$831	$748	6% - 24%
Refrigerator	227	$50 - $100	127	$1,642	$1,492	3% - 6%
Dehumidifier	86	$25 - $35	30	$243	$245	10% - 14%

[1] Table shows application data aggregated from online applications only; excludes mail-in applications.

3.3.1.2 Participant Spillover

Nearly one-fifth of respondents (19%) 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 (5%) reported that the program had some influence on their decision to purchase the energy-efficient product (Table 160). The participant who reported installing one ENERGY STAR refrigerator rated the program's influence on their decision a 2 on a 1 to 5 scale, where 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 other two participants both rated the program's impact on their decision to install an ENERGY STAR clothes washer and a smart thermostat a 3; we assigned them spillover influence scores of 50%.

Table 160: Spillover Influence Scores for Retail Efficient Appliances Program

Influence Rating	Assigned Influence Score (%)	Spillover Measures	Count of Respondents
Rating of 2 (some influence)	25%	Refrigerator	1
Rating of 3	50%	Clothes Washer; Smart Thermostat	2
Rating of 4	75%	-	-
Rating of 5 (great influence)	100%	-	-
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 57 survey respondents to calculate the spillover rate for the program. This resulted in a spillover rate of 3% for the Retail Efficient Appliances program (Table 161).

Table 161: Spillover Rate for Retail Efficient Appliances Program

	Average	Minimum	Maximum
Spillover Rate	3%	0%	136%

3.3.1.3 NTG Ratio

The savings-weighted NTG ratio for the Retail Efficient Appliances program equals 45%, after rounding (Table 162).

Table 162: NTG Ratio for Retail Efficient Appliances Program

	Free-ridership	Participant Spillover	NTG (1 – FR + PSO)
Net-to-Gross Ratio	58%	3%	45%

3.3.2 Process Evaluation

For the process evaluation of the Retail Efficient Appliances program, the NMR team completed telephone surveys with 57 program participants. For each unique participant in FY2020, 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.[36] 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 FY2020 (Table 163).

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[36] According to program tracking data, nearly two-thirds of Retail Efficient Appliances program participants (64%) received a rebate for one appliance, while 33% received rebates for two appliances. Three percent of participants received a rebate for three or more appliances in FY2020.

Table 163: Retail Efficient Appliances Program Survey Completes by Measure

Primary Measure	% of Survey Respondents[1]	% of FY2020 Program Participation
Clothes washer	33%	36%
Clothes dryer	33%	32%
Refrigerator	26%	23%
Dehumidifier	7%	9%

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

3.3.2.1 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, where 1 is "not at all satisfied" and 5 is "very satisfied," participants rated their satisfaction with the program overall a 4.8, on average.

- The NPS[37] for the Retail Heating and Cooling program was 86.

- One-half of participants (49%) reported purchasing their appliance to replace an older or failing unit.

- Nearly two-thirds of participants (63%) 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 a retail store employee (26%) or on the DCSEU website (26%).

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 9.5, on average. The NPS for the program among participating end users was 86. 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.

- Participants rated their overall satisfaction with the program a 4.8, where 1 is "not at all satisfied" and 5 is "very satisfied," on average. Table 164 shows their satisfaction ratings in detail.

- When asked if they had any additional comments at the close of the survey, four participants praised the program's offerings and the DCSEU in general.

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[37] 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 164: Participant Experience with the Retail Efficient Appliances Program

Feature	n[1]	1 Not at All Satisfied	2	3	4	5 Very Satisfied	Average Rating
Your experience overall	**57**	**0%**	**0%**	**2%**	**14%**	**84%**	**4.8**
The performance of the measure	56	0%	0%	4%	18%	79%	4.8
The application process	56	0%	0%	7%	23%	70%	4.6
Time it took to receive rebate	54	0%	0%	13%	22%	65%	4.5
Energy savings from the new appliance	36	0%	0%	11%	28%	61%	4.5
The rebate amount	57	0%	4%	7%	32%	58%	4.4
The variety of eligible equipment	49	4%	2%	8%	35%	51%	4.3
Information on the DCSEU website	40	0%	5%	13%	25%	58%	4.2

[1] Sample size varies because results exclude those who said, "Not applicable" or "I'm not sure." One respondent had not yet installed the measure.

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

- The two respondents who rated their satisfaction with the rebate amount a 2 reported that the rebate was smaller than expected.

- The three respondents who rated their satisfaction with the variety of eligible equipment a 1 or 2 indicated that other appliances they purchased alongside the rebated measure did not qualify for a rebate as expected (two respondents) and that the list of eligible products is too limited (one respondent).

- The two respondents who rated their satisfaction with the information available about eligible equipment on the DCSEU website a 2, cited a lack of clarity on eligible equipment and difficulty navigating the website.

Based on their experience, participants provided feedback on what they would change about the Retail Efficient Appliances program (Table 165). The rebate amount (19%), application process (18%), and variety of eligible equipment (16%) were the most commonly suggested program changes. Twelve percent of respondents suggested increasing the program's publicity in order to improve awareness. Seven percent of respondents requested additional clarity on which types of equipment were eligible for the program.[38] Four percent of respondents suggested improving the retail experience; in particular, they suggested identifying program-eligible appliances in-store with DCSEU stickers and providing training to retail employees. Respondents also suggested updating the program website (2%) and increasing the program application window (2%).[39] Nearly one-third of respondents (32%) did not suggest any changes based on their experience with the program.

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[38] One of the respondents elaborated in the comment section that they would like a search function on the DCSEU website that allows the user to confirm program eligibility using the model number of the purchased appliance.
[39] This respondent purchased two appliances through the program in June and July of 2020 and would have had nearly three months to complete the application for both products.

Table 165: Suggested Changes to the Retail Efficient Appliances Program

Program Feature	Percent of Respondents (n=57)[1]
The rebate amount	19%
The application process	18%
The variety of eligible equipment	16%
Program visibility/publicity	12%
Clarity of eligible equipment types	7%
The retail experience	4%
The program website	2%
The rebate eligibility window	2%
No change	32%

[1] Percentages sum to greater than 100% because some respondents provided more than one suggested change.

3.3.2.3 Program Experience

Participants were asked to report their reasons for purchasing the appliances (Table 166). Nearly one-half of respondents (49%) reported purchasing the appliance to replace an older or failing unit, followed by a desire for energy savings (12%) and increased capacity and/or performance (12%). Nearly one in ten respondents (9%) purchased the appliance to accommodate requirements in their home (e.g., size of laundry area or vent accessibility) and 7% of respondents purchased the appliance during a home renovation.

