Performance Benchmark Assessment of FY2018 DC Sustainable Energy Utility Programs

FINAL

June 25, 2019

SUBMITTED TO:
District of Columbia Department of Energy and Environment

SUBMITTED BY:
NMR Group, Inc.
Ecometric Consulting
Demand Side Analytics
Blue Path Labs
Setty and Associates

Table of Contents

Key Highlights

This report presents the results of an independent assessment of the performance of the District of Columbia Sustainable Energy Utility (DCSEU) energy programs against established benchmarks for Fiscal Year 2018 (FY2018). In FY2018, the DCSEU achieved the minimum target for the first five benchmarks and achieved the maximum target for three of the five benchmarks with maximum targets (Table 1). However, after the second year of the contract, the DCSEU is behind pace on the five-year external funds cumulative benchmark assuming equal progress is intended each year.

Table 1: FY2018 Performance Benchmarks Summary

Benchmark Type	Benchmark		Minimum Target	Maximum Target
Annual Cumulative Target	1. Reduce Electricity Consumption		✓	✓
	2. Reduce Natural Gas Consumption		✓	✓
	3. Increase Renewable Energy Generating Capacity		✓	✓
Annual Target	4. Improve Energy Efficiency of Low-income Properties	a. Expenditures	✓	*n/a*
		b. Savings	✓	X
	5. Increase Green-collar Jobs		✓	X
Five-year Cumulative Target	6. Leverage External Funds		28%	14%

The cost of first-year energy savings for DCSEU energy efficiency programs declined from FY2017 to FY2018, though the cost for renewable energy savings increased slightly. In addition, the cost of first-year energy savings for the DCSEU in FY2018 is less than that of nearby PECO Energy, Baltimore Gas & Electric, and Philadelphia Gas Works. This indicates that the DCSEU is delivering programs at a cost that is better than neighboring utilities although there may be other factors in these jurisdictions that affect both costs and savings. Lastly, cost-effectiveness testing found that the DCSEU portfolio was cost-effective as a whole, although the Low-income Emergency Equipment Replacement program was not cost-effective.

Executive Summary

NMR Group, EcoMetric Consulting, Demand Side Analytics, BluePath Labs, and Setty – collectively referred to as *the NMR team* – were contracted by the District of Columbia Department of Energy and Environment (DOEE) to evaluate the energy-efficiency and renewable energy programs implemented by the District of Columbia Sustainable Energy Utility. This report presents the results of our independent assessment of the DCSEU's Fiscal Year 2018 programs, including performance against established benchmarks. The DCSEU FY2018 programs began on October 1, 2017 and ended on September 30, 2018.

Unlike the previous DCSEU contract, which involved a series of one-year renewals, the current DCSEU contract has a five-year base period, with an option to extend for an additional five years. The DCSEU officially began working under this new multiyear contract in April 2017. The DCSEU's performance against established benchmark targets is based on all results attained against performance benchmarks under Option Year 6 of Contract No. DDOE-2010-SEU-001 combined with FY2018 results achieved under the new multiyear contract.

For more details on our evaluation methodology and findings for each of the DCSEU residential and commercial programs selected for evaluation in FY2018, please review the *Evaluation of DC Sustainable Energy Utility FY2018 Programs* report. In addition, Appendix A provides descriptions for each of the program tracks offered by the DCSEU in FY2018.

PERFORMANCE BENCHMARK AND TRACKING GOALS ASSESSMENT

The DCSEU contract specifies performance benchmarks related to energy savings, renewable energy generation capacity, expenditures, leveraging funds, and job creation that the DCSEU is responsible for achieving, as outlined in Table 2. Three of the benchmarks provide performance incentives associated with meeting or exceeding the minimum performance targets on an annual basis and cumulative basis, while the leveraging external funds benchmark provides an incentive at the end of the five-year contract period. Additionally, the low-income and green jobs benchmarks only provide incentives for meeting or exceeding the targets on an annual basis. Likewise, penalties will be assessed on an annual basis if the DCSEU fails to achieve the minimum targets for the low-income and green jobs benchmarks, while penalties for the electric, gas, renewable energy, and leveraging funds benchmarks will be assessed at the end of the five-year contract period if the DCSEU fails to achieve the cumulative minimum targets.

In FY2018, the DCSEU achieved the minimum target for each of the first five benchmarks (Table 2). In addition, the DCSEU achieved the maximum target for three of the five benchmarks with maximum targets. However, after the second year of the contract, the DCSEU is behind pace on the five-year external funds cumulative benchmark for both the minimum (28%) and maximum targets (14%), which should be near 40% assuming constant 20% progress is made each year.

Table 2: FY2018 Performance Benchmarks Summary

Benchmark Type	Benchmark		Verified Results	Minimum Benchmark		Maximum Benchmark	
				Target	Achieved	Target	Achieved
Annual Cumulative Target	1. Reduce Electricity Consumption (MWh)		227,414	121,756	✓	172,945	✓
	2. Reduce Natural Gas Consumption (Therms)		4,235,994	2,250,770	✓	3,410,258	✓
	3. Increase Renewable Energy Generating Capacity (kW)		4,080	1,380	✓	2,000	✓
Annual Target	4. Improve Energy Efficiency of Low-income Properties	a. Expenditures	$4,130,208	$3,900,168	✓	*n/a*	*n/a*
		b. Savings (MMbtu)	44,916	23,278	✓	46,556	X
	5. Increase Green-collar Jobs		86.5	66	✓	88	X
Five-year Cumulative Target	6. Leverage External Funds		$707,992	$2.5M	28%	$5.0M	14%

Figure 1 illustrates the percentage progress towards each of the first five benchmarks. The DCSEU exceeded the first four minimum targets by a substantial degree – ranging from 187% for gas savings to 296% for renewable energy capacity. While the DCSEU achieved the minimum targets for the low-income expenditure and the green jobs benchmarks, they did so to a lesser degree – with achievements of 106% and 131%, respectively.

In addition, the DCSEU exceeded the maximum target for each of the first three benchmarks – with achievements of 131% for electric savings, 124% for gas savings, and 204% for renewable energy capacity. However, the DCSEU fell just short of the maximum target for both the low-income savings (96%) and green jobs (98%) benchmarks.

Figure 1: FY2018 Achievement of Annual Performance Benchmarks

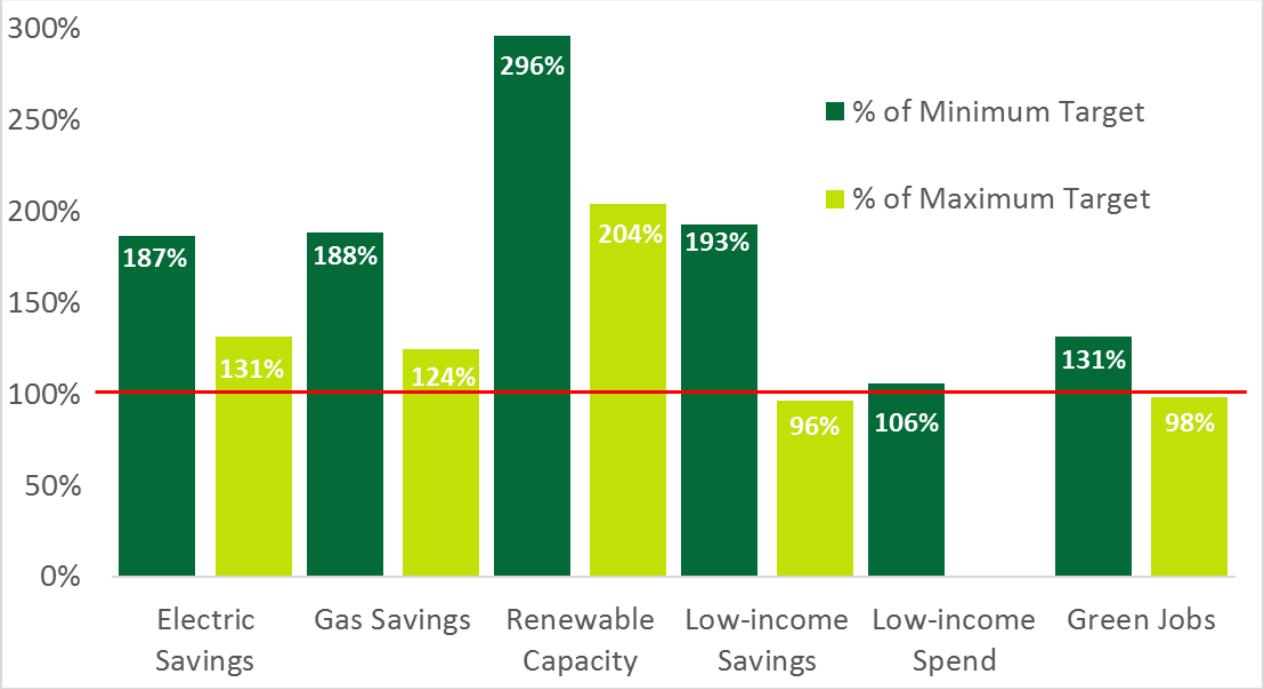

Figure 2 displays progress towards the five-year cumulative performance benchmarks with a red line shown at the 40% level to illustrate the second year goal assuming constant linear progress.[1] At about 50%, the DCSEU is ahead of pace on the minimum benchmarks for electric and gas savings and on pace for the maximum benchmarks. At 94%, the DCSEU has almost achieved the minimum five-year target for renewable capacity and is well ahead on the maximum target (82%). As described earlier, the DCSEU is behind pace for both the minimum (28%) and maximum (14%) targets for leveraging external funds.

Figure 2: Progress towards Five-Year Cumulative Performance Benchmarks

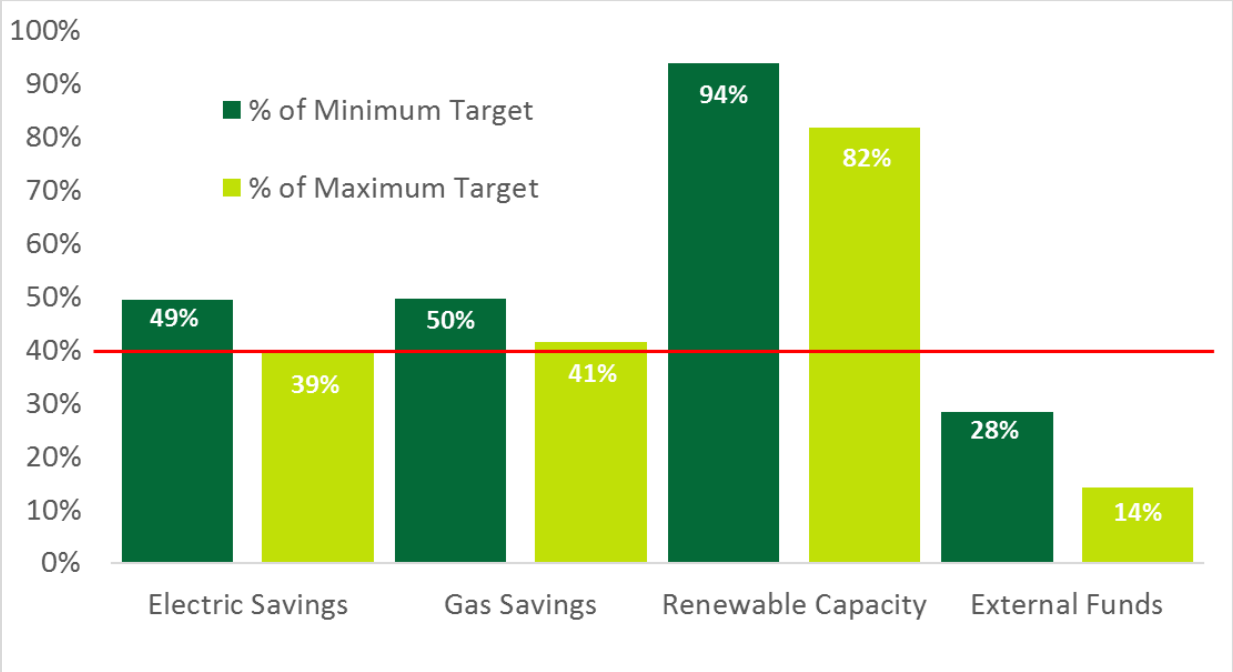

Table 3 displays the DCSEU's progress towards its two tracking goals. The DCSEU achieved 21,406 kW of summer peak demand savings, which represents nearly 1% of District peak demand usage in 2018. In addition, DCSEU completed 127 projects with large energy users in FY2018.

Table 3: FY2018 Progress Towards Tracking Goals

Tracking Goal	Evaluated Number
Reduce Growth in Peak Demand (kW)	21,406
Reduce Growth in Energy Demand of Largest Energy Users	127

The FY2017 and FY2018 DCSEU programs are estimated to have saved a combined 94,677 metric tons of annual CO2 emissions. The FY2018 avoided emissions of 52,040 metric tons represents 0.7% of the estimated District-wide emissions of 7,552,734 metric tons in 2016. In

[1] The electricity savings and gas savings benchmarks generally have larger incremental annual savings goals during the latter years of the five-year contract.

addition, the FY2017 and FY2018 DCSEU programs are projected to yield 2,617,897 MWh in lifetime electricity savings and 37,156,011 therms in lifetime natural gas savings over the full life of the measures.

