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August 1, 2017

VIA ELECTRONIC FILING

The Honorable Jocelyn G. Boyd
Chief Clerk/Administrator
Public Service Commission of South Carolina
101 Executive Center Drive, Suite 100
Columbia, South Carolina 29210

Re: Application of Duke Energy Progress, LLC for Approval of Rider 9
Docket No. 2017-__-E

Dear Ms. Boyd:

Enclosed for filing please find the Application of Duke Energy Progress, LLC for Approval of Rider 9, Demand-Side Management and Energy Efficiency. We are providing a copy to the S.C. Office of Regulatory Staff.

Should you have any questions regarding this matter, please do not hesitate to contact me at 803.988.7130.

Sincerely,

Rebecca J. Dulin

Enclosure

cc: Mr. Jeffrey Nelson, Chief Counsel & Director of Legal Services
Mr. Andrew Bateman, Office of Regulatory Staff
Ms. Shannon Hudson, Office of Regulatory Staff

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BEFORE
THE PUBLIC SERVICE COMMISSION
OF SOUTH CAROLINA

DOCKET NO. 2017-__-E

In re:	)	
Application of Duke Energy Progress, LLC. For Approval of Rider DSM/EE-9	)	DUKE ENERGY PROGRESS, LLC'S APPLICATION FOR APPROVAL OF RIDER DSM/EE-9

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Pursuant to S.C. Code Ann. § 58-37-20 (Supp. 2016) and 10 S.C. Code Ann. Regs. 103-819 and 103-823 (Supp. 2016), the Rules of Practice and Procedure of the Public Service Commission of South Carolina ("Commission"), Duke Energy Progress, LLC (the "Company" or "DEP") respectfully requests that the Commission approve its application for Rider DSM/EE- 9 ("Rider 9") to recover certain costs and revenue associated with its demand side management ("DSM") and energy efficiency ("EE") programs. Rider 9 provides for the recovery of DSM/EE costs allocated jurisdictionally to South Carolina for the test period, January 1, 2016 through December 31, 2016, and for the forecast period, January 1, 2018 through December 31, 2018; net lost revenues for DSM and EE programs as applicable; and program/portfolio performance incentives ("PPI") as applicable, in accordance with Order No. 2015-596.[1]

In support of this Application, Duke Energy Progress shows the Commission the following:

NAME AND ADDRESS OF DUKE ENERGY PROGRESS

1. The general offices of Duke Energy Progress, LLC are located at 410 South Wilmington Street, Raleigh, North Carolina; its mailing address is Post Office Box 1551, Raleigh, North Carolina 27602-1551.

NOTICES AND COMMUNICATIONS

2. The names and addresses of the attorneys of DEP who are authorized to receive notices and communications with respect to this Application are:

[1] *Application of Duke Energy Progress, LLC to Establish a New Cost Recovery and Incentive Mechanism for Demand-Side Management and Energy Efficiency Programs*, Docket No. 2015-163-E, Order No. 2015-596 (August 19, 2015) ("Order No. 2015-596").

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DESCRIPTION OF THE COMPANY

3. The Company is engaged in the generation, transmission, distribution, and sale of electric energy at retail in the eastern portion of South Carolina and eastern and western portions of North Carolina. It also sells electricity at wholesale to municipal, cooperative, and investor-owned electric utilities. DEP is a public utility under the laws of South Carolina and is subject to the jurisdiction of this Commission with respect to its operations in this State. The Company also is authorized to transact business in the State of North Carolina and is a public utility under the laws of that state. Accordingly, its operations in North Carolina are subject to the jurisdiction of the North Carolina Utilities Commission.

BACKGROUND

4. The Commission approved the Company's new cost recovery mechanism and compensation model for DSM and EE (the "New Mechanism") in Order No. 2015-596. The New Mechanism effective January 1, 2016, replaces the cost recovery mechanism and compensation model reflected in the stipulation approved by the Commission in Order No. 2009-373 (the "Stipulation").

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5. In pertinent part, the New Mechanism provides that the revenue requirements for DEP's EE and DSM programs recover a reasonable and appropriate estimate of the expenses and net lost revenues expected to be incurred during the rate period along with any PPI earned. Costs are deferred and amortized over a period of time not to exceed ten years, and DEP can earn a rate of return at the overall weighted average net-of-tax rate of return approved in the most recent general rate case on the unamortized balance of such costs. DEP can also defer and recover through its Rider the difference between the reasonable and prudent DSM/EE costs incurred during the test period and the revenues actually realized during such test period under the Rider then in effect. The Rider is to be trued up each year to reflect the difference between the reasonable expenses prudently incurred, net lost revenues incurred, and PPI based on realized results during the test period and the revenues that were actually realized during the test period under the DSM/EE Rider then in effect. Net lost revenues can be recovered for the first 36 months after the installation of the measure and shall be trued up in the first DSM/EE cost recovery proceeding following the completion and review of a program or measure's impact evaluation. The kWh sales reductions that result from measurement units installed will cease being eligible for use in calculating net lost revenues as of the effective date of the implementation of new rates approved by the Commission in a general rate case or comparable proceeding to the extent the rates set in the general rate case are set to explicitly or implicitly recover the net lost revenues associated with those kWh sales reductions.[2] The PPI shall be based on the net dollar savings of the portfolio as calculated using the Utility Cost Test.[3]

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[2] Order No. 2015-596, p. 16. Please note that net lost revenues are not requested for Vintages 2014 and 2015 for billing periods subsequent to January 1, 2017, when new general base rates were implemented as a result of the Duke Energy Progress general rate case.

[3] Id. at page 18, section L.

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RIDER 9 RATE OVERVIEW

6. The revenue Duke Energy Progress proposes to recover under the proposed Rider 9 is as follows: `

- $27,853,090 from Residential Customers and
- $11,915,832 from General Service Customers.

7. For Rider 9, the billing factors were separated to reflect participation in EE programs, DSM programs, or both EE and DSM programs. The proposed Rider 9 billing factors include prospective and true-up components.

Based on the total costs to be recovered under the proposed Rider 9, the billing factors applicable to South Carolina customers for the billing period January 1, 2018 through December 31, 2018, inclusive of gross receipts taxes ("GRT") and South Carolina Regulatory Fees, would be as follows (shown in cents per kWh):

Rate Class	EE Rate	DSM Rate	Adjustment*	DSM/EE Annual Rider
Residential	0.846	0.421	0.015	1.282
General Service – EE only	0.624		0.002	0.626
General Service – DSM only		0.146	0.001	0.147
Lighting	0.000	0.000	0.000	0.000

** Adjustment to include charges related to Residential RECD discount, SC GRT and Reg Fee*

Note: All billing factors are rounded to the nearest thousandth of a cent

A summary of the calculations used to determine these billing factors and the revenue requirement for Rider 9 can be found in Exhibit 1 and Exhibit 2 (pages 1 and 2).

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The support calculations for Exhibits 1 and 2 are included within Exhibits 3 through 15.

8. A detailed description and evaluation of the Company's EE and DSM programs for 2016 is set forth in Exhibit 11.

9. DEP submits the following information as required in Order No. 2015-596. DEP performed cost-effectiveness test evaluations for each of its approved DSM & EE Programs and prospective aggregated portfolio-level cost-effectiveness test evaluations. These prospective cost-effectiveness test results are attached as Exhibit 15.[4] Program modifications are addressed in Exhibit 11.

For each Program or Measure for which it seeks PPI inclusion, DEP provides the annual projected and actual utility costs, participant costs, number of Measurement Units installed, per kW and kWh impacts for each Measurement Unit, and per kW and KWh avoided costs for each Measurement Unit consistent with the UCT, related to the applicable Vintage Year installations for which it seeks approval in attached Exhibit 7.[5] Information on projections and the variance drivers is included in Exhibit 14. DEP also includes a report of all interim measurement and verification data in attached Exhibit 12.[6]

CONCLUSION

Based on the foregoing, the Company respectfully requests that the Commission approve its Rider 9 as described in this Application. Additionally, the Company respectfully requests the Commission to allow the proposed rates to be put into effect without notice and hearing

[4] Id. at p. 6.
[5] Id. at p. 19.
[6] Id. at p. 21.

pursuant to S.C. Code Ann. Section § 58-27-870(F). The proposed rates do not require a determination of the entire rate structure and overall rate of return, and will facilitate an orderly rate administration.

Submitted this 1st day of August, 2017.

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Rider 9 Exhibits

Exhibit 1	Summary of DSM/EE Billing Rates
Exhibit 2, page 1	Energy Efficiency Rate Derivation
Exhibit 2, page 2	Demand Side Management Rate Derivation
Exhibit 2, page 3	Rate Period Revenue Requirement Summary
Exhibit 2, page 4	Determination of Net Revenue Requirement for Test Period
Exhibit 2, page 5	Test Period Revenue Requirement Adjustments
Exhibit 2, page 6	EMF Period Revenue Requirement Summary
Exhibit 2, page 7	Revenue Adjustment Factors
Exhibit 3	Calculation of Interest
Exhibit 4	2016 Actual Revenues
Exhibit 5, page 1	Allocation Factor Summary through 2015
Exhibit 5, page 2	Allocation Factor for Year 2016
Exhibit 5, page 3	Allocation Factor for Year 2017 and Estimated Factor for Year 2018
Exhibit 5, page 4	Energy Allocation Factors
Exhibit 5, page 5	Demand Allocation Factors
Exhibit 6	Forecasted 2018 kWh Sales and Actual 2016 Opt out kWh
Exhibit 7, pages 1 and 2	True up for 2014 Load Impacts and Estimated Revenue Requirements, Excluding Lost Revenue by Program
Exhibit 7, pages 3 and 4	True up for 2015 Load Impacts and Estimated Revenue Requirements, Excluding Lost Revenue by Program
Exhibit 7, pages 5 and 6	True up for 2016 Load Impacts and Estimated Revenue Requirements, Excluding Lost Revenue by Program
Exhibit 7, pages 7 and 8	Estimated 2018 Load Impacts and Revenue Requirements, Excluding Lost Revenue by Program
Exhibit 8, pages 1 and 2	SC Net Lost Revenue for Vintages 2013-2018
Exhibit 8, pages 3 through 6	SC Net Lost Revenue True-Up for Vintages 2014-2015
Exhibit 9	Actual Program Costs – Year 2016
Exhibit 10	Found Revenue
Exhibit 11	Program Descriptions
Exhibit 12	EM&V Activities & Reports
Exhibit 13A	Opted-Out in 2016
Exhibit 13B	Opted-In and Participated in 2016
Exhibit 14	Changes from Prior Filing Due to Application of M&V and Participation; System kWh and kW Impacts Net Free Riders at the Plant
Exhibit 15	Projected Cost Effectiveness for Vintage 2018

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Exhibit 1

DUKE ENERGY PROGRESS, LLC

Docket No. 2017-XX-E

Summary of DSM/EE Billing Rates - January 2018 through December 2018

All rates are shown in cents per kWh

Rates Net of South Carolina Gross Receipts Taxes (GRT) and Regulatory Fee

SC Rate Class	EE Rate (1)	DSM Rate (2)	Total EE/DSM Rate (3)	RECD Adjustment (4)	DSM/EE Billing Rate (5)
Residential	0.845861	0.420740	1.266601	0.009542	1.27614
General Service (EE only)	0.623671		0.623671	0.000000	0.62367
General Service (DSM only)		0.146051	0.146051	0.000000	0.14605
Lighting	0.000000	0.000000	0.000000	0.000000	-

Rates Including SC Gross Receipts Taxes at 0.30% and Regulatory Fee at 0.146722%

SC Rate Class	DSM/EE Rate *(net of GRT and Regulatory Fee)* (6)	Gross Receipts Tax and Regulatory Fee Adjustment (7)	DSM/EE Billing Rate (8)
Residential	1.27614	0.00573	1.282
General Service (EE only)	0.62367	0.00280	0.626
General Service (DSM only)	0.14605	0.00066	0.147
Lighting	0.00000	0.00000	0.000

NOTES:

(1) Total EE Rate is derived in Exhibit 2 page 1, column (10).
(2) Total DSM Rate is derived in Exhibit 2 page 2, column (10).
(3) Total DSM/EE Rate is sum of columns (1) and (2).
(4) Adjustment factors derived in Exhibit 2 page 7 applied to column (3).
(5) DSM and EE Rate is derived from the sum of columns (3) and (4) and rounded to 5 decimal points.
(6) DSM and EE Billing Rate from column (5).
(7) Calculated Gross Receipts Tax and Regulatory Fee at the combined rate of 0.446722% on column (6).
(8) DSM and EE Billing Rate is derived from the sum of columns (6) and (7) and rounded to 3 decimal points.

DUKE ENERGY PROGRESS, LLC

Docket No. 2017-xx-E

Energy Efficiency Rate Derivation

			EE Revenue Requirements							
SC Rate Class	Adjusted SC Rate Class kWHr Sales [1]	Rate Class Energy Allocation Factor [2]	Residential Programs[3]	CIG Programs[4]	Common Programs	Allocated A&G Costs[5]	Allocated Carrying Costs[5]	Net Test Period Revenue Requirement[6]	Total of Allocated Costs	Total EE Rate (cents/ per kWh)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) = Σ (3 thru 8)	(10) = (9) / (1)
Residential	2,199,041,789	57.28%	$12,219,627	$0	$0	$723,088	$911,627	$4,746,504	$18,600,846	0.845861
General Service	1,548,548,038	40.33%	$0	$8,584,289	$0	$344,527	$434,359	$294,673	$9,657,848	0.623671
Lighting	91,778,523	2.39%	$0	$0	$0	$0	$0	$0	$0	-
SC Retail	3,839,368,350	100%	$12,219,627	$8,584,289	$0	$1,067,615	$1,345,986	$5,041,177	$28,258,694	

NOTES:

(1) Rate Class Sales, excluding "Opt-Out" sales, are derived in Exhibit 6.
(2) Rate Class Energy Allocation Factor is derived in Exhibit 5, page 4.
(3) Lighting Program costs were allocated to both Residential and General Service Customer Classes.
All other Residential programs outlined on Exhibit 2 page 3 are allocated solely to the Residential customer class.
(4) Lighting Program costs were allocated to both Residential and General Service Customer Classes.
All other Non-Residential programs outlined on Exhibit 2 page 3 are allocated solely to the Non-Residential customer class.
(5) A&G and Carrying Costs are allocated on the basis of revenue requirements (excluding incentives and lost revenues).
(6) Net Test Period Revenue Requirements are derived on Exhibit 2, page 4.

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DUKE ENERGY PROGRESS, LLC

Docket No. SC 2017-xx-E

Demand Side Management Rate Derivation

			DSM Revenue Requirement							
SC Rate Class	Adjusted SC Rate Class kWHr Sales (1)	Rate Class Demand Allocation Factor(2)	Residential Programs(3)	CIG Programs(4)	DSDR(5)	Non-DSDR Assigned A&G and Carrying Costs(6)	DSDR Assigned A&G and Carrying Costs(5)	Net Test Period Revenue Requirement(7)	Total of Allocated Costs	Total DSM Rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) = Σ (3 thru 8)	(10) = (9) / (1)
Residential	2,199,041,789	65.64%	$4,112,933	$0	$3,365,345	$543,230	$147,171	$1,083,564	$9,252,243	$0.420740
General Service	1,546,025,798	34.36%	$0	$852,752	$1,762,002	$123,989	$77,055	-$557,813	$2,257,984	$0.146051
Lighting	91,781,623	0.00%	$0	$0	$0	$0	$0	$0	$0	$0.000000
SC Retail	3,836,849,210	100.00%	$4,112,933	$852,752	$5,127,347	$667,218	$224,226	$525,751	$11,510,228	

NOTES:

(1) Rate Class Sales, excluding "Opt-Out" sales, are derived in Exhibit 6.
(2) Rate Class Demand Allocation Factor is derived in Exhibit 5 page 5.
(3) EnergyWise costs are directly assigned solely to Residential Rate Class.
(4) CIG DR and EnergyWise for Business Program costs are directly assigned solely to General Service Class.
(5) DSDR Costs and assigned A&G and carrying costs are allocated using Rate Class Demand Allocation Factor from column (2).
(6) Non-DSDR A&G and Carrying Costs are allocated on the basis of revenue requirements (before adjustment for incentives) assigned in columns (3) and (4).
(7) Net DSM Revenue Requirements are derived on Exhibit 2 page 4.

Please note: Exhibit may not foot due to rounding.

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DUKE ENERGY PROGRESS, LLC
Docket Number 2017-XX-E
Rate Period Revenue Requirement Summary - SC
January 2018 - December 2018

			SOUTH CAROLINA JURISDICTIONALLY ALLOCATED RETAIL COSTS ONLY																	
			O&M	Insurance	A&G Expense	Capitalized O&M and A&G	Amortization of Capitalized O&M	Amortization of Capitalized A&G	Current Period Amortization	Prior Period Amortization	DSDR Capital Costs	Income Taxes on DSDR Capital Costs	DSDR Property Taxes	DSDR Depreciation	Carrying Costs Net of Taxes	Income Taxes on Carrying Cost	Rev Reqmt Before PPI & NLR	Net Lost Revenue	PPI	Total Revenue Requirement
			(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
						ΣCols(1)thru(3)	((1)+(2))/10	(3)/10									ΣCols(5)thru(12)			ΣCols(13)thru(15)
	SC DSM Program Expenses																			
1	CIG DR	*Per Forecast*	$ 318,523	$ -	$ -	$ 318,523	$ 106,174	$ -	$ 106,174	$ 352,952					$ -	$ -	$ 459,126		$ 203,634	$ 662,760
2	EnergyWise	*Per Forecast*	1,772,740	-	-	1,772,740	590,913	-	590,913	2,059,587					-	-	2,650,500		1,462,433	4,112,933
3	EnergyWise for Business	*Per Forecast*	184,095	-	-	184,095	61,365	-	61,365	84,468					-	-	145,833	15,079	29,080	189,992
4	Total DSM	*Σ Lines 1 thru 3*	$ 2,275,358	$ -	$ -	$ 2,275,358	$ 758,453	$ -	$ 758,453	$ 2,497,007					$ -	$ -	$ 3,255,460	$ 15,079	$ 1,695,147	$ 4,965,685
5	DSM A&G and Carrying Costs	*Per Forecast*	-		122,350	122,350	-	40,783	40,783	194,334					300,600	131,501	667,218			667,218
6	Total DSM and Assigned Cost	*Σ Lines 4 thru 5*	$ 2,275,358		$ 122,350	$ 2,397,708	$ 758,453	$ 40,783	$ 799,236	$ 2,691,341					$ 300,600	$ 131,501	$ 3,922,678	$ 15,079	$ 1,695,147	$ 5,632,904
	SC EE Program Expenses																			
7	Res Home Advantage	*Per Forecast*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 65,027							$ 65,027	$ -	$ 28,759	93,786
8	Res Home Energy Improvem't	*Per Forecast*	524,543	-	-	524,543	174,848	-	174,848	961,296							1,136,144	58,903	73,174	1,268,221
9	Neighborhood Energy Saver	*Per Forecast*	262,646	-	-	262,646	87,549	-	87,549	333,641							421,190	42,006	-	463,196
10	My Home Energy Report	*Per Forecast*	920,376	-	-	920,376	920,376	-	920,376	-							920,376	59,219	78,771	1,058,366
11	Solar Hot Water Pilot	*Per Forecast*	-	-	-	-	-	-	-	6,680							6,680	-		6,680
12	Lighting - Residential	*Per Forecast*	1,407,061	-	-	1,407,061	469,020	-	469,020	2,176,375							2,645,395	745,890	946,408	4,337,694
13	Res Appliance Recycling	*Per Forecast*	102,562	-	-	102,562	34,187	-	34,187	148,758							182,945	45,176	24,905	253,026
14	Residential New Construction	*Per Forecast*	1,758,186	-	-	1,758,186	586,062	-	586,062	1,354,618							1,940,680	103,177	264,738	2,308,595
15	Multi Family Energy Efficiency	*Per Forecast*	369,145	-	-	369,145	123,048	-	123,048	179,406							302,454	166,525	158,880	627,860
16	Energy Education Program for Schools	*Per Forecast*	101,887	-	-	101,887	33,962	-	33,962	92,994							126,956	47,763	-	174,720
17	Save Energy & Water Kit	*Per Forecast*	210,607	-	-	210,607	70,202	-	70,202	77,371							147,573	1,015,784	208,112	1,371,469
18	Residential Assessments	*Per Forecast*	137,940	-	-	137,940	45,980	-	45,980	122,500							168,480	52,163	37,907	258,550
19	Home Depot - CFL	*Per Forecast*	-	-	-	-	-	-	-	535							535		-	535
20	Found Revenue	*Per Forecast*																(3,070)		(3,070)
	Subtotal Residential EE Programs		5,794,953	-	-	5,794,953	2,545,235	-	2,545,235	5,519,201	-	-	-	-	-	-	8,064,436	2,333,539	1,821,652	12,219,627
21	CIG Energy Efficiency	*Per Forecast*	-	-	-	-	-	-	-	695,260							695,260			695,260
22	Lighting - General Service	*Per Forecast*	170,892	-	-	170,892	56,964	-	56,964	264,328							321,292	212,662	299,003	832,957
23	Small Business Energy Saver	*Per Forecast*	1,447,262	-	-	1,447,262	482,421	-	482,421	1,178,792							1,661,213	771,426	563,894	2,996,533
24	Non-Res Custom Incentive	*Per Forecast*	203,072			203,072	67,691			-							-		263,404	263,404
25	Non- Res Prescriptive Lighting	*Per Forecast*	1,328,427			1,328,427	442,809			-							-		936,235	936,235
26	Non- Res Performance Incentive	*Per Forecast*								-							-		(4,268)	(4,268)
26	Energy Efficiency for Business	*Per Forecast*	-	-	-	-	-	-	-	1,152,696							1,152,696	1,732,821		2,885,517
27	Business Energy Report	*Per Forecast*	-	-	-	-	-	-	-	11,965							11,965			11,965
28	Found Revenue																-	(33,314)		(33,314)
	Subtotal Non-Residential EE Programs		3,149,653	-	-	3,149,653	1,049,884	-	539,385	3,303,041	-	-	-	-	-	-	3,842,426	2,683,596	2,058,267	8,584,289
29	Total EE	*Σ Lines 7 thru 27*	$ 8,944,606	$ -	$ -	$ 8,944,606	$ 3,595,119	$ -	$ 3,084,620	$ 8,822,242	-	-	-	-	-	-	$ 11,906,862	$ 5,017,135	$ 3,879,920	$ 20,803,916
30	EE A&G and Carrying Costs	*Per Books*	-	-	587,321	587,321	-	195,774	195,774	871,841					936,363	409,623	2,413,601	-		2,413,601
31	Total EE and Assigned Cost	*Σ Lines 29 thru 30*	$ 8,944,606		$ 587,321	$ 9,531,927	$ 3,595,119	$ 195,774	$ 3,280,393	$ 9,694,083					$ 936,363	$ 409,623	$ 14,320,462	$ 5,017,135	$ 3,879,920	$ 23,217,517
	SC DSDR Program Expenses																			
32	DSDR Program	*Per Forecast*	$ 767,125	$ 112,954	$ -	$ 880,079	$ 293,360	$ -	$ 293,360	$ 1,185,564	$ 922,697	$ 402,152	$ 418,926	$ 1,904,648			$ 5,127,347	$ -	$ -	$ 5,127,347
33	DSDR A&G and Carrying Costs	*Per Forecast*	-	-	-	-	-	-	-	17,902					143,534	62,790	224,226	-	-	224,226
34	Total DSDR and Assigned Cost	*Σ Lines 32 thru 33*	$ 767,125	$ 112,954	$ -	$ 880,079	$ 293,360	$ -	$ 293,360	$ 1,203,466	$ 922,697	$ 402,152	$ 418,926	$ 1,904,648	$ 143,534	$ 62,790	$ 5,351,573	$ -	$ -	$ 5,351,573
35	Rate Period Totals	*Lines 6 + 31 + 34*	$ 11,987,089	$ 112,954	$ 709,671	$ 12,809,714	$ 4,646,932	$ 236,557	$ 4,372,989	$ 13,588,890	$ 922,697	$ 402,152	$ 418,926	$ 1,904,648	$ 1,380,497	$ 603,914	$ 23,594,713	$ 5,032,214	$ 5,575,066	$ 34,201,993

[1] Residential EE Benchmarking Program costs are recovered during the current period. All other program costs are recovered over a 3 year period.

Please note: Exhibit may not foot due to rounding.

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DUKE ENERGY PROGRESS, LLC
Docket No. 2017-XX-E
Determination of Net Revenue Requirement for Test Period

			Residential	General Service	Lighting	Total
1	**Prior Period Recovery Balance at December 31, 2015**					
2	Energy Efficiency Programs	*Doc No. 2016-289-E Exh 2*	4,838,590	2,551,620	-	7,390,210
3	Demand Side Management Programs	*Doc No. 2016-289-E Exh 2*	206,241	108,480	-	314,721
4	DSDR Program Expenses	*Doc No. 2016-289-E Exh 2*	216,018	537,497	-	753,515
5	Balance - Prior (Over) or Under Collection	*Lines 2 + 3 + 4*	5,260,849	3,197,597	-	8,458,446
6						
7	**Current Period Cost of Service** ***(1-16 to 12-16)***					
8	Energy Efficiency Programs	*Exhibit 2 (Page 6 of 7)*	5,042,272	2,326,356	-	7,368,628
9	E E A&G and Carrying Cost Allocation	*Exhibit 2 (Page 6 of 7)*	1,613,796	744,558	-	2,358,354
10	E E PPI and Net Lost Revenues	*Exhibit 2 (Page 6 of 7)*	4,698,703	4,160,727	-	8,859,430
11	Total Energy Efficiency Cost of Service	*Lines 8 + 9 + 10*	11,354,771	7,231,641	-	18,586,412
12						
13	Demand Side Management Programs	*Exhibit 2 (Page 6 of 7)*	1,481,551	238,201	-	1,719,752
14	DSM A&G and Carrying Cost Allocation	*Exhibit 2 (Page 6 of 7)*	675,866	108,664	-	784,530
15	DSM PPI and Net Lost Revenues	*Exhibit 2 (Page 6 of 7)*	905,124	21,284	-	926,408
16	Total DSM Cost of Service	*Lines 13 + 14 + 15*	3,062,541	368,149	-	3,430,690
17						
18	DSDR Program	*Exhibit 2 (Page 6 of 7)*	3,292,540	1,723,884	-	5,016,424
19	DSDR A&G and Carrying Cost Allocation	*Exhibit 2 (Page 6 of 7)*	258,951	135,580	-	394,531
20	DSDR Net Lost Revenues	*Exhibit 2 (Page 6 of 7)*	30,493	15,965		46,458
21	Total DSDR Cost of Service	*Lines 18 + 19 + 20*	3,581,985	1,875,429	-	5,457,413
22						
23	Cost of Service for 12 ME 12-31-16	*Line 11 + Line 16 + Line 21*	17,999,297	9,475,219	-	27,474,516
24						
25	**Cost of Service & Prior Bal at December 31, 2016**					
26	Energy Efficiency Programs	*Line 2 + Line 11*	16,193,361	9,783,261	-	25,976,622
27	Demand Side Management Programs	*Line 3 + Line 16*	3,268,782	476,629	-	3,745,411
28	DSDR Program	*Line 4 + Line 21*	3,798,003	2,412,926	-	6,210,928
29	Total Net COS Before Revenue Offsets	*Lines 26 + 27 + 28*	23,260,146	12,672,816	-	35,932,962
30						
31	**Actual & Trued Up Revenue** ***(1-16 to 12-16)***					
32	EE Revenue	*Exhibit 4*	11,511,992	9,339,206	-	20,851,198
33	DSM Revenue	*Exhibit 4*	2,667,417	659,665	-	3,327,082
34	DSDR Revenue	*Exhibit 4*	3,485,042	2,716,199	-	6,201,241
35	Est Total Test Period Revenue *(1-16 to 12-16)*	*Lines 32 + 33 + 34*	17,664,451	12,715,070	-	30,379,521
36						
37	**Adjustments**					
38	Energy Efficiency	*Exhibit 2 (page 5 of 7)*	65,135	(149,382)		(84,247)
39	Demand Side Management	*Exhibit 2 (page 5 of 7)*	103,953	(27,167)		76,787
40	DSDR	*Exhibit 2 (page 5 of 7)*	65,285	(44,337)		20,948
41	Total Adjustments	*Lines + 38 + 39 + 40*	234,373	(220,885)	-	13,487
42						
43	**Revenue Requirement at December 31, 2016**					
44	EE Portion of Revenue Requirement	*Lines 26 - 32 + 38*	4,746,504	294,673	-	5,041,177
45	DSM Portion of Revenue Requirement	*Lines 27 - 33 + 39*	705,319	(210,203)	-	495,116
46	DSDR Portion of Revenue Requirement	*Lines 28 - 34 + 40*	378,246	(347,610)	-	30,636
47	**Total Net Test Period Revenue Requirement**	*Lines + 44 + 45 + 46*	5,830,068	(263,140)	-	5,566,928
48	Forecasted Rate Period Revenue Requirement	*Exhibit 2 (Page 3 of 7)*				34,201,993
49	**Referenced Rate Period Recovery Level**	*Lines 47 + 48*				39,768,922

Please note: Exhibit may not foot due to rounding.

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DUKE ENERGY PROGRESS, LLC
Docket No. 2017 - XX- E
Test Period Revenue Requirement Adjustments

A.	Recognition of 2016 Test Period Uncollectible - Adjustments		Res	Gen Svc	Total
	EE Component	*Workpapers*	$ (23,334.81)	$ (1,456.92)	$ (24,791.73)
	DSM Component	*Workpapers*	(5,406.85)	(102.91)	(5,509.76)
	DSDR Component	*Workpapers*	(7,064.18)	(423.73)	(7,487.91)
	Total	*Totals from Above*	$ (35,805.84)	$ (1,983.56)	$ (37,789.40)

B.	Recognition of 2016 Test Period Uncollectibles In Rates		Res	Gen Svc	Total
	EE Component	*Workpapers*	$ 83,657.65	$ 4,837.71	$ 88,495.36
	DSM Component	*Workpapers*	19,384.12	341.71	19,725.83
	DSDR Component	*Workpapers*	25,325.80	1,406.99	26,732.79
	Total	*Totals from Above*	$ 128,367.57	$ 6,586.41	$ 134,953.98

C	Recognition of Revenues to be Received in 2018 as part of Net Metering Rider		Res	Gen Svc	Total
	EE Component	*Workpapers*	$ (13,062.12)		$ (13,062.12)
	DSM Component	*Workpapers*	(4,396.50)		(4,396.50)
	DSDR Component	*Workpapers*	(3,597.37)		(3,597.37)
	Total	*Totals from Above*	$ (21,056.00)	$ -	$ (21,056.00)

D	Recognition on Interest on 2016 Test Period Net Undercollections		Res	Gen Svc	Total
	EE Component	*Exhibit 3*	$ 635,222.15	$ 38,418.31	$ 673,640.46
	DSM Component	*Exhibit 3*	94,392.41	(27,405.41)	66,987.00
	DSDR Component	*Exhibit 3*	50,620.41	(45,320.03)	5,300.38
	Total	*Totals from Above*	$ 780,234.97	$ (34,307.13)	$ 745,927.84

E	Summary Total of Adjustments		Res	Gen Svc	Total
	EE Component	*Σ Sections A through D*	$ 682,482.87	$ 41,799.10	$ 724,281.97
	DSM Component	*Σ Sections A through D*	103,973.18	(27,166.61)	76,806.57
	DSDR Component	*Σ Sections A through D*	65,284.66	(44,336.77)	20,947.89
	Total	*Totals from Above*	$ 851,740.70	$ (29,704.28)	$ 822,036.42

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EM&V TRUE-UPS

F Recognition of EM&V True-Ups

		Res	Gen Svc	Total
Vintage 2014 PPI True Up (Overcollection)				
EE Component	*Exhibit 7 page 1*	$ (216,949.00)	$ (46,683.07)	$ (263,632.07)
Vintage 2014 PPI True Up				
DSM Component	*Exhibit 7 page 1*	-	-	-
Vintage 2015 PPI True Up (Net Overcollection)				
EE Component	*Exhibit 7 page 3*	(116,529.68)	1,683.52	(114,846.16)
Vintage 2015 PPI True Up (Overcollection)				
DSM Component	*Exhibit 7 page 3*	(20.00)	-	(20.00)
Vintage 2014 Lost Revenue True up				
EE Component	*Exhibit 8 page 6*	(89,427.74)	(38,939.01)	(128,366.75)
Vintage 2015 Lost Revenue True Up				
EE Component	*Exhibit 8 page 6*	(194,441.61)	(107,242.61)	(301,684.22)

G Summary Total of EM&V Related Adjustments

EE Component	*Σ Section F Above*	$ (617,348.03)	(191,181.16)	$ (808,529.20)
DSM Component	*Σ Section F Above*	(20.00)	-	(20.00)
DSDR Component	*Σ Section F Above*	-	-	-
Total	*Totals from Above*	$ (617,368.03)	$ (191,181.16)	$ (808,549.20)

H Net Revenue Requirement Adjustments

		Res	Gen Svc	Total
EE Component	*Σ Sections E and G*	$ 65,134.84	$ (149,382.07)	$ (84,247.23)
DSM Component	*Σ Sections E and G*	103,953.18	(27,166.61)	76,786.57
DSDR Component	*Σ Sections E and G*	65,284.66	(44,336.77)	20,947.89
Total	*Totals from Above*	$ 234,372.67	$ (220,885.45)	$ 13,487.22

Please note: Exhibit may not foot due to rounding.