Table 166: Retail Efficient Appliances Program Participants' Reason for Purchase

Reason for Purchase	Percent of Respondents (n=57)[1]
Replace older or failing unit	51%
Increased capacity and/or performance	12%
To save energy	12%
To accommodate space and/or feature requirements in the home	9%
Due to home remodeling or renovation	7%
Existing unit stopped working or broke	5%
Installed in a new home	5%
To improve comfort or temperature	5%
To reduce humidity	5%
To save money on bills	2%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

3.3.2.4 Program Awareness

Nearly two-thirds of participants (63%) reported that they first learned they could obtain a rebate from the program while they were purchasing the appliance, while one-quarter of respondents (25%) learned about the availability of the rebate before deciding to purchase the appliance (Table 167).

Table 167: Awareness of Retail Efficient Appliances Program Rebate Availability

When Respondent Learned About the Rebate	Percent of Respondents (n=57)[1]
Before respondent decided to purchase the measure	25%
While respondent was deciding to purchase the measure	63%
After respondent had already decided to purchase the measure	11%
Don't know	2%

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

When asked how they heard about the rebate, participants most often cited retail store employees (26%), the DCSEU website (26%), and DCSEU online advertisements (18%). Fourteen percent of participants heard about the rebate from a colleague, friend, or family member. Respondents also indicated they had heard about the program through in-store program signage (9%) and information on the manufacturer's website (4%) (Table 168).

Table 168: Awareness of the Retail Efficient Appliances Program

Source of Program Awareness	Percent of Respondents (n=57)[1]
Retail store employee	26%
The DCSEU website	26%
DCSEU online advertisement	18%
A colleague, friend, or family member	14%
Signs in store indicating DCSEU rebates available	9%
Manufacturer's website	4%
A DCSEU mailing or email	2%
DCSEU social media	2%
A newspaper, radio, or television ad	2%
Retailer website	2%
Internet research	2%
Don't know	7%

[1] Percentages sum to greater than 100% because some respondents provided more than one reason.

More than three-quarters of the respondents (77%) reported visiting the DCSEU website. On a scale of 1 to 5, where 1 is "not at all useful" and 5 is "very useful," respondents gave an average rating of 4.5 for the information provided on the DCSEU's energy saving programs.

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3.3.2.5 Appliance Installation Experience

All but one of the respondents (98%) reported that the measure for which they received the rebate was installed at the time of the survey. The respondent who had not yet installed the appliance reported that construction was delayed on their home remodeling project.

More than one-half of respondents (57%) reported having their rebated appliance installed by a representative from the retailer.[40] One-quarter of respondents (25%) indicated that someone in their household installed the appliance. The remaining respondents had their appliance installed by a contractor (14%), friend (2%), or maintenance technician (2%).

On a scale of 1 to 5, where 1 is "very difficult" and 5 is "very easy," the 14 respondents who indicated that someone in their household installed the appliance rated the ease of installation a 4.0 on average. The three respondents who indicated that the installation was difficult installed clothes washers (two) and a dehumidifier (one).

3.3.3 Recommendations

Based on the findings from our evaluation, we offer the following recommendations for the Retail Efficient Appliances program:

- Consider increasing the rebate amount for eligible equipment types where feasible.

- Continue to offer education about savings provided by energy-efficient appliances so customers are prepared to choose an energy-efficient option when their current equipment fails.

3.4 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 to pass the resulting monetary benefits on to low- or moderate-income residents in the District of Columbia. A total of 27 energy-efficiency projects were funded at DC multifamily properties, shelters, or clinics in FY2020.

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[40] n=56; one respondent reported that their measure was not installed. According to survey respondents, contractors and representatives from the retailer installed the large appliances (clothes washers, clothes dryers, and refrigerators). All of the dehumidifiers in the survey were self-installed.

Table 169 provides the breakdown of tracked savings by measure type. Combined, boilers, furnaces, and water heaters accounted for two-thirds (67%) of program-level energy savings.

Table 169: Income Qualified Efficiency Fund Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Peak Demand Savings	Percent of FY2020 Gas Savings
Boilers/Furnaces	42%	1%	-	60%
Water Heating	25%	-	-	37%
Indoor LED Fixtures	11%	36%	10%	<-1%[41]
Central AC	6%	19%	63%	-
LED Downlights	5%	17%	7%	<-1%
Heat Pumps	4%	12%	17%	-
Thermostats	2%	1%	-	3%
Outdoor LED Fixtures	2%	6%	-	-
Linear LEDs	1%	5%	1%	<-1%
Screw Base LEDs	1%	3%	1%	<-1%
LED Exit Signs	<1%	<1%	<1%	<-1%
Occupancy Sensors	<1%	<1%	<1%	<-1%

For the FY2020 Income Qualified Efficiency Fund program, we completed the following evaluation activity:

- Gross Savings Verification

3.4.1 Gross Savings Verification

Table 170 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the Income Qualified Efficiency Fund program.

Table 170: Income Qualified Efficiency Fund Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	570	100%	572	±0.2% @ 80%
FY2020 Peak Demand Savings (MW)	0.2	105%	0.2	±5.7% @ 80%
FY2020 Gas Savings (MMBtu)	3,757	101%	3,786	±3.3% @ 80%

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[41] Lighting gas savings are negative because of the heating penalty for efficient lighting.

3.4.1.1 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 a virtual on-site verification visit at one sampled project.

3.4.1.2 Sampling Plan

We conducted desk reviews for the five projects with the most energy savings. For the IQEF program, the top five projects represented 56% of the tracked energy savings from all 27 projects that participated in the program in FY2020.

3.4.1.3 Results

Table 171 displays the realization rates for the measures installed at the five sampled projects. Boilers/furnaces, water heaters, and central air conditioners achieved realization rates of 100% in all applicable savings categories. Thermostats achieved electric and gas realization rates of 126% because smart thermostats installed at one project had been mischaracterized as programmable thermostats in the tracking data.

Table 171: Income Qualified Efficiency Fund Realization Rates by Measure Type

Measure Category*	FY2020 Electric Savings Realization Rate	FY2020 Peak Demand Savings Realization Rate	FY2020 Gas Savings Realization Rate
Boilers/Furnaces	100%	-	100%
Water Heating	-	-	100%
Central AC	100%	100%	-
Thermostats	126%	n/a[42]	126%
Total	**100%**	**105%**	**101%**

*Sampled measures only.