COST-EFFECTIVENESS ASSESSMENT

The NMR team calculated the costs of saved energy and conducted cost-effectiveness testing for the DCSEU's FY2018 programs.

Costs of Saved Energy

To inform future planning of budgets and savings goals, we calculated the DCSEU's cost of acquiring the FY2018 verified energy savings. The cost of gross and modified gross first-year electricity savings, excluding the DCSEU's renewables programs, was $123 per megawatt hour ($123/MWh) and $114/MWh, respectively (Table 4). In addition, we calculated that the DCSEU's cost for gross and modified gross electricity savings from renewables programs was $240/MWh and $193/MWh, respectively. For natural gas savings, the DCSEU's cost of gross and modified gross savings, excluding renewables programs, was $2.30/therm and $1.75/therm, respectively.

Modified gross electricity savings exceed gross electricity savings due to adjustments for line losses, as well as for spillover from renewable energy projects (see Section 1.1.1 for more detail). In addition, modified gross natural gas savings exceed gross natural gas savings due to the exclusion of cross-fuel interactive effects (see Section 1.1.2 for more detail).

Table 4: DCSEU FY2018 Cost of First-Year Energy Savings

Fuel Savings Type	Cost per Unit of Saved Energy	
	Gross	Modified Gross
Electric savings excluding renewables	$123/MWh	$114/MWh
Electric savings from renewables only	$240/MWh	$193/MWh
Gas savings excluding renewables	$2.30/therm	$1.75/therm

The DCSEU's cost for gross energy savings across the entire portfolio declined by 23% from $42/MMBtu in FY2017 to $33/MMBtu in FY2018. While the cost of gross savings for both electric (from $162/MWh) and gas (from $3.19/therm) energy-efficiency programs also declined, the cost for gross electricity savings from renewables programs rose slightly from $236/MWh in FY2017.

At $123/MWh, the DCSEU's cost for gross electricity savings in FY2018 is less than the cost for PECO Energy ($147/MWh) from June 2017 to May 2018 and substantially less than the cost for Baltimore Gas & Electric ($232/MWh) from 2017. In addition, the DCSEU's FY2018 cost for gross gas savings ($2.30/therm) is less than one-half the cost for Philadelphia Gas Works ($6.25/therm) from Sept. 2017 to Aug. 2018. While these comparisons are useful, it is important to understand that these jurisdictions have different markets, savings goals, regulatory requirements, cost-effectiveness tests, program maturity, and delivery systems, which may affect both costs and savings.

Cost-effectiveness Testing

The NMR Team conducted a benefit-cost analysis of the DCSEU's FY2018 offerings at the program and portfolio level using a Societal Cost Test (SCT). The SCT examines cost-effectiveness from the perspective of the utility, program participants, and non-participants. The model inputs were taken largely from DCSEU tracking data, which were then adjusted using the results of the FY2018 evaluation. The mechanics of the DCSEU tracking database are well-organized to facilitate benefit cost modeling and their application was well-documented. However, several of the financial assumptions used to monetize program impacts were outdated as the primary analysis used to develop the forecast is almost five years old. Therefore, four scenarios were considered for the FY2018 benefit-cost analysis:

- **Modified Replica**: This scenario replicated the DCSEU cost-effectiveness calculations to ensure that our model returned comparable results to the DCSEU model. Once we confirmed that our model produced similar results with the same data, we implemented some corrections to inputs and formulas.
- **Updated Avoided Costs**: This scenario incorporated an updated avoided cost forecast to monetize program benefits.
- **Gross Verified Savings**: This scenario relied on the updated avoided cost forecast and incorporates the realization rates as determined by the impact evaluation.
- **Net Verified Savings**: This scenario relied on the updated avoided cost forecast and adjusted the tracked savings by both the realization rate and net-to-gross ratio. Incremental measure costs are discounted by the applicable free-ridership rate.

Table 5 lists the DCSEU portfolio-level cost-effectiveness ratios under each scenario. The NMR team found that the DCSEU program portfolio, when taken as a whole, was cost-effective under each of the four scenarios. SCT benefit/cost ratios declined from 2.34 in the Modified Replica scenario to 1.83 under the Net Verified Savings scenario. These results mean that, from a societal cost test perspective, for every $1.00 spent, the District realized between $2.34 to $1.83 return on its investment.

All of the individual programs implemented by the DCSEU were cost-effective with the exception of Low-income Emergency Equipment Replacement, which was not cost-effective under any of the four scenarios.

Table 5: FY2018 Portfolio-level Societal Cost Test Results

Scenario	Benefit/Cost Ratio
Modified Replica	2.34
Updated Avoided Costs	1.88
Gross Verified Savings	1.87
Net Verified Savings	1.83

In Section 2.2.3, we offer recommendations to improve the accuracy of future cost-effectiveness testing.

CONCLUSIONS & RECOMMENDATIONS

Our assessment of DCSEU's progress towards its FY2018 benchmarks found that the DCSEU is succeeding in meeting the minimum targets for the first five benchmarks. In particular, the DCSEU exceeds both the minimum and maximum targets for the portfolio electricity savings, portfolio gas savings and renewable energy generating capacity benchmarks by a significant amount. While DCSEU improved performance in FY2018 on the green jobs benchmark and, in particular, the low-income savings benchmark, they fell just short of achieving these maximum targets. Given how close the DCSEU was to reaching the maximum green jobs and low-income savings benchmarks, we anticipate they will achieve both in FY2019. However, the DCSEU is falling behind on the five-year cumulative leveraged funds benchmark assuming equal progress is made each year; this benchmark should be a focus for FY2019 and future years. Because the full array of benchmarks reflects diverse and sometimes competing objectives, achieving the benchmarks requires constant monitoring on the part of the DCSEU.

The cost of FY2018 energy savings declined from FY2017 for electric and gas energy-efficiency programs, indicating that DCSEU has improved the effectiveness of its operations. However, the cost for electricity savings from renewables programs increased slightly. In addition, the cost of FY2018 energy savings for the DCSEU continues to be less than that for neighboring utilities.

The cost-effectiveness testing found that the DCSEU portfolio was cost-effective, except for the Low-income Emergency Equipment Replacement program. The DCSEU should assess the design and delivery of this program in an effort to improve cost-effectiveness.

For detailed recommendations regarding specific DCSEU programs, please see Appendix B.

Section 1 Assessment of Performance Benchmarks and Tracking Goals

In this section, we assess the DCSEU's FY2018 progress towards its performance benchmarks and tracking goals. We also provide information regarding lifetime energy savings and reductions in greenhouse gas (GHG) emissions.

1.1 Performance Benchmarks

In this section, we assess the DCSEU's FY2018 progress towards each of the following performance benchmarks:

- Reduce Electricity Consumption
- Reduce Natural Gas Consumption
- Increase Renewable Energy Generating Capacity
- Improve the Energy Efficiency of Low-income Properties
- Increase the Number of Green-collar Jobs
- Leverage External Funds

1.1.1 Reduce Electricity Consumption

The enumerated benchmark for reductions in electricity consumption states that DCSEU shall develop and implement energy-efficiency programs that directly lead to annual reductions of weather-normalized total electricity consumption, measured as a percentage of the total consumption of electricity in the District in 2014. The contract requires that DCSEU achieve a minimum of 121,756 MWh savings across the first two years, which represents 1.06% of 2014 weather-normalized consumption in the District. The maximum target equals 172,945 MWh savings, which represents 1.5% of 2014 weather-normalized consumption in the District.

The DCSEU tracks electric savings in two ways: gross meter-level savings and modified gross generator-level savings. The gross meter-level savings reflect the annual electric savings that the customer is expected to receive at the meter. The modified gross generator-level savings are calculated by increasing all gross meter-level electric savings by 8% to adjust for line losses and by further increasing savings from renewable energy projects by 15% to reflect spillover. Spillover reflects the assumption that renewable energy projects are likely to lead to additional savings beyond the savings from the incentivized projects. The formulas are displayed below.

*Modified gross electric savings for solar projects = Gross electric savings * 1.08 * 1.15*

*Modified gross electric savings for non-solar projects = Gross electric savings * 1.08*

Modified gross generator-level savings are used to assess progress towards this performance benchmark.

Table 6 displays the modified gross generator-level electric savings as tracked by DCSEU, our calculated portfolio-level realization rate, and the evaluated savings. The realization rate equals the ratio of evaluated savings to tracked savings (i.e., DCSEU savings recorded in their tracking

database). The NMR team estimates that the actual portfolio electric savings equals 134,728 MWh for FY2018, which is 99% of the DCSEU reported tracked electric savings. The cumulative savings across both FY2017 and FY2018 equals 227,414 MWh.

Table 6: Modified Gross Electric Savings Verification

Year	Tracked Modified Gross Savings (MWh)	Realization Rate	Evaluated Modified Gross Savings (MWh)
FY2018	135,898	99%	134,728
FY2017	93,958	99%	92,686
Total	229,856	99%	227,414

Our gross savings verification of the FY2018 programs found that DCSEU expended the appropriate amount of rigor on their savings calculations. In general, the documentation provided was thorough and the methods and assumptions were suitable. Therefore, we believe the tracked electricity savings were calculated with a reasonable degree of accuracy.

Table 7 displays our assessment of the DCSEU's progress towards the electric savings benchmark. Our evaluation found that the DCSEU achieved 227,414 MWh in electric savings across both FY2017 and FY2018, which represents 187% of the minimum cumulative benchmark and 131% of the maximum cumulative benchmark for the second year of the contract. The 227,414 MWh figure represents 49% of the minimum five-year cumulative benchmark and 39% of the maximum benchmark.

Table 7: Reduce Electricity Consumption Benchmark Performance

Modified Gross Annual Electric Savings (MWh)	Minimum Target (MWh)	Maximum Target (MWh)	Evaluated Savings (MWh)	Percent of Minimum Target	Percent of Maximum Target
Year Two Cumulative Target	121,756	172,945	227,414	187%	131%
Five-year Cumulative Progress	461,188	576,486	227,414	49%	39%

Table 8 displays the modified gross electric savings projected over the lifetime of the measures. Overall, the FY2017 and FY2018 programs are projected to save over 2,600,000 MWh in lifetime electric savings. The lifetime savings for each measure are calculated by multiplying the first-year energy savings by its expected lifetime. Because certain measures are subject to increased efficiency standards in the future, the lifetime savings may be adjusted to reflect this situation.

Table 8: Lifetime Modified Gross Electric Savings

Year	Tracked Lifetime Modified Gross Savings (MWh)	Realization Rate	Evaluated Lifetime Modified Gross Savings (MWh)
FY2018	1,507,610	99%	1,496,844
FY2017	1,140,086	98%	1,121,053
Total	2,647,696	99%	2,617,897

1.1.2 Reduce Natural Gas Consumption

The contract requires that DCSEU achieve a minimum of 2,250,770 therms of natural gas savings across the first two years, which represents 0.66% of 2014 weather-normalized consumption in the District. The maximum target equals 3,410,258 therms of natural gas reductions, which represents 1.0% of 2014 weather-normalized consumption in the District.

The DCSEU tracks natural gas savings in two ways: gross savings and modified gross savings. The gross savings reflect the estimated annual savings, including both cross-fuel and like-fuel interactive effects but excluding free-ridership and spillover. Per the DCSEU contract, modified gross savings are calculated by excluding cross-fuel interactive effects and are used to assess progress towards this performance benchmark.

Interactive effects reflect the increase or decrease in energy usage due to the installation of an energy-efficiency measure. A common example is energy-efficient lighting: an LED bulb installed in conditioned space produces less waste heat than an incandescent bulb, which then reduces the energy consumption from cooling equipment but increases consumption from heating equipment. In this case, the cooling savings is a like-fuel interactive effect (the lighting and cooling equipment both use electricity), while the heating penalty is likely a cross-fuel interactive effect (the lighting uses electricity, while the heating equipment likely uses gas).

The NMR team converted the gas savings, which the DCSEU tracks in MMBtu, to therms by multiplying by a factor of 10.

Table 9 displays the modified gross gas savings as tracked by the DCSEU, our calculated portfolio-level realization rate, and the evaluated savings. The realization rate equals the ratio of evaluated savings to tracked savings. The NMR team estimates that the actual portfolio gas savings equals 2,237,961 therms in FY2018, which is 97% of the DCSEU tracked gas savings of 2,300,391 therms.

In order to compare gas savings to electricity savings, we converted the gas savings from therms to MWh.[2] At the equivalent of 29,382 MWh, the cumulative FY2017-FY2018 evaluated gas savings represent about 56% of the comparable electricity savings.

Table 9: Modified Gross Gas Savings Verification

Year	Tracked Modified Gross Savings (Therms)	Realization Rate	Evaluated Modified Gross Savings (Therms)
FY2018	2,300,391	97%	2,237,961
FY2017	2,114,138	95%	1,998,033
Total	4,414,529	96%	4,235,994

The FY2018 realization rate is less than 100% due to the evaluation of the smart thermostat seasonal savings initiative, which found that gas savings were incorrectly claimed due to a

[2] We converted therms to MWh by first dividing by 10 therms per MMBtu then dividing by 3.412 MMBtu per MWh.

summer deployment (rather than a winter deployment). However, overall, our evaluation found that the tracked gas savings were calculated with a reasonable degree of accuracy.