DUKE ENERGY PROGRESS, LLC
Docket Number 2017-XX-E
EMF Period Revenue Requirement Summary - SC
January 2016 - December 2016

			SOUTH CAROLINA JURISDICTIONALLY ALLOCATED RETAIL COSTS ONLY																	
			O&M	Insurance	A&G Expense	Capitalized O&M and A&G	Amortization of Capitalized O&M	Amortization of Capitalized A&G	Current Period Amortization	Prior Period Amortization	DSDR Capital Costs	Income Taxes on DSDR Capital Costs	DSDR Property Taxes	DSDR Depreciation	Carrying Costs Net of Taxes	Income Taxes on Carrying Cost	Rev Reqmt Before PPI & NLR	Net Lost Revenue	PPI	Total Revenue Requirement
			(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
						ΣCols(1)thru(3)	((1)+(2))/10	(3)/10									ΣCols(5)thru(12)			ΣCols(13)thru(15)
	SC DSM Program Expenses																			
1	CIG DR	*Per Books*	$ 211,538		$ -	$ 211,538	$ 70,513	$ -	$ 70,513	$ 118,965							$ 189,478		$ 25,494	$ 214,972
2	EnergyWise	*Per Books*	1,785,046		-	1,785,046	595,015	-	595,015	886,536							1,481,551		905,124	2,386,675
3	EnergyWise for Business	*Per Books*	145,701		-	145,701	48,567	-	48,567	156							48,723	1,104	(5,315)	44,513
4	Total DSM	*Σ Lines 1 thru 3*	$ 2,142,285	$ -	$ -	$ 2,142,285	$ 714,095	$ -	$ 714,095	$ 1,005,657	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,719,752	$ 1,104	$ 925,304	$ 2,646,160
5	DSM A&G and Carrying Costs	*Per Books*	-	-	126,693	126,693	-	42,231	42,231	91,266					476,729	174,304	784,530			784,530
6	Total DSM and Assigned Cost	*Σ Lines 4 thru 5*	$ 2,142,285	$ -	$ 126,693	$ 2,268,978	$ 714,095	$ 42,231	$ 756,326	$ 1,096,923	$ -	$ -	$ -	$ -	$ 476,729	$ 174,304	$ 2,504,282	$ 1,104	$ 925,304	$ 3,430,690
	SC EE Program Expenses																			
7	Res Home Advantage	*Per Books*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 71,591							$ 71,591	$ -	$ 28,759	$ 100,350
8	Res Home Energy Improvem't	*Per Books*	828,835	-	-	828,835	276,278	-	276,278	544,405							820,683	76,921	72,195	969,800
9	Neighborhood Energy Saver	*Per Books*	282,919	-	-	282,919	94,306	-	94,306	165,757							260,063	62,346	-	322,409
10	Solar Hot Water Pilot	*Per Books*	-	-	-	-	-	-	-	6,778							6,778		-	6,778
11	Energy Efficient Lighting[1] - Residential	*Per Books allocated*	2,143,804	-	-	2,143,804	714,601	-	714,601	1,301,320							2,015,921	2,257,032	648,531	4,921,484
12	Appliance Recycling Program	*Per Books*	(18,883)	-	-	(18,883)	(6,294)	-	(6,294)	104,880							98,586	85,528	20,246	204,360
13	Res EE Benchmarking/My HER[1]	*Per Books*	811,879	-	-	811,879	811,878	-	811,878	-							811,878	742,850	81,034	1,635,763
14	Home Depot CFL	*Per Books*	-	-	-	-	-	-	-	2,140							2,140		10,473	12,613
15	Residential New Construction	*Per Books*	1,296,410	-	-	1,296,410	432,137	-	432,137	217,191							649,328	57,140	98,498	804,966
16	Energy Education Program for Schools	*Per Books*	114,060	-	-	114,060	38,020	-	38,020	16,779							54,799	35,607	-	90,406
17	Save Energy & Water Kits	*Per Books*	92,974			92,974	30,991		30,991								30,991	31,447	62,394	124,832
18	Residential Energy Assessments	*Per Books*	195,438			195,438	65,146		65,146								65,146	9,117	24,137	98,400
19	Multi-Family EE Programs	*Per Books*	281,909	-	-	281,909	93,970	-	93,970	60,398							154,368	213,568	80,879	448,815
	Subtotal Residential EE Programs		6,029,345	-	-	6,029,345	2,551,033	-	2,551,033	2,491,239	-	-	-	-	-	-	5,042,272	3,571,557	1,127,147	9,740,975
20	Lighting[1] - General Service	*Per Books allocated*	260,372	-	-	260,372	86,791	-	86,791	158,049							244,840	888,439	210,474	1,343,753
21	CIG Energy Efficiency/ EE for Business	*Per Books*	1,951,640	-	-	1,951,640	650,547	-	650,547	689,604							1,340,151	1,187,899	829,886	3,357,936
22	Small Business Energy Saver	*Per Books*	1,286,894	-	-	1,286,894	428,965	-	428,965	308,646							737,611	788,697	260,184	1,786,492
23	Business Energy Report	*Per Books*	9,582	-	-	9,582	3,194	-	3,194	560							3,754		-	3,754
24	Found Revenues	*Per Books*															-	(4,852)		(4,852)
	Subtotal Non-Residential EE Programs		3,508,488	-	-	3,508,488	1,169,497	-	1,169,497	1,156,859	-	-	-	-	-	-	2,326,356	2,860,184	1,300,543	6,487,083
24	Total EE	*Σ Lines 7 thru 23*	$ 9,537,833	$ -	$ -	$ 9,537,833	$ 3,720,530	$ -	$ 3,720,530	$ 3,648,098	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,368,628	$ 6,431,740	$ 2,427,690	$ 16,228,058
25	EE A&G and Carrying Costs	*Per Books*	-	-	501,022	501,022	-	167,007	167,007	236,668					1,431,457	523,222	2,358,354			2,358,354
26	Total EE and Assigned Cost	*Σ Lines 24 thru 25*	$ 9,537,833	$ -	$ 501,022	$ 10,038,855	$ 3,720,530	$ 167,007	$ 3,887,537	$ 3,203,409	$ -	$ -	$ -	$ -	$ 1,431,457	$ 523,222	$ 9,726,982	$ 6,431,740	$ 2,427,690	$ 18,586,412
	SC DSDR Program Expenses																			
27	DSDR Program	*Per Books*	$ 737,434	$ 129,347	$ -	$ 866,781	$ 288,927		$ 288,927	$ 611,613	$ 1,289,099	$ 602,526	$ 443,304	$ 1,780,955			$ 5,016,424	$ 46,458		$ 5,062,882
28	DSDR A&G and Carrying Costs	*Per Books*	-	-	-	-	-		-	42,206					257,994	94,331	394,531			394,531
29	Total DSDR and Assigned Cost	*Σ Lines 27 thru 28*	$ 737,434	$ 129,347	$ -	$ 866,781	$ 288,927	$ -	$ 288,927	$ 653,819	$ 1,289,099	$ 602,526	$ 443,304	$ 1,780,955	$ 257,994	$ 94,331	$ 5,410,955	$ 46,458	$ -	$ 5,457,413
									-	-										
30	Test Period Totals	*Lines 6 + 26 + 29*	$ 12,417,552	$ 129,347	$ 627,715	$ 13,174,614	$ 4,723,552	$ 209,238	$ 4,932,790	$ 4,954,151	$ 1,289,099	$ 602,526	$ 443,304	$ 1,780,955	$ 2,166,180	$ 791,857	$ 17,642,219	$ 6,479,303	$ 3,352,994	$ 27,474,516

[1] Residential EE Benchmarking Program costs are recovered during the current period. All other program costs are recovered over a 3 year period.

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DUKE ENERGY PROGRESS, LLC

Docket No. 2017 - XX - E

EE/DSM Billing Rate - January 1, 2018 through December 31, 2018

Revenue Adjustment Factors

Residential Adjustment Factor

1	Billed kWh (12ME 12/31/16)	*Per Books*	2,127,244,554	
2	Billed RECD kWh (12ME 12/31/16)	*Per Books*	318,131,271	(a)
3	RECD kWh Percent of Total Billed	*Line 2 / Line 1*	14.9551%	
4	RECD Discount Percentage	*RECD Discount*	5.0000%	(b)
5	RECD Impact (Weighted Discount)	*Line 3 x Line 4*	0.7478%	(d)
6	Uncollectable Estimate for Forecast Period	*N/A for 2018*		(c)
7	Residential Adjustment Factor for Rate Period	*Line 5 + Line 6*	**0.7478%**	(d)

General Service Adjustment Factor

8	Uncollectable Estimate for Forecast Period	*N/A for 2018*		(c)
9	General Service Adjustment Factor for Rate Period	*Line 8*	**0.0000%**	(d)

Notes:

(a) Energy billed and discounted pursuant to Residential Energy Conservation Discount, Rider RECD-2B.

(b) Five-percent discount provided under Residential Energy Conservation Discount, Rider RECD-2B.

(c) DEP is not requesting an uncollectible adjustment for the prospective period as a new base level of uncollectibles was approved with rates going into effect 1/1/17. Starting with rates going into effect 1/1/19, the Company perform an analysis of the actual uncollectible experience versus amounts in base rates and make an adjustment if necessary

(d) Estimated impacts of uncollectable and RECD related discounts will be trued up as necessary in future filings.

DUKE ENERGY PROGRESS, LLC
Docket No. 2017-XX-E
Calculation of Interest on Over and Undercollections

A. Residential

								Change in Rev Rqmt
1	Residential Undercollection	*(Exh2 pg 4 Line 47 - Interest Adj Exh 2 pg 5)*			$ (5,049,833.32)			
2								
3	Monthly 7.75% Rate *(per SC Supreme Court)*		*Int Rate / 12*		0.646%			
4								
5		Res Sales *(kWh)*	Percent Tot		Balance	Avg Balance	Interest	
6	Jul-16			Static Principal	$ (5,049,833.32)	$ (5,049,833.32)	$ (32,613.51)	
7	Aug-16				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
8	Sep-16				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
9	Oct-16				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
10	Nov-16				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
11	Dec-16				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
12	Jan-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
13	Feb-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
14	Mar-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
15	Apr-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
16	May-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
17	Jun-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
18	Jul-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
19	Aug-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
20	Sep-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
21	Oct-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
22	Nov-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
23	Dec-17				(5,049,833.32)	(5,049,833.32)	(32,613.51)	
24	Jan-18	216,515,260	9.85%	Declining Principal *(returned via rates)*	(4,552,632.23)	(4,801,232.77)	(31,007.96)	
25	Feb-18	159,843,871	7.27%		(4,185,570.13)	(4,369,101.18)	(28,217.11)	
26	Mar-18	209,777,438	9.54%		(3,703,841.63)	(3,944,705.88)	(25,476.23)	
27	Apr-18	174,677,837	7.94%		(3,302,715.12)	(3,503,278.37)	(22,625.34)	
28	May-18	173,081,397	7.87%		(2,905,254.64)	(3,103,984.88)	(20,046.57)	
29	Jun-18	200,945,109	9.14%		(2,443,808.51)	(2,674,531.57)	(17,273.02)	
30	Jul-18	230,659,890	10.49%		(1,914,125.99)	(2,178,967.25)	(14,072.50)	
31	Aug-18	150,617,022	6.85%		(1,568,252.23)	(1,741,189.11)	(11,245.18)	
32	Sep-18	135,942,539	6.18%		(1,256,076.64)	(1,412,164.44)	(9,120.23)	
33	Oct-18	127,741,105	5.81%		(962,734.65)	(1,109,405.65)	(7,164.91)	
34	Nov-18	160,725,251	7.31%		(593,648.57)	(778,191.61)	(5,025.82)	
35	Dec-18	258,515,069	11.76%		-	(296,824.28)	(1,916.99)	
36	Total	2,199,041,788	100.00%				$ (780,234.97)	**$ 780,234.97**

(Sum of Lines 6 thru 35)

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B. General Service

								Change in Rev Rqmt
1	General Service Overcollection	*(Exh 2 Pg 4 Line 47 - Interest Adj. Exh 2 pg 5)*			$ 228,832.72			
2								
3	Monthly 7.75% Rate *(per SC Supreme Court)*		*Int Rate / 12*		0.646%			
4								
5		Gen Svc *(kWh)*	Percent Tot		Balance	Avg Balance	Interest	
6	Jul-16			Static Principal	$ 228,832.72	$ 228,832.72	$ 1,477.88	
7	Aug-16				228,832.72	228,832.72	1,477.88	
8	Sep-16				228,832.72	228,832.72	1,477.88	
9	Oct-16				228,832.72	228,832.72	1,477.88	
10	Nov-16				228,832.72	228,832.72	1,477.88	
11	Dec-16				228,832.72	228,832.72	1,477.88	
12	Jan-17				228,832.72	228,832.72	1,477.88	
13	Feb-17				228,832.72	228,832.72	1,477.88	
14	Mar-17				228,832.72	228,832.72	1,477.88	
15	Apr-17				228,832.72	228,832.72	1,477.88	
16	May-17				228,832.72	228,832.72	1,477.88	
17	Jun-17				228,832.72	228,832.72	1,477.88	
18	Jul-17				228,832.72	228,832.72	1,477.88	
19	Aug-17				228,832.72	228,832.72	1,477.88	
20	Sep-17				228,832.72	228,832.72	1,477.88	
21	Oct-17				228,832.72	228,832.72	1,477.88	
22	Nov-17				228,832.72	228,832.72	1,477.88	
23	Dec-17				228,832.72	228,832.72	1,477.88	
24	Jan-18	122,278,075	7.90%	Declining Principal *(collected via rates)*	210,763.39	219,798.05	1,419.53	
25	Feb-18	61,897,917	4.00%		201,616.58	206,189.99	1,331.64	
26	Mar-18	169,972,771	10.98%		176,499.29	189,057.94	1,221.00	
27	Apr-18	117,303,175	7.58%		159,165.12	167,832.20	1,083.92	
28	May-18	91,248,391	5.89%		145,681.12	152,423.12	984.40	
29	Jun-18	171,519,017	11.08%		120,335.34	133,008.23	859.01	
30	Jul-18	165,835,912	10.71%		95,829.36	108,082.35	698.03	
31	Aug-18	108,140,975	6.98%		79,849.10	87,839.23	567.30	
32	Sep-18	168,472,246	10.88%		54,953.55	67,401.33	435.30	
33	Oct-18	126,646,462	8.18%		36,238.69	45,596.12	294.47	
34	Nov-18	65,440,313	4.23%		26,568.42	31,403.56	202.81	
35	Dec-18	179,792,784	11.61%		0.00	13,284.21	85.79	
36	**Total**	1,548,548,038	100.00%				$ 34,307.13	**(34,307.13)**
								(Sum of Lines 6 thru 26)

C. Interest Allocation Factors

	Residential	Pre-Interest Under (Over)	Under (Over) Allocation	Total Interest	Allocated Interest	Revenue Reqmt Impact
1	EE	$ 4,111,281.98	81.41%	$ 780,234.97	$ 635,222.15	Increase
2	DSM	610,926.16	12.10%	780,234.97	94,392.41	Increase
3	DSDR	327,625.18	6.49%	780,234.97	50,620.41	Increase
4	Totals	$ 5,049,833.32	100.00%	NA	$ 780,234.97	Increase

	General Service	Pre-Interest Under (Over)	Under (Over) Allocation	Total Interest	Allocated Interest	Revenue Reqmt Impact
5	EE	$ 256,254.73	-111.98%	$ (34,307.13)	$ 38,418.31	Increase
6	DSM	(182,797.39)	79.88%	(34,307.13)	(27,405.41)	Decrease
7	DSDR	(302,290.06)	132.10%	(34,307.13)	(45,320.03)	Decrease
8	Totals	$ (228,832.72)	100.00%	NA	$ (34,307.13)	Decrease

D. Residential Interest Allocations

					Residential Interest Breakdown			
		Allocation	AVG Balance		EE	DSM	DSDR	Total
1	Jul-16	*Undercollection*	(5,049,833.32)	Static Principal	(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
2	Aug-16	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
3	Sep-16	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
4	Oct-16	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
5	Nov-16	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
6	Dec-16	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
7	Jan-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
8	Feb-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
9	Mar-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
10	Apr-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
11	May-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
12	Jun-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
13	Jul-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
14	Aug-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
15	Sep-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
16	Oct-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
17	Nov-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
18	Dec-17	*Undercollection*	(5,049,833.32)		(26,552.03)	(3,945.56)	(2,115.91)	(32,613.51)
19	Jan-18	*Undercollection*	(4,801,232.77)	Declining Principal *(returned via rates)*	(25,244.89)	(3,751.33)	(2,011.75)	(31,007.96)
20	Feb-18	*Undercollection*	(4,369,101.18)		(22,972.74)	(3,413.69)	(1,830.68)	(28,217.11)
21	Mar-18	*Undercollection*	(3,944,705.88)		(20,741.27)	(3,082.10)	(1,652.86)	(25,476.23)
22	Apr-18	*Undercollection*	(3,503,278.37)		(18,420.24)	(2,737.20)	(1,467.90)	(22,625.34)
23	May-18	*Undercollection*	(3,103,984.88)		(16,320.76)	(2,425.22)	(1,300.59)	(20,046.57)
24	Jun-18	*Undercollection*	(2,674,531.57)		(14,062.69)	(2,089.68)	(1,120.65)	(17,273.02)
25	Jul-18	*Undercollection*	(2,178,967.25)		(11,457.01)	(1,702.48)	(913.00)	(14,072.50)
26	Aug-18	*Undercollection*	(1,741,189.11)		(9,155.17)	(1,360.44)	(729.57)	(11,245.18)
27	Sep-18	*Undercollection*	(1,412,164.44)		(7,425.16)	(1,103.36)	(591.71)	(9,120.23)
28	Oct-18	*Undercollection*	(1,109,405.65)		(5,833.26)	(866.81)	(464.85)	(7,164.91)
29	Nov-18	*Undercollection*	(778,191.61)		(4,091.73)	(608.02)	(326.07)	(5,025.82)
30	Dec-18	*Undercollection*	(296,824.28)		(1,560.70)	(231.92)	(124.37)	(1,916.99)
31	Totals	*(Σ Lines 1 thru 21)*			(635,222.15)	(94,392.41)	(50,620.41)	(780,234.97)

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E. General Service Interest Allocations

					General Service Interest Breakdown			
		Allocation	AVG Balance		EE	DSM	DSDR	Total
1	Jul-16	*Overcollection*	228,832.72	Static Principal	(1,654.98)	1,180.57	1,952.29	1,477.88
2	Aug-16							
3	Sep-16	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
4	Oct-16	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
5	Nov-16	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
6	Dec-16	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
7	Jan-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
8	Feb-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
9	Mar-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
10	Apr-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
11	May-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
12	Jun-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
13	Jul-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
14	Aug-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
15	Sep-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
16	Oct-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
17	Nov-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
18	Dec-17	*Overcollection*	228,832.72		(1,654.98)	1,180.57	1,952.29	1,477.88
19	Jan-18	*Overcollection*	219,798.05	Declining Principal *(collected via rates)*	(1,589.64)	1,133.96	1,875.21	1,419.53
20	Feb-18	*Overcollection*	206,189.99		(1,491.22)	1,063.75	1,759.11	1,331.64
21	Mar-18	*Overcollection*	189,057.94		(1,367.32)	975.37	1,612.95	1,221.00
22	Apr-18	*Overcollection*	167,832.20		(1,213.81)	865.86	1,431.86	1,083.92
23	May-18	*Overcollection*	152,423.12		(1,102.36)	786.36	1,300.40	984.40
24	Jun-18	*Overcollection*	133,008.23		(961.95)	686.20	1,134.76	859.01
25	Jul-18	*Overcollection*	108,082.35		(781.68)	557.61	922.11	698.03
26	Aug-18	*Overcollection*	87,839.23		(635.28)	453.17	749.40	567.30
27	Sep-18	*Overcollection*	67,401.33		(487.46)	347.73	575.04	435.30
28	Oct-18	*Overcollection*	45,596.12		(329.76)	235.23	389.00	294.47
29	Nov-18	*Overcollection*	31,403.56		(227.12)	162.01	267.92	202.81
30	Dec-18	*Overcollection*	13,284.21		(96.07)	68.53	113.33	85.79
31	Totals	*(Σ Lines 1 thru 21)*			(38,418.31)	27,405.41	45,320.03	34,307.13

F. Values / Adjustments for 2016 SC DSM/EE Filing - Increase / (Decrease) in Revenue Requirement

			Res	Gen Svc	Total
	Recognition on Interest on 2016 Test Period Over & (Under) Collections				
1	EE Component	*Sections D & E, Line 22*	$ 635,222.15	$ 38,418.31	$ 673,640.46
2	DSM Component	*Sections D & E, Line 22*	94,392.41	(27,405.41)	66,987.00
3	DSDR Component	*Sections D & E, Line 22*	50,620.41	(45,320.03)	5,300.38
4	Total		$ 780,234.97	$ (34,307.13)	$ 745,927.84

Exhibit 4

DUKE ENERGY PROGRESS,LLC
Docket No. 2017-xx-E
2016 Actual Revenues

Rate Period	DSM	DSDR	EE	Total
Residential	$ 2,667,417	$ 3,485,042	$ 11,511,992	$ 17,664,451
General Service	659,665	2,716,199	9,339,206	12,715,070
Lighting	-	-	-	-
Total	$ 3,327,082	$ 6,201,241	$ 20,851,198	$ 30,379,520

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DUKE ENERGY PROGRESS, LLC
Docket No. 2017-XX-E
Allocation Factor Summary through 2015

						DSM		EE	
						NC	SC	NC	SC
A.	**Allocation Factors**								
	1	May-08	to	Apr-09	*Calendar 2007 Analysis* [1]	86.73%	13.27%	84.81%	15.19%
	1	May-09	to	Apr-10	*Calendar 2008 Analysis* [1]	86.16%	13.84%	85.06%	14.94%
	2	May-10	to	Apr-11	*Calendar 2009 Analysis* [2]	85.89%	14.11%	85.41%	14.59%
	3	May-11	to	Apr-12	*Calendar 2010 Analysis* [3]	86.49%	13.51%	85.53%	14.47%
	4	May-12	to	Apr-13	*Calendar 2011 Analysis* [4]	86.63%	13.37%	85.92%	14.08%
	5	May-13	to	Apr-14	*Calendar 2012 Analysis* [5]	86.47%	13.53%	86.06%	13.94%
	6	May-14	to	Apr-15	*Calendar 2013 Analysis* [6]	85.68%	14.32%	85.57%	14.43%
	7	May-15	to	Dec-15	*Calendar 2014 Analysis* [7]	86.23%	13.77%	85.15%	14.85%
B.	**Custom Period Factors**								
		Test Period [4]							
	4	Apr-10	to	Mar-11	*Line 1 x* $\frac{1}{12}$ *+ Line 2 x 11 x* $\frac{1}{12}$	85.91%	14.09%	85.38%	14.62%
		Prospective Period [4]							
	5	Apr-11	to	Jul-11	*Line 2 x* $\frac{1}{4}$ *+ Line 3 x* $\frac{3}{4}$	86.34%	13.66%	85.50%	14.50%
		Rate Period [4]							
	6	Dec-11	to	Nov-12	*Line 3*	86.49%	13.51%	85.53%	14.47%
		Calendar Year 2010 [8]							
	8	Jan-10	to	Dec-10	*Line 1 x* $\frac{1}{3}$ *+ Line 2 x* $\frac{2}{3}$	85.98%	14.02%	85.29%	14.71%
		Calendar Year 2011 [8]							
	9	Jan-11	to	Dec-11	*Line 2 x* $\frac{1}{3}$ *+ Line 3 x* $\frac{2}{3}$	86.29%	13.71%	85.49%	14.51%
		Calendar Year 2012 [8]							
	10	Jan-12	to	Dec-12	*Line 3 x* $\frac{1}{3}$ *+ Line 4 x* $\frac{2}{3}$	86.58%	13.42%	85.79%	14.21%
		Calendar Year 2013 [8]							
	11	Jan-13	to	Dec-13	*Line 4 x* $\frac{1}{3}$ *+ Line 5 x* $\frac{2}{3}$	86.52%	13.48%	86.01%	13.99%
		Calendar Year 2014 [8]							
	12	Jan-14	to	Dec-14	*Line 5 x* $\frac{1}{3}$ *+ Line 6 x* $\frac{2}{3}$	85.94%	14.06%	85.73%	14.27%
		Calendar Year 2015 [8]							
	13	Jan-15	to	Dec-15	*Line 6 x* $\frac{1}{3}$ *+ Line 7 x* $\frac{2}{3}$	86.05%	13.95%	85.29%	14.71%

Notes:

[1] Allocation Factors values from Docket No. E-2, Sub 951
[2] Allocation Factors values from Docket No. E-2, Sub 977
[3] Allocation Factors values from Docket No. E-2, Sub 1002
[4] Allocation Factors values from Docket No. E-2, Sub 1019
[5] Allocation Factors values from Docket No. E-2, Sub 1030
[6] Allocation Factors values from Docket No. E-2, Sub 1044
[7] Allocation Factors values from Docket No. E-2, Sub 1073
[8] Employed in the allocation of Utility Cost Test (UCT) results for PPI determination.

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Duke Energy Progress, LLC
Allocation Factor For Year 2016
Docket Number 2017-xx-E
Allocation Factors from 2016 Filed Cost of Service Study

Line			MWh
	New Mechanism Sales Allocator at Generator		
1	NC Retail MWh Sales Allocation	Company Records	38,844,803
2	SC Retail MWh Sales Allocation	Company Records	6,620,461
3	Total Retail	Line 1 + Line 2	45,465,264
	Allocation 1 to state based on kWh sales		
4	SC Retail	Line 2 / Line 3	**14.5615796%**

			NC	SC	Total
	Demand Allocators (kW)				
5	Residential	Company Records	3,530,456	484,305	4,014,761
6	Non Residential	Company Records	4,003,521	724,998	4,728,519
7	Total	Line 5 + Line 6	7,533,977	1,209,303	8,743,280
	Allocation 2 to state based on peak demand				
8	SC Retail	Line 7, SC / Line 7 Total	**13.8312281%**		
	Allocation 3 SC res vs non-res Peak Demand to retail system peak				
9	SC Residential	Line 5 SC/ Line 7 Total	**5.5391684%**		
10	SC Non-residential	Line 6 SC/ Line 7 Total	**8.2920597%**		

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Duke Energy Progress, LLC
Allocation Factor For Year 2017
Estimated Allocation Factor for Year 2018
Docket Number 2017-xx-E
Allocation Factors from 2017 Filed Cost of Service Study

Line			MWh		
	New Mechanism Sales Allocator at Generator				
1	NC Retail MWh Sales Allocation	Company Records	38,923,501		
2	SC Retail MWh Sales Allocation	Company Records	6,596,650		
3	Total Retail	Line 1 + Line 2	45,520,152		
	Allocation 1 to state based on kWh sales				
4	SC Retail	Line 2 / Line 3	**14.4917135%**		
	Demand Allocators (kW)		**NC**	**SC**	**Total**
5	Residential	Company Records	3,743,750	509,212	4,252,962
6	Non Residential	Company Records	4,012,019	736,825	4,748,844
7	Total	Line 5 + Line 6	7,755,769	1,246,037	9,001,806
	Allocation 2 to state based on peak demand				
8	SC Retail	Line 7, SC / Line 7 Total	**13.8420779%**		
	Allocation 3 SC res vs non-res Peak Demand to retail system peak				
9	SC Residential	Line 5 SC/ Line 7 Total	**5.6567760%**		
10	SC Non-residential	Line 6 SC/ Line 7 Total	**8.1853019%**		

NOTE: These allocation factors are used for vintages 2017-2018 based on the most recently filed Cost of Service Study (May 2017)

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DUKE ENERGY PROGRESS, LLC
Docket No. 2017-XX-E

Energy Allocation Factors - Applicable to EE Program Costs

South Carolina Rate Class Energy Allocation Factors

Rate Class	Total SC Rate Class Sales (MWh) [1]	Opt-Out Sales[2]	Adjusted SC Rate Class MWh Sales	Rate Class Energy Allocation Factor
	(1)	(2)	(3) = (1) - (2)	(4) = (3) / SC Total in Column 3
Residential	2,199,042	0	2,199,042	57.28%
General Service	4,272,732	2,724,184	1,548,548	40.33%
Lighting	96,213	4,435	91,779	2.39%
SC Retail	6,567,987	2,728,619	3,839,368	100.00%

NOTES:

(1) Total SC Rate Class Sales (MWh) are for the forecasted year ended December 2017.

(2) Opt-Out sales are provided in Exhibit 6

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DUKE ENERGY PROGRESS, LLC
Docket No. 2017-XX-E
Demand Allocation Factors - Applicable to DSM Programs

South Carolina Rate Class Demand Allocation Factors

Rate Class	Total SC Rate Class Sales [1]	Sales Subject to Opt-Out [2]	Rate Class Demand [3]	Revised Rate Class Demand	Rate Class Allocation Factor
	(1)	(2)	(3)	(4) = ((1 - 2) / 1) * 3	(5) = (4)/Total of Column 4
Residential	2,199,042	0	509,212	509,212	65.63521%
General Service	4,272,732	2,726,706	736,825	266,609	34.36479%
Lighting	96,213	4,431	0	0	0.00000%
SC Retail	6,567,987	2,731,138	1,246,037	775,821	100.00000%

NOTES:

(1) Total SC Rate Class Sales (MWh) are for the forecasted year ended December 2017.

(2) Opt-Out sales are provided in Exhibit 6

(3) The CP demands are based on the 2016 Coincident Peak occurring on July 26, 2016 during the hour ended at 1700 EDT.

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Exhibit 6

Duke Energy Progress, LLC
DSM/EE Cost Recovery Rider 9
Docket Number 2017-xx-E
Forecasted 2018 kWh Sales
Estimated 2018 Opt out kWh based on 2016 actuals

Line	**Spring 2017 Sales Forecast - kWhs**	**Total 2018**
	South Carolina Retail:	
1	Residential	2,199,041,789
2	General Service - EE	4,272,732,023
3	Lighting	96,213,092
4	Total Retail	6,567,986,904

	Non-Residential	**Gross kWh**	**Opt Outs**	**Net kWh**
5	Energy Efficiency	4,272,732,023	(2,724,183,985)	1,548,548,038
6	DSM	4,272,732,023	(2,726,706,225)	1,546,025,798
7	Lighting - EE	96,213,092	(4,434,569)	91,778,523
8	Lighting - DSM	96,213,092	(4,431,469)	91,781,623

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Duke Energy Progress
Vintage 2014 True Up - January 1, 2014 to December 31, 2014
Docket Number 2017 -XX-E
Load Impacts and Estimated Revenue Requirements by Program

			A	B	C	D	E	F	G	H
						=(A-B)*C	= (B+D)		=E*F	=O(from page 2)
Residential Programs	System kW Reduction - Summer Peak (Net @Plant)	System Energy Reduction (kWh) (Net @ Plant)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement [2]	SC Retail kWh Sales Allocation Factor	SC Residential Unadjusted Revenue Requirement [2]	SC Residential Adjusted Revenue Requirement (EMF)
EE Programs										
1 Appliance Recycling Program	686	5,268,745	$ 1,637,801	$ 1,158,669	13.0%	$ 62,287	$ 1,220,956	14.2700000%	$ 174,230	$ -
2 Home Energy Improvement Program	1815	5,546,097	$ 5,750,886	$ 4,815,463	13.0%	$ 121,605	$ 4,937,068	14.2700000%	$ 704,520	$ -
3 Energy Efficient Lighting	15812	109,696,283	$ 44,964,508	$ 19,568,074	13.0%	$ 3,301,536	$ 22,869,611	14.2700000%	$ 3,263,493	$ 216,949
4 Neighborhood Energy Saver Program	283	1,615,087	$ 854,095	$ 1,731,995		$ -	$ 1,731,995	14.2700000%	$ 247,156	$ -
5 Home Depot CFL	-	-	$ -	$ -		$ -	$ -		$ -	$ -
6 Residential New Construction	2371	5,537,299	$ 9,958,239	$ 6,463,222	13.0%	$ 454,352	$ 6,917,575	14.2700000%	$ 987,138	$ -
7 Total for Residential Conservation Programs	20,967	127,663,511	$ 63,165,529	$ 33,737,423		$ 3,939,781	$ 37,677,204		$ 5,376,537	$ 216,949
8 Residential Energy Efficient Benchmarking [1]	2809	16,152,020	$ 1,051,078	$ 171,840	13.0%	$ 114,301	$ 286,141	14.2700000%	$ 40,832	$ -
9 My Home Energy Report [1]	-	-	$ -	$ 69,946		$ -	$ 69,946	14.2700000%	$ 9,981	$ -
10 Total Residential Conservation and Behavioral Prog	23,775	143,815,531	$ 64,216,607	$ 33,979,209		$ 4,054,082	$ 38,033,291		$ 5,427,350	$ 216,949
								SC Residential Peak Demand Allocation Factor		
11 EnergyWise [3]	36,438	-	$ 46,090,768	$ 7,853,109	8.0%	$ 3,059,013	$ 10,912,122	14.05667%	$ 1,533,881	$ -
12 Total Residential	60,213	143,815,531	$ 110,307,375	$ 41,832,319		$ 7,113,094	$ 48,945,413		$ 6,961,231	$ 216,949

Non-Residential Programs	System kW Reduction - Summer Peak (Net @Plant)	System Energy Reduction (kWh) (Net @ Plant)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement [2]	SC Retail kWh Sales Allocation Factor	SC Non-Residential Revenue Requirement	SC Non-Residential Adjusted Revenue Requirement (EMF)
EE Programs										
13 Energy Efficiency for Business	11,011	56,573,996	$ 35,264,862	$ 7,246,868	13.0%	$ 3,642,339	$ 10,889,207	14.2700000%	$ 1,553,890	$ -
14 Small Business Energy Saver Program	8,096	38,090,354	$ 23,982,238	$ 10,108,917	13.0%	$ 1,803,532	$ 11,912,448	14.2700000%	$ 1,699,906	$ -
15 Non-Residential Lighting Program	10,798	52,552,070	$ 9,793,661	$ 2,376,609	13.0%	$ 964,217	$ 3,340,826	14.2700000%	$ 476,736	$ 46,683
16 Total for Non-Residential Conservation Programs	29,904	147,216,419	$ 69,040,761	$ 19,732,394		$ 6,410,088	$ 26,142,482		$ 3,730,532	$ 46,683
								SC Non-Residential Peak Demand Allocation Factor		
17 Commercial, Industrial, & Governmental Demand R	5,015	-	$ 6,188,262	$ 3,586,779	8.0%	$ 208,119	$ 3,794,897			
18 Total for Non-Residential DSM Programs	5,015	-	$ 6,188,262	$ 3,586,779		$ 208,119	$ 3,794,897	14.05667%	$ 533,436	$ -
19 Total Non Residential	34,919	147,216,419	$ 75,229,023	$ 23,319,173		$ 6,618,206	$ 29,937,379		$ 4,263,968	$ 46,683
20 Total All Programs	95,133	291,031,951	$ 185,536,397	$ 65,151,491		$ 13,731,301	$ 78,882,792		$ 11,225,199	$ 263,632

DSDR	System kW Reduction - Summer Peak (Net @Plant)	System Energy Reduction (kWh) (Net @ Plant)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement [2]	SC Retail kWh Sales Allocation Factor	SC DSDR Unadjusted Revenue Requirement (2)	SC DSDR Adjusted Revenue Requirement (EMF)
21 DSDR	329,603	# 39,546,086	N/A	$ 4,879,170	N/A	$ -	$ 4,879,170		$ -	$ -
22 Total All Programs with DSDR	424,736	330,578,037	185,536,397	70,030,662		13,731,301	83,761,962		11,225,199	263,632

(1) Energy Efficient Benchmarking impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Unadjusted Revenue Requirement does not include amortization of Incentive, which is reflected on page 2

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
			=A*B	=A+C			=-PMT(E,F,D)	=1-B	=G/H		=J-I		=L*K	=M*L*E	=M+N
Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2014 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Original Vintage 2014 PPI	PPI Over / (Under) Collection	Years at Original PPI Level	Cumulative PPI Over / (Under) Collection	Carrying Costs	PPI Over/(Under) Collection w/CCost
EE Programs															
1 **Appliance Recycling Program**	$ 8,888	38.71%	$ (3,441)	$ 5,448	8.88%	10	$ 844	61.29%	$ 1,378	$ 1,378	$ -	1.000	$ -	$ -	$ -
2 **Home Energy Improvement Program**	$ 17,353	38.71%	$ (6,717)	$ 10,636	8.88%	10	$ 1,649	61.29%	$ 2,690	$ 2,690	$ -	1.000	$ -	$ -	$ -
3 **Residential Lighting Program**	$ 471,129	38.71%	$ (182,376)	$ 288,753	8.88%	10	$ 44,758	61.29%	$ 73,027	$ 136,433	$ 63,405	2.750	$ 174,364	$ 42,585	$ 216,949
4 **Neighborhood Energy Saver Program**	$ -	38.71%	$ -	$ -	8.88%	10	$ -	61.29%	$ -	$ -	$ -	1.000	$ -	$ -	$ -
5 **Home Depot CFL**	$ -	38.71%	$ -	$ -	8.88%	1	$ -	61.29%	$ -	$ -	$ -	1.000	$ -	$ -	$ -
6 **Residential New Construction**	$ 64,836	38.71%	$ (25,098)	$ 39,738	8.88%	10	$ 6,160	61.29%	$ 10,050	$ 10,050	$ -	1.000	$ -	$ -	$ -
7 **Total for Residential Conservation Programs**	$ 562,207		$ (217,632)	$ 344,574			$ 53,411		$ 87,145	$ 150,550	$ 63,405		$ 174,364	$ 42,585	$ 216,949
8 **Residential Energy Efficient Benchmarking (1)**	$ 16,311	38.71%	$ (6,314)	$ 9,997	8.88%	1	$ 9,997	61.29%	$ 16,311	$ 16,311	$ -	1.000	$ -	$ -	$ -
9 **My Home Energy Report**	$ - #	38.71%	$ -	$ -	8.88%	1	$ -	61.29%	$ -	$ -	$ -	1.000	$ -	$ -	$ -
10 **Total Residential Conservation and Behavioral Programs**	$ 578,517		$ (223,946)	$ 354,571			$ 63,407		$ 103,456	$ 166,861	$ 63,405		$ 174,364	$ 42,585	$ 216,949
11 **EnergyWise**	$ 429,995	38.71%	$ (166,453)	$ 263,542	8.88%	10	$ 40,850	61.29%	$ 66,651	$ 66,651	$ -	1.000	$ -	$ -	$ -
12 **Total Residential**	$ 1,008,513		$ (390,399)	$ 618,113			$ 104,258		$ 170,107	$ 233,512	$ 63,405		$ 174,364	$ 42,585	$ 216,949

Non-Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2014 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Original Vintage 2014 PPI	PPI Over / (Under) Collection	Years at Original PPI Level	Cumulative PPI Over / (Under) Collection	Cumulative PPI Over / (Under) Collection	PPI Over/(Under) Collection w/CCost
EE Programs															
13 **Energy Efficiency for Business**	$ 519,762	38.71%	$ (201,202)	$ 318,560	8.88%	10	$ 49,378	61.29%	$ 80,566	$ 80,566	$ -	1.000	$ -	$ -	$ -
14 **Small Business Energy Saver Program**	$ 257,364	38.71%	$ (99,627)	$ 157,737	8.88%	10	$ 24,450	61.29%	$ 39,893	$ 39,893	$ -	1.000	$ -	$ -	$ -
15 **Non-Residential Lighting Program**	$ 137,594	38.71%	$ (53,263)	$ 84,331	8.88%	10	$ 13,072	61.29%	$ 21,328	$ 34,971	$ 13,644	2.750	$ 37,520	$ 9,163	$ 46,683
16 **Total for Non-Residential Conservation Programs**	$ 914,720		$ (354,092)	$ 560,628			$ 86,900		$ 141,786	$ 155,430	$ 13,644		$ 37,520	$ 9,163	$ 46,683
17 **Commercial, Industrial, & Governmental Demand Response**	$ 29,255	38.71%	$ (11,325)	$ 17,930	8.88%	10	$ 2,779	61.29%	$ 4,535	$ 4,535	$ -	1.000	$ -	$ -	$ -
18 **Total for Non-Residential DSM Programs**	$ 29,255		$ (11,325)	$ 17,930			$ 2,779		$ 4,535	$ 4,535	$ -		$ -	$ -	$ -
19 **Total Non Residential**	$ 943,974		$ (365,416)	$ 578,558			$ 89,679		$ 146,321	$ 159,964	$ 13,644		$ 37,520	$ 9,163	$ 46,683
20 **Total All Programs**	$ 1,952,487		$ (755,815)	$ 1,196,671			$ 193,937		$ 316,427	$ 393,476	$ 77,049		$ 211,884	$ 51,748	$ 263,632