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[42] Tracked peak demand savings for thermostats were zero KW while verified peak demand savings were 2.6 KW. We did not include a realization rate for thermostats in this table because 2.6 is not divisible by zero. The total peak demand realization rate of 105% accounts for the additional 2.6 KW in peak demand savings from thermostats.

3.4.1.4 Recommendations

Based on the findings of our analysis, we offer the following recommendation for the Income Qualified Efficiency Fund program:

- Ensure that measures are accurately characterized in the tracking data.

3.5 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 FY2020, ECMs included in-unit and common area lighting, heating and cooling systems, domestic hot water systems, low flow water fixtures, solar PV, ventilation fans, air sealing, appliances, thermostats, and motors.

In FY2020, the program provided incentives for 40 projects. Table 172 provides the breakdown of tracked savings by measure type. Combined together, lighting (36%), boilers/furnaces (21%), and water heating (15%) accounted for nearly three-quarters of program-level savings.

Table 172: Low-income Multifamily Comprehensive Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Peak Demand Savings	Percent of FY2020 Gas Savings
Lighting	36%	73%	54%	<-1%[43]
Boilers/Furnaces	21%	-	-	45%
Water Heating	15%	-	-	31%
Heat Pumps	9%	7%	20%	10%
Low Flow Water Fixtures	7%	3%	1%	12%
Solar PV	6%	9%	14%	-
Ventilation	2%	4%	1%	-
Other	4%	5%	9%	2%

*Others include air sealing, air conditioning, motors, set back thermostats, and Energy Star appliances (clothes washers, clothes dryers, refrigerators, and dishwashers).

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[43] Lighting gas savings are negative because of the heating penalty for efficient lighting.

For the FY2020 LICP program, we completed the following evaluation activity:

- Gross Savings Verification

3.5.1 Gross Savings Verification

Table 173 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the LICP program.

Table 173: Low-income Multifamily Comprehensive Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	3,244	98%	3,170	±4.1% @ 80%
FY2020 Peak Demand Savings (MW)	0.3	114%	0.4	±17.6% @ 80%
FY2020 Gas Savings (MMBtu)	6,471	101%	6,561	±2.7% @ 80%

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 virtual on-site verification for three sampled projects.

3.5.1.2 Sampling Plan

We conducted desk reviews for the 11 projects with the most energy savings. For the LICP program, the top 11 projects represented 62% of the tracked energy savings from all 40 projects that participated in the program in FY2020.

3.5.1.3 Results

Table 174 displays the realization rates for the measures installed at the 11 sampled projects. Boilers/furnaces, water heaters, heat pumps, low flow water fixtures, and ventilation 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 174: Low-income Multifamily Comprehensive Realization Rates by Measure Type

Measure Category*	FY2020 Electric Savings Realization Rate	FY2020 Peak Demand Savings Realization Rate	FY2020 Gas Savings Realization Rate
Lighting	94%	100%	88%
Boilers/Furnaces	-	-	100%
Water Heating	-	-	100%
Heat Pumps	100%	100%	100%
Low Flow Water Fixtures	100%	100%	100%
Solar PV	101%	147%	-
Ventilation	100%	100%	-
Other**	109%	108%	101%

*Sampled measures only.
**Other includes custom air conditioning, air sealing, and Energy Star clothes washers, clothes dryers, refrigerators, and dishwashers.

Lighting

- At one sampled project, 160 LED fixtures installed in bathrooms within residential units had been incorrectly recorded as installed in multifamily common areas. Tracked savings were based on multifamily common area HOU and waste heat factors. We recalculated the savings from these fixtures using the HOU and waste heat factors appropriate for LEDs installed within residential units. Because residential bathroom lights are in use for less than half of the hours that multifamily common area lights are in use, this adjustment reduced the electric savings from these LEDs by over 50%. This adjustment is the primary force driving the LICP program-level electric realization rate to 98%.

- At another sampled project, gas waste heat factors had been utilized to calculate indoor LED fixture savings for a building heated with electric heat pumps. We recalculated the savings using the correct waste heat factors, which reduced the electric savings but eliminated the gas heating penalty from the LED fixtures at this project.

Solar PV

- Solar PV was installed at two sampled LICP projects. The NMR team calculated tracked savings using NREL's PV Watts Calculator[44] with site-specific inputs, such as DC system size, module type (standard, premium, or thin film), and inverter efficiency. At both projects, "standard" module type had been entered into the PV Watts Calculator; however, the module spec sheets indicated that they were "premium" modules. The NMR team reran the PV Watts calculations using the "premium" module type, which increased electric savings from these projects.

  The NMR team made further adjustments to tracked savings for one of these two LICP projects. We observed that a higher DC system size (planned versus actual) and lower inverter efficiency than listed on the spec sheet had been entered into the PV Watts

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

Calculator. In addition, zero peak demand savings had been recorded in the tracking data. The revised electric savings based on the actual DC system size and inverter efficiency were virtually the same as tracked electric savings since these two adjustments had opposing effects. However, the addition of peak demand savings from this project had a substantial, positive impact on the solar PV (147%) and program-level (114%) peak demand realization rates.

Other

- Air sealing was performed at one sampled LICP project. This project is heated with electric heat pumps; therefore, air sealing produced savings from both heating and cooling. However, tracked electric savings only accounted for the heating season. We calculated electric and peak demand savings for the cooling season, which had a positive impact on the program-level electric and peak demand realization rates.

- We identified a data entry error in the savings calculator for Energy Star clothes dryers installed at one sampled project. The baseline (i.e., standard efficiency) combined energy factor (CEF) had been entered in place of the CEF of the Energy Star model installed. Correcting this error increased program-level electric savings, though the impact was small due to the relatively low proportion of savings that Energy Star clothes dryers constitute among sampled projects.

- Tracked dishwasher savings for one sampled project had been calculated using deemed savings inputs. The Energy Star dishwasher model installed at this project was less efficient than the hypothetical model on which deemed savings inputs are based. Therefore, verified savings based on inputs from the spec sheet were lower than the tracked savings. However, this adjustment had a negligible impact on the program-level realization rates because these measures accounted for a very small portion of savings from sampled projects.