Table 10 displays our assessment of the DCSEU's progress towards the gas savings benchmark. Our evaluation found that the DCSEU achieved 4,235,994 therms in gas savings across both FY2017 and FY2018, which represents 188% of the minimum cumulative benchmark and 124% of the maximum cumulative benchmark for the second year of the contract. The 4,235,994 therms figure represents 50% of the minimum five-year cumulative benchmark and 41% of the maximum benchmark.

Table 10: Reduce Gas Consumption Benchmark Performance

Modified Gross Annual Gas Savings	Minimum Target (Therms)	Maximum Target (Therms)	Evaluated Savings (Therms)	Percent of Minimum Target	Percent of Maximum Target
Year Two Cumulative Target	2,250,770	3,410,258	4,235,994	188%	124%
Five-year Cumulative Progress	8,525,645	10,230,774	4,235,994	50%	41%

Table 11 displays the lifetime modified gross gas savings. Overall, the FY2017 and FY2018 programs are projected to save over 37,000,000 therms in lifetime gas savings. The lifetime savings for each measure are calculated by multiplying the first-year energy savings by its expected lifetime. Because certain measures are subject to increased efficiency standards in the future, the lifetime savings may be adjusted to reflect this situation.

Table 11: Lifetime Modified Gross Gas Savings Verification

Year	Tracked Lifetime Modified Gross Savings (Therms)	Realization Rate	Evaluated Lifetime Modified Gross Savings (Therms)
FY2018	18,562,650	102%	18,850,804
FY2017	20,298,108	90%	18,305,207
Total	38,860,758	96%	37,156,011

1.1.3 Increase Renewable Energy Generation Capacity

The DCSEU is tasked with increasing the renewable energy generation capacity in the District, primarily through the installation of solar photovoltaic (PV) and solar thermal systems. The contract requires that the DCSEU provide incentives to fund the installation of a minimum of 1,380 kW of renewable energy generating capacity across the first two years. The maximum target is 2,000 kW.

According to the DCSEU tracking database, solar PV systems were installed at ten sites during FY2018. These installations spanned two programs, as illustrated in Table 12.

Table 12: FY2018 Solar System Summary

Program Name	Track Number	Number of Sites	Tracked Solar Capacity (kW)	Verified Solar Capacity (kW)
Solar PV Market Rate	7101PVMR	9	1,743	1,743
Low-income Multifamily Comprehensive	7612LICP	1	93	93
Total		**10**	**1,836**	**1,836**

For these ten sites, we summed the renewable energy capacity of solar PV or solar thermal systems using the *KWLoad* variable[3] included in the DCSEU tracking database. The NMR team verified that the generation capacity matched the DCSEU tracking data for the five solar projects that were reviewed as part of the impact evaluation. Therefore, we estimate that the actual renewable energy generation capacity is 1,836 kW, which equals the DCSEU tracked capacity of 1,836 kW. The majority of FY2018 renewable energy projects were completed at commercial buildings.

Table 13 displays our assessment of the DCSEU's progress towards the renewable energy generating capacity benchmark. Our evaluation found that the DCSEU incentivized 4,080 kW of

[3] The *KWLoad* variable reflects the electric generation capacity of solar PV systems in Alternating Current kilowatts.

renewable generation capacity across both FY2017 (2,244 kW) and FY2018 (1,836 kW), which represents 296% of the minimum cumulative benchmark and 204% of the maximum cumulative benchmark for the second year of the contract. The 4,080 kW figure represents 94% of the minimum five-year cumulative benchmark and 82% of the maximum benchmark.

Table 13: Renewable Energy Capacity Benchmark Performance

Electric generation capacity from solar PV and solar thermal sources	Minimum Target (kW)	Maximum Target (kW)	Evaluated Savings (kW)	Percent of Minimum Target	Percent of Maximum Target
Year Two Cumulative Target	1,380	2,000	4,080	296%	204%
Five-year Cumulative Progress	4,350	5,000	4,080	94%	82%

1.1.4 Improve the Energy Efficiency and Renewable Energy Generating Capacity at Low-income Properties

Per the DCSEU contract, the low-income benchmark includes two separate metrics:

- Spend 20% of Sustainable Energy Trust Fund (SETF) funds on low-income housing, shelters, clinics, or other buildings serving low-income residents in the District.
- Achieve 46,556 MMBtu in electricity and natural gas savings from low-income programs.

In order to verify that tracked low-income program expenditures and savings were accrued to eligible low-income projects, we reviewed the 28 low-income multifamily projects that were sampled for the FY2018 evaluation to ensure that they met the low-income program requirements. For FY2018, *low-income households* are defined as those with annual incomes equal to or below 80% of the Area Median Income (AMI) or 60% of the State Median Income (SMI). Affordable, low-income housing in the District is defined as one of the following:

a. A single home where the owner or occupant meets the definition of *low-income household*;

b. A multifamily building where at least 66% of the households meet the definition of *low-income household;*

c. Buildings owned by non-profit organizations or the government that meet the definition of *low-income households*; or

d. Buildings where there are contracts or other legal instruments in place that assure that at least 66% of the housing units will be occupied by *low-income households*.[4]

In addition to low-income housing, the DCSEU contract allows low-income programs to target shelters, clinics, or other buildings serving low-income residents in the District. After reviewing supporting documentation and third-party sources, the NMR team was able to verify that all 28 sampled low-income multifamily projects met at least one of these low-income criteria. Table 14

[4] "Low-income – Income Qualification FY17."

displays these 28 sites and notes the verification category or categories they met to achieve low-income status.

Table 14: FY2018 Low-income Site Verification

Program Track	Site ID	Project ID	Site Name	Verified (Y/N)	Verification Criteria
Income Qualified Efficiency Fund (7610IQEF)	23846	15449	Douglas Knolls	Y	163 low-income units out of 163 (100%); meets 66% threshold (b)
	1344	15592	Paradise at Parkside	Y	594 low-income units out of 594 (100%); meets 66% threshold; Listed as Section 8 Housing on DC website (b)
	24691	15737	Samuel Kelsey Apartments	Y	Listed on HUD Affordable Housing site as LIHTC; Provided Tax Credit Regulatory Agreement (d)
	24936	15743	Douglas Knolls	Y	162 low-income units out of 162 (100%); meets 66% threshold (b)
	1457	15359	Cavalier Apartments (Hubbard Place)	Y	Listed on HUD Affordable Housing site as LIHTC; 428 low-income units out of 487 (88%); meets 66% threshold (b)
	1446	15360	Christ House	Y	On FHQC List; Listed as Public Housing on DC website (c)
	23592	15368	The Avenue	Y	Listed on HUD Affordable Housing site; Listed as Public Housing on DC website; 100% low-income units (b)
	23555	15437	Samuel Kelsey Apartments	Y	Listed on HUD Affordable Housing site as LIHTC (b)
Low-income Prescriptive Rebate (7613LIRX)	2568	15955	Washington View Apartments	Y	Listed as Public Housing on DC website; 100% low-income units (b)
	1606	15970	Manor Village	Y	326 low-income units out of 327 (99.7%); meets 66% threshold (b)
	1771	15971	Garden Village Apartments – The Villages of Parkland	Y	100% low-income units (b)
	1605	15977	Shipley Park Apartments	Y	Listed as LIHTC on HUD Affordable Housing Site (b)
	16502	15981	Skyland	Y	100% low-income units (b)
	8241	16052	The Normandie	Y	100% low-income units (b)
	6583	16053	The Cromwell	Y	170 low-income units out of 180 (94%); meets 66% threshold (b)
	25163	16076	The Winchester-Luzon Apartments	Y	53 low-income units out of 64 (83%); meets 66% threshold (b)
	8374	16081	Linwood Apartments	Y	100% low-income units (b)

Program Track	Site ID	Project ID	Site Name	Verified (Y/N)	Verification Criteria
Low-income Multifamily Comprehensive (7612LICP)	419	16091	Frederick Douglas Apartments	Y	100% low-income units (b)
	12468	15884	Deanwood Hills	Y	Provided Affordable Housing Covenant (d)
	378	12736	Parkchester Apartments	Y	Listed as Section 8 Housing on DC website; Provided DHCD Indenture of Restrictive Covenants for Low-income Tax Credits (d)
	7045	6836	Conway Center	Y	On DCHousing.org's New Markets Tax Credits page; Will house 200 low-income families (c)
	11042	9456	Saint Stephens Apartments	Y	Rent level form provided with 100% low-income rents (b)
	8795	13433	Portner Flats Apartments	Y	100% low-income units or units receiving subsidies (b)
	15814	13523	Plaza West	Y	Featured on DCHA website as affordable housing community; Overseen by DHCD; Provided Affordable Housing Covenant (d)
	15084	14427	West End – Square 50	Y	Overseen by DHCD; Provided Low-income Covenant/Affordable Housing Covenant; Income limits listed on website meet low-income levels (d)
	8333	14743	Hilltop Apartments	Y	Provided Affordable Housing Covenant; According to application, 90 low-income units out of 105 (86%); Meets 66% threshold (d)
	710	15044	Claridge Towers	Y	Listed as Public Housing on DC website; Listed on DCHA website; Serves senior and disabled residents (c)
	1460	15362	Minnesota Terrace Apartments	Y	Tenant list with voucher numbers provided

Based on our review of the 28 sampled projects, we assume that all program costs and savings allocated to low-income programs were accrued by eligible low-income properties.

Next, we assessed progress towards the expenditure benchmark, followed by the savings benchmark.

1.1.4.1 Spend 20% of SETF funds at Low-income Housing, Shelters, Clinics, or Other Buildings

The DCSEU contract specifies that the calculation of the low-income spend percentage include portfolio-wide administrative and support costs in the denominator but not the numerator. Therefore, the NMR team applied the following equation:

$$\textit{Low-income spend \%} = \frac{\textit{Low-income program costs}}{\textit{Cumulative program costs + Portfolio administrative \& support costs}}$$

Table 15 displays our assessment of DCSEU's progress towards the low-income expenditure benchmark. Based on total FY2018 portfolio expenditures of $19,500,841, the contract requires that DCSEU spend a minimum of $3,900,168 (20%) on low-income programs. There is no maximum target for low-income expenditures.

DCSEU reported that they spent $4,130,208 across the eight low-income programs, which represents 106% of the target.

Table 15: FY2018 Low-income Expenditure Benchmark Performance

Measurement	Minimum Target	Evaluated Number	Percent of Minimum Target
Dollars spent on low-income properties	$3,900,168	$4,130,208	106%

1.1.4.2 Achieve 46,556 MMBtu in Electricity and Gas Savings from Low-income Programs

In Table 16, we list the tracked energy (electric plus gas) savings and evaluated savings for each of the eight low-income programs offered by the DCSEU in FY2018. Overall, the DCSEU tracking database reported 44,713 MMBtu in savings and we verified 44,916 MMBtu.[5]

Table 16: FY2018 Low-income Savings by Program

Program	Track	Tracked Modified Gross Savings (MMBtu)	Evaluated Modified Gross Savings (MMBtu)
Low-income Emergency Equipment Replacement	7413LIER	63	63
Implementation Contractor Direct Install	7610ICDI	6,998	6,998
Income Qualified Efficiency Fund	7610IQEF	5,319	5,319
Low-income Custom Projects	7610LICP	148	150
Low-income Multifamily Comprehensive	7612LICP	15,911	16,115
Low-income Prescriptive Rebate	7613LIRX	14,504	14,500
Retail Lighting Food Bank	7717FBNK	430	430
Low-income Home Energy Conservation Kit	7717HEKT	1,340	1,340
Total		44,713	44,916

Table 17 displays our assessment of DCSEU's progress towards the low-income savings benchmark. The contract requires that the DCSEU achieve a minimum of 23,278 MMBtu savings from low-income programs. The maximum target equals 46,556 MMBtu.

Our evaluation found that DCSEU achieved 44,916 MMBtu in energy savings from low-income programs, which represents 193% of the minimum target and 96% of the maximum target. This represents significant progress compared to FY2017, when 62% of the maximum target was achieved. According to DCSEU, the continued maturation of the Income Qualified Efficiency Fund program and strong contractor engagement contributed to improved results in FY2018. As discussed in more detail in Section 2.1, the costs of saved energy for low-income programs is typically multiple times greater than for other types of programs.

Table 17: FY2018 Low-income Savings Benchmark Performance

Measurement	Minimum Target	Maximum Target	Evaluated Number	Percent of Minimum Target	Percent of Maximum Target
Modified gross electric savings plus modified gross gas savings from low-income programs (MMBtu)	23,278	46,556	44,916	193%	96%

[5] The DCSEU tracking database reports natural gas savings in MMBtu and electricity savings in kWh. The kWh electricity savings were converted to MMBtu by multiplying by a factor of 0.003412.

1.1.5 Increase the Number of Green-collar Jobs

This benchmark requires that the DCSEU create green jobs in the District during each year of the contract. The contract requires that the DCSEU create a minimum of 66 full-time equivalent (FTE) jobs each year. The maximum annual target is 88 jobs.

In order to calculate the number of FTE jobs created, the contract specifies the following criteria:

- One FTE green job equals 1,950 hours worked by the DCSEU staff and subcontractors.
- One FTE green job equals $200,000 worth of DCSEU incentives provided to customers or manufacturers.
- Only direct jobs are to be considered. Indirect jobs and induced jobs are not counted.

