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Department of Energy and Environment

Evaluation, Measurement, and Verification of Energy Efficiency and Renewable Energy Programs in the District of Columbia

FY2015 Annual Evaluation Report

Volume I (Final Draft)

April 15, 2016

(August 29, 2016 Revised)

DEPARTMENT OF ENERGY & ENVIRONMENT

DC SUSTAINABLE ENERGY UTILITY

Your Guide to Green

leidos

BAUMANN CONSULTING

Formerly Ebert & Baumann Consulting Engineers

GDS Associates, Inc.

Engineers and Consultants

Department of Energy and Environment

Evaluation, Measurement, and Verification of Energy Efficiency and Renewable Energy Programs in the District of Columbia

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ACKNOWLEDGEMENTS

This evaluation effort was performed by Tetra Tech, GDS Associates, Leidos, and Baumann Consulting under the leadership of Tetra Tech.

This effort was supported by the provision of project data in the form of KITT data extracts, project files, memos, staff interviews, and responses to other requests for data and information by the DOEE, DCSEU, and VEIC Evaluation, Measurement, and Verification Services group.

The evaluation team thanks the DOEE, DCSEU, and VEIC teams for their timely and thorough responses to all data requests and follow-up questions. In particular, we thank Robert Stephenson, VEIC EM&V Services Group, for his support and responses to the many questions from the evaluation team as we conducted our impact evaluation activities.

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ACRONYMS

ACEEE	American Council for an Energy Efficient Economy
BER	Business Energy Rebates
Btu	British thermal unit
C&I	Commercial and institutional
CAT	Comprehensive Analysis Tool
CBE	Certified business enterprise
CF	Coincidence factor
CEI	Comprehensive efficiency improvements
CFL	Compact fluorescent lamp
DI	Direct install
DCSEU	District of Columbia Sustainable Energy Utility
DOEE	Department of Energy and Environment
DDOE	District Department of the Environment
DHW	Domestic hot water
EC	Energy consultant
ECM	Energy conservation measure
EFI	Energy Federation Incorporated
EFLH	Equivalent full load hours
EISA	Energy Independence and Security Act
EM&V	Evaluation, measurement, and verification
FY	Fiscal year
GWh	Gigawatt hour
HERO	Home Energy Reporting Online
HPwES	Home Performance with ENERGY STAR®
HVAC	Heating, ventilation, and air conditioning
ICDI	Implementation contractor direct install
KITT	Knowledge Information Transfer Tool
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
LI	Low-income
LIMF	Low-income multifamily

Mcf	1,000 cubic feet
MF	Multifamily
MMBtu	1 million British thermal unit
M&V	Measurement and verification
N	Population
n	Sample
NREL	National Renewable Energy Laboratory
NTG	Net-to-gross
PV	Photovoltaic
PY	Plan year
QA/QC	Quality assurance/quality control
RFP	Request for proposal
RR	Realization rate
SOME	So Others Might Eat
TRM	Technical Reference Manual
VEIC	Vermont Energy Investment Corporation
VFD	Variable frequency drive

1. EXECUTIVE SUMMARY

The Department of Energy and Environment (DOEE) has contracted with Tetra Tech (as the prime contractor), Leidos, GDS Associates, Inc., and Baumann Consulting to provide evaluation, measurement, and verification of the portfolio of energy efficiency and renewable energy initiatives offered in the District of Columbia (DC) along with the six performance benchmarks associated with these initiatives. The initiatives are implemented through the DC Sustainable Energy Utility (DCSEU) partnership.

The DCSEU is led by the Sustainable Energy Partnership and under contract to the Department of Energy and Environment (DOEE). The Sustainable Energy Partnership includes the following organizations:[1]

- Vermont Energy Investment Corporation (VEIC) - Partnership Lead
- George L. Nichols & Associates
- Groundswell
- Institute for Market Transformation
- Nextility
- PEER Consultants.

This report presents the evaluation and verification results for each initiative, or track, offered by the DCSEU as a part of the DCSEU Energy Efficiency and Renewable Energy Portfolio in the District of Columbia for fiscal year (FY) 2015. Overall portfolio results are also provided along with cross-sectional findings and evaluation team recommendations. The fiscal year is defined as October 1, 2014, through September 30, 2015. This is the fourth DCSEU annual evaluation report.

The evaluation focus for the FY2015 was on impact evaluation and verifying the reported energy savings numbers. A brief customer satisfaction survey was conducted during the scheduling of the on-site verification visits and is reported in section 2.4 of this report. The independent evaluation and verification of the six performance benchmarks included within the DOEE contract with the DCSEU is reported separately. See the *Department of Energy and Environment Verification of the District of Columbia Sustainable Energy Utility Performance Benchmarks, FY2015 Annual Evaluation Report*.

Other evaluation activates that took place during FY2015 that are reported outside of this document include:

- Three commercial and institutional custom track case studies will be completed to explore and document attribution that goes beyond free-ridership and spillover effects, which traditionally are captured in the net-to-gross assessment. The results will be reported in April or May 2016.

[1] DC Sustainable Energy Utility 2015 Annual Report, page 36.

- Review of the DCSEU Technical Reference Manual updates and additions on an as needed basis.
- A District Hotel Hours of Use study dated January 2016. The analysis was conducted in FY2014; however, the reporting of the results took place in early FY2015.
- Development and undertaking of a Pilot effort to coordinate M&V on-site verification with DCSEU's quality assurance on-site visits. The Pilot will begin in April/May and last for a few months. This verification will supplement FY2016 on-site verification efforts.
- A chiller peak load study to start will begin May 2016 and conclude in September 2016.
- Development of a 5-Year Strategic EM&V Plan to support a five-year contract period for the DCSEU.

Section 1 (this section) provides an executive summary. Section 2 provides background on the evaluation efforts to date and the performance benchmark evaluation. Detailed summaries of the portfolio overall and crosscutting evaluation findings are presented in Section 3 of this document. Section 4 provides detailed track level assessments.

1.1 EVALUATION VERIFIED SAVINGS SUMMARY

The evaluation team's verified (ex-post) results of DCSEU's Knowledge Information Transfer Tool (KITT) reported electric savings, demand reduction, and natural gas savings for each track, or initiative, and for the overall portfolio are presented in Table 1-4. How these savings match to the DCSEU's performance benchmarking targets is detailed in the FY2015 Annual Evaluation Report for Performance Benchmarks.

These verified results reflect portfolio level realization rate estimates of 0.94 for kWh, 1.19 for kW, 1.13 for MMBtu (including all interactive effects) and 1.08 for MMBtu (excluding cross-fuel interactive effects for lighting). This means that the evaluation team estimates that the actual portfolio electric savings result is 94 percent of the DCSEU reported electric savings, the demand reduction result is 119 percent of the DCSEU reported demand reduction, the actual portfolio gas savings result is 113 percent of the DCSEU reported gas savings (when including all interactive effects) and the gas savings net of cross-fuel interactive effects for lighting resulted in 108 percent of savings. This compares to FY2014 realization rate estimates at the portfolio level of 0.98, 0.92, and 1.00 for kWh, kW, and MMBtu, respectively.

Table 1-1. Portfolio Level Realization Rates (RR) FY2015

Metric	RR Estimates
kWh	0.94
kW	1.19
MMBtu[1]	1.13
MMBtu (Excluding IE)[2]	1.08

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Realization rates are the ratio of verified savings to the tracking system savings for a representative sample of projects reported within each track. Realization rates are typically calculated for each end-use category and then applied to the total end-use tracking system savings for a particular program, or track. The results are rolled up to develop program, or track, verified savings. The verified savings for all tracks are summed to obtain portfolio level verified savings. The portfolio level realization rates over the past four years (as detailed below in Table 1-2) have hovered between 0.92 to 1.19, with results ranging from 0.92–1.04 kWh, 0.93–1.19 kW, and 0.99–1.08 MMBtu. In FY2012 and FY2014, across kWh, kW, and MMBtu the implementation contractor slightly over estimated savings numbers. In FY2013 savings across all three measurements were slightly underestimated by the implementation contractor. In FY2015, the savings were overestimated for kWh and underestimated for kW and MMBtu.

Table 1-2. Portfolio Level Realization Rate FY2012 through FY2015

Fiscal Year	kWh	kW	MMBtu
FY2012	0.92	0.95	0.99
FY2013	1.04	1.07	1.00
FY2014	0.98	0.92	1.00
FY2015	0.94	1.19	1.08

These realization rate estimates are comparable to realization rates found in neighboring states. The realization rates for Pennsylvania utilities and EmPower Maryland for the last two program years where data was available are listed in Table 1-3 below.

Table 1-3. Comparison of DCSEU's RRs to Neighboring States

	PA Range		Maryland Statewide	
Metric	2013–2014	2014–2015	2012	2013
kWh	1.06	1.12	1.00	0.93
kW	1.02	1.10	1.15	1.01
MMBtu	NA	NA	NA	NA

Although DCSEU's portfolio realization rates are near or greater than 1.0, there are specific initiatives for which realization rates are lower (see Table 1-4 and Table 1-5). The chief initiatives with lower realization rates typically rely on custom calculations, an area of potential improvement for DCSEU. Additionally, DCSEU does not appear to be fully utilizing the TRM in terms of the documentation gathered by the program to support prescriptive measure savings or the resulting savings calculations. This was the first year where realization rates for kW and MMBtu where significantly above 1.00, meaning that the projects verified more savings than DCSEU took credit for in its tracking systems. More detail about the track-level realization rates can be found in the individual initiative descriptions to follow in section 4.

Table 1-4. DCSEU FY2015 Energy Efficiency and Renewable Energy Portfolio Gross Verified Savings, Meter Level (Including All Interactive Effects)

Track	Description	kWh			kW			MMBtu - Gas Savings		
		Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
7101PVMR	Solar Market Rate	232,236	232,236	1.00	30	30	1.00	1,166	1,166	1.00
7107PV	Solar Photovoltaic	606,096	606,096	1.00	80	80	1.00	0	0	n/a
7110SHOT	Solar Hot Water	-2,154	-2,154	1.00	0	0	1.00	1,508	1,508	1.00
7401FHLB	Income Qualified Home Improvement	14,865	14,865	1.00	2	2	0.88	552	622	1.13
7420HPES	Home Performance with ENERGY STAR	42,733	42,215	0.99	7	7	1.00	798	1,103	1.38
7511CIRX	Business Energy Rebates	8,594,703	8,299,391	0.97	771	1,152	1.50	-3,292	-2,910	0.88
7512MTV	T12 Market Transformation Value	3,587,788	3,301,235	0.92	582	687	1.18	-2,196	-2,106	0.96
7520CUST	Custom Services for Large C&I Customers	14,837,521	12,732,804	0.86	1,883	2,157	1.15	60,134	67,790	1.13
7520MARO	Custom Market Opportunity	1,978,521	1,818,074	0.92	347	260	0.75	14,474	14,116	0.98
7520NEWC	Custom New Construction	229,937	226,849	0.99	38	36	0.92	937	879	0.94
7610ICDI	LI MF Implementation Contractor Direct Install	2,856,247	2,895,554	1.01	159	158	1.00	-837	-1,049	1.25
7610LICP	LI MF Comprehensive Efficiency Improvements	638,491	539,624	0.85	147	560	3.80	431	265	0.62
7612LICP	LI MF Custom Efficiency Improvements	1,264,544	931,593	0.74	119	139	1.16	1,147	310	0.27
7710APPL	Retail Efficient Appliances	109,084	125,052	1.15	39	44	1.12	1,153	1,115	0.97
7710FBNK	Efficient Products at Food Banks	264,521	264,031	1.00	24	24	1.00	-446	-446	1.00
7710LITE	Retail Efficient Lighting	17,590,664	17,591,167	1.00	2,045	2,148	1.05	-22,071	-22,092	1.00
Reported (ex-ante) / Verified (ex-post)		**52,845,797**	**49,618,633**	**0.94**	**6,274**	**7,484**	**1.19**	**53,459**	**60,272**	**1.13**

Table 1-5. DCSEU FY2015 Energy Efficiency and Renewable Energy Portfolio Gross Verified Savings, Meter Level (Excluding Cross-fuel Lighting Interactive Effects)

Track	Description	kWh			kW			MMBtu - Gas Savings		
		Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
7101PVMR	Solar Market Rate	232,236	232,236	1.00	30.1	30.1	1.00	1,166	1,166	1.00
7107PV	Solar Photovoltaic	606,096	606,096	1.00	79.6	79.6	1.00	0	0	n/a
7110SHOT	Solar Hot Water	-2,154	-2,154	1.00	-0.3	-0.3	1.00	1,508	1,508	1.00
7401FHLB	Income Qualified Home Improvement	14,865	14,865	1.00	2.1	1.9	0.88	553	623	1.13
7420HPES	Home Performance with ENERGY STAR	42,733	42,215	0.99	6.8	6.8	1.00	805	1,110	1.38
7511CIRX	Business Energy Rebates	8,594,703	8,299,391	0.97	770.5	1,152.4	1.50	121	196	1.63
7512MTV	T12 Market Transformation Value	3,587,788	3,301,235	0.92	582.5	687.3	1.18	0	0	n/a
7520CUST	Custom Services for Large C&I Customers	14,837,521	12,732,804	0.86	1,882.8	2,157.5	1.15	61,363	68,974	1.12
7520MARO	Custom Market Opportunity	1,978,521	1,818,074	0.92	347.1	259.9	0.75	14,493	14,137	0.98
7520NEWC	Custom New Construction	229,937	226,849	0.99	38.4	35.5	0.92	975	916	0.94
7610ICDI	LI MF Implementation Contractor Direct Install	2,856,247	2,895,554	1.01	158.6	158.1	1.00	1,529	1,384	0.91
7610LICP	LI MF Comprehensive Efficiency Improvements	638,491	539,624	0.85	147.4	559.6	3.80	533	367	0.69
7612LICP	LI MF Custom Efficiency Improvements	1,264,544	931,593	0.74	119.2	138.5	1.16	1,376	598	0.43
7710APPL	Retail Efficient Appliances	109,084	125,052	1.15	39.2	44.0	1.12	1,153	1,115	0.97
7710FBNK	Efficient Products at Food Banks	264,521	264,031	1.00	24.5	24.5	1.00	0	0	n/a
7710LITE	Retail Efficient Lighting	17,590,664	17,591,167	1.00	2,045.0	2,148.4	1.05	0	0	n/a
Reported (ex-ante) / Verified (ex-post)		**52,845,797**	**49,618,633**	**0.94**	**6,273.6**	**7,483.9**	**1.19**	**85,573.6**	**92,096.4**	**1.08**

Table 1-6 provides a summary of initiative metrics since the inception of the program as verified by Tetra Tech. FY2012 and FY2013 results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects and FY2015 includes the like fuel interactive effects; and excludes cross-fuel interactive effects.

Table 1-6. DCSEU FY2012–FY2015 Energy Efficiency and Renewable Energy Portfolio Gross Verified Savings, Meter Level and Realization Rates

Fiscal Year	Verified Gross kWh Savings	kWh RR	Verified Gross KW Savings	kW RR	Verified Gross MMBtu Saving	MMBtu RR
FY2012	19,875,083	0.92	3,227	0.95	4,651	0.99
FY2013	48,399,192	1.04	7,558	1.07	49,616	1.00
FY2014[2]	55,156,931	0.98	7,453	0.92	132,579	1.00
FY2015	49,618,633	0.94	7,611	1.19	92,096	1.08

[2] Exclude interactive effects that reflects a gas heating offset for the installation of energy efficiency lighting.

Table 1-7 provides a summary of net verified savings by track and for the overall portfolio after adjustments for line losses[3], and in the case of the solar initiatives, an adjustment for spillover.[4] The free-ridership and spillover for all other tracks are assumed to be 1.00, except for the Solar Photovoltaic and Solar Hot Water initiatives where it is assumed to be 1.15. These are the savings numbers that will feed into the contract performance benchmarking evaluation.

Table 1-7. DCSEU FY2015 Net Verified kWh and kW Savings, Generator Level

Track	Description	kWh		kW	
		Generator level kWh ex-ante	Generator level kWh ex-post	Generator level kW ex-ante	Generator level kW ex-post
7101PVMR	Solar Market Rate	288,437	288,437	36.7	36.7
7107PV	Solar Photovoltaic	752,771	752,771	97.0	97.0
7110SHOT	Solar Hot Water	-2,675	-2,675	-0.3	-0.3
7401FHLB	Income Qualified Home Improvement	16,054	16,054	2.3	2.0
7420HPES	Home Performance with ENERGY STAR	46,152	45,592	7	7
7511CIRX	Business Energy Rebates	9,282,280	8,963,343	817	1,222
7512MTV	T12 Market Transformation Value	3,874,811	3,565,334	617	729
7520CUST	Custom Services for Large C&I Customers	16,024,522	13,751,429	1,996	2,287
7520MARO	Custom Market Opportunity	2,136,802	1,963,519	368	276
7520NEWC	Custom New Construction	248,332	244,997	41	38
7610ICDI	LI MF Implementation Contractor Direct Install	3,084,747	3,127,199	168	168
7610LICP	LI MF Comprehensive Efficiency Improvements	689,571	582,794	156	593
7612LICP	LI MF Custom Efficiency Improvements	1,365,708	1,006,121	126	147
7710APPL	Retail Efficient Appliances	117,811	135,056	42	47
7710FBNK	Efficient Products at Food Banks	285,683	285,153	26	26
7710LITE	Retail Efficient Lighting	18,997,917	18,998,460	2,168	2,277
Reported (ex-ante) / Verified (ex-post)		**57,208,921**	**53,723,585**	**6,667**	**7,950**

Note: Table total may not add; difference due to rounding.

[3] The reported and verified electric savings (kWh) and demand reduction (kW) results are adjusted for line losses (8 percent and 6 percent increases, respectively).

[4] The savings and demand for the Solar PV program are increased by an additional 15 percent to reflect spillover; reference DCSEU memorandum to the DDOE and Tetra Tech, *Screening assumptions for the DCSEU solar renewable energy program portfolio*, dated August 30, 2012.

1.2 KEY FINDINGS AND RECOMMENDATIONS

Cost Effectiveness. The total societal cost/benefit results for the portfolio as conducted across four step-wise scenarios range from 5.07 to 4.06, which means that as a group the DCSEU continued to operate its initiatives in a very cost effective manner in FY2015.[5] On a track level the Federal Home Loan and the Home Performance are the only two programs that are not cost effective and have not been since the first evaluation in FY2012. The evaluation team recognizes initiatives serve a purpose and a market that would not be served otherwise. There are a number of drivers for this initiative beyond energy savings given the orthogonal nature of the DCSEU goals. The primary reason for this program was to focus on contractor outreach and education, green jobs, workforce development and CBES goals. Given the comprehensive nature of a Home Performance with Energy Star program the level of support required from DCSEU staff has been significant. The DCSEU is currently reviewing incentive levels and the program offerings within the residential existing homes programs to identify opportunities to increase cost-effectiveness moving forward.

Overview of FY2015 Electric Portfolio by:

- **Initiative type:** The contribution to the overall electric savings by the type of initiative is closely split across retail lighting (one-third), commercial custom initiatives (one-third), and all other initiatives (one-third).
- **Measure type:** Lighting measures made up 76 percent of the portfolio saving in FY2015. Lighting has regularly represented roughly three-fourths of the savings since FY2012 ranging from 71 percent in FY2014 to 80 percent in FY2012[6].
- **Sector:** Commercial and institutional tracks were responsible for 55 percent of the electric savings in FY2015 followed by the residential sector at 34 percent and low income at 11 percent.

Overview of FY2015 Gas Portfolio by:

- **Measure type:** The total of space heating, water heating and industrial process (which is both space and water heating) categories represents 94 percent of the natural gas savings. This is comparable to FY2014 where space heating and water heating combined represented 95 percent of the savings.
- **Sector:** The vast majority of the natural gas savings (90 percent) were from the commercial and institutional sector, followed by 6 percent from low income and 4 percent from the residential sector.

[5] The evaluation team reviewed four scenarios to compare cost-effectiveness results. The analysis first compares VEIC's cost-effectiveness results to the Tetra Tech team model results (Scenario 1). The analysis then further applies—in a stepwise fashion—other adjustments to see how each impacts the cost-effectiveness results. From the base cost-effectiveness results (Scenario 1), the third-party evaluation costs are added (Scenario 2), realization rates are then applied (Scenario 3), and NTG factors are then applied (Scenario 4).

[6] Lighting represented 75 percent in FY2013.

Diversity portfolio savings measures. Currently lighting measures represents 76% of portfolio savings. DCSEU may want to explore how to further diversify its portfolio and gain further market reach with other existing measures. This will become more important once the commercial lighting baseline (T12) from which a portion of the commercial lighting savings is calculated changes sometime in the future, consequently reducing claimed savings for those high efficiency lighting installations with a T12 baseline.

Acquisition costs. DCSEU acquisition costs increased in FY2015 which is in line with maturing programs and consistent with neighbouring state trends. After two years of decline, the FY2015 acquisition costs increase by 21.5 percent to $237. A similar trend is taking place in Pennsylvania and Maryland and is not unexpected as research has concluded that costs increase as programs mature.[7] This might be due to a couple of factors—less expensive resource acquisition opportunities are diminishing, and there are increasing efficiency codes and standards, such as EISA impacts for lighting efficiency standards. The DCSEU's FY2015 acquisition costs of $237 per MWh continues to be comparable to these Pennsylvania and Maryland benchmarks.

Customer satisfaction. Results from a limited customer satisfaction survey of customers in the commercial and industrial, multifamily, and solar initiatives found that overall, customer satisfaction with the initiatives provided by the DCSEU is very high. Further, customers found value in the initiative and want to continue to participate. Thirty-six percent of respondents were dissatisfied however with the amount of time it took to receive rebates. Decreasing the rebate return time could increase initiative participation.

Realization rates. In FY2015, the portfolio level realization rates were 0.94 for kWh, 1.19 for kW, 1.08 for MMBTUs (excluding cross fuel interactive effects) and 1.13 MMBTu (including all interactive effects). This means that for FY2015, in the aggregate, the DCSEU over estimated kWh by 6 percent, underestimated kW by 19 percent and underestimate MMBTu by 8 percent (when excluding cross-fuel effects) and 13 percent (when including all interactive effects). The kWh and MMBTu portfolio realization rates are within a reasonable (6 and 8 percent respectively) however the kW reporting at 19 percent off from reported savings should be addressed. On a track level analysis there was some significant variances that feed into these aggregate results. Adding protocols to the TRM (as discussed below) could help develop more accurate savings estimates.

Files and estimator tools. Tracking and reporting in KITT and CAT continues to improve particularly for non-prescriptive measures where the records have become more transparent and allow the evaluator to more easily trace numbers back to in the supporting documents. There are however areas for improvement.

- For KITT, keeping more accurate project files that clearly detail the project customer (contact) and multi-project tracking was identified as an area for improvement.
- For CAT, the team noted overall improvement in the files however there are a number of recommendations to help make the process and savings calculations more transparent that are called out in the conclusions and track level

[7] *An Empirical Model for Predicting Electric Energy Efficiency Resource Acquisition Costs in North America: Analysis and Application,* John Plunkett, Theodore Love, and Francis Wyatt, Green Energy Economics Group, Inc., Summer 2012.

recommendations including noting why measure level savings deviated significantly from the TRM.

- The HERO estimation tool was relatively accurate for impact evaluation and verifiable once the correct algorithms that were being used in the tool where obtained by the evaluation team. It is recommended that DCSEU clearly document HERO algorithms to provide correct versions to the evaluation team at the onset of the evaluation.

TRM. A number of recommendations were made to help increase the accuracy of the DCSEU savings estimates and helping to validate savings.

- Use the TRM assumptions and calculation methods to reduce initiative risk and only rely on (and document) complex analyses when absolutely necessary. For example, there is a fully deemed showerhead measure in the TRM however for some multifamily projects savings was calculated using different assumptions for a number of residents.
- Update the DCSEU TRM to incorporate those Vermont TRM algorithms that are being regularly used. There are a number of measures not included in the DCSEU TRM that rely on the Vermont TRM algorithms. This is a reasonable practice; however, they should be moved into the DCSEU TRM explicitly.
- Expand the TRM to include a standard approach to documenting custom projects, and to the degree possible, establishing general calculation methods.
- Reconcile algorithms used in the estimator tools with the TRM. We are unsure why there where algorithms (e.g., HPwES) unique to HERO that were not in the TRM.
- Establish protocols for when to use deemed values (savings or other assumptions) and when to use custom ones. Procedural TRM guidance is built into the Pennsylvania, Texas, and Arkansas TRMs, which could serve as examples for DCSEU.