(1) Energy Efficient Benchmarking impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak

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				A	B	C	D	E	F		G	H
							=(A-B)*C	= (B+D)				=O (from page 2)
Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)		System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement [3]	SC Retail kWh Sales Allocation Factor		SC Residential Unadjusted Revenue Requirement (2)	Adjusted Revenue Requirement (EMF)
EE Programs												
1 **Appliance Recycling Program**	566	4,407,053		$ 1,508,567	$ 1,219,750	13.00%	$ 37,546	$ 1,257,296	14.7100000%	E1 * F1	$ 184,948	$ -
2 **Energy Education Program for Schools**	227	2,285,597		$ 1,026,722	$ 703,591	0.00%	$ -	$ 703,591	14.7100000%	E2 * F2	$ 103,498	$ -
3 **Energy Efficient Lighting**	8,839	61,303,976		$ 35,910,710	$ 14,612,619	13.00%	$ 2,768,752	$ 17,381,371	14.7100000%	E3 * F3	$ 2,556,800	$ 69,442
4 **Home Energy Improvement Program**	1,911	6,086,957		$ 6,858,804	$ 5,294,395	13.00%	$ 203,373	$ 5,497,768	14.7100000%	E4 * F4	$ 808,722	$ (2)
5 **Multi-Family**	1,887	19,250,271		$ 9,063,458	$ 2,615,745	13.00%	$ 838,203	$ 3,453,947	14.7100000%	E5 * F5	$ 508,076	$ 47,090
6 **Neighborhood Energy Saver**	315	2,067,494		1,134,613	$ 1,579,671	0.00%	$ -	$ 1,579,671	14.7100000%	E6 * F6	$ 232,370	$ -
7 **Residential New Construction**	2,381	5,563,316		$ 10,171,573	$ 7,441,832	13.00%	$ 354,866	$ 7,796,698	14.7100000%	E7 * F7	$ 1,146,894	$ -
8 **Save Energy and Water Kit**	-	-		$ -	$ -	13.00%	$ -	$ -	14.7100000%	E8 * F8	$ -	$ -
9 **Residential Home Advantage**	-	-		$ -	$ -	13.00%	$ -	$ -	14.7100000%		$ -	$ -
10 **Total for Residential Conservation Programs**	16,126	100,964,664		$ 65,674,447	$ 33,467,602		$ 4,202,740	$ 37,670,343			$ 5,541,308	$ 116,530
11 **My Home Energy Report**	35,955	132,315,687		$ 7,732,605	$ 5,808,845	13.00%	$ 250,089	$ 6,058,934	14.7100000%	E11 * F11	$ 891,269	$ -
12 **Total Residential Conservation and Behavioral Programs**	52,081	233,280,351		$ 73,407,052	$ 39,276,448		$ 4,452,829	$ 43,729,277			$ 6,432,577	$ 116,530
									SC Residential Peak Demand Allocation Factor			
13 **EnergyWise**	28,015	-		$ 32,617,641	$ 5,204,195	8.00%	$ 2,193,076	$ 7,397,271	13.9533333%		$ 1,032,166	$ 20
14 **Total Residential**	80,097	233,280,351		$ 106,024,693	$ 44,480,642		$ 6,645,905	$ 51,126,547			$ 7,464,743	$ 116,550
Non-Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)		System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	System Revenue Requirement	SC Retail kWh Sales Allocation Factor		SC Non-Residential Unadjusted Revenue Requirement (2)	Adjusted Revenue Requirement (EMF)
EE Programs												
14 **Business Energy Report**	-	-		$ -	$ 73,518	13.00%	$ -	$ 73,518	14.7100000%	E13 * F13	$ 10,815	$ -
15 **Energy Efficiency for Business**	4,829	57,365,602		$ 29,902,372	$ 6,220,063	13.00%	$ 3,078,700	$ 9,298,763	14.7100000%	E14 * F14	$ 1,367,848	$ -
16 **Energy Efficient Lighting**	4,172	19,250,609		$ 11,551,470	$ 1,775,531	13.00%	$ 1,270,872	$ 3,046,403	14.7100000%	E16 * F16	$ 448,126	$ (1,684)
17 **Small Business Energy Saver**	6,829	42,318,074		$ 25,239,036	$ 9,779,593	13.00%	$ 2,009,728	$ 11,789,321	14.7100000%	E17 * F17	$ 1,734,209	$ -
18 **Total for Non-Residential Conservation Programs**	15,830	118,934,285		$ 66,692,877	$ 17,848,706		$ 6,359,300	$ 24,208,005			$ 3,560,998	$ (1,684)
19 **EnergyWise for Business**	-	-		$ -	$ 64,145	8.00%	$ -	$ 64,145	13.9533333%	E19 * F19	$ 8,950	$ -
20 **Commercial, Industrial, & Governmental Demand Response**	894	-		$ 1,025,439	$ 569,290	8.00%	$ 36,492	$ 605,782	13.9533333%	E20 * F20	$ 84,527	$ -
21 **Total for Non-Residential DSM Programs**	894	-		$ 1,025,439	$ 633,435		$ 36,492	$ 669,926	13.9533333%		$ 93,477	$ -
22 **Total Non Residential**	16,725	118,934,285		$ 67,718,316	$ 18,482,140		$ 6,395,792	$ 24,877,932			$ 3,654,475	$ (1,684)
23 **Total All Programs**	96,821	352,214,636		$ 173,743,009	$ 62,962,783		$ 13,041,697	$ 76,004,479			$ 11,119,218	$ 114,866
(1) My Home Energy Report impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages												
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak												
24 DSDR	315,673	41,988,428			7,999,427			$ 7,999,427				
25 Total with DSDR	412,494	394,203,064		$ 173,743,009	$ 70,962,210		$ 13,041,697	$ 84,003,907			$ 11,119,218	$ 114,866

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
			=A*B	=A+C			=-PMT(E,F,D)	=1-B			=J-I		=L*K	=M*L*E	=M+N
Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2015 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Original Vintage 2015 PPI	PPI Over / (Under) Collection	Years at Original PPI Level	Cumulative PPI Over / (Under) Collection	Carrying Costs	PPI Over/(Under) Collection w/CCost
EE Programs															
1 **Appliance Recycling Program**	$ 5,523	38.16%	$ (2,108)	$ 3,415	8.90%	10	$ 530	61.84%	$ 857	$ 857	$ -	1	$ -	$ -	$ -
2 **Energy Education Program for Schools**	$ -	38.16%	$ -	$ -	8.90%	N/A	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
3 **Energy Efficient Lighting**	$ 407,283	38.16%	$ (155,420)	$ 251,863	8.90%	10	$ 39,079	61.84%	$ 63,194	$ 126,959	$ 63,765	1	$ 63,765	$ 5,677	$ 69,442
4 **Home Energy Improvement Program**	$ 29,916	38.16%	$ (11,416)	$ 18,500	8.90%	10	$ 2,870	61.84%	$ 4,642	$ 4,640	$ (2)	1	$ (2)	$ (0)	$ (2)
5 **Multi-Family**	$ 123,300	38.16%	$ (47,051)	$ 76,248	8.90%	3	$ 30,070	61.84%	$ 48,626	$ 91,866	$ 43,240	1	$ 43,240	$ 3,850	$ 47,090
6 **Neighborhood Energy Saver**	$ -	38.16%	$ -	$ -	8.90%	N/A	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
7 **Residential New Construction**	$ 52,201	38.16%	$ (19,920)	$ 32,281	8.90%	10	$ 5,009	61.84%	$ 8,099	$ 8,099	$ -	1	$ -	$ -	$ -
8 **Home Depot CFL**	$ -	38.16%	$ -	$ -	8.90%	1	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
9 **Save Energy and Water Kit**	$ -	38.16%	$ -	$ -	8.90%	3	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
10 **Residential Home Advantage**	$ -	38.16%	$ -	$ -	8.90%	10	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
11 **Total for Residential Conservation Programs**	$ 618,223		$ (235,915)	$ 382,308			$ 77,559		$ 125,419	$ 232,421	$ 107,003		$ 107,003	$ 9,527	$ 116,530
12 **My Home Energy Report**	$ 36,788	38.16%	$ (14,038)	$ 22,750	8.90%	1	$ 22,750	61.84%	$ 36,788	$ 36,788	$ -	1	$ -	$ -	$ -
13 **Total Residential Conservation and Behavioral Programs**	$ 655,011		$ (249,954)	$ 405,058			$ 100,308		$ 162,207	$ 269,209	$ 107,003		$ 107,003	$ 9,527	$ 116,530
14 **EnergyWise**	$ 306,007	38.16%	$ (116,773)	$ 189,234	8.90%	10	$ 29,361	61.84%	$ 47,480	$ 47,498	$ 18	1	$ 18	$ 2	$ 20
15 **Total Residential**	$ 961,018		$ (366,727)	$ 594,292			$ 129,670		$ 209,687	$ 316,708	$ 107,021		$ 107,021	$ 9,529	$ 116,550

	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2015 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Original Vintage 2015 PPI	PPI Over / (Under) Collection	Years at Original PPI Level	Cumulative PPI Over / (Under) Collection	Carrying Costs	PPI Over/(Under) Collection w/CCost
Non-Residential Programs															
EE Programs															
15 **Business Energy Report**	$ -	38.16%	$ -	$ -	8.90%	1	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
16 **Energy Efficiency for Business**	$ 452,877	38.16%	$ (172,819)	$ 280,058	8.90%	10	$ 43,454	61.84%	$ 70,268	$ 70,268	$ -	1	$ -	$ -	$ -
17 **Energy Efficient Lighting**	$ 186,945	38.16%	$ (71,339)	$ 115,607	8.90%	10	$ 17,937	61.84%	$ 29,006	$ 27,460	$ (1,546)	1	$ (1,546)	$ (138)	$ (1,684)
18 **Small Business Energy Saver**	$ 295,631	38.16%	$ (112,813)	$ 182,818	8.90%	10	$ 28,366	61.84%	$ 45,870	$ 45,870	$ -	1	$ -	$ -	$ -
19 **Total for Non-Residential Conservation Programs**	$ 935,453		$ (356,971)	$ 578,482			$ 89,757		$ 145,144	$ 143,599	$ (1,546)		$ (1,546)	$ (138)	$ (1,684)
20 **EnergyWise for Business**	$ -	38.16%	$ -	$ -	8.90%	10	$ -	61.84%	$ -	$ -	$ -	1	$ -	$ -	$ -
21 **Commercial, Industrial, & Governmental Demand Response**	$ 5,092	38.16%	$ (1,943)	$ 3,149	8.90%	10	$ 489	61.84%	$ 790	$ 790	$ -	1	$ -	$ -	$ -
22 **Total for Non-Residential DSM Programs**	$ 5,092		$ (1,943)	$ 3,149			$ 489		$ 790	$ 790	$ -		$ -	$ -	$ -
23 **Total Non Residential**	$ 940,545		$ (358,914)	$ 581,631			$ 90,246		$ 145,935	$ 144,389	$ (1,546)		$ (1,546)	$ (138)	$ (1,684)
24 **Total All Programs**	$ 1,901,563		$ (725,640)	$ 1,175,923			$ 219,915		$ 355,621	$ 461,096	$ 105,475		$ 105,475	$ 9,391	$ 114,866

(1) Energy Efficient Benchmarking impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak

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			A	B	C	D	E	F	G		H	I
						=(A-B)*C	= (B+D)					=K (from page 2)
Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement (1)	SC Retail kWh Sales Allocation Factor	SC Allocation Factor (2)		SC Residential Unadjusted Revenue Requirement (2)	SC Residential Adjusted Revenue Requirement
EE Programs												
1 **Appliance Recycling Program**	27	206,569	$ 75,967	$ (136,970)	11.75%	$ 25,020	$ (111,950)	14.5615796%		E1 * F1	$ (16,302)	$ 20,246
2 **Energy Education Program for Schools**	222	2,242,237	$ 1,069,008	$ 825,794		$ -	$ 825,794	14.5615796%		E2 * F2	$ 120,249	$ -
3 **Energy Efficient Lighting**	6,006	41,649,479	$ 33,900,924	$ 15,516,690	11.75%	$ 2,160,147	$ 17,676,838	14.5615796%		E3 * F3	$ 2,574,027	$ 648,531
4 **Home Energy Improvement Program**	1,904	6,290,162	$ 6,972,997	$ 5,998,375	11.75%	$ 114,518	$ 6,112,893	14.5615796%		E4 * F4	$ 890,134	$ 72,195
5 **Multi-Family**	1,337	13,354,259	$ 6,817,700	$ 2,039,856	11.75%	$ 561,397	$ 2,601,253	14.5615796%		E5 * F5	$ 378,784	$ 80,879
6 **Neighborhood Energy Saver**	304	1,992,091	$ 1,170,879	$ 2,041,134		$ -	$ 2,041,134	14.5615796%		E6 * F6	$ 297,221	$ -
7 **Residential Energy Assessments**	692	4,141,847	$ 3,790,119	$ 1,414,281	11.75%	$ 279,161	$ 1,693,442	14.5615796%		E7 * F7	$ 246,592	$ 24,137
8 **Residential New Construction**	4,769	11,092,839	$ 21,268,023	$ 9,381,404	11.75%	$ 1,396,678	$ 10,778,082	14.5615796%		E8 * F8	$ 1,569,459	$ 98,498
9 **Home Depot CFL**	-	-	$ -	$ -		$ -	$ -	14.5615796%		E9 * F9	$ -	$ 10,473
10 **Save Energy and Water Kit**	1,298	16,214,719	$ 9,916,115	$ 673,150	11.75%	$ 1,086,048	$ 1,759,198	14.5615796%		E10 * F10	$ 256,167	$ 62,394
11 **Residential Home Advantage**	-	-	$ -	$ -	11.75%	$ -	$ -	14.5615796%		E11 * F11	$ -	$ 28,759
12 **Total for Residential Conservation Programs**	16,558	97,184,201	$ 84,981,734	$ 37,753,714		$ 5,622,970	$ 43,376,684				$ 6,316,331	$ 1,046,112
13 **My Home Energy Report**	34,858	128,280,914	$ 10,613,915	$ 5,877,786	11.75%	$ 556,495	$ 6,434,281	14.5615796%		E13 * F13	$ 936,933	$ 81,034
14 **Total Residential Conservation and Behavioral Programs**	51,417	225,465,114	$ 95,595,649	$ 43,631,501		$ 6,179,465	$ 49,810,965				$ 7,253,264	$ 1,127,146
								SC Residential Peak Demand Allocation Factor	**SC Allocation Factor (2)**			
15 **EnergyWise**	34,059	-	$ 70,854,171	$ 6,800,534	11.75%	$ 7,526,302	$ 14,326,836	13.8312281%	40.0482757%	(E15+E24) *F15*G15	$ 852,984	$ 905,124
16 **Total Residential**	85,476	225,465,114	$ 166,449,820	$ 50,432,035		$ 13,705,767	$ 64,137,802				$ 8,106,248	$ 2,032,271
Non-Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	System Revenue Requirement	SC Retail kWh Sales Allocation Factor			SC Non-Residential Unadjusted Revenue Requirement (2)	SC Non-Residential Adjusted Revenue Requirement
EE Programs												
17 **Business Energy Report**	740	4,546,814	$ 308,351	$ 69,211		$ -	$ 69,211	14.5615796%		E16 * F16	$ 10,078	$ -
18 **Energy Efficiency for Business**	10,202	71,161,894	$ 47,738,458	$ 14,122,010	11.75%	$ 3,949,933	$ 18,071,943	14.5615796%		E17 * F17	$ 2,631,560	$ 829,886
19 **Energy Efficient Lighting**	2,818	12,180,303	$ 10,838,755	$ 1,885,382	11.75%	$ 1,052,021	$ 2,937,403	14.5615796%		E18 * F18	$ 427,732	$ 210,474
20 **Small Business Energy Saver**	8,751	50,286,062	$ 33,095,951	$ 9,316,875	11.75%	$ 2,794,041	$ 12,110,917	14.5615796%		E19 * F19	$ 1,763,541	$ 260,184
21 **Total for Non-Residential Conservation Programs**	22,511	138,175,073	$ 91,981,515	$ 25,393,478		$ 7,795,995	$ 33,189,473				$ 4,832,911	$ 1,300,543
22 **EnergyWise for Business**	1,402	1,062,193	$ 807,334	$ 1,107,571	11.75%	$ (35,278)	$ 1,072,294	13.8312281%	100.0000000%	H24 * G22	$ 1,276,905	$ (5,315)
23 **Commercial, Industrial, & Governmental Demand Response**	(5,344)	-	$ (10,684,733)	$ -	11.75%	$ -	$ -	13.8312281%	0.0000000%	H24 * G23	$ -	$ 25,494
24 **Total for Non-Residential DSM Programs**	(3,943)	1,062,193	$ (9,877,399)	$ 1,107,571		$ (35,278)	$ 1,072,294	13.8312281%	59.9517243%	(E15+E24) *F24 *G24	$ 1,276,905	$ 20,179
25 **Total Non Residential**	18,569	139,237,266	$ 82,104,116	$ 26,501,049		$ 7,760,718	$ 34,261,767				$ 6,109,816	$ 1,320,723
26 **Total All Programs**	104,044	364,702,380	$ 248,553,935	$ 76,933,084		$ 21,466,485	$ 98,399,569				$ 14,216,064	$ 3,352,993

(1) My Home Energy Report impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak

24 DSDR	281,372	33,941,086		7,944,728			$ 7,944,728					
25 Total with DSDR	385,416	398,643,466	$ 248,553,935	$ 84,877,812		$ 21,466,485	$ 106,344,296				$ 14,216,064	$ 3,352,993

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Duke Energy Progress
Vintage 2016 True Up - January 1, 2016 to December 31, 2016
Docket 2017-XX-E
Load Impacts and Estimated Revenue Requirements by Program

	A	B	C	D	E	F	G	H	I	J								K
			=A*B	=A+C			=-PMT(E,F,D)	=1-B										=J+I
Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2016 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Σ Prior Period PPI	Vintage 2009 PPI	Vintage 2010 PPI	Vintage 2011 PPI	Vintage 2012 PPI	Vintage 2013 PPI	Vintage 2014 PPI	Vintage 2015 PPI	PPI Values for Test Period
EE Programs																		
1 **Appliance Recycling Program**	$ 3,643	37.61%	$ (1,370)	$ 2,273	8.93%	3	$ 897	62.39%	$ 1,437	$ 18,808	$ -	$ 5,380	$ 3,477	$ 4,782	$ 2,935	$ 1,378	$ 857	$ 20,246
2 **Energy Education Program for Schools**	$ -	37.61%	$ -	$ -	8.93%	N/A	$ -	62.39%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3 **Energy Efficient Lighting**	$ 314,552	37.61%	$ (118,303)	$ 196,248	8.93%	3	$ 77,427	62.39%	$ 124,102	$ 524,429	$ -	$ 94,447	$ 86,665	$ 97,403	$ 109,693	$ 73,027	$ 63,194	$ 648,531
4 **Home Energy Improvement Program**	$ 16,676	37.61%	$ (6,272)	$ 10,404	8.93%	3	$ 4,105	62.39%	$ 6,579	$ 65,616	$ 1,844	$ 17,530	$ 21,167	$ 17,744	0	$ 2,690	$ 4,642	$ 72,195
5 **Multi-Family**	$ 81,748	37.61%	$ (30,746)	$ 51,003	8.93%	3	$ 20,122	62.39%	$ 32,253	$ 48,626	$ -	$ -	$ -	$ -	$ -	$ -	$ 48,626	$ 80,879
6 **Neighborhood Energy Saver**	$ -	37.61%	$ -	$ -	8.93%	N/A	$ -	62.39%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7 **Residential Energy Assessments**	$ 40,650	37.61%	$ (15,289)	$ 25,362	8.93%	3	$ 10,006	62.39%	$ 16,038	$ 8,099	$ -	$ -	$ -	$ -	$ -	$ -	$ 8,099	$ 24,137
8 **Residential New Construction**	$ 203,378	37.61%	$ (76,491)	$ 126,888	8.93%	3	$ 50,062	62.39%	$ 80,240	$ 18,258	$ -	$ -	$ -	$ -	$ 8,208	$ 10,050	$ -	$ 98,498
9 **Home Depot CFL**	$ -	37.61%	$ -	$ -	8.93%	3	$ -	62.39%	$ -	$ 10,473	$ 10,473	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,473
10 **Save Energy and Water Kit**	$ 158,146	37.61%	$ (59,479)	$ 98,667	8.93%	3	$ 38,928	62.39%	$ 62,394	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 62,394
11 **Residential Home Advantage**	$ -	37.61%	$ -	$ -	8.93%	3	$ -	62.39%	$ -	$ 28,759	$ 1,421	$ 5,257	$ 12,043	$ 10,037	$ -	$ -	$ -	$ 28,759
12 **Total for Residential Conservation Programs**	$ 818,793		$ (307,949)	$ 510,844			$ 201,546		$ 323,043	$ 723,069	$ 13,738	$ 122,614	$ 123,352	$ 129,965	$ 120,836	$ 87,145	$ 125,419	$ 1,046,112
13 **My Home Energy Report**	$ 81,034	37.61%	$ (30,477)	$ 50,557	8.93%	1	$ 50,557	62.39%	$ 81,034	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 81,034
14 **Total Residential Conservation and Behavioral Programs**	$ 899,828		$ (338,426)	$ 561,402			$ 252,104		$ 404,078	$ 723,069	$ 13,738	$ 122,614	$ 123,352	$ 129,965	$ 120,836	$ 87,145	$ 125,419	$ 1,127,147
15 **EnergyWise**	$ 1,040,980	37.61%	$ (391,514)	$ 649,466	8.93%	3	$ 256,238	62.39%	$ 410,704	$ 494,420	$ 21,414	$ 133,740	$ 134,840	$ 40,586	$ 49,709	$ 66,651	$ 47,480	$ 905,124
16 **Total Residential**	$ 1,940,808		$ (729,940)	$ 1,210,868			$ 508,342		$ 814,782	$ 1,217,489	$ 35,152	$ 256,354	$ 258,192	$ 170,551	$ 170,545	$ 153,796	$ 172,898	$ 2,032,271

Non-Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2016 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Σ Prior Period PPI	Vintage 2009 PPI	Vintage 2010 PPI	Vintage 2011 PPI	Vintage 2012 PPI	Vintage 2013 PPI	Vintage 2014 PPI	Vintage 2015 PPI	PPI Values for Test Period
EE Programs																		
16 **Business Energy Report**	$ -	37.61%	$ -	$ -	8.93%	1	$ -	62.39%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17 **Energy Efficiency for Business**	$ 575,173	37.61%	$ (216,323)	$ 358,850	8.93%	3	$ 141,579	62.39%	$ 226,926	$ 602,960	$ 27,282	$ 78,191	$ 110,576	$ 119,215	$ 116,862	$ 80,566	$ 70,268	$ 829,886
18 **Energy Efficient Lighting**	$ 153,191	37.61%	$ (57,615)	$ 95,576	8.93%	3	$ 37,708	62.39%	$ 60,439	$ 150,034	$ -	$ 23,309	$ 20,870	$ 25,901	$ 29,621	$ 21,328	$ 29,006	$ 210,474
19 **Small Business Energy Saver**	$ 406,857	37.61%	$ (153,019)	$ 253,837	8.93%	3	$ 100,148	62.39%	$ 160,520	$ 99,664	$ -	$ -	$ -	$ -	$ 13,901	$ 39,893	$ 45,870	$ 260,184
20 **Total for Non-Residential Conservation Programs**	$ 1,135,220		$ (426,957)	$ 708,263			$ 279,435		$ 447,885	$ 852,658	$ 27,282	$ 101,500	$ 131,446	$ 145,116	$ 160,384	$ 141,786	$ 145,144	$ 1,300,543
21 **EnergyWise for Business**	$ (4,879)	37.61%	$ 1,835	$ (3,044)	8.93%	1	$ (3,316)	62.39%	$ (5,315)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (5,315)
22 **Commercial, Industrial, & Governmental Demand Response**	$ -	37.61%	$ -	$ -	8.93%	3	$ -	62.39%	$ -	$ 25,494	$ -	$ 10,743	$ 4,625	$ 3,199	$ 1,602	$ 4,535	$ 790	$ 25,494
23 **Total for Non-Residential DSM Programs**	$ (4,879)		$ 1,835	$ (3,044)			$ (3,316)		$ (5,315)	$ 25,494	$ -	$ 10,743	$ 4,625	$ 3,199	$ 1,602	$ 4,535	$ 790	$ 20,179
24 **Total Non Residential**	$ 1,130,341		$ (425,122)	$ 705,218			$ 276,119		$ 442,570	$ 878,152	$ 27,282	$ 112,243	$ 136,071	$ 148,316	$ 161,986	$ 146,321	$ 145,935	$ 1,320,723
25 **Total All Programs**	$ 3,071,148		$ (1,155,062)	$ 1,916,086			$ 784,461		$ 1,257,352	$ 2,095,641	$ 62,434	$ 368,596	$ 394,263	$ 318,867	$ 332,531	$ 300,117	$ 318,833	$ 3,352,993

(1) Energy Efficient Benchmarking impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak

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Duke Energy Progress
Vintage 2018 Estimate - January 1, 2018 to December 31, 2018
Docket 2017-XX-E
Load Impacts and Estimated Revenue Requirements by Program

			A	B	C	D =(A-B)*C	E = (B+D)	F	G		H	I =K (from page 2)
Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement (1)	SC Retail kWh Sales Allocation Factor	SC Allocation Factor (2)		Unadjusted Revenue Requirement (2)	Adjusted Revenue Requirement
EE Programs												
1 Appliance Recycling Program	304	2,298,513	980,427	752,274	11.75%	$ 26,808	$ 779,082	14.4917132%		E1 * F1	$ 112,902	$ 24,905
2 Energy Education Program for Schools	198	1,997,287	1,078,034	744,749	0.00%	$ -	$ 744,749	14.4917132%		E2 * F2	$ 107,927	$ -
3 Energy Efficient Lighting	3,334	23,122,871	28,205,786	10,319,840	11.75%	$ 2,101,599	$ 12,421,439	14.4917132%		E3 * F3	$ 1,800,079	$ 946,408
4 Home Energy Improvement	1,141	3,133,816	4,113,974	3,847,421	11.75%	$ 31,320	$ 3,878,741	14.4917132%		E4 * F4	$ 562,096	$ 73,174
5 Multi-Family	1,837	13,578,543	10,954,883	2,640,920	11.75%	$ 976,891	$ 3,617,811	14.4917132%		E5 * F5	$ 524,283	$ 158,880
6 Neighborhood Energy Saver	310	2,033,179	1,344,323	1,922,686	0.00%	$ -	$ 1,922,686	14.4917132%		E6 * F6	$ 278,630	$ -
7 Residential Energy Assessments	455	2,719,898	2,719,655	1,008,625	11.75%	$ 201,046	$ 1,209,671	14.4917132%		E7 * F7	$ 175,302	$ 37,907
8 Residential New Construction	6,950	16,047,598	33,045,380	12,886,524	11.75%	$ 2,368,666	$ 15,255,190	14.4917132%		E8 * F8	$ 2,210,738	$ 264,738
9 Residential Home Advantage	-	-	-	-	11.75%	$ -	$ -	14.4917132%		E9 * F9	$ -	$ 28,759
10 Save Energy and Water Kit	1,720	21,484,411	14,808,971	1,544,762	11.75%	$ 1,558,545	$ 3,103,307	14.4917132%		E10 * F10	$ 449,722	$ 208,112
11 Total for Residential Conservation Programs	16,249	86,416,115	97,251,434	35,667,800		$ 7,264,874	$ 42,932,674				$ 6,221,679	1,742,882
12 My Home Energy Report (1)	36,113	132,895,213	11,436,247	6,810,235	11.75%	$ 543,556	$ 7,353,791	14.4917132%		E11 * F11	$ 1,065,690	$ 78,771
13 Total Residential Conservation and Behavioral Programs	52,362	219,311,328	$ 108,687,681	$ 42,478,035		$ 7,808,430	$ 50,286,465				$ 7,287,369	$ 1,821,652
								SC Residential Peak Demand Allocation Factor				
14 EnergyWise ® Home	29,079	-	54,193,492	5,385,230	11.75%	$ 5,734,971	$ 11,120,201	13.8420755%	40.8665233%	(E13+E23) *F13 *G13	$ 1,062,757	$ 1,462,433
15 Total Residential	81,441	219,311,328	$ 162,881,173	$ 47,863,265		$ 13,543,401	$ 61,406,666				$ 8,350,126	$ 3,284,086
Non-Residential Programs	System kW Reduction - Summer Peak	System Energy Reduction (kWh)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement (1)	SC Retail kWh Sales Allocation Factor			Unadjusted Revenue Requirement (2)	Adjusted Revenue Requirement
EE Programs												
16 Energy Efficient Lighting	1,587	6,127,641	8,853,250	1,253,380	11.75%	$ 892,985	$ 2,146,364	14.4917132%		E15 * F15	$ 311,045	$ 299,003
17 Non-Residential Smart $aver Performance (Custom)	1,311	11,484,274	8,514,660	1,783,447	11.75%	$ 790,917	$ 2,574,365	14.4917132%		E16 * F16	$ 373,070	$ 263,404
18 Non-Residential Smart $aver Performance (Prescriptive)	3,145	29,918,863	24,145,753	7,610,009	11.75%	$ 1,942,950	$ 9,552,959	14.4917132%		E17 * F17	$ 1,384,387	$ 936,235
19 Non-Residential Smart $aver Performance Incentive	197	1,729,413	1,282,219	1,945,905	11.75%	$ (77,983)	$ 1,867,922	14.4917132%		E18 * F18	$ 270,694	$ (4,268)
20 Small Business Energy Saver	9,940	53,575,693	40,683,626	10,712,026	11.75%	$ 3,521,663	$ 14,233,689	14.4917132%		E19 * F19	$ 2,062,705	$ 563,894
21 Total for Non-Residential Conservation Programs	16,181	102,835,884	$ 83,479,507	$ 23,304,767		$ 7,070,532	$ 30,375,299				$ 4,401,901	$ 2,058,267
								SC Non-Residential Peak Demand Allocation Factor				
22 EnergyWise ® for Business	10,542	2,157,913	2,920,347	1,398,553	11.75%	$ 178,811	$ 1,577,364				$ 316,373	$ 29,080
23 Commercial Industrial Governmental Demand Response	7,357	-	13,599,809	5,089,840	11.75%	$ 999,921	$ 6,089,761				$ 1,221,426	$ 203,634
24 Total for Non-Residential DSM Programs	17,899	2,157,913	$ 16,520,157	$ 6,488,393		$ 1,178,732	$ 7,667,125	13.8420755%	59.1334767%	(E13+E23) *F23 *G23	$ 1,537,799	$ 232,713
25 Total Non Residential	34,080	104,993,797	$ 99,999,664	$ 29,793,160		$ 8,249,264	$ 38,042,425				$ 5,939,700	$ 2,290,981
26 Total All Programs	115,521	324,305,125	$ 262,880,837	$ 77,656,426		$ 21,792,665	$ 99,449,091				$ 14,289,826	$ 5,575,066
DSDR	System kW Reduction - Summer Peak	System Energy Reduction (kWh)	System NPV of Avoided Costs	Total Cost	Shared Savings %	Incentive	Unadjusted Rev Requirement (1)	SC Retail kWh Sales Allocation Factor	SC Retail kWh Sales Allocation Factor		Unadjusted Revenue Requirement (2)	Adjusted Revenue Requirement
27 DSDR	310,515	49,637,083		$ 12,534,749	N/A	$ -	$ 12,534,749					
Total All Programs with DSDR	$ 426,037	$ 373,942,208	$ 262,880,837	$ 90,191,175		$ 21,792,665	$ 111,983,840				$ 14,289,826	$ 5,575,066

(1) My Home Energy Report impacts reflect cumulative capability as of end of vintage year, including impacts for participants from prior vintages
(2) Total System DSM programs allocated to Residential and Non-Residential based on contribution to retail system peak

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Duke Energy Progress
Vintage 2018 Estimate - January 1, 2018 to December 31, 2018
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Load Impacts and Estimated Revenue Requirements by Program

	A	B	C	D	E	F	G	H	I	J										K
			=A*B	=A+C			=-PMT(E,F,D)	=1-B												=J+I
Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	PPI Amortization Period	Vintage Year 2018 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Σ Prior Period PPI	Vintage 2009 PPI	Vintage 2010 PPI	Vintage 2011 PPI	Vintage 2012 PPI	Vintage 2013 PPI	Vintage 2014 PPI	Vintage 2015 PPI	Vintage 2016 PPI	Vintage 2017 PPI	PPI Values for Test Period
EE Programs																				
1 **Appliance Recycling Program**	$ 3,885	37.06%	$ (1,440)	$ 2,445	6.52%	3	$ 924	62.94%	$ 1,467	$ 23,437	$ -	$ 5,380	$ 3,477	$ 4,782	$ 2,935	$ 1,378	$ 857	$ 1,437	$ 3,192	$ 24,905
2 **Energy Education Program for Schools**	$ -	37.06%	$ -	$ -	6.52%	N/A	$ -	62.94%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3 **Energy Efficient Lighting**	$ 304,558	37.06%	$ (112,869)	$ 191,689	6.52%	3	$ 72,402	62.94%	$ 115,033	$ 831,375	$ -	$ 94,447	$ 86,665	$ 97,403	$ 109,693	$ 73,027	$ 63,194	$ 124,102	$ 182,844	$ 946,408
4 **Home Energy Improvement**	$ 4,539	37.06%	$ (1,682)	$ 2,857	6.52%	3	$ 1,079	62.94%	$ 1,714	$ 71,460	$ 1,844	$ 17,530	$ 21,167	$ 17,744	$ -	$ 2,690	$ 4,642	$ 6,579	$ (736)	$ 73,174
5 **Multi-Family**	$ 141,568	37.06%	$ (52,465)	$ 89,103	6.52%	3	$ 33,655	62.94%	$ 53,471	$ 105,409	$ -	$ -	$ -	$ -	$ -	$ -	$ 48,626	$ 32,253	$ 24,530	$ 158,880
6 **Neighborhood Energy Saver**	$ -	37.06%	$ -	$ -	6.52%	N/A	$ -	62.94%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7 **Residential Energy Assessments**	$ 29,135	37.06%	$ (10,797)	$ 18,338	6.52%	3	$ 6,926	62.94%	$ 11,004	$ 26,903	$ - 0	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,038	$ 10,865	$ 37,907
8 **Residential New Construction**	$ 343,260	37.06%	$ (127,212)	$ 216,048	6.52%	3	$ 81,602	62.94%	$ 129,651	$ 135,087	$ -	$ -	$ -	$ -	$ 8,208	$ 10,050	$ 8,099	$ 80,240	$ 28,490	$ 264,738
9 **Residential Home Advantage**	$ -	37.06%	$ -	$ -	6.52%	3	$ -	62.94%	$ -	$ 28,759	$ 1,421	$ 5,257	$ 12,043	$ 10,037	$ -	$ -	$ -	$ -	$ -	$ 28,759
10 **Save Energy and Water Kit**	$ 225,860	37.06%	$ (83,703)	$ 142,156	6.52%	3	$ 53,693	62.94%	$ 85,308	$ 122,804	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 62,394	$ 60,409	$ 208,112
11 **Total for Residential Conservation Program**	1,052,805		(390,168)	662,636			250,281		397,649	1,345,233	3,265	122,614	123,352	129,965	120,836	87,145	125,419	323,043	309,594	1,742,882
12 **My Home Energy Report (REEB pre-2015)**	$ 78,771	37.06%	$ (29,192)	$ 49,578	6.52%	1	$ 49,578	62.94%	$ 78,771	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 78,771
13 **Total Residential Conservation and Behavio**	1,131,575		(419,361)	712,215			299,859		476,419	1,345,233	3,265	122,614	123,352	129,965	120,836	87,145	125,419	323,043	309,594	1,821,652
14 **EnergyWise ® Home**	$ 793,839	37.06%	$ (294,196)	$ 499,643	6.52%	3	$ 188,717	62.94%	$ 299,836	$ 1,162,597	$ 21,414	$ 133,740	$ 134,840	$ 40,586	$ 49,709	$ 66,651	$ 47,480	$ 410,704	$ 257,472	$ 1,462,433
15 **Total Residential**	1,925,414		(713,557)	1,211,858			488,576		776,256	2,507,830	24,679	256,354	258,192	170,551	170,545	153,796	172,898	733,748	567,066	3,284,086