In order to calculate the number of green jobs created by the DCSEU staff and subcontractors, DOEE provided a spreadsheet of payroll hours worked by the DCSEU staff and subcontractors during FY2018. The NMR team divided the total number of hours worked by 1,950 to yield the number of green jobs created by the DCSEU (Table 18).

In addition, the DCSEU provided a spreadsheet with the total incentive amount distributed in FY2018, which equaled $9,526,495. However, a portion of these incentives flowed through DCSEU subcontractors, whose created jobs were already counted under the payroll hours calculation. Therefore, we excluded a total of $2,716,807 in subcontractor incentives and used the remaining $6,809,688 as the basis for the calculation of jobs created due to incentives (Table 18).

Table 18: FY2018 Green Jobs Calculation

Category	Total Hours or Dollars (A)	Assumed Hours or Dollars per Job (B)	Number of Green Jobs Created (A / B)
DCSEU Staff Hours	75,537 hours	1,950 annual hours	38.7
DCSEU Subcontractor Hours	26,749 hours	1,950 annual hours	13.7
Incentive Dollars	$6,809,688	$200,000	34.0
Total Green Jobs Created			**86.5**

Table 19 displays our assessment of the DCSEU's progress towards the green jobs benchmark. We calculated that the DCSEU created 86.5 jobs, which represents 131% of the minimum target and 98% of the maximum target. According to DCSEU, higher than expected staff turnover combined with the time required to replace staff led to falling short of the maximum target, similar to FY2017.

Table 19: FY2018 Green Jobs Benchmark Performance

Measurement	Minimum Target	Maximum Target	Evaluated Number	Percent of Minimum Target	Percent of Maximum Target
Number of FTE jobs created by the DCSEU	66	88	86.5	131%	98%

1.1.6 Leverage External Funds

The contract requires the DCSEU to secure outside funds, excluding SETF funds or other District government funds, to support the energy programs implemented by the DCSEU. The DCSEU is required to obtain a total of $5,000,000 of outside funds over the five-year period of the base contract. There is no annual target for this benchmark; there is only a cumulative five-year goal. Therefore, we tracked the DCSEU's annual progress towards the $5,000,000 five-year benchmark.

The DCSEU provided the NMR team with a spreadsheet listing details regarding the outside funds received during FY2018. The DCSEU reported obtaining a total of $268,881 in outside funds during FY2018, mostly from participating in the PJM forward capacity market (Table 20).

Table 20: FY2018 Leveraged Funds Calculation

Funding Source	Description	Amount
PJM Capacity Market	Forward Capacity Market Credits	$202,743
Department of Energy	Creating platform to better utilize building benchmarking data	$63,138
Focus on Green Tech Event Sponsorship	Event Sponsorship	$3,000
Total		**$268,881**

Including the reported outside funding of $439,111 from FY2017, we calculate that the DCSEU has secured a total of $707,992, which represents 28% of the $2,500,000 minimum target and 14% of the $5,000,000 maximum target (Table 21). In order to be on track to meet the minimum requirement after the second year of the five-year contract, the percent progress should equal about 40% assuming a linear progression towards the target. While the DCSEU may obtain greater funding in subsequent years of the contract, the amount obtained in the second year ($268,881) was substantially less than the amount obtained in the first year ($439,111).

Table 21: Cumulative Leveraged Funds Benchmark Performance

Measurement	Minimum Target	Maximum Target	Evaluated Number	Percent of Minimum Target	Percent of Maximum Target
Dollars received from external sources	$2,500,000	$5,000,000	$707,992	28%	14%

1.2 TRACKING GOALS

In this section, we assess the DCSEU's FY2018 progress towards its two tracking goals:

- Reduce Growth in Peak Demand
- Reduce Growth in Energy Demand of Largest Energy Users

1.2.1 Reduce Growth in Peak Demand

While the DCSEU is not required to offer programs to exclusively reduce peak demand, demand savings result from the electric savings programs, and the DCSEU is required to report on

demand savings. Because the peak demand savings goal is for tracking purposes only, it does not have a contractual performance target.

The DCSEU tracks peak demand savings in two ways: gross meter-level savings and modified gross generator-level savings. The contract requires that modified gross generator-level peak demand savings be used to assess progress towards this tracking goal.

The gross meter-level savings reflect the annual peak demand savings that the customer is expected to receive at the meter. Per the DCSEU contract, the modified gross generator-level savings are calculated by increasing all gross meter-level peak demand savings by 6% to adjust for line losses and by further increasing savings from solar projects by 15% to reflect spillover. The formulas are displayed below.

*Modified gross peak demand savings for solar projects = Gross peak demand savings * 1.06 * 1.15*

*Modified gross peak demand savings for non-solar projects = Gross peak demand savings * 1.06*

The peak demand period occurs between 2:00 PM and 6:00 PM from June through September. In 2018, the peak load usage for DC was 2,310 MW.[6]

Table 22 displays the modified gross peak demand savings as tracked by the DCSEU, our calculated portfolio-level realization rate, and the evaluated modified gross peak demand savings. The realization rate equals the ratio of evaluated savings to tracked savings. The NMR team estimates that the actual portfolio peak demand savings equals 21,406 kW, which is 105% of the DCSEU tracked peak demand savings of 20,346 kW. The 21,406 kW figure represents 0.9% of the estimated peak load usage of 2,310 MW.

Table 22: Modified Gross Summer Peak Demand Savings Verification

Measurement	Tracked Savings (kW)	Realization Rate	Evaluated Savings (kW)
Modified gross electric demand savings during summer peak period	20,346	105%	21,406

The evaluation team found an incongruence between hours of use and peak demand coincidence factors for lighting measures which contributed to the higher evaluated than tracked peak demand savings.

[6] 2019 Consolidated Report. Potomac Electric Power Company. April 2019. Table 1.2-B.

The evaluated peak demand savings of 21,406 kW for FY2018 is substantially higher than the 12,409 kW from FY2017 and prior years (Table 23).

Table 23: Evaluated Modified Gross Summer Peak Demand Savings Trends

Measurement	FY2014	FY2015	FY2016	FY2017	FY2018
Evaluated modified gross electric demand savings during summer peak period (kW)	7,912	7,950	8,917	12,409	21,406

1.2.2 Reduce Growth in Energy Demand Of Largest Energy Users

While the DCSEU is not required to offer programs aimed exclusively at reducing the energy usage of large energy users, they are required to track projects with large users. Because the large user goal is for tracking purposes only, it does not have any contractual performance targets.

The DCSEU contract's definition of a large energy user is as follows:

> *Large energy users are defined as organizations, individuals, or government entities that own a building with more than 200,000 square feet of gross floor area or own a campus of buildings in a contiguous geographic area that share building systems or at least one common energy meter without separate metering or sub-metering, such that their energy use cannot be individually tracked. Gross floor area includes infrastructure that contain heated and unheated space that is connected to a qualifying building. Energy-efficiency or renewable energy measures must be installed in a qualified building or an infrastructure connected to a qualified building in order to qualify as a large energy user project.*

The DCSEU provided a spreadsheet listing 136 large user projects from FY2018, titled *FY2018 Largest Energy Users*. Using the addresses listed in this spreadsheet or listed with the given Company ID in the DCSEU tracking database, we evaluated the large energy user status of the 136 companies. To confirm that the organizations met these specifications, the NMR team reviewed the DOEE Covered Building List for 2018[7], which lists buildings over 50,000 gross square feet in the DC tax records, which must submit benchmarking data for 2017. For locations not listed in this document we sought external verification through institution websites, news articles, or government documents.

For projects completed under organizations that manage multiple sites, their entire portfolio of properties in DC was considered to assess the organization's status. For schools this includes all buildings on a campus; for federal departments this includes all buildings operated by that

[7] The DOEE Covered Building List for 2018 may be accessed here: https://doee.dc.gov/publication/download-covered-building-list-2018

department; and for property management firms this includes their entire portfolio of managed locations.

Some projects included multiple sites. For these projects, the sum of the property areas was used to verify large energy user status. Additionally, some sites participated in multiple projects and project tracks. The number of unique sites participating in each track are listed below (Table 24).

Table 24: FY2018 Large Energy User Sites

Program	Track	Number of Unique Sites
Solar PV Market Rate	7101PVMR	2
CI RX – Equipment Replacement	7511 CIRX	62
Market Transformation Value	7512MTV	4
Commercial Upstream	7513UPLT	114
Retrofit – Custom	7520CUST	91
Market Opportunities – Custom	7520MARO	9
New Construction – Custom	7520NEWC	26
Low-Income Multifamily Custom Projects	7610LICP	1
Low-Income Multifamily Comprehensive	7612LICP	4
Low-Income Prescriptive	7613LIRX	33
Retail Lighting	7710LITE	3
Total		**349**

There was insufficient data to verify nine organizations, however the team was able to verify 127 of 136 organizations (93%) as large energy users. Therefore, based on our review, the DCSEU completed projects with 127 large energy users in FY2018 (Table 25).

Table 25: FY2018 Large Energy User Verification

Measurement	Evaluated Number
Number of large energy users with completed projects	127

The 127 completed projects with large energy users in FY2018 exceeded the number from prior years, with the exception of 132 projects in FY2016 (Table 26).

Table 26: Evaluated Large Energy User Trends

Measurement	FY2014	FY2015	FY2016	FY2017	FY2018
Number of large energy users with completed projects	67	52	132	104	127

1.3 GREENHOUSE GAS REDUCTIONS

While reductions in GHG emissions are neither a performance benchmark nor a tracking goal for DCSEU, we provide an overview of the reduced GHG emissions resulting from the energy savings of the DCSEU programs.

Table 29 displays the avoided CO2 equivalent emissions in annual metric tons for FY2017 and FY2018 based on the evaluated gross savings. The team utilized a GHG emissions calculator spreadsheet from DOEE to calculate the avoided annual GHG emissions. Overall, we estimate the DCSEU's programs saved nearly 95,000 metric tons of annual CO2 emissions across FY2017 and FY2018. The FY2018 avoided emissions represent 0.7% of the estimated District-wide emissions of 7,552,734 metric tons in 2016.

Table 27: Greenhouse Gas Emission Reductions

Year	Avoided CO2 Equivalent Emissions (Metric Tons)
FY2018	52,040
FY2017	42,637
Total	94,677

Section 2 Cost-effectiveness Assessment

In this section, we describe our evaluation efforts to assess the cost of saved energy and the cost-effectiveness of the DCSEU programs.

2.1 Cost of Saved Energy

To inform future planning of budgets and savings goals, we calculated the DCSEU's cost of first-year verified energy savings in FY2018. In order to calculate the cost of saved energy, the DCSEU provided the NMR team with program-specific incentive costs for electric and natural gas measures, as well as portfolio-wide administrative and support costs for FY2018. In order to calculate total electric and natural gas costs, we allocated the portfolio-wide administrative and support costs to each program and fuel type based on its program-specific incentive cost. We then summed the total costs by fuel type and program.

Because renewable energy projects typically cost more per unit of savings than energy-efficiency projects, we calculated costs separately for energy-efficiency projects and renewable energy projects. Therefore, we provide the costs for three categories of savings:

- Electric savings excluding renewables programs
- Electric savings from renewables programs only
- Natural gas savings excluding renewables programs

As described in Section 1.1.1, modified gross electricity savings exceed gross electricity savings due to adjustments for line losses, as well as for spillover from solar projects. In addition, modified gross gas savings exceed gross gas savings due to the exclusion of cross-fuel interactive effects, as described in Section 1.1.2. Therefore, the DCSEU's costs for modified gross energy savings are less than the costs for gross energy savings.

We calculated that the DCSEU's cost for first-year gross and modified gross electricity savings excluding renewables programs was $123/MWh and $114/MWh, respectively (Table 28). In addition, we calculated that the DCSEU's cost for gross and modified gross electricity savings from renewables programs was $240/MWh and $193/MWh, respectively. For natural gas savings, we calculated that the DCSEU's cost of gross and modified gross savings excluding renewables programs was $2.30/therm and $1.75/therm, respectively.

Table 28: DCSEU FY2018 Cost of First-Year Energy Savings

Fuel Savings Type	Cost	Evaluated Energy Savings		Cost per Unit of Saved Energy	
		Gross	Modified Gross	Gross	Modified Gross
Electric savings excluding renewables programs	$14,950,526	121,731 MWh	131,491 MWh	$123/MWh	$114/MWh
Electric savings from renewables programs	$625,234	2,606 MWh	3,236 MWh	$240/MWh	$193/MWh
Gas savings excluding renewables programs	$3,925,081	1,708,386 therms	2,237,961 therms	$2.30/therm	$1.75/therm
Total	**$19,500,841**	**595,076 MMBtu**	**683,487 MMBtu**	**$33/MMBtu**	**$29/MMBtu**

The DCSEU's cost for saved energy declined by 23% from $42/MMBtu in FY2017 to $33/MMBtu in FY2017 across the entire portfolio (Table 29). While the cost of energy savings for both electric and gas energy-efficiency programs declined, the cost for electricity savings from renewables programs increased slightly.

According to DCSEU, the decreased cost of energy savings resulted from a multitude of continuous improvement efforts focusing on program service delivery excellence and targeting more cost-effective solutions.