3.5.2 Recommendations

Based on the findings of our analysis, we offer the following recommendations for the Low-income Multifamily Comprehensive program:

- Ensure that lighting installation locations and heating fuel types are recorded correctly so the appropriate HOU and waste heat factors are applied.

- Calculate cooling and peak demand savings for projects heated with heat pumps where air sealing was performed.

- Calculate savings utilizing site-specific inputs as opposed to TRM defaults where available.

3.6 LOW-INCOME PRESCRIPTIVE REBATE (7613LIRX)

The DCSEU Low-Income Prescriptive Rebates (LIRX) program offers increased rebates for the installation of energy-efficient lighting and lighting controls in buildings that serve low-income DC residents. These include affordable housing, clinics, and shelters. By lowering energy costs, the LIRX program enables funding to improve client services and implement building upgrades rather than pay for unnecessary energy use. Rebates are available for lighting controls and sensors and a range of LED bulbs and fixtures.[45]

In FY2020, the program provided incentives for 15 projects. Table 175 provides the breakdown of tracked savings by measure type. The bulk of total energy savings (68%) were derived from screw-base LEDs.

Table 175: Low-income Prescriptive Rebate Program Savings Contributions

Measure Type	Percent of FY2020 Combined Energy Savings	Percent of FY2020 Electric Savings	Percent of FY2020 Peak Demand Savings	Percent of FY2020 Gas Savings
LED Screw-base Bulb	41%	45%	50%	68%
Linear LEDs	23%	22%	26%	16%
Outdoor LED Fixtures	14%	12%	-	-
LED Downlights	13%	13%	15%	9%
Indoor LED Fixtures	7%	6%	8%	5%
LED Pin-based CFL Replacements	2%	2%	2%	2%

For the FY2020 Low-income Prescriptive Rebate program, we completed the following evaluation activity:

- Gross Savings Verification

3.6.1 Gross Savings Verification

Table 176 displays the tracked savings, realization rates, evaluated savings, and sample precisions for the Low-income Prescriptive Rebate program.

Table 176: Low-income Prescriptive Rebate Savings and Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	1,051	112%	1,173	±5.2% @ 80%
FY2020 Peak Demand Savings (MW)	0.1	92%	0.1	±12.4% @ 80%
FY2020 Gas Savings (MMBtu)	-463	107%	-496	±4.8% @ 80%

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[45] https://www.dcseu.com/commercial-and-multifamily/income-qualified-lighting

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 in the tracking data. We then verified that the savings algorithms and inputs from the TRM were applied correctly in calculating savings. When the tracking data provided more accurate site-specific information, the NMR team overwrote TRM assumptions with site-specific data.

3.6.1.2 Sampling Plan

We conducted desk reviews for the seven projects with the most energy savings. For the Low-income Prescriptive Rebate program, the top seven projects represented 84% of the tracked energy savings from all 15 projects that participated in the program in FY2020.

3.6.1.3 Results

Realization rates for measures present in sampled projects are displayed in Table 177. Electric, peak demand, and gas realization rates for most measures were greater than 100%. The primary factor influencing the realization rates was the NMR team's use of site-specific wattages instead of deemed wattages from the TRM. The tracking data included site-specific efficient measure wattages. We cross-referenced these with the project files and verified that they were accurate. In most cases the actual wattages were lower than the deemed wattages listed in the TRM, which had a net positive effect on realization rates.

A secondary factor influencing the realization rates results from rounding in DCSEU's system. For 7 of the 13 sampled item codes,[46] DCSEU's system rounds the deemed MMBTU (i.e., heating penalty) listed in the TRM from the fourth to the third decimal place. For most of these item codes, the impact was negligible, increasing or reducing MMBTU by 1% or less. However, for LED screw-base bulbs installed in multifamily residential units, which accounted for 9% of FY2020 LIRX savings, this rounding issue overestimated the heating penalty by 5%. It is best practice to consistently apply the same parameters across all measures. Overall, adjusting for this rounding issue reduced the program-level heating penalty slightly.

The NMR team made one additional adjustment that affected the linear LED peak demand realization rate. Two-thirds of the linear LEDs installed at sampled projects were installed in multifamily residential units, while one-third were installed in multifamily common areas. However, tracked peak demand savings for all these linear LEDs used the commercial indoor lighting coincidence factor (57.82%). We applied the residential indoor lighting coincidence factor (11.00%) to the linear LEDs installed in residential units, which reduced linear LED peak demand savings and the program-level peak demand realization rate.

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[46] An item code is a sub-category for TRM measures with different savings values (i.e., various lumen outputs or installation locations).

Table 177: Low-income Prescriptive Rebate Realization Rates by Measure Type

Measure Category	Electric Savings Realization Rate	Peak Demand Savings Realization Rate	Gas Savings Realization Rate
LED Screw-base Bulb	105%	104%	102%
Linear LEDs	121%	51%	122%
Outdoor LED Fixtures	116%	-	-
LED downlights	116%	114%	115%
Indoor LED Fixtures	108%	108%	108%
LED Pin-based CFL Replacements	132%	132%	130%

3.6.2 Recommendations

Based on the findings of our analysis, we offer the following recommendations for the Low-income Prescriptive Rebate program:

- Utilize site-specific efficient measure wattages in savings calculations instead of deemed wattages from the TRM. This should not require additional data gathering since DCSEU's system already accurately captures incentivized measure wattages. Utilizing site-specific wattages improves the accuracy of tracked savings and ensures that DCSEU gets credit for the full amount of energy savings resulting from the program.

- Ensure that deemed prescriptive savings are rounded to the same decimal place across item codes.

- Ensure that the appropriate coincidence factors are utilized based on the location in which lighting measures are installed (multifamily in-unit versus common area).

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 FY2020 evaluation.

4.1 DEFAULT REALIZATION RATES

As described in Section 1.5, the FY2020 evaluation verified the gross savings for 12 programs. In order to assign default realization rates for the eight programs that the NMR team did not evaluate for FY2020, we reviewed previous realization rates for these DCSEU programs, as well as the calculated FY2020 realization rates for other programs. Because realization rates can change over time as measure offerings and markets evolve, we opted to apply the FY2019, FY2018, or FY2017 realization rate for the same program or the FY2020 realization rate from similar programs or similar measures if they exist.

Table 178 lists each of the eight programs that did not undergo an evaluation in FY2020, the source of the realization rate, and the default realization rate values.