Non-Residential Programs	SC Incentive	Income Tax Rate	Income Taxes	Net-of-Tax PPI - Total NPV	Discount Rate	Vintage Year 2014 - Year 1 PPI	Vintage Year 2018 - Year 1 PPI	Income Tax Gross-Up Factor	Adjusted PPI	Σ Prior Period PPI	Vintage 2009 PPI	Vintage 2010 PPI	Vintage 2011 PPI	Vintage 2012 PPI	Vintage 2013 PPI	Vintage 2014 PPI	Vintage 2015 PPI	Vintage 2016 PPI	Vintage 2017 PPI	PPI Values for Test Period
EE Programs																				
16 **Energy Efficient Lighting**	$ 129,409	37.06%	$ (47,959)	$ 81,450	6.52%	3	$ 30,764	62.94%	$ 48,878	$ 250,125	$ -	$ 23,309	$ 20,870	$ 25,901	$ 29,621	$ 21,328	$ 29,006	$ 60,439	$ 39,651	$ 299,003
17 **Non-Residential Smart $aver Performance I**	$ 114,617	37.06%	$ (42,477)	$ 72,140	6.52%	3	$ 27,248	62.94%	$ 43,292	$ 220,113	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 220,113	$ 263,404
18 **Non-Residential Smart $aver Performance I**	$ 281,567	37.06%	$ (104,348)	$ 177,218	6.52%	3	$ 66,936	62.94%	$ 106,349	$ 829,886	$ 27,282	$ 78,191	$ 110,576	$ 119,215	$ 116,862	$ 80,566	$ 70,268	$ 226,926	$ -	$ 936,235
19 **Non-Residential Smart $aver Performance I**	$ (11,301)	37.06%	$ 4,188	$ (7,113)	6.52%	3	$ (2,687)	62.94%	$ (4,268)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ (4,268)
20 **Small Business Energy Saver**	$ 510,349	37.06%	$ (189,135)	$ 321,214	6.52%	3	$ 121,324	62.94%	$ 192,761	$ 371,133	$ -	$ -	$ -	$ -	$ 13,901	$ 39,893	$ 45,870	$ 160,520	$ 110,949	$ 563,894
21 **Total for Non-Residential Conservation Proj**	1,024,641		(379,731)	644,910			243,585		387,011	1,671,256	27,282	101,500	131,446	145,116	160,384	141,786	145,144	447,885	370,713	2,058,267
22 **EnergyWise ® for Business**	$ 24,751	37.06%	$ (9,173)	$ 15,578	6.52%	1	$ 16,594	62.94%	$ 26,365	$ 2,715	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,715	$ 29,080
23 **Commercial, Industrial, & Governmental De**	$ 138,410	37.06%	$ (51,295)	$ 87,115	6.52%	3	$ 32,904	62.94%	$ 52,278	$ 151,356	$ -	$ 10,743	$ 4,625	$ 3,199	$ 1,602	$ 4,535	$ 790	$ -	$ 125,861	$ 203,634
24 **Total for Non-Residential DSM Programs**	163,161		(60,467)	102,694			49,498		78,643	154,071	-	10,743	4,625	3,199	1,602	4,535	790	-	128,577	232,713
25 **Total Non Residential**	1,187,802		(440,198)	747,604			293,083		465,654	1,825,327	27,282	112,243	136,071	148,316	161,986	146,321	145,935	447,885	499,289	2,290,981
26 **Total All Programs**	3,113,216		(1,153,755)	1,959,462			781,659		1,241,910	4,333,157	51,961	368,596	394,263	318,867	332,531	300,117	318,833	1,181,633	1,066,356	5,575,066

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				Vintage 2013			
Line	**Residential**	**2013**	**2014**	**2015**	**2016(a)**	**2017(a)**	**Total**
1	Appliance Recycling Program	$ 19,999	$ 40,756	$ 42,013	$ 20,720	$ -	$ 123,488
2	Home Energy Improvement Program	$ 19,085	$ 33,032	$ 34,050	$ 13,794	$ -	$ 99,961
3	Residential Lighting Program	$ 456,487	$ 913,651	$ 941,822	$ 456,119	$ -	$ 2,768,079
4	Neighborhood Energy Saver Program	$ 6,849	$ 14,072	$ 14,506	$ 7,214	$ -	$ 42,641
5	Residential New Construction	$ 9,910	$ 21,381	$ 22,040	$ 11,476	$ -	$ 64,808
6	Residential Energy Efficient Benchmarking	$ 110,790	$ (10,550)	$ -	$ -	$ -	$ 100,239
7	Residential Home Advantage	$ 703	$ 717	$ 740	$ -	$ -	$ 2,160
8	Net Lost Residential Revenues	**$ 623,823**	**$ 1,013,059**	**$ 1,055,171**	**$ 509,323**	**$ -**	**$ 3,201,376**

	Non-Residential	**2013**	**2014**	**2015**	**2016(a)**	**2017(a)**	**Total**
9	Energy Efficiency for Business	$ 303,726	$ 484,811	$ 499,759	$ 178,090	$ -	$ 1,466,386
10	Small Business Energy Saver Program	$ 26,480	$ 85,412	$ 88,046	$ 59,504	$ -	$ 259,442
11	Non-Residential Lighting Program	$ 196,825	$ 393,942	$ 406,089	$ 196,667	$ -	$ 1,193,523
12	Net Lost Non-Residential Revenues	**$ 527,031**	**$ 964,165**	**$ 993,894**	**$ 434,260**	**$ -**	**$ 2,919,351**

			Vintage 2014				
Line	**Residential**	**2014**	**2015**	**2016[a]**	**2017[b]**	**2018(b)**	**Total**
1	Appliance Recycling Program	$ 18,995	$ 42,388	$ 42,994	$ -	$ -	$ 104,377
2	Home Energy Improvement Program	$ 26,808	$ 44,619	$ 45,258	$ -	$ -	$ 116,685
3	Residential Lighting Program	$ 467,582	$ 856,123	$ 877,224	$ -	$ -	$ 2,200,929
4	Neighborhood Energy Saver Program	$ 5,957	$ 12,994	$ 13,180	$ -	$ -	$ 32,130
5	Residential New Construction	$ 29,055	$ 44,548	$ 45,186	$ -	$ -	$ 118,789
6	Residential Energy Efficient Benchmarking	$ 127,704	$ (700)	$ -	$ -	$ -	$ 127,004
7	Net Lost Residential Revenues	**$ 676,102**	**$ 999,971**	**$ 1,023,841**	**$ -**	**$ -**	**$ 2,699,914**

	Non-Residential	**2014**	**2015**	**2016[a]**	**2017[b]**	**2018(b)**	**Total**
8	Energy Efficiency for Business	$ 254,479	$ 404,990	$ 406,343	$ -	$ -	$ 1,065,813
9	Small Business Energy Saver Program	$ 132,324	$ 272,673	$ 273,584	$ -	$ -	678,581
10	Non-Residential Lighting Program	$ 203,462	$ 364,946	$ 369,898	$ -	$ -	938,306
11	Net Lost Non-Residential Revenues	**$ 590,265**	**$ 1,042,610**	**$ 1,049,825**	**$ -**	**$ -**	**$ 2,682,700**

			Vintage 2015				
Line	**Residential**	**2014**	**2015**	**2016[a]**	**2017[b]**	**2018(b)**	**Total**
1	Appliance Recycling Program	$ -	$ 11,178	$ 21,542	$ -	$ -	$ 32,720
2	Energy Education Program for Schools	$ -	$ 19,236	$ 27,596	$ -	$ -	46,831
3	Energy Efficient Lighting	$ -	$ 358,431	$ 733,611	$ -	$ -	1,092,042
4	Home Energy Improvement Program	$ -	$ 5,941	$ 11,915	$ -	$ -	17,855
5	Multi-Family	$ -	$ 78,122	$ 158,876	$ -	$ -	236,998
6	My Home Energy Report	$ -	$ 531,756	$ -	$ -	$ -	531,756
7	Neighborhood Energy Saver	$ -	$ 8,488	$ 30,649	$ -	$ -	39,137
8	Residential New Construction	$ -	$ 374	$ 478	$ -	$ -	852
9	Save Energy and Water Kit	$ -	$ -	$ -	$ -	$ -	
10	Total Lost Revenues	**$ -**	**$ 1,013,527**	**$ 984,667**	**$ -**	**$ -**	**$ 1,998,193**
11	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
12	Net Lost Residential Revenues	**$ -**	**$ 1,013,527**	**$ 984,667**	**$ -**	**$ -**	**$ 1,998,193**

	Non-Residential	**2014**	**2015**	**2016[a]**	**2017[b]**	**2018(b)**	**Total**
13	Energy Efficiency for Business	$ -	$ 221,090	$ 386,976	$ -	$ -	$ 608,066
14	Energy Efficient Lighting	$ -	$ 129,003	$ 261,331	$ -	$ -	390,334
15	Small Business Energy Saver	$ -	$ 128,708	$ 319,774	$ -	$ -	448,482
16	EnergyWise for Business	$ -	$ -	$ -	$ -	$ -	-
17	Total Lost Revenues	**$ -**	**$ 478,800**	**$ 968,081**	**$ -**	**$ -**	**$ 1,446,882**
18	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
19	Net Lost Non-Residential Revenues	**$ -**	**$ 478,800**	**$ 968,081**	**$ -**	**$ -**	**$ 1,446,882**

	DSDR	**2014**	**2015**	**2016[a]**	**2017[b]**	**2018(b)**	**Total**
20	DSDR	**$ -**	**$ 71,965**	**$ 24,619**		$	96,584

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Vintage 2016

Line	Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
1	Appliance Recycling Program	$ -	$ -	$ 272	$ 32,914	$ 306	$ 33,492
2	Energy Education Program for Schools	$ -	$ -	$ 8,012	$ 16,027	$ 16,945	$ 40,984
3	Energy Efficient Lighting	$ -	$ -	$ 190,078	$ 363,734	$ 409,210	$ 963,023
4	Home Energy Improvement Program	$ -	$ -	$ 5,955	$ 13,580	$ 13,610	$ 33,145
5	Multi-Family	$ -	$ -	$ 54,692	$ 86,467	$ 101,138	$ 242,297
6	My Home Energy Report	$ -	$ -	$ 742,850	$ -	$ -	$ 742,850
7	Neighborhood Energy Saver	$ -	$ -	$ 11,304	$ 13,917	$ 15,472	$ 40,693
8	Residential New Construction	$ -	$ -	$ -	$ 70,434	$ -	$ 70,434
9	Residential Energy Assessment	$ -	$ -	$ 9,117	$ 10,970	$ 28,411	$ 48,497
10	Save Energy and Water Kit	$ -	$ -	$ 31,447	$ 100,348	$ 81,756	$ 213,551
11	Total Lost Revenues	**$ -**	**$ -**	**$ 1,053,726**	**$ 708,390**	**$ 666,849**	**$ 2,428,965**
12	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
13	Net Lost Residential Revenues	**$ -**	**$ -**	**$ 1,053,726**	**$ 708,390**	**$ 666,849**	**$ 2,428,965**

	Non-Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
14	Business Energy Reports	$ -	$ -	$ -	$ -	$ -	$ -
15	Energy Efficiency for Business	$ -	$ -	$ 216,489	$ 954,348	$ 416,228	$ 1,587,065
16	Energy Efficient Lighting	$ -	$ -	$ 60,544	$ 226,376	$ 127,556	414,476
17	Small Business Energy Saver	$ -	$ -	$ 135,835	$ 281,766	$ 250,316	667,917
18	EnergyWise for Business	$ -	$ -	$ 1,104	$ 2,947	$ 1,598	5,650
19	Total Lost Revenues	**$ -**	**$ -**	**$ 413,973**	**$ 1,465,437**	**$ 795,698**	**$ 2,675,108**
20	Found Non-Residential Revenues	**$ -**	**$ -**	$ (4,852)	$ (7,607)	$ (7,607)	**$ (20,065)**
21	Net Lost Non-Residential Revenues	**$ -**	**$ -**	**$ 409,122**	**$ 1,457,830**	**$ 788,092**	**$ 2,655,043**

	DSDR	2014	2015	2016[a]	2017[b]	2018(b)	Total
22	DSDR	**$ -**	**$ -**	**$ 21,839**	**$ 12,638**		$ 34,478

Vintage 2017

Line	Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
1	Appliance Recycling Program	$ -	$ -	$ -	$ 16,381	$ 34,800	$ 51,181
2	Energy Education Program for Schools	$ -	$ -	$ -	$ 7,973	$ 16,945	24,919
3	Energy Efficient Lighting	$ -	$ -	$ -	$ 167,553	$ 236,657	404,210
4	Home Energy Improvement Program	$ -	$ -	$ -	$ 9,268	$ 19,698	28,966
5	My Home Energy Report	$ -	$ -	$ -	$ 759,515	$ -	759,515
6	Neighborhood Energy Saver	$ -	$ -	$ -	$ 6,924	$ 17,232	24,155
7	Multi-Family Energy Efficiency	$ -	$ -	$ -	$ 40,869	$ 53,561	94,430
8	Residential Energy Assessments	$ -	$ -	$ -	$ 11,017	$ 23,414	34,432
9	Residential New Construction	$ -	$ -	$ -	$ 52,276	$ 3,875	56,150
10	Save Energy and Water Kit	$ -	$ -	$ -	$ 61,306	$ 130,290	191,596
11	Total Lost Revenues	**$ -**	**$ -**	**$ -**	**$ 1,133,082**	**$ 536,472**	**$ 1,669,555**
12	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
13	Net Lost Residential Revenues	**$ -**	**$ -**	**$ -**	**$ 1,133,082**	**$ 536,472**	**$ 1,669,555**

	Non-Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
14	Business Energy Reports	$ -	$ -	$ -	$ 27,888	$ -	$ 27,888
15	Energy Efficiency for Business	$ -	$ -	$ -	$ 490,277	$ 1,009,874	1,500,150
16	Energy Efficient Lighting	$ -	$ -	$ -	$ 95,346	$ 58,600	153,946
17	Small Business Energy Saver	$ -	$ -	$ -	$ 122,402	$ 315,665	438,067
18	EnergyWise ® for Business	$ -	$ -	$ -	$ 2,186	$ 4,580	6,766
19	Total Lost Revenues	$ -	$ -	$ -	$ 738,098	$ 1,388,719	$ 2,126,817
20	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	$ (6,150)	$ (11,354)	**$ (17,504)**
21	Net Lost Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ 731,948**	**$ 1,377,365**	**$ 2,109,313**

Vintage 2018

Line	Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
1	Appliance Recycling Program	$ -	$ -	$ -	$ -	$ 10,070	$ 10,070
2	Energy Education Program for Schools	$ -	$ -	$ -	$ -	$ 13,873	13,873
3	Energy Efficient Lighting	$ -	$ -	$ -	$ -	$ 100,023	100,023
4	Home Energy Improvement Program	$ -	$ -	$ -	$ -	$ 25,595	25,595
5	Multi-Family	$ -	$ -	$ -	$ -	$ 59,219	59,219
6	Neighborhood Energy Saver	$ -	$ -	$ -	$ -	$ 9,302	9,302
7	Residential Energy Assessments	$ -	$ -	$ -	$ -	$ 11,826	11,826
8	Residential New Construction	$ -	$ -	$ -	$ -	$ 338	338
9	Save Energy and Water Kit	$ -	$ -	$ -	$ -	$ 99,303	99,303
10	My Home Energy Report	$ -	$ -	$ -	$ -	$ 803,738	803,738
11	Total Lost Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,133,287**	**$ 1,133,287**
12	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	$ (3,070)	**$ (3,070)**
13	Net Lost Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,130,217**	**$ 1,130,217**

	Non-Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
14	Business Energy Reports	$ -	$ -	$ -	$ -	$ -	$ -
15	Energy Efficiency for Business	$ -	$ -	$ -	$ -	$ 306,719	306,719
16	Energy Efficient Lighting	$ -	$ -	$ -	$ -	$ 26,506	26,506
17	Small Business Energy Saver	$ -	$ -	$ -	$ -	$ 205,445	205,445
18	EnergyWise ® for Business	$ -	$ -	$ -	$ -	$ 8,901	8,901
19	Total Lost Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ 547,572**	**$ 547,572**
20	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	$ (14,353)	**$ (14,353)**
21	Net Lost Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ 533,219**	**$ 533,219**

(a) Lost revenues were estimated by applying forecasted lost revenue rates for residential and non-residential customers to state specific forecasted program participation.
(b) DEP ineligible for 2017 lost revenues for Vintage 2014 and 2015. New base rates from rate case in effect 1/1/2017

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Vintage 2014 as Filed MWh

Line	Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
1	Appliance Recycling Program	328.69	739.07	732	-	-	1,799
2	Home Energy Improvement Program	464	778	770	-	-	2,012
3	Residential Lighting Program	9,638	18,331	18,146	-	-	46,115
4	Neighborhood Energy Saver Program	103	227	224	-	-	554
5	Residential New Construction	503	777	769	-	-	2,048
6	Residential Energy Efficient Benchmarking	2,210	(12)	-	-	-	2,198
7	Net Lost Residential Revenues	**13,247**	**20,839**	**20,641**	**0**	**0**	**54,726**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
8	Energy Efficiency for Business	4,856	7,949	7,869	-	-	$ 20,674
9	Small Business Energy Saver Program	2,525	5,352	5,298	-	-	$ 13,175
10	Non-Residential Lighting Program	4,626	8,797	8,709	-	-	$ 22,131
11	Net Lost Non-Residential Revenues	**12,007**	**22,099**	**21,876**	**0**	**0**	**55,981**

Vintage 2015 as Filed Lost Revenue kWh $

Line	Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
1	Appliance Recycling Program	$ -	$ 11,010.01	$ 20,706.31	$ -	$ -	$ 31,716.32
2	Energy Education Program for Schools	$ -	$ 18,908.78	$ 26,476.31	$ -	$ -	45,385
3	Energy Efficient Lighting	$ -	$ 373,373.89	$ 688,803.58	$ -	$ -	1,062,177
4	Home Energy Improvement Program	$ -	$ 7,262.01	$ 11,487.38	$ -	$ -	18,749
5	Multi-Family	$ -	$ 70,963.72	$ 139,438.31	$ -	$ -	210,402
6	My Home Energy Report	$ -	$ 523,757.32	$ -	$ -	$ -	523,757
7	Neighborhood Energy Saver	$ -	$ 7,139.02	$ 25,155.92	$ -	$ -	32,295
8	Residential New Construction	$ -	$ 368.83	$ 459.43	$ -	$ -	828
9	Save Energy and Water Kit	$ -	$ -	$ -	$ -	$ -	0
10	Total Lost Revenues	**$ -**	**$ 1,012,784**	**$ 912,527**	**$ -**	**$ -**	**$ 1,925,311**
11	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
12	Net Lost Residential Revenues	**$ -**	**$ 1,012,784**	**$ 912,527**	**$ -**	**$ -**	**$ 1,925,311**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
13	Energy Efficiency for Business	$ -	$ 217,326.53	$ 375,304.33	-	-	$ 592,631
14	Energy Efficient Lighting	$ -	$ 158,949.25	$ 293,255.25	-	-	$ 452,205
15	Small Business Energy Saver	$ -	$ 126,516.90	$ 310,128.67	-	-	$ 436,646
16	EnergyWise for Business	$ -	$ -	$ -	-	-	$ -
17	Total Lost Revenues	**$ -**	**$ 502,793**	**$ 978,688**	**$ -**	**$ -**	**$ 1,481,481**
18	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	$ -
19	Net Lost Non-Residential Revenues	**$ -**	**$ 502,793**	**$ 978,688**	**$ -**	**$ -**	**$ 1,481,481**
					-	-	$ -
					-	-	$ -
	DSDR						
20	DSDR	**$ -**	$ 71,965	$ 24,619	**$ -**	**$ -**	**96,584**

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South Carolina Net Lost Revenue True Up for Vintages 2014 - 2015

Vintage 2014 True Up MWh

Line	Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
1	Appliance Recycling Program	329	739	732	-	-	1,799.37
2	Home Energy Improvement Program	464	778	770	-	-	2,011.99
3	Residential Lighting Program	8,091	14,927	14,927	-	-	37,945.68
4	Neighborhood Energy Saver Program	103	227	224	-	-	553.91
5	Residential New Construction	503	777	769	-	-	2,048.41
6	Residential Energy Efficient Benchmarking	2,210	(12)	-	-	-	2,197.58
7	Net Lost Residential Revenues	**11,699**	**17,435**	**17,422**	**0**	**0**	**46,557**

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	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
8	Energy Efficiency for Business	4,856.21	7,949.21	7,869.00	-	-	20,674.42
9	Small Business Energy Saver Program	2,525.12	5,352.07	5,298.07	-	-	13,175.27
10	Non-Residential Lighting Program	3,882.66	7,163.22	7,163.22	-	-	18,209.09
11	Net Lost Non-Residential Revenues	**11,264**	**20,464**	**20,330**	**0**	**0**	**52,059**

Vintage 2015 True Up Lost Revenue kWh $

Line	Residential	2014	2015	2016[a]	2017[a]	2018(a)	Total
1	Appliance Recycling Program	$ -	$ 11,178.15	$ 21,542.07	$ -	$ -	$ 32,720.22
2	Energy Education Program for Schools	$ -	$ 19,235.75	$ 27,595.73	$ -	$ -	46,831.48
3	Energy Efficient Lighting	$ -	$ 358,431.34	$ 733,611.14	$ -	$ -	1,092,042.48
4	Home Energy Improvement Program	$ -	$ 5,940.58	$ 11,914.86	$ -	$ -	17,855.44
5	Multi-Family	$ -	$ 78,122.18	$ 158,875.78	$ -	$ -	236,997.96
6	My Home Energy Report	$ -	$ 531,756.03	$ -	$ -	$ -	531,756.03
7	Neighborhood Energy Saver	$ -	$ 8,488.17	$ 30,649.13	$ -	$ -	39,137.30
8	Residential New Construction	$ -	$ 374.46	$ 477.97	$ -	$ -	852.43
9	Save Energy and Water Kit	$ -	$ -	$ -	$ -	$ -	-
10	Total Lost Revenues	**$ -**	**$ 1,013,527**	**$ 984,667**	**$ -**	**$ -**	**$ 1,998,193**
11	Found Residential Revenues	**$ -**	$ -	-	**$ -**	**$ -**	**$ -**
12	Net Lost Residential Revenues	**$ -**	**$ 1,013,527**	**$ 984,667**	**$ -**	**$ -**	**$ 1,998,193**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
13	Energy Efficiency for Business	-	$ 221,090.02	$ 386,976.34	$ -	$ -	$ 608,066.36
14	Energy Efficient Lighting	-	$ 129,002.59	$ 261,331.16	-	-	390,333.76
15	Small Business Energy Saver	-	$ 128,707.82	$ 319,773.72	-	-	448,481.53
16	EnergyWise for Business	-	$ -	$ -	-	-	-
17	Total Lost Revenues	**$ -**	**$ 478,800**	**$ 968,081**	**$ -**	**$ -**	**$ 1,446,882**
18	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	$ -
19	Net Lost Non-Residential Revenues	**$ -**	**$ 478,800**	**$ 968,081**	**$ -**	**$ -**	**$ 1,446,882**
					-	-	$ -
					-	-	$ -
	DSDR						
20	DSDR	**$ -**	$ 71,965	$ 24,619	**$ -**	**$ -**	**96,584**

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Vintage 2014 Variance MWh

Line	Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
1	Appliance Recycling Program	-	-	-	-	-	-
2	Home Energy Improvement Program	-	-	-	-	-	-
3	Residential Lighting Program	(1,547.45)	(3,403.23)	(3,218.28)	-	-	(8,168.97)
4	Neighborhood Energy Saver Program	-	-	-	-	-	-
5	Residential New Construction	-	-	-	-	-	-
6	Residential Energy Efficient Benchmarking	-	-	-	-	-	-
7	Net Lost Residential Revenues	**(1,547)**	**(3,403)**	**(3,218)**	**0**	**0**	**(8,169)**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
8	Energy Efficiency for Business	-	-	-	-	-	-
9	Small Business Energy Saver Program	-	-	-	-	-	-
10	Non-Residential Lighting Program	(743.07)	(1,634.05)	(1,545.29)	-	-	(3,922.41)
11	Net Lost Non-Residential Revenues	**(743)**	**(1,634)**	**(1,545)**	**0**	**0**	**(3,922)**

Vintage 2015 Variance Lost Revenue kWh $

Line	Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
1	Appliance Recycling Program	$ -	$ 168	$ 836	$ -	$ -	$ 1,003.90
2	Energy Education Program for Schools	$ -	$ 327	$ 1,119	$ -	$ -	1,446.39
3	Energy Efficient Lighting	$ -	$ (14,943)	$ 44,808	$ -	$ -	29,865.01
4	Home Energy Improvement Program	$ -	$ (1,321)	$ 427	$ -	$ -	(893.95)
5	Multi-Family	$ -	$ 7,158	$ 19,437	$ -	$ -	26,595.94
6	My Home Energy Report	$ -	$ 7,999	$ -	$ -	$ -	7,998.70
7	Neighborhood Energy Saver	$ -	$ 1,349	$ 5,493	$ -	$ -	6,842.36
8	Residential New Construction	$ -	$ 6	$ 19	$ -	$ -	24.18
9	Save Energy and Water Kit	$ -	$ -	$ -	$ -	$ -	-
10	Total Lost Revenues	**$ -**	**$ 743**	**$ 72,139**	**$ -**	**$ -**	**$ 72,883**
11	Found Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
12	Net Lost Residential Revenues	**$ -**	**$ 743**	**$ 72,139**	**$ -**	**$ -**	**$ 72,883**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
13	Energy Efficiency for Business	-	3,763.49	11,672.01	-	-	15,435.50
14	Energy Efficient Lighting	-	(29,946.66)	(31,924.09)	-	-	(61,870.75)
15	Small Business Energy Saver	-	2,190.92	9,645.04	-	-	11,835.96
16	EnergyWise for Business	-	-	-	-	-	-
17	Total Lost Revenues	**$ -**	**$ (23,992)**	**$ (10,607)**	**$ -**	**$ -**	**$ (34,599)**
18	Found Non-Residential Revenues	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	$ -
19	Net Lost Non-Residential Revenues	**$ -**	**$ (23,992)**	**$ (10,607)**	**$ -**	**$ -**	**$ (34,599)**
					-	-	$ -
					-	-	$ -
	DSDR						
20	DSDR	$ -	$ -	$ -	$ -	$ -	**$ -**

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LR Rates $/MWh	2014	2015	2016	2017	2018
Res	$ 57.79	$ 57.35	$ 58.77	$ 56.49	$ 60.02
Non-Res	$ 52.40	$ 50.95	$ 51.64	$ 50.08	$ 52.47

Vintage 2014 Variance $

Line	Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
1	Appliance Recycling Program	$ -	$ -	-	$ -	$ -	$ -
2	Home Energy Improvement Program	$ -	$ -	-	$ -	$ -	$ -
3	Residential Lighting Program	$ (89,428)	$ (195,185)	(189,127)	$ -	$ -	$ (473,739)
4	Neighborhood Energy Saver Program	$ -	$ -	-	$ -	$ -	$ -
5	Residential New Construction	$ -	$ -	-	$ -	$ -	$ -
6	Residential Energy Efficient Benchmarking	$ -	$ -	-	$ -	$ -	$ -
7	Net Lost Residential Revenues	**(89,428)**	**(195,185)**	**(189,127)**	**0**	**0**	**(473,739)**

	Non-Residential	2014	2015	2016[a]	2017[b]	2018(b)	Total
8	Energy Efficiency for Business	$ -	$ -	-	$ -	$ -	$ -
9	Small Business Energy Saver Program	$ -	$ -	-	$ -	$ -	$ -
10	Non-Residential Lighting Program	$ (38,939)	$ (83,250)	(79,796)	$ -	$ -	$ (201,986)
11	Net Lost Non-Residential Revenues	**(38,939)**	**(83,250)**	**(79,796)**	**0**	**0**	**(201,986)**

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Exhibit 9

Duke Energy Progress
For the Period January 1, 2016 - December 31, 2016
Docket 2017-XX-E
Actual Program Costs for Vintage Year 2016

			Carolinas System - 12 Months Ended 12/31/2016
1	Appliance Recycling Program		$ (136,970)
2	Home Energy Improvement Program		$ 5,998,375
3	Residential Lighting Program		$ 15,516,690
4	Neighborhood Energy Saver		$ 2,041,134
5	Residential New Construction		$ 9,381,404
6	Residential Energy Efficient Benchmarking		$ -
7	Residential Home Advantage		$ -
8	Energy Education Program for Schools		$ 825,794
9	Multi-Family		$ 2,039,856
10	My Home Energy Report		$ 5,877,786
11	Business Energy Report		$ 69,211
12	Energy Efficiency for Business		$ 14,122,010
13	Energy Efficient Lighting		$ 1,885,382
14	Small Business Energy Saver		$ 9,316,875
15	Save Energy and Water Kit		$ 673,150
16	Residential Energy Assessments		$ 1,414,281
17	EnergyWise		$ 12,906,434
18	EnergyWise for Business		$ 1,107,571
19	CIG DR		$ 1,529,520
20	**Total Energy Efficiency & Demand Side Program Costs**	Sum(Lines 1-19)	**$ 84,568,504**

21	SC Allocation Factor for EE programs	Final SC 2016 Allocation Factors	14.56%
22	SC Allocation Factor for DSM programs	Final SC 2016 Allocation Factors	13.83%

			SC Allocated - 12 Months Ended 12/31/2016 (1)
23	Appliance Recycling Program	Line 1 * Line 21	$ (19,944.99)
24	Home Energy Improvement Program	Line 2 * Line 21	$ 873,458.20
25	Residential Lighting Program	Line 3 * Line 21	$ 2,259,475.19
26	Neighborhood Energy Saver	Line 4 * Line 21	$ 297,221.42
27	Residential New Construction	Line 5 * Line 21	$ 1,366,080.58
28	Residential Energy Efficient Benchmarking	Line 6 * Line 21	$ -
29	Residential Home Advantage	Line 7 * Line 21	$ -
30	Energy Education Program for Schools	Line 8 * Line 21	$ 120,248.61
31	Multi-Family	Line 9 * Line 21	$ 297,035.30
32	My Home Energy Report	Line 10 * Line 21	$ 855,898.52
33	Business Energy Report	Line 11 * Line 21	$ 10,078.21
34	Energy Efficiency for Business	Line 12 * Line 21	$ 2,056,387.75
35	Energy Efficient Lighting	Line 13 * Line 21	$ 274,541.34
36	Small Business Energy Saver	Line 14 * Line 21	$ 1,356,684.22
37	Save Energy and Water Kit	Line 15 * Line 21	$ 98,021.27
38	Residential Energy Assessments	Line 16 * Line 21	$ 205,941.59
39	EnergyWise	Line 17 * Line 22	$ 1,785,118.29
40	EnergyWise for Business	Line 18 * Line 22	$ 153,190.74
41	CIG DR	Line 19 * Line 22	$ 211,551
42	**Total Energy Efficiency & Demand Side Program Costs**	Sum (Lines 23-41)	**$ 12,200,988**

(1) SC Allocations are based on annual weighted average, which are employed in the allocation of Utility Cost Test (UCT) results for PPI determination. This differs from the allocation used in Exhibit 2, which allocates actual costs by month.

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Exhibit 10

Duke Energy Progress, LLC
January - December 2016 Actuals
January 2017 - December 2018 Estimates
Docket No. 2017-XX-E
South Carolina Found Revenues

	Actual/Reported	Estimated KWH	
	2016	2017	2018
Economic Development	11,000,000	-	-
Lighting			
Residential	9,257	9,257	9,257
Non Residential (Regulated)	49,512	49,512	49,512
MV to LED Credit - Residential (Regulated)	(191,894)	(149,297)	-
MV to LED Credit - Non-Residential (Regulated)	(35,070)	(27,285)	-
Total KWH	10,831,805	(117,813)	58,769
Total KWH Included	(168,195)	(117,813)	58,769
Total KWH Included (net of Free Riders 15%)	(142,966)	(100,141)	49,954
Annualized Found Revenue - Non Residential	$ 7,607	$ 11,354	$ 26,498
Annualized Found Revenue - Residential	$ (109,476)	$ (80,686)	$ 5,668

	2016	2017	2018
Vintage 2016 - Non Res	$ 4,852	7,607	7,607
Vintage 2017 - Non Res		$ 6,150	11,354
Vintage 2018 - Non Res			$ 14,353
Net Negative Found Revenues to Zero*	-	-	-
Subtotal - Non Res	**$ 4,852**	**$ 13,757**	**$ 33,314**
Vintage 2016 - Res	$ (59,359)	(109,476)	(109,476)
Vintage 2017 - Res		$ (43,705)	(80,686)
Vintage 2018 - Res			$ 3,070
Net Negative Found Revenues to Zero*	59,359	153,180	187,091
Subtotal - Residential	$ -	$ -	$ -
Total Found Revenues	**$ 4,852**	**$ 13,757**	**$ 33,314**

* Eliminates the inclusion of total negative found revenues at the Residential level

Appliance Recycling Program

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A. Description

The Appliance Recycling Program ("Program") promotes the removal and responsible disposal of operating refrigerators and freezers from Duke Energy Progress (DEP) LLC's (the "Company") residential customers. The refrigerator or freezer must have a capacity of at least 10 cubic feet but not more than 30 cubic feet. The Program recycles approximately 95% of the material from the harvested appliances.

Audience

Eligible Program participants include the Company's residential customers who own operating refrigerators and freezers used in individually metered residences.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	4,182	207	(3,975)
Savings (MW)	0.55	0.03	(0.53)
Participants		342	
2016 Program Expenses		($137,009)	

D. Qualitative Analysis

Highlights

Continued support to service customers who were impacted with the abrupt closure of the Program in late, 2015. The participation received during the January – March 2015 was due to pickup of appliances from canceled appointments for DEP customers (145 total appliances; 118 Refrigerators and 27 Freezers). At this time, we believe all impacted customers have been addressed.

Issues

During the first three months of 2016, the Program was primarily focused on servicing customers with canceled appointments and reissuing incentive payments to customers who were not paid or who received bounced incentive check from JACO. Additionally, the Company is reviewing all data submitted by JACO and will submit any participation records that were not processed by JACO prior to the receivership.

Potential Changes

No changes at this time.

E. Marketing Strategy

No Marketing efforts were conducted.

F. Evaluation, Measurement and Verification

No evaluation activities are planned in 2017.

Energy Efficiency Education Program

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A. Description

The Energy Efficiency Education Program ("Program") is an energy efficiency program available in North Carolina and South Carolina. The Program is available to students in grades K-12 enrolled in public and private schools who reside in households served by Duke Energy Progress. The current curriculum administered by The National Theatre for Children ("NTC") targets K-8 grade students.

The Program provides principals and teachers with an innovative curriculum that educates students about energy, resources, how energy and resources are related, ways energy is wasted and how to be more energy efficient. The centerpiece of the current curriculum is a live theatrical production focused on concepts such as energy, renewable fuels and energy efficiency performed by two professional actors. Teachers receive supportive educational material for classroom and student take home assignments.
The workbooks, assignments and activities meet state curriculum requirements.

School principals are the main point of contact responsible for scheduling their school's performance at their convenience. Once the principal confirms the performance date and time, two weeks prior to the performance, all materials are delivered to the principal's attention for classroom and student distribution. Materials include school posters, teacher guides, and classroom and family activity books.

Students are encouraged to complete a home energy survey with their family (included in their classroom and family activity book) to receive an Energy Efficiency Starter Kit. The kit contains specific energy efficiency measures to reduce home energy consumption. The kit is available at no cost to all student households at participating schools, including customers and non-customers.

Audience

Eligible participants include the Company's residential customers who reside in households served by Duke Energy Progress with school-age children enrolled in public and private schools.

B &C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	1,998	2,242	244
Savings (MW)	0.20	0.22	0.02
Participants		9,877	
2016 Program Expenses		$ 827,497	

D. Qualitative Analysis

Highlights

The Program in its third year has been well received by schools, teachers, students and parents. It provides an important message about energy efficiency through an innovative delivery channel for children. The message is enhanced with a live theatrical production which reinforces the curriculum material in the classroom.