In order to compare the cost of saved electricity to the cost of saved gas, we converted the gas savings from therms to an MWh equivalent.[8] At $78/MWh in FY2018 and $109/MWh in FY2017, the cost of gross gas savings is less than the cost of gross electricity savings (at $123/MWh and $162/MWh, respectively).

Table 29: DCSEU Trends for Costs of First-Year Gross Energy Savings

Fuel Savings Type	FY2018	FY2017
Electric savings excluding renewables programs	$123/MWh	$162/MWh
Electric savings from renewables programs	$240/MWh	$236/MWh
Gas savings excluding renewables programs	$2.30/therm	$3.19/therm
Total	**$33/MMBtu**	**$42/MMBtu**

Due to the similar geographic location and climate, we compare the DCSEU's costs of first-year electricity savings to those from two nearby utilities: PECO Energy in Pennsylvania and Baltimore Gas & Electric (BG&E) in Maryland. In addition, we compare DCSEU's costs of first-year gas savings to the costs for Philadelphia Gas Works (PGW) which serves the city of Philadelphia. While these comparisons are useful, it is important to understand that these jurisdictions have different markets, savings goals, regulatory requirements, cost-effectiveness tests, program maturity, and delivery systems, which may affect both costs and savings.

PECO Energy serves the city of Philadelphia and surrounding counties, which are less urban than DC. PECO is subject to Pennsylvania's Act 129, which requires that energy-efficiency

[8] We converted therms to MWh by first dividing by 10 therms per MMBtu then dividing by 3.412 MMBtu per MWh.

programs achieve nearly a 4% cumulative reduction in annual electricity use (or approximately 0.8% per year) over the five-year period of the Phase III programs that launched in 2016. In addition, at least 5.5% of savings must come from programs solely directed at low-income customers in multifamily housing and at least 3.5% from government, non-profit, and institutional organizations. Pennsylvania Act 129 requires the portfolio of programs offered by each electric distribution company to be cost-effective using a modified version of the Total Resource Cost (TRC) test. The TRC typically includes a more limited range of benefits than the Societal Cost Test employed by DC.

BG&E services the city of Baltimore, as well as surrounding counties, which are less urban than DC. Beginning with the 2016 program year, the Maryland EmPOWER programs are designed to achieve an annual incremental gross energy savings equivalent to 2.0% of the weather normalized gross retail sales baseline, with a ramp-up rate of 0.20% per year. The programs are screened on four factors: cost-effectiveness, impact on the rates of each ratepayer class, impact on jobs, and impact on the environment. Maryland requires that each utility's programs be cost-effective at both the residential and commercial sector-level using the Total Resource Cost test.

In comparison, the DCSEU has multiple benchmarks, in particular low-income and green jobs, that may impact costs. In addition, the DCSEU budget and goals are a fraction of those for either PECO or BG&E, although substantially greater than for PGW.

At $123/MWh, the DCSEU's FY2018 cost for gross electricity savings is less than the cost for either PECO ($147/MWh) or BG&E ($232/MWh) (Table 30). Because PECO and BG&E only offer electric energy-efficiency programs, we only compare the costs to save electricity.

Table 30: Comparison of Cost of First-Year Gross Electricity Savings

Region	Period	Costs	Evaluated Electricity Savings (MWh)	Cost per Unit of Saved Electricity ($/MWh)
DCSEU excluding renewables	FY2018	$14,950,526	121,731	$123
	FY2017	$13,469,131	82,888	$162
PECO[9,10]	June 2017 – May 2018	$57,241,000	390,151	$147
	June 2016 – May 2017	$52,225,000	210,689	$248
BG&E[11,12]	2017	$104,114,861	448,234	$232
	2016	$105,736,633	518,117	$204

[9] Pennsylvania SWE Annual Report Act 129 Program Year 8. NMR Group, Ecometric Consulting, Demand Side Analytics.
http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx

[10] Pennsylvania SWE Annual Report Act 129 Program Year 9. NMR Group, Demand Side Analytics, BrightLine Group Ecometric Consulting.
http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/act_129_statewide_evaluator_swe_.aspx

[11] *Verification of the 2016 Empower Maryland Energy Efficiency Program Impact Evaluation*. Itron. October 20, 2017. *The Empower Maryland Energy Efficiency Act STANDARD REPORT OF 2017 With Data for Compliance Year 2016*. Maryland Public Service Commission. September 2017.

[12] *Verification of the 2017 Empower Maryland Energy Efficiency Program Impact Evaluation*. Itron. October 5, 2018. *The Empower Maryland Energy Efficiency Act STANDARD REPORT OF 2018 With Data for Compliance Year 2017*. Maryland Public Service Commission. February 2018.

At $2.30/therm, the DCSEU's FY2018 cost for gross gas savings is less than one-half the cost for Philadelphia Gas Works ($6.25/therm) (Table 31). A similar situation occurred in FY2017 as well.

Table 31: Comparison of Cost of First-Year Gross Gas Savings

Region	Period	Costs	Gas Savings (Therms)	Cost per Unit of Saved Gas ($/Therm)
DCSEU excluding renewables programs	FY2018	$3,925,081	1,708,386	$2.30
	FY2017	$5,124,231	1,606,644	$3.19
PGW[13,14]	Sept 2017 - Aug 2018	$1,390,310	222,570	$6.25
	Sept 2016 - Aug 2017	$1,462,930	204,990	$7.14

Table 32 displays the costs of saved energy across all eight low-income programs listed in Table 16. We calculated that the DCSEU's FY2018 cost for gross and modified gross electricity savings for low-income programs was $511/MWh and $473/MWh, respectively. These were both lower than in FY2017. In addition, we calculated that the DCSEU's cost for gross and modified gross natural gas savings was $34/therm and $15/therm, respectively. These were also lower than in FY2017.

Table 32: DCSEU Cost of First-Year Low-income Energy Savings

Fuel Savings Type	Fiscal Year	Cost	Evaluated Energy Savings		Cost per Unit of Saved Energy	
			Gross	Modified Gross	Gross	Modified Gross
Electric	FY2018	$5,307,719	10,379 MWh	11,232 MWh	$511/MWh	$473/MWh
	FY2017	$3,376,742	5,571 MWh	6,085 MWh	$606/MWh	$555/MWh
Gas	FY2018	$990,019	28,737 therms	65,911 therms	$34/therm	$15/therm
	FY2017	$2,726,596	51,133 therms	80,939 therms	$53/therm	$34/therm
Total	**FY2018**	**$6,297,738**	**38,288 MMBtu**	**44,916 MMBtu**	**$164/MMBtu**	**$140/MMBtu**
	FY2017	**$6,103,338**	**24,123 MMBtu**	**28,858 MMBtu**	**$253/MMBtu**	**$211/MMBtu**

Because low-income projects typically require greater levels of program investment, the costs of saved energy are higher than for other types of programs. We calculated the cost of saved energy for DCSEU's low-income programs to be about four to five times greater than the cost of saved energy across the entire DCSEU portfolio. This result is similar to the findings from a

[13] *Demand Side Management Program Annual Report, FY 2018 Results.* Philadelphia Gas Works. December 2018.

[14] *Demand Side Management Program Annual Report, FY 2017 Results.* Philadelphia Gas Works. December 2017.

recent national study that estimated the cost of saved electricity for low-income programs as approximately four times greater than for other types of programs.[15]

2.2 COST-EFFECTIVENESS ASSESSMENT

The NMR team modeled the cost-effectiveness of the DCSEU FY2018 program offerings at the portfolio level and for each of the energy-efficiency programs that were active in FY2018. All of the NMR team's modeling was done using a Societal Cost Test (SCT) perspective. The SCT is a variant of the Total Resource Cost (TRC) Test, which includes various externalities and a lower societal discount rate than the discount rate based on the utility weighted average cost of capital used in the TRC. The discount rate determines the net present value of future resource savings. Table 33 lists the cost and benefit elements included in the SCT Test.

Table 33: Societal Cost Test – Costs and Benefits

SCT Costs	SCT Benefits
Incremental Measure Cost	Avoided Energy Costs (kWh, MMBtu)
Other Financial or Technical Support Costs	Avoided Generating Capacity Costs
Program Administration Costs	Avoided T&D Capacity Costs
Evaluation, Measurement, & Verification	Avoided Water Cost
	Reduced Risk\Increased Reliability
	Reduced Operation and Maintenance Cost
	Benefits from reducing environmental externalities, including air and water pollution, GHG emissions, and cooling water use.
	Non-energy Benefits (NEBs), including comfort, noise reduction, aesthetics, health and safety, ease of selling/leasing home or building, improved occupant productivity, reduced work absences due to illness, ability to stay in home/avoided moves, and macroeconomic benefits.

The primary data sources that the NMR team used for the cost-effectiveness assessment were as follows:

- Measure-level energy savings, effective useful life (EUL) assumptions, incremental measure cost values, incentive amounts, and projections of operation and maintenance (O&M) savings from the DCSEU tracking database.
- Non-incentive expenditures for program administration and delivery, as provided by the DCSEU. This includes both costs that were allocated to specific tracks and common costs for support services that are assigned at the portfolio level.

[15] *The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009–2015.* Lawrence Berkeley National Laboratory. June 2018.

- Avoided cost assumptions, as documented in a Program Implementation Procedure document. The NMR team updated the forecast of several key energy elements to reflect current market conditions in the Mid-Atlantic region, as discussed in Section 2.2.2.
- Realization rates and net-to-gross ratios, as determined by the FY2018 impact evaluation.

In addition to the detailed information contained in the DCSEU program tracking database, the DCSEU provided the NMR team with its cost-effectiveness findings for FY2018. The DCSEU calculated a portfolio SCT ratio of 2.14 and $136.7M of net benefits at the portfolio level for FY2018. As a first step in the analysis, the NMR team developed a parallel set of calculations using DCSEU inputs, assumptions, and formulas. This analysis returned a portfolio SCT ratio of 2.34 and $147.6 million in net benefits. The NMR replica model generally calculates higher SCT benefits despite treating interactive effects that increase heating fuel consumption as a negative benefit instead of an SCT cost. Section 2.2.1 provides additional details about the differences observed between models. The NMR team produced three additional cost-effectiveness result scenarios using different inputs and assumptions. The four scenarios are described below. The results are summarized in Table 34 and presented in detail in Section 2.2.1.

- ***Scenario #1 – Modified Replica:*** Replicates the DCSEU calculations with corrections to inputs and formulas. The first modification in Scenario #1 was formulaic and was also noted in the FY2017 report. Some measures have interactive effects on other fuels. For example, installation of cooler LED lighting increases the consumption of fossil fuel heating systems because there is less waste heat in the space. The DCSEU treated this heating *penalty* as a cost for fossil fuels and a benefit for electricity and water. The NMR team standardized the accounting across resources and treated all interactive penalties (and associated externalities) as a negative benefit. This does not affect the Present Value of Net Benefits (PVNB) calculation, but does change the SCT ratios because dollars are moved from the denominator to the numerator. The second correction was an adjustment to measure costs. In reviewing the FY2018 financial data, further adjustments were required for total costs and lifetime benefit years. In some instances, the customer share and the utility share did not add up to total cost of the measure. In other instances, negative shares balanced with positive shares and resulted in net zero total costs. The NMR team adjusted cost shares to ensure positive shares for customers and utilities, and that these shares added to the correct total cost. Zero total costs were maintained whenever appropriate, such as for the money only measures. Measure life was restricted to a max of 30 years for all measures.
- ***Scenario #2 – Updated Avoided Costs****:* A review of the DCSEU screening assumptions during the FY2017 evaluation revealed that several key energy benefits were based on a somewhat dated forecast from 2013. This forecast was developed at a time when market prices were higher in the region and the study forecasted an increase in energy costs over time. In fact, market prices of electricity and natural gas have fallen over the last five years. Section 2.2.2 discusses the development of updated screening assumptions in more detail. Scenario #2 relies on unadjusted energy impacts as captured in the DCSEU tracking system. In addition, the 15% spillover assumption

applied to measures with solar in Scenario #1 was excluded from Scenario #2 as the NMR team believes attribution effects such as free-ridership and spillover should only be included in the net verified savings scenario.

- ***Scenario #3 – Gross Verified Savings****:* This scenario relies on the updated avoided cost forecast and incorporates the realization rates as determined by the impact evaluation. Realization rates are applied to the first-year savings and future adjusted savings (in the case of measures with dual baselines) equally.
- ***Scenario #4 – Net Verified Savings****:* This scenario relies on the updated avoided cost forecast and adjusts the reported savings in the DCSEU system by both the realization rate and net-to-gross ratio. Regardless of program delivery mechanism (incentive vs. direct install), incremental measure costs are discounted by the applicable free-ridership rate. The net-to-gross ratios applied in Scenario #4 account for any spillover benefits in lieu of directly applying a spillover assumption, as was initially included in Scenario #1 but excluded from subsequent scenarios.

Appendix A provides descriptions for each of the program tracks offered by the DCSEU in FY2018. The program groupings shown in Table 34 and subsequent tables are a function of the way DCSEU reports direct costs. Track-specific direct costs were provided at the four digit *job* level and some jobs include multiple tracks. For example, job number 7520 includes three commercial custom tracks: Retrofit (7520CUST), Market Opportunities (7520MARO), and New Construction (7520NEWC).