Table 178: FY2020 Default Realization Rates

Sector	Program Name	Source for Default Realization Rate	Default Realization Rates		
			Electric Savings	Peak Demand Savings	Gas Savings
Solar	Low-income Solar Renewable Credit (7107SREC)	FY2019 Evaluation for Solar PVMR	102%	103%	-
Commercial	Market Transformation Value (7512MTV)	FY2018 Evaluation	108%	139%	107%
Low-income	Income Qualified Gas Efficiency Fund (4335IGEF)	100% Assumption	-	-	100%
	Retail Lighting Food Bank (7717FBNK)	FY2020 Evaluation for Retail Lighting	100%	100%	100%
	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%

4.2 NET-TO-GROSS REVIEW

The NMR team estimated NTG values for ten FY2020 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 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 179 presents the recommended NTG estimates for these FY2020 programs.

Table 179: Recommended Default FY2020 NTG Estimates

Sector	Program Name	Track Number	NTG Value	Source
Solar	Low-income Solar Renewable Credit	7107SREC	100%	Assumed
Commercial	Small & Medium Business Rebates	7511SMRX	69%	Same as CIRX
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 FY2020 NTG estimates, the NMR team reviewed the previous DCSEU NTG values and also 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 180 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 179 are reasonable values for FY2020.

Table 180: 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	62%	FY2020	-	-
	7511CIRX	C&I RX - Equipment Replacement	69%	FY2020	Lighting: 64%-77% Prescriptive: 44%-54%	PA First Energy Companies (2018-2019)[a]
					77%	PA PECO (2019-2020)[b]
					Lighting: 77% Equipment: 56%	PA PPL (2019-2020)[c]
					88%	EMPOWER Maryland (2019)[d]
	7512MTV	Market Transformation Value	85%	FY2020	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 (2019)[d]
Commercial	7513UPLT	Commercial Upstream Lighting	74%	FY2020	62%	PA PPL (2019-2020)[c]
					74% A-line LEDs 67% Other LEDs	PA Duquesne (2018-2019)[e]
					80%	EMPOWER Maryland (2019)[c]
	7520CUST	Retrofit - Custom	52%	FY2020	Lighting: 64%-80% Custom: 53%-84%	PA First Energy Companies (2019-2020)[f]
					60%	EMPOWER Maryland (2019)[d]
					66%	PA PPL (2019-20120)[c]
					60%	PA PECO (2019-2020)[b]
	7520MARO	Market Opportunities - Custom	66%	FY2020	Lighting: 66%-85% Custom: 37%-56%	PA First Energy Companies (2016-2017)[g]
					60%	EMPOWER Maryland (2019)[d]
					66%	PA PPL (2019-2020)[c]
					60%	PA PECO (2019-2020)[b]
	7520NEWC	New Construction - Custom	42%	FY2020	Small: 33% Large: 48%	PA PECO (2019-2020)[b]
	7520P4PX	P4P	74%	FY2020	n/a	--
Multifamily	7610IQEF	Income Qualified Efficiency Fund	100%	Assumed	45%	PA Duquesne (2017-2018)[h]

Sector	Track	Initiative	DCSEU NTG	Year Assessed	Benchmark NTG	Benchmark Source Program Administrator (Program Year)
	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]
	7710APPL	Retail Efficient Appliances	45%	FY2020	90%-222%	PA PECO (2019-2020)[b]
					50%-65%	PA First Energy Companies (2019-2020)[f]
					40%	EMPOWER Maryland (2019)[d]
					61%	PA Duquesne (2019-2020)[i]
	7710HTCL	Retail Heating and Cooling	45%	FY2020	81%-100%	PA PECO (2019-2020)[b]
					51%-55%	PA First Energy Companies (2019-2020)[f]
					52%	EMPOWER Maryland (2019)[d]
					64%	PA PPL (2016-2017)[j]
Efficient Products	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 (2019)[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]
					19%	EMPOWER Maryland (2019)[d]
					Standard LED: 43% Specialty LED: 43%	PA Duquesne (2017-2018)[h]
					83%	PA PPL (2016-2017)[j]

Sector	Track	Initiative	DCSEU NTG	Year Assessed	Benchmark NTG	Benchmark Source Program Administrator (Program Year)

[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] Navigant. 2020. Overview Memo - Calendar Year 2019 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 (Itron); 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.

A

Appendix A   Program Descriptions

This appendix provides a description for each of the program tracks offered by DCSEU in FY2020.

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.

7107SREC - Low-income Solar Renewable Credit

Through this program, DCSEU has partnered in the past with a local solar nonprofit to provide upfront value for the first five years of Solar Renewable Energy Certificates (SRECs) generated by residential systems installed under the nonprofit's solar program. By partnering with SREC offtakers through a competitive process and capital providers, DCSEU was able to provide upfront value for these SRECs beyond market rates, thereby resulting in increased solar capacity beyond the status quo.

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.

7415LIDP - Low-income Decarbonization Pilot

In FY2020, the DCSEU operator received funding from the 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 HVAC equipment and appliances.

To achieve the goal, 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.

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 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.

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.

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 DC residents the benefits of solar electricity to 100,000 low-income eligible household and reduce their energy bills by 50%. The Solar for All program was established by the Renewable Portfolio Standard (RPS) act of 2016, which is funded by the Renewable Energy Development Fund (REDF). By enrolling in the Solar for All program, the installed system will offset the homeowner electricity costs by about $500.00 per year or more while providing a portion of the homeowner electricity from the grid. Renters who meet the income requirements as outlined are eligible for the program if the homeowner agrees to the terms and conditions of the program. Once a homeowner is qualified, the system is then installed at no cost and is fully funded by the DCSEU through the Solar for All program. Note that applying for the Solar for All program does not guarantee that the homeowner will receive a solar system. 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.

B Appendix B Additional Survey Findings

B.1   RESIDENTIAL PROGRAMS SURVEY – DEMOGRAPHICS

Nearly all of the residential survey respondents reported owning their own home: 98% of Retail Efficient Appliance program participants and 95% of Retail Heating and Cooling participants. More than one-half of Retail Efficient Appliances program participants (54%) and two-fifths of Retail Heating and Cooling program participants (40%) 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 181). 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 181: Home Type of Residential Program Participants

Type of Home	Census Estimates[1]	Percent of Respondents[2]	
		Retail Efficient Appliances (n=57)	Retail Heating and Cooling (n=43)
Single-family attached	24%	54%	40%
Single-family detached	12%	21%	33%
Apartment/condo with 2-4 units	10%	5%	7%
Apartment/condo with 5-9 units	7%	2%	12%
Apartment/condo with 10 to 19 units	10%	4%	2%
Apartment/condo with 20+ units	37%	9%	7%
Other	--	2%	--
Don't know/Refused	--	2%	--

[1] ACS 2019 five-year estimates (Census data).
[2] Percentages do not sum to 100% due to rounding.