The 2016--2017 school year, offered two productions delivered by The National Theatre for Children (NTC). *The Conservation Caper*, is a 25-minute live production delivered to elementary school aged students and teaches them how to use resources wisely through a fun super hero adventure. *The Energy Agents*, a 40-minute improvisational sketch comedy is offered to middle school aged students.

During 2016, the Program visited 232 schools in NC and SC and reached over 85,000 students with the energy efficiency curriculum. Additionally, the program distributed over 9,800 Energy Efficiency Starter kits to student households served by Duke Energy Progress Carolinas.

School contests encourage kit sign ups and the return of the Family Business Reply Card (BRC). In the fall and spring of each year, a drawing is held selecting one school and one household contest winner.

A school in Indiana won the fall 2016 school contest drawing for $2,500. A website, www.trackmysignups.org, provides principals, teachers and students an avenue to view their school's progress and compare sign ups to other schools in the area and helps foster community involvement.

The Program is reviewing how to enhance the offering by providing an alternative kit for student households that have already received the current Energy Efficiency Starter Kit. This will increase customer satisfaction and provide additional energy savings impacts for those customers that would otherwise have been excluded from the kit offering.

E. Marketing Strategy

The Company will work through the vendor to deliver marketing efforts for outreach to schools. The marketing channels may include but are not limited to:

- Direct mail (letters to school administrators)
- Email
- Program Website
- Events or assemblies
- Printed materials for classrooms
- Social media promotions

These marketing efforts are designed to engage students and their families in energy conservation behavior and provide energy saving opportunities for their households with the EE Starter kits.

F. Evaluation, Measurement and Verification

An impact and process evaluation report for the Energy Efficiency Education Program is scheduled for completion in the second quarter of 2017. The process evaluation of the Program will include program manager, implementer and teacher interviews to assess program operations, and student family surveys to assess program awareness, satisfaction, and compliance with installations and recommendations.

The goal of the impact evaluation is to assess the net energy savings attributable to the Program, as well as the persistence of the energy savings over time. The independent, third-party EM&V consultant will determine the detailed analysis methodologies, sample design and data collection activities. The impact evaluation for this Program is expected to consist of engineering estimates and a billing analysis.

Where applicable, a statistically representative sample of participants will be selected for the analysis. The Company intends to follow industry-accepted methodologies for all measurement and verification activities, consistent with International Performance Measurement Verification Protocol (IPMVP) Options A, C or D depending on the measure.

There is currently no planned difference in the EM&V plans for the Programs in DEC and DEP. However, due to the pre-established schedule of DEC evaluation and the launch schedule for the Program in DEP, the evaluations will initially be performed separately at different times. Subsequent evaluations will be combined for the Programs in DEC and DEP, with a planned completion date of second quarter of 2018. Allocation of combined DEC/DEP EM&V costs is proposed to be based on the projected number of participants of the Programs for each company.

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A. Description

The Lighting Program launched in January of 2010 and expanded to offer additional measures in January 2013 (now called Energy Efficient Lighting Program). This program works through lighting manufacturers and retailers to offer discounts to DEP customers at the register on CFLs, LEDs, and energy-efficient fixtures. Participation levels for all years of the program have been higher than originally forecasted. This success can be attributed to high customer interest in energy efficiency, increased knowledge of the benefits associated with energy efficient lighting and effective promotion of the program in the marketplace.

As the program moves into the sixth year, the DEP Energy Efficient Lighting Program will continue to encourage customers to adopt energy efficient lighting through incentives on a wide range of products, including CFLs, LEDs and fixtures. Customer education is imperative to ensure customers are purchasing the right bulb for the application in order to obtain high satisfaction with lighting products and subsequent purchases.

Audience

The Program is available to existing residential and non-residential customers. Customers simply shop for their lighting needs at a wide variety of retail locations. Incentives are provided at the point of purchase.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	68,441	53,830	(14,612)
Savings (MW)	11.23	8.82	(2.41)
Participants		3,244,448	
2016 Program Expenses		$ 17,441,878	

D. Qualitative Analysis

Highlights

The Energy Efficient Lighting Program continues to be successful and outperform expectations. For the period of January to December 2016, the program has moved a total of 3,244,101 measures, including 1,076,109 CFLs; 1,957,988 LEDs; 210,004 Fixtures. LEDs gained in share of the program from 6% in 2013 to 20% in 2014 to 37% in 2015, and in 2016 60%. This is largely due to greater availability, prominent placement and decrease in initial retail price. Adoption of CFLs continues as it is still seen as the entry energy efficient choice.

The DEP Energy Efficiency Program had 15 lighting retail channels actively participating during the first half of 2016. While the top four retail channels account for 59% of the program sales, all retail channels are considered important in that they allow access to the program for a widely diverse and geographically population of DEP customers. This assures that the Program reaches 90% of customers within 30 miles of a participating retail location.

The Program also continues to operate efficiently with 85% of overall Program costs going directly to customers in the form of incentives. Additionally, a total of 99% of the Program costs are spent on implementation and administration of the Program, including incentives and management fees. Therefore, only 1% is spent on marketing, labor and other costs.

Issues

No issues at this time.

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Potential Changes

Continue to evaluate the market and adjust products and incentive levels offered focusing on specialty applications as well as strategically target underserved customers through select channels and events.

E. Marketing Strategy

The Company will continue the Program marketing efforts in the remainder of 2016 through:

- Point of Purchase materials at the participating retailer locations
- Duke Energy Progress and Program website
- General Awareness Campaigns
    - Bill Inserts
    - Email
    - Online Advertising
    - Paid advertising/mass media
    - Out of Home advertising
- Advertised events at key retailers including:
    - Direct mail
    - Email
    - Paid advertising/mass media (radio, newspaper, etc.)
    - Social media
    - In Store materials (fliers, bag stuffers, posters, banners, etc.)
- Community outreach events (home shows, sporting events, cultural events, etc.)

These marketing efforts are designed to create customer awareness of the Program, to educate customers on energy saving opportunities and to emphasize the convenience of Program participation. Additionally, marketing efforts related to advertised in-store events are designed to motivate customer participation.

F. Evaluation, Measurement and Verification

The program had both the PY2014 and PY2015 evaluations complete in 2016.

The PY2014 process and impact evaluation completed in June 2016. In PY2014, DEP achieved 314,650 MWH in claimed/ex-ante energy savings for a realization rate of 211% . The program also achieved 40.3 MW in summer peak demand savings, and 56.0 MW in winter peak demand savings. Net-to-gross was 37%.

The PY2015 process and impact evaluation completed in December 2016. In PY2015, DEP achieved 239,702 MWH in claimed/ex-ante energy savings for a realization rate of 73%. The program also achieved 37.5 MW in summer peak demand savings, and 26.5 MW in winter peak demand savings. Net-to-gross in PY 2015 was similar to that seen in PY2014 – 38%.

For 2017, the DEP Retail Lighting evaluation will be combined with the DEC Retail Lighting evaluation. On-site data collection for the Retail Lighting program was conducted late 2016, and the combined process and impact report is scheduled for the third quarter of 2017.

Home Energy Improvement Program

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A. Description

The purpose of this program is to offer customers a variety of energy conservation measures designed to increase energy efficiency in existing residential dwellings that can no longer be considered new construction. This Program will utilize a network of participating contractors to install energy efficiency measures: (1) to encourage the installation of high efficiency central air conditioning (AC) and heat pump systems with optional add on measures such as Quality Installation and Smart Thermostats, (2) to encourage attic insulation and sealing, (3) to perform maintenance in combination with diagnostic audits on heat pumps or central AC units, (4) to encourage the installation of heat pump water heaters, and (5) to encourage high efficiency room air conditioning, (6) to encourage high efficiency variable speed pool pumps.

The program is available to customers whose premise is at least one year old, is served under a residential service schedule by Company, and is applicable to all electric service of the same available type supplied to Customer's premises at one point of delivery through one kilowatt-hour meter under the provisions of this Program. Incentives are only applicable to measures installed by a prequalified contractor approved by Company; however, high efficiency room air conditioners may be self-installed and do not require the use of a prequalified contractor.

Duke Energy contracts with a third party vendor who is responsible for application processing, incentive payment disbursement, and customer/Trade Ally call support.

Audience
The program is available to single and multi-family customers whose premise is at least one year old, is served under a residential service schedule by Company, and is applicable to all electric service of the same available type supplied to Customer's premises at one point of delivery through one kilowatt-hour meter under the provisions of this Program.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	2,403	6,290	3,887
Savings (MW)	0.88	1.90	1.02
Participants		19,466	
2016 Program Expenses		$ 6,013,170	

D. Qualitative Analysis

Highlights
The program launched the new tiered incentive structure in the market for HVAC replacements with the optional add on measures of Quality Installation and Smart Thermostat. The new incentive structure has received a positive reaction from customers as well as Trade Allies. Initial reporting shows that the increased incentive amounts for higher SEER equipment has encouraged customers to install higher efficiency equipment as well as having it properly installed and managed with new technologies.

The Referral Channel successfully launched on June 30, 2016 providing free, trusted referrals to customers who are trying to find reliable qualified contractors for their energy saving home improvement needs. Updates for the referral channel will be available during the next quarterly update as reporting becomes available.

Variable Speed pool pumps were launched in April 2016. The Company has been successful in recruiting contractors to support the new measure and looks to expand coverage throughout the jurisdiction.

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Issues

The buy-in and participation of the Trade Ally network is vital to the success of the Program. The Program aims to transform the market; shifting market practices away from some of the more commonly utilized practices which rely heavily on decentralized training and varying knowledge levels, as well as imprecise and manual field calculations, towards industry trained and certified trade allies using higher quality diagnostic instruments and processes. The Company has continued to struggle to gain contractor acceptance with the HVAC Audit due to the required diagnostic equipment purchases, obtaining additional industry certifications and altering current business practices as well as getting contractor acceptance for promoting the new heat pump water heater technology.

Potential Changes

The program is reviewing participation and cost over the next quarter and will look to sunset non-cost effective measures out of the program over the next 12 months.

E. Marketing Strategy

Promotion of the Program is primarily targeted to HVAC and home performance contractors. Trade Allies are important to the Program's success because they interface with the customer during the decision-making event, which does not occur often for most customers.

Program information and Trade Ally enrollment links are available on the Program's website to educate customer about the Program and encourage participation. By increasing the overall awareness of the Program and the participation of Trade Allies, it ensures more customers are discussing the benefits of the Program at time of purchase.

The Company implemented several customer marketing campaigns during 2016 which leveraged channels such as bill inserts and email messaging to build awareness of the program. Other channels such as a paid search and co-branded direct mail campaigns with selected Trade Allies were also utilized to create awareness for the program.

F. Evaluation, Measurement and Verification

Due to broader changes in the Program in 2016, and subsequent measure removals in 2017, there are no planned EM&V activities associated with the Program in 2017.

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A. Description

The Multifamily Energy Efficiency program ("Program") allows Duke Energy Progress to utilize an alternative delivery channel which targets multifamily apartment complexes. Currently, Franklin Energy is the 3rd party vendor who administers the program. They are in charge of all aspects of the program which include outreach, direct installations and customer care.

The program is designed to help property managers upgrade lighting with energy efficient 13 watt CFLs and also save energy by offering water measures such as bath and kitchen faucet aerators, water saving showerheads and pipe wrap. The water measures are available to eligible customers with electric water heating. The Program adopts a tiered structure to determine the number of lighting measures installed in apartments. Franklin Energy may install up to 12 bulbs in a one bedroom apartment, up to 15 bulbs in a two bedroom apartment and up to 18 bulbs in a three bedroom apartment.

The Multifamily Energy Efficiency program will offer properties the option of direct install (DI) service by Franklin Energy crews. However, Property Managers would also have the option of using their own property maintenance crews to complete the installations (Do-It-Yourself or "DIY") and is available upon request.

The CFLs and water measures are installed during scheduled direct install visits by Franklin Energy crews or routine maintenance visits by property personnel. In the case of direct installs, crews carry tablets to keep track of what is installed in each apartment. In the case of DIY installations, the Property Manager maintenance crew tracks the number of measures installed and reports them back to Franklin Energy. Franklin Energy then validates this information and uploads the results to Duke Energy.

After installations are complete, Quality Assurance (QA) inspections would be conducted on 20% of properties that completed installations in a given month. The QA inspections are conducted by an independent third party.

Audience

The target audience is property managers who have properties that consist of four or more units and are served on an individually metered residential rate schedule. In order to receive water measures, apartments must have electric water heating.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	10,993	13,354	2,361
Savings (MW)	1.08	1.34	0.26
Participants		240,435	
2016 Program Expenses		$ 2,045,220	

D. Qualitative Analysis

Highlights

The Program completed installations at approximately 196 properties from January to December 2016. These installations accounted for close to 15,185 units. During this period 151,863 lighting measures were installed and 88,573 water measures were installed.

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Issues

In 2016 it came to the Program Managers attention that multi-family facilities with less than four units were being allowed to participate in the program. Upon further investigation it was determined that a contract employee for the third-party program administrator, Franklin Energy, was intentionally facilitating this violation of program eligibility rules. The contract employee has since been terminated as this behavior was tracked back to the 2015 program year. After further discussions it was determined that there were no adverse effects on participation or impacts, as attempting to remove these participants would result in larger issues with EM&V samples sizes. The issue is considered resolved and the program has continued to operate as planned.

Potential Changes

Upgrade the lighting technology from CFLs to LEDs. Internal evaluation and analysis is in motion with the hope to begin offering LEDs later in 2016. To support the potential transition to LEDs, updates to program collateral and website will be completed in advance of the transition date.

These above changes were implemented in December of 2016. The program now offers LED A-line, Globes, and candelabra bulbs

E. Marketing Strategy

Franklin Energy uses internet searches to target properties in the Duke Energy Progress service territory. Based on this data, outbound calls are placed to solicit initial interest in the program from Property Managers. On-site visits by appointment and cold stop-ins are also used as a way to attract properties to participate in the program.

In addition, a Multifamily Energy Efficiency promo and public website landing page have been developed for managers to learn more about the program. A program brochure and a frequently asked question sheet are available for download.

Once enrolled, Franklin Energy provides property managers with a variety of marketing tools to create awareness of the program to their tenants. These include letters to each tenant informing them of what is being installed and when the installation will take place. Tenants are provided an educational leave-behind brochure when the installation is complete. The brochure provides additional details on the installed measures as well as a tear-off customer satisfaction survey to fill out and mail back to Duke Energy to provide valuable program feedback.

Additionally, the program has added a piece of marketing collateral, window clings. At the conclusion of the product installation, window clings will be placed in strategic areas throughout the property. Placement of the window clings at a minimum will be at the common areas entry and each residential building on site (to the extent applicable). Using the window cling ensures that the program and Duke Energy are recognized long after the installation has taken place.

F. Evaluation, Measurement and Verification

An impact and process evaluation was completed October 2016 which was a combined evaluation between Duke Energy Progress and Duke Energy Carolinas. Duke Energy Progress evaluated lighting measures (CFLs) and water measures.

Samples of tenants and property managers were selected for the process evaluation, which collected information needed to estimate net impacts, assess program satisfaction, and identify program improvement opportunities.

The impact evaluation consisted of estimating annual energy and demand impacts associated with program participation. The primary activity involved an engineering-based analysis to estimate the impacts of the various program measures. The analysis was supplemented by on-site field verification of sampled participants. Evaluated gross energy impacts were 21,398 MWh for a realization rate of 101%.

A subsequent process and impact evaluation report is planned for completion in the fourth quarter of 2017. This report is planned to be combined for the Program in Duke Energy Carolinas and Duke Energy Progress. The allocation of combined EM&V costs is proposed to be based on the projected number of participants in the Multifamily Energy Efficiency program for each company.

The key research objectives are to conduct impact and process evaluations, as well as a net-to-gross analysis. The evaluation will include interviews with program staff and customer surveys. An engineering- based analysis, augmented with on-site will be used to estimate the impacts of the program. Subject to change by the independent third-party evaluator, the analysis is expected to be supplemented by on-site field verification of program measures, and will be consistent with the International Performance Measurement and Verification Protocol (IPMVP) Option A.

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My Home Energy Report

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A. Description

My Home Energy Report (MyHER) helps customers put their energy use in perspective. The report educates customers about their energy use with simple and easily understood graphics, compares customers' energy use with similar homes in their area based on home size, age and heating source and motivates customers to change behavior and reduce their energy use by presenting them with timely tips and program offers. Reports are distributed up to 8 times per year.

My Home Energy Interactive is an interactive portal that allows customers to complete a home profile, set savings goals and track their progress, get answers to their personal energy questions from an energy expert and share their energy saving tips with other customers. Customers can also see how much electricity they might use in the coming months based on their historical usage.

Audience

Program participants are identified through demographic information and must reside in an individually-metered, single-family residence on a Company offered residential rate schedule who have at least 13 months of electric usage with the Company.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	133,917	128,281	(5,636)
Savings (MW)	36.39	34.86	(1.53)
Participants		673,285	
2016 Program Expenses		$ 5,890,093	

D. Qualitative Analysis

As of December 31, 2016, just over 640,000 DEP customers were receiving the MyHER and just shy of 9,000 DEP customers were enrolled in the MyHER Interactive portal.

E. Marketing Strategy

The MyHER paper report is an opt-out program so customers who meet the eligibility requirements automatically receive the report. Less than .001% of customers chose to opt out. The MyHER Interactive portal is an opt-in portal. Marketing for the portal includes email campaigns, messages in the paper report and a message on the envelope the paper report is mailed in.

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F. Evaluation, Measurement and Verification

The next process and impact evaluation report is scheduled for completion in second quarter of 2017. Impact evaluation goals will follow standard industry protocols and definitions, where applicable, and will consist of a billing analysis. The impact evaluation will accurately quantify monthly and annual energy impacts (kWh) for the average participant in the treatment group compared to the average participant in the control group from January 2016 through December 2016.

The process evaluation will focus on continuous program improvement and use data collected from participants, staff, and other market actors to assess the effectiveness and efficiency of current program operations.

Neighborhood Energy Saver Program

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A. **Description**

The purpose of Duke Energy Progress, (DEP) Neighborhood Energy Saver program (the "Program") is to reduce energy usage through the direct installation of energy efficiency measures within the households of income qualifying residential customers. The Program utilizes a Company-selected vendor: (1) to provide an on-site energy assessment of the residence to identify appropriate energy conservation measures, (2) to install a comprehensive package of energy conservation measures at no cost to the customer, and (3) to provide one-on-one energy education. Program measures address end-uses in lighting, refrigeration, air infiltration and HVAC applications.

Program participants receive a free energy assessment of their home followed by a recommendation of energy efficiency measures to be installed at no cost to the resident. A team of energy technicians will installed applicable measures and provide one-on-one energy education about each measure emphasizing the benefit of each and recommending behavior changes to reduce and control energy usage

Audience

The Program is designed for individually-metered residential homeowners and tenants within DEP. Implementation of the program is done in neighborhood entities designated by DEP. Eligible income-eligible neighborhoods shall have at least 50% of households with income equal to or less that 150% of the poverty level set by the U.S. Department of Energy. Participants in eligible income-eligible neighborhoods are limited to the one-time receipt of energy efficiency measures under the Program.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	1,735	1,992	257
Savings (MW)	0.30	0.30	(0.00)
Participants		4,412	
2016 Program Expenses		$ 2,052,535	

D. Qualitative Analysis

Highlights

After receiving regulatory approval from both the North Carolina Utilities Commission and the South Carolina Public Service Commission in the fall of 2009, the Program was officially launched by the Company in October 2009. The yearly goal was to serve 4,500 households. Honeywell Building Solutions was awarded the contract to administer the Program through a competitive bid process. Since inception the program has been offered in 39 different neighborhoods. Approximately 32,600 Duke Energy Progress customers have participated in the program and approximately 1,003,500 energy conservation measures have been installed in their households. The program has been very successful and widely accepted by the eligible Duke Energy Progress customers. Nearly 80 percent of the eligible customers in the neighborhoods where the program has been offered have participated.

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Issues

After five years in existence the program continues to operate with few issues. The implementers of the program are constantly striving to install the best quality measures and to use techniques that will motivate better customer behavior responses.

Potential Changes

The program receive approval to replace installing CFL's with LEDs. This change will be implemented in the field operation by mid-2017. Also, to make the program consistent with the DEC program, 15 bulbs are now allowed per household as well as increase eligibility to <200% of federal poverty guidelines.

E. Marketing Strategy

Current methods of marketing the program have been very successful in getting participation. The Company will continue these marketing strategies listed below in 2017:

- Direct mail (letters and postcards to qualifying customers)
- Secure local support from community leaders and organizations
- Community outreach events
- Publicized kickoff events
- Door-to-door canvassing

These marketing efforts are designed to create customer awareness of the Program, educate customers on energy saving opportunities and emphasize the convenience of Program participation.

F. Evaluation, Measurement and Verification

The impact and process evaluation results for Neighborhood Energy Saver Program Year 2015 was completed in January 2017. The process evaluation included interviews with program management and field verification survey conducted with customer participants.

The impact evaluation consisted of a review of deemed savings, installation verification and persistence, engineering estimate of annual per-customer savings, and a billing analysis. For the billing analysis, 2016 program participants were used as a control group as comparison to the 2015 participants (treatment group). Note that a billing analysis that uses an appropriate comparison group incorporates the effects of free ridership and spillover, thus resulting in the program net savings estimates. In addition, a billing analysis captures savings due to behavioral changes.

Verified evaluation results include net energy savings per participant of 430 kWh, and summer and winter demand impacts of .298 kW and .340 kW, respectively.

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A. Description

The Home Energy House Call Program ("Program") is offered under the Energy Assessment Program. Duke Energy Progress, LLC (the "Company") partners with several key vendors to administer the Program.

The Program provides a free in-home assessment performed by a Building Performance Institute ("BPI") certified energy specialist designed to help customers reduce energy usage and save money. The BPI certified energy specialist completes a 60 to 90 minute walk through assessment of a customer's home and analyzes energy usage to identify energy savings opportunities. The energy specialist discusses behavioral and equipment modifications that can save energy and money with the customer. The customer also receives a customized report that identifies actions the customer can take to increase their home's efficiency. Examples of recommendations might include the following:

- Turning off vampire load equipment when not in use.
- Turning off lights when not in the room.
- Using energy efficient lighting.
- Using a programmable thermostat to better manage heating and cooling usage.
- Replacing older equipment.
- Adding insulation and sealing the home.

In addition to a customized report, customers receive an energy efficiency starter kit with a variety of measures that can be directly installed by the energy specialist. The kit includes measures such as energy efficiency lighting, shower head, faucet aerators, outlet/switch gaskets, weather stripping and an energy saving tips booklet.

Audience

Eligible Program participants are Company's residential customers that own a single-family residence with at least four months of billing history and have central air, electric heat or an electric water heater.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	1,282	4,142	2,860
Savings (MW)	0.21	0.69	0.48
Participants		27,614	
2016 Program Expenses		$ 1,417,924	

D. Qualitative Analysis

Highlights

We launched with a multi-channel approach to include online marketing on Duke Energy website, email, bill insert, bill messages and a direct mail letter introducing the program. Examples of online, bill inserts and direct mail promotions are available in the appendix.

Since launching the program mid April 2016, the program has conducted 5,169 assessments and installed 22,445 additional LEDs. In second quarter, we incorporated a training focusing on measure installation to maximize the savings opportunity per participant.

Issues

The program experienced unexpected demand late summer and paused marketing campaigns due to a delays in appointment availability.

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Potential Changes

The program engaged additional subcontractors to facilitate and allow more flexibility in seasons of high demand**.**

E. Marketing Strategy

The program launched in April with a multichannel approach including targeted mailings to pre-qualified residential customers, bill inserts, online promotions and online video. For those who elect to receive offers electronically, email marketing is used to supplement direct mail. The campaign was temporarily paused after experiencing unexpected volumes of demand in July. The core messaging is simple and focuses on key benefits (a free energy assessment from Duke Energy can help save energy and money while also increasing comfort) and three easy steps: you call, we come over, you save.

Home Energy House Call program information and an online assessment request form are available at www.duke-energy.com.

F. Evaluation, Measurement and Verification

Due to the April 2016 launch, no EM&V activity was planned in 2016. Future evaluation timing is dependent upon sufficient participation.

G. **Appendix**

2016 Bill Insert:

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2016 Introduction Letter:

HOME ENERGY HOUSE CALL

Ding Dong!

DUKE ENERGY. PROGRESS

Dear Customer,

We now offer **Home Energy House Call**, a free in-home energy assessment valued at $180 to help eligible homeowners reduce their energy use and costs.

What is Home Energy House Call?
As part of this free program, an energy expert will analyze your home to identify areas that may be wasting energy. Following the assessment, our expert will provide solutions on how you can save on your energy bill.

What's included?
As part of the assessment, our trained energy expert will:

- ✓ Inspect insulation levels
- ✓ Check for air leaks
- ✓ Examine your heating and cooling system and appliances
- ✓ Analyze your energy use and recommend ways to lower your energy costs

Plus, you will receive a FREE energy efficiency starter kit to jump-start your energy savings. Our expert will even install some of the products for you to help you get started.

To take advantage of this exclusive offer, call 855.739.9114 or visit duke-energy.com/housecall to see if you qualify.

Sincerely,

Shannon Gardner
Home Energy House Call Program Manager

Free kit
includes FREE LEDs, a showerhead and more!

DUKE ENERGY. PROGRESS

Home Energy House Call
ST24A | 400 South Tryon Street
Charlotte, NC 28202

PRSRT STD
U.S. POSTAGE PAID
CHARLOTTE, NC
PERMIT NO. 83

Exclusive offer to help cut your energy bill.
See inside.

Email:

Short pre-header text less than 50 characters. Trouble viewing? View in browser

DUKE ENERGY.

Discover ways to save
with Home Energy House Call.

Looking for ways to save on your summer energy bill? Have an energy expert come over for free. Our expert will assess your home, and you'll learn how to lower your bill. Improve your home's energy efficiency and comfort today.

SCHEDULE A VISIT

OR CALL 877.388.7676

Here's what you'll get:

FREE in-home energy assessment – a **$150 value!**

Info on **$1,325** in home improvement rebates.

FREE energy efficiency starter kit – a **$30 value!**

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Duke Energy | 550 South Tryon Street | Charlotte, NC 28202

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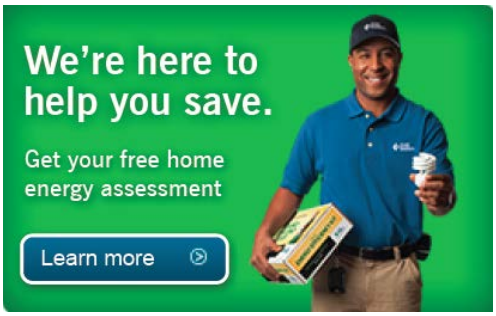

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Residential New Construction

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A. Description

The purpose of this Program is to incent new construction that falls within the 2012 North Carolina Residential Building Code to meet or exceed the 2012 North Carolina Energy Conservation Code High Efficiency Residential Option ("HERO"). If elected by a builder or developer constructing to the HERO standard, the Program offers the homebuyer an incentive guaranteeing the heating and cooling consumption of the dwelling's total annual energy costs. Additionally, the Program incents the installation of high-efficiency heating ventilating and air conditioning ("HVAC") and heat pump water heating ("HPWH") equipment in new residential construction.

Audience

The Program is available to builders and developers installing high-efficiency HVAC and HPWH equipment in new single family, manufactured, and multi-family residential housing units that are served under any of the Company's residential rate schedules.

The program is also available to builders and developers of new single family and multi-family residential dwellings (projects of three stories and less) that comply with all requirements of the 2012 HERO standard and are served under any of the Company's residential schedules. Manufactured housing, multi-family residential housing projects over three stories in height, and any other dwellings which do not fall within the 2012 North Carolina Residential Building Code, are not eligible for any whole house incentives.

The Program also supports the initial homeowner for any home constructed to meet or exceed the HERO standard when the builder or developer elects to extend a heating and cooling energy usage guarantee to the homeowner. At the sole option of the builder or developer, homeowners may be offered a Heating and Cooling Energy Usage Limited Guarantee for homes with a HERS Index Score verified by a certified HERS rater calculating the heating and cooling energy usage that the home should use during an average weather year.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	8,955	11,093	2,138
Savings (MW)	3.87	4.77	0.90
Measures		5,731,320	
2016 Program Expenses		$ 9,405,615	

D. Qualitative Analysis

Highlights

In 2016 the RNC program moved to whole-house incentive structure that pays incentives to builders for HERO-compliant homes based solely on annual kWh savings. The move away previous structure's HERS index tiers has led to higher kWh savings per home. The increased average savings combined with strong and steady participation resulted in the RNC program exceeding the 2016 kWh impact goal of 7,750,000 kWh. The 2016 impact total was 10,555 MWH – 9.4% above goal.

Currently there are 392 builders participating and 23 approved raters. The top 10 builders in the Program contribute 40% of the savings. ICF is responsible for the operational oversight of Home Energy Raters and Builders or Developers participating in the Program.

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	Whole-House Eligibility Requirement	Incentive
HERO	Meet 2012 NCECC HERO standards	$750
HERO plus HERS Score	Meet HERO standards and submit confirmed annual kWh savings from the Energy Summary Report.	$0.90/kWh
	Equipment Incentive Description	**Incentive**
Tier 1	AC or heat pump with SEER (Seasonal Energy Efficiency Ratio) of 14 or greater but less than 15. The HVAC system must meet the Quality Installation Standard of 90%. High Efficiency Heat Pumps: The unit(s) shall be a minimum SEER of 14 with ECM. High Efficiency Central AC: The unit(s) shall be a minimum SEER of 14 with ECM.	$250 per unit
	Quality Installation Standard (Optional for Tier 2).	$75 per unit
Tier 2	AC or heat pump with SEER of 15 or greater.	$300 per unit
Heat Pump Water Heater	ENERGY STAR® qualified HPWH(s) with minimum Energy Factor of 2.0.	$350 per unit

Issues

Air sealing of townhomes and multifamily projects continues to be a sticking point for many builders. While the North Carolina building code has specific requirements for fire rated assemblies, there are different approaches being used to meet these requirements, and the acceptance and interpretations of these assemblies differs among code officials by jurisdiction. To assist builders and the Program we plan to work with various resources to identify code compliant separation wall assemblies as well as accepted air sealing methods. This info will allow the program to provide builders and raters recommendations that will not only meet the code, but also increase compliance with program standards.

Potential Changes

Currently no Program changes being evaluated and closely following NC's next residential building and energy codes, which will take effect in 2019.

E. Marketing Strategy

The Company will expand and increase the Program marketing efforts in 2016 through various marketing channels that include but are not limited to:

- Duke Energy Progress website
- Community outreach events/Parade of Homes
- Paid advertising/mass media
- Social media promotions

These marketing efforts are designed to create customer awareness of builders participating in the Program, and to educate customers on the quality, comfort and energy savings these homes offer.

F. Evaluation, Measurement and Verification

Process and impact evaluation activities will begin in second quarter of 2017 due to the changes in the Program. A final report is planned to be completed in first quarter of 2018.

The goal of the evaluation will be to verify energy savings, demand savings, and savings from market effects attributable to the RNC program. Process evaluation activities will assess the effectivenss of program processes and their impact on the broader RNC market, with a particular focus on the new program processes and associated customer satisfaction.

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A. Description

The Save Energy and Water Kit Program launched in November of 2015. The Program is designed to increase the energy efficiency of residential customers by offering customers energy efficient water fixtures and insulated pipe tape for use within their homes.

Participants receive a free kit that includes installation instructions and varying numbers (based on the number of full bathrooms in their home) of bath aerators, kitchen aerators, shower heads and pipe insulation tape.

The program fulfillment is administered by Energy Federation Incorporated (EFI). EFI furnishes the measures provided in the kit and assembles all kits. EFI receives the Business Reply Card (BRC) that customers use to accept the offer and processes the order. EFI manages a call center that is used to support the program and can take order's if a customer prefers to place their order over the phone as opposed to using the postage paid BRC reply card.

The program has a website in place that customers can access to learn more about the program or watch video's produced to aid in the installation of the kit measures.

Audience

The Program is available to eligible customers residing in a single-family home with an electric water heater who has not received similar measures through another Company-offered energy efficiency program..

B & C. Impacts, Participants and Expenses

2016 Year End Results	Forecasted	Actual	Variations
Savings (MWH)	12,758	16,215	3,457
Savings (MW)	1.02	1.30	0.28
Participants		325,146	
2016 Program Expenses		$674,538	

D. Qualitative Analysis

Highlights

In 2016, over 390,000 Business Reply Cards (BRC) were distributed to Duke Energy Progress customers in the Carolinas. Over 29,000 customers accepted the offer and were provided with kits. These kits delivered approximately 99,000 bath aerators, 29,000 kitchen aerators, 49,000 showerheads and 146,000 feet of pipe insulation.

Issues

The program was successfully launched without any issues regarding ordering, fulfillment or support of the program.

Potential Changes

Duke Energy intends to add an online ordering platform for customers to access if they prefer to complete their order online. The online ordering platform will offer customers the ability to customize their order by, modifying the number, finish and design of the measures within the kit.

E. Marketing Strategy

Due to the unique eligibility requirements of the program, all marketing is done through an offer only Business Reply Card (BRC) approach. Customers who qualify are sent a BRC inviting them to participate. They can accept the offer by returning the postage paid reply card or by calling EFI's call center.

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F. Evaluation, Measurement and Verification

No evaluation work was performed for the Save Energy and Water Kit program in 2016. Evaluation work began in 2017 for a combined DEC/DEP process and impact evaluation. The evaluation will consist of engineering estimates of the measures provided in the kits. A final report is expected in third quarter of 2017.

EnergyWise Home Program

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A. Description

EnergyWise Home ("Program") allows Duke Energy Progress, LLC ("Company") to install load control switches at the customer's premise to remotely control the following residential appliances.

- Central air conditioning or electric heat pumps
- Auxiliary strip heat on central electric heat pumps (Western Region only)
- Electric water heaters (Western Region only)

For each of the appliance options above, an initial one-time bill credit of $25 following the successful installation and testing of load control device(s) and an annual bill credit of $25 is provided to program participants in exchange for allowing the Company to control the listed appliances.

Audience

The Program is available to all Company's residential customers residing in owner-occupied or leased, single-family, or multi-family residences.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	-NA-	-NA-	-NA-
Savings (MW) [1]	22.81	34.06	11.25
Participants		18,465	
2016 Program Expenses		$ 13,633,666	

1 MW Savings include Summer MW for AC participants and Winter MW for Heat Strip and Water Heater Participants

D. Qualitative Analysis

Highlights

After receiving regulatory approval from both the North Carolina Utilities Commission and the South Carolina Public Service Commission late in 2008, the Program was officially launched by the Company in April of 2009. Comverge, who specializes in integrated demand response solutions, was awarded the contract for the load management system software and switch technology, and GoodCents was awarded the contract for enrollment, field implementation, and call center support.

The program has been successful since inception, meeting or exceeding its customer acquisition and impact goals ever year. The program has achieved approximately 14% market penetration in seven years with over 143,000 participants and full shed load impacts of 297 MW summer and 10 MW winter.

Potential Changes

The Company is currently investigating the market potential and cost-effectiveness of expanding the EnergyWise Home brand with two-way smart Wi-Fi thermostats under a BYOT (Bring Your Own Thermostat) model in all regions to provide more resources for both summer and winter peak loads.

E. Marketing Strategy

The Company continues to deploy Program marketing efforts through various channels that include but are not limited to:

- Direct mail (letters and postcards to qualifying customers)
- Duke Energy Progress website
- Email
- Bill Inserts
- Outbound calling
- Door-to-door canvassing

Additional detailed program information is located at https://www.progress-energy.com/carolinas/home/save-energy-money/energy-efficiency-improvements/energy-wise/index.page?

F. Evaluation, Measurement and Verification

The impact evaluation results for EnergyWise Home program year 2015 Summer was completed January 2016 by Navigant Consulting. Navigant also completed an impact evaluation for EnergyWise Home program year 2014/2015 Winter in May 2016.

The PY 2015 Summer impact highlights include:

- EnergyWise event days in PY2015 delivered load reduction impacts of between 0.75 and 1.53
  kW per participant, driven primarily by the cycling strategy employed. Enrolled participants were subject to six events (three 50%, two 65%, and one 100% cycling).

- The six events days in PY2015 delivered between 95 and 193 MW of load reduction across all
  participants. These are estimated by applying the estimated per participant impacts above to the
  total program population of approximately 126,000 customers.

- Validation analysis using system loads indicates that the PY2015 estimated impacts are reasonable and in line with expectations.