Baseline study. A baseline study has been a consideration for a number of years however was never undertaken due to budget constraints. District specific baseline data could be used to update the potential study (we understand there was limited District specific data available for that study) and would help inform the initiative moving forward.

Coordinate third-party on-site evaluation efforts with the DCSEU. Coordinating the on-site visit with the DCSEU quality assurance on-site review continues to be important and will reduce the number of contacts and site visits the customer will experience. Additionally, the evaluation effort will occur much closer to the completion of the project, which will improve data and information gathering as customer recall will likely be sharper. The Pilot will begin in April or May of 2016.

Look to further diversify the DCSEU portfolio. Lighting measures made up 76 percent of the portfolio savings in FY2015. While it is common for portfolios to rely upon lighting measures due to the ease of implementation and low acquisition cost, it is recommended that DCSEU look to further diversify its portfolio and expand market reach of existing measures.. This will become increasingly important as the lighting baseline for a portion of the

commercial energy savings calculations (T12) will increase due to changes in the federal standard, and, thereby, erode the savings for relevant measures.

Apply a collaborative approach to annually updating the TRM. Currently, VEIC oversees the TRM updating process. VEIC analyzes and updates the measures as needed. The updates are done several times a year (usually two to three batches), and must be completed before the end of the program year in order to be applied for reporting. This process may be enhanced by applying a collaborative approach to determining which measures are updated early in the process and producing a clearly documented and approved versions of the TRM for the program year.

2. BACKGROUND

DCSEU energy efficiency and renewable energy initiatives began in March 2011. Evaluation of the initiatives began in the first full fiscal year spanning from October 1, 2011–September 30, 2012 (FY2012). Since that time, annual retrospective evaluations and implementer contractor performance benchmarking verification has taken place. FY2015 is DCSEU's fourth full year evaluation.

The key evaluation activities for the first four years of the DCSEU programs are detailed in Table 2-1 below. Over the four years, evaluation activities regularly included:

- Staff interviews
- Materials review
- Desk Audits
- Engineering analysis/modelling when needed
- Onsite verification.

The evaluation activities are described in the relevant boxes below.

Table 2-1. Evaluation Activities from FY2102 through FY2016

Fiscal Year	Time Period	Impact[8]	Process[9]	NTG	CE[10]	PB[11]
FY2012	10/1/2011–9/30/2012	-Project file reviews -Desk audits -Engineering analysis when needed -Onsite verification	-Staff interviews -Materials review -Targeted participant surveys -Market Actor Interviews	No	Yes	Yes
FY2013	10/1/2012–9/30/2013	-Project file reviews -Desk audits -Engineering analysis when needed -Onsite verification -Phone verification	-Staff interviews -Materials review -Store visits for retail lighting -Customer surveys for initiatives not covered in NTG -Select market actor interviews	Yes (on larger savings initiative)	Yes	Yes
FY2014	10/1/2013–9/30/2014	-Project file reviews -Desk audits -Engineering analysis when needed -Onsite verification	-Staff interviews -Materials review -Full process -Market actor interviews Logic model updates	Yes (all except res lighting)	Yes	Yes

[8] Impact evaluation regularly includes staff interviews**,** project file reviews, desk audits, engineering analysis/modeling (when appropriate), and on-site verification of installed measures.
[9] Process evaluation regularly includes staff interviews and initiative materials review.
[10] (CE) Cost Effectiveness.
[11] (PB) Performance Benchmarks.

Fiscal Year	Time Period	Impact[8]	Process[9]	NTG	CE[10]	PB[11]
		-On-site metering -Hotel HOU study				
FY2015	10/1/2014–9/30/2015	-Project file reviews -Desk audits -Engineering analysis when needed -Onsite verification -Hotel HOU study (carry over) -Chiller study	-Selected staff interviews -Materials review -Custom case studies -Customer satisfaction survey	No	Yes	Yes
FY2016	10/1/2015–9/30/2016	-QA/M&V on-site verification coordination on custom projects	TBD	TBD	TBD	TBD

DOEE's contract with the DCSEU implementation contractor contains both cost reimbursement (fixed fee) and at-risk/incentive compensation features for not meeting, meeting or exceeding certain established performance benchmarks.

From FY2012 through FY2016, the DCSEU contract with the DOEE contained six performance benchmarks that are assessed each year as part of the evaluation effort. These performance benchmarks and metrics are detailed in Table 2-2.

The impact evaluation kWh, kW, and MMBtu findings in this report help to inform and validate savings numbers for three of the performance benchmarks, including:

- 1a: Reduced per-capita energy consumption—electricity
- 1b: Reduced per-capita energy consumption—gas
- 3: Reduce growth in peak demand.

The DCSEU portfolio must also pass a societal cost effectiveness test.

The results of the performance benchmarking analysis as well as the cost effectiveness analysis can be found in the FY2015 Annual Evaluation Report for the Performance Benchmarks, Final Draft dated June 21, 2016.

Table 2-2. Historical Performance Benchmarks from FY2012 through FY2016

Item	Benchmark	Metric	Comments
1a	Reduced per-capita energy consumption—electricity	MWh	Annual reduction 85% of weather-normalized total electricity consumption and 85% of weather-normalized total gas consumption in DC for 2009. Contractor must achieve the minimum target for *both* electricity and natural gas to be eligible for an incentive payments.
1b	Reduced per-capita energy consumption—gas	Mcf	
2	Increase renewable energy generation capacity	Cost/kW	10% reduction in $/kWh over previous years $/kWh (minimum)
3	Reduce growth in peak demand	kW	Not required to undertake initiatives exclusively to reduce kW.
4	Improve energy efficiency in low-income housing	% spend over annual budget	30% minimum spend (minimum)
5	Reduce growth in energy demand of largest users	# of projects completed	Buildings with sq./ft. > 200,000. Went in place in FY2014.
6	Increase number of green-collar jobs (GJ)	GJ hours + FTE spend equivalent	That earn a living wage. FTE conversion for $ spend. Targets set through contract modification.

3. EVALUATION METHODOLOGY

The FY2015 evaluation effort followed the evaluation guidance provided in the *Department of Energy and Environment Energy Efficiency Evaluation Plan for Portfolio of Programs Offered in the District of Columbia* submitted as a draft on January 11, 2016.

The FY2015 impact evaluation effort focused primarily on the verification of the individual track and overall portfolio reported, or ex-ante, results for electric savings (kWh), demand reduction (kW), and natural gas savings (MMBtu, mcf). The effort was prioritized by track or initiative, based upon the contribution to the portfolio to ensure those tracks providing the most savings received more robust evaluation.

Process evaluation and net savings assessments were implemented according to the "DCSEU Portfolio Evaluation Strategic Timeline" developed to plan evaluation activities over a four-year time period to maximize evaluation expenditures and to provide the DOEE, DCSEU, and other stakeholders with timely and useful data and information to support portfolio design and policy development. A full process evaluation as well as NTG assessment was conducted in FY2014. The focus for the FY2015 was on impact evaluation and verifying the reported energy savings numbers. A brief customer satisfaction survey was conducted during the scheduling of the on-site verification visits and is reported in section 3.4.3. of this report. Further, three C&I case studies are being conducted to explore and document attribution that goes beyond free-ridership and spillover effects, which traditionally are captured in the net-to-gross assessment. The case studies will provide concrete examples of how the implementer, in their "trusted energy efficiency advisor" role, provide benefits to the customer (e.g., energy savings and costs) that are not quantified in the savings numbers.

3.1 PORTFOLIO RESULTS EXAMINATION

Since inception, the DCSEU initiatives shifted from early "quick start" direct install initiatives to a combination of direct install and incentive-based initiatives consisting of upstream buy-downs, rebates, give-away events, and negotiated incentive agreements. A comparison of reported electric savings for FY2012 through FY2015 is provided below.

Figure 3-1 illustrates a steady shift from "giveaway" initiatives to other initiative strategies. One of the largest shifts in FY2015 electric savings was in the rebate initiatives, which nearly doubled over FY2014 savings. This, however, was primarily due to the effect of two very large lighting projects that took place during FY2015 that, when combined, represented 96 percent of the electric savings in that category. Therefore, this is less likely to represent a trend but rather a potential outlier year for rebate savings. Gross electric savings in FY2015 from direct installation and incentive agreement initiatives were roughly proportional at 27 percent and 26 percent respectively. While there was an increase in the percent of direct installation savings there was a decrease in both incentive agreement and upstream savings.

Figure 3-1. Portfolio Electric Savings by Initiative Design Type Comparison, Reported Gross Savings

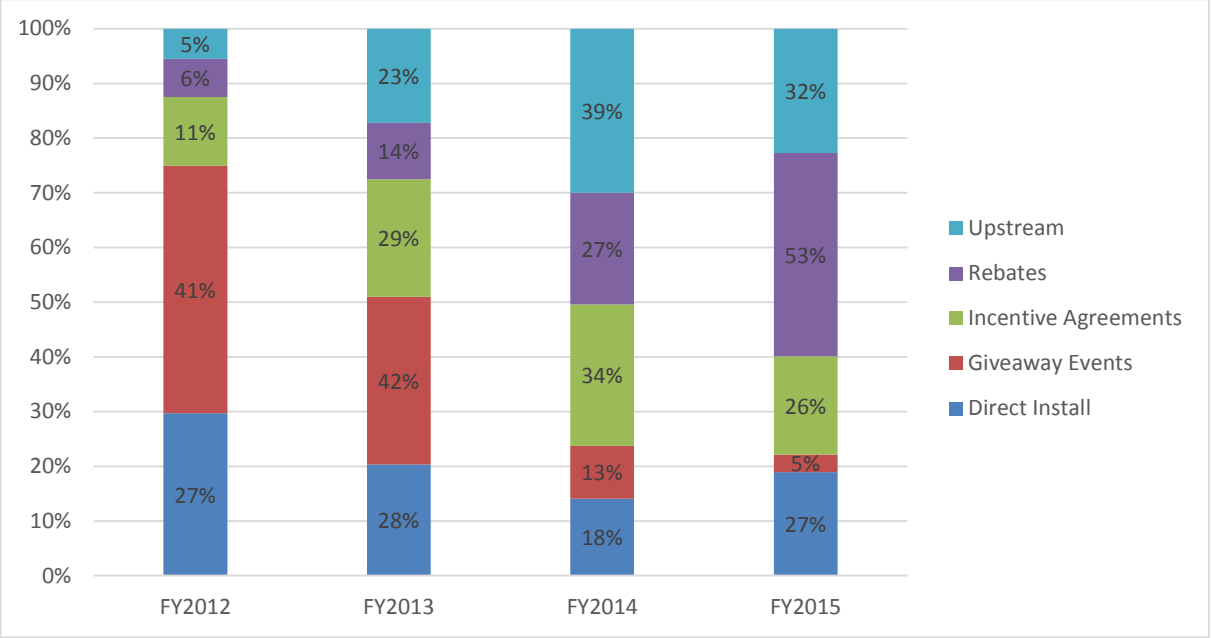


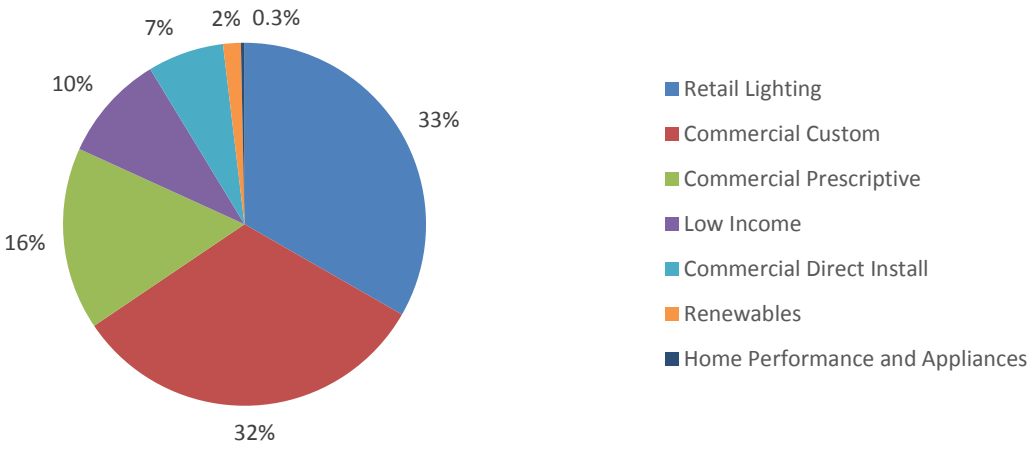
Table 3-1 provides an overview of the portfolio initiative at a- glance. The table identifies the customers sector and the implementation strategy by initiative. This table may help inform the discussion and analysis that follows.

Table 3-1. FY2015 Portfolio by Customer Type and by Initiative Strategy

Imitative		Customer Type				Initiative Strategy									
		Low Income	Residential	C&I	Multifamily	No Cost to Customer	Direct Installation	Up Stream Market	Rebates	Custom	Renewables	Incentive Agreement	Audit	Lighting only	Contractor Implementation
7101PVMR	Solar Market Rate		X	X	X				X		X	X			X
7107PV	Solar Photovoltaic	X	X			X					X	X			X
7110SHOT	Solar Hot Water	X		X	X	X					X	X			X
7401FHLB	Income Qualified Home Improvement (Formerly Federal Home Loan Bank)	X	X						X			X	X		X
7420HPES	Home Performance with ENERGY STAR		X						X			X	X		X
7511CIRX	Business Energy Rebates			X					X						
7512MTV	T12 Market Transformation Value			X					X					X	X
7520CUST	Custom Services for Large C&I Customers			X					X	X					
7520MARO	Custom Market Opportunity			X					X	X					
7520NEWC	Custom New Construction			X					X	X					
7610ICDI	LI MF Implementation Contractor Direct Install	X			X		X								X
7610LICP	LI MF Comprehensive Efficiency Improvements	X			X							X			
7612LICP	LI MF Custom Efficiency Improvements	X			X					X		X			
7710APPL	Retail Efficient Appliances		X						X						
7710FBNK	Efficient Products at Food Banks	X	X			X								X	
7710LITE	Retail Efficient Lighting		X	X				X						X	

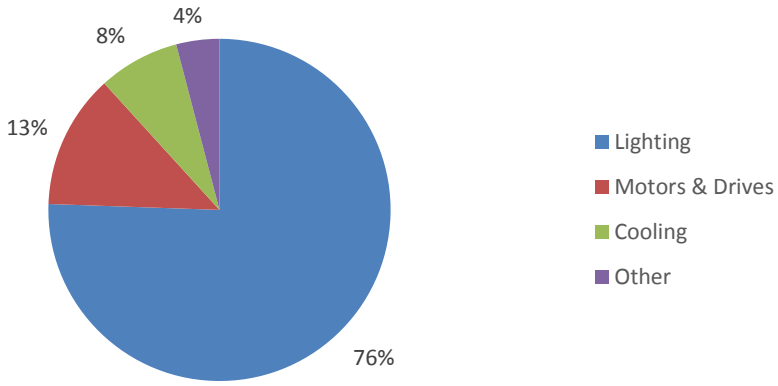
The following figure provides a summary of the contribution to the portfolio overall electric savings by initiatives and by sectors. In FY2015, the contribution to the overall electric savings by the type of initiative is closely split across retail lighting (one-third), commercial custom initiatives (one-third), and all other initiatives (one-third).

Figure 3-2. FY2015 Portfolio Electric Savings by Initiative Sector Category, Reported Savings



Lighting measures made up 76 percent of the portfolio saving in FY2015. Lighting has regularly represented roughly three-fourths of the savings since FY2012 ranging from 71 percent in FY2014 to 80 percent in FY2012[12]. While it is common for portfolios to rely upon lighting measures due to the ease of implementation and low acquisition cost, the evaluation team recommends that DCSEU look to further diversify its portfolio.

Figure 3-3. FY2015 Portfolio Electric Savings by Measure Type, Reported Savings

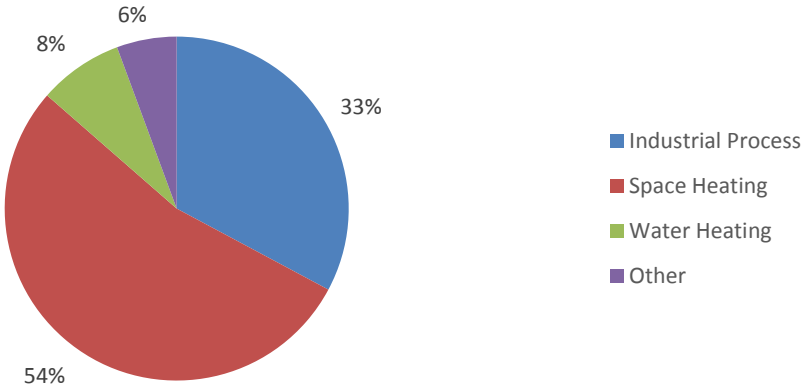


Space heating (primarily boiler and furnace replacement) represents more than half of the gas savings in FY2015. The Industrial Process category, representing over a third of the gas

[12] Lighting represented 75 percent in FY2013.

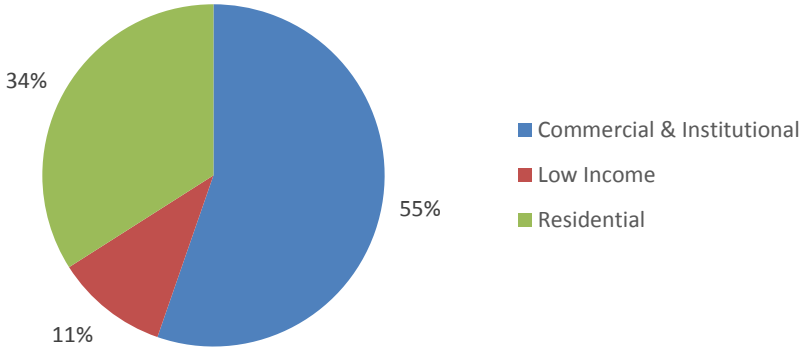
energy savings, is related to a Reverse Osmosis process on a district boiler plant, which is space and water heating. The total of space heating, water heating and industrial process (which is both space and water heating) categories represents 94 percent of the natural gas savings. This is comparable to FY2014 where space heating and water heating combined represented 95 percent of the savings.

Figure 3-4. FY2014 Portfolio Natural Gas Savings by Measure Type, Reported Savings



In FY2015 the commercial and institutional sector tracks contributed 55 percent to electric savings followed by 34 percent from residential and 11 percent for low income. Figure 3-5 illustrates these numbers. The commercial and institutional percentage has steadily declined since the inception of the DCSEU[13] as other harder to reach sectors savings ramped up.

Figure 3-5. FY2015 Portfolio by Sector, Reported Electric Savings

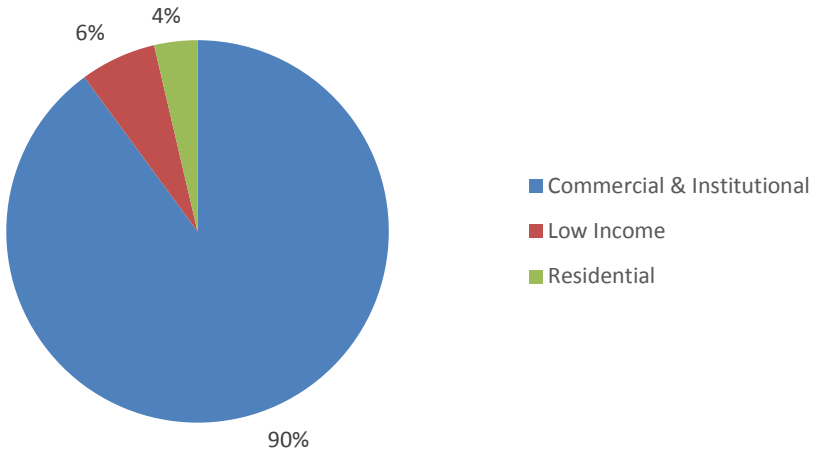


In FY2015, The vast majority of the natural gas savings (90 percent) were from the commercial and institutional sector,[14] followed by 6 percent from low income and 4 percent from the residential sector. Figure 3-6 illustrates these numbers. The savings in the

[13] With 56 percent in FY2014, 59 percent in FY2013, and 64 percent in FY2012.
[14] As compared to 78 percent in FY2014 and 84 percent in FY2013.

commercial and industrial sector, while it has fluctuated some since FY2012, is at its highest level to date.

Figure 3-6. FY2015 Portfolio by Sector, Reported Gas Savings



3.2 SAMPLING METHODOLOGY

Tetra Tech conducted the sampling for each track as summarized in Table 3-2 based on the preliminary KITT[15] extract results snapshot. Table 3-3 and Table 3-4 provide a summary by fuel type of those projects sampled with certainty and those randomly sampled. 3-5 provides a summary of the actual number of completed activities.

The evaluation team considered each track's characteristics when approaching sampling. Some tracks have relatively few or no differences from one project to the next, while others can vary widely. The evaluation team took one of three approaches to sampling, based on each track's characteristics.

1. For tracks with little variation in project savings, we selected a simple random sample. These are likely to have similar measures installed with less uncertainty and variability in the inputs to savings calculations.
2. For tracks with higher variation in project savings, we sampled the top ten percent of projects by electricity and/or gas savings (first stratum) with certainty (100 percent sample), and supplemented these projects with a random sample of other projects (second stratum). This approach allows us to include a larger portion of the savings in our sample to increase the level of precision and confidence in the results at the initiative level.
3. For tracks with differences in measure types, we stratified that track's sample by measure type and sampled randomly within each stratum. Thus, we are able to calculate realization rates by end-use category and roll up the results to improve the accuracy of the overall track realization rate.

For sampling purposes, negative savings values are removed from the tracking data. Negative savings primarily come from lighting interactive effects. Those MMBtu savings values directly correlate with the kWh savings values claimed for the measure, so cases with high MMBtu penalties will be sampled under scenario 2 above because they will also have high kWh savings.

Table 3-2. Sampling Summary by Track and Measure Category[16]

Track	Measure Category	Total Projects	Population kWh Savings	Population Gas Savings	Sampled Projects	Sampled kWh Savings	Sampled Gas Savings	Sampled % kWh	Sampled % Gas
7107PV, 7101PVMR	Renewables	144	839,517	1,166	30	384,951	1,166	46%	100%
	Total	**144**	**839,517**	**1,166**	**30**	**384,951**	**1,166**	**46%**	**100%**
7110SHOT	Renewables	5	0	1,508	5	0	1,508	n/a	100%

[15] VEIC tracks program tracking in their proprietary database, KITT. KITT is an acronym for "Knowledge Information Transfer Tool".

[16] Table 3-2 represents the original sample plan set forth in the Draft Evaluation Plan dated January 11, 2016. As the evaluation effort progressed, the sample was adjusted for some programs to attempt greater on-site verification opportunity and to match replacement on-site evaluation with project file reviews.