Table 182 shows the year that the residential program participants' homes were built. Participants reported having older homes than the average DC home; 46% of Retail Efficient Appliances program participants and 60% of Retail Heating and Cooling participants have homes built before 1940, compared to 35% of DC residents.

Table 182: Year Home Built of Residential Program Participants

Year Home Built	Census Estimates[1]	Percent of Respondents[2]	
		Retail Efficient Appliances (n=57)	Retail Heating and Cooling (n=43)
2010 or later	7%	7%	9%
2000 to 2009	8%	7%	7%
1990 to 1999	3%	--	--
1980 to 1989	4%	--	--
1970 to 1979	7%	4%	2%
1960 to 1969	11%	5%	5%
1950 to 1959	13%	18%	7%
1940 to 1949	12%	5%	9%
Before 1940	35%	46%	60%
Don't know/Refused	--	9%	--

[1] ACS 2019 five-year estimates (Census data).
[2] Percentages do not sum to 100% due to rounding.

Table 183 shows the size of the residential program participants' homes in square feet. Most of the respondents reported that their homes were 2,000 square feet or less.

Table 183: Square Footage of Residential Program Participants' Homes

Square Footage	Percent of Respondents[1]	
	Retail Efficient Appliances (n=57)[1]	Retail Heating and Cooling (n=43)
Less than 500 square feet	2%	0%
500 to 1,000 square feet	23%	16%
1,001 to 1,500 square feet	19%	26%
1,501 to 2,000 square feet	21%	23%
2,001 to 2,500 square feet	11%	7%
2,501 to 3,000 square feet	9%	14%
More than 3,000 square feet	0%	7%
Don't know/Refused	16%	7%

[1] Percentages do not sum to 100% due to rounding.

As shown in Table 184, the majority of participants in the Retail Efficient Appliances and the Retail Heating and Cooling program reported having a graduate or professional degree (68% and 60%, respectively) or a Bachelors' degree (18% and 26%, respectively). The share of participants with a graduate or professional degree is substantially greater than the DC population as a whole.

Table 184: Educational Attainment of Residential Program Participants

Highest Level of Education Completed	Census Estimates[1]	Percent of Respondents	
		Retail Efficient Appliances (n=57)	Retail Heating and Cooling (n=43)
Graduate or professional degree	34%	68%	60%
Bachelors' degree	26%	18%	26%
Associate degree	--	0%	2%
Some college, no degree	16%	2%	5%
High school graduate	16%	7%	5%
Refused	--	5%	2%

[1] ACS 2019 one-year estimates (Census data); Associate degree data was not available; 8% of DC residents have no degree.

More than nine in ten respondents reported having a household income greater than the LIHEAP-eligibility threshold for a household of their size, while 4% of respondents reported a household income less than the threshold. [47] Nearly two-thirds of Retail Efficient Appliance program participants (65%) and three-fifths of Retail Heating and Cooling program participants (60%) identified as white, and approximately one-fifth of respondents (21% and 19%, respectively) identified as Black or African American (Table 185). When compared to Census estimates of the population in Washington, D.C., white residents are overrepresented as program participants.

Table 185: Race of Residential Program Participants

Race of Respondent	Census Estimates[2]	Percent of Respondents[1]	
		Retail Efficient Appliances (n=57)	Retail Heating and Cooling (n=43)
White	46%	65%	60%
Black or African-American	46%	21%	19%
Asian	5%	3%	9%
Biracial or multiracial	3%	2%	2%
Other	1%	2%	2%
Refused	--	5%	7%

[1] Percentages do not sum to 100% due to rounding.
[2] ACS 2019 one-year estimates (Census data).

Seven percent of Retail Efficient Appliances program participants and 5% 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 respondents from

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[47] https://doee.dc.gov/liheap

both programs), other respondents reported primarily speaking Spanish (5%), German, or French at home.

B.2 COMMERCIAL PROGRAMS SURVEY

B.2.1 Respondent Roles

In one-quarter of projects, facility managers or property managers (25%) were responsible for deciding whether or not to participate in the program. Facilities and/or property managers were involved in the decision-making for nearly one-third of all projects (30%), as were architects, engineers, and/or designers (31%). Table 186 shows the people involved in the decision to participate in the DCSEU program.[48]

Table 186: People Involved in Decision to Participate in the Program

Decision-Maker	Percent of Respondents (n=89)	
	Ultimate Decision Maker	Involved in Decision[1]
Facilities or Property Manager	25%	30%
Architect/Engineer/Designer	16%	31%
Board of Directors	12%	17%
Owner	10%	18%
President/CEO/Executive Director	6%	9%
CFO/Accounting	1%	3%
Other senior leader/manager	16%	22%
Contractor/Distributor/Vendor	--	15%
Other	10%	7%
Don't know/Refused	4%	--

[1] Does not sum to 100%; multiple responses accepted. "Involved in Decision" column includes the ultimate decision-maker.

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[48] Other decision-makers included project managers, owners' association representatives, and contracting officers.

B.2.2 Engagement with DCSEU

Over one-third of respondents described their business organization as being "fully engaged" (37%) with DCSEU, while another 37% said that they were "Engaged with DCSEU but could probably do more." (Table 187). In addition, over two-thirds of C&I program respondents (69%) indicated that their organization had plans for energy-efficient or renewable energy improvements in the next two years. Nearly all respondents (94%) said they would consider involving DCSEU in their future plans.

Table 187: Participant Engagement with DCSEU

Engagement Level	Percent of Respondents (n=89)
Fully engaged with DCSEU	37%
Engaged with DCSEU but could probably do more	37%
Rarely engaged with DCSEU because we have little need	18%
Rarely engaged with DCSEU because ROI is too low	2%
Don't know	6%
Total	*100%*

When asked how DCSEU could assist respondents in meeting their organizations' future energy needs, respondents most often requested that DSCEU continue offering rebates (42%) and programs (39%) and provide information on all available rebates (35%). Table 188 shows all of the responses provided by commercial program participants overall and by their level of engagement with DCSEU.