Table 34: Societal Cost Test Ratios by Scenario

Program(s)	Modified Replica Scenario #1	Updated Avoided Costs Scenario #2	Gross Verified Savings Scenario #3	Net Verified Savings Scenario #4
Solar PV Market Rate	1.82	1.03	1.03	1.03
Low-income Emergency Equipment Replacement	0.43	0.47	0.47	0.47
C& I RX – Equipment Replacement	7.57	6.02	6.11	5.99
Market Transformation Value	6.67	5.46	6.01	5.93
Commercial Upstream – Lighting	8.81	7.15	7.37	7.30
Commercial Custom	2.01	1.65	1.64	1.59
Low-income Custom Projects, Implementation Direct Install, Income Qualified Efficiency Fund	2.02	1.66	1.65	1.65
Low-income MF Comprehensive	2.24	1.77	1.78	1.77
Low-income Prescriptive Rebate	11.44	8.08	8.12	8.12
Retail – Smart Thermostats, Efficient Appliances, Heating & Cooling, Lighting, Market Rate Home Energy Conservation Kit	4.39	3.61	3.38	3.15
Low-income Home Energy Conservation Kit & Retail Lighting Food Bank	7.90	6.82	6.82	6.82
Residential Upstream	5.52	4.24	4.24	4.99
Total Portfolio Level	**2.34**	**1.88**	**1.87**	**1.83**

Incentives are neither a cost nor a benefit in the SCT Test. The incremental cost of the efficient measure is included in the SCT regardless of the proportion paid by the participant and program administrator. Program administration costs are treated as a cost in the SCT and include planning, IT, evaluation, marketing, customer service and all other non-incentive costs. Table 35 provides a breakdown of the FY2018 cost elements after moving increased fuel consumption to the benefits side of the ledger.

Table 35: FY2018 Cost Summary

Parameter	Cost Component	FY2018 Portfolio Total
A	Incentive Payments	$9,484,226
B	Participant Cost (Net of Incentives)	$90,615,917
C	Incremental Measure Cost (A + B)	$100,100,143
D	Track-specific Administrative Costs (Non-incentive)	$3,350,970
E	Portfolio Administrative Costs	$6,683,822
F	Total Program Administration Cost (D+E)	$10,034,792
G	**Total SCT Costs (C+F)**	**$110,134,935**

There are two different bins of administrative cost listed in Table 35. The track-specific administrative costs (Parameter D) are allocated to a specific program track, so they are

included as a cost in the track-level SCT results, presented in Table 35 and Section 2.2.1. The portfolio-level results presented in this report include both the track-specific administrative costs and portfolio administrative costs (Parameter E). This is the same approach used by the DCSEU to calculate cost-effectiveness, and is commonly used by other states and utilities. The implication of this methodology is that each of the track-level results is slightly overstated because the SCT ratio does not reflect its share of costs allocated to the portfolio as a whole. If track-level cost-effectiveness results are important to DOEE, we could work with the DCSEU to develop an allocation method. Possible allocation approaches could include kWh contribution, MMBtu contribution, or spending (Parameter A + D).

The DCSEU takes a strong position on the valuation of NEBs. In addition to a general 5% adder for the items listed in Table 33, a $100 per short ton ($110.23 per metric ton) benefit is assigned to all avoided CO2 emissions. The original DCSEU avoided cost values assume a more conservative marginal emission rate than the updated forecast developed by the NMR team, so the value of NEBs differs by scenario. Using Scenario #1, which replicates original DCSEU avoided costs, the NEBs (5% adder plus $100 per short ton for CO2) account for 28% of all SCT benefits. For the remaining scenarios, NEBs represent 40% of all SCT benefits. Without NEBs, the portfolio SCT ratios are still cost-effective using the updated avoided cost forecast. However, the ratios are much closer to one, at 1.69, 1.17, 1.16, and 1.12 for Scenarios #1, #2, #3, and #4, respectively. Table 36 shows the estimated lifetime reduction in CO2 emissions attributable to FY2018 programs by scenario.

Table 36: Lifetime CO2 Emission Reductions – FY2018 Programs

Scenario	Lifetime Avoided CO2 Emissions (Metric Tons)
1 – Modified Replica	595,777
2 – Updated Avoided Costs	853,680
3 – Gross Verified Savings	841,537
4 – Net Verified Savings	488,965

2.2.1 Cost-effectiveness Results

Table 37 presents the results of the NMR team's modified replica model. This scenario utilizes the DCSEU savings values, assumptions, and inputs. Eleven of the twelve program groups are cost-effective in this scenario and the portfolio is estimated to achieve $147 million of net benefits (benefits minus costs). There are a few key differences between this analysis (SCT ratio = 2.34) and the DCSEU analysis (SCT ratio = 2.14):

- The NMR model treats increased fossil fuel usage as a negative benefit rather than a positive cost. It is more appropriate to compare net benefit figures because the DCSEU model differed from the NMR team model in its treatment of interactive effects between space conditioning and lighting, as discussed in the Scenario #1 description.
- Reporting of participant shares and utility shares in the tracking data was not straightforward. There are instances where non-zero shares net to zero or do not add to the total cost. The NMR team implemented adjustments to make sure the values are correctly attributed and the shares equal the total cost.

- There were some differing cost and benefit values between the DCSEU results summary and the NMR team's replica model using the detailed program tracking data. The NMR team treated all cost data in the program tracking system as nominal 2018 dollars. DCSEU's model uses a mix of 2016, 2017, and 2018 as the present value base year. We recommend that DCSEU define *present* consistently when calculating net *present* value for future fiscal years.
- In the DCSEU analysis, the spillover impact was not correctly applied to solar projects installed through January 2018. DCSEU noted that a system error caused the FY2018 solar projects installed through January 2018 to screen against the non-solar set of measure screening assumptions. As a result, the SCT benefits reflected in the database are not what they should have been. The NMR replica model applies the 15% spillover assumption to all market rate solar PV savings.
- When site-specific hours of operation are utilized, DCSEU does not adjust the peak demand impacts stored in the program tracking data, but instead scales capacity benefits using the ratio of the site-specific operating hours to the TRM characterization. The replica model uses the kW impacts stored in the program tracking data to calculate capacity benefits. To the extent that the site-specific results are higher or lower than the TRM characterization, this is reflected in the NMR team's demand realization rate, which is incorporated into Scenario #3 and Scenario #4.

Table 37: Scenario #1 Modified Replica – SCT Results

Program(s)	Sector	SCT Benefit	SCT Cost	SCT Net	SCT Ratio
Solar PV Market Rate	Solar	$9,679,733	$5,328,925	$4,350,808	1.82
Low-income Emergency Equipment Replacement	Residential	$23,681	$55,088	-$31,407	0.43
C& I RX – Equipment Replacement	Commercial	$34,899,125	$4,607,301	$30,291,824	7.57
Market Transformation Value	Commercial	$4,473,339	$671,103	$3,802,235	6.67
Commercial Upstream – Lighting	Commercial	$7,172,166	$813,643	$6,358,523	8.81
Commercial Custom	Commercial	$161,193,595	$80,219,068	$80,974,527	2.01
Low-income Custom Projects, Implementation Direct Install, Income Qualified Efficiency Fund	Multifamily	$5,501,599	$2,726,835	$2,774,764	2.02
Low-income MF Comprehensive	Multifamily	$8,833,284	$3,950,468	$4,882,816	2.24
Low-income Prescriptive Rebate	Multifamily	$5,745,716	$502,213	$5,243,503	11.44
Retail – Smart Thermostats, Efficient Appliances, Heating & Cooling, Lighting, Market Rate Home Energy Conservation Kit	Efficient Products	$19,596,958	$4,465,945	$15,131,014	4.39
Low-income Home Energy Conservation Kit & Retail Lighting Food Bank	Efficient Products	$571,436	$72,289	$499,148	7.90
Residential Upstream	Efficient Products	$73,272	$13,273	$59,999	5.52
Total Portfolio Level	**Portfolio**	**$257,763,905**	**$110,134,935**	**$147,628,970**	**2.34**

Table 38 presents the results for Scenario #2. The updated forecast produced by the NMR team lowered the avoided costs for several key energy resources (kWh, peak kW, natural gas). This led to a reduction in the overall benefits for this scenario. However, the value of avoided CO2 emissions is higher in this scenario as the assumed emission rate (tons of CO2 per MWh) is greater in the NMR team's avoided cost forecast. The 15% spillover assumption for solar PV is also removed in Scenario #2. As a result, the Solar PV Market Rate track is estimated to be just above a cost-effective ratio of 1.0 in Scenario #2, whereas it was 1.82 in Scenario #1. Eleven program groups are cost-effective. For this scenario, only the Low-income Emergency Equipment Replacement track is not cost-effective. The portfolio is estimated to achieve $97 million of net benefits (benefits minus costs).

Table 38: Scenario #2 Updated Avoided Costs – SCT Results

Program(s)	Sector	SCT Benefit	SCT Cost	SCT Net	SCT Ratio
Solar PV Market Rate	Solar	$5,503,479	$5,328,925	$174,554	1.03
Low-income Emergency Equipment Replacement	Residential	$25,788	$55,088	-$29,300	0.47
C& I RX – Equipment Replacement	Commercial	$27,717,140	$4,607,301	$23,109,839	6.02
Market Transformation Value	Commercial	$3,664,988	$671,103	$2,993,885	5.46
Commercial Upstream – Lighting	Commercial	$5,819,274	$813,643	$5,005,631	7.15
Commercial Custom	Commercial	$132,363,919	$80,219,068	$52,144,851	1.65
Low-income Custom Projects, Implementation Direct Install, Income Qualified Efficiency Fund	Multifamily	$4,523,802	$2,726,835	$1,796,967	1.66
Low-income MF Comprehensive	Multifamily	$6,993,772	$3,950,468	$3,043,304	1.77
Low-income Prescriptive Rebate	Multifamily	$4,055,612	$502,213	$3,553,400	8.08
Retail – Smart Thermostats, Efficient Appliances, Heating & Cooling, Lighting, Market Rate Home Energy Conservation Kit	Efficient Products	$16,140,066	$4,465,945	$11,674,121	3.61
Low-income Home Energy Conservation Kit & Retail Lighting Food Bank	Efficient Products	$492,871	$72,289	$420,582	6.82
Residential Upstream	Efficient Products	$56,223	$13,273	$42,950	4.24
Total Portfolio Level	**Portfolio**	**$207,356,934**	**$110,134,935**	**$97,221,999**	**1.88**

Table 39 presents the results for Scenario #3. This scenario uses the same updated avoided costs forecast as Scenario #2. The electric energy, peak demand, and natural gas realization rates developed through the FY2018 impact evaluation were generally close to 100%, so the Scenario #3 SCT results were similar to Scenario #2 at the portfolio level. Eleven of the program groups are cost-effective in this scenario, and the portfolio is estimated to achieve over $96 million of net benefits (benefits minus costs).

Table 39: Scenario #3: Gross Verified Savings – SCT Results

Program(s)	Sector	SCT Benefit	SCT Cost	SCT Net	SCT Ratio
Solar PV Market Rate	Solar	$5,503,479	$5,328,925	$174,554	1.03
Low-income Emergency Equipment Replacement	Residential	$25,788	$55,088	-$29,300	0.47
C& I RX – Equipment Replacement	Commercial	$28,171,690	$4,607,301	$23,564,389	6.11
Market Transformation Value	Commercial	$4,032,031	$671,103	$3,360,927	6.01
Commercial Upstream – Lighting	Commercial	$5,999,100	$813,643	$5,185,457	7.37
Commercial Custom	Commercial	$131,217,398	$80,219,068	$50,998,330	1.64
Low-income Custom Projects, Implementation Direct Install, Income Qualified Efficiency Fund	Multifamily	$4,493,000	$2,726,835	$1,766,165	1.65
Low-income MF Comprehensive	Multifamily	$7,043,343	$3,950,468	$3,092,875	1.78
Low-income Prescriptive Rebate	Multifamily	$4,077,519	$502,213	$3,575,306	8.12
Retail – Smart Thermostats, Efficient Appliances, Heating & Cooling, Lighting, Market Rate Home Energy Conservation Kit	Efficient Products	$15,077,791	$4,465,945	$10,611,846	3.38
Low-income Home Energy Conservation Kit & Retail Lighting Food Bank	Efficient Products	$493,153	$72,289	$420,864	6.82
Residential Upstream	Efficient Products	$56,223	$13,273	$42,950	4.24
Total Portfolio Level	**Portfolio**	**$206,190,514**	**$110,134,935**	**$96,055,579**	**1.87**

Table 40 presents the results of Scenario #4. This scenario uses the updated avoided cost forecast developed by the NMR team and adjusts energy savings by incorporating realization rates and net-to-gross ratios. Eleven of the program groups are cost-effective in this scenario. Both the benefits and costs are reduced in this scenario because no savings (or benefits) are assigned to free riders and the incremental measure costs associated with free riders are not included as an SCT cost (because they would have purchased the efficient equipment absent the program). Although the SCT ratio is only slightly lower in Scenario #4 compared to Scenario #3 (1.83 vs. 1.87), the net benefits are significantly lower ($52 million vs. $96 million).