Winter PYU2014/2015 highlights include:

- Average winter event impacts per household were approximately 0.4 kW for water heaters and 1.37 kW for auxiliary heat strips. The average per household impact across all curtailment events by device type and cycling strategy is presented in Table 1, below.
- The average program impact across the four events to which the entire program population was subject is estimated to be nearly 11 MW.

The EnergyWise Home Summer 2016 evaluation is underway and will consist of an impact and process evaluation. To estimate impacts, the evaluator will rely on data collected by loggers installed on a sample of EnergyWise Home participant's homes that is broadly representative of the geographic distribution of Duke Energy Progress customers. The process evaluation will survey program participants to assess event awareness and satisfaction and event comfort. The Summer 2016 final report is expected in second quarter of 2017.

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EnergyWise Business

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A. Description

The Duke Energy Progress, LLC's (the "Company's" or "DEP") EnergyWise Business (the "Program") is an energy efficiency and demand response program for non-residential customers that will allow the Company to reduce the operation of participants AC units to mitigate system capacity constraints and improve reliability of the power grid. The Program provides customers with options on how they would like to participate in the Program. For participation in the program, the Company provides participants with an annual incentive applied directly to their bill.

Program participants can choose between a Wi-Fi thermostat or load control switch that will be professionally installed for free by the program for each air conditioning or heat pump unit that they have. In addition to equipment choice, the participants also can choose at what cycling level they would like to participate. There are three levels of cycling, 30%, 50% or 75%. The levels are the percentage reduction of the normal on/off cycle of the unit. During a conservation period, the Company will send a signal to the thermostat or switch to reduce the on time of the unit by the percentage selected by the participant. For participating at the 30% level the customer will receive a $50 annual bill credit for each unit, $85 for 50% cycling, or $135 for 75% cycling. Finally, participants that have a heat pump unit with electric resistance emergency/back up heat and choose the thermostat can also participate in a winter option that will allow the Company to control the emergency/back up heat. For the 100% control of the emergency/back up heat, the Company will provide an additional $25 annual bill credit.

Participants choosing the thermostat will be given access to a portal that will allow them to control their units from anywhere they have internet access. They can set schedules, adjust the temperature set points, and receive energy conservation tips & communications from the Company. In addition to the portal access, participants will also receive conservation period notifications. This will allow participants to make adjustments to their schedules or notify their employees of the upcoming conservation period. Finally, the participants will be allowed to override two conservation periods per year. They can do this before the conservation period starts or during the conservation period.

Audience

The Program is available to existing non-residential customers that are not opted-out of the DSM Rider, have at least one air conditioner or heat pump that operates to maintain a conditioned space on weekdays during the calendar months of May through September, and are not served under Schedules LGS-RTP and SI, Riders NM, DRA, 57, 68 IPS, LLC or NFS. Also, customers must have an average minimum usage of 1,000 kWh during those same calendar months.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	649	1,062	413
Savings (MW)	1.55	1.40	(0.15)
Incremental Switches		697	
2016 Program Expenses		$ 1,112,815	

D. Qualitative Analysis

Highlights

The Program received approval from the SC Public Service Commission on September 30, 2015 and from the NC Utilities Commission on October 27, 2015. The planned launch of the program was scheduled for January 4th, 2016. Thirteen customers in the Greenville/Spartanburg area of SC were chosen in December of 2015 to test all system functionality as part of the Program development process.

Issues

The major issue will be building customer awareness for a new program. In addition, the program equipment is limited to the control of standard air conditioners and heat pumps. Those customers that have direct digital controls and other new control systems may not be compatible with program equipment.

Potential Changes

E. Marketing Strategy

The Program is using a multi layered approach to build customer awareness. The first item completed was building a Program website on Duke-Energy.com with cross promotion from other areas of the website. In addition to the website content, material was created to market the program through email, newsletters and face to face conversation. Activities during 2016 include the following,

- Face to face with small business customers through the Small Business Energy Saver program and other Door to Door marketing resources
- Face to face with business customers through Duke Energy Business Energy Advisors and Account Managers
- Outbound calling
- Duke Energy Business Newsletter
- Quarterly email

F. Evaluation, Measurement and Verification

The next process and impact evaluation report is scheduled for completion in second quarter of 2017 with activities beginning in early 2016. The evaluation report is planned to be combined for DEC and DEP.

The allocation of combined EM&V costs is proposed to be based on the projected number of participants in the EnergyWise for Business Program for each company.

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Business Energy Report

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A. Description

The Business Energy Report ("BER" or the "Program"), is a periodic comparative usage report that compares a customer's energy use to their peer groups. Comparative groups are identified based on the customer's energy use, type of business, operating hours, square footage, geographic location, weather data and heating/cooling sources. Pilot participants will receive targeted energy efficiency tips in their report informing them of actionable ideas to reduce their energy consumption. The recommendations may include information about other Company offered energy efficiency programs. Participants will receive at least six reports over the course of a year.

Audience

This Pilot is offered to approximately 12,500 customers served on an eligible Duke Energy Progress , LLC (the "Company") non-residential rate schedule who are not opted out of the EE portion of the Rider and have at least 12 months of electric usage with the Company. Initial program participants will be automatically enrolled in the Program. Program participants may request their removal from the Program at any time.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	4,184	4,547	363
Savings (MW)	0.68	0.74	0.06
Participants		163,493	
2016 Program Expenses		$ 69,516	

D. Qualitative Analysis

As customers receive subsequent reports, their engagement increases as they learn more about their specific energy use and how they compare to their peer group. The report then provides customers tools to reduce their usage in the form of targeted energy efficiency tips that provide customers with actionable ideas to help them become more efficient. Customers are also encouraged to register for BER Interactive, an online portal that offers additional tips and information on their energy usage. Program participants are encouraged to contact the Company with their questions, comments and report corrections.

Highlights

The Company mailed letters to pilot participants on December 30, 2015 welcoming them to the program. Customers were provided a form and a business reply envelope to update information about the business such as business type, operating hours, square footage, own/lease, heating/cooling information, and a contact name. After providing customers an opportunity to respond, the first report was mailed to customers on February 17, 2016. Since February 2016 nine reports have been mailed. The next report is scheduled to be mailed by end of March 2017. A customer satisfaction online survey was conducted on October 2016. The survey was sent to 2,663 treatment group DEP customers and 2,911 control group DEP customers. There was a 4% response rate from both the treatment and control group, with a total of 117 completed surveys received from the treatment group and 112 received from the control group. Key findings indicate that 35% of DEP BER participants recalled receiving the reports. Overall, 76% of BER

participants are satisfied with the reports. Customers like the reports because they find them informative and that it helps them manage their usage.

E. Marketing Strategy

The Company will communicate information about the Pilot via the customized proactive reports distributed through, but not limited to, direct mail.

F. Evaluation, Measurement and Verification

There was no evaluation activity for the Program in 2017. The evaluation for the Program is scheduled for completion in first quarter of 2018.

The evaluation is a combined evaluation between DEC and DEP. The impact evaluation consists of a randomized control trial methodology that estimates the total net energy change in a treatment group comprised of BER customers compared to a control group of non-participating business customers.

For the process evaluation, interviews will be conducted among program staff and surveys will be conducted among BER customers who received a BER to assess awareness and satisfaction with recommendations in the BER.

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CIG Demand Response Automation

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A. Description

Demand Response Automation ("Program") allows Duke Energy Progress, LLC ("Company") to install data acquisition and optional load control devices to remotely monitor and control the following electrical equipment:

- HVAC
- Lighting
- Standby generation
- Variable speed motors
- Non-critical, interruptible operations

Program participants are expected to reduce their total metered demand by the seasonal contracted kilowatt (kW) amount during the time specified in an event notification. Participants may reduce their demand using any method, including the use of other power sources. In return, these businesses receive valuable incentives as follows:

1. A one-time participation incentive of $50/kW for demonstrated demand reduction during initial summer event(s) on the program,
2. Monthly credits of $3.25/kW for the contracted amount of curtailable demand, and
3. Performance credits of $6/kW for demand reduced during each curtailment event.

Audience

The Program is available to commercial, industrial and governmental customers with a service base that is capable of contracting for a minimum of 75 kW in curtailable demand. Some exclusions apply based on rate schedules and participation in other riders.

B & C. Impacts, Participants and Expenses

Year End 2016 Results	Forecasted	Actual	Variations
Savings (MWH)	-NA-	-NA-	-NA-
Savings (MW)	12.93	(5.34)	(18.27)
Participants		(5,085)	
2016 Program Expenses		$1,615,703	

D. Qualitative Analysis

Highlights

After receiving regulatory approval from both the North Carolina Utilities Commission and the South Carolina Public Service Commission late in 2009, the Program was officially launched by the Company in November of 2009. Comverge, who specializes in integrated demand response solutions, was awarded the contract for the load management system software, control technology, and customer energy management application.

The program has encountered several challenges to participant growth since inception including DSM/EE rider costs and introduction of new EPA regulations affecting use of standby generators in demand response programs. In the past few years, DEP has responded to many of these barriers through successful filings of rider revisions expanding the eligible customer base and creating a new option for emergency generators. Additionally, separation of the DSM and EE Opt-In requirements and associated commitment periods, which became effective on January 1, 2016, are expected to lead to expanded growth opportunities for DRA going forward.

However, on May 1, 2016, the DC Circuit Court of Appeals mandated vacatur of the 100-hour demand response provision in the EPA's RICE (Reciprocating Internal Combustion Engines) NESHAP (National Emission Standards for Hazardous Air Pollutants) Rule. The vacatur means that only generators meeting current EPA emissions standards are eligible to participate in a demand response program. As a result, six Emergency Generator participants representing 5 MW in load reduction capability had to terminate their DRA agreements in order to remain compliant with the federal regulations. The rule change also negatively impacts program market potential in the future. Since the Emergency Generator Option was designed specifically to comply with the EPA criteria that is no longer valid and includes restrictions that are inconsistent with dispatch strategies for all other DEP demand side management programs, the Company has sought and received approval to remove the Emergency Generator Option from the DRA tariff.

Potential Changes

No further changes to the program are anticipated.

E. Marketing Strategy

The Company continues to market the Program directly through Large Account Management and has expanded efforts to reach eligible unassigned customers through various channels that include but are not limited to:

- Direct mail (letters and postcards to qualifying customers)
- Duke Energy Progress website
- Email
- Video
- Trade event presence
- Promotion by the new Medium Business Energy Advisors team

Additional detailed program information is located at www.duke-energy.com/dra.

F. Evaluation, Measurement and Verification

The impact and process evaluation results for CIG Demand Response Automation Program Year 2015 were completed in May 2016 by Navigant Consulting.

The impact evaluation had three objectives;

1. Replication of DEP Reported Impacts
2. Verification of Impacts
3. Estimation of Program Capability

Impact evaluation finding highlights;

- EM&V analysis showed average load reductions were 20.1 MW per summer event (approximately 370 kW per meter) This was 100% of the MW originally reported by DEP.
- For the two winter events, EM&V analysis showed average load reductions of 8.1 MW (approximately 260 kW per meter); 97% of the 8.3 MW figure reported by DEP

EM&V work for Program Year 2016 began in fourth quarter of 2016 for final report delivery projected in the second quarter of 2017. The evaluation objectives primarily remain unchanged from prior years, however Program Year 2016 will also provide detailed baseline methodology and explanation of kW impact calculations.

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Non-Residential Energy Efficiency for Business Program

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A. Description

The Non-Residential Energy Efficiency for Business Program (”Program”) provides incentives to Duke Energy Progress, LLC’s (the “Company’s”) commercial and industrial customers to install high efficiency equipment in applications involving new construction and retrofits and to replace failed equipment.
Commercial and industrial customers can have significant energy consumption but may lack knowledge and understanding of the benefits of high efficiency alternatives. The Program provides financial incentives to help reduce the cost differential between standard and high efficiency equipment, offer a quicker return on investment, save money on customers’ utility bills that can be reinvested in their business, and foster a cleaner environment. Incentives are determined based on the Company’s cost effectiveness modeling to assure cost effectiveness over the life of the measure. In addition, the Program encourages dealers and distributors (or market providers) to stock and provide these high efficiency alternatives to meet increased demand for the products.

The program provides incentives through prescriptive measures, custom measures and technical assistance.

Prescriptive Measures: Customers receive incentive payments after the installation of certain high efficiency equipment found on the list of pre-defined prescriptive measures, including lighting; heating, ventilating and air conditioning equipment; and refrigeration measures and equipment. A list of eligible equipment and measures and specific incentive amounts are available at the Program website:https://www.duke-energy.com/business/products/smartsaver .

Custom Measures: Custom measures are designed for customers with electrical energy saving projects involving more complicated or alternative technologies, whole-building projects, or those measures not included in the Non-Residential Energy Efficiency for Business Prescriptive measure list. The intent of the Program is to encourage the implementation of energy efficiency projects that would not otherwise be completed without the Company’s technical or financial assistance. Unlike the Non-Residential Energy Efficiency for Business Prescriptive Program, the Program requires pre-approval prior to the project implementation. Proposed energy efficiency measures may be eligible for customer incentives if they clearly reduce electrical consumption.

Technical Assistance: Technical Assistance Incentives are available for new construction and retrofit projects to provide assistance to qualified customers with development and implementation of system and building energy efficiency enhancements. Assistance may include, but is not limited to, feasibility studies, detailed energy audits, and retro-commissioning of existing systems, or for efficiency design or energy modeling for new structures and systems. All measures involving technical assistance incentives must receive pre-approval before implementation.

In 2016, the Company moved most program administration in-house, including application processing. Custom incentive applications receive a technical review by an external engineering firm.

Audience

All of the Company’s non-residential customers billed on an eligible Duke Energy Progress rate schedule

B & C. Impacts, Participants and Expenses

2016 Year End Results	Forecasted	Actual	Variations
Savings (MWH)	60,754	71,162	10,408
Savings (MW)	9.61	10.20	0.59
Participants		20,877,826	
2016 Program Expenses [1]		$ 14,159,310	

[1] *Period in which Forecasted Program Expenses and Measures contained in Exhibit 1 of DEP’s cost recovery requests are presently not aligned with calendar periods.*

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D. Qualitative Analysis

Highlights

The program has continued to take steps to align the company's commercial energy efficiency portfolio in the two operating companies in the Carolinas. The prescriptive, custom, and assessment/technical assistance programs will continue to generate substantial savings and customer satisfaction by leveraging internal staff focused on providing similar solutions to participants. Prescriptive measures will continue to foster high-volume participation for common retrofit projects, while custom programs will seek ways to provide the efficient in-depth technical expertise required to bring in larger and more unique projects.

As of the end of 2016, the program has contracted with outreach professionals to manage trade ally relationships. Currently, there are 316 energy-efficiency equipment vendors, contractors, engineers, architects and energy services providers who are registered as a trade ally with the Energy Efficiency for Business program. Trade ally buy-in has proven to be the most effective way to promote the Program to the Company's business customers. The Energy Efficiency for Business outreach team builds and maintains relationships with trade allies associated with the technologies in and around Duke Energy Progress' service territory. Existing relationships continue to be cultivated while recruitment of new trade allies also remains a focus. Trade ally company names and contact information appears on the trade ally search tool located on the Program's website. This tool was designed to help customers, who are not aware of a local energy service providers in their area who can serve their needs. The tool has been revised to incorporate enhanced search criteria functionality. The Company continues to look for ways to engage the trade allies in promotion of the Program as well as more effective targeting of trade allies based on market opportunities.

A new online application portal launched in 2016, and provides the ability for applicants to apply for incentives, save their progress and track projects throughout the submission process.

The program offers a co-marketing trade ally campaign to encourage trade allies to include Energy Efficiency for Business program messaging and information in their marketing. If trade ally marketing efforts are approved by Duke Energy Progress program managers, the program will pay up to 50% of the marketing cost with a maximum of $2,000. To date, we have approved five applications for marketing items including brochures, lunch and learns, and large events.
The Company continues to consider ways to expand EEB program participation through new channels that offer instant prescriptive incentives that reduce the price of energy efficient products at the time of purchase, reducing or eliminating the need for a separate incentive application. In 2016, an online energy efficiency savings store and a midstream marketing channel were launched. More information about these exciting new channels follow.

ONLINE ENERGY SAVINGS STORE
Duke Energy also offers the Business Savings Store on the Duke Energy website, with orders fulfilled by the third-party EFI. The site provides customers the opportunity to take advantage of a limited number of Prescriptive incentive measures by purchasing qualified products from an on-line store and receiving an instant incentive that reduces the purchase price of the product. The incentives offered in the store are consistent with current program incentive levels.

MIDSTREAM MARKETING CHANNEL
The midstream marketing channel provides instant Prescriptive incentives to eligible customers at a participating distributor's point of purchase. Approved midstream distributors validate eligible customers and selected lighting, HVAC, food service and IT products through an online portal, and use that information to show customers the Prescriptive incentive-reduced price of high efficiency equipment. Upon purchase, the distributor reduces the customer's invoice for eligible equipment by the amount of the Prescriptive incentive. Distributors then provide the sales information to Duke Energy electronically for reimbursement. The incentives offered through the midstream channel are consistent with current program incentive levels.

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In 2016, Duke Energy launched this marketing channel in DEP and also partnering with the third-party Energy Solutions. Energy Solutions provides the online portal for distributors to manage the paperless validation and incentive application, which is expected to help this channel grow significantly. Interest in this channel has quickly grown. In December 2016, approximately 10% of the Prescriptive measure impacts were from participation through the midstream marketing channel. At the end of 2016, Duke Energy had 85 distributors signed up for the midstream channel, and an additional 6 that were in the process of joining. Duke Energy continues to work to add more well-known distributors to this channel. Duke Energy expects this channel to continue increasing participation in Prescriptive measures.

Issues

As in past years, program participation is dominated by high efficiency lighting measures. HVAC participation is challenged given dependencies on failed equipment and facility expansions (existing and new construction) that result from measure design. The Company continues to work with outside consultants and internal resources to understand equipment supply/value chains and increase awareness of these measures going forward. The technologies that seem to be a good fit for the Non-Residential Energy Efficiency for Business Prescriptive Program will be recommended for addition to the prescriptive application. The more measures offered through the Prescriptive program, the fewer burdens there are on the customer that prevents participation in the Energy Efficiency for Business Program

The Custom Program continues to see issues regarding eligible customers. Many customers who would be targeted to submit Custom applications choose to remain opted-out. The Custom process is also often thought of as burdensome because of the technical nature of the applications. The Custom team continues to improve processing time of application and is down 50% from Q1.

Potential Changes

In January 2017, Duke Energy Progress rebranded the Energy Efficiency for Business program to Duke Energy Progress Non-Residential Smart $aver program. This will benefit the customers of North Carolina and South Carolina by offering consistent incentives across both programs. This included the addition of more Prescriptive technology groups , including pumps & motors, process equipment, and information technology equipment, and removal of the incentive payment tiers.

The Company planned and has launched two new ways to participate in the Custom Program. One way is through a Fast Track option which allows eligible customers to pay a fee to have their application expedited and an offer delivered in 7 business days. The Custom Program also launched a new marketing channel for whole building new construction projects called New Construction Energy Efficiency Design Assistance. Customers with these projects now have access to help in calculating the energy efficiency savings associated to such projects.

In addition, numerous Prescriptive measures were evaluated last year and added the program under flexibility guidelines in January 2017, including but not limited to the following:

- Additional lighting sensors and controls
- HVAC water source heat pumps, chiller variable speed drive, and destratification fan
- Controls for escalator motors, kitchen exhaust
- Additional air compressor measures
- Additional LEDs – channel signs, sport lighting, and updated LED lamps and linear tubes
- De-lamping (when part of a lighting retrofit)
- Measures for agricultural businesses

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E. Marketing Strategy

The Company will continue the Program marketing efforts in 2016 through various marketing channels that include but are not limited to:

- Direct mail (letters and postcards to qualifying customers)
- Duke Energy Progress website
- Community outreach events
- Small Business Group outreach events
- Paid advertising/mass media
- Social media promotions
- Trade ally outreach
- Account managers
- Segmentation managers

These marketing efforts are designed to create customer awareness of the Program, to educate customers on energy saving opportunities and to emphasize the convenience of Program participation.

Non-residential customers are informed of programs via targeted marketing material and communications. Information about incentives is also distributed to trade allies, who in turn sell equipment and services to all sizes of nonresidential customers. Large business or assigned accounts are targeted primarily through assigned Company account managers. Unassigned small to medium business customers are supported by the Company's business energy advisors. The business energy advisors follow up on customer leads to assist with program questions and steer customers to the trade ally search tool who are not already working with a trade ally. In addition, the business energy advisors are contacting customers with electrical costs between $60,000 and $250,000 to promote the Energy Efficiency for Business program.

The internal marketing channel is comprised of assigned Large Business Account Managers and Local Government and Community Relations who all identify potential opportunities as well as distribute program collateral and informational material to customers and trade allies. In addition, the Economic and Business Development groups also provide a channel to customers who are new to the service territory.

F. Evaluation, Measurement and Verification

Evaluation work for the Program's process and impact evaluation began in the third quarter of 2016, with a combined DEC and DEP final report planned for completion in the fourth quarter of 2017.

The process evaluation will include interviews with program management, Trade Allies and customer participants. Customer and Trade Ally interviews will include data collection to gauge customer satisfaction, freeridership and spillover.

The impact evaluation will consist of estimating annual energy and demand impacts associated with program participation. The primary activity will involve an engineering-based analysis to estimate the impacts of the various program measures. The analysis will be supplemented by on-site field verification of sampled participants, as well as database and deemed savings reviews.

Small Business Energy Saver

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A. Description

The purpose of the Duke Energy Progress Small Business Energy Saver program (the "Program") is to reduce energy usage through the direct installation of energy efficiency measures within qualifying small non-residential customer facilities. All aspects of the Program are administered by a single Company-authorized vendor. Program measures address major end-uses in lighting, refrigeration, and HVAC applications.

Program participants receive a free, no-obligation energy assessment of their facility followed by a recommendation of energy efficiency measures to be installed in their facility along with the projected energy savings, costs of all materials and installation, and up-front incentive amount from Duke Energy Progress. Upon receiving the results of the energy assessment, if the customer decides to move forward with the proposed energy efficiency project, the customer makes the final determination of which measures will be installed. The energy efficiency measure installation is then scheduled at a convenient time for the customer and the measures are installed by electrical subcontractors of the Company-authorized vendor.

The Program is designed as a pay-for-performance offering, meaning that the Company-authorized vendor administering the Program is only compensated for energy savings produced through the installation of energy efficiency measures.

Audience

The Program is available to existing non-residential customers that are not opted-out of the Company's EE/DSM rider. Program participants must have an average annual demand of 180 kW or less per active account.

B & C. Impacts, Participants and Expenses

2016 Year End Results	Annual Forecast	Actual	Variations
Savings (MWH)	39,581	50,286	10,705
Savings (MW)	7.55	8.75	1.20
Participants		42,784,494	
2016 Program Expenses		$ 9,336,274	

D. Qualitative Analysis

Highlights

Lime Energy is the Company-authorized vendor administering the Program in both DEC and DEP service areas.

The mid-year point of 2016 marked three full years that the Program has been in operation in DEP. Though the program has now matured in the DEP service territory, customer interest remains strong with nearly 1,600 Small Business Energy Saver projects completed through year-end.

The Company has administered a customer satisfaction survey to Program participants in DEP since 2014. Customers continue to respond very positively to the Program, with 88% of all 2016 survey participants rating their overall satisfaction with the Program experience at an 8 or above (out of a 10 scale). Also, Program participants have overwhelmingly responded that the Program has served to improve their perception of Duke Energy, with 83% of responders indicating that the Program has had a positive effect on their overall satisfaction with the Company.

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In order to expand the Program offering to more small and medium business customers who will benefit from the direct install model and turn-key Program process, the Company filed a Program modification proposal with both the NC Utilities Commission and the Public Service Commission of SC in September to expand Program availability to include all existing non-residential customer accounts with an average annual demand of 180 kW or less, which is an increase from the previous eligibility limit of 100 kW annual average demand per account. This Program expansion modification was approved in October 2016 by both the NCUC and PSC of SC and implemented within the Program shortly thereafter.

As further explained below in the Evaluation, Measurement and Verification section, the combined DEC and DEP process and impact evaluation report, which was the first Program EM&V report to include DEC, was completed in September. The report included positive results for both jurisdictions, with a Program Realization Rate of 1.11 in DEP and a Net to Gross Ratio of 1.04.

Issues

While lighting measures are expected to remain the primary driver of kWh savings in the Program for the foreseeable future, in 2016 the Company worked with our vendor Lime Energy to implement an initiative focused on making the refrigeration measure energy assessment process more efficient, as well as improving customer uptake of project proposals which include refrigeration measures. The Company expects that this continued focus on refrigeration will lead to a significant increase in refrigeration-related savings and participation in 2017.

HVAC-related measures, however, continue to struggle due to the kWh savings-based incentive structure, long payback periods and high measure cost to savings ratio. In order to offer customers additional HVAC-related solutions, the Program started collaboration in early 2016 with the EnergyWise Business demand response program, wherein our Company-authorized vendor Lime Energy is also promoting the free Wi-Fi thermostat offer available through EnergyWise Business to customers while on-site for the Small Business Energy Saver assessment.

Potential Changes

In addition to promoting the EneryWise Business offer, the Company has continued to explore and evaluate potential new HVAC measures to add to the Program with the goal of offering customers more comprehensive energy efficiency projects with “deeper” energy retrofits. With this goal in mind, the Company plans to add HVAC-related control, optimization, and tune-up measures to the Program in early 2017.

As the Program matures, the Company will continue to evaluate opportunities to add incentivized measures suitable for the small business market to the approved Program which fit the direct install program model. The Company would ultimately like to ensure that small business customers are given the opportunity to maximize their energy savings by being offered comprehensive energy efficiency project through the Program wherever possible.

E. Marketing Strategy

In 2016, the Program was marketed primarily using the following channels:

- Direct mail (letters and postcards to qualifying customers)
- Duke Energy Progress website
- Email & Duke Energy Business E-Newsletters
- Social media and search engine marketing
- Direct marketing & outreach via Program administrator
- Outreach via Duke Energy Business Energy Advisors
- Community events

All marketing efforts are designed to create customer awareness of the Program, to educate customers on energy saving opportunities and to emphasize the convenience of Program participation for the target market.

F. Evaluation, Measurement and Verification

A combined DEC and DEP process and impact evaluation report was completed in September 2016. High level results include DEP-verified gross energy savings of 54,318 MWh, and 11.2 MW summer peak savings and 6.2 MW winter peak savings. Net-to-gross was 1.04

The process evaluation included interviews with program management, implementation contractors, and customer participants. Customer interviews included data collection that was used in the spillover and free ridership analysis.

The impact evaluation focused on verifying the key inputs to the engineering algorithms for lighting measures. A lighting metering study (on a nested participant sample) also served as a primary data source for operating hours. In addition, the analysis was supplemented with on-site field verification of program measures consistent with IPMVP protocols.

Evaluation activities will begin in the third quarter of 2017 for the next evaluation cycle, with a final report expected in first quarter of 2018. New process evaluation activities will include a customer journey mapping exercise to assess the qualitative experience of the customer, and reveal key information such as loyalty, satisfaction, and frustrations with the program. For the impact evaluation, new activities will include revisiting the sampling methodology based on the current measures mix and customer facility size due to the higher demand consumption cap for participation (180 kW rather than 100 kW).

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EMV Activities

Planned Evaluation, Measurement and Verification (EMV) Activities through the rate period (Dec. 31, 2017)

Evaluation is a term adopted by Duke Energy Progress (DEP), and refers generally to the systematic process of gathering information on program activities, quantifying energy and demand impacts, and reporting overall effectiveness of program efforts. Within evaluation, the activity of measurement and verification (M&V) refers to the collection and analysis of data at a participating facility/project. Together this is referred to as "EM&V."

Refer to the accompanying Exhibit 12 chart for a schedule of process and impact evaluation analysis and reports that are currently scheduled.

Energy Efficiency Portfolio Evaluation

DEP has contracted with independent, third-party evaluation consultants to provide the appropriate EM&V support, including the development and implementation of an evaluation plan designed to measure the energy and demand impacts of the residential and non-residential energy efficiency programs.

Typical EM&V activities:

- Evaluation plan development
- Deemed savings review
- Process evaluation interviews
- Program data collections
- Verification of measure installation and performance through surveys and/or on-site visits
- Program database review
- Impact data analysis
- Reporting

The process evaluation provides unbiased information on past program performance, current implementation strategies and opportunities for future improvements. Typically, the data collection for process evaluation consists of interviews with program management, implementation vendor(s), and program partner(s). In addition surveys of participants, and, in some cases, non-participants, are conducted. A statistically representative sample of participants is selected for the analysis.

The impact evaluation provides energy and demand savings resulting from the program. Impact analysis may involve engineering analysis (formulas/algorithms), billing analysis, statistically adjusted engineering analysis, and/or building simulation models, depending on the program and the nature of the impacts. Data collection may involve surveys and/or site visits. A statistically representative sample of participants is selected for the analysis. Duke Energy Progress intends to follow industry-accepted methodologies for all measurement and

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verification activities, consistent with International Performance Measurement Verification Protocol (IPMVP) Options A, C or D depending on the measure.

The field of evaluation is constantly learning from ongoing data collection and analysis, and best practices for evaluation, measurement and verification continually evolve. As updated best practices are identified in the industry, DEP will consider these and revise evaluation plans as appropriate to provide accurate and cost-effective evaluation.

Demand Response Program Evaluation

Duke Energy Progress has contracted with independent, third-party evaluation consultants to provide an independent review of the evaluation plan designed to measure the demand impacts of the residential and non-residential demand response programs and the final results of that evaluation.

Typical EM&V activities:

- Evaluation plan development
- Deemed savings review
- Process evaluation interviews
- Program data collections
- Verification of operability of technology
- Interval data and or/logger data collection
- Program database review
- Impact data analysis
- Dispatch optimization modeling, if appropriate
- Reporting

The process evaluation provides unbiased information on past program performance, current implementation strategies and opportunities for future improvements. Typically, the data collection for process evaluation consists of interviews with program management, implementation vendor(s), program partner(s). In addition, participants, and, in some cases, non-participants are surveyed. A statistically representative sample of participants is selected for the analysis.

The impact evaluation provides demand savings resulting from the program. Impact analysis for EnergyWise® involves determining program impacts and device operability through the use of data loggers. Impact analysis for Demand Response Automation involves statistical modeling to replicate reported Impacts, verify program impacts, and estimate program capability.

The field of evaluation is constantly learning from ongoing data collection and analysis, and best practices for evaluation, measurement and verification continually evolve. As updated best practices are identified in the industry, DEP will consider these and revise evaluation plans as appropriate to provide accurate and cost-effective evaluation.

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DEP DSM/EE Programs - Anticipated EM&V Schedule

As of July 20, 2017

DEP DSM/EE Programs - Anticipated EM&V Schedule

Program Name	SC Docket	Short name	2017 3rd Quarter	2017 4th Quarter	2018 1st Quarter	2018 2nd Quarter	2018 3rd Quarter	2018 4th Quarter	Notes
~~Business Energy Report~~	~~Docket 2015-178-E~~	~~BER~~	~~PROC~~	~~PROC / IMP~~	~~REP~~				Program pilot has been discontinued
Commercial Demand Response	Docket 2010-41-E	CIG DR	REP (2016)			REP (2017)			
Distribution System Demand Response	Docket 2009-190-E	DSDR							
Nonresidential Smart $aver EE Products & Assessment	Docket 2009-190-E	EEB		REP					Report delivery 4Q-2017 to include participation period of Mar 2016-Feb 2017; combined with DEC Smart $aver eval report (Prescriptive Measures)
Nonresidential Smart $aver EE Products & Assessment	Docket 2009-190-E	EEB	PROC/IMP	IMP	PROC/IMP	PROC/IMP	REP		EEB Custom projects combined with DEC Smart $aver Custom eval report
EnergyWise	Docket 2009-190-E	EW	REP (W2016/2017)(S2016)	IMP (S2017)	REP (S2017)				
EnergyWise for Business	Docket 2015-163-E	EWB	REP (2016)		PROC/IMP	REP (2017)			2017 report (PY2016) to be combined with DEC evaluation report
Energy Efficiency Education	Docket 2014-420-E	K12	REP (2016)		PROC/IMP	REP (2017)			Report in 2017 will be the first evaluation of program in DEP; 2nd eval in 2018 to be combined evaluation with DEC
Residential Energy Assessment	Docket 2016-82-E	REA			PROC	IMP	REP		Program approved Feb 2016; timing of evaluation dependent upon participation levels; tentatively planned as combined evaluation with DEC
Lighting (Retail)	Docket 2010-41-E	LP	REP (PY2016)						Report in 2016 to include participation period of 2015-middle of 2016; 2017 report to be combined with DEC
Multi-Family Energy Efficiency	Docket 2014-419-E	MF					PROC/IMP		Will be combined DEC/DEP evaluation
My Home Energy Report	Docket 2011-180-E	MyHER	REP						Report in 2017 will be the first evaluation of program in DEP
Neighborhood Energy Saver	Docket 2009-190-E	NES			PROC	IMP	REP		2018 evaluation to be combined with DEC evaluation
Residential New Construction	Docket 2015-237-E	RNC	PROC	IMP	REP				Report in 2017 to include participation period beginning with 2016; no PY2015 evaluation
Residential Save Energy & Water Kit	Docket 2015-322-E	SEW		REP					Report in 2017 will be first evaluation of program in DEP (timing to be determined by participation level); to be combined with DEC evaluation
Small Business Energy Saver	Docket 2015-163-E	SBES	PROC	IMP	REP				To be combined with DEC evaluation report

LEGEND	
PROC	Process surveys/interviews (customers or other) for purposes of report that follows
IMP	Impact data collection (onsites, billing data) and analysis for purposes of report that follows
REP	Evaluation, Measurement & Verification Report

NOTE: THESE DATES ARE SUBJECT TO CHANGE

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Evaluation of the PY2015 Duke Energy Progress Energy Efficient Lighting Program

December 12, 2016

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Opinion Dynamics

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1. Evaluation Summary

1.1 Program Summary

Duke Energy Progress (DEP) launched the Energy Efficient Lighting (EEL) program in January 2010 with the goal of reducing electric energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. DEP partners with retailers and manufacturers across North and South Carolina to provide predetermined price markdowns on customer purchases of efficient lighting. The program promotes customer awareness and purchase of the program-discounted products through a range of marketing and outreach strategies, including in-store collateral and events, bill inserts, direct mail marketing, mass media advertising, online advertising, and community events. The program also provides training to store staff. Product mix includes standard and specialty CFLs, LEDs, and ENERGY STAR® fixtures, with a wide range of products across these technologies. Participating retailers include a variety of channel types, including Big Box, Do-It-Yourself (DIY), Club, and Discount stores.

DEP manages the EEL program and is responsible for overseeing program design, marketing, and operations. Ecova has implemented the EEL program on behalf of DEP since 2010.

The program period under evaluation is from January 1, 2015 through December 31, 2015 (PY2015). Over this period, DEP discounted more than 4.4 million lighting products, achieving 239,702 MWh in claimed/ex ante energy savings, 37.5 MW in summer peak demand savings, and 26.5 MW in winter peak demand savings.[1] Table 1-1 provides a summary of PY2015 sales and achievements.

Table 1-1. PY2015 Sales Ex-Ante Program Saving Achievements

Metric	Achievements
Number of bulbs sold	*4,444,021*
Total energy savings (MWh)	**239,702**
Energy savings (MWh) from PY2015 sales	195,324
Carryover energy savings (MWh) from previous years	44,378
Total summer peak demand savings (MW)	**37.5**
Summer peak demand savings (MW) from PY2015 sales	31.8
Carryover summer peak demand savings (MW) from previous years	5.7
Winter peak demand savings (MW)	**26.5**
Winter peak demand savings (MW) from PY2015 sales	17.3
Carryover winter peak demand savings (MW) from previous years	9.2

Source: Program-tracking data.

[1] Note that this number includes carryover savings from previous program years. This number is based on the analysis of the program-tracking data.

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1.2 Evaluation Objectives and High-Level Findings

The evaluation of the DEP EEL program in PY2015 included process, impact, and market assessment components and addressed several major research objectives:

- Assess program performance and estimate gross and net annual energy (kWh) and peak demand (kW) savings associated with program activity
- Assess program implementation processes and marketing strategies and identify opportunities for improvement
- Understand lighting market dynamics

To achieve these research objectives, the evaluation team completed a range of data collection and analytic activities, including interviews with program staff, a review of deemed savings, program-tracking data analysis, a retailer shelf audit, sales data modeling, impact analysis, and a commercial lighting logger study. Table 1-2 provides an overview of the evaluation activities, the scope of each, the research area that each activity supported, and an overview of the activity's purpose.