Customers who reported that they were "fully engaged" with DCSEU were more likely than less engaged customers to request that DCSEU continue offering programs (42%), inform them when programs or rebates change (36%), and visit their facility for an energy audit (21%). Customers that are engaged with DCSEU "but could do more" were more likely than others to request that DCSEU provide information on all available rebates (45%) and increase rebate amounts (33%).

Table 188: Ways DCSEU Can Meet Future Energy Needs by Customer Engagement Level[1]

DCSEU action	Overall (n=89)	Engagement with DCSEU		
		Fully engaged (n=33)	Could do more (n=33)	Rarely engages/don't know (n=25)
Continue offering rebates	**42%**	39%	39%	44%
Continue offering programs	**39%**	42%	39%	32%
Provide information on all rebates	**35%**	30%	45%	24%
Inform us when programs or rebates change	**28%**	36%	24%	20%
Increase rebate amounts	**25%**	18%	33%	20%
Visit facility for an energy audit	**16%**	21%	12%	8%
Streamline application process	**6%**	--	12%	4%
Speed up rebate payment	**4%**	--	9%	4%
Increase frequency of contact (e.g., emails)	**3%**	--	9%	--
Make DCSEU staff more available for assistance	**2%**	--	6%	--
Provide additional technical support	**2%**	3%	3%	--
Add more eligible equipment to programs	**2%**	--	--	4%
Other[49]	**4%**	3%	6%	--
Do not have any needs	**10%**	3%	15%	16%
Don't know	**9%**	9%	--	20%

[1] Does not sum to 100%; multiple responses accepted.

Over two-thirds of all respondents (69%) reported that they had heard of the Building Energy Performance Standards enacted by the District.[50] Approximately one-third of all respondents considered themselves either "very familiar" (13%) or "mostly familiar" (19%) with the standards, while 30% were "somewhat familiar" and 6% were "not at all familiar" with the Building Energy Performance 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. More than four-fifths of the respondents (85%) provided a response.

Nearly one-half of respondents (48%) noted that their businesses or organization had been negatively impacted – some gravely – by a reduction in business traffic, tourism, and/or students on campus. Many respondents reported experiencing heavy financial losses, layoffs, and disruptions to work schedules. Residential property managers noted that some of their buildings'

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[49] Other responses included suggestions to increase program visibility/advertisements, broadening the scope of DCSEU program support, and offering companies recognition for completing energy retrofits.
[50] https://doee.dc.gov/service/building-energy-performance-standards-beps

occupants left the city, while the tenants that remained had difficulty paying rent. Businesses that could not operate remotely (e.g., health care facilities and service providers) noted challenges in keeping staff and clients safe while continuing to fulfill their organization's mission.

While some respondents described reduced utility bills due to diminished occupancy, managers of residential properties noted that utility bills had increased because their tenants were home more often. One respondent noted that utility bills had increased due to additional use of the common areas, despite reduced occupancy in the building overall.

One respondent made equipment upgrades, including touchless bathroom fixtures and modified HVAC systems to reduce virus transmissibility. Another respondent reported that the pandemic provided their organization an opportunity to make energy-efficient improvements, including HVAC and lighting upgrades, while the building was unoccupied. One respondent who was struggling financially with the impacts of COVID-19 credited DCSEU funding for being able to move ahead with their energy-efficiency project.

Less than one in ten respondents (9%) reported that they were not impacted by the pandemic.

B.2.4 Commercial Program – Firmographics

Over two-thirds of the respondents (70%) said their organizations owned their space (Table 189).

Table 189: Organizational Tenure at Facility Participating in C&I Program

Facility Tenure	Percent of Respondents (n=89)
Own	70%
Manage	19%
Lease	9%
Don't know/Refused	2%

Nearly one-third of respondents (30%) described their organization as a non-profit, and one-quarter of respondents (25%) worked for a for-profit company operating in the commercial sector. Table 190 describes the organization types represented in the survey.

Table 190: Type of Organization

Organization Type	Percent of Respondents (n=89)
Non-profit organization	30%
For-profit business – commercial sector	25%
For-profit business – commercial/residential sector	15%
For-profit business – residential sector	9%
Federal government institution	7%
Residential housing co-op	3%
District institution	3%
Other	1%
Don't know/Refused	6%

The most common types of business activities conducted at the facilities that implemented a project through the DCSEU were lodging (33%) and office/professional (31%). Table 191 describes the primary business types across the facilities represented in the survey.

Table 191: Primary Business Activity at Participating Facility

Primary Business Activity	Percent of Respondents (n=89)[1]
Lodging	33%
Office/Professional	31%
Health care	7%
Education	6%
Religious worship	4%
Industrial/Manufacturing	3%
Municipal government	3%
Service	1%
Food sales or service	1%
Retail	1%
Public order and safety	1%
Other	4%
Don't know/Refused	3%

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

Nearly one-third of respondents reported that less than ten employees worked at the location where the organization implemented a project through the DCSEU. Table 192 describes the number of employees at locations represented in the survey.

Table 192: Number of Employees at Facility

Number of Employees	Percent of Respondents (n=89)[1]
Less than 10	30%
11 to 20	12%
21 to 50	11%
51 to 100	8%
101 to 250	7%
251 to 500	7%
501 to 1,000	3%
1,001 to 2,000	4%
2,001 to 3,000	2%
More than 3,000	3%
Don't know/Refused	11%

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

Nearly one-quarter of respondents (22%) were unsure of the square footage of their facility. Square footage of facilities differed widely across organizations represented by the survey; one-third of respondents (33%) indicated that their facilities were approximately 100,000 to 500,000 square feet (Table 193).

Table 193: Size of Facility in Square Feet

Square Footage	Percent of Respondents (n=89)[1]
Less than 1,000	3%
1,000 to less than 2,000	3%
2,000 to less than 3,000	1%
3,000 to less than 5,000	3%
5,000 to less than 10,000	1%
10,000 to less than 15,000	1%
15,000 to less than 25,000	6%
25,000 to less than 50,000	2%
50,000 to less than 100,000	3%
100,000 to less than 200,000	11%
200,000 to less than 500,000	22%
500,000 to less than 750,000	7%
750,000 to less than 1 million	2%
More than 1 million	10%
Don't know/Refused	22%

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

C
 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 FY2020, the Solar for All LISF program provided incentives for 120 projects and claimed 0.63 MW of generation capacity. We completed the following evaluation activity:

- Gross Savings Verification

C.1.1   Gross Savings Verification

Table 194 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 127%, while the capacity realization rate equals 110%.