Track	Measure Category	Total Projects	Population kWh Savings	Population Gas Savings	Sampled Projects	Sampled kWh Savings	Sampled Gas Savings	Sampled % kWh	Sampled % Gas
	Total	**5**	**0**	**1,508**	**5**	**0**	**1,508**	**n/a**	**100%**
7401FHLB, 7420HPES	Building Shell	118	44,559	1,098	14	10,712	88	24%	8%
	Cooling	1	450	0	0	0	0	0%	0%
	Lighting	8	5,345	0	1	1,178	0	22%	n/a
	Refrigeration	3	547	0	1	350	0	64%	n/a
	Space Heating	19	5,444	222	4	404	19	7%	9%
	Water Heating	14	1,314	38	4	141	9	11%	24%
	Total	**123**	**57,659**	**1,358**	**15**	**12,784**	**117**	**22%**	**9%**
7511CIRX	Appliances	1	104	67	1	104	67	100%	100%
	Cooling	3	5,977	0	3	5,977	0	100%	n/a
	Lighting	157	8,502,182	0	36	4,403,273	0	52%	n/a
	Motors & Drives	1	72,284	0	1	72,284	0	100%	n/a
	Refrigeration	3	14,155	0	3	14,155	0	100%	n/a
	Water Heating	1	0	54	1	0	54	n/a	100%
	Total	**161**	**8,594,703**	**121**	**40**	**4,495,794**	**121**	**52%**	**100%**
7512MTV	Lighting	27	3,594,020	4	15	2,206,789	4	61%	100%
	Total	**27**	**3,594,020**	**4**	**15**	**2,206,789**	**4**	**61%**	**100%**
7520CUST, 7520MARO, 7520NEWC	Appliances	3	65,410	528	1	65,410	449	100%	85%
	Building Shell	1	273	38	0	0	0	0%	0%
	Cooling	13	3,276,606	0	8	3,216,686	0	98%	n/a
	Industrial Process	2	151,755	28,077	1	78,798	28,077	52%	100%
	Lighting	43	6,572,471	3	23	4,948,593	0	75%	0%
	Motors & Drives	30	6,517,500	102	21	5,818,083	0	89%	0%
	Other	1	2,350	1,427	1	2,350	1,427	100%	100%
	Refrigeration	2	6,089	0	0	0	0	0%	0%
	Space Heating	14	462	43,453	7	0	41,386	0%	95%
	Ventilation	8	466,148	1,172	4	308,068	417	66%	36%
	Water Heating	6	0	2,034	3	0	1,051	n/a	52%
	Total	**93**	**17,059,063**	**76,833**	**52**	**14,437,987**	**72,807**	**85%**	**95%**

Track	Measure Category	Total Projects	Population kWh Savings	Population Gas Savings	Sampled Projects	Sampled kWh Savings	Sampled Gas Savings	Sampled % kWh	Sampled % Gas
7610ICDI	Lighting	70	2,768,521	0	35	1,264,871	0	46%	n/a
	Water Heating	39	87,726	1,529	18	54,210	603	62%	39%
	Total	**70**	**2,856,247**	**1,529**	**35**	**1,319,081**	**603**	**46%**	**39%**
7610LICP, 7612LICP	Appliances	5	90,383	15	3	87,215	13	96%	83%
	Building Shell	5	33,442	61	3	27,506	56	82%	92%
	Cooling	10	722,905	0	4	278,435	0	39%	n/a
	Lighting	8	642,452	1	3	340,916	1	53%	100%
	Motors & Drives	1	121,190	0	0	0	0	0%	0%
	Other	1	5,784	0	0	0	0	0%	0%
	Refrigeration	7	40,123	0	3	25,525	0	64%	n/a
	Space Heating	7	40,875	1,267	4	25,835	975	63%	77%
	Ventilation	4	27,933	167	3	26,067	167	93%	100%
	Water Heating	8	178,241	462	4	160,855	341	90%	74%
	Total	**13**	**1,903,327**	**1,973**	**4**	**972,354**	**1,552**	**51%**	**79%**

Table 3-3. Sampled Electric Savings by Sampling Method

Track	Total kWh	Certainty kWh	% of Total kWh	Random Sample kWh	% of Total kWh	Site Sampled kWh	% of Total kWh	kWh Not Sampled	% of Total kWh
7107PV, 7101PVMR	839,517	354,424	42%	30,527	4%	0	0%	454,566	54%
7110SHOT	0	0	0%	0	n/a	0	0%	0	0%
7401FHLB, 7420HPES	57,659	0	0%	12,784	22%	0	0%	44,874	78%
7511CIRX	8,594,703	3,991,394	46%	400,713	5%	103,687	1%	4,098,909	48%
7512MTV	3,594,020	1,499,027	42%	707,762	20%	0	0%	1,387,230	39%
7520CUST, 7520MARO, 7520NEWC	17,059,063	11,871,469	70%	2,498,500	15%	68,018	0%	2,621,077	15%
7610ICDI	2,856,247	0	0%	1,319,081	46%	0	0%	1,537,166	54%
7610LICP, 7612LICP	1,903,327	965,041	51%	7,313	0%	0	0%	930,974	49%
Total	**34,904,536**	**18,681,354**	**54%**	**4,976,681**	**14%**	**171,706**	**0%**	**11,074,796**	**32%**

Table 3-4. Sampled Gas Savings by Sampling Method

Track	Total MMBtu	Certainty MMBtu	% of Total MMBtu	Random Sample MMBtu	% of Total MMBtu	Site Sampled MMBtu	% of Total MMBtu	MMBtu Not Sampled	% of Total MMBtu
7107PV, 7101PVMR	1,166	1,166	100%	0	0%	0	0%	0	0%
7110SHOT	1,508	0	0%	1,508	100%	0	0%	0	0%
7401FHLB, 7420HPES	1,358	0	0%	117	9%	0	0%	1,241	91%
7511CIRX	121	121	100%	0	0%	0	0%	0	0%
7512MTV	4	0	1%	4	99%	0	0%	0	0%
7520CUST, 7520MARO, 7520NEWC	76,833	72,679	95%	95	0%	33	0%	4,026	5%
7610ICDI	1,529	0	0%	603	39%	0	0%	926	61%
7610LICP, 7612LICP	1,973	1,318	67%	234	12%	0	0%	420	21%
Total	**84,491**	**75,285**	**89%**	**2,560**	**3%**	**33**	**0%**	**6,613**	**8%**

Note: Table total may not add; difference due to rounding.

3.3 SUMMARY OF EVALUATION ACTIVITIES

The evaluation activities to support the impact and process evaluations for FY2015 results are listed below and described in each section, and a summary is presented in Table 3-5. Survey instruments, introduction letters and logic models can be found in Volume II of this report.

Table 3-5. Evaluation Completed Activity Summary

Track	Track Description	FY15 Project Count	NTG	Program Staff Interviews	Project File Reviews	Desk Audits	Engineering Analysis/Modeling	On-site Measure Verification	On site Metering	On-site Recruitment with Limited CSAT
7110SHOT	Solar Hot Water	5	none	1	5	0	0	1	0	1
7101PVMR, 7107PV	Photovoltaic	144	none		15	0	0	2	0	2
7401FHLB	Federal Home Loan Bank	38	none	0	0	15	0	0	0	0
7420HPES	Home Performance with ENERGY STAR®	85	none							
7511CIRX	Business Energy Rebates	161	none	1	40	39	1	16	0	10
7512MTV	T12 Market Transformation	27	Case Studies	1	15	0	0	11	0	6
7520CUST, 7520MARO, 7520NEWC	Custom Services for C&I Customers	93	Case Studies	1	50	0	0	15	0	15
7610ICDI	Low Income Contractor Direct Install	70	none	1	0	35	0	6	0	2
7610LICP	Low Income Custom Projects	14	none		0	4	0	5	0	3
7612LICP	Low Income Multifamily Comprehensive		none	1						
7710APPL	Energy Efficient Appliances	825	none	0	0	70	0	0	0	0
7710FBNK	Food Bank Lighting	6374	none	0	0	5 report reviews	0	0	0	0
7710LITE	Energy Efficient Lighting	297577	none	0	0	6 report reviews	0	0	0	0

3.4 PROCESS EVALUATION METHODOLOGY SUMMARY AND ACTIVITIES DESCRIPTION

Process evaluations tell the story behind the impact evaluation results, net-to-gross assessments, and participation levels. Process evaluations examine factors such as program design and procedures, administration and delivery, customer satisfaction and/or response, marketing and education effectiveness, internal and external program barriers, market response, and non-energy benefits of the program (e.g., more money to spend on other needs, more comfortable living spaces).

A well-designed and implemented process evaluation serves as a basis for recommendations to program managers involved in program design and implementation. The evaluation team strongly believes that an evaluator must be independent, but also able to work openly and collaboratively with program staff and the program implementers so that findings from the process evaluation are most valuable and result in timely program improvements.

3.4.1 Methodology

The process evaluation effort began with a review of the DCSEU FY2015 Annual Plan, Annual Report, and the DCSEU portfolio tracking data provided by the DCSEU. This review was followed by DCSEU staff interviews to understand how the tracks operated in FY2015, whether there were significant changes from FY2014, how the prior evaluation recommendations had been incorporated, as well as to identify changes that have or would occur in FY16. Discussions took place along those topic lines at the kick off meeting followed by a memo from DCSEU that detailed key changes to the programs from FY2014. Interviews were reserved for programs with key changes.

3.4.2 Activities

DCSEU program staff interviews: Staff interviews were conducted with many of the staff to ensure evaluators understood how the program operated in FY2015 and to identify changes that took place between the FY2014 and FY2015 programs. The FY2014 program logic models were reviewed; however, they were not updated.

Customer satisfaction surveys: Brief customer satisfaction surveys (CSAT) were conducted to understand how the program operated from the customer perspective, to support process evaluation, and/or to verify the installation of measures reported by the program. The CSAT where administered to customers when scheduling on-site verification visits. CSAT were conducted for the following track participants: Solar Hot Water, Solar Photovoltaic, Business Energy Rebates, T12 Market Transformation, Customer Services for C&I Customers, Low Income Contractor Direct Installation and Low Income Comprehensive.

Case studies: Three C&I custom case studies will be conducted to explore and document attribution that goes beyond free-ridership and spillover effects, which traditionally are captured in the net-to-gross assessment. The case studies will provide concrete examples of how the implementer, in their “trusted energy efficiency advisor” role, can provide benefits to the customer (e.g., energy savings and costs) that are not quantified in the savings numbers.

3.4.3 Customer satisfaction surveys

Tetra Tech conducted interviews with customers in the commercial and industrial, multifamily, and solar initiatives while attempting to schedule the on-site visits. The purpose of these interviews was to gauge customer satisfaction with the involvement in DCSEU initiatives. The interviews aimed to answer three main questions:

- How satisfied are you with the overall initiative experience?
- How satisfied are you with the rebate amount you received through the initiative?
- How satisfied are you with the amount of time it took to receive the rebate through the initiative?

The interviews were conducted over a five-week period between January and early February 2016. The evaluation team attempted to contact a total of 112 unique customers who participated in a DCSEU initiative in fiscal year 2015. Of these, a total of 39 interviews were completed with respondents in a variety of roles within their organization. The total number of completes across the three initiatives are shown in Table 3-6 below. The interviews by track are detailed in Table 3-5.

Table 3-6. Number of Completed Customer Satisfaction Surveys

Sector	Number of Completes
Commercial & Institutional	31
Multi-Family	5
Solar	3
Total Completes	**39**

Overall, customer satisfaction with the initiatives provided by the DCSEU is very high.

- Customers were asked to rate their overall experience with the DCSEU initiative they participated in on a 1-to-5 scale, with 1 being “not at all satisfied” and 5 being “extremely satisfied.” Of the 39 respondents, 34 answered with either a 4 or 5, and the remainder answered with a 3.
- Satisfaction with the rebate amount offered through the initiative is also very high. On the same satisfaction scale, four-fifths of customers scored a 4 or 5 to this question, with a mean score of 4.2.
- Satisfaction with the contractor who installed the equipment offered through the initiative was also very high. On the same 1-to-5 satisfaction scale, all respondents answered a 4 or 5 to this question, with a mean score of 4.7.
- Customers were least satisfied with the amount of time it took to receive the rebate—two-thirds of customers rated it as a 4 or 5, with a mean rating of 3.9.

Customers who interacted with and received information from a DCSEU Energy Advisor described such interactions as being “extremely helpful.” Verbatim responses from customers include the following:

> *They were very knowledgeable and came out and did a quick study. They were very responsive and they made sure our project was successful.*
>
> *They talked about calculations, the technical knowledge, being able to crunch numbers together and have an outside objective eye. That way when you are ready to move forward, it is sound because you had an extra set of eyes.*
>
> *His knowledge of what was required to complete the job was invaluable. The workers that they brought were very efficient, strictly about business. They came in, got started, and finished the job. They didn’t even take lunch. We were very, very satisfied with the end results.*

All customers that were asked if they planned on utilizing the initiative for other properties going forward answered in the affirmative.

A few respondents questioned whether or not the rebate for the overall project cost was adequate. Verbatim responses from two respondents on this issue are as follows:

> *It [the rebate amount] was not very much compared to how much the system cost. We were going to do it anyway. I don't know if other people would do the investment if they could do it cheaper.*
>
> *[The rebate amount is] significantly low in comparison to cost. Headache with amount of paperwork.*

Respondents were also asked if there was any part of the process that was complicated or difficult. Very few customers had recommendations. Specific parts of the process commented on are as follows:

> *With the lighting sensors, we've taken them all out. Part of the problem is that I got a lot of complaints because the sensors weren't programmed. We did not receive instructions for the sensors and we weren't told that they needed to be programmed.*
>
> *Determining what energy measure will result in what dollar value. These were both new construction, they are offsetting the cost of purchasing and installing these different items.*
>
> *Some of the residents complained about the showerheads, they complained about the water being strong when it came out.*

Based on this limited data collection activities, we present the following recommendation:

- Consider decreasing the rebate return time. Thirty-six percent of respondents were dissatisfied with the amount of time it took to receive rebates. Decreasing the rebate return time could increase initiative participation.

3.4.4 C&I case studies

Case studies were developed for three customers to illustrate attribution, spillover, and the value of the "trusted energy advisor" role that cannot be easily captured in the impact numbers and are provided as a separate document.

3.5 IMPACT EVALUATION METHODOLOGY SUMMARY AND ACTIVITIES DESCRIPTION

3.5.1 Methodology

The impact evaluation reviews the energy savings and demand reductions claimed through the initiatives for reasonableness and accuracy and to inform the performance benchmarks evaluation. This effort results in verified, or ex-post, savings. Because it is very expensive to review 100 percent of initiative activity and projects, a sample of projects and other initiative documentation is selected. Refer to Section 3.2 for detail on sampling.

3.5.2 Activities

Desk review: Project files were reviewed to ensure project file data and information support the reported, or ex-ante, savings. Typically, quantities of measures installed were compared to reported quantities in the tracking system (KITT) and deemed measures were reviewed to ensure calculations were accurate and done in accordance with the DCSEU FY2015 Technical Reference Manual[17].

Engineering analysis: Projects that contained measures that were not deemed savings measures in accordance with the DCSEU Technical Reference Manual were assessed through engineering analysis review and/or engineering modeling. The analysis was conducted to ensure reported, or ex-ante, savings were reasonable given completed project scope. Information collected during on-site verification was also used where appropriate to inform the review.

Project file review: In addition to a desk review, other documentation in the project files (invoices, applications, equipment specification sheets, quality assurance forms, etc.) were reviewed and cross-referenced to each other to ensure accuracy and consistency of data reported and used in the savings calculations for the project.

On-site metering: On-site metering was conducted on a select number of larger custom C&I projects. The metering sample was based on specific criteria, including uncertainty and variability of data, project size and importance, and the correlation between energy savings and the summer peak demand period. Summer metering was conducted to determine factors that may be affecting the energy savings for projects whose energy savings are primarily observed in the warm, summer. The data collected was 5-minute kW or amperage interval data. This data collected was used where appropriate to inform the review.

[17] *DCSEU Technical Reference Manual (TRM)—Measure Savings Algorithms and Cost Assumptions Savings Verification, Fiscal Year 2015.*

On-site verification: Evaluator on-site visits were conducted to verify such things as equipment installation and quantities, operating characteristics, hours of use, fuel sources, and location of equipment in facility.

3.6 DCSEU TRACKING SYSTEM AND ESTIMATION TOOL REVIEW

The DCSEU uses the following tools to track program and project data and information and to estimate electric savings, demand reductions, and natural gas savings at the measure, project, program, and portfolio levels.

KITT: The Knowledge Information Transfer Tool (KITT) tracks and calculates prescriptive measures and savings by project status (opportunity, cancelled, in-progress, completed) and by program track. KITT also tracks measures, status, and savings for completed custom projects.

CAT: The Comprehensive Analysis Tool (CAT) is the interface with the cost-effectiveness screening tool and is used to calculate the savings associated with custom projects and associated measures. It is also a repository for savings that are calculated using external tools. Project results and key information for completed projects are uploaded to KITT for reporting.

HERO: The Home Energy Reporting Online (HERO) is a web-based savings tool used by contractors performing work for the Home Performance with ENERGY STAR® (HPwES) program. HERO tracks key project parameters, estimates savings, and interfaces with KITT for reporting.

3.6.1 KITT database extract

The VEIC Evaluation, Measurement and Verification Services group provided the evaluation team with the final FY2015 program results dataset from KITT as an Access database file on December 10, 2015.

For FY2015, the savings Performance Benchmark (Reduce per-Capita Energy Consumption[18]) calls for the exclusion of the interactive effects associated with the installation of energy efficient lighting. Specifically, the benchmark states, “Energy and demand savings measure the amount of energy and demand saved as a result of the DCSEU programs without the inclusion of the facility heating and cooling interactive effects whether they are gas or electric.” For FY2015, DCSEU interpreted this policy to exclude cross-fuel interactive effects, or effects where the measure savings occur in one fuel but interactive effects are present in another fuel. Following discussions with DCSEU and examination of the KITT database and TRM, the evaluation team identified that this situation only occurred for the lighting end use. For this end use, the measures produce electric savings but interactive effects produce gas penalties for increased space heating usage. Given this clear delineation of a single end use and fuel type, the evaluation team excluded cross-fuel interactive effects for FY2015 by substituting 0 MMBtu for all lighting measures when reporting from KITT.

[18] Contract Number DDOE-2010-SEU-0001, Amendment/Modification No. M07.

For the proposes of the impact evaluation and verification of reported energy and demand savings, the evaluation team divided the KITT gross "ex-ante" savings values by the pertinent KITT interactive effects adjustment factor to determine the energy and demand ex-ante values for evaluation. For example, to quantify the reported, or ex-ante, kWh savings, the following calculation was performed:

kWh ex-ante = KWHTotal (KITT kWh savings field) / CoolingBonusKWHFactor (KITT kWh Interactive Effects Adjustment field)

The table below lists the fields used for the verification of reported, or ex-ante, electric savings, demand reduction, and gas savings.

Table 3-7. KITT Tracking Database Extract Fields for Evaluation

Field Name	Table Name(s)	Description
Track	Project	Code used to identify the project's program
ProjectID	Project, ActionSummary	Unique system ID for a project, used to link a project with its measures and site location
MAS90Project	Project	Public project identifier used to locate project files and HERO records
MeasureID	ActionSummary, ActionSave	Unique system ID for a measure installation, used to link the installation record with the savings record
MeasureCode, MeasureDesc	ActionSummary	Measure description text
ItemCode, Description	ItemCode	Additional measure description
Qty	ActionSummary	Quantity of measure installed
KWHTotal	ActionSave	Gross kWh savings
KWReductionSummer	ActionSave	Gross summer peak kW reduction
SaveNGas	ActionSave	Gross natural gas savings (MMBtu)
ReportDate	ActionSummary	Date when savings are claimed

3.6.2 Comprehensive Analysis Tool (CAT)

For evaluation of the FY2015 program results, CAT files associated with the sampled projects for relevant programs were reviewed by evaluation team members to ensure data entered into CAT were consistent with project file records, calculations of savings were accurate, and savings were accurately reflected in KITT.

3.6.3 Home Energy Reporting Online (HERO)

The HERO tool was reviewed for Home Performance with ENERGY STAR projects to ensure agreement with other project files and KITT.

4. PORTFOLIO AND CROSSCUTTING EVALUATION

Process evaluations also address crosscutting strategic and policy issues related to organizational structure, resources to conduct programs, regulatory requirements, reasonableness of program goals and objectives, brand identity, and other factors that affect overall program portfolio performance.

As a part of the impact evaluation implementation, several crosscutting process-related improvement opportunities were identified and are summarized in this section along with recommendations to address.

4.1 KEY FINDINGS AND RECOMMENDATIONS

Evaluation of the DCSEU portfolio's reported savings and delivery is in its fourth year. Since inception, the DCSEU plans have shifted from early "quick start" direct install initiatives to a combination of direct install and incentive-based initiatives consisting of upstream buy-downs, rebates, give-away events, and negotiated incentive agreements. DCSEU has also shifted away give-away efforts to more market based incentive structures.

4.1.1 Key findings

The evaluation team noted—as in past years—that program staff are knowledgeable and enthusiastic about their initiatives. In addition, the VEIC evaluation lead was very helpful in responding in a timely manner to numerous requests from the evaluation team for program data, reviews, and other information requests.

A. The portfolio of energy efficiency initiatives is cost effective and the DCSEU cost effectiveness results are accurate.

The total societal cost/benefit results for the portfolio ranges from 5.07 to 4.06, which meant that as a group the DCSEU continued to operate its initiatives in a very cost effective manner in FY2015.[19] This is true for each scenario tested—(1) DCSEU costs included, (2) DCSEU costs plus third-party evaluation costs, (3) all costs with realization rates applied, and (4) all costs with realization rates and net-to-gross estimates applied. The total portfolio accounting for all these scenario adjustments is 5.32 and is adjusted to 4.01 when including support and administrative costs. The initiatives are cost effective at the track level except for the Federal Home Loan (0.97 to 1.00) and the Home Performance with ENERGY STAR. (0.70 to 0.77) tracks. These two initiative tracks have not been cost effective across all analysis scenarios since the start of the programs (FY2012).

In addition, the third-party independent cost benefit model indicated that the DCSEU's cost model results are accurate. Variability between benefit/cost models is expected. However, the resultant variances are minimal, especially at the portfolio level.

[19] For detailed discussion on the cost effectiveness assessment, see *Department of Energy and Environment Verification of the District of Columbia Sustainable Energy Utility Performance Benchmarks, FY2015 Annual Evaluation Report*.

Recommendation: The evaluation team recognizes that Federal Home Loan and the Home Performance with ENERGY STAR initiatives serve a purpose and a market that would not be served otherwise. The volume of projects within the tracks are limited; therefore, reported savings were limited. We recommend, DCSEU explore program strategies that could help scale up participation as well as to increase the cost effectiveness of the initiatives.

B. Acquisition costs increased in FY2015 which is in line with maturing programs and consistent with neighboring state trends.

Since FY2013, DCSEU acquisition costs steadily decreased from $549 in FY2012 to $195 in FY2014. In FY2015 the acquisition costs increase to $237 or by 21.5 percent. Table 4-1 below shows a similar trend in Pennsylvania and Maryland. This is not unexpected as research has concluded that costs increase as programs mature.[20] This might be due to a couple of factors—less expensive resource acquisition opportunities are diminishing, and there are increasing efficiency codes and standards, such as EISA impacts for lighting efficiency standards. The DCSEU's FY2015 acquisition costs of $237 per MWh continues to be comparable to these Pennsylvania and Maryland benchmarks.

Table 4-1. Portfolio Level Acquisition Costs FY2012 through FY2015 for DCSEU, PA, and MD

Fiscal Year	DCSEU Acquisition Cost $/MWh	DCSEU Acquisition Cost MMBtu	Pennsylvania Acquisition Cost	Maryland[21] Acquisition Cost
FY2012	$549	$152	-	-
FY2013	$230	$64	-	$208/MWh
FY2014	$195	$32	$170/MWh	$271/MWh
FY2015	$237	$44	$209/MWh	

C. Customers satisfaction is very high with room for improvement on rebate turnaround time

The results of the limited customer satisfaction survey conducted for the commercial and institutional, multifamily, and solar initiatives while attempting to schedule the on-site visits found that overall, customer satisfaction with the initiatives provided by the DCSEU is very and high. Furthermore, customers who interacted with and received information from a DCSEU Energy Advisor described such interactions as being "extremely helpful." Customers were least satisfied, however, with the amount of time it took to receive the rebate.

Recommendation: Explore ways to shorten the rebate turnaround time.

[20] *An Empirical Model for Predicting Electric Energy Efficiency Resource Acquisition Costs in North America: Analysis and Application,* John Plunkett, Theodore Love, and Francis Wyatt, Green Energy Economics Group, Inc., Summer 2012.

[21] Maryland 2014 evaluation in not yet available as there is a two-year lag on regulatory reporting. The report should be public in May 2016.