Table 1-2. Evaluation Data Collection and Analytical Activities

#	Evaluation Activity	Scope	Impact	Process	Market	Purpose of Activity
1	Program staff interviews	n=2		X		• Provide insight into program design and delivery
2	Deemed savings review	All program-tracking data	X			• Review accuracy and appropriateness of the energy savings assumptions
3	Materials review	All materials provided		X		• Provide insight into program design and delivery
4	Program-tracking data analysis	All program-tracking data	X	X	X	• Calculate gross energy and peak demand savings • Understand program footprint, measure mix, retailer mix, and incentive levels
5	Retailer shelf audit	n=20	X	X	X	• Assess shelf space for general service and reflector products and presence of incandescent products on store shelves • Estimate baseline wattage adjustments • Provide insight into program marketing
6	Commercial lighting logger study	n=88	X	X	X	• Estimate hours of use and coincidence factors for program products installed in commercial settings • Assess lighting use among commercial customers who purchase program lighting products
7	Sales data modeling	All program-tracking data	X			• Estimate net-to-gross (NTG)

Source: Opinion Dynamics analysis.

The DEP EEL program was successful in PY2015. The program realized 73% of its reported gross energy savings, 75% of its summer peak demand savings, and 34% of its winter peak demand savings, achieving 174,679 MWh in evaluated/ex post gross energy savings, 28.1 MW in summer peak demand savings, and 9.0 MW in winter peak demand savings. The main reason the realization rates are less than 100% is that

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there was a change in the method used to claim savings from future installations of program-discounted bulbs (from staggered carryover to discounted method). Because customers do not install all of the bulbs they purchase within a year of purchase, program administrators had been setting aside a portion of sales to claim in future years. In PY2014, the evaluation team transitioned to claiming all savings in the year of purchase, with savings from future installations discounted using the utility discount rate. Program administrators did not have sufficient time to make this change to their PY2015 tracking systems, thus the difference in tracked versus evaluated savings. Otherwise, the program's sales tracking and savings estimation processes were generally rigorous and accurate. Table 1-3 summarizes the PY2015 EEL gross impact results.

Table 1-3. DEP PY2015 EEL Gross Impact Results

Savings Type	Savings Category	Claimed/Ex Ante Savings	Evaluated/Ex Post Savings	Gross Realization Rate
Energy savings (MWh)	Residential savings	131,880	112,171	73%
	Commercial savings	63,443	37,363	
	Carryover savings from PY2013 and PY2014	44,378	–	
	Future savings from 2015	–	25,145	
	Total	**239,702**	**174,679**	**73%**
Summer peak demand savings (MW)	Residential savings	18.8	16.2	75%
	Commercial savings	13.0	8.2	
	Carryover savings from PY2013 and PY2014	5.7	–	
	Future savings from 2015	–	3.7	
	Total	**37.5**	**28.1**	**75%**
Winter peak demand savings (MW)	Residential savings	6.5	5.4	34%
	Commercial savings	10.8	2.4	
	Carryover savings from PY2013 and PY2014	9.2	–	
	Future savings from 2015	–	1.2	
	Total	**26.5**	**9.0**	**34%**

Source: Program-tracking data and Opinion Dynamics analysis.

Opinion Dynamics used sales data modeling to estimate program NTG, resulting in an estimate of 0.38 for the program. Applying this NTG ratio to the evaluated/ex post gross savings resulted in net energy savings of 66,378 MWh, net summer peak demand savings of 10.7 MW, and net winter peak demand savings of 3.4 MW.

Table 1-4. Evaluated/Ex Post Net Savings

Savings Type	Evaluated/ Ex Post Gross Savings	NTG Ratio	Evaluated/ Ex Post Net Savings	Claimed/ Ex Ante Net Savings	Net Realization Rate[A]
Energy savings (MWh)	174,679	0.38	66,378	146,364	45%
Summer peak demand savings (MW)	28.1	0.38	10.7	28.2	38%
Winter peak demand savings (MW)	9.0	0.38	3.4	9.2	37%

Source: Program-tracking data and Opinion Dynamics analysis.
[A] Denominator is ex ante net savings.

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Program implementation processes were smooth and effective, resulting in high levels of stakeholder and market actor satisfaction. The program had 269 participating retail storefronts across the DEP service territory providing equitable customer access to program discounts.

Since 2010, the program discounted more than 21 million light bulbs. According to our conservative estimates, which are based on past research on CFL and LED saturation, analysis of sales data, and the number of customers in DEP's service territory, energy-efficient lighting products were in 49% of sockets in customer homes at the end of PY2015. This high level of socket saturation is due, in large part, to the DEP EEL program.

The lighting market is in a state of transition. Retailers have dramatically changed the lighting products that they stock over the past 4 years. In 2012, incandescent and halogen bulbs occupied a majority of shelf space (58%). There were three times as many CFL products than LEDs in 2012 (32% compared to 10%). By 2014, efficient products held the majority of shelf space (60%), with twice as many LED products on shelves than CFLs (40% compared to 20%). Between 2014 and 2015 little has changed in terms of LED prominence on retailer shelves, However, there has been a considerable increase in the prominence of halogens, all at the expense of incandescents. Incandescents were still the most common less-efficient product in 2014 (24% of all products), but by 2015, there were three times as many halogen products than incandescents (30% compared to 8%).

LEDs are dropping in price and are an increasingly attractive alternative to CFLs. Based on the shelf survey data, prices for non-discounted standard LED products dropped by approximately $5 to from $15 to $10, and prices for non-discounted reflector LEDs dropped by approximately $8 from $23 to $15. CFL prices for both standard and specialty products, on the other hand, remained largely unchanged 2014 and 2015.

A comparison of the products at participating and non-participating stores of the same retailer suggests that the DEP program is not affecting the products that most retailers stock. The share of efficient versus less efficient products is similar at participating and non-participating retailers.

These findings indicate that the key barriers to energy efficient lighting adoption, such as product availability and price, at least for CFLs, have been largely mitigated, which may signal diminishing program effects moving forward. The NTG ratio remained steady at 38% (the NTG ratio was 37% in PY2014). The relatively low NTG ratio is a likely signal of further diminishing effects of the program. NTG is not the only area of diminished program effects. As CFLs and LEDs saturate more sockets, customers are likely to install newly purchased CFLs and LEDs in sockets that previously contained a high efficiency product, resulting in limited future opportunities for savings. The long life of CFLs and LEDs may also lead to customers to purchase more products than they need and put extra bulbs in storage for much later use, which will delay the realization of program savings.

The DEP program has been transitioning to LEDs. In PY2015, LEDs made up 42% of bulbs sold through the program, which is twice the percentage sold in PY2014 (21%). With the new Energy Star® 2.0 lamp specifications, CFLs will no longer be Energy Star certified as of 2017. The DEP program is well-positioned to move entirely to LEDs at that point.

1.3 Evaluation Recommendations

Opinion Dynamics provides the following recommendations:

- Evaluation results suggest that the lighting market is changing rapidly and has begun to transform. There are still cost-effective lighting savings to be had, but a change in program design may be required. Given the rapid pace of change in the lighting market, the mass market design may not be

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cost-effective in the near future. Energy Star 2.0 lamp specifications will accelerate the change. The DEP program has been correctly transitioning to LEDs. In addition, program administrators should reconsider the prominent role that standard bulbs play in the program. The existing mass market retail design targets all customers regardless of their existing use of efficient bulbs. Strategic targeting of underserved customers and/or underserved sockets would be a method to meet the remaining program potential while achieving high net positive savings. The evaluation team sees two potential program design options that DEP could pursue:

- **A mass market program design focused on specialty and reflector LED products.** Specialty LED products are unaffected by EISA legislation. Efficient bulb socket saturation is also typically lower than standard sockets. Specialty and reflector CFLs never caught on with consumers, primarily because they did not fit well in these applications. Specialty and reflector LEDs are a better performing product, but they are significantly more expensive than standard LEDs. By offering larger discounts on specialty products in the context of the mass market program at point of sale, DEP can accelerate the transformation of the specialty LED market.
- **A more targeted program focus that would reach** underserved customer segments. Such a design could include a targeted offering of free products or products for purchase through an online store or other avenue. Our PY2014 analysis of saturation rates by customer segment revealed that while efficient bulb saturation is relatively evenly distributed across the DEP population, there are still some demographic groups that lag behind in their use of CFLs and LEDs. Customers residing in mobile homes and multifamily residences, transient customers (less than 4-year tenure), renters, and customers with lower incomes are significantly more likely to have no CFLs or LEDs in their homes than their counterparts. These segments could be the primary program target. The scale of this program will likely be much smaller and the program is likely to be more costly than the streamlined upstream delivery model due to costs associated with tailored customer targeting. Given the expected higher net-to-gross ratio of this targeted design, the program should still be cost-effective

- Given the program's successes to-date, DEP may want to consider conducting a market effects study to assess unclaimed savings from the program's impact on the larger market to date. The Evaluation Team believes that the program is at least, in part, responsible for changes to the lighting market in DEP's service territory by increasing customer awareness of efficient lighting technologies, influencing the products sold in retail stores, and changing customer lighting preferences.

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2. Program Description

2.1 Program Design

Duke Energy Progress (DEP) launched the Energy Efficient Lighting (EEL) program in January 2010 with the goal of reducing energy consumption and peak demand through increased awareness and adoption of energy-efficient lighting technologies. The program addresses two key barriers to the purchase of efficient lighting: (1) the higher prices of CFLs and LEDs compared to incandescent and halogen bulbs and (2) customer awareness and knowledge of the benefits of efficient lighting. DEP partners with retailers and manufacturers across North and South Carolina to provide predetermined price markdowns on customer purchases of efficient lighting. The program promotes customer awareness and purchase of the program-discounted products through a range of marketing and outreach strategies, including in-store collateral and events, bill inserts, direct mail marketing, mass media advertising, online advertising, and community events. The program also provides training to store staff. Product mix includes standard and specialty CFLs, LEDs, and ENERGY STAR® fixtures, with a wide range of products across these technologies. Participating retailers include a variety of channel types, including Big Box, Do-It-Yourself (DIY), Club, and Discount stores.

2.2 Program Implementation

DEP manages the EEL program and is responsible for overseeing program design, marketing, and operations. Ecova has implemented the EEL program on behalf of DEP since 2010. Ecova's key responsibilities include maintaining manufacturer and retailer communications, obtaining and processing program sales data, training retailer staff, and promoting program products through in-store demonstration events and point-of-purchase (POP) marketing materials.

2.3 Program Performance

The program period under evaluation is from January 1, 2015 through December 31, 2015 (PY2015). Over this period, DEP discounted more than 4.4 million lighting products, achieving 239,702 MWh in claimed/ex ante energy savings, 37.5 MW in summer peak demand savings, and 26.5 MW in winter peak demand savings.[2] Table 2-1 provides a summary of PY2015 sales and savings achievements.

[2] Note that this number includes carryover savings from previous program years. This number is based on the analysis of the program-tracking data.

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Table 2-1. PY2015 Sales and Achievements

Metric	Achievements
Number of bulbs sold	*4,444,021*
Total energy savings (MWh)	239,702
Energy savings (MWh) from PY2015 sales	195,324
Carryover energy savings (MWh) from previous years	44,378
Total summer peak demand savings (MW)	37.5
Summer peak demand savings (MWh) from PY2015 sales	31.8
Carryover summer peak demand savings (MWh) from previous years	5.7
Total winter peak demand savings (MW)	26.5
Winter peak demand savings (MWh) from PY2015 sales	17.3
Carryover winter peak demand savings (MWh) from previous years	9.2

Source: Program-tracking data from Ecova.

Table 2-2 provides a summary of the product mix discounted through the program in PY2015. Standard bulbs accounted for more than three-quarters of bulbs sold (79%). Standard CFLs accounted slightly over half of reported sales and energy savings (55%). Standard LEDs accounted for 24% of the reported sales and 22% of energy savings. LEDs made up the majority of specialty, reflector, and fixture sales. Across all bulb types, CFLs comprised 58% of sales compared to 42% for LEDs.

Table 2-2. PY2015 Reported Performance by Product Mix

Bulb Type	Reported Bulbs		Reported Energy Savings (kWh)[A]		Reported Summer Peak Demand Savings (kW)[A]		Reported Winter Peak Demand Savings (kW)[A]	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Standard CFLs	2,435,045	55%	107,838,511	55%	17,607	55%	9,469	55%
Specialty CFLs	16,424	0%	592,091	0%	96	0%	53	0%
Reflector CFLs	45,127	1%	1,844,449	1%	300	1%	162	1%
CFL fixtures	93,343	2%	5,845,963	3%	826	3%	667	4%
Standard LEDs	1,072,314	24%	43,240,651	22%	7,099	22%	3,759	21%
Specialty LEDs	218,658	5%	6,652,096	3%	1,091	3%	574	3%
Reflector LEDs	366,758	8%	17,031,812	9%	2,795	9%	1,485	9%
LED fixtures	196,352	4%	12,278,054	6%	1,969	6%	1,121	6%
Total	4,444,021	100%	195,323,628	100%	31,783	100%	17,291	100%

Source: Program-tracking data.

[A] Savings exclude carryover savings from previous years.

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3. Key Research Objectives

Opinion Dynamics evaluation of the PY2015 EEL program included process, impact, and market components and was guided by the following key research objectives:

- Assess program performance and estimate gross and net annual energy and peak demand savings associated with program activity in PY2015
- Assess program implementation processes and marketing strategies and identify opportunities for improvement
- Understand lighting market dynamics

We designed our evaluation tasks to answer the following impact-related research questions:

- What are the estimated program gross energy and demand savings?
- What are the estimated program net energy and demand savings?
- What is the program impact on energy-efficient lighting purchases? How many customers would have chosen less-efficient lighting alternatives in the absence of the program?
- For commercial customers who purchase program-discounted bulbs:
  - Develop in-service rates (ISRs) for medium screw-based products (e.g., CFLs and LEDs)
  - Understand and describe the mix (e.g., penetration rate, saturation rate) of medium screw-based products installed in participating commercial facilities
  - Develop hours of use (HOU) and summer and winter peak coincidence factors (CFs) for medium screw-based products

Through our evaluation, we examined the following process-related questions:

- Did the program change its design or footprint in PY2015 in terms of participating retailer mix, product mix, incentive levels, or participation requirements? If so, why and were those changes advantageous?
- How effective have the program implementation and data-tracking practices been?
- What strategies did program marketing include? What was the relative effectiveness of the various strategies?
- What are the opportunities for program improvement?

Finally, we focused on the following research questions pertaining to the lighting market:

- How have manufacturing, stocking, and sales practices changed?
- What are the current and future trends in the lighting market?
- Who are commercial customers participating in DEP's EEL program?
- What is the state of lighting at the commercial facilities participating in DEP's EEL program?

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4. Overview of Evaluation Activities

To answer the research questions in the previous section, Opinion Dynamics performed a range of data collection and analytical activities. Table 4-1 provides a summary of evaluation activities and the areas of inquiry each helped address. Following the table, we provide details on each activity's scope, sampling approach, if applicable, and timing.

Table 4-1. Overview of Evaluation Activities

#	Evaluation Activity	Scope	Impact	Process	Market	Purpose of Activity
1	Program staff interviews	n=2		X		• Provide insight into program design and delivery
2	Deemed savings review	All program-tracking data	X			• Review accuracy and appropriateness of the energy savings assumptions
3	Materials review	All materials provided		X		• Provide insight into program design and delivery
4	Program-tracking data analysis	All program-tracking data	X	X	X	• Calculate gross energy and peak demand savings • Understand program footprint, measure mix, retailer mix, and incentive levels
5	Retailer shelf audit	n=20	X	X	X	• Assess shelf space for general service and reflector products and presence of incandescent products on store shelves • Estimate baseline wattage adjustments • Provide insight into program marketing
6	Commercial lighting logger study	n=88	X	X	X	• Estimate hours of use and coincidence factors for program products installed in commercial settings • Assess lighting use among commercial customers who purchase program lighting products
7	Sales data modeling	All program-tracking data	X			• Estimate net-to-gross (NTG)

Source: Opinion Dynamics analysis.

Program Staff Interviews

Opinion Dynamics completed two interviews with program staff at Duke Energy and Ecova. We completed the interviews in April 2016. The interviews explored, among other topics, changes in program design and implementation; overview of program performance; participating retailer, product, and incentive mix; and data-tracking and communication processes.

Deemed Savings Review

In support of the impact evaluation, Opinion Dynamics completed a review of the energy savings assumptions used by DEP to estimate the EEL program energy and peak demand savings. The objectives of the review were to identify the deemed savings values DEP used to calculate PY2015 impacts; review the deemed savings values for reasonableness; verify their accurate application; and identify data gaps, omissions, inconsistencies, and errors. As part of this task, we reviewed past evaluation reports and checked the savings

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assumptions used to calculate PY2015 program reported gross savings against the PY2015 evaluation recommended savings assumptions to confirm their accuracy and consistency of application. As part of the review process, we also checked the PY2015 tracking data for accuracy and completeness.

Materials Review

Opinion Dynamics conducted a review of program materials and data, including marketing materials, plans, and past evaluation reports and research studies.

Program-Tracking Data Analysis

Opinion Dynamics assessed PY2015 sales data. Analyses included:

- Applying revised savings assumptions and estimating energy and demand savings
- Understanding product mix, retailer mix, and incentive levels
- Analyzing sales trends over time, by geography and by retailer

Retailer Shelf Audit

Opinion Dynamics completed shelf audits at 20 retailers across a range of retail channels. We completed shelf audits between August and December 2015. Fourteen of the 20 retailers were participating retailers and six were non-participating retailers.

When selecting retailers and stores for inclusion in the study, we selected ones that would provide good geographic and retail channel coverage, as well as those that would account for a high percentage of program bulb sales. Overall, the 14 participating retailers included in the study accounted for 27% of program bulb sales in PY2015.

Table 4-2. Retailer Shelf Audit Sample Distribution by Retail Channel

Stratum	Number of Retailers		% of Program Sales (Participating Retailers Only)
	Participating Retailers	Non-Participating Retailers	
Big box	1	1	1%
DIY	3	3	4%
Club	5	1	19%
Discount[A]	2	1	1%
Hardware	3	0	2%
Total	**14**	**6**	**27%**

[A]Discount channel includes Dollar Tree, Goodwill, and Habitat ReStore stores

As part of the shelf audit, the evaluation team recorded the number and price ranges of different lighting products in key wattage categories. We recorded data separately for general service products and reflector products. The evaluation team also recorded the presence of program-sponsored point-of-purchase (POP) marketing and promotional materials. We used the study results to adjust baseline wattage assumptions and to provide insight into the shelf space devoted to different lighting products.

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Commercial Lighting Logger Study

Opinion Dynamics completed a lighting logger study among commercial customers likely to purchase program-discounted products. The overall goal of the study was to estimate average daily HOU, summer and winter peak CFs, and ISRs for program-discounted CFLs and LEDs purchased by commercial customers. In addition, the study collected firmographic data and data on the penetration and saturation of medium screw-based lighting technologies. These data allowed us to characterize businesses that purchase program-discounted lighting products and assess the state of medium screw-based lighting at their facilities.

Sample Design and Fielding

For purposes of this study, eligible customers were defined as commercial customers who: (1) purchase at least some lighting for their business at retail stores and (2) have medium screw-based CFL or LED products installed at their facilities. Due to its upstream nature, the program cannot track customers who purchased program-discounted lighting. Furthermore, commercial customers themselves may not be aware of the program discounts. Therefore, data collection for the study consisted of two distinct activities:

- **Telephone recruitment survey:** To identify and recruit commercial customers who are likely to have purchased energy-efficient medium screw-based light bulbs at retail stores instead of some other source
- **On-site visits:** To collect data on lighting products in use and to deploy and retrieve lighting logger equipment

We drew the sample for this study from the population of DEP commercial customers provided by Duke Energy, starting with an initial sample frame of 217,162 commercial customers with valid telephone numbers. We then narrowed the sample frame and excluded customer accounts without contact information, non-retrofittable accounts, and accounts for commercial customers who would likely be ineligible for the study. Previous studies on lighting purchasing and maintenance in the commercial sector suggest that large commercial customers, major chains (financial institutions, food service, etc.), government facilities, and businesses located in facilities managed by property management companies source their lighting purchases through distributors, suppliers, and lighting contractors. In total, we dropped 110,677 customers across the following commercial customers from the sample frame:

- Large customers: large rate codes, high usage, high peak demand
- Non-retrofittable sites: street lighting, pumps, sewers, missing or invalid addresses
- Large chain stores
- Property management companies
- Certain business segments: industrial sector, large construction, education facilities, farming, and government
- Unable to contact: missing or erroneous phone numbers
- Seasonal rate codes
- Other smaller accounts associated with any of the above criteria through the same chain

Refining the sample frame made the calling process more efficient by increasing the incidence of reaching a qualifying business. From a final sample frame of 106,485 customers, we pulled a random sample of 5,948 whom we attempted to contact. Our recruitment identified 196 eligible customers, and we ultimately deployed

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loggers at 88 different sites. Table 4-3 displays the sampling steps and associated number of customers. Customers who qualified and agreed to participate in the lighting logger study received a $50 gift card upon completion of the logger deployment site visit and another $50 gift card upon logger retrieval visit.

Table 4-3. Summary of Sampling and Recruitment

Sampling Step	Customers
Population	217,162
Sample frame	106,485
Sample	5,948
Recruited customers	196
Completed site visits	88

Source: Opinion Dynamics analysis.

Figure 4-1 provides a visual depiction of the study recruitment process.

Figure 4-1. Lighting Logger Recruitment

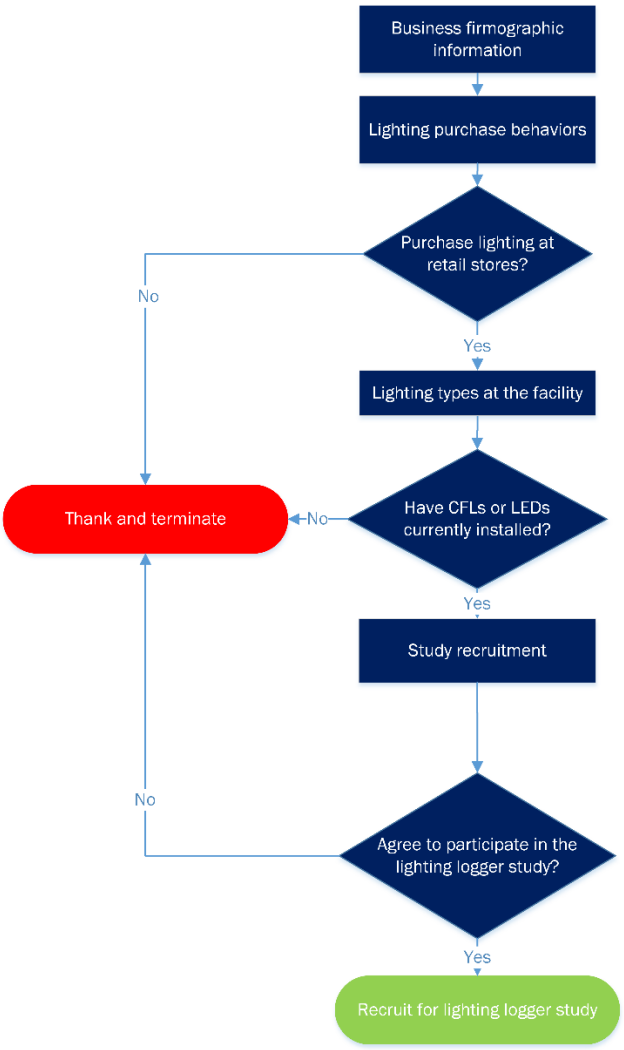

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Table 4-4 provides the final survey dispositions by phase.

Table 4-4. Lighting Logger Recruitment Disposition Summary

Disposition	Customers
Completed logger visit (I)	**88**
Eligible non-interviews (NC)	**2,115**
Answering machine	820
Call back	619
Not available	644
Language problems	32
Not eligible (NE)	**1,498**
Doesn't purchase lighting at retailer/not responsible for lighting	59
No eligible light bulbs	352
Disconnected phone/Wrong number	522
Residential number	411
Do not call list	61
Computer tone	56
Recruited but later deemed ineligible (no eligible bulbs)	37
Refused (R)	**1,436**
Other (O)	**79**
Unknown (U)	**732**
Total customers in sample	***5,948***

Source: Opinion Dynamics analysis.

Table 4-5 provides the response rate for the lighting logger recruitment.

Table 4-5. Lighting Logger Recruitment Response Rate

AAPOR[A] Rate	Response Rate
Response rate	7%

Source: Opinion Dynamics analysis.
[A] American Association for Public Opinion Research.

Figure 4-2 illustrates the location of the 88 sites that participated in the lighting logger study.

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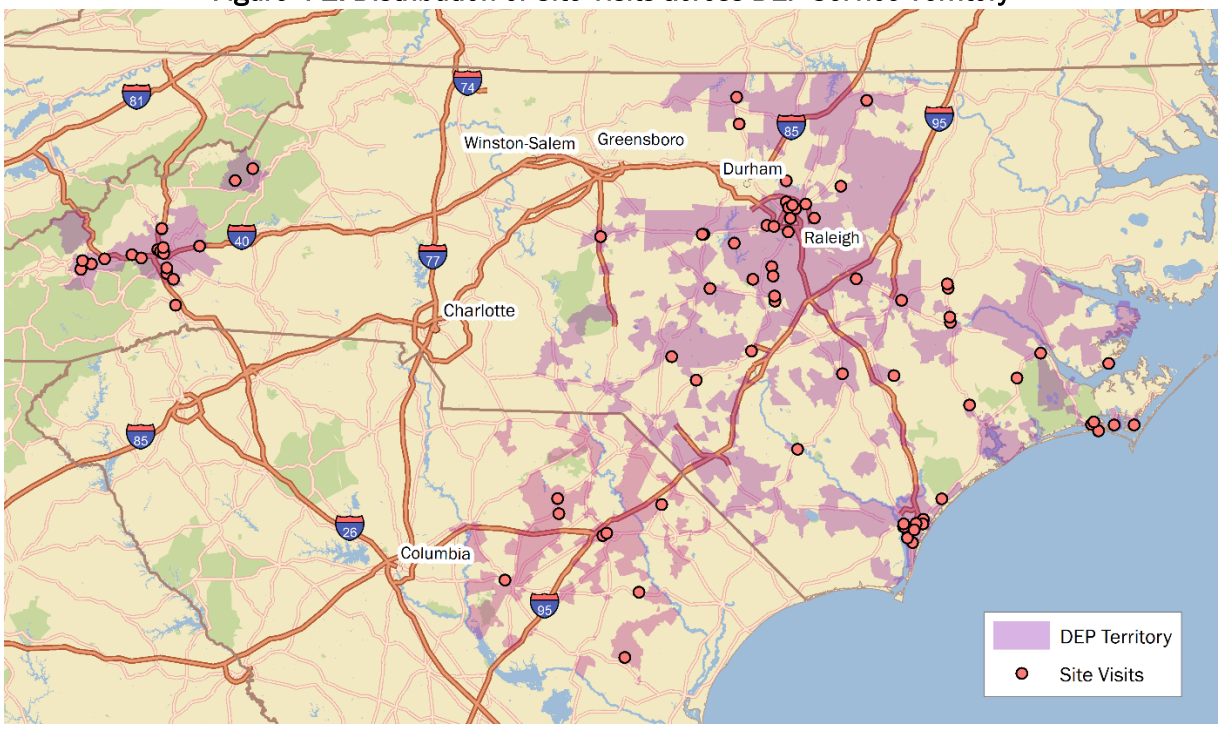
Figure 4-2. Distribution of Site Visits across DEP Service Territory



We compared facility type and business type between the eligible customers and the sites where we deployed loggers and determined that they are similar enough that we did not need to use segment-based post-stratification weights.

Logger Deployment

As part of the site visits, we conducted an inventory of all interior medium screw-based sockets, sampled fixtures for logging, and placed lighting loggers. During the site visits, technicians recorded up to seven unique lighting usage areas within each facility. Usage areas are areas within the premise with a distinct function for which lighting equipment behaves similarly with respect to its operation. They are:

- Customer service area/retail space
- Bathroom
- Office space
- Storage space
- Stairwell/hallway/corridor
- Kitchen space/food prep space
- Front desk/reception space
- Other (specify)

For each area, technicians collected information on the total number of switches, switch controls, total number of light sockets controlled by each switch, lighting technology (CFL, LED, incandescent, halogen, empty socket)

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and bulb shape (twist, reflector, globe) in each socket. Business owners/managers provided detailed information on the business's hours of operation.

To capture lighting usage, we used DENT loggers. We deployed up to seven loggers per site, one in each distinct lighting usage area. For facilities with fewer than seven usage areas, we deployed more than one logger per area (but no more than three loggers per area) to increase the overall estimated precision as well as to act as a backup logger. Within each area, we randomly selected the light switch to log and placed lighting loggers only on switches[3] that controlled at least one interior CFL or LED. For each logger, we recorded the switch it was placed on and the count of light bulbs, by technology, that it controlled. We also recorded a detailed description of the logger placement to aid in subsequent retrieval visits (e.g., "light above the cash register").

In general, we kept loggers in place for 8 months (an average of 229 days per logger), deploying them in August–October 2015 and retrieving them in April–May 2016. We removed the loggers using standard procedures for logger testing prior to removal. We conducted a closing interview with the business owner about any changes in lighting usage or business operation over the course of the logging period.

Logger Data Preparation and Cleaning

We deployed a total of 282 loggers across 88 sites. We were unable to retrieve a total of 20 loggers. In addition, we dropped 20 loggers because the data were corrupted or the logger was inadvertently deployed on exterior lighting, which was not part of the study scope. We performed analyses and cleaning that resulted in dropping 26 additional loggers. In total, of 282 deployed loggers, we could not use 66 loggers in our analysis (23%). Appendix E contains detailed information on the data-cleaning steps we undertook.

Table 4-6. Logger Attrition Summary

Cut or Drop Decision	Loggers Affected		Sites Affected	
	#	%	#	%
Total deployed	282	100%	88	100%
Total dropped	66	23%	9	10%
Unable to retrieve	*20*	*7%*	*0*	*0%*
Corrupted/failed/deployed on exterior lighting	*20*	*7%*	*7*	*8%*
No "on" periods or low activity	*11*	*4%*	*2*	*2%*
Less than 30 days logged	*15*	*5%*	*0*	*0%*
Total used in analysis	**216**	**77%**	**79**	**90%**

As illustrated in Table 4-7, more than one-third of the analyzed loggers were placed in customer service areas/retail space (36% of loggers analyzed), with the next most frequently logged room types being bathrooms (19%) and office spaces (16%).

[3] The bulbs had to be on a non-dimmable switch.

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Table 4-7. Total Number and Percent of Loggers by Room Type Included in the Analysis

Space Type	# of Loggers Analyzed	% of Loggers Analyzed
Customer service area/retail space	78	36%
Bathroom	41	19%
Office space	34	16%
Storage space	20	9%
Stairwell/hallway/corridor	23	11%
Kitchen space/food prep space	6	3%
Front desk/reception space	6	3%
Other	8	4%
Total	**216**	**100%**

Note that although the total number of loggers analyzed is 216, the total number of switches that were logged is 215. This is because there was one instance where two different loggers were deployed on the same switch. The HOU and CF estimation for the two loggers were unsurprisingly identical and thus we simply combined the two loggers using an average.

Sales Data Modeling

The goal of the sales data modeling was to develop an estimate of NTG. As part of this research activity, we estimated lighting price elasticities using regression modeling of PY2015 program sales and pricing data. We calculated a NTG estimate from the price elasticities. A detailed description of the sales data modeling methodology can be found in Section 6.1.

Confidence and Precision

Sales data modeling uses entire year of sales data rather than a sample of the program sales records. Because no sampling was used, the concept of sampling error does not apply, so there is no estimate of precision for the resulting NTG estimate.

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5. Gross Impact Evaluation

This section describes the methodology for conducting the gross impact analysis and the results of the analysis. The evaluation team completed the following activities:

- Reviewed program-tracking data and savings assumptions for accuracy, completeness, and consistency
- Conducted engineering analysis of energy and demand savings and developed evaluated/ex post savings estimates

5.1 Methodology

Neither North Carolina nor South Carolina has a Technical Reference Manual that provides a recommended savings estimation approach and savings assumptions. Therefore, savings assumptions used by the program staff to calculate program impacts are based on the most recent evaluation studies. As part of the engineering review and analysis, Opinion Dynamics reviewed past evaluation reports and attempted to replicate program reported gross savings.

We estimated savings using the recommended approach in the Uniform Methods Project (UMP) protocols. Per the UMP protocols, energy savings calculations include delta watts, ISRs, HOU, and interactive effects. According to prior evaluations of the EEL program, customers install a portion of program-discounted bulbs in commercial applications. Energy and demand savings from lighting installed in commercial settings are higher due to longer operating hours and higher CFs. Interactive effects and the first-year ISR could also be different in commercial settings. Accordingly, we used two sets of savings assumptions: one for commercial installations and another for residential installations. Equation 5-1 provides the formula that we used to estimate energy savings, while Equation 5-2 provides the formula for demand savings.

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Equation 5-1. Annual Energy Savings

$$Res\ kWh_{saved} = NUMUNIT * ResShare\left[\left(\frac{\Delta W}{1{,}000}\right) * HOU_{Res} * ISR_{Res} * INTEF_{Res}\right]$$

$$Com\ kWh_{saved} = NUMUNIT * ComShare\left[\left(\frac{\Delta W}{1{,}000}\right) * HOU_{Com} * ISR_{Com} * INTEF_{Com}\right]$$

Equation 5-2. Annual Demand Savings

$$Res\ kW_{saved} = NUMUNIT * ResShare\left[\left(\frac{\Delta W}{1{,}000}\right) * CF_{Res} * ISR_{Res} * INTEF_{Res}\right]$$

$$Com\ kW_{saved} = NUMUNIT * ComShare\left[\left(\frac{\Delta W}{1{,}000}\right) * CF_{Com} * ISR_{Com} * INTEF_{Com}\right]$$

Where:

kWh_{saved} = First-year electric energy savings

kW_{saved} = Summer peak electric demand savings

$NUMUNIT$ = Number of bulbs

$ResShare$ = Percentage of light bulbs installed in residential applications

$ComShare$ = Percentage of light bulbs installed in commercial applications

ΔW = Delta watts = Baseline wattage minus efficient lighting product wattage

HOU = Annual operating hours

ISR = In-service rate

$INTEF$ = Cooling and heating interactive effects

CF = Summer/winter peak coincidence factor

Res = Residential values

Com = Commercial values

Table 5-1 presents a summary of the savings assumptions used to calculate program gross energy and demand savings and specifies the sources of each input. Following the table, we detail the sources behind each input and rationale for the input selection.

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Table 5-1. Summary of Gross Savings Assumptions

Assumption[A]	Residential Savings Assumption	Commercial Savings Assumption	Residential Assumption Source	Commercial Assumption Source
Sales to residential/ commercial customers	0.823	0.10	• 2011 and 2012 DEP intercept surveys	
Leakage rate	0.077			
Delta watts	Baseline wattage – actual bulb wattage	Baseline wattage – actual bulb wattage	• Program-tracking data • 2015 Retailer Shelf Audit	
HOU	2.922	6.930 (CFLs) 5.783 (LEDs)	• 2012 DEP Residential Metering Study	• 2015 Commercial Lighting Logger Study
CF	Summer: 0.1138 Winter: 0.0960	Summer: 0.497 (CFLs) 0.547 (LEDs) Winter: 0.174 (CFLs) 0.120 (LEDs)		
Interactive effects	0.94 (Energy savings) 1.27 (Summer peak demand savings) 0.50 (Winter peak demand savings)	1	• 2012 DOE2 Simulation Models	• No interactive effects applied
First-year ISR and carryover savings	0.795 (CFLs) 0.744 (LEDs) 1.00 (Fixtures)	0.879 (CFLs) 0.979 (LEDs) 1.00 (Fixtures)	• 2013 General Population Survey (for CFLs and LEDs) • Assumed value (for fixtures) • 2014 Storage Log Study (for carryover savings trajectory)	

Source: Program-tracking data, prior evaluation reports, and Opinion Dynamics analysis.

[A] See Section 5.3 for references to the past evaluation studies.

Sales to Residential/Commercial Customers and Leakage Rate

Although the DEP EEL program targets retail channels, program-discounted lighting products are installed in both residential and non-residential settings. Due to higher operating hours, savings from the discounted lighting products installed in commercial settings are higher than residential savings. Furthermore, not all program bulbs are installed in homes where DEP provides electric service. The nature of the upstream program design makes it difficult to limit the purchase of program-discounted products to DEP customers only. As part of the previous evaluations (namely, 2011 and 2012 in-store intercept survey efforts), Navigant Consulting estimated the percentage of program sales to non-DEP customers and the commercial and residential sectors (see Figure 5-1). As part of the PY2015 evaluation, Opinion Dynamics explored purchases of lighting products by commercial customers as part of the store-level retailer interviews. However, store staff were either unable to provide an estimate or highly uncertain of the estimate that they provided. We therefore decided not to use the results from our interviews and rather to continue to use the results from the 2011 and 2012 intercept surveys.