Table 40: Scenario #4: Net Verified Savings – SCT Results

Program(s)	Sector	SCT Benefit	SCT Cost	SCT Net	SCT Ratio
Solar PV Market Rate	Solar	$5,503,479	$5,328,925	$174,554	1.03
Low-income Emergency Equipment Replacement	Residential	$25,788	$55,088	-$29,300	0.47
C& I RX – Equipment Replacement	Commercial	$18,593,315	$3,104,891	$15,488,425	5.99
Market Transformation Value	Commercial	$3,628,828	$611,585	$3,017,243	5.93
Commercial Upstream – Lighting	Commercial	$5,099,235	$698,275	$4,400,960	7.30
Commercial Custom	Commercial	$60,306,209	$37,847,188	$22,459,021	1.59
Low-income Custom Projects, Implementation Direct Install, Income Qualified Efficiency Fund	Multifamily	$4,332,575	$2,625,101	$1,707,474	1.65
Low-income MF Comprehensive	Multifamily	$5,845,975	$3,304,680	$2,541,294	1.77
Low-income Prescriptive Rebate	Multifamily	$4,077,519	$502,213	$3,575,306	8.12
Retail – Smart Thermostats, Efficient Appliances, Heating & Cooling, Lighting, Market Rate Home Energy Conservation Kit	Efficient Products	$8,055,748	$2,559,902	$5,495,846	3.15
Low-income Home Energy Conservation Kit & Retail Lighting Food Bank	Efficient Products	$493,153	$72,289	$420,864	6.82
Residential Upstream	Efficient Products	$33,734	$6,759	$26,975	4.99
Total Portfolio Level	**Portfolio**	**$115,995,556**	**$63,425,678**	**$52,569,878**	**1.83**

2.2.2 Avoided Cost Update

As a part of the cost-effectiveness analysis, the NMR team reviewed the cost-effectiveness assumptions utilized by the DCSEU for measure screening. Table 41 summarizes the values and sources applied by DCSEU in their cost-effectiveness testing.

Table 41: DCSEU FY2018 Avoided Cost Summary

Screening Assumption	Value	Source
Future Inflation Rate	1.690%	Based on past ten years of consumer price index data, calculated October 2017.
Water Avoided Cost	Forecast by year and Sector	"Avoided Costs in Maryland," published April 2014, prepared for the Maryland Dept. of Natural Resources by Exeter Associates, Inc.
Real Discount Rate	4.343%	Ten-year treasury rate posted in the Wall Street Journal on the first business day of October 2017 (2.343%) plus 2% (as specified in the DCSEU contract no. DOEE-2016-C-0002).
Line Losses	8% (energy) 6% (demand)	Based on a PEPCO screening tool developed by ICF International, Inc.
Natural Gas Capacity Adder	5%	Per Section C.40.10.3 of contract DOEE-2016-C-0002.
Transmission Cost	$25.229/kW-year	PEPCO's 2017 filing of the FERC formula transmission rate update.
Distribution Cost	$220.180/kW-year	Calculated based on PEPCO's indication that distribution costs are 8.73 times that of transmission costs.
Electric & Fuel Externalities	$100 per short ton (2,000 pounds) ($110.23 per metric ton)	"2018 DC externality values" memo for methodology.
Electric Energy Cost	Forecast by Year and Period	"Avoided Costs in Maryland," published April 2014, prepared for the Maryland Dept. of Natural Resources by Exeter Associates, Inc.
Electric Power Cost	Forecast by Year	"Avoided Costs in Maryland," published April 2014, prepared for the Maryland Dept. of Natural Resources by Exeter Associates, Inc.
Natural Gas Cost	Forecast by Year and Sector	"Avoided Costs in Maryland," published April 2014, prepared for the Maryland Dept. of Natural Resources by Exeter Associates, Inc.
Other Fuels Cost	Forecast by Year, Fuel, and Sector	"Avoided Costs in Maryland," published April 2014, prepared for the Maryland Dept. of Natural Resources by Exeter Associates, Inc. Kerosene costs sourced from "Avoided Energy Supply Costs in New England: 2015 Report." The average ten-year historical price ratio between the DC and New England retail markets, sourced from the U.S. EIA, was used to adjust values to the DC market.

Screening Assumption	Value	Source
Risk Adder	5%	Specified in the DCSEU contract no. DOEE-2016-C-0002.
NEB Adder	5%	Specified in the DCSEU contract no. DOEE-2016-C-0002.

The primary source for the core energy benefits in Table 41 is a 2014 avoided cost study from Maryland. There is significant uncertainty in any long-range forecast of commodity prices, and the 2014 Maryland avoided cost proved to be a poor forecast, at least in the short term. The study was developed when market prices for electricity and natural gas were higher than they are currently, and had been increasing for the previous one or two years. The Exeter study forecast them to continue increasing somewhat sharply over time. However, the opposite has occurred and energy prices have declined. Low natural gas prices, improving average heat rates,[16] and small spark spreads[17] have created very low market prices for electric energy.

Because the vintage of the avoided cost forecast led to questionable SCT results for FY2017 – and because of the fact that several of the non-energy benefits streams were adders to the energy benefits – the NMR team developed updated avoided cost values for several energy benefit streams. The updated values were used to model cost-effectiveness in Scenario #2, #3, and #4 in both the FY2017 and FY2018 reports. The methodology of the updates is discussed in detail in the FY2017 report;[18] however, the five main areas of impact are summarized here.

- Electric Energy values were updated by calculating a new load-weighted marginal price by energy period and the resulting marginal cost per kWh was about 40% lower than DCSEU's assumption.
- Electric Generation Capacity was replaced through compiling the Base Residual Auction[19] clearing prices for the years in which they occurred during DCSEU's fiscal years. Forecasted values result from an average of the 15 delivery years that PJM has held capacity auctions.
- Electric Distribution Capacity was reduced from $202.754/kW-year to $80/kW-year, based on professional judgement.
- Avoided Cost of Natural Gas was replaced with projected prices for the industrial sector from the EIA Energy Price by Sector and Source report.[20] Retail industrial prices are used because they best approximate marginal cost. A single price is used rather than the DCSEU's separate pricing for Residential and Commercial sectors.

[16] The heat rate of a power plant is the amount of fuel (Btu) used to generate one kWh. The more efficient the plant, the lower the heat rate.
[17] Spark spread is the difference between the fuel cost and price received per unit of electricity for a gas-fired generator.
[18] https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/DCSEU%20FY2017%20Performance%20Benchmarks%20report%20-%20FINAL%20092818.pdf
[19] https://www.pjm.com/markets-and-operations/rpm.aspx
[20] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2018&region=1-2&cases=ref2018&start=2016&end=2050&f=A&linechart=ref2018-d121317a.3-3-AEO2018.1-2&map=ref2018-d121317a.4-3-AEO2018.1-2&sourcekey=0

- Carbon Emissions from Electricity Production values were adjusted through a change to assumed marginal emissions rates for production of electricity. The NMR team maintained DCSEU's $100 per short ton ($110.23 per metric ton) value for avoided carbon emissions. The updated emissions rate values were pulled from PJM's 2013-2017 CO_2, SO_2, and NO_x Emissions Rate Report,[21] published in March 2018.

2.2.3 Cost-effectiveness Recommendations

The FY2018 cost-effectiveness analysis required the NMR team to explore in detail several of the energy, economic, and policy assumptions used by the DCSEU. Based on the review, we offer the following observations and recommendations:

- Although the calculation of SCT benefits and costs happens in external workbooks, the mechanics of the DCSEU tracking system are expertly organized to facilitate benefit cost modeling. The application was well-documented and the DCSEU staff was very responsive to inquiries.
    - It is surprising that the NMR team's replica model shows more SCT benefits than the DCSEU calculations when the NMR model treats interactive effects as a negative benefit rather than a cost. NMR will continue to work with DCSEU to improve alignment as we load FY2019 tracking data into our benefit-cost model and compute SCT benefits.
- Several of the financial assumptions used to monetize program impacts were questionable. The issues are largely a function of vintage as the primary analysis used to develop the forecast is almost five years old.
    - Many of the key inputs were updated as part of the FY2017 evaluation.
    - For FY2019, DCSEU has implemented an updated avoided cost forecast that is well-aligned with the avoided costs used by the NMR team in Scenario #2, #3, and #4.
    - Avoided costs should receive a complete and thorough review at the beginning of each new contract period. The current contract period is five years, and it began without a refresh of avoided cost values. Updates to avoided costs should be an initial step in planning program cycles.
- The handling of dual baselines was well executed in the DCSEU system. The most important dual baseline measure is LED lighting. The DCSEU savings assumptions for FY2018 assume implementation of the 2020 Energy Independence and Security Act (EISA) Phase II backstop. Energy savings from screw-based LED lamps were assigned full savings for three years and then a significantly reduced annual savings value for the remainder of their useful life.

[21] http://www.pjm.com/-/media/library/reports-notices/special-reports/20180315-2017-emissions-report.ashx?la=en

- Implementation and enforcement of the 2020 backstop provision at the federal level is highly uncertain. DOE is currently proposing a change to the definition of General Service Lighting that would remove reflector, globe, and candelabra lamp types from the catalog of lighting subject to the 2020 backstop.
- For FY2019 and FY2020, we recommend the DCSEU weigh the available evidence and consult with the evaluation team and DOEE to decide how to handle the EISA backstop provision in lighting baseline assumptions.

- Incremental costs for LED lighting were significantly overstated. The assumed cost of LED lamps was between $9 and $14 for FY2018. The retail cost of ENERGY STAR LED lamps has dropped rapidly and is currently $3-$5 per lamp. Assuming a $1.50 cost for a halogen bulb means the incremental measure cost should be closer to $3/lamp.
  - The DCSEU tracking system has actual retail prices for all upstream lamps, so it is unclear why the calculations rely on dated cost assumptions rather than actual values. If the actual retail prices can be leveraged for FY2019 cost-effectiveness, it will be important to carefully distinguish per-package prices from per-lamp prices.
  - Reducing the incremental cost assumptions would improve the cost-effectiveness of retail lighting measures.

- Reduced CO2 emissions and other NEBs represent a significant share of the SCT benefits from FY2018 programs.
  - The $100 per short ton ($110.23 per metric ton) assumption for avoided CO2 emissions should be reviewed to ensure it is consistent with the District's policy objectives and other regional research on the value of reduced carbon emissions. There is considerable variation in estimates of the value of CO2 emissions, but several recent estimates have placed the social cost in the $40-$50 per ton range.
  - The 5% adder for non-energy benefits other than CO2 emissions is a proxy value to recognize tangible benefits that are challenging to directly quantify. The NMR team will work closely with DCSEU and DOEE to assess the appropriate value for the NEBs adder and possibly incorporate NEB research into our future evaluation activities.

Appendix A Program Descriptions

This appendix provides a description for each of the program tracks offered by DCSEU in FY2018.

A.1 Commercial Sector

C&I RX - Equipment Replacement (7511CIRX)

The C&I RX Equipment Replacement initiative provides rebates to small-to-medium sized businesses and institutions. The program offers prescriptive incentives for lighting, HVAC, compressed air, refrigeration, food service, and vending equipment. Rebates require written pre-approval and are provided for facility improvements that result in a permanent reduction in electrical and/or natural gas energy usage (persisting for a minimum of five years). The DCSEU provides per-unit rebates of up to $5 per bulb for screw-in LEDs, $40 per fixture for more advanced interior lighting, $60 per fixture for exterior lighting, $10-$20 per sensor for installation of lighting controls, $350 for an efficient reach-in refrigerated case, and $750 for installation of qualifying commercial kitchen equipment. Other measures are rebated based on the size and efficiency of the equipment, with all rebates capped at 100% of the participant cost.

Market Transformation Value (7512MTV)

The MTV program provides rebates to large businesses and institutions for lighting upgrades. The program offers prescriptive incentives for lighting. The DCSEU provides per-unit rebates of up to $5 per bulb for screw-in LEDs, $40 per fixture for more advanced interior lighting, $60 per fixture for exterior lighting, and $10-$20 per sensor for installation of lighting controls. The program completed seven unique projects during FY2018.

Commercial Upstream (7513UPLT)

The Commercial Midstream/Upstream program provides instant rebates to customers purchasing lighting equipment through qualified distributors. Through this program, customers can purchase light bulbs from any one of nine participating distributors, including ENERGY STAR 2.0 certified LED directional, omnidirectional, and decorative bulbs, as well as DLC certified linear LED tubes.

Retrofit - Custom (7520CUST)

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

Market Opportunities - Custom (7520MARO)

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

New Construction - Custom (7520NEWC)

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

A.2 Solar Sector

Solar PV Market Rate (7101PVMR)

The PVMR Program provides incentives to buildings that install solar panels that produce local electric energy to reduce their consumption from the electric grid. The program is looking to meet the DCSEU performance benchmark and address the needs of the solar market by serving as a low- or no-cost technical assistance center for solar installations. This effort will supplement the Solar for All program, which DCSEU recently signed a contract amendment with DOEE to support.

A.3 Multifamily Sector

Implementation Contractor Direct Install (7610ICDI)

The Low-income Multifamily (LIMF) Implementation Contractor Direct Install (ICDI) initiative supports low-income multifamily communities in the District of Columbia. Under this program, DCSEU hires implementation contractors to install energy-efficient equipment in eligible buildings and covers 100% of the product and installation costs. Measures covered can be in-unit or common area measures and may include the installation of heating and cooling systems, domestic hot water systems, in-unit and common area lighting, refrigeration, and controls. While this track is aimed at low-income residences, multifamily residential buildings that do not meet the low-income requirements are eligible to install common space fixtures under this track. DCSEU promotes this opportunity to property owners, property managers, developers, architects and engineers.