D. The kWh and MMBTu are reported fairly accurately in the aggregate however the kW savings is being underestimated.

In FY2015, the portfolio level realization rates were 0.94 for kWh, 1.19 for kW, 1.08 for MMBTUs (excluding cross-fuel interactive effects) and 1.13 MMBTu (including all interactive effects). This compares to FY2014 where the portfolio level results, and much of the kWh and MMBtu results, were all within a 10 percent swing. This means that for FY2015, in the aggregate, the DCSEU over estimated kWh by 6 percent, underestimated kW by 19 percent and underestimate MMBTu by 8 percent (when excluding cross-fuel effects) and 13 percent (when including all interactive effects). The kWh and MMBTu portfolio realization rates are within a reasonable (6 and 8 percent respectively) however the kW reporting at 19 percent off from reported savings should be looked at more closely. On a track level analysis there was some significant variances that feed into these aggregate results.

Recommendations: Refer to track level recommendations as well as estimator tool and TRM recommendations to develop more accurate savings estimations.

E. The DCSEU tracking and estimation tools are for the most part transparent and robust with some areas for improvement.

Tracking and reporting in KITT and CAT continues to improve particularly for non-prescriptive measures where the records have become more transparent and allow the evaluator to more easily trace numbers back to in the supporting documents. There are however areas for improvement that are documented below[22].

KITT

The evaluation team found that the correct customer contact information was not always available for a number of files used for on-site scheduling and that it was difficult to identify when multiple projects (e.g., solar thermal and multifamily measures) where undertaken by a customer, particularly if a measure was added later in a multi-stage project.

Recommendation: Keep more accurate project files that clearly detail the project customer (contact) and multi project tracking.

CAT

The evaluation team noted overall improvement in the CAT system, yet the team encountered some challenges in fully understanding how savings were calculated and obtaining clear documentation and input assumptions used in the calculation. In some cases it was unclear why measure level savings deviated significantly from TRM assumptions.

Recommendations:

[22] Areas of improvement specific to tracking data for performance benchmarking purposes are discussed in more detail in the FY2015 Evaluation Performance Benchmarking Report.

- Fully document calculations and assumptions used to calculate savings. (This is a repeated recommendation from the FY2013 and FY2014 results evaluation efforts.)
- During QA/QC, document the differences between what is found during the on-site inspection and/or other project documentation.
- Use TRM assumptions and calculation methods when possible.
- Provide easier mapping of initiative extract database results to the line items in CAT entries.
- When creating project documentation, such as the CAT spreadsheets, make all information accessible to the evaluation team.
- Avoid hard coding of savings values so that algorithms can be easily determined.
- When working with a customer installing solar thermal projects, ensure that any efficiency projects capture the effect of the solar thermal project.
- Review baseline assumptions used for each project to ensure consistency with federal minimum standards, effective remaining useful life, and cost-effectiveness considerations (such as incremental cost).

HERO

The HERO estimation tool was relatively accurate for impact evaluation and verifiable once the correct algorithms that were being used in the tool where obtained by the evaluation team. Documenting the algorithms is important as it took a few attempts when validating the Home Performance with ENERGY STAR measures using incorrect algorithms before obtaining the correct one.

Recommendation: Clearly document HERO algorithms to provide correct versions to the evaluation team at the onset of the evaluation.

F. The DCSEU Technical Reference Manual (TRM) has opportunity for expansion to more accurately calculate and report on achievements.

The DCSEU TRM is easy to follow and clearly documents key assumptions, algorithms, and sources of data and information. In this initial evaluation effort, the evaluators found the assumptions reasonable and generally applicable within the District. We do see a few key areas for improvement and expansion. They include:

Recommendations:

- Use the TRM assumptions and calculation methods to reduce initiative risk and only rely on (and document) complex analyses when absolutely necessary. For example, there is a fully deemed showerhead measure in the TRM however for some multifamily projects savings was calculated using different assumptions for a number of residents.
- Update the DCSEU TRM to incorporate those Vermont TRM algorithms that are being regularly used. There are a number of measures not included in the DCSEU

TRM that rely on the Vermont TRM algorithms. This is a reasonable practice; however, they should be moved into the DCSEU TRM explicitly.

- Expand the TRM to include a standard approach to documenting custom projects, and to the degree possible, establishing general calculation methods.
- Reconcile algorithms used in the estimator tools with the TRM. We are unsure why there where algorithms (e.g., HPwES) unique to HERO that were not in the TRM.
- Establish protocols for when to use deemed values (savings or other assumptions) and when to use custom ones. Procedural TRM guidance is built into the Pennsylvania, Texas, and Arkansas TRMs, which could serve as examples for DCSEU.

4.1.2 Other recommendations

A. Complete a baseline study to identify and validate and/or update the 2013 potential study results and to inform initiative efforts.

A baseline and market potential study is a key foundation on which to identify and build energy efficiency programs. A potential study was conducted in 2013 for Electric and Gas Energy Efficiency and Demand Response Potential, which was made public April 17, 2015, and can be found on the DOEE website. [23] A baseline study has been a consideration for a number of years however was never undertaken due to budget constraints. District specific baseline data could be used to update the potential study (we understand there was limited District specific data available for that study) and would help inform the initiatives moving forward.

B. Coordinate third-party on-site evaluation efforts with the DCSEU quality assurance on-site reviews continues to be important.

When contacting customers to schedule on-site verification visits for the FY2015 evaluation, a number of customers refused to schedule an on-site visit or asked why there was a need to come out again as DCSEU had already inspected the project. For large projects, this visit can take up to three hours of the customer's time for a walkthrough. Coordinating the on-site visit with the DCSEU quality assurance on-site review will reduce the number of contacts and site visits the customer will experience. Additionally, the evaluation effort will occur much closer to the completion of the project, which will improve data and information gathering as customer recall will likely be sharper. The Pilot began in May of 2016.

[23] Electric and Gas Energy Efficiency and Demand Response Potential for the District of Columbia: http://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/ELECTRIC%20AND%20NATURAL%20GAS%20ENERGY%20EFFICIENCY%20AND%20DEMAND%20RESPONSE%20POTENTIAL%20FOR%20THE%20DISTRICT%20OF%20COLUMBIA.pdf.
Renewable Energy Technologies Potential for the District of Columbia: http://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/ELECTRIC%20AND%20NATURAL%20GAS%20ENERGY%20EFFICIENCY%20AND%20DEMAND%20RESPONSE%20POTENTIAL%20FOR%20THE%20DISTRICT%20OF%20COLUMBIA.pdf.

C. Further diversify the DCSEU portfolio.

Lighting measures made up 76 percent of the portfolio savings in FY2015. Lighting has regularly represented roughly three-fourths of the savings since FY2012 ranging from 71 percent in FY2014 to 80 percent in FY2012[24]. While it is common for portfolios to rely upon lighting measures due to the ease of implementation and low acquisition cost, it is recommended that DCSEU look to further diversify its portfolio. This will become more important once the commercial lighting baseline (T12) from which a portion of the commercial lighting savings is calculated will change sometime in the future, consequently reducing claimed savings for those high efficiency lighting installations with a T12 baseline.

D. Apply a collaborative approach to annually updating the TRM.

Currently VEIC oversees the TRM updating process. VEIC analyzes and updates the measures as needed. The updates are done several times a year (usually 2-3 batches), and must be completed before the end of the program year in order to be applied for reporting. Currently, VEIC sends a copy of the TRM change write-up with supporting analysis to the EM&V team for review. The evaluation team has approximately three weeks to review and comment on the recommended changes. The evaluation team's recommendations are either accept or further discussed.

The TRM revision process may be enhanced by applying a collaborative approach to determining which measures are updated early in the process and producing a clearly documented and approved versions of the TRM for the program year.

[24] Lighting represented 75 percent in FY2013.

5. TRACK EVALUATION REPORTS

The evaluation team's verified, or ex-post, results of the KITT reported electric savings, demand reduction, and natural gas savings for each track, or initiative, and for the overall portfolio are presented in

. These verified results reflect portfolio level realization rate estimates of 0.94, 1.19, and 1.13 for kWh, kW, and MMBtu, respectively. MMBTu eliminating the cross-fuel interactive effects is 1.08. This means that the evaluation team estimates that the actual portfolio electric savings result is 94 percent of the DCSEU reported electric savings, the demand reduction result is 119 percent of the DCSEU reported demand reduction, and the actual portfolio gas savings result is 113 percent of the DCSEU reported gas savings. The actual portfolio gas savings (net gas interactive effects for lighting) is 108 percent of the DCSEU reported gas savings.

Realization rates are the ratio of verified savings to the tracking system savings for a representative sample of projects reported within each track. Realization rates are typically calculated for each end-use category and then applied to the total end-use tracking system savings for a particular program, or track. The results are rolled up to develop program, or track, verified savings. The verified savings for all tracks are summed to obtain portfolio level verified savings.

Table 5-1. Track Level Realization Rates Summary

Track	Description	kWh	kW	MMBtu - Gas Savings
		RR	RR	RR
7101PVMR	Solar Market Rate	1.00	1.00	1.00
7107PV	Solar Photovoltaic	1.00	1.00	n/a
7110SHOT	Solar Hot Water	1.00	1.00	1.00
7401FHLB	Income Qualified Home Improvement	1.00	0.88	1.13
7420HPES	Home Performance with ENERGY STAR	0.99	1.00	1.38
7511CIRX	Business Energy Rebates	0.97	1.50	0.88
7512MTV	T12 Market Transformation Value	0.92	1.18	0.96
7520CUST	Custom Services for Large C&I Customers	0.86	1.15	1.13
7520MARO	Custom Market Opportunity	0.92	0.75	0.98
7520NEWC	Custom New Construction	0.99	0.92	0.94
7610ICDI	LI MF Implementation Contractor Direct Install	1.01	1.00	1.25
7610LICP	LI MF Comprehensive Efficiency Improvements	0.85	3.80	0.62
7612LICP	LI MF Custom Efficiency Improvements	0.74	1.16	0.27
7710APPL	Retail Efficient Appliances	1.15	1.12	0.97
7710FBNK	Efficient Products at Food Banks	1.00	1.00	1.00
7710LITE	Retail Efficient Lighting	1.00	1.05	1.00
Reported (ex-ante) / Verified (ex-post)		**0.94**	**1.19**	**1.13**

5.1 7107PV, 7101PVMR, 7110SHOT SOLAR ENERGY SYSTEMS

5.1.1 Track description

These initiatives encourage renewable energy development in low-income communities and market rate customers.

The District has a strong foundation in supporting sustained development of customer-sited renewable energy systems. With the launch of Solar Photo Voltaic 7107PV (formerly Solar Energy Systems) in fiscal year 2012, the DCSEU began supporting customer-sited renewable energy in low-income markets in Wards 7 and 8 in the District of Columbia that would likely be otherwise underserved absent the DCSEU incentives. During the 2011 Quick-Start Renewable Energy Program, the DCSEU implemented activities in two market segments, commercial solar hot water and rooftop PV for small scale (<10 kW) installations.

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. Prior to FY2015, the contractor would be paid after all work was completed and verified but before the PV system was interconnected. As of FY2015, proof of interconnection from Pepco is required for DCSEU to issue payment to the contractor.

In FY2015, DOEE provided additional funding to increase the number of solar PV projects installed in the District and launched the "Solar Advantage Plus program (tracked under 7107PV)," which fully subsidizes the cost of installation of solar PV system for eligible low-income customers up to $10,000 per project.

The solar thermal track (7110SHOT) targets solar domestic hot water systems in low-income multifamily buildings and commercial and institutional facilities with high hot water demand. The track is designed to replace existing inefficient hot water heating systems.

The DCSEU provides support in this developing market through the development of contractor capacity and capability—sometimes directly to implementation contractors, which allows for greater control over materials and methods. Other contractor development activities include contractor training for market-based activities, focusing specifically on both sales training and technical training. When DCSEU incentives are used, whether directly through contracting or indirectly by customer payments, quality control and quality assurance protocols are implemented to mentor contractors in the field and ensure best-practice installations.

Through FY2014, incentive funds for either initiative (7110SHOT and 7107PV) were not offered to the open market because of the limited budget and the expected number of projects. Starting

in FY2015 a market rate offering (7101PVMR) was provided for both Solar PV as well as Solar Hot Water.

Table 5-2 provides a summary of initiative metrics since inception as reported by DCSEU.

Table 5-2. Initiative Summary Metrics—7107PV, 7101PVMR, and 7110SHOT

Metric	FY2012	FY2013	FY2014	FY2015
7107PV				
Participants (Units=projects)	42	56	108	139
kWh savings, meter level	148,368	192,877	561,838	606,096
kW	25.7	31.6	72.4	80
7101PVMR				
Participants (Units=projects)	N/A	N/A	N/A	5
kWh savings, meter level	N/A	N/A	N/A	232,236
kW	N/A	N/A	N/A	30
MBTU	N/A	N/A	N/A	1,166
7110SHOT				
Participants (Units=projects)	n/a	12	6	5
MMBTU	n/a	4,620	3,135	1,508

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

Table 5-3, Table 5-4, and Table 5-5 provide summaries of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates. For track 7110SHOT, the negative kWh savings reflect the addition of electric control units to support the thermal hot water system.

Table 5-3. FY2015 Reported and Verified Results—7107PV

Metric	Reported	Verified	Realization Rate
kWh	606,096	606,096	1.00
kW	80	80	1.00

Table 5-4. FY2015 Reported and Verified Results—7101PVMR

Metric	Reported	Verified	Realization Rate
kWh	232,236	232,236	1.00
kW	30	30	1.00
MMBTU[1]	1,166	1,166	1.00

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

Table 5-5. FY2015 Reported and Verified Results—7110SHOT

Metric	Reported	Verified	Realization Rate
kWh	-2,154	-2,154	1.00
kW	-0.28	-0.28	1.00
MMBtu[1]	1,508	1,508	1.00

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

5.1.2 Overall sampling methodology

There is generally little variation within the Solar PV (7107PV) initiative and there is only one type of measure installed by this track. However, there were five multifamily projects that contributed significantly higher amounts to the track's overall savings. These projects were sampled with certainty; the remaining projects were randomly sampled.

For the Solar PV Market Rate Initiative (7101PVMR) and the Solar Hot Water Initiative (7110SHOT), there were five projects each completed in FY2015, and all the projects were reviewed for the impact evaluation and for the assessment of the Low Income Performance Benchmark. The Solar PV Market Rate initiative category includes market rate participants for both Solar PV as well as for Solar Hot Water Heating.

Table 5-6. FY2015 Population and Sample Summary—7107PV

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Solar PV	139	25	151,530	20.0	0.0	25.0%	25.1%	0%
Total	**139**	**25**	**151,530**	**20.0**	**0.0**	**25.0%**	**25.1%**	0%

Table 5-7. FY2015 Population and Sample Summary—7101PVMR

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Solar Hot Water Heating	3	3	-1,185	-0.2	1,166.1	100.0%	100.0%	100.0%
Solar PV System	2	2	233,421	30.2	0.0	100.0%	100.0%	-
Total	**5**	**5**	**2,236**	**30**	**1,166**	**100.0%**	**100.0%**	**100.0%**

Table 5-8. FY2015 Population and Sample Summary—7110SHOT

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Solar Hot Water	5	5	-2,154	0.0	206	n/a	n/a	100.0%
Total	5	5	-2,154	0,0	206	n/a	n/a	100.0%

5.1.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.1.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.1.5 Impact evaluation

The impact evaluation consisted of a combination of project file reviews and on-site verification results. The initial task for the impact evaluation for the 7107PV and 7101PVMR projects was to review and verify the variables used to calculate claimed savings for FY2015. Using the National Renewable Energy Laboratory's (NREL) PVWatts 5 software, the evaluation team calculated program kWh savings using the measure data from the Solar PV and PVMR files. For the 7110SHOT and 7101PVMR SHOT projects, a standard solar hot water algorithm from the Pennsylvania TRM[25] was used by the evaluation team to calculate program MMBtu savings using measure data from the tracking system. Once this was completed, realization rates were calculated by dividing verified savings by reported savings.

Physical site inspections were performed on two solar PV projects and one solar hot water project to verify installed measures. The on-site inspector confirmed the equipment listed in the project files were indeed in place. For two out of the three inspections, we were able to speak to the building owner at one and a home owner at the other. The building owner, for whom the solar hot water project was installed, was very pleased and indicated that the building uses 30 percent less electricity than similar buildings. The home owner, for whom the solar PV project was installed, felt the system was not working. However, the photos provided by the inspector seem to indicate the system was indeed working. Details for this project are listed in section 1.1.6 Recommendations.

A. Impact sampling methodology for on-site measurement and verification

There is generally little variation within the Solar PV, Solar PMR, and SHOT initiatives, and there is only one type of measure—either solar PV units or solar thermal units—installed for each of these tracks.

Table 5-9. FY2015 On-site M&V Sample Summary—7107PV

Measure	On-site M&V Sample Subset							
	$N_{measure}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Solar PV System	139	2	7,705	1.0	0.0	1.3%	1.3%	-
Total	**139**	**2**	**7,705**	**1.0**	**0.0**	**1.3%**	**1.3%**	-

Table 5-10. FY2015 On-site M&V Sample Summary—7101PVMR

[25] Technical Reference Manual, State of Pennsylvania Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards, June 2016, pg. 94.

Measure	On-site M&V Sample Subset							
	$N_{measure}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Solar PV	3	0	0	0	0.0	-	-	-
Total	**3**	**-**	**0**	**0.0**	**0.0**	**-**	**-**	-

Table 5-11. FY2015 On-site M&V Sample Summary—7110SHOT

Measure	On-site M&V Sample Subset							
	$N_{measures}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Solar hot water heating	5	1	-376	0.0	206.0	n/a	n/a	13.7%
Total	**5**	**1**	**-376**	**0.0**	**206.0**	**n/a**	**n/a**	**13.7%**

B. Verification of impacts

The evaluation team conducted engineering reviews of the DCSEU savings estimates for reasonableness for the PV, PVMR, and SHOT projects.

Reported savings for the PV and PVMR Solar projects are based on the PVWatts 5 modeling tool used by the program implementation contractor. Variables that were available from the PV Watts 5 output were included in the PV and PVMR Solar files. Based on the variables available in the PVWatts 5 outputs, the evaluation team was able to verify the reported savings based on rerunning PVWatts 5 software. Based on the review of the PVWatts 5 model and verified (within tolerance of the PVWatts output) results, the evaluation team is comfortable with a 100 percent realization rate for the PV and PVMR Solar program based on the PVWatts 5 model output.

Reported savings for the SHOT and PVMR SHOT projects are based on the Polysun modeling tool used by the program implementation contractor. Variables that were available from the Polysun model output were input into the Pennsylvania TRM algorithm used to estimate project MMBtu savings. The evaluation team was able to verify the reported MMBtu savings to within ± 10 percent of the Polysun savings and recommends a 100 percent realization rate for solar hot water projects based on past experience with Polysun and the internal interactions of the Polysun software verses a straight algorithm analysis.

Table 5-12. FY2015 Summary of Impact Evaluation Results—7107PV

Measure	kWh			kW			MMBtu[1]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Solar PV System	606,096	606,096	1.00	79.6	79.6	1.00	0	0	n/a
Track Total	**606,096**	**606,096**	**1.00**	**79.6**	**79.6**	**1.00**	**0**	**0**	**n/a**
Relative Precision at 90% Confidence	0.0%			0.0%			n/a		

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

Table 5-13. FY2015 Summary of Impact Evaluation Results—7701PVMR

Measure	kWh			kW			MMBtu[1]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Solar hot water heating	-1,185	-1,185	1.00	-0.2	-0.2	1.00	1,166	1,166	1.00
Solar PV System	233,421	233,421	1.00	30.2	30.2	1.00	0	0	n/a
Track Total	**232,236**	**232,236**	**1.00**	**30.1**	**30.1**	**1.00**	**1,166**	**1,166**	**1.00**
Relative Precision at 90% Confidence	n/a			n/a			n/a		

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

Table 5-14. FY2015 Summary of Impact Evaluation Results—7110SHOT

Measure	kWh			kW			MMBtu[1]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Solar hot water heating	-2,154	-2,154	1.00	-0.3	-0.3	1.00	1,508	1,508	1.00
Track Total	**-2,154**	**-2,154**	**1.00**	**-0.3**	**-0.3**	**1.00**	**1,508**	**1,508**	**1.00**
Relative Precision at 90% Confidence	n/a			n/a			n/a		

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

C. Impact evaluation deviation from plan

Table 5-15. FY2015 Impact Evaluation Plan vs. Actual Sample—7107PV

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	10	10	
Conduct on-site verification	3	2	Did not obtain cooperation from 1 participant for on-site verification effort. One of the two on-site verifications was done in a neighborhood where multiple PV projects were completed. The inspector verified the external equipment installation but was unable to speak with anyone at the site.

Table 5-16. FY2015 Impact Evaluation Plan vs. Actual Sample—7701PVMR

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	5	5	
Conduct on-site verification	0	0	

Table 5-17. FY2015 Impact Evaluation Plan vs. Actual Sample—7110SHOT

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	5	5	
Conduct on-site verification	3	1	Did not obtain cooperation from 2 participants for the on-site verification effort.

D. Summary of key findings describing adjustments to ex-ante savings

- Project file documentation for 7101PVMR, 7107PV, and 7110SHOT was updated and well organized. The project data was easy to identify and reported savings was able to be verified.
- The project contractors used the PVWatts 5 modeling tool to estimate the kWh savings. The variables they used in the model were available to the evaluation team. Based on this situation, the evaluation team was able to verify reported savings.
- The project contractors used Polysun modeling to estimate the MMBtu savings. The variable used in the model was available to the evaluation team and the evaluation team was able to verify reported savings. The verified MMBtu savings used actual variables from the Polysun outputs—specifically for hot water usage, hot water temperature, and incoming water temperature of 58 degrees. The incoming water temperature is based on the results pulled from the Polysun thermal output file. The Polysun software is very reliable and used throughout the industry. It blends additional variables into the overall savings calculations that a simple algorithm cannot.

5.1.6 Recommendations

A. To improve impact evaluation results

i. No recommendations.

5.2 7420HPES AND 7401FHLB HOME PERFORMANCE WITH ENERGY STAR® MARKET RATE AND INCOME QUALIFIED

5.2.1 Track description

The Home Performance with ENERGY STAR® (HPwES) Initiative is a national program sponsored by the US Department of Energy (US DOE) and operated locally by the DCSEU. Typical HPwES home improvement projects begin with a comprehensive energy audit of a home conducted by a certified HPwES contractor. Using a number of diagnostic tests, the contractor provides the homeowner with a home energy audit report. The comprehensive report includes recommendations for energy efficient improvements specific to the home along with each improvement's associated annual energy savings. The homeowner then works with the contractor to decide on which improvements make the best sense for the home and the homeowner's budget. The certified contractor then completes the agreed upon home efficiency improvements.

Information about the HPwES initiative is available on the DCSEU website and leads are also generated by contractors. The HPwES initiative targets the District of Columbia's residents living in single-family homes, row homes (each unit is ground to sky), or converted (1 to 4 unit) apartments and row homes. Both owner-occupied homes and rental properties with the property owners' authorization are eligible to participate.

All audit data are entered into the Home Energy Reporting Online (HERO) web-based savings tool by the contractor. DCSEU staff reviews the HERO application for completeness, accuracy, and health and safety requirements for recommended measures. The contractors then install the recommended equipment and perform a test-out and then enter the test-out data into HERO. DCSEU reviews the test-out data, and if approved, forwards a document to the customer for signature. Participants receive incentive payment upon the contractor's completion of qualified home energy retrofit work. The DCSEU offers financial incentives of up to $1,800 for qualifying home energy upgrades, such as air sealing and insulating a home.

DCSEU incentives include:

- $200 off a BPI energy audit
- 50% cash back on air sealing work, up to $800 upon completion of project
- 50% cash back on insulation work, up to $800 upon completion of project
- A personal Home Energy Coach who will review the home energy audit and provide guidance on what improvements will help achieve the most energy savings.

The 7401FHLB Income Qualified Home Performance initiative (formerly the Federal Home Loan Bank initiative) is the companion initiative that tracks low-income single-family existing home projects and provides income eligible customers with funding sources to implement audit recommendations. In FY2014, the Federal Home Loan Bank funding for this initiative was suspended. In response, the DCSEU adapted and funded the Income Qualified Home Performance Initiative to work in cooperation with the Home Performance with ENERGY STAR® initiative (its market rate counterpart). Through this initiative, income qualified homeowners may

receive up to $5,000 in home energy efficiency improvements and up to $1,000 in health and safety improvements for a total of up to $6,000 in incentive cost. Within the low-income community, many of the homes are in varying states of disrepair and require some health and safety improvements in order to make durable and safe energy efficiency improvements. When health and safety issues arise, the DCSEU reviews each on a case-by-case basis and tackles those that are within the initiatives capabilities. The DCSEU views these projects as integral to supporting District businesses by contributing to the increase of District-based green jobs, the growth of District-based businesses, and the growth of the DCSEU work with the low-income community.