Table 194: LISF Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	591	127%	750
FY2020 Max. Generation Capacity (MW)	0.63	110%	0.69

C.1.1.1   Sampling

Due to the homogeneous makeup of the program, we randomly selected one to two LISF projects from each of the four participating contractors. Table 195 displays the participating contractors, their FY2020 participation, and the number of sampled projects. The evaluation team randomly selected five of the 120 projects for review in the FY2020 evaluation.

Table 195: LISF Sampling Plan[51]

Contractor	Percent of Program Energy Savings	FY2020 Participation	Number of Sampled Projects
Greenscape Environmental Services, Inc.	33%	40	2
Solar Solution LLC	43%	56	1
WDC Solar, Inc.	22%	20	1
GRID Alternatives Mid-Atlantic	2%	4	1

C.1.1.2   Methodology

The NMR team conducted desk reviews for the five sampled projects. We gathered key data 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[52] 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.

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[51] The database extract provided to the evaluation team included both FY2019 and FY2020 projects: 86 projects listed as being initiated in FY2019 and 124 projects listed as being initiated in FY2020. At the time that the database extract was pulled (around November 2020), 86 FY2019 projects were complete, and 120 FY2020 projects were complete. While sampling was performed based on all completed projects in the database, the verified savings presented in this report only reflect the 120 completed FY2020 projects.
[52] https://pvwatts.nrel.gov/

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 196. The program-level realization rates are 127% for electric savings and 110% for capacity. The selected sample ultimately achieved a ±2.9% precision at 80% confidence for electric savings. 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 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 196: LISF Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	591	127%	750	±2.9% @ 80%
FY2020 Max. Generation Capacity (MW)	0.63	110%	0.69	±3.6% @ 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.

For the FY2020 CREF program, we completed the following evaluation activity:

- Gross Savings Verification

C.2.1 Gross Savings Verification

Table 197 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 104%, while the capacity realization rate equals 105%.

Table 197: CREF Realization Rates

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings
FY2020 Electric Savings (MWh)	7,957	104%	8,275
FY2020 Max. Generation Capacity (MW)	6.42	105%	6.74

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 1,500 MMBtu. All projects above that threshold were included in the sample. The NMR team placed projects that had total energy savings between 400 and 1,500 MMBtu in the large probability stratum, while we placed projects below 400 MMBtu in the small probability stratum. The NMR team randomly selected one project from within each of the two probability strata. There were also 35 projects (including 5 from FY2019 and 30 from FY2020) listed in the tracking database with zero savings.

Table 198: CREF Sampling Plan[53]

Stratum	Percent of Database Energy Savings	FY2019 Participation	FY2020 Participation	Number of Sampled Sites
Certainty	25%	1	2	3
Large Probability	32%	13	6	1
Small Probability	43%	65	12	1
Zero Savings*	0%	5	30	0

*Thirty-five projects were listed in the SEU tracker with no savings associated with them. The NMR team assumed that these were active projects, but ones for which no energy savings were achieved as of the date that the database extract was pulled.

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[53] The database extract provided to the evaluation team included both FY2019 and FY2020 projects: 84 projects listed as being initiated in FY2019 and 50 projects listed as being initiated in FY2020. At the time that the database extract was pulled (around November 2020), 79 FY2019 projects were complete, and 20 FY2020 projects were complete. While sampling was performed based on all completed projects in the database, the verified savings presented in this report only reflect the 20 completed FY2020 projects.

C.2.1.2   Methodology

The NMR team conducted desk reviews for the five 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[54] 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 Watts hourly data to calculate the electricity savings. We attempted to visually confirm the installation of each PV system using google earth;[55] 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 199. The findings that contributed to the realization rates are detailed in the text that follows.

Table 199: CREF Program Impact Results

Savings Type	Tracked Savings	Realization Rate	Evaluated Savings	Precision & Confidence
FY2020 Electric Savings (MWh)	7,957	104%	8,275	80% ± 2.9%
FY2020 Max. Generation Capacity (MW)	6.42	105%	6.74	80% ± 3.9%

The program-level realization rates are 104% for electric savings and 105% for generation capacity. The selected sample ultimately achieved a ±2.9% precision at 80% confidence for electric savings and ±3.9% precision for generation capacity.

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[54] https://pvwatts.nrel.gov/
[55] https://www.google.com/earth/

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, D.C., 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 (15-19%), while the actual efficiencies of the systems involved in the sampled projects tended to be "premium" (>19%).

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,[56] providing the DCSEU with a weather normalized generation estimate.

The electric savings and generation capacity realization rates are both slightly higher than 100% primarily due to a Small Probability stratum project. The project achieved realization rates of 111% for electric savings and 117% for generation capacity. The ex-ante savings calculations apply 23% as the system loss; however, the project documentation did not include a source or explanation for this value. The evaluator used the default value of 14% for system loss in verified calculations.

C.2.2 Recommendations

Based on the findings of our analysis, we offer the following recommendations:

- Ensure that an SFA Substantial Completion Report is provided for all projects. The reports provide critical site- and equipment-specific inputs for the PV Watts Calculator. One of the sampled projects did not have the SFA Substantial Completion Report document included in project files.

- Use the Solar Permit and SFA Substantial Completion Report, found in the project file, to check to ensure that the DC System Size adds up to the correct value. For four of the five projects, multiple DC system sizes were listed within different documents provided in the projects file, but the Solar Permit and SFA Substantial Completion Report provide the final DC System Size values used.

- Ensure that critical inputs for PV Watts are provided in project files for every project. One out of five projects did not provide the DC System Size, Tilt, and Azimuth values for each array in the projects file.

- Use the PV Watts tool for predicting solar generation data when the actual production data is not given. If the projects solar generation data is provided to DCSEU, use that data rather than the estimates from the PV Watts tool.

- Use the value of the inverter efficiency found within the projects file rather than the default value found on the PV Watts Calculator for a more accurate energy savings

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

result. One out of five projects did not have the inverter efficiency in any of the documents found in the projects file so the default value of 96% had to be used.