Income Qualified Efficiency Fund (7610IQEF)

The Income Qualified Efficiency fund is an initiative designed to serve low-income, multifamily housing, shelters, and approved clinics. DCSEU approved contractors are awarded funding to implement energy-efficiency projects, which will provide energy and financial savings benefits for low-income DC residents. Efficiency measures receive priority that maximize energy savings, reach a large number of low-to-moderate income residents, and/or assist residents who face a loss of heating or air conditioning due to inoperable equipment. Measures eligible for funding include domestic hot water systems, lighting, appliances, controls, and measures improving the thermal envelope.

Low-income Custom Projects (7610LICP)

The Low-income Custom Project initiative is designed to serve low-income multifamily housing – specifically, new construction, substantial renovation, and redevelopment housing. This program works with developers and owners of low-income multifamily projects to provide custom technical services and incentives for energy-efficiency improvements. Each project is independently evaluated and specific energy conservation measures (ECM) are chosen depending on the project's needs. Projects are generally focused on specific end uses and may include thermal envelope (air and thermal barriers, doors, and windows) improvements, domestic hot water systems, in-unit and common area lighting, appliances, and controls.

Low-income Multifamily Comprehensive (7612LICP)

The Low-income Multifamily Comprehensive program supports energy-efficiency measures in gut-rehab or new construction projects of low-income multifamily buildings. Each project is evaluated independently and energy-efficiency measures are selected to best meet the project's needs. Supported measures include domestic hot water systems, lighting, appliances, controls and thermal envelope measures. The program enables DCSEU to provide technical expertise and funding to comprehensive energy-efficiency upgrades or installations in low-income multifamily housing.

Low-income Prescriptive Rebate (7613LIRX)

The Low-income Prescriptive Rebate program provides financial support for lighting installations in low-income multifamily housing and low-income shelters and clinics. Approved installations must be EnergyStar or Design Lighting Consortium qualified. This initiative enables DCSEU to provide incentives and custom technical services for lighting improvements to low-income multifamily establishments.

A.4 EFFICIENT PRODUCTS SECTOR

Retail Efficient Appliances (7710APPL)

The Retail Efficient Appliances program offers mail-in and online rebates for qualifying refrigerators, clothes washers, clothes dryers, heat pumps, air conditioners, boilers, furnaces, thermostats, and other products. Under this initiative, DCSEU partners with local retailers and contractors to promote these rebates, providing rebate forms in retail stores when possible.

Retail Lighting (7710LITE)

DCSEU supports the installation of LED lighting in the District through its Retail Efficient Lighting Program. This initiative coordinates with lighting retailers and manufacturers to increase the availability of LEDs and offer them at lower prices in the District of Columbia. The initiative also aims to increase awareness of LED technology through educational materials as LEDs are less familiar to residents than CFLs or incandescent bulbs.

Home Energy Conservation Kit - Market Rate (7710HEKT)

The Home Energy Conservation Kit - Market Rate track was developed to track non-low-income installs for energy-efficiency kits sent to residents of the District. The only measures in this track are home energy conservation kits, which include an advanced power strip, a faucet aerator, and six LEDs. These kits offer District residents a free, easy way to implement energy savings measures.

Retail Heating and Cooling (7710HTCL)

The Retail Heating & Cooling project track works with participating contractors in the District to install heating and cooling equipment in residential applications. Measures found in this track include central air conditioners, ductless heat pumps, domestic hot water, programmable thermostats, boilers, furnaces, and air-source heat pumps.

Retail Smart Thermostats (7710STAT)

The Retail Smart Thermostats program aims to reduce HVAC energy use by offering rebates for the installation of smart thermostats in DC homes. DCSEU partners with Nest and local retailers to offer point-of-sale or conventional rebates for qualifying thermostats. Residents who install Nest thermostats can enroll in the Nest Thermostat Seasonal Savings program to garner additional energy savings.

Retail Lighting Food Bank (7717FBNK)

The Food Bank Energy Efficient Lighting Distribution initiative supplies LEDs to low-income households in the District of Columbia that receive goods from participating food banks. The DCSEU provided LEDs to residents after verifying that their household is located in the District and conducted a short survey with the client to determine the appropriate number of bulbs needed.

Home Energy Conservation Kit - Low-income (7717HEKT)

The Home Energy Conservation Kit - Low-income track was developed to track low-income installs for energy-efficiency kits sent to residents of the District. The only measures in this track are home energy conservation kits, which include an advanced power strip, a faucet aerator, and six LEDs. These kits offer low-income District residents a free, easy way to implement energy savings measures.

Residential Upstream (7725RSUP)

The Residential Upstream project track is used to track the upstream program of residential, efficient lighting projects purchased through electrical distributors. Participating electrical distributors buy down the price of the lighting products, offering a point-of-sale rebate to their

customers. Eligible products include TLEDs, directional LEDs, and omnidirectional LEDs. After sale, the distributors submit rebate documentation to DCSEU for reimbursement.

A.5 SINGLE-FAMILY RESIDENTIAL SECTOR

Low-income Emergency Equipment Replacement (7413LIER)

The Low-income Emergency Equipment Replacement initiative is designed to serve the low-income homeowner that is referred to the DCSEU from the DC Department of Energy & Environment Low-income Home Energy Assistance Program (LIHEAP). The approved specific ECMs include furnaces, boilers, domestic hot water systems, appliances, and controls. Each project utilizes the TRM to determine energy savings.

B

Appendix B Detailed Program Recommendations

This section contains detailed program recommendations from the *Evaluation of DC Sustainable Energy Utility FY2018 Programs* report.

The evaluation of the FY2018 programs found that DCSEU expended the appropriate amount of effort and rigor on their savings calculations. In general, the documentation provided was thorough, and the methods and assumptions were suitable. The evaluation team believes the DCSEU calculated energy savings with a reasonable degree of accuracy.

However, our evaluation yielded several key findings and recommendations, as described below. While DCSEU prescriptive savings estimates were reasonable, in aggregate, for FY2018 programs, the NMR team believes the DCSEU can continue to improve calculation methods, but should prioritize those improvements which offer the most cost effective outcomes. The bullet below outlines a recommendation that applies to all of the prescriptive programs.

- **Apply project-specific efficiency levels and capacities to improve the accuracy of tracked savings when feasible**. Deemed values or ranges for efficiency levels, wattages, capacities, and configurations were input into savings algorithms when site specific information was available. This issue was most prominent for commercial lighting where the actual wattage values for program-incentivized lighting were often lower than the tracked wattage values resulting in higher electricity savings as well as a larger gas heating penalty. Also, efficiency and capacity values for HVAC equipment were sometimes based on nominal ratings rather than project-specific values. In these cases, project-specific input values were available, which would improve the accuracy of tracked savings. DCSEU should examine how integrating site-specific information within the tracking system can be done efficiently for instances where these data are already collected from customers.

For the CIRX Equipment Replacement and Market Transformation Value programs, we offer the following recommendations.

- **Calculate summer coincidence factors for lighting to ensure that peak demand savings are not understated due to an incongruency in energy and demand load shapes.** The DCSEU uses a blended interior commercial lighting coincidence factor[22] (CF) of 58%; however, the hours of use (HOU) is a continuous variable that can be adjusted. The CF and HOU values typically have a proportional relationship that should be maintained for savings to be accurately estimated. The bulk of discrepancies stem from the blended CF being used for lighting that operates continuously 24/7. At a minimum, a flag should be used to apply a CF of 100% to any lighting that continuously operates.

[22] A coincidence factor quantifies the likelihood that the lighting measures will be turned on during DCSEU's peak demand window of 2:00 PM to 6:00 PM from June through August.

- **Reduce summer coincidence factor to 0% for exterior LEDs.** The TRM assigns a 3.7% summer coincidence factor for exterior lighting. However, most exterior LEDs come standard with integral photocells and an analysis of historical sunrise and sunset times shows that fixtures controlled by photocells will not have any summer coincidence. As noted above, exceptions should be made for 24/7 lighting where the summer CF equals 100%.
- **Apply the waste heat factor based on the installation location of the lighting product**. SEU currently assumes that 26% of lighting products are installed in exterior or unconditioned spaces. Waste heat factors[23] are applied to all measures that are considered likely to be interior equipment regardless of the location under the assumption that the waste heat factor appropriately captures the likelihood of the measure being exterior. However, our review indicates that installation location data is generally available and, if not, could be assigned based on the type of bulb or fixture. We found the location data to be accurate based on available project details and submitted lamp specification sheets. Assigning waste heat factors in this fashion should be straightforward to implement and would improve the accuracy of tracked savings.
- **Update the DCSEU lighting calculator to reflect the current TRM lighting assumptions.** The DCSEU calculator used assumptions from the 2017 TRM rather than the 2018 TRM. The evaluation team understands the calculator is used internally at DCSEU and does not impact final savings claims. However, the NMR team believes maintaining internal consistency is beneficial to avoid technical errors and maintain consistent customer communication.

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

- **Streamline the CI RX application and use simpler, more accessible language for potential applicants.** The results from the CI RX program staff and partner interviews indicated that application requirements might be burdensome for some customers. Partners noted that some commercial customers might not understand the technical language on the application.
- **Maintain existing CI RX digital marketing and outreach efforts but consider additional options for face-to-face engagement.** Nearly two-thirds of CI RX participating customers reported that they had visited the DCSEU website for information, indicating that the website is known and accessible to the majority of customers. However, face-to-face engagement may help foster personal relationships and develop other connections with specific market segments such as small businesses and contractor networks.

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

[23] The waste heat factor accounts for cooling savings from efficient lighting.

- **Calculate peak demand savings independently from energy savings for Custom Retrofit projects.** When sufficient information exists for Custom Retrofit projects, peak demand savings should be calculated independently of energy savings, incorporating an appropriate summer coincidence factor, because peak demand savings do not necessarily scale linearly with hours of use.
- **Utilize rated efficiencies at standard test conditions whenever possible.** Code minimums must be met at standard conditions, and adjustments should only be made if the equipment cannot be tested at standard conditions.
- **Continue promoting the value of technical assistance**. Program staff and partners noted that the limited incentives for the Custom Retrofit program might pose a barrier to participation. However, technical assistance and sharing of best practices provide supplemental benefits to engaging with the DCSEU.

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

- **Confirm that building simulation models are fully updated for commercial new construction projects.** First, verify the savings claimed in the tracking database match the final version of savings from the building models. Second, cross-check the measures claimed within the models to ensure that specific equipment, such as variable speed drives, controls, or garage CO sensors, so that savings for code required measures are removed after any baseline scaling calculations. Third, verify the application of coincidence factors to estimate peak demand savings.
- **Review modeled outputs for excessive lighting interactive effects penalties.** Projects which utilized energy simulations included heating penalties for upgraded lighting. However, in two cases the heating penalty was uncharacteristically high. The DCSEU should carefully review the calculated heating penalties when different heating systems are used in the baseline and efficient case to ensure heating penalties remain reasonable.
- **Improve communication about projected incentive amounts.** Program partners expressed concern regarding the lack of information about anticipated incentives for new construction projects. They suggested sharing examples of historic incentive awards or offering an expected incentive range. Providing greater clarity regarding anticipated incentives will help reduce confusion and garner earlier buy-in.
- **Increase transparency of DCSEU staff roles and responsibilities.** Because new construction partners voiced confusion regarding the appropriate DCSEU staff to contact, they would benefit from an organizational chart including whom to contact for which issues. This information may also improve response times and partners' experiences with the approval process.

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

- **Continue to utilize the PV Watts model for predicting solar generation data when actual production data is not available.** If solar generation data is available to the

DCSEU, actual generation data should be prioritized over the theoretical estimates of the PV Watts tool.

- **With the expansion of the Solar programs, the DCSEU should emphasize its technical expertise and assistance.** While financial incentives may be limited, the DCSEU should promote the value of non-financial contributions such as their technical expertise and assistance.

For the Retail Smart Thermostats program, we offer the following recommendations:

- **Continue to promote the smart thermostats' distinct characteristics in marketing materials**. Most smart thermostat participants reported positive experiences with their thermostat and provided high satisfaction ratings with its different features. Marketing materials should provide equal if not more emphasis on addressing concerns related to ease of use as on reducing costs.
- **Revise the approach to estimating savings from the Seasonal Savings initiative.** The impacts of the Seasonal Savings program are season specific. Therefore, a separate tracking record should be created for each season as the number of participating thermostats will vary. Second, because small control groups increase the uncertainty of the savings estimate, we recommend a control group size of at least 3,000 thermostats. Third, model specification is important when both the control group and effect are small, so consider selecting the model a priori to eliminate any perception of bias. Fourth, we recommend aligning the claimed savings with the same fiscal year when the Nest fees are incurred.

For the Low-income Multifamily Comprehensive program, we offer the following recommendation:

- **Confirm that heating fuel types are coded correctly so that the appropriate waste heat factors for lighting are applied.** We identified a few projects that were coded as having gas heat when in fact they had electric heat. This discrepancy affects both the electric savings and gas savings due to the application of fuel-specific waste heat factors.