This initiative is promoted to potential households through referrals from contractors and initiative partners. The DCSEU also markets to households that expressed interest in the previous Federal Home Loan Bank initiative. This initiative is not promoted through the DCSEU website. More emphasis was placed on the installation of more comprehensive, or deeper savings, measures in FY2014 and FY2015.

Table 5-18 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects. FY2015 includes like-fuel interactive effects but excludes cross-fuel effects.

It is worth noting that in FY2015 the Federal Home Loan Bank experienced a significant drop in kWh savings from FY2014 even while undertaking more projects. This was due to DCSEU encountering a higher rate of health and safety issues, which caused them to change the measures use to address this market segment. Since that time, the DCSEU has been implementing process improvements to ensure the initiative is as cost effective as possible.

Table 5-18. Initiative Summary Metrics—7420HPES and 7401FHLB

Metric	FY2012	FY2013	FY2014	FY2015
7420HPES				
Participants (Units=projects)	108	272	50	85
kWh savings, meter level	70,750	171,098	12,061	42,733
kW	7.6	16.9	0.10	6.8
MMBtu	13	802	472	805
7401FHLB				
Participants (Units=projects)	21	43	29	38
kWh savings, meter level	12,912	30,531	27,089	14,865
kW savings, meter level	1.4	3.2	1.4	2.1
MMBtu	1	152	537	553

Table 5-19 and Table 5-20 provide summaries of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates.

Table 5-19. FY2015 Reported and Verified Results—7420HPES

Metric	Reported	Verified	Realization Rate
kWh	42,733	42,215	0.99
kW	6.8	6.8	1.00
MMBtu[1]	798	1,103	1.38
MMBtu (Excluding IE)[2]	805	1,110	1.38

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-20. FY2015 Reported and Verified Results—7401FHLB

Metric	Reported	Verified	Realization Rate
kWh	14,865	14,865	1.00
kW	2.1	1.9	0.88
MMBtu[1]	552	622	1.13
MMBtu (Excluding IE)[2]	553	623	1.13

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.2.2 Overall sampling methodology

Because of the similarities between 7420HPES and 7401FHLB, we treated these tracks as one for the purposes of sampling. We then broke them out by initiative as detailed below. While there were various measures installed by this initiative, choosing a random sample of projects was likely to result in a representative distribution of measures for evaluation. In addition, this initiative had a higher number of projects evaluated, so coverage of measures was not expected to be an issue. The evaluation team selected a random sample of projects and ensured that the resulting list of projects had appropriate representation for measure types.

Table 5-21. FY2015 Population and Sample Summary—7420HPES

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Building Shell	84	9	8,776	2.8	59.1	25.0%	47.3%	7.62%
Cooling	1	0	0	0	0	-	-	-
Lighting	5	1	1,178	0	-2	24.5%	24.5%	24.07%
Space Heating	6	2	404	0	0	25.4%	-	0.00%
Water Heating	4	2	141	0	1	16.6%	12.7%	100.00%
Total	**100**	**14**	**10,498**	**2.9**	**58.7**	**24.6%**	**43.3%**	**7.4%**

Table 5-22. FY2015 Population and Sample Summary—7401FHLB

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Building Shell	34	5	1,936	1.2	29.4	20.3%	76.2%	9.1%
Lighting	3	0	0	0	0	-	-	-
Refrigeration	3	1	350	0	0	72.0%	33.3%	-
Space Heating	13	2	0	0	19	-	-	10.0%
Water Heating	10	2	0	0	8	-	-	21.1%
Total	**63**	**10**	**2,286**	**1.4**	**56.4**	**15.4%**	**64.4%**	**10.2%**

5.2.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.2.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.2.5 Impact evaluation

The initial impact evaluation task was to review the DCSEU TRM and document changes from last year in our worksheet to confirm algorithms and variables used to calculate claimed savings for FY2015. Using the DCSEU TRM, the evaluation team calculated initiative kWh, kW, and MMBtu savings using the measure data from the HERO tracking system. Once this was completed, realization rates were calculated by dividing verified savings by reported savings.

A. Impact sampling methodology for on-site measurement and verification

On-site verification was not conducted for the FY2015 results evaluation due to the low contribution to portfolio savings and limited issues found in prior on-site verification efforts.

B. Verification of impacts

The evaluation team conducted reviews of the HERO inputs and outputs compared them to project file documentation.

Table 5-23. FY2015 Summary of Impact Evaluation Results—7420HPES

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Building Shell	35,036	35,036	1.00	5.9	5.9	1.00	775	1,080	1.39	775	1,080	1.39
Cooling	450	450	1.00	0.3	0.3	1.00	0	0	n/a	0	0	n/a
Lighting	4,811	4,811	1.00	0.4	0.4	1.00	-7	-7	1.00	0	0	n/a
Space Heating	1,591	1,548	0.97	0.0	0.0	n/a	28	28	1.00	28	28	1.00
Water Heating	846	370	0.44	0.1	0.1	1.00	1	2	1.17	1	2	1.17
Track Total	**42,733**	**42,215**	**0.99**	**6.8**	**6.8**	**1.00**	**798**	**1,103**	**1.38**	**805**	**1,110**	**1.38**
Relative Precision at 90% Confidence	0.0%			0.0%			6.0%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-24. FY2015 Summary of Impact Evaluation Results—7401FHLB

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Building Shell	9,523	9,523	1.00	1.6	1.6	1.00	323	390	1.21	323	390	1.21
Lighting	534	534	1.00	0.0	0.0	1.00	-1	-1	1.00	0	0	n/a
Refrigeration	486	486	1.00	0.4	0.2	0.41	0	0	n/a	0	0	n/a
Space Heating	3,853	3,853	1.00	0.0	0.0	n/a	194	189	0.97	194	189	0.97
Water Heating	469	469	1.00	0.0	0.0	1.00	36	44	1.23	36	44	1.23
Track Total	**14,865**	**14,865**	**1.00**	**2.1**	**1.9**	**0.88**	**552**	**622**	**1.13**	**553**	**623**	**1.13**
Relative Precision at 90% Confidence	0.0%			0.0%			2.0%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-25. FY2015 Impact Evaluation Plan vs. Actual Sample—7420HPES

Activity	Plan	Actual	Explanation for Variance
Conduct desk audits	10	10	

Table 5-26. FY2015 Impact Evaluation Plan vs. Actual—7401FHLB

Activity	Plan	Actual	Explanation for Variance
Conduct desk audits	5	5	

D. Summary of key findings describing adjustments to ex-ante savings

- As we experienced in 2014, the insulation and air sealing savings were calculated using the raw algorithms from the DCSEU TRM and Mid-Atlantic TRM, which produced higher or lower kWh savings than expected. Using the same algorithms, the MMBTU savings were closer to the reported data. Upon further investigation, it was found that the TRM algorithms used in HERO had been upgraded and did not reflect the TRM assumptions in the current DCSEU TRM.
- The savings algorithms used in HERO were provided to the evaluator to verify the reported kWh, kW, and MMBtu savings. The new algorithms are robust and contain many variables that add to the accuracy of the calculations. Using the savings algorithms in HERO, the evaluator was able to verify the MMBtu savings for the air sealing measures that were reviewed. However, the evaluation team had difficulty verifying the kWh/kW savings for each of the insulation measures. Three alternative HERO algorithms were provided to the evaluation team to try to verify the kWh savings. While the last of algorithms provided to the evaluation team resulted in savings numbers that were more in line with the reported savings, it appears that there are other interacting factors with the insulation calculation in the HERO database that account for the higher and likely more accurate reported savings. For this reason, the reported kWh/kW savings were not adjusted.

5.2.6 Recommendations

A. To improve impact evaluation results

Clearly document HERO algorithms to provide correct versions to the evaluation team at the onset of the evaluation. The savings algorithms used in HERO were eventually provided to the evaluation team but only after testing of two other versions failed to verify the reported kWh, kW, and MMBtu savings. The new algorithms are very robust and contain many variables that add to the accuracy of the calculations. To assist with future evaluations, it is recommended that HERO's algorithms be clearly labeled and accurately documented so the appropriate algorithms can be provided to the evaluation team at the start of the evaluation.

B. To improve cost effectiveness results

We recommend, DCSEU explore program strategies to help scale up participation and increase cost effectiveness of these initiatives. All initiatives are cost effective with the

exception of these two initiatives-- the Federal Home Loan (7401FHLB) and the (7420HPES) Home Performance with ENERGY STAR. These two low income programs have not been cost effective since the first evaluations in FY2012. The evaluation team recognizes that Federal Home Loan Bank and the Home Performance with ENERGY STAR initiatives serve a purpose and a market that would not be served otherwise. Yet it is it is important to continue to look for ways to make these initiatives more cost effective.

5.3 7511CIRX BUSINESS ENERGY REBATES

5.3.1 Track description

The Business Energy Rebate (BER) initiative provides a comprehensive set of services and financial incentives to serve the varied needs of small- to medium-sized business and institutions located within the District. The initiative covers prescriptive rebates for lighting, HVAC, compressed air, refrigeration, food service equipment, and vending machines. The initiative, which was based on other implemented VEIC programs, was launched in the second quarter of FY2012.

BER targets small- to medium-sized business (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 initiative. 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.

The DCSEU Project Intake Coordinator (PIC) screens projects, answers questions, and directs projects to the appropriate track. Program Managers and Program Assistants assist customers or customer agents to develop viable projects and offer "preapproval." Although that was not a requirement for participation, some customers wanted assurance ahead of project investment. A two-phase, multi-page application spreadsheet is downloadable from the website. Certified Business Enterprise (CBE) contractors are not a requirement, although they do promote and participate.

The list of measures includes:

- Lighting (LED products with DesignLights Consortium (DLC) approval replaced on a one-by-one basis only)
- HVAC
- Compressed air
- Refrigeration
- Food service and vending
- Spray rinse valves
- Domestic hot water heaters
- Faucet aerators, low flow showerheads, and commercial clothes washers.

In FY2015 the allowable project incentive was increased from $10,000 to a total of $20,000 per business site location per business year.

Table 5-27 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy

efficient lighting. FY2014 excludes these effects. FY2015 includes like-fuel interactive effects but excludes cross-fuel effects.

Table 5-27. Initiative Summary Metrics—7511CIRX

Metric	FY2012	FY2013	FY2014	FY2015
Participants (Units=projects)	19	60	179	161
kWh savings, meter level	1,047,000	2,194,303	4,301,800	8,594,703
kW	129.3	372.9	383.0	771
MMBtu	n/a	191	1,326	121

Table 5-28 provides a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates.

Table 5-28. FY2015 Reported and Verified Results—7511CIRX

Metric	Reported	Verified	Realization Rate
kWh	8,594,703	8,299,391	0.97
kW	770.5	1,152.4	1.50
MMBtu[1]	-3,292	-2,910	0.88
MMBtu (Excluding IE)[2]	121	196	1.63

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.3.2 Overall sampling methodology

The C&I Business Energy Rebates track primarily includes lighting projects this year. The priority for the evaluation of this initiative is to account for non-lighting projects first, then large lighting projects, and finally to randomly select additional projects. Selecting all non-lighting projects and the top 10 percent of lighting projects results in 23 projects sampled with certainty. Three additional projects were sampled with certainty because they were part of a larger project already included in the sample.

Table 5-29. FY2015 Population and Sample Summary—7511CIRX

	Project File Evaluation Sample							
Measure	N	$n_{project}$	$kWh_{n,\ ex\ ante}$	$kW_{n,\ ex\ ante}$	$MMBtu_{n,\ ex\ ante}$	% kWh	% kW	% MMBtu
Appliances	1	1	104	0.0	67.2	100.0%	100.0%	100.0%
Cooling	3	3	5,977	4.0	0.0	100.0%	100.0%	-
Lighting	157	35	4,403,273	364.9	0.0	51.8%	47.9%	-
Motors & Drives	1	1	72,284	3.2	0.0	100.0%	100.0%	-
Refrigeration	3	3	14,155	2.0	0.0	100.0%	100.0%	-

Measure	Project File Evaluation Sample							
	N	$n_{project}$	$kWh_{n,\ ex\ ante}$	$kW_{n,\ ex\ ante}$	$MMBtu_{n,\ ex\ ante}$	% kWh	% kW	% MMBtu
Water Heating	1	1	0	0.0	53.6	-	-	100.0%
Total	**166**	**44**	**4,495,794**	**374.1**	**120.8**	**52.3%**	**48.6%**	**-3.7%**

5.3.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.3.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.3.5 Impact evaluation

The impact evaluation for Business Energy Rebates consisted of conducting file reviews, desk audits, and on-site inspections to verify key energy savings characteristics.

A. Impact sampling methodology for on-site measurement and verification

Table 5-30. FY2015 On-site M&V Sample Summary

Measure	On-site M&V Sample Subset							
	N	n_{onsite}	$kWh_{onsite,\ ex\ ante}$	$kW_{onsite,\ ex\ ante}$	$MMBtu_{onsite,\ ex\ ante}$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0	0	-	-	-
Cooling	3	2	965	0.7	0.0	16.1%	17.7%	-
Lighting	157	13	2,106,006	137.7	-760.1	24.8%	18.1%	-
Motors & Drives	1	0	0	0	0	-	-	-
Refrigeration	3	2	11,191	1.8	0	79.1%	87.2%	-
Water Heating	1	1	0	0	53.6	-	-	100.0%
Total	**166**	**18**	**2,118,162**	**140.2**	**53.6**	**24.6%**	**18.2%**	**n/a**

B. Verification of impacts

The evaluation team conducted reviews of the engineering algorithms documented by the DCSEU for reasonableness and in accordance with the DCSEU TRM. The evaluation team also reviewed the Mid-Atlantic TRM to assess potential variations in inputs and methods from those implemented in the District. For this track, the net-to-gross ratio is assumed to be 1.00 for FY2015.

Table 5-31. FY2015 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Appliances	104	104	1.00	0.0	0.0	1.00	67	67	1.00	67	67	1.00
Cooling	5,977	17,078	2.86	4.0	4.8	1.20	0	0	n/a	0	0	n/a
Lighting	8,502,182	8,235,986	0.97	761.3	1,142.4	1.50	-3,412	-3,106	0.91	0	0	n/a
Motors & Drives	72,284	36,142	0.50	3.2	4.1	1.30	0	0	n/a	0	0	n/a
Refrigeration	14,155	10,081	0.71	2.0	1.2	0.57	0	0	n/a	0	0	n/a
Water Heating	0	0	n/a	0.0	0.0	n/a	54	129	2.41	54	129	2.41
Track total	**8,594,703**	**8,299,391**	**0.97**	**770.5**	**1,152.4**	**1.50**	**-3,292**	**-2,910**	**0.88**	**121**	**196**	**1.63**
Relative Precision at 90% Confidence	2.8%			29.0%			0.0%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-32. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	25	40	Conducted cursory review of all potential projects
Conduct desk audits	10	39	Conducted additional reviews to provide more robust results
Engineering analysis / modeling	5	1	All but one of the desk audit projects were deemed
Conduct on-site verification	10	16	Addition on-sites conducted due to multiple claimed projects at the same site.
On-site Metering	0	0	

D. Summary of key findings describing adjustments to ex-ante savings

During the desk audits and on-site inspections, several factors were found that led to adjustments in the ex-ante savings as well as a few calculation outliers:

- In the opinion of the evaluation team, the TRM stipulated loadshapes for lighting end uses is understating the peak demand savings in the ex-ante case. In the evaluator's opinion there were 49 instances of stipulated coincident factors that may not be consistent with their hours of use claims. The issue of whether the stipulated coincident factors and hours of use are accurate for the population has been a year-to-year evaluation finding resulting in realization rates for kW that are well above 1.0. With some minor exceptions, the TRM protocols were adhered to consistently well in the ex-ante case. The coincident factor adjustments made by the evaluation team fell into three categories:
  - Use of the Commercial Outdoor Lighting or Commercial Indoor Lighting – Blended coincident factors for fixtures with 8,760 hours of use. The coincident factor loadshape for fixtures with constant use was changed to the Flat (8,760) from the TRM loadshapes, which resulted in higher demand savings.
  - Use of the Commercial Indoor Lighting – Blended coincident factor for fixtures in hotel guest rooms. The estimated hours of use for these fixtures was 574, which is consistent with the Lodging – Guest Room Lighting loadshape from the TRM The ex-post savings were adjusted to the Lodging – Guest Room Lighting loadshape.
  - Use of the Commercial Indoor Lighting – Blended coincident factors for exterior fixtures with photocell controls. One line item had an exterior location and hours of use consistent with the Commercial Outdoor Lighting loadshape hours of use but used a different coincident factor. Two additional line items were found to have photocell control during the on-site when 8,760 operation was claimed and both the hours of use and coincident factor were adjusted to the Commercial Outdoor Lighting TRM values.

- During the on-site inspections, fixture quantities were found to differ from the claimed savings, applications, and invoices. Overall, quantity adjustments were minor. There were some on-site projects that had differences from the claimed savings quantities, but due to limited access to portions of facilities or time constraints, they could not be fully quantified. No adjustments to claimed savings were made unless line items could be fully quantifiable.
- A few projects had incorrect equipment size or type calculations. These included an air conditioning project with two measures that followed the calculation procedure for the size bin below the actual equipment capacities, and a water heating project that followed the calculation method for kitchen faucet aerators when they were installed in bathroom fixtures.
- The single Motors & Drives project examined in the desk reviews had a transcription error of the results from the analysis spreadsheet to the CAT and claimed savings. The total kWh savings for the project were entered as the per unit savings in CAT, and when combined with the quantity of two for the measure led to a 100 percent overstatement of the kWh savings.
- One of the air conditioning projects claimed savings based on the prescriptive packaged cooling savings algorithms when the units were actually heat pumps that provide heating as well. The impact evaluation analysis evaluated the items strictly on the cooling algorithm; however, there are additional electric savings that could be claimed with a heat pump algorithm to capture the heating savings as well.
- A commercial ice maker project had a claimed savings that could not be duplicated from the TRM algorithms. In the evaluation team's opinion, the claimed savings for this measure were quite large when compared to the unit cut sheet information and the TRM calculation results were deemed reasonable. This measure had a large realization rate adjustment and is the single driver behind the low realization rate for the Refrigeration end-use category.

5.3.6 Recommendations

A. To improve impact evaluation results

i. **Provide easier mapping of initiative extract database results to the line items in CAT entries.** The addition of a column to track between the CAT spreadsheets and line items in the database would be very beneficial to reporting results. For large projects, it is often difficult to determine which line items may line up with which assumptions from CAT files, and this is particularly true if there are some line items that have the same quantity. For instance, carrying the measure index numbers through from the final CAT files through to the database reporting results would greatly speed up the evaluation process.

ii. **Provide clear tracking of external calculation sources in CAT files.** Since per-unit results are copied over to CAT files in a hard-coded manner, inserting a comment into cells where this is done that gives the name of the source file and the cell reference would be helpful in tracking where final calculations are being done. Since this is a

deemed savings track with very few external calculations, this suggestion is a low priority.

5.4 7512MTV T12 MARKET TRANSFORMATION VALUE

5.4.1 Track description

The T12 Market Transformation (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 T12 fluorescent tube lighting to high efficiency T8 products in qualifying businesses, institutions, and multifamily residential buildings in the District, by the DCSEU implementation contractors. The DCSEU staff interview applicants to determine incentive levels needed to move viable projects forward.

The existing T12 lighting must be replaced by HPT8 28W lamps with low ballast factors (except in cases where specific conditions warrant higher ballast factors). The initiative also provides incentives for replacing incandescent or fluorescent exit signs with higher efficiency LED models. DCSEU covers 70 percent of the cost of the project.

To participate in the initiative, customers download application forms from the DCSEU website. All downloaded forms are tracked in KITT, along with the contact information of the person downloading the form. The preapproval process consists of screening projects for custom eligibility—projects that contain over 100 items for lighting or have an annual energy use of 65,000 kWh/year are considered more of a custom project. As part of the preapproval process, the customer submits spec sheets. After being preapproved, the customer then installs the products and provides a proof of purchase. A submittal checklist is filled out by the customer and verified by the DCSEU staff (the submittal checklist interactively calculates rebates). The DCSEU staff conduct follow-up quality assurance and quality control inspection on 100 percent of projects.

Eligible measures include:

- T8 lighting upgrades
- LED exit signs
- CFLs
- Controls measures including daylighting, occupancy sensors and exterior photocell.

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 percent of the projects prior to release of the financial incentive.

Table 5-33 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects. FY2015 includes like-fuel interactive effects but excludes cross-fuel effects.

Table 5-33. Initiative Summary Metrics—7512MTV

Metric	FY2012	FY2013	FY21014	FY2015
Participants (Units=projects)	n/a	39	94	27
kWh savings, meter level	n/a	1,079,285	2,562,394	3,587,788
kW	n/a	238	476	582

Table 5-34 provides a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates.

Table 5-34. FY2015 Reported and Verified Results—7512MTV

Metric	Reported	Verified	Realization Rate
kWh	3,587,788	3,301,235	0.92
kW	582.5	687.3	1.18
MMBtu[1]	-2,196	-2,106	0.96
MMBtu (Excluding IE)[2]	0	0	n/a

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.4.2 Overall sampling methodology

This track focuses on nonresidential lighting projects. The evaluation team sampled the top 10 percent of projects by total electricity savings and supplemented with randomly selected smaller projects to fill out the sample. This resulted in 2 projects sampled with certainty from the highest savings stratum and 13 selected randomly from the second stratum of all other electricity savings for impact evaluation activities.

Table 5-35. FY2015 Population and Sample Summary—7512MTV

Measure	Project File Evaluation Sample							
	N	$n_{project}$	$kWh_{n,\ ex\ ante}$	$kW_{n,\ ex\ ante}$	$MMBtu_{n,\ ex\ ante}$	% kWh	% kW	% MMBtu
Lighting	27	15	2,200,558	376.0	-1,331.5	61.3%	64.5%	60.6%
Total	**27**	**15**	**2,200,558**	**376.0**	**-1,331.5**	61.3%	64.5%	**60.6%**

5.4.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.4.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.4.5 Impact evaluation

The impact evaluation for the MTV track consisted of conducting file reviews, desk audits and on-site inspections to verify key energy savings characteristics.

A. Impact sampling methodology for on-site measurement and verification

Table 5-36. FY2015 On-site M&V Sample Summary

Measure	Onsite M&V Sample Subset							
	N	n_{onsite}	$kWh_{onsite,\ ex\ ante}$	$kW_{onsite,\ ex\ ante}$	$MMBtu_{onsite,\ ex\ ante}$	% kWh	% kW	% MMBtu
Lighting	27	11	1,384,116	308.4	-822.8	38.6%	52.9%	-
Total	**27**	**11**	**1,384,116**	**308.4**	**-822.8**	**38.6%**	**52.9%**	**-**

B. Verification of impacts

The evaluation team conducted reviews of the claimed savings for reasonableness and in accordance with the DCSEU TRM. The evaluation team also reviewed the Mid-Atlantic TRM to assess potential variations in inputs and methods from those implemented in the District.

Table 5-37. FY2015 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Lighting	3,587,788	3,301,235	0.92	582.5	687.3	1.18	-2,196	-2,106	0.96	0	0	n/a
Track total	**3,587,788**	**3,301,235**	**0.92**	**582.5**	**687.3**	**1.18**	**-2,196**	**-2,106**	**0.96**	**0**	**0**	**n/a**
Relative Precision at 90% Confidence	1.27%			21.32%			n/a			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-38. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	15	15	
Conduct on-site verification	10	11	An additional project was sampled because the site had measures in both CIRX and MTV.

D. Summary of key findings describing adjustments to ex-ante savings

- For some measures, it was difficult to duplicate the ex-ante savings results from the information that was available. This was almost exclusively on measures that did not follow TRM categories for claimed savings. In most cases, the documentation seemed to be clear about the assumptions for baseline and proposed wattages and quantities as well as the hours of use and load shapes; however, the calculation results differed by up to 7 percent.
- In the opinion of the evaluation team, the TRM stipulated loadshapes for lighting end uses is understating the peak demand savings in the ex-ante case. In the evaluator's opinion there were 134 instances of stipulated coincident factors that may not be consistent with their hours of use claims. The issue of whether the stipulated coincident factors and hours of use are accurate for the population has been a year-to-year evaluation finding resulting in realization rates for kW that are well above 1.0. With some minor exceptions, the TRM protocols were adhered to consistently well in the ex-ante case. The coincident factor adjustments made by the evaluation team fell into three categories:
  - Use of loadshape coincident factors other than Flat (8,760) for fixtures with 8,760 hours of use. The coincident factor loadshape for fixtures with constant use were revised to the Flat (8,760) from the TRM loadshapes table for the ex-post savings.
  - Use of the Residential Indoor Lighting coincident factor for fixtures in a college academic building. The estimated hours of use for these fixtures was 3,456, which is consistent with the College Indoor Lighting loadshape from the TRM and were revised in the ex-post savings.
  - Use of the Commercial Indoor Lighting – Blended coincident factor for fixtures in a religious worship building. The hours of use estimates were consistent with the Religious Worship Indoor Lighting loadshape from the TRM and were revised in the ex-post savings.
- During the on-site inspections, fixture quantities were found to differ from the claimed savings, applications, and invoices. Overall, quantity adjustments were minor. There were some on-site projects that had differences from the claimed savings quantities, but due to limited access to portions of facilities or time constraints, they could not be fully quantified. No adjustments to claimed savings were made unless line items could be fully quantifiable.
- For some on-site projects, site personnel's estimated hours of use differed substantially from the ex-ante documentation. Where the estimated hours of use from the on-site

was deemed robust and consistent, it was used in the ex-post calculations. These adjustments generally resulted in a lowering of the realization rates.

5.4.6 Recommendations

A. To improve impact evaluation results

i. **Fully document calculations and assumptions used to calculate savings.** To facilitate evaluation efforts, the calculations used to produce the ex-ante savings should be fully documented, including such factors as the hours of use, coincident factors, heat/cool interactive factors, baseline fixture wattage and proposed fixture wattage. For many projects, determining the basis of the ex-ante savings calculations was difficult, and for others it was not possible to reproduce the ex-ante results after determining the key factors from the project documents. Having these key factors from the tracking database would reduce efforts and clarify assumptions prior to the evaluation of each project. This is a repeated recommendation from the FY2013 and FY2014 results evaluation effort.

ii.

5.5 7520CUST, 7520MARO, AND 7520NEWC CUSTOM SERVICES FOR C&I CUSTOMERS

5.5.1 Track description

The C&I Custom Services ("Non-prescriptive") initiative was launched in Q2 of FY2012. The commercial custom initiatives consist of Retrofit (7520CUST), Market Opportunity (7520MARO) and New Construction (7520NEWC). The initiative provides a comprehensive set of energy services to owners of typically larger buildings who are replacing old equipment, renovating an existing building, or beginning a new construction project.

The initiative targets building envelope, lighting, and HVAC system measures. The key features of the incentive structure are to offset the incremental costs of adding more energy efficient equipment, provide comprehensive technical services, and share the economic effects with the customer. Technical services can include but are not limited to:

1. Provide a reality check to vendors' equipment, design, and commissioning claims
2. Perform walkthroughs at customer sites and follow up with relevant recommendations that the customer should consider (working with their preferred contractors/vendors) in order to improve energy efficiency at their site
3. Develop savings estimates and thus economic effects, based on conservative analysis methodology for implementation of more efficient equipment
4. Create an appropriate incentive amount to offset the incremental costs of adding such equipment.

Account Managers recruit large customers into the non-prescriptive tracks**.** Other projects may come in from sources such as business and trade associations, the General Services Administration, city government, and through trade allies. A DCSEU Project Intake Coordinator assigns projects in KITT to the appropriate track. Energy Consultants (ECs) or Energy Associates (EAs) then provide technical assistance to customers, determine energy savings, and provide incentive calculations for measures. The ECs conduct a technical savings analysis to determine energy savings metrics (kWh, kW, and therms) and determine incentives based on the project savings and DCSEU performance contract spend requirements. The customer selects the contractor or contractors to complete the project. A follow-up QA/QC inspection is conducted by DCSEU ECs/EAs. Based on the results of the follow-up inspection, the final incentive is determined and paid to the customer.

A list of measures in this initiative include:

- Lighting
- HVAC
- Compressed Air
- Chiller Performance
- Demand-Controlled Ventilation/Economizer

- Energy Recovery Ventilation
- VFD
- Refrigeration Analysis
- New Construction
- Industrial Process
- Other.

In FY2015, the following initiative adjustments took place.

- Commercial Custom Retrofit (7520CUST)—greater guidelines on incentives for certain technologies (e.g., $/hp. for VFD projects) were provided.
- Commercial Custom Market Opportunity (7520MARO)—a shifting from prescriptive rebate applications to custom when any aspect of the project required a custom analysis.
- Commercial Custom New Construction (7520NEWC)—Conducting a custom analysis where specific project information is provided.

Table 5-39 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects. FY2015 includes like-fuel interactive effects but excludes cross-fuel effects.

Table 5-39. Initiative Summary Metrics—7520CUST, 7520MARO, 7520NEWC

Metric	FY2012	FY2013	FY2014	FY2015
7520CUST				
Participants (Units=projects)	39	98	94	78
kWh savings, meter level	7,836,030	19,751,948	22,818,145	14,837,521
kW savings, meter level	124.7	2,858.8	2,995.8	1,883
MMBtu	2,076	65,839	77,878	61,363
7520MARO				
Participants (Units=projects)	n/a	4	9	12
kWh savings, meter level	n/a	636,671	306,634	1,978,521
kW savings, meter level	n/a	55.1	115.2	347
MMBtu	n/a	0	23,265	14,493
7520NEWC				
Participants (Units=projects)	n/a	1	4	3
kWh savings, meter level	n/a	88,749	1,157,874	229,937
kW savings, meter level	n/a	8.8	339.1	38
MMBtu	n/a	0	2,061	975

The following tables provide a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates.

Table 5-40. FY2015 Reported and Verified Results—7520CUST

Metric	Reported	Verified	Realization Rate
kWh	14,837,521	12,732,804	0.86
kW	1,882.8	2,157.5	1.15
MMBtu[1]	60,134	67,790	1.13
MMBtu (Excluding IE)[2]	61,363	68,974	1.12

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-41. FY2015 Reported and Verified Results—7520MARO

Metric	Reported	Verified	Realization Rate
kWh	1,978,521	1,818,074	0.92
kW	347.1	259.9	0.75
MMBtu[1]	14,474	14,116	0.98
MMBtu (Excluding IE)[2]	14,493	14,137	0.98

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-42. FY2015 Reported and Verified Results—7520NEWC

Metric	Reported	Verified	Realization Rate
kWh	229,937	226,849	0.99
kW	38.4	35.5	0.92
MMBtu[1]	937	879	0.94
MMBtu (Excluding IE)[2]	975	916	0.94

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.5.2 Overall sampling methodology

These initiatives are similar in the methodology for estimating energy savings, so they were sampled together. There is very wide variability in the energy savings resulting from these initiatives' projects, so the highest-saving projects stratum were sampled with certainty (24 projects). One of the new construction projects was also included to ensure sampling of that program. The remainder of projects were randomly sampled.

Table 5-43. FY2015 Population and Sample Summary—7520CUST

Measure	Project File Evaluation Sample							
	N	$n_{project}$	$kWh_{n,\ ex\ ante}$	$kW_{nex\ ante}$	$MMBtu_{n,\ ex\ ante}$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0.0	0.0	-	-	-
Cooling	7	4	1,681,006	50	0	97.3%	78.8%	-
Industrial Process	2	1	78,798	8	28,077	51.9%	100.0%	100.0%
Lighting	39	16	3,394,473	417	-462	53.8%	50.0%	37.6%
Motors & Drives	28	6	3,368,747	354	0	53.2%	39.1%	-

Measure	Project File Evaluation Sample							
	N	$n_{project}$	$kWh_{n,\ ex\ ante}$	$kW_{nex\ ante}$	$MMBtu_{n,\ ex\ ante}$	% kWh	% kW	% MMBtu
Other	1	1	2,350	0	1,427	100.0%	100.0%	100.0%
Refrigeration	1	0	0	0	0	-	-	-
Space Heating	9	5	0	0	28,433	-	-	95.1%
Ventilation	6	4	308,068	71	417	97.4%	98.0%	97.9%
Water Heating	2	1	0	0	739	-	-	51.4%
Total	**96**	**38**	**8,833,441**	**900**	**58,630**	**59.5%**	**47.8%**	**97.5%**

Table 5-44. FY2015 Population and Sample Summary—7520MARO

Measure	Project File Evaluation Sample							
	$N_{measures}$	$n_{measures}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Appliances	1	1	65,410	4.8	448.5	100.0%	100.0%	100.0%
Cooling	4	4	1,531,761	316.0	0	100.0%	100.0%	-
Lighting	2	1	101,549	7.7	-19	51.3%	41.3%	100.0%
Motors & Drives	1	0	0	0.0	0	-	-	-
Space Heating	5	2	0	0	12,953	-	-	95.7%
Water Heating	3	2	0	0	313	-	-	62.0%
Total	**16**	**10**	**1,698,720**	**328.6**	**13,696**	**85.9%**	**94.7%**	**94.6%**

Table 5-45. FY2015 Population and Sample Summary—7520NEWC

Measure	Project File Evaluation Sample							
	$N_{measures}$	$n_{measures}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0.0	0.0	-	-	-
Building Shell	1	0	0	0	0	-	-	-
Cooling	2	0	0	0	0	-	-	-
Lighting	2	1	37,001	2	-23	61.6%	36.9%	61.6%
Motors & Drives	1	0	0	0	0	-	-	-
Refrigeration	1	0	0	0	0	-	-	-
Ventilation	2	1	147,357	27	683	98.2%	96.4%	91.5%
Water Heating	1	1	0	0	92	-	-	100.0%
Total	**11**	**3**	**184,358**	**29**	**752**	**80.2%**	**75.9%**	**80.2%**

5.5.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.5.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.5.5 Impact evaluation

The impact evaluation consisted of a combination of desk audits and on-site verification results in order to cover all of the projects in the sample given the short time frame. Fourteen sites received on-site verifications and an additional 36 projects received file reviews and/or engineering analysis for calculation of the realization rates. Engineering analysis was conducted from the on-site inspection and project file review findings based on the identification of measures with possible calculation methodology shortcomings, questionable key assumptions, or incorrect inputs from the available on-site and program documentation evidence.

A. Impact sampling methodology for on-site measurement and verification

A weighted sampling methodology was applied to the savings values for each project to develop the on-site sample. Out of a total of 93 projects in the programs, 50 were selected for project file reviews, out of which 14 were successfully recruited for on-site verifications. Out of the 50 project file and on-site reviews, 51 individual measure types were identified for an engineering analysis and recalculation of the savings for the ex-post data. The additional measure types without engineering analysis were deemed to have sufficiently documented calculations with reasonable assumptions and accurate inputs to include as 100 percent realized savings measures.

Table 5-46. FY2015 On-site M&V Sample Summary—7520CUST

Measure	On-site M&V Sample Subset							
	$N_{measure}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0.0	0	-	-	-
Cooling	7	2	305,741	48.9	0	17.7%	77.7%	-
Industrial Process	2	1	78,798	8.1	28,077	51.9%	100.0%	100.0%
Lighting	39	7	2,195,047	286.0	-291	34.8%	34.3%	-
Motors & Drives	28	5	3,129,727	298.2	0	49.4%	32.9%	-
Other	1	0	0	0.0	0	-	-	-
Refrigeration	1	0	0	0.0	0	-	-	-
Space Heating	9	3	0	0.0	26,093	-	-	87.2%
Ventilation	6	2	90,605	19.1	95	28.7%	26.4	22.3%
Water Heating	2	0	0	0.0	0	-	-	-
Total	**96**	**20**	**5,799,918**	**660.3**	**53,974**	**39.1%**	**35.1%**	**88.0%**

Table 5-47. FY2015 On-site M&V Sample Summary—7520MARO

Measure	On-site M&V Sample Subset							
	$N_{measure}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0	0	-	-	-
Cooling	4	1	909,942	114.4	0.0	59.4%	36.2%	-
Lighting	2	0	0	0	0	-	-	-
Motors & Drives	1	0	0	0	0	-	-	-
Space Heating	5	0	0	0	0	-	-	-
Water Heating	3	0	0	0	0	-	-	-
Total	**16**	**1**	**909,942**	**114.4**	**0.0**	**46.0%**	**33.0%**	**-**

Table 5-48. FY2015 On-site M&V Sample Summary—7520NEWC

Measure	On-site M&V Sample Subset							
	$N_{measure}$	n_{onsite}	kWh_{onsite}	kW_{onsite}	$MMBtu_{onsite}$	% kWh	% kW	% MMBtu
Appliances	1	0	0	0.0	0	-	-	-
Building Shell	1	0	0	0.0	0	-	-	-
Cooling	2	0	0	0.0	0	-	-	-
Lighting	2	0	0	0.0	0	-	-	-
Motors & Drives	1	0	0	0.0	0	-	-	-
Refrigeration	1	0	0	0.0	0	-	-	-
Ventilation	2	0	0	0.0	0	-	-	-
Water Heating	1	0	0	0.0	0	-	-	-
Total	**11**	**0**	**0**	**0.0**	**0**	**-**	**-**	**-**

B. Verification of impacts

The evaluation team conducted reviews of the engineering algorithms documented by the DCSEU for reasonableness and in accordance with the DCSEU TRM for those measures with valid TRM calculation protocols or assumptions. For measures without valid TRM protocols, a review of the custom calculations was conducted.

Table 5-49. FY2015 Summary of Impact Evaluation Results—7520CUST

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Appliances	0	0	n/a	0.0	0.0	n/a	31	31	1.00	31	31	1.00
Cooling	1,728,368	390,030	0.23	63.0	63.4	1.01	0	0	n/a	0	0	n/a
Industrial Process	151,755	199,603	1.32	8.1	11.8	1.46	28,077	36,184	1.29	28,077	36,184	1.29
Lighting	6,305,115	6,601,251	1.05	832.7	869.3	1.04	-1,228	-1,184	0.96	0	0	n/a
Motors & Drives	6,330,591	5,249,860	0.83	906.4	1,148.5	1.27	51	51	1.00	51	51	1.00
Other	2,350	2,350	1.00	0.3	0.3	1.00	1,427	1,427	1.00	1,427	1,427	1.00
Refrigeration	2,736	2,736	1.00	0.2	0.2	1.00	0	0	n/a	0	0	n/a
Space Heating	462	462	1.00	0.0	0.0	n/a	29,913	30,829	1.03	29,913	30,829	1.03
Ventilation	316,145	286,514	0.91	72.2	64.0	0.89	426	37	0.09	426	37	0.09
Water Heating	0	0	n/a	0.0	0.0	n/a	1,437	415	0.29	1,437	415	0.29
Track total	**14,837,521**	**12,732,804**	**0.86**	**1,882.8**	**2,157.5**	**1.15**	**60,134**	**67,790**	**1.13**	**61,363**	**68,974**	**1.12**
Relative Precision at 90% Confidence	4.5%			9.7%			1.1%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-50. FY2015 Summary of Impact Evaluation Results—7520MARO

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Appliances	65,410	65,410	1.00	4.8	7.5	1.55	449	45	0.10	449	45	0.10
Cooling	1,531,761	1,385,880	0.90	316.0	218.8	0.69	0	0	n/a	0	0	n/a
Lighting	198,131	183,565	0.93	18.8	26.2	1.40	-19	-21	1.11	0	0	n/a
Motors & Drives	183,219	183,219	1.00	7.5	7.5	1.00	0	0	n/a	0	0	n/a
Space Heating	0	0	n/a	0.0	0.0	n/a	13,540	13,542	1.00	13,540	13,542	1.00
Water Heating	0	0	n/a	0.0	0.0	n/a	505	550	1.09	505	550	1.09
Track Total	**1,978,521**	**1,818,074**	**0.92**	**347.1**	**259.9**	**0.75**	**14,474**	**14,116**	**0.98**	**14,493**	**14,137**	**0.98**
Relative Precision at 90% Confidence	0.0%			0.0%			3.26%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-51. FY2015 Summary of Impact Evaluation Results—7520NEWC

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Appliances	0	0	n/a	0.0	0.0	n/a	48	48	1.00	48	48	1.00
Building Shell	273	273	1.00	0.0	0.0	n/a	38	38	1.00	38	38	1.00
Cooling	12,558	12,558	1.00	3.5	3.5	1.00	0	0	n/a	0	0	n/a
Lighting	60,059	60,434	1.01	6.4	11.7	1.82	-37	-38	1.01	0	0	n/a
Motors & Drives	3,690	3,690	1.00	0.0	0.0	n/a	51	51	1.00	51	51	1.00
Refrigeration	3,353	3,353	1.00	0.7	0.7	1.00	0	0	n/a	0	0	n/a
Ventilation	150,003	146,541	0.98	27.8	19.6	0.71	746	687	0.92	746	687	0.92
Water Heating	0	0	n/a	0.0	0.0	n/a	92	92	1.00	92	92	1.00
Track Total	**229,937**	**226,849**	**0.99**	**38.4**	**35.5**	**0.92**	**937**	**879**	**0.94**	**975**	**916**	**0.94**
Relative Precision at 90% Confidence	n/a			n/a			n/a			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-52. Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Conduct project file reviews	50	50	
Conduct engineering analysis	25	51	51 individual measure types from the 50 project file reviews received engineering analysis. These were done in an attempt to sample 50% of the energy savings across each technology on CUST and all measures on NEWC and MARO.
Conduct on-site verification	10	16	CUST/MARO/NEWC were oversampled due to the crossover projects with other energy savings programs.
Conduct on-site metering	5	5	

Summer metering activities were conducted at five sites:

- 7520-9204 Akridge: Metered the VFDs on the chiller, chilled water pump and condenser water pumps. The data was used to determine the loading profiles of the equipment with respect to ambient temperature and was applied to revised bin analysis for the verified savings.
- 7520-9587 George Washington: Metered a selection of chilled and condenser water pumps and air handling supply fans with VFDs installed. The data was used to determine the loading profile with respect to ambient temperature and occupancy schedules and was used to revise portions of bin analysis on this project for the verified savings.
- 7520-9558 Georgetown: Metered a primary chilled water pump. The data was not representative of typical operation due to a sequence of operations change during the monitoring period.
- 7520-A049 Watergate West: Metered a secondary chilled water pump. The data from this installation was bad to an incorrect meter placement. The metered data was useful for verifying the schedule of operations but was not able to be used it for load adjustments as planned.
- 7520-A523 SC Herman: Collected control system data for two years of operation, with at least 1 year of pre-operation on the chiller plant and building chilled water loops. This project did not close for the FY2015 program year as expected.

D. Summary of key findings describing adjustments to ex-ante savings

- There was inconsistent use of coincident factors when compared to loadshapes and hours of use across multiple types of projects. There were 47 instances of coincident factors that were not consistent with their hours of use claims. The issue of coincident factor and hours of use consistency has been a year-to-year evaluation finding

resulting in realization rates for kW that are well above 1.0. The coincident factor adjustments fell into three categories:

  - Use of the Commercial Outdoor Lighting or Commercial Indoor Lighting – Blended coincident factors for fixtures with 8,760 hours of use. The coincident factor loadshape for fixtures with constant use should be the Flat (8760) from the TRM loadshapes.
  - Use of the Residential Indoor Lighting coincident factor for fixtures in multi-family common areas and support spaces. The estimated hours of use for these fixtures was more consistent with the Commercial Indoor Lighting – Blended loadshape from the TRM and should be utilized for consistency.
  - Use of the Commercial Indoor Lighting – Blended coincident factors for exterior fixtures with photocell controls.

- In many cases, the source of assumptions and calculations used to determine the peak demand could not be determined from the available documentation. The CAT file often contains hard-coded values that may not match with other available documents. In these cases, consistent methodologies were applied to calculate the demand in the ex-post cases and compared to the ex-ante estimates without knowing the exact reason for the variance.
- For projects with bin analysis, a summer demand period bin analysis was conducted for the ex-post savings, which increased savings in most cases.
- In some instances, the proposed fixture input power was adjusted in the verified savings calculations due to different nominal lamp wattage, ballast factor, or the number of lamps per fixture.
- For water heating projects, the calculator developed for the projects uses an adjustment based on actual fuel use that results in the capacity of the water heater not mattering in the final calculation. Also, the minimum turn-down ratio for modulating burners was not taken into account. The verified savings attempted to correct for these two factors.
- In some cases, NEMA motor efficiency ratings were used in calculations, while the ex-post calculations used the actual motor efficiencies.
- The ex-ante calculations for several VFD projects assumed the sequence of operations for multiple pump systems was parallel while the actual operation was found to be lead-lag. This resulted in much lower savings for pumps retrofit beyond the first in the sequence. The operating hours and savings were divided equally among all pumps in these cases.
- An energy recovery ventilator was found to have an unusually low dehumidification setpoint (32 percent RH) that was causing extended runtime in the ex-ante calculations. This was revised to 50 percent RH in the ex-post calculations.
- For cooling projects, revisions were made to the baseline and proposed efficiencies based on energy standards and actual product documentation.
- A few projects assumed 8,760 operation of equipment where evidence from on-sites or in the ex-ante documents indicated a reduced equipment schedule.

- For some of the lighting projects, inconsistencies were found between the heating fuel source assumptions and the documentation from other measures at the same site. These resulted in misclassification of heating interactive effects in the ex-ante calculations.
- A project involving a rooftop unit had three different measures associated with it, but the calculations did not take into account interactive effects. For example, the presence of demand-controlled ventilation would reduce the outside air requirements and lower the heat recovery ventilator savings as a result. The ex-post analysis took the interactive effects into account.
- For one large cooling project, the ex-ante calculations used an estimate for the winter operating load point that was much higher than monitored data included in the ex-ante documents indicated. The savings for this project were revised based on the monitored data, resulting in a large variance.

5.5.6 Recommendations

A. To improve impact evaluation results

i. **During QA/QC, document the differences between what is found during the on-site inspection and/or other project documentation.** The QA/QC process seems to focus on counts of measures and less about the key inputs into each of those measures. The simplified, often handwritten, checklist of items does not give the same rich detail as a report documenting potential differences found on-site and how those differences were handled in calculation adjustments. For instance, some VFD projects had pictures of motor nameplate efficiencies; however, these were not used to recalculate the energy savings for the project despite being a key input to the savings models. These findings were also noted in FY2014.

ii. **Provide clear references to outside calculation sources**. For all custom projects, the CAT files include hard-coded values for kWh, kW, and MMBtu savings without reference to the sources of those outside calculations. In some cases, the sources of those values could not be identified. Adding comments to hard-coded values that reference the source documents for those values would help in tracking the source of the savings estimates.

iii. **Use supplemental data to validate key energy savings assumptions.** There was one large project that had monitored data available in the ex-ante documents that could have been used to refine the baseline load assumptions for chiller operation. For other projects, there were nameplate photos available with equipment ratings and efficiencies that were not used in the ex-ante calculations.

iv. **Obtain the sequence of operation and associated setpoints for all pumps and chillers with multiple pieces of equipment.** For projects that have additional chillers and pumps as part of the system or for those looking for rebates on multiple pieces of equipment on the same system, obtain the sequence of operations and refine ex-ante assumptions. For chilled water, hot water, and condenser water pump VFD projects, projects were identified that assumed parallel operation in the ex-ante savings when the pumps operated in a lead-lag configuration. Also, for large central plants, the operation

of an individual chiller or boiler may not reflect the expected variation of total load depending on how it is used in the plant operating sequence.

v. **Use a consistent approach for demand and energy savings.** For projects using a bin analysis approach for energy savings, conducting a summer demand period bin analysis for the demand reduction would be more accurate than using loadshape factors based on connected load reduction.

5.6 7610ICDI LI MF IMPLEMENTATION CONTRACTOR DIRECT INSTALL

5.6.1 Track description

The Low Income Multi Family (LIMF) Implementation Contractor Direct Install (ICDI) initiative provides specific services and products to LIMF community residents of the District of Columbia. The initiative is promoted to property owners, property managers, developers, architects, and engineers and is designed to serve a wide variety of energy efficiency needs. The ICDI initiative, initially launched as the Property Manager Direct Install (PMDI) initiative in April of 2012, covers 100 percent of the costs (products and direct installation) and hires implementation contractors to perform the direct installation rather than having the property managers install the equipment.

Through the LIMF ICDI initiative, all spaces in a building can be served, including common areas and individual residential units. The track covers the replacement of fixtures inside rental units of qualifying low income multifamily residential buildings. Multifamily residential buildings that do not qualify as low income can still have common space fixtures incented under the initiative.

Once there is an interested party and eligibility for the initiative has been confirmed, the DCSEU evaluation team assesses the site and provides recommendations. After three-party agreements (between DCSEU, contractor, and owner) have been signed, the implementation contractors start the project and install the products.

The FY2015 initiative's products include:

- LED bulb replacement in property-owned fixtures
- CFL replacement in resident-owned fixtures
- Upgraded water-saving shower head replacement
- Low-flow faucet aerator replacement
- Pipe wrap
- Exterior lighting, wall packs, and parking lot lighting
- Lighting controls.

During implementation, the DCSEU performs QA/QC on 100 percent of the projects, visiting a representative sample of the total number of units in a project (30 units maximum per property or 20 percent of the total, whichever is lower).

As the low-income multifamily direct install initiative (LIMFICDI) has evolved, more options for common area direct-install measures have been added. In FY2015, these measures included LED wall packs, T12 lighting retrofits, parking lot lights, LED exit signs, various outdoor LED lighting, and lighting controls.

Table 5-53 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects and FY2015 includes like-fuel interactive effects but excludes cross-cutting effects.

Table 5-53. Initiative Summary Metrics—7610ICDI

Metric	FY2012	FY2013	FY2014	FY2015
Participants (Units=projects)	23	26	59	70
kWh savings, meter level	1,007,783	1,187,537	1,705,554	2,856,247
kW savings, meter level	113.5	124.0	209.2	159
MMBtu	865	418	2,410	1,529

Table 5-54 provides a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates.

Table 5-54. FY2015 Reported and Verified Results—7610ICDI

Metric	Reported	Verified	Realization Rate
kWh	2,856,247	2,895,554	1.01
kW	158.6	158.1	1.00
MMBtu[1]	-837	-1,049	1.25
MMBtu (Excluding IE)[2]	1,529	1,384	0.91

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.6.2 Overall sampling methodology

This track primarily includes two types of measures (lighting and water-saving devices). There is less variation in project savings, so this initiative is sampled randomly. Thirty-five (35) projects were randomly selected for desk reviews and potential on-site verification. All 35 projects contained lighting measures, and 18 of the 35 also included water-saving devices.

Table 5-55. FY2015 Population and Sample Summary—7610ICDI

	Project File Evaluation Sample							
End-use	$N_{measure}$[26]	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Lighting	70	35	1,264,871	73.8	0.0	45.7%	47.9%	-
Water Heating	39	18	54,210	2.8	603	61.8%	62.0%	39.4%
Total	**70**	**35**	**1,319,081**	**76.6**	**603**	**46.2%**	**48.3%**	**39.4%**

5.6.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

[26] This represents unique projects.

5.6.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.6.5 Impact evaluation

The impact evaluation effort for this track included on-site measure installation verification and desk audit reviews to validate KITT report data. The purpose of the review was to confirm that the project file supporting data, such as internal desk reviews, QA/QC reports, calculators/calculation methods, and applications or incentive agreements, were accurate and/or present in the project files. Desk reviews also checked the veracity of the savings values and user inputs for measures, informed the on-site data collection plans, and identified any issues to be addressed.

A. Impact sampling methodology for on-site measurement and verification

The selection of on-site visits was based upon the availability of property managers during the on-site measurement timeframe. Fewer on-site verification efforts were conducted than originally planned due to the availability of participants. In a number of cases, a property manager could not be contacted due to the lack of contact information being recorded by the initiative. In these cases, the contractor doing the direct install work was identified as the contact; but without an on-site manager to provide access to areas, including getting permission to inspect dwelling units, no site verification could be completed.

Table 5-56. FY2015 On-site M&V Sample Summary

Measure	Project File Evaluation Sample							
	N	$n_{project}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Lighting	70	35	1,264,871	73.8	-1,444.4	45.7%	47.9%	61.1%
Water Heating	39	18	54,210	2.8	603	61.8%	62.0%	39.4%
Total	**109**	**53**	**1,319,081**	**76.6**	**(841)**	**46.2%**	**48.3%**	**100.5%**

B. Verification of impacts

For the desk review, the evaluation team reviewed the project file documents uploaded to Tetra Tech's Attunity MFT Web Client by the VEIC Evaluation. In particular, the project files most critical and utilized for the evaluation were mostly located in the "Agreement," "Desk Review," "CAT Analysis," and "QAQC" project folders. Measure information within these Excel files were compared to the KITT reported quantities by measure type. The evaluation team also spot-checked QA/QC forms and other various project data and information such as the application and direct install worksheets. The folder titled "Agreement," which contained files for applications and income verification, contained files for all projects. The CAT Analysis files were frequently used by the evaluation team to confirm measure counts and savings values tracked in KITT, but in many cases, files outside of the CAT Analysis file folder had to be used. In nearly all cases, the files did not contain all information necessary for the evaluation team to verify major measure inputs (e.g., space heating fuel type and DHW heating fuel type). Most projects included multiple end uses (lighting and hot water heating) and multiple deemed calculation

methodologies for each end use. The desk reviews included a review of all reported measures, savings calculations, user input data, and/or TRM assumptions.

For the on-site verification, the evaluation team attempted to verify the installation of the measures listed in the KITT file. However, it was not possible to visit every occupied unit within the facility, so a sample of units were reviewed. If a site had common area installed measures (e.g., common area lighting), then the on-site verification typically reviewed a census of those measures. The on-site verification information was primarily used to inform the evaluation process in general and to confirm major algorithm inputs such as space heating fuel type and DHW heating fuel type, as well as common area installations of lighting measures, which were used to establish realization rates.

Table 5-57. FY2014 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Lighting	2,768,521	2,817,974	1.02	154.1	154.1	1.00	-2,366	-2,433	1.03	0	0	n/a
Water Heating	87,726	77,581	0.88	4.5	4.0	0.89	1,529	1,384	0.91	1,529	1,384	0.91
Track Total	**2,856,247**	**2,895,554**	**1.01**	**158.6**	**158.1**	**1.00**	**-837**	**-1,049**	**1.25**	**1,529**	**1,384**	**0.91**
Relative Precision at 90% Confidence	1.16%			0.01%			17.71%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-58. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Conduct Desk audits	35	35	
Conduct on-site verification	10	5	In many cases, contact information only included the installation contractor and correct property contacts could not be identified. In other cases, property managers refused or were unable to be reached for scheduling the on-site verification visits. We physically went to three locations, but those three locations covered five reported projects. One site could have more than one associated project.

D. Summary of key findings describing adjustments to ex-ante savings

i. Crosscutting

- Although a consistent file folder structure was used for all projects, the organization of the files was inconsistent. In many cases multiple CAT files were present or it was unclear which files represented the final implemented project in terms of measures and counts of measures. While the evaluation was able to identify files that aligned with the KITT quantities and savings, there was no clear pattern.
- The assumptions made to generate savings values for the projects implemented through this track often underestimated or overestimated savings. This was due to most lighting measures assumed to be installations with “unknown” heating type, while all faucet aerators were assumed to be bathroom installations.
- Information regarding fundamental building energy use, such as space heating fuel types for common areas or dwelling units, were only identified in the CAT files, and water heating fuel assumptions were not clearly stated or presented in all cases. As a result, the evaluation had to assume the CAT file space heating type applied to all areas of the building, while the water heater fuel type was assumed based on the energy savings (electric or MMBTU savings) from KITT if it could not be identified in KITT.
- The on-site verification identified cases in which the in-unit measures may have been removed. These measures were CFLs and faucet aerators. It is possible that these measures broke or were removed after the DCSEU’s QA visit, particularly for faucet aerators. For one of the projects receiving on-site verification, the measures were installed in a large complex covering eight buildings and three street addresses. In this case, it is possible that the sample of units did not reflect the diversity of measures

installed in specific units. The evaluation team did not alter savings for these projects (or the initiative) due to the small on-site sample.

ii. Lighting measures

- The evaluation team found that in all cases, in-unit lighting measures assumed the "Unknown" heating fuel type and corresponding TRM-based savings. The evaluation team adjusted the savings based on the space heating fuel type identified in the CAT file, resulting in greater kWh savings than recorded by the initiative. This upward adjustment reflects the removal of the electric heating penalty assumed in the TRM measure for "Unknown" heating fuels. The corresponding increase in MMBTU consumption was calculated but not reported for purposes of performance benchmarking per DOEE and DCSEU policy regarding cross-fuel interactive effects.
- The use of the "Unknown" heating fuel type is not a conservative assumption. However, there is some risk to the evaluation team assuming that the CAT file heating fuel type is accurate for in-unit measures. In the review of custom/comprehensive projects, there were some cases in which the common area space heating fuel differed from the in-unit space heating fuel. However, the CAT file documentation is more likely to be accurate than assuming an "Unknown" heating fuel type.
- For common area lighting, the evaluation team reviewed the individual file calculations and found that the DCSEU was applying a custom analysis rather than the TRM assumptions to derive savings. The differences typically involved the hours of use or baseline technology assumptions. While the evaluation team accepted the calculations under the assumption that initiative contractor staff had better information regarding the common area lighting technology and use than the TRM, there was no documentation presented to justify hours of use or baseline technology assumptions.

iii. Water heating measures

- The water heating fuel types were found to be accurate based on initiative documentation and no adjustments were made to water heater fuel types.
- As with the prior year's evaluation, the DCSEU continues to record savings for kitchen faucet aerators under the TRM savings value for bath faucet aerators. The evaluation team adjusted the corresponding measure savings downward to reflect the lower savings associated with kitchen aerators. Because the DCSEU recorded these aerators as different line items in KITT, the evaluation team was able to identify and assign the TRM savings values to the correct measure line item.

5.6.6 Recommendations

A. To improve impact evaluation results

i. **Modify project application to include both the space and water heating fuel types and verify the fuel type during QA inspection or as a part of standard project enrollment requirements.** The initiative has access to the information required to identify space heating and water heating fuel types for common and in-unit areas. This can be done through the contractors doing the measure installation or through the DCSEU's QA inspection.

ii. **Use site specific information to inform reported savings.** Several adjustments to space heating fuel type were made based upon evaluation team review of project documents. Additionally, kitchen faucet aerators were assigned savings based on bath faucet aerators. Roughly half are installed in "kitchen" locations. These issues were found during the FY2013 and FY2014 results evaluation effort as well. Differentiate between space heating fuel types for common and in-unit area to correctly assign and calculate interactive effects for lighting measures.

iii. **To ease both project development and evaluation efforts, use deemed TRM assumptions for all common area lighting retrofits.** All fluorescent lighting projects evaluated in PY2015 utilized custom versus deemed TRM assumptions. This takes additional time and effort. The deemed approach offers numerous efficiencies. Alternatively, clearly document all aspects of custom calculations, particularly for hours of use and baseline technology. Absent clear documentation and justification, the TRM values for either hours of use or baseline technology should be used.

iv. **Provide an explanation why measures identified in the project are not included in final savings calculations.** Providing an explanation for why measures described within project documentation but were not passed during the QA process may allow for the potential of more eligible savings. An example includes additional exterior lighting retrofits, which was identified within all project documentation. No notes were provided to explain their omission within the final project KITT savings. Therefore, it was unclear whether this omission was purposeful or erroneous. While the evaluation only included savings for measures identified in KITT, the multiple files with measures not included in KITT may point to missed opportunities or accidentally omitted measures.

v. **Track projects or savings at the individual building or street address level and conduct QA inspections at that level.** For the two LIMFICDI projects that received on-site verification, variances were noted in terms of the presence of some measures. However, in one case, eight buildings across three addresses were involved with the single project, with differences in what measures were installed in each unit (or not installed at all). As a result, the evaluation's field verification found dwelling units without measures but cannot confirm whether the measures should have been in place at the specific units, if the units were mislabeled, or how the QA procedure identified its quantifies. Focusing tracking efforts at a building level, even if a project covers multiple buildings even if with the same decision maker, would reduce the potential for sampling error, improve the accuracy of QA, provide better project transparency, and improve the value of the evaluation's on-site verification.

vi. **Consider applying an in-service rate adjustment to all direct install measures.** Issues such as breakage, removal, or documentation errors can lead to measure attrition and reduce actual savings. Lighting measures using the TRM calculations already include an assumed in-service rate adjustment; however, common area lighting measures and water conservation measures do not. The evaluation's on-site verification found specific units missing water aerator measures that were assigned savings and were part of the QA documentation (suggesting removal post-installation).

5.7 7610LICP AND 7612LICP LOW INCOME MULTIFAMILY COMPREHENSIVE EFFICIENCY IMPROVEMENTS

5.7.1 Track description

This initiative, launched near the end of February 2012, is designed to serve low-income multifamily housing—specifically, new construction, substantial renovation, and redevelopment housing. 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. Projects tracked under 7610LICP are generally focused on specific end uses, whereas the 7612LICP projects are comprehensive in nature and related to gut-rehab or new construction type projects.

A list of measures in this initiative include:

- Heating, ventilation, air conditioning (HVAC), and domestic hot water systems
- Major appliances, such as refrigerators and laundry equipment
- Lighting (in-unit and common area lighting)
- Building air and thermal barriers and other building shell measures.

The initiative works with developers and owners of low-income multifamily projects who are constructing, redeveloping, or rehabilitating affordable housing projects. The initiative provides custom technical services and incentives for energy efficiency improvements to low-income multifamily projects. To be eligible for participation, multifamily projects must meet the following criteria:

- Be located in the District of Columbia
- Be in the design or planning stage of a new construction or substantial rehabilitation development
- Be able to document that at least 66 percent of the residential units per building are designated for or inhabited by households with incomes at or below 60 percent of the Area Median Income
- Have substantial funding commitments in place.

Table 5-59 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects and FY2015 includes like-fuel interactive effects but excludes cross-cutting effects.

Table 5-59. Initiative Summary Metrics—7610LICP, 7612LICP

(Formerly Track 7620LICP)

Metric	FY2012	FY2013	FY2014	FY2015
Participants (Units=projects)	5	10	19	14
kWh savings, meter level	773,711	1,959,041	814,246	1,903,035
kW savings, meter level	99.4	184.3	109.4	266.6
MMBtu	1,139	6,200	20,981	1,909

Table 5-60 provides a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates for this evaluation year.

Table 5-60. FY2015 Reported and Verified Results—7610LICP

Metric	Reported	Verified	Realization Rate
kWh	638,491	539,624	0.85
kW	147.4	559.6	3.80
MMBtu	431	265	0.62
MMBtu (Excluding IE)	533	367	0.69

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-61. FY2015 Reported and Verified Results—7612LICP

Metric	Reported	Verified	Realization Rate
kWh	1,264,544	931,593	0.74
kW	119.2	138.5	1.16
MMBtu[1]	1,147	310	0.27
MMBtu (Excluding IE)[2]	1,376	598	0.43

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.7.2 Overall sampling methodology

The Low Income Multifamily Comprehensive initiative includes a wide variety of installed measure types. To sample between the two tracks in this initiative, the evaluation team combined the two LICP tracks, sampling with certainty the three highest saving projects and then randomly sampling two other projects. The result was that three projects were sampled from 7612LICP and two projects were sampled from 7610LICP.

Table 5-62. FY2015 Population and Sample Summary—7610LICP

Measure	Project File Evaluation Sample							
	N	$n_{project}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Building Shell	1	0	0	-	0.0	-	-	-
Cooling	5	1	4,649	0.6	0	1.3%	0.5%	-
Lighting	3	0	0	-	0	-	-	-
Motors & Drives	1	0	0	-	0	-	-	-
Refrigeration	2	0	0	-	0	-	-	-
Space Heating	3	1	2,664	-	116	100.0%	-	39.6%
Ventilation	1	0	0	-	0	-	-	-
Water Heating	4	1	0	-	118	-	-	49.3%

Table 5-63. FY2015 Population and Sample Summary—7612LICP

Measure	Project File Evaluation Sample							
	N	$n_{project}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Appliances	5	3	87,215	6.3	12.8	96.5%	94.8%	83.4%
Building Shell	4	3	27,506	0.2	56	87.0%	21.5%	100.0%
Cooling	5	3	273,786	51.0	0	77.9%	84.1%	-
Lighting	5	3	340,624	25.4	-161	65.7%	77.4%	70.2%
Other	1	0	0	-	0	-	-	-
Refrigeration	5	3	25,525	4.8	0	84.2%	88.9%	-
Space Heating	4	3	23,171	0.2	859	60.6%	100.0%	88.2%
Ventilation	3	3	26,067	4.4	167	100.0%	100.0%	100.0%
Water Heating	4	3	160,855	6.9	164	93.3%	93.2%	100.0%
Total	**36**	**24**	**964,749**	**99.2**	**1,098**	**76.3%**	**83.2%**	**95.7%**

5.7.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

5.7.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.7.5 Impact evaluation

The impact evaluation effort for this track included on-site measure installation verification and desk audits to verify KITT reports for measures and calculations. The desk audits and on-site verification helped to confirm whether the projects were supported by project file information, such as QA/QC reports, external calculators/calculation methods, CAT files, and applications or incentive agreements. Desk reviews also checked the accuracy of savings values and user inputs for measures to inform the on-site data collection plans and to identify any issues to be addressed.

A. Impact sampling methodology for on-site measurement and verification

The evaluation team attempted to schedule on-site verification with all five of the sampled 7610LICP and 7612LICP projects. Three were scheduled and completed. The evaluation team was unable to schedule the remaining two on-site verifications during the evaluation timeline. The evaluation team made no adjustments to savings based on the site visit but did use the site visit to inform recommendations.

B. Verification of impacts

For the desk review, the evaluation team reviewed the project file documents uploaded to Tetra Tech's Attunity MFT Web Client by the VEIC Evaluation group. In particular, the project files most critical and utilized for the evaluation were the CAT Excel files located in the "CAT Analysis" project folder as well as the custom calculators used for developing savings. In the CAT file, key data was most commonly found within the "Review" worksheet and compared to the KITT reported quantities of measure and savings by measure type. However, the CAT files also provided project descriptions as well as additional worksheets for particular measure types. The evaluation team also reviewed all external calculators and calculation methodologies referenced in the CAT file. Other critical files reviewed included the project application, spot-checks of equipment specifications, and other various project data and information available. The evaluation team was able to verify major measure inputs (e.g., space and DHW heating fuel types) from the CAT files. The two 7610 LICP projects included both space conditioning and water heating retrofits using custom assumptions and deemed or custom calculation methodologies. Most 7612 LICP projects included multiple end uses (e.g., lighting, heating, cooling, and appliances) and multiple custom calculation methodologies for each end-use. The desk reviews included a review of all reported measures, savings calculations, user input data, and/or TRM assumptions.

For the on-site verification, the evaluation team attempted to verify the installation of the measures listed in the KITT file. As the measures reviewed during the on-site verification were part of both in-unit and common area systems, the on-site verification team attempted to verify a mix of in-unit and common area measures. The on-site verification information was primarily used to inform the evaluation process in general and to confirm major algorithm inputs such as equipment capacity and efficiency, which were used to establish realization rates.

Table 5-64. FY2015 Summary of Impact Evaluation Results—7610LICP

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Building Shell	1,827	1,827	1.00	0.0	0.0	n/a	0	0	1.00	0	0	1.00
Cooling	371,250	272,382	0.73	123.8	536.0	4.33	0	0	n/a	0	0	n/a
Lighting	123,967	123,967	1.00	9.5	9.5	1.00	-102	-102	1.00	0	0	n/a
Motors & Drives	121,190	121,190	1.00	11.6	11.6	1.00	0	0	n/a	0	0	n/a
Refrigeration	9,826	9,826	1.00	2.1	2.1	1.00	0	0	n/a	0	0	n/a
Space Heating	2,664	2,664	1.00	0.0	0.0	n/a	293	132	0.45	293	132	0.45
Ventilation	1,866	1,866	1.00	0.2	0.2	1.00	0	0	n/a	0	0	n/a
Water Heating	5,902	5,902	1.00	0.2	0.2	1.00	239	234	0.98	239	234	0.98
Track Total	**638,491**	**539,624**	**0.85**	**147.4**	**559.6**	**3.80**	**431**	**265**	**0.62**	**533**	**367**	**0.69**
Relative Precision at 90% Confidence	n/a			n/a			n/a			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

Table 5-65. FY2015 Summary of Impact Evaluation Results—7612LICP

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Appliances	90,383	90,383	1.00	6.6	10.8	1.63	15	6	0.42	15	6	0.42
Building Shell	31,615	31,615	1.00	1.1	1.1	1.00	56	56	1.00	56	56	1.00
Cooling	351,655	169,464	0.48	60.7	71.2	1.17	0	0	1.00	0	0	1.00
Lighting	518,194	523,481	1.01	32.8	45.0	1.37	-229	-289	1.26	0	0	n/a
Other	5,784	5,784	1.00	0.7	0.7	1.00	0	0	1.00	0	0	1.00
Refrigeration	30,297	31,644	1.04	5.4	5.0	0.93	0	0	1.00	0	0	1.00
Space Heating	38,211	30,459	0.80	0.2	0.0	0.00	973	298	0.31	973	298	0.31
Ventilation	26,067	13,675	0.52	4.4	3.0	0.68	167	167	1.00	167	167	1.00
Water Heating	172,339	35,088	0.20	7.4	1.8	0.25	164	71	0.43	164	71	0.43
Track Total	**1,264,544**	**931,593**	**0.74**	**119.2**	**138.5**	**1.16**	**1,147**	**310**	**0.27**	**1,376**	**598**	**0.43**
Relative Precision at 90% Confidence[3]	2.39%			6.90%			189.1%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

C. Impact evaluation planned activities and completed activities comparison

Table 5-66. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Conduct desk audits	5	5	
Conduct on-site verification	4	3	The evaluation team was unable to schedule on-site verification with more than two participants during the evaluation timeline.

D. Summary of key findings describing adjustments to ex-ante savings

i. Cross-cutting

- All the CAT files reviewed during the evaluation matched the tracking data in the KITT for claimed savings values.
- The evaluation found that all external calculators were clearly stated within the CAT file and could be found within the file structure. However, not all calculation results could be traced between the external calculators and CAT file.
- For a number of external calculators, the complexity and lack of clarity regarding input assumptions or how some of the custom input assumptions were developed is a significant gap in terms of explaining savings.

ii. Lighting measures

- For 7612LICP lighting, the kWh realization rate is approximately 1.0 with a 1.37 realization rate for kW. Driving this result is that realization rates for kWh and kW are at 100 percent based on a review of the custom calculations for common area lighting. In the case of in-unit CFLs, there was variability in terms of the assumptions regarding space heating types and hours of use. In one case, the CFLs were serving units heated by heat pumps, implying the need to reduce savings based on the heating impact. In another case, the hours of use were less than the TRM assumed hours of use, increasing energy savings.

iii. Cooling measures

- Cooling measures (including heat pump heating savings) exhibited low realization rates. The evaluation team utilized the TRM formulae, finding that baseline assumptions may be outdated vis-à-vis federal standards and that for in-unit measures, the EFLH were higher than the TRM assumed EFLH. There was no substantiation of the DCSEU's EFLH assumptions that could be located other than in cases that used the TRM EFLH (for some common area measure assumptions). In the case of new construction or a gut rehab project, new equipment was likely to be installed and subject to minimum federal standards. In those cases, the evaluation team used federal efficiency standards in place between 2006 and 2015 as the baseline. In the case of one retrofit project, the evaluation team used the minimum federal standards in place prior to 2006, reflecting a purchase date prior to the 2006 standards.

- In general, kW savings for air-conditioner and heat pump measures were not well documented and experienced substantial swings in claimed kW realization rates. This measure is tracked under space cooling, the source of heat pump kW savings.

iv. Water heating measures:

- Many 7612LICP water heating measures had low realization rates. For one 7612LICP project, DCSEU calculation failed to account for a solar water heater project also installed through DCSEU initiatives. In the case of low-flow showerheads and faucets, the custom savings calculation method and resulting savings were substantially higher than their TRM corollaries and lacked documentation on the specific number of each water conservation measure being installed. The evaluated results are based on the TRM savings for these measures.

v. Building shell measures:

- Realization rates for kWh, kW, and MMBtu are at 100 percent, although they were a minor portion of project energy savings.

vi. Space heating measures:

- Realization rates for kWh and MMBtu were highly variable, though often low. Baseline equipment assumptions and different EFLH assumptions led to substantial differences in the evaluated savings, which used project equipment specifications but general TRM formulae. For many of these measures, DCSEU did not explain the logic of the underlying assumptions in project documentation or why specific calculation methods were used. The substantial deviation from the TRM suggests caution in how custom calculations are developed and used.

- One site developed savings for three small natural gas furnaces that presented very high natural gas savings per furnace, with savings approaching the annual fuel use that the furnaces were likely to use to meet heat loads. Each furnace was rated at 80,000 BTUh, and using the TRM formula resulted in a heat load of 81 MMBTU per furnace. DCSEU showed savings of 117 MMBTU per furnace, well in excess of even the underlying heat load.

vii. Appliance measures, including refrigeration:

- In all cases, DCSEU calculated savings based on ENERGY STAR® calculators and not the TRM. The evaluation team accepted the evaluation kWh calculations from these calculators, as they reflect the specific equipment being installed. Refrigerator savings were nearly in alignment with the TRM savings, although in-unit clothes washers were not. The calculators did not present the kW calculations. Additionally, the presence of the solar thermal project detracted from clothes washer savings for the project affected by the solar thermal installation.

viii. Ventilation

- In general, realization rates for individual 7612LICP ventilation projects were 100 percent for kWh and kW. However, two projects exhibited lower ventilation savings—in one case due to baseline efficiency assumptions and in another case by utilizing the

DCSEU ERV calculator but adjusting the cooling system EER to reflect specifications of the air conditioners installed by the project and changing the space type being ventilated (to reflect the project description), reducing the amount of ventilation required. In one case, DCSEU identified a ventilation project claimed for savings in KITT that was not installed (resulting in zero evaluated savings).

5.7.6 Recommendations

A. To improve impact evaluation results

i. **Provide an explanation when calculations or key inputs deviate from standards.** Some measures were found to be without a reference or explanation for the use of custom values. In most cases, using the TRM assumptions and calculation methods would reduce initiative risk. However, where custom calculations are necessary, provide clear documentation in the calculation tool regarding the underlying calculation logic. Many of the custom calculator tools were extremely complex, particularly for heating and cooling calculations, making it impossible for the evaluation team to validate the assumptions or calculations without a substantial investment of time. That the TRM calculations are relatively straight forward suggests an opportunity to simplify even the custom calculations and only rely on (and document) complex analyses when absolutely necessary. When measure level savings deviate significantly from TRM assumptions, those deviations should be noted, used as a point for the initiative to validate the input assumptions and results, and then corrected or accepted (accepted with clear documentation on *why* the deviations exist).

ii. **Utilize the TRM savings for in-unit measures.** The primary concern is with water conservation measures. There was an apparent disconnect between the savings assumptions, number of fixtures, and TRM savings. At the least, specify precise numbers of each type of water conservation measure. If using custom calculations, present the underlying logic and reason for deviating from the TRM assumptions, but consider using the underlying TRM formulae. Consider applying an in-service rate to the water conservation measures as is done in the TRM for in-unit CFL measures, reflecting the potential for breakage or removal.

iii. **When creating project documentation, such as the CAT spreadsheets, make all information accessible to the evaluation team.** As with past years, the CAT files have unknown macros, hard coded data, and many obscure references. Simplifying or creating a general project roll-up document within or outside the CAT file that presents all key input assumptions would improve the process and potentially catch errors.

iv. **Avoid hard coding of savings values so that algorithms can be easily determined.** As discussed above, the CAT Excel file contained hard-coded savings values, whereas the rest of the worksheets retained the formulas used to generate savings. This resulted in an inability to verify some of the savings claimed in KITT through recreation of savings algorithms. Although this finding was not as frequent as last year, it did limit the evaluation efforts for some projects. As the projects in this track are custom, transparency of the methodology and critical inputs are necessary for fully evaluating the track.

v. **When working with a customer installing solar thermal projects, ensure that any efficiency projects capture the effect of the solar thermal project.** One of the 7612LICP projects saw substantial reductions in evaluated savings due to the presence of the solar thermal project. Ideally, the projects should be analyzed as a unitary whole with solar thermal project assumptions aligned with water conservation or other efficiency assumptions.

vi. **Review baseline assumptions used for each project to ensure consistency with federal minimum standards, effective remaining useful life, and cost-effectiveness considerations (such as incremental cost).** In one project, the evaluation team found end-of-life assumptions used to justify incremental costs but with

old federal standards used to present the baseline. As a default, particularly for new construction or major rehab projects, federal standards active at the time of equipment purchase should be assumed absent justification of why the old equipment would have otherwise been retained. Federal standards changes are known years in advance, with the DCSEU able to integrate changes into their calculation workbooks based on project timing.

5.8 7710APPL RETAIL EFFICIENT APPLIANCES

5.8.1 Track description

In January 2013, the DCSEU began offering mail-in rebates for qualifying energy efficient ENERGY STAR® refrigerators and clothes washers. Starting July 1, 2013, additional rebates were offered for natural gas water heaters, furnaces, and boilers. The DCSEU has partnered with local retailers and contractors to promote these rebates, including providing rebate forms in retail stores where possible. These stores include 5 within Washington, DC, and 19 in Maryland. Stores outside of the DC are included because of the relatively small number of stores that sell appliances within the DC and the proximity of the surrounding stores. The rebates are processed by EFI.

Rebated measures included in this track along with the rebate amounts for FY2014 and FY2015 are included in Table 5-67.

Table 5-67. Program Measures and Rebate Amounts FY2104 and FY2015

Measures	FY2014 Rebates	FY2015 Rebates
Refrigerators (ENERGY STAR)	$50 to $75 based on efficiency level	
Dehumidifiers	$25	
Clothes Washers (ENERGY STAR)	$50 to $75 based on efficiency level	
Dryers	N/A	
Furnaces	$500 to $800	
Boilers (ENERGY STAR)	flat $500	
Storage Water Heaters (ENERGY STAR)	$100 to $150	
Programmable Thermostats	$25	
Central AC Units & Ductless Mini-split AC Systems	$150 to $500	
Tankless Water Heaters	$300 to $500	

In FY2013, the DCSEU realized that the majority of appliances sold at the District of Columbia appliance retailers were ENERGY STAR qualified. In an effort to encourage customers to purchase the most energy efficient appliances, in FY2014 the DCSEU changed the appliance rebates (where appropriate) to tiered rebate amounts based on efficiency level of the equipment. That approach remained in place in FY2015.

Table 5-68 provides a summary of initiative metrics since inception.

Table 5-68. Initiative Summary Metrics—7710APPL

Metric	FY2012	FY2013	FY2014	FY2015
Participants (Units=rebates)	n/a	875	912	825
kWh savings, meter level	n/a	99,569	104,221	109,084
kW savings, meter level	n/a	14.3	19.6	39.2
MMBtu savings	n/a	162	1,125	1,153

Table 5-69. FY2015 Reported and Verified Results—7710APPL

Metric	Reported	Verified	Realization Rate
kWh	109,084	125,052	1.15
kW	39.2	44.0	1.12
MMBtu[1]	1,153	1,115	0.97

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

5.8.2 Overall sampling methodology

The Retail Efficient Appliances initiative includes several types of measures, which were grouped into the following end-uses for sampling purposes. Some of these measures are simply purchased from a retailer, while others require contractor installation. The evaluation team randomly sampled an equal number of measures of each type.

Table 5-70. FY2015 Population and Sample Summary—7710APPL

Measure	Project File Evaluation Sample							
	$N_{measure}$	$n_{measure}$	kWh_n	kW_n	$MMBtu_n$	% kWh	% kW	% MMBtu
Clothes Washers	364	14	1,744	0.2	7	3.9%	3.9%	4.4%
Cooling[27]	166	14	4,172	2.8	0	7.6%	8.6%	-
Refrigeration	132	14	856	0.1	0	10.7%	10.7%	-
Space Heating[28]	139	14	0	0.0	87	-	-	9.2%
Water Heating	24	14	1,402	0	35	100.0%	100.0%	57.7%
Total	**825**	**70**	**8,174**	**3.3**	**129**	**7.5%**	**8.4%**	**11.2%**

5.8.3 Process evaluation

A process evaluation was not conducted on this initiative for FY2015.

[27] Central AC Units, Ductless Mini-split AC Systems, and dehumidifiers were grouped into this end-use for sampling purposes.
[28] Furnaces, boilers, and thermostats were grouped into this end-use for sampling purposes.

5.8.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.8.5 Impact evaluation

The evaluation team reviewed updates to TRM measure characterizations in FY2015. This included new measures as well as updates to existing measures, and the review addressed savings algorithms and the associated inputs and assumptions such as baseline characterization and measure life.

The evaluation team conducted a tracking system review of all fully-deemed measures rebated by the appliance track, as well as a review of a sample of rebate applications to verify tracked quantities and efficiency levels. We conducted more extensive project file reviews (desk reviews) for measures whose savings are calculated rather than deemed.

A. Impact sampling methodology for on-site measurement and verification

On-site verification was not conducted.

B. Verification of impacts

The tracking system review of fully-deemed savings measures found no discrepancies. The evaluation team identified recurring issues with partially-deemed space heating and cooling measures.

The TRM entries for both furnaces and boilers include unit capacity as an input to the savings calculations. Neither case specifically states whether this is the input or output (heating) capacity of the unit. On review of the formula, it appears that it should be output capacity since the TRM formula calculates input capacity for the baseline and efficient units as follows:

$$BTUh_{input\text{-}b} = BTUh / AFUE_{BASE}$$

A much smaller issue arose this year for boilers and furnaces that was not identified in previous years. During verification, the evaluation team calculated savings using both input and output capacity and some rebated measures did not match the tracked savings using either capacity. We discovered that by rounding the AFUE to have no decimals, we were able to reproduce the tracked savings. This is a smaller impact than the issue noted above, but in cases where the AFUE is rounded down, the tracked savings are up to 4 percent lower than what they would be using the full AFUE.

The evaluation team reviewed project files for four boiler rebates. In all four cases, it appears that the savings were calculated using the input capacity instead of the output capacity. Two of the four rebates rounded the efficiency to a whole number. Realization rates for boilers range from 90 percent to 96 percent depending on the capacity and efficiency of the boiler. The overall realization rate for boilers is 94 percent when adjusting for both of the issues noted above. For the one furnace measure reviewed by the evaluation team, neither input nor output capacities produced the tracked savings; this measure had a 94 percent realization rate.

For air conditioners and heat pumps, the TRM states that deemed savings will be used if unit capacity and efficiency levels are not available. However, the deemed savings values were used for heat pumps and air conditioners despite all applications being submitted with detailed capacity and efficiency information. Calculating savings using the TRM algorithm and incorporating actual measure capacity and efficiency produces individual measure realization rates ranging from 67 percent to 229 percent. The average realization rate for air conditioners and heat pumps was 129 percent for energy and 114 percent for demand.

Table 5-71. FY2015 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu[1]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Clothes Washers	45,045	45,045	1.00	5.2	5.2	1.01	153	153	1.00
Cooling	54,610	70,578	1.29	32.9	37.7	1.14	0	0	1.00
Refrigeration	8,027	8,027	1.00	1.0	1.0	1.00	0	0	1.00
Space Heating	0	0	1.00	0.0	0.0	1.00	938	901	0.96
Water Heating	1,402	1,402	1.00	0.2	0.2	1.00	61	61	1.00
Track Total	**109,084**	**125,052**	**1.15**	**39.2**	**44.0**	**1.12**	**1,153**	**1,115**	**0.97**
Relative Precision at 90% Confidence[2]	2.7%			13.8%			1.1%		

[1] Because there were no savings associated with lighting for this initiative, MMBtu results are not split out by inclusion and exclusion of interactive effects as in other reports.

[2] We are working on correcting these calculations and will provide revised tables once the calculation is corrected.

C. Impact evaluation planned activities and completed activities comparison

Table 5-72. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Desk reviews	70	70	

D. Summary of key findings describing adjustments to ex-ante savings

- Some space heating equipment used the input capacity in the savings calculation when the output capacity should be used.
- Rounding AFUE for heating equipment understates individual measure savings by up to 4 percent.
- Despite having all of the necessary inputs to the savings algorithms, air conditioning and heat pump measures applied a deemed savings value from the TRM.

5.8.6 Recommendations

A. To improve impact evaluation results

Recommendations i-iii below were presented in FY2014 and are still pending implementation.

i. **Use TRM algorithms and actual measure characteristics when all of the required information is collected.** Currently the program tracks deemed savings based on default size and efficiency. Using actual measure size and efficiency enhances accuracy by representing the actual equipment installed by the DCSEU, rather than averages from other sources.

ii. **Collect AHRI certificates for all applicable types of equipment.** Currently, the DCSEU requires AHRI certificates for air conditioning measures, but they are also relevant to furnaces, boilers, heat pumps, and water heaters. This can help avoid confusion with illegible or incorrect model numbers and increase the completeness and accuracy of data used to calculate savings.

iii. **Update the TRM and tracking system to use output capacity for furnace and boiler measures.** The TRM does not specify input or output capacity, and this distinction is important since the savings formula assumes output capacity.

iv. **Increase precision of inputs to savings formulas such as AFUE and SEER.** This issue was identified while evaluating boilers, but because of recommendation A-i above the EM&V team is unable to identify if it affects air conditioners as well.

5.9 7710FBNK EFFICIENT PRODUCTS AT FOOD BANKS INITIATIVE

5.9.1 Track description

The Food Bank Energy Efficient Lighting Distribution initiative supplies light-emitting diodes (LEDs) to low-income households in the District of Columbia area that receive goods from participating food banks. The DCSEU provided up to 12 LEDs per household after verifying that the household is located in the DC area and conducted a short survey with the client to determine the appropriate number of bulbs needed.

The initiative began in FY2012 as a free CFL lighting giveaway held at local food banks in different wards of DC. Participating food banks were allowed to give out up to 12 CFLs per household after verifying that the household is located in the District and falls within the initiative's income requirements. If the household was eligible, the food bank asked a series of questions to determine how many CFLs should be distributed based on their household needs.

In FY2013, the initiative stopped distributing free lighting at the various food banks and instead worked solely with Bread for the City. The plan was for Bread for the City to be the sole distributor of the initiative, but they encountered issues where they were not able to distribute as many bulbs as anticipated. Therefore, the Covenant Baptist Church and the DC Housing Authority were added to the initiative to help reach initiative goals. The DCSEU staff were always in attendance for events at these locations.

During FY2014, the DCSEU held events at food banks located in all wards in the District with the exception of Ward 3. During FY2015, the initiative switched to distributing only LED bulbs and held events at 15 food banks or community outreach events.

Table 5-73 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects and FY2015 include like-fuel interactive effects but excludes cross-fuel interactive effects.

Table 5-73. Initiative Summary Metrics—7710FBNK

Metric	FY2012	FY2013	FY2014	FY2015
CFL units (units=bulbs)	42,954	49,581	2,584	0
LED units (units=bulbs)	0	0	16,754	6,374
kWh savings, meter level	2,392,132	2,416,513	736,100	264,521
kW savings, meter level	281.7	269.6	79.1	24.5

Table 5-74 provides a summary of the reported and verified kWh, kW, and MMBtu along with the resulting realization rates for FY2015.

Table 5-74. FY2015 Reported and Verified Results—7710FBNK

Metric	Reported	Verified	Realization Rate
kWh	264,521	264,031	1.00
kW	24.5	24.5	1.00

MMBtu	-446	-446	1.00
MMBtu (Excluding IE)	0	0	n/a

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.9.2 Overall sampling methodology

These tracks were not sampled by participant or project, as these initiatives do not collect data at the customer level. Instead, the evaluation team reviewed all measures tracked in the database, since the initiative relies entirely on deemed savings.

5.9.3 Process evaluation

A process evaluation was not conducted for this initiative in FY2015.

5.9.4 Net-to-gross

Net-to-gross rates were not calculated in FY2015.

5.9.5 Impact evaluation

The impact evaluation involved reviewing tracking data and supporting invoices. There were no differences identified between tracked and evaluated savings.

A. Impact sampling methodology for on-site measurement and verification

On-site verification of measure installation was not conducted. The evaluation team attended two food bank distribution events and reviewed participant screening and data tracking procedures with the DCSEU staff.

B. Verification of impacts

The evaluation team verified impacts for the retail lighting initiative by comparing tracked savings to deemed savings established in the DCSEU TRM. In addition, we reviewed tracked quantities in conjunction with reported quantities directly from the DCSEU purchasing records. The purchasing records allowed the EM&V team to verify the bulb models to confirm that the correct TRM entry was used, but these records do not reflect actual quantities of bulbs distributed. Instead, DCSEU maintains a tracking spreadsheet of the customers who receive bulbs at each event. This spreadsheet serves as documentation of bulb distribution.

Table 5-75. FY2015 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu			MMBtu (Excluding IE)		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
ENERGY STAR Screw Base LED	264,521	264,031	1.00	24.5	24.5	1.00	-446.2	-446.2	1.00	0.0	0.0	0.00
Track Total	**264,521**	**264,031**	**1.00**	**24.5**	**24.5**	**1.00**	**-446.2**	**-446.2**	**1.00**	**0.0**	**0.0**	**n/a**
Relative Precision	0.0%			0.0%			0.0%			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

[3]We are working on correcting these calculations and will provide revised tables once the calculation is corrected.

C. Impact evaluation planned activities and completed activities comparison

Table 5-76. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Review report files	6	5	DCSEU only had 4 invoices for FY2015 as well as the tracking spreadsheet

D. Summary of key findings describing adjustments to ex-ante savings

- There were no adjustments made to ex-ante savings.

5.9.6 Recommendations

A. To improve impact evaluation results

Reported savings were accurate; therefore, the evaluation team has no recommendations for this initiative.

5.10 7710LITE ENERGY EFFICIENT PRODUCTS

This section presents the evaluation findings for the Energy Efficient Products Retail Lighting track. The section provides a brief description of the initiative followed by process and impact evaluation results and recommendations for future initiative operation.

5.10.1 Track description

The Retail Efficient Lighting initiative works with retailers and manufacturers to lower prices on CFLs and LEDs in the District of Columbia. LED bulbs are not as familiar to residents and are less commonly used than incandescent or CFL equivalents. The DCSEU initiative provides educational material to increase awareness of different types of efficient light bulbs and works with participating retailers and manufacturers to increase availability of the LED bulbs.

The Retail Efficient Lighting initiative targets lighting manufacturers and retailers to reach residents and small businesses. The manufacturers and retailers are provided incentives on a per-bulb basis. The initiative is implemented by DCSEU with Energy Federation Incorporated (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.

Table 5-77 provides a summary of initiative metrics since inception as reported by DCSEU. FY2012 and FY2013 reported results include the interactive effects for the installation of energy efficient lighting. FY2014 excludes these effects. FY2015 includes like-fuel interactive effects but excludes cross-fuel interactive effects.

Table 5-77. Initiative Summary Metrics—7710LITE

Metric	FY2012	FY2013	FY2014	FY2015
CFL units (units=bulbs)	43,454	218,621	321,007	183,890
LED units (units=bulbs)	0	6,336	92,255	113,687
kWh savings, meter level	2,725,914	12,699,881	21,113,004	17,590,664
kW savings, meter level	401.4	1,895.3	3,259.3	2,045

The DCSEU is successfully moving to greater sales of LED lighting. CFL bulbs are still the larger component; however, sales for LED bulbs rose by over 1,600 percent from FY2013 to FY2014 and around 23 percent from FY2014 to FY2015. CFL incentives decreased by 43 percent from FY2014 to FY2015, reflecting the initiative's goal to transition from CFLs to LEDs.

Table 5-78 provides a summary of the reported and verified kWh and kW, along with the resulting realization rates.

Table 5-78. FY2015 Reported and Verified Results—7710LITE

Metric	Reported	Verified	Realization Rate
kWh	17,590,664	17,591,167	1.00
kW	2,045.0	2,148.4	1.05
MMBtu[1]	-22,071	-22,092	1.00
MMBtu (Excluding IE)[2]	0	0	n/a

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

5.10.2 Overall sampling methodology

These tracks are not sampled by participant or project, as these initiatives do not collect data at the customer level. Instead, Tetra Tech randomly sampled a small number of monthly reports to verify against the tracking data. These monthly reports submitted by the manufactures to EFI include retailer point-of-sale reports as well as manufacturer rebate invoices, and provide a basic level of documentation that the bulbs are reaching end-use customers. Process evaluation

A process evaluation was not conducted for this initiative for FY2015.

5.10.3 Net-to-gross methodology and results

Net-to-gross rates were not calculated in FY2015.

5.10.4 Impact evaluation

The impact evaluation involved reviewing tracking data, sales reports from EFI, and invoices from manufacturers. The evaluation team verified that the correct TRM algorithms were applied to the tracked measures. Overall, the impacts claimed by the initiative were evaluated to be quite accurate. Minimal issues were identified and these issues did not significantly affect claimed savings. The evaluation team also reviewed relevant lighting measure TRM updates during FY2015.

A. Verification of impacts

Commercial Standard CFL demand impacts did not align with the TRM. The demand (kW) realization rate for this specific measure was 125 percent. Since the coincidence factor for commercial bulbs is high and therefore peak demand reduction for commercial bulbs is high, this results in a 105 percent overall realization rate despite being a small proportion of the bulbs sold.

There were minor fluctuations in the MMBtu penalties by measure, but overall the initiative came out to a 100 percent realization rate.

Table 5-79. FY2015 Summary of Impact Evaluation Results

Measure	kWh			kW			MMBtu[1]			MMBtu (Excluding IE)[2]		
	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR	Ex-ante Gross	Ex-post Gross	RR
Compact fluorescent screw-base bulb	9,170,842	9,170,842	1.00	1,025.1	1,128.6	1.10	-11,523.7	-11,796.9	1.02	0.0	0.0	n/a
ENERGY STAR Integrated Screw Based SSL (LED) Lamps	6,181,771	6,181,771	1.00	759.7	759.7	1.00	-7,927.9	-7,502.0	0.95	0.0	0.0	n/a
LED - Solid State Recessed Downlight	1,395,428	1,395,975	1.00	166.8	166.7	1.00	-1,616.0	-1,751.4	1.08	0.0	0.0	n/a
LED Lighting Fixture	120,776	120,776	1.00	9.5	9.5	1.00	-97.1	-107.7	1.11	0.0	0.0	n/a
Specialty Bulb	721,846	721,802	1.00	83.9	83.9	1.00	-906.6	-933.9	1.03	0.0	0.0	n/a
Track Total	**17,590,664**	**17,591,167**	**1.00**	**2,045.0**	**2,148.4**	**1.05**	**-22,071.3**	**-22,091.9**	**1.00**	**0.0**	**0.0**	**n/a**
Relative Precision	n/a			n/a			n/a			n/a		

[1]These savings numbers include all interactive effects.

[2]These savings numbers are comparable to that reported by the DCSEU and reflect DOEE's FY2015 policy to include like-fuel effects in the calculations while eliminating the cross-fuel interactive effects. These savings will be reflected in the "FY2015 Annual Evaluation Report for the Performance Benchmarks".

B. Impact evaluation planned activities and completed activities comparison

Table 5-80. FY2015 Impact Evaluation Plan vs. Actual

Activity	Plan	Actual	Explanation for Variance
Report reviews	6	6	

C. Summary of key findings describing adjustments to ex-ante savings

- Commercial standard CFLs did not apply the correct peak demand savings.

5.10.5 Recommendations

A. To improve impact evaluation results

i. Review deemed savings by measure type to ensure that the correct savings values are being applied.

ii. The DCSEU should maintain a record of product attributes, such as the entries from the ENERGY STAR-qualified products list, for all products sold through the initiative.