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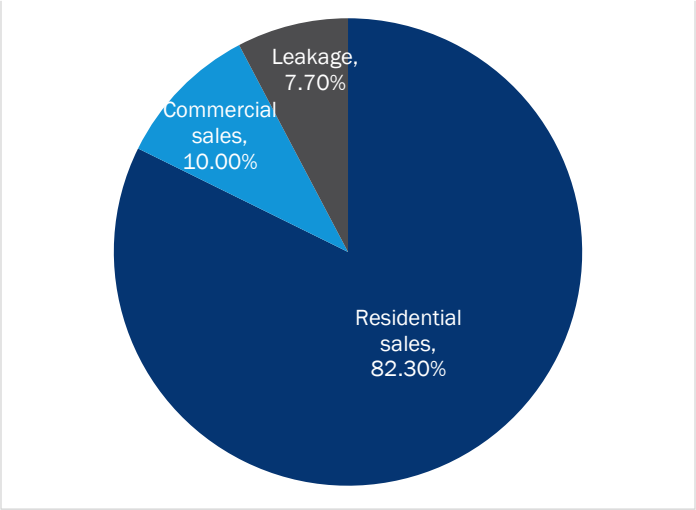
Figure 5-1. Cross-Customer and Cross-Service Area Sales Split



Source: Prior evaluation reports.

Delta Watts

We estimated delta watts by subtracting the actual bulb wattage from the baseline wattage estimates. To estimate the baseline wattages of the bulbs replaced by the program, the evaluation team used the lumen equivalency mapping approach. Through this approach, we developed a range of lumen bins, assigned each program-discounted product into one of the bins, and assigned a representative baseline wattage to each of the bins. We relied on the ENERGY STAR lumen bin categories specified in the ENERGY STAR Program Requirements Document, as well as EPA-recommended lumen ranges for the application of the 2007 Energy Independence and Security Act (EISA) adjustments.

EISA's provisions have slowly increased the efficiency requirements of general service incandescent light bulbs. The regulations were gradually phased in, affecting 100-watt incandescents in January 2012, 75-watt incandescents in January 2013, and 60-watt and 40-watt incandescents in January 2014. Manufacturers responded to EISA by developing a halogen bulb that meets the new requirements and uses fewer watts per lumen. These new "EISA-compliant" halogens will replace incandescents as the baseline for calculating program savings. Because manufacturers and retailers were allowed to sell through their existing inventory of incandescents, products did not immediately disappear from the market. Given the continued availability of incandescent bulbs, it is appropriate to use a baseline wattage that falls between the wattage of an incandescent and a halogen bulb based on market research.

The evaluation team used the results of the retailer shelf audit completed in 2015 to estimate baseline wattages. For each EISA-affected wattage category, Opinion Dynamics calculated the percentage of retailers that carried at least one incandescent product within each wattage category. If a retailer carried an incandescent product, we calculated the percentage of all products within the wattage category that were incandescents. Depending on the wattage, general service incandescents were present on the shelves of up to about a third (36%) of participating retailers. The shelf space dedicated to those products ranged from 8% to 15% of the wattage category.

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Table 5-2. Presence of EISA-Affected General Service Incandescent Products on Store Shelves

Equivalent Incandescent Wattage	% of Stores with Incandescent Products (n=15)	% of Products That Were Incandescents (n=6, n=3, n=8, n=8)
100-watt equivalents	36%	11%
75-watt equivalents	7%	15%
60-watt equivalents	36%	8%
40-watt equivalents	36%	15%

Source: 2015 Retailer Shelf Audit.

For each wattage, we developed an adjustment rate that is equal to the percentage of participating stores that stock incandescents. We weighted each participating store by its contribution to overall program sales. To develop adjusted baseline wattages, we calculated the delta watts between the incandescent and EISA baseline equivalent wattages, multiplied the resulting value by the respective adjustment rate, and added the result to the EISA baseline wattage. Equation 5-3 provides the formula we used to calculate adjusted baseline wattages.

Equation 5-3. Baseline Wattage Adjustment Formula

$$Adjusted\ Baseline\ Wattage = W_{EISA} + \left((W_{INC} - W_{EISA}) \times Adj\right)$$

Where:

W_{EISA}= EISA baseline wattage

W_{INC}= Incandescent baseline wattage

Adj= Adjustment rate

Table 5-3 provides the adjustment rates we used and the resulting adjusted baseline wattages. The table also contains baseline wattages used by the program team to estimate ex ante savings.

Table 5-3. Recommended Baseline Wattage Adjustments

Equivalent Incandescent Wattage	EISA Baseline Wattage	Adjustment Rate	Opinion Dynamics Adjusted Baseline Wattage	Baseline Wattages Used in Ex Ante Savings Calculations
100-watt equivalents	72	36%	82	79
75-watt equivalents	53	7%	54	67
60-watt equivalents	43	36%	49	57
40-watt equivalents	29	36%	33	38

To determine baseline wattages for flood lights and reflector bulbs and fixtures, we relied on the approach established by the Navigant Consulting team during its PY2013 evaluation of the DEP EEL program. Baselines were assigned based on a combination of the maximum allowable wattage and the available replacement bulbs and accounted for higher efficiency standards for these types of products that went into effect in July of 2012. We deemed this approach reasonable given the complexities associated with assigning baseline wattages to reflector products, which include a non-linear lumen-to-watt ratio, a variety of bulb shapes and sizes of varying efficacies, and the discrepancy between maximum allowable wattages and product availability on store shelves.

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Table 5-4. Baseline Wattage Assumptions for Reflector and Flood Light Products

Bulb Type	Lumen Range		Baseline Watts	Exemption Status
	Lower End	Upper End		
R, PAR, ER, BR, BPAR, or similar bulb shapes with medium screw bases with diameter > 2.5" (*see exceptions below)	600	739	50	
	740	849	50	
	850	999	55	
	1,000	1,300	65	
*ER30, BR30, BR40, ER40	400	449	40	Exempt
	450	499	45	Exempt
	500	1,419	65	Exempt
*R20	400	449	40	Exempt
	450	719	45	Exempt
*All reflector lamps below the lumen ranges specified above	200	299	30	
	300	399	40	

Source: Opinion Dynamics analysis and prior evaluation reports.

Hours of Use and Coincidence Factors

A light metering study is the industry standard method to estimate HOU and CF. As part of the previous evaluations, Navigant Consulting completed a metering study in 2012. As part of the study, Navigant Consulting developed estimates of HOU and CF in the residential sector. The study is relatively recent and DEP-specific, and we therefore used its HOU and CF estimates. Table 5-5 provides a summary of the residential HOU and CF assumptions that we used in our analysis.

Table 5-5. Residential HOU and CF Assumptions

Assumption Type	Assumption
HOU	2.9
Summer CF	0.1138
Winter CF	0.0960

Source: Opinion Dynamics analysis and prior evaluation reports.

The evaluation team derived commercial HOU and CF estimates from a recently completed commercial lighting logger study. As part of the study, Opinion Dynamics logged CFL and LED lighting in 79 commercial facilities across the DEP service territory over an 8-month period.[4] The overall average daily HOU estimate is 6.6 (±9.9% precision at the 90% confidence level). The average HOU for CFLs is 6.9 (±11.4% precision at the 90% confidence level) while the average for LEDs is 5.8 (±18.4% precision at the 90% confidence level). We also computed the summer and winter peak CF for CFLS, LEDs, and overall. Summer peak is defined as weekdays from 3 p.m. to 5 p.m. from June through August (not including weekends and holidays). Winter peak is defined as weekdays from 7 a.m. to 9 a.m. from December through February (not including weekends and holidays). The overall summer CF is 0.51 (±7.9% at the 90% confidence level) and the overall winter CF is 0.16 (±18.7% at the 90% confidence level) (Table 5-6).

[4] Opinion Dynamics placed loggers in 88 facilities. We removed loggers from 9 facilities during the data-cleaning process, which we discuss in detail in Appendix E.

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Table 5-6. Commercial HOU and CF Assumptions

Statistic	Overall	CFL	LED
HOU	6.6	6.9	5.8
Summer CF	0.51	0.50	0.55
Winter CF	0.16	0.17	0.12

Source: 2015 Commercial Light Logger Study.

Appendix E provides detailed information on the study design, analysis, and additional results.

Interactive Effects

The evaluation team chose to use residential HVAC system interaction factors of 0.94 for energy savings, 1.27 for summer peak demand savings, and 0.50 for winter peak demand savings. These interactive effects are consistent with the previous evaluation. Our review of the estimates determined that these factors were reasonable, relatively recent, and based on DEP-specific research. Consistent with the most recent evaluation, we chose to set commercial interactive effects to 1.0. In the absence of a reliable interactive effects estimate and a projected small impact of the lighting products on heat loss or gain given the nature of large commercial-scale HVAC systems in place in commercial settings, we believe that not applying interactive effects is appropriate and reasonable.

First-Year In-Service Rate and Carryover Savings

For residential installations, we used the first-year ISR estimated through the general population survey as part of the EEL PY2013 evaluation. The survey yielded an ISR of 79.5% for CFLs and 74.4% for LEDs.[5]

For commercial savings, we estimated a first-year installation rate using the results of the recently completed lighting logger study. As part of the logger deployment process, we completed a full inventory of all medium screw-based sockets within each business facility, including bulbs that were in storage. The ISR for a given bulb type is defined as the number of installed bulbs divided by the number of bulbs found within the facility (i.e., the number installed + the number in storage). Overall, we found that 91% of the medium screw-based lamps within the business facilities we visited were installed (with the remaining 9% in storage). The ISR was 98% for LEDs and 88% for CFLs. We surmise that the ISR is higher for LEDs because they are significantly more expensive than CFLs and, thus, customers are more likely to install them immediately (rather than letting them sit on the shelf). Until recently, LEDs were also less likely to be sold in multi-packs. For lighting fixtures, we used a first-year ISR of 100% for both residential and commercial. It is highly unlikely that customers who purchase lighting fixtures do not install them right away.

Table 5-7. In-Service Rate

Bulb Type	ISR	Std Error	Precision[A]
CFLs (n=73)	0.88	0.026	4.86%
LEDs (=35)	0.98	0.013	2.18%
Overall (n=87)	0.91	0.021	3.80%

Source: 2015 Commercial Lighting Logger Study.
[A] At 90% confidence level.

[5] Opinion Dynamics is currently conducting a residential HOU study. We will update the residential ISR as part of this study. The results will be used to evaluate EEL PY2016.

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Although the first-year ISR is less than 100% for both CFLs and LEDs, research studies across the country have found that customers eventually install nearly all bulbs received through a program. The two main approaches to claiming savings from these later installations are: (1) staggering the savings over time and claiming some in later program years and (2) claiming the savings from the expected installation in the program year the product was sold but discounting the saving by a societal or utility discount rate. While the "staggered" approach allows program administrators to more accurately capture the timing of the realized savings, the "discounted savings" approach allows for the simplicity of claiming all costs and benefits during the program year and eliminates the need to keep track of and claim savings from future installations.

The DEP EEL program previously relied on the staggered approach to claiming savings. Starting in PY2014, Opinion Dynamics changed the approach to the discounted savings approach. In PY2015, we are claiming savings from PY2015 sales that are installed in 2015, as well as those that customers will install in future years.

To allocate installations over time, we used the installation trajectory from the recently completed lighting storage log study conducted for DEP as part of the PY2013 EEL program. The DEP study estimates that participants install 97% of bulbs within 4 years of purchase. Table 5-8 presents the approach to developing installation rates over the 4 years following purchase based on the study.

Table 5-8. Installation Rate Trajectory

Year	Installation Rate Trajectory Formula
Year 1	First-Year ISR
Year 2	((1 – First-Year ISR) * 41%) + First-Year ISR)
Year 3	((1 – First-Year ISR) * 69%) + First-Year ISR)
Year 4	97%

Source: Opinion Dynamics analysis and prior evaluation reports.

To claim savings from future installations of PY2015 sales, we discounted any future savings by the utility discount rate using the net present value (NPV) formula (Equation 5-4). We used a DEP-specific discount rate for 2015 of 6.75%

Equation 5-4. Net Present Value Formula

$$NPV = \frac{R_t}{(1+i)^t}$$

Where:

R = savings

t = number of years in the future savings take place

i = discount rate

Table 5-9 provides a cumulative installation rate trajectory by bulb type and sector for PY2015.

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Table 5-9. Installation Rate Trajectory

Year	Residential[A]		Commercial[B]		Fixtures
	CFLs	LEDs	CFLs	LEDs	
Year 1	79.5%	74.4%	87.9%	97.9%	100.0%
Year 2	8.5%	10.6%	5.0%	0.0%	0.0%
Year 3	5.7%	7.2%	3.4%	0.0%	0.0%
Year 4	3.3%	4.8%	0.7%	0.0%	0.0%

[A] Source: Opinion Dynamics analysis.
[B] Source: Opinion Dynamics Lighting Logger Study.

5.2 Gross Impact Results

As a first step in the gross impact analysis, the evaluation team analyzed the PY2015 program sales data for any gaps, inconsistencies, and inaccuracies. As part of the analysis, we performed the following steps:

- Checked the core data fields for missing values
- Checked the data for temporal gaps (due to missing invoices, transactions, or other data gaps) by exploring reasonable variation in monthly invoiced sales
- Analyzed package and rebate information for outliers and unreasonable values
- Verified consistency of bulb type classification across measure type and detailed measure description data fields
- Cross-checked wattages (actual and baseline), lumen output, and detailed measure description data fields for consistency and accuracy

We found that data fields were generally clean and fully populated. Opinion Dynamics did not identify any observable gaps in transactions over time. Rebates by product type were reasonable, and so were package sizes given technology (e.g., no large multi-packs for LEDs or specialty CFLs).

Opinion Dynamics identified and corrected slight inconsistencies in bulb categorizations, bulb wattage, and lumen assignments. None of those inconsistencies was considerable nor resulted in a significant difference in savings.

Our gross impact analysis also included the following assessments of the claimed/ex ante savings methods:

- Accurate application of evaluation-recommended baseline wattages
- Accurate application of evaluation-recommended adjustments to **residential** sales and savings assumptions, such as leakage rate, ISR, HOU, interactive effects, and CF
- Accurate application of evaluation-recommended adjustments to **commercial** sales and savings assumptions, such as leakage rate, ISR, HOU, interactive effects, and CF
- Accurate application of accounting of savings from future installations

Overall, we found that the program applied ex ante savings correctly. Several minor inconsistencies include bulb type classifications and applying different HOU estimates than prescribed for outdoor fixtures. Overall,

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claimed/ex ante program savings (both residential and commercial) were 2% higher than what they would have been with the correct application of savings assumptions; summer peak demand savings were 1% higher, and winter peak demand savings were 6% higher. Appendix D provides a comparative overview of the PY2015 recommended savings assumptions, claimed/ex ante savings assumptions, and evaluated/ex post savings assumptions.

Using the equations and inputs discussed in Section 5.1, we calculated gross energy and peak demand savings achieved by the program during PY2015. Table 5-10 presents the results of the analysis.

In PY2015, the program achieved 239,702 MWh in claimed energy savings, 37.5 MW in summer peak demand savings, and 26.5 MW in winter peak demand savings. The respective gross realization rates are 73% for energy savings, 75% for summer peak demand savings, and 34% for winter peak demand savings.

Table 5-10. Gross Impact Results – Energy Savings

Savings Type	Savings Category	Claimed/Ex Ante Savings	Evaluated/Ex Post Savings	Gross Realization Rate
Energy savings (MWh)	Residential savings	131,880	112,171	73%
	Commercial savings	63,443	37,363	
	Carryover savings from PY2013 and PY2014	44,378	–	
	Future savings from 2015	–	25,145	
	Total	**239,702**	**174,679**	**73%**
Summer peak demand savings (MW)	Residential savings	18.8	16.2	75%
	Commercial savings	13.0	8.2	
	Carryover savings from PY2013 and PY2014	5.7	–	
	Future savings from 2015	–	3.7	
	Total	**37.5**	**28.1**	**75%**
Winter peak demand savings (MW)	Residential savings	6.5	5.4	34%
	Commercial savings	10.8	2.4	
	Carryover savings from PY2013 and PY2014	9.2	–	
	Future savings from 2015	–	1.2	
	Total	**26.5**	**9.0**	**34%**

Source: Program-tracking data and Opinion Dynamics analysis.

Key drivers behind the energy savings realization rates include:

- Lower baseline wattage used in the calculation of the evaluated/ex post savings resulted in a 14% decrease in the gross realization rate
- Lower HOU on the commercial side resulted in a 4% decrease in the gross realization rate
- Higher ISR on the commercial side resulted in a 2% increase in the gross realization rate
- Removing already claimed carryover savings contributed to a 17% decrease in the gross realization rate
- Savings from future installations resulted in a 10% higher gross realization rate

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Key drivers behind the summer peak demand savings realization rate include:

- Lower baseline wattage used in the calculation of the evaluated/ex post savings resulted in about a 14% decrease in the gross realization rate
- Correcting for some application of interactive effects resulted in a 2% increase in the gross realization rate
- Higher ISR on the commercial side resulted in a 2% increase in the gross realization rate
- Lower summer CF on the commercial side resulted in a 2% decrease in the gross realization rate
- Removing already claimed carryover savings resulted in a 14% lower gross realization rate
- Savings from future installations resulted in 10% higher gross realization rate

Key drivers behind the winter peak demand savings realization rate include:

- Lower baseline wattage used in the calculation of the evaluated/ex post savings resulted in about a 14% decrease in the gross realization rate
- Correcting for some application of interactive effects resulted in a 2% increase in the gross realization rate
- Higher ISR on the commercial side resulted in a 2% increase in the gross realization rate
- Removing already claimed carryover savings resulted in a 18% lower gross realization rate
- Savings from future installations resulted in a 5% higher gross realization rate

5.3 References

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6. Net-to-Gross Analysis

This section describes our approach for estimating the NTG ratio for the EEL program and presents the resulting NTG ratios and the program net impacts.

6.1 Methodology

The NTG ratio represents the portion of the gross energy savings associated with a program-supported measure or behavior change that would not have been realized in the absence of the program. In other words, the NTG ratio represents the share of gross savings that are attributable to the program. The NTG ratio consists of free-ridership (FR) and spillover (SO) and is calculated as $(1 - FR + SO)$. FR is the proportion of the program-achieved verified gross savings that would have been realized absent the program. SO is additional energy-saving actions that are influenced by program interventions but did not receive program support. Sales data modeling only produces an estimate of FR.

The assessment of NTG for upstream residential lighting programs, like the DEP EEL program, is extremely challenging due to the following key reasons.

- Because customers purchase discounted bulbs in a retail setting where they do not need to provide contact information, we lack a representative list of customers who purchased discounted bulbs through the program. Light bulbs are a low-cost commodity product. Customers tend to not give much consideration to or have a good recall of these purchases. Many customers are unaware that they purchased discounted bulbs, so it would not be possible for them to answer these questions. Therefore, we cannot survey a sample of customers and ask them about past light bulb purchases and what they would have purchased in the absence of the program.[6]
- Program interventions may affect manufacturer distribution and retailer stocking practices, resulting in shelf space changes. Those changes are not visible to participants and therefore call for research with a range of market actors and, ultimately, triangulation of NTG estimates from multiple sources.
- Although we have detailed data regarding sales for the bulbs associated with the program, we lack any information about sales of other bulbs at participating retailers (including sales of less efficient products and non-discounted energy efficient products). Thus, while we can successfully model the relationship between bulb price and sales for the products associated with the program, we cannot take into consideration how other factors (e.g., discounts of non-program bulbs) may have affected our results.

The sales data modeling approach to estimating NTG is based on the simple economic principle that a change in price generates a change in product sales. The sales data modeling method relies on the program sales data, models the relationship between the product price and sales, and develops price elasticity curves to predict sales at various prices, namely, program and non-program price levels.

For the modeling effort to succeed, there must be sufficient variation in pricing of the same product during the program year. As such, as the first step in our analysis, we obtained and processed program sales data for

[6] With the certain stores placing program discounted products in prominent places in the store and deploying program marketing materials, customers can certainly recall purchasing program-discounted products, especially if the evaluation survey were to be conducted soon after product purchase. However, the key challenge is finding those customers, whose incidence is likely quite low at any given time, thus requiring large sample sizes and extensive calling hour or other survey outreach.

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PY2015 and ran preliminary analyses to establish whether there was sufficient variation in pricing. Based on the results of our analysis, we deemed the variation sufficient for this modeling effort.

The sales data we received for PY2015 contained transaction-level sales summaries. Depending on the retailer, transaction periods ranged from a week to a month, though most (77%) were weekly. To ensure time-series consistency and to maximize the chance of seeing an effect of in-store events on bulb sales, we normalized transaction periods to a weekly level. In instances where transactions were available only at the monthly level, the sales were split evenly across weeks of the month. We also performed additional cleaning and preparation of the data, such as standardizing pricing and bulb quantity data.

To reach our final estimate of price elasticity for CFLs and LEDs, we fit a series of theoretically driven models to the data. These analyses fell into two categories: (1) models that included bulb characteristics (e.g., lumens) and interactions between bulb characteristics and price as factors predicting bulb sales and (2) models that included individual products' unique model numbers as dummy-coded variables as predictors of bulb sales. In both cases, we examined a number of diagnostics to assess the models' performance in terms of efficiency, omitted variables, and heteroscedasticity of residuals.[7] We also considered model fit indices, favoring models with larger R-squared value[8] and lower Akaike's Information Criterion (AIC) value[9] relative to other models.

For both CFLs and LEDs, the model that included each product's unique model number (i.e., product SKU) emerged as the best performing. Equation 6-1 contains the final sales data model specification.

Equation 6-1. Final Sales Data Model Specification

$$ln(Q_m) = \alpha + \beta_1 ln(P_m) + \sum_{\mu} (\beta_\mu model\ dummy_m)$$

Where:

m = model

ln = natural log

Q = quantity of bulbs sold

P = price per bulb[10]

model dummy = a vector of dummy variables equaling 1 for each unique model number, and 0 for all others

β_1 = coefficient representing average price elasticity

[7] Heteroscedasticity is a statistical term that describes errors in prediction that vary in size across different values of a predictor. One of the assumptions of the ordinary least squares regression is that the errors are homoscedastic (that the variance around the regression line is the same for all values of a predictor variable), so when they are heteroscedastic, an assumption of the method is violated.

[8] R-squared value is a summary statistic for many regression techniques. It shows the proportion of the total variance in the outcome variable that is correctly predicted by the model's predictor variables.

[9] AIC is a summary statistic that is based on how well the outcome variable is predicted given the number of predictor variables in the regression model. The AIC value has no inherent meaning except in comparison to the values on the same statistic produced by alternative models under consideration. Modelers seek to minimize the AIC value, along with other ways of judging the models.

[10] We received two discounted prices in the data set: one that reflects discounted price after program discounts and one that reflects discounted price after program discounts and any other retailer-specific discounts. We used the pricing that included both sets of discounts for this analysis. However, it is important to note that the correlation between these two prices is very high (r = 0.97) and thus selection of one discount price or the other would not have a substantial effect on the pattern of results observed.

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β_μ = a vector of coefficients representing each unique model number (*m*)

α = constant

Using the modeled results, the evaluation team estimated sales at non-discounted prices using Equation 6-2. We estimated sales of CFLs and LEDs separately. We used MSRP data supplied as part of the program sales data extract for estimates of non-discounted prices.

Equation 6-2. Estimating Sales at Non-Discounted Prices

$$\widehat{Sales}_{wo} = Sales_w * \left(\frac{Price_{wo}}{Price_w}\right)^{PC}$$

Where:

$\widehat{Sales}_{wo}$ = Estimated sales without discount (MSRP)

$Sales_w$ = Sales with discount (actual sales)

$Price_{wo}$ = Price without discount (MSRP)

$Price_w$ = Price with discount (actual price)

PC = Price coefficient

Although the final estimates of NTG reported here are representative of the entire population of sales data, a handful of data points were excluded from the modeling process. Specifically, we excluded fixture sales due to the varied nature of the products. That is, program-discounted fixtures include such products as reflector retrofit kits, flush mount ceiling fixtures, and desk lamps. The reflector retrofit kits are similar to a bulb purchase, whereas others are a different product category and thus consumer decision making is likely different. We also excluded sales from online store TechniArt because this retailer is geared toward a fairly niche market.[11] For both sales of fixtures and sales through TechniArt, we applied the NTG calculated from the models. We also excluded sales data from discount stores from the modeling. Rather than applying the model NTG to these sales, we applied a NTG of 1.0: If it were not for the program, none of the bulb sales in those retail locations would have occurred and therefore all sales should be attributed to the program.

We developed NTG ratios by comparing the predicted sales at non-discounted prices to the actual sales at program-discounted prices using Equation 6-3 below.

Equation 6-3. Sales Data Modeling NTG Estimation Formula

$$NTG\ Ratio = \frac{\widehat{Sales}_{wo} - Sales_w}{Sales_w} = \frac{NetSales}{DiscountedSales}$$

Where:

$NTG\ Ratio$ = NTG ratio (excluding any SO)

$\widehat{Sales}_{wo}$= Estimated sales without discount (MSRP)

$Sales_w$= Sales with discount

[11] Fixture sales accounted for 6% of all sales while Techniart.com sales accounted for just 0.11% of total sales.

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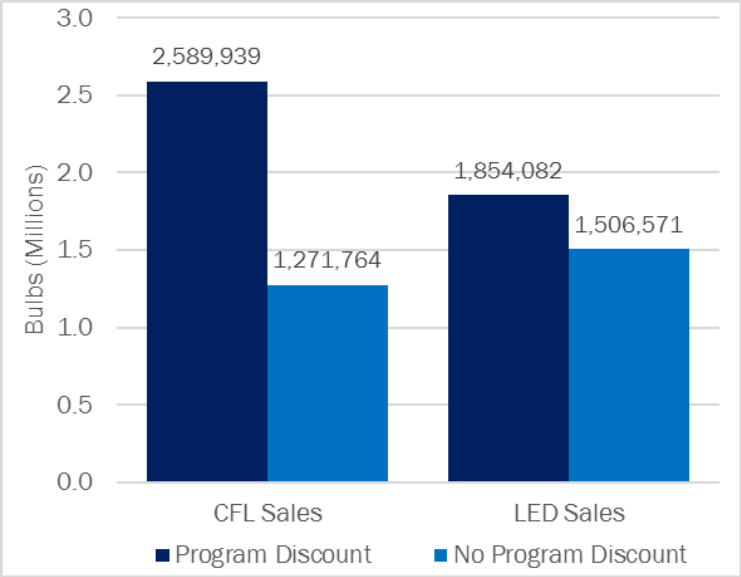
Appendix F of this report contains final model outputs.

6.2 Net-to-Gross Results

Using the results from the sales data model, Opinion Dynamics estimated total sales at program-discounted and non-discounted prices, separately for CFLs and LEDs. Figure 6-1 provides a summary of the predicted sales by technology.

Figure 6-1. Predicted Bulb Sales with and without Program Discount



Source: Sales data modeling analysis.

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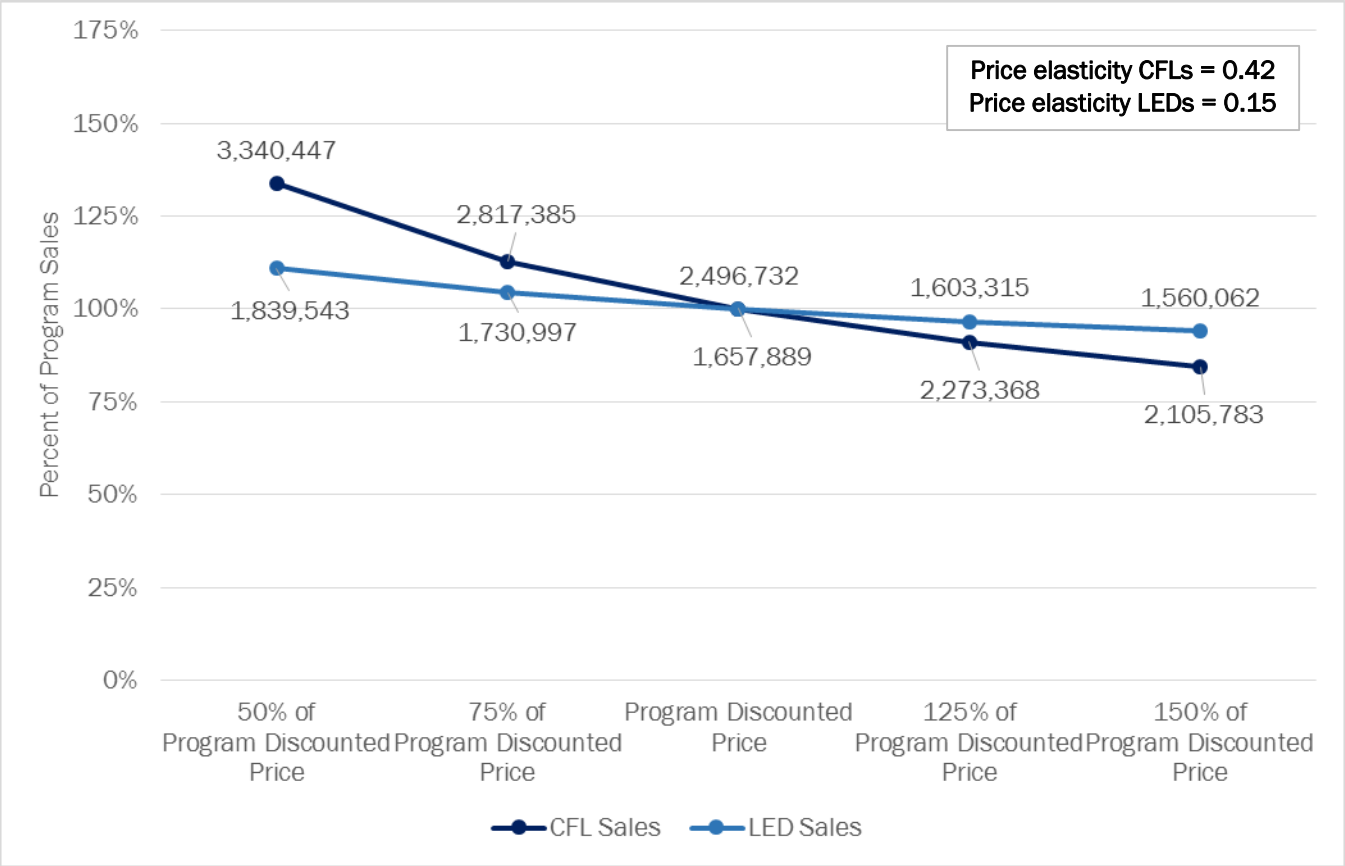
We used the modeling results to estimate price elasticities for both CFLs and LEDs. The elasticity curves show low to moderate sensitivity to changes in price. CFLs exhibited greater sensitivity to price changes than LEDs. As can be seen in Figure 6-2, LED price elasticity is 0.15 and CFL elasticity is 0.42. A price elasticity of 0.15 for LEDs means that for every 10% increase in price, there is a 1.5% decrease in sales. Similarly, a price elasticity of 0.42 for CFLs means that for every 10% increase in price there is a 4.2% decrease in sales.

Figure 6-2. Modeled Price Elasticity for CFLs and LED



Source: Sales data modeling analysis.

Figure 6-2 also displays the estimated program sales at each discount level based on the model results. We estimated separate NTG ratios for CFLs and LEDs using the sales predictions. To arrive at the program-level NTG ratio, we weighted the CFL and LED values by program sales. The technology-specific NTG ratios and the weighted combinations are shown in Table 6-1. Sales data modeling was based on the entire sales data rather than a sample of the program sales records. Because no sampling was used, the concept of sampling error does not apply, so there is no estimate of precision for the resulting NTG estimate.

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Table 6-1. NTG Ratios by Technology

Bulb Type	% of Total Program Bulb Sales	NTG Ratio	Weighted Combined NTG Ratio
CFLs	58%	0.51	0.38
LEDs	42%	0.19	

Source: Sales data modeling analysis.

The sales model estimated a modest decline in CFL and LED bulb sales at non-program pricing. Nearly two-thirds of program sales would have occurred regardless of the program discounts. The larger price elasticity for CFLs than LEDs could represent a shift in the market toward LEDs. With two efficient products available for purchase, a larger discount may be needed for consumers to select CFLs over LEDs, particularly when the program is discounting both products. The larger NTG ratio for CFLs over LEDs is not a sign that the program should slow its shift to LEDs. However, the low NTG ratio for LEDs suggests that price plays a smaller role in customers' decision to purchase this product. LEDs have become less expensive in their own right, and if seen as a superior product, there may be less of a need for a price discount to convince consumers to purchase LEDs.

6.3 Net Savings

We applied the program-level NTG ratio to the evaluated/ex post gross energy savings to arrive at the evaluated/ex post net energy savings (Table 6-2). Program net energy savings in PY2015 were 66,378 MWh, net summer peak demand savings were 10.7 MW, and net winter peak demand savings were 3.4 MW.

Table 6-2. Evaluated/Ex-Post Net Savings

Savings Type	Evaluated/ Ex Post Gross Savings	NTG Ratio	Evaluated/ Ex Post Net Savings	Claimed/ Ex Ante Net Savings[A]	Net Realization Rate[B]
Energy savings (MWh)	174,679	0.38	66,378	146,364	45%
Summer peak demand savings (MW)	28.1	0.38	10.7	28.2	38%
Winter peak demand savings (MW)	9.0	0.38	3.4	9.2	37%

Source: Program-tracking data and Opinion Dynamics analysis.
[A] The source of ex ante net savings is program-tracking data extract.
[B] Denominator is ex ante net savings.

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7. Process Evaluation and Lighting Market Assessment

Opinion Dynamics relied on the following data collection and analytic activities to support evaluation of program processes and characterization of the lighting market in the DEP service territory.

- Program staff interviews (n=2)
- Materials review
- Program-tracking data analysis
- Commercial lighting logger study (n=88)
- Retailer shelf audit (n=20)

We provide a detailed overview of each data collection method, as well as targeted and achieved confidence and precision levels in Section 4 of this report.

As part of the process evaluation specifically, Opinion Dynamics examined the following key performance indicators:

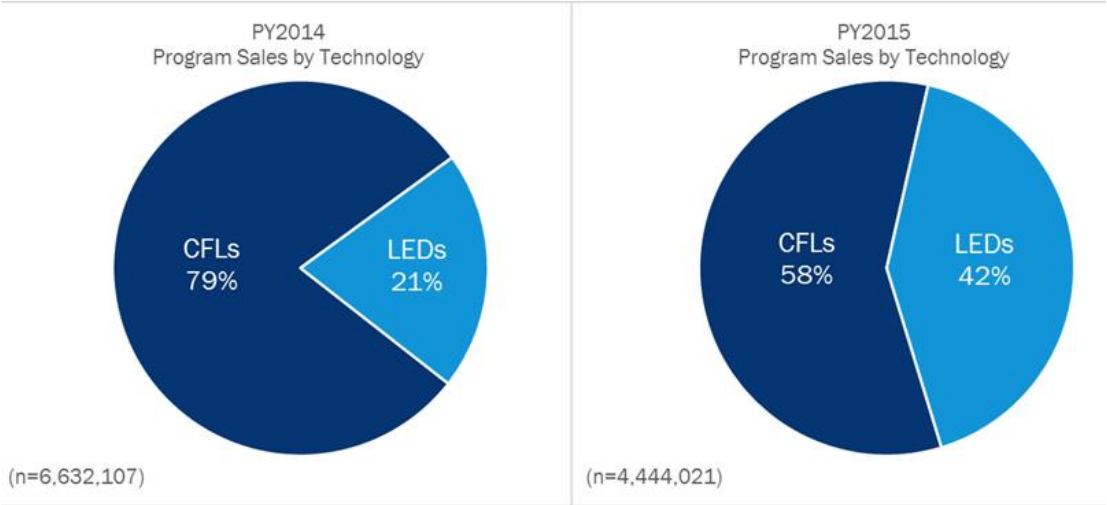
- Presence of program marketing at participating stores

7.1 Results

Program Participating Product Mix

The DEP EEL program sold 4,444,021 bulbs and fixtures in PY2015, which included 2,589,829 CFLs and CFL fixtures and 1,854,192 LEDs and LED fixtures. While overall bulb sales decreased from PY2014 to PY2015, sales of LED products continued to increase. In PY2015, LED sales accounted for twice the portion of program sales than they did in PY2014 (42% compared to 21%) as shown by Figure 7-1.

Figure 7-1. Changes in Bulb Technology Shares



Source: Program-tracking data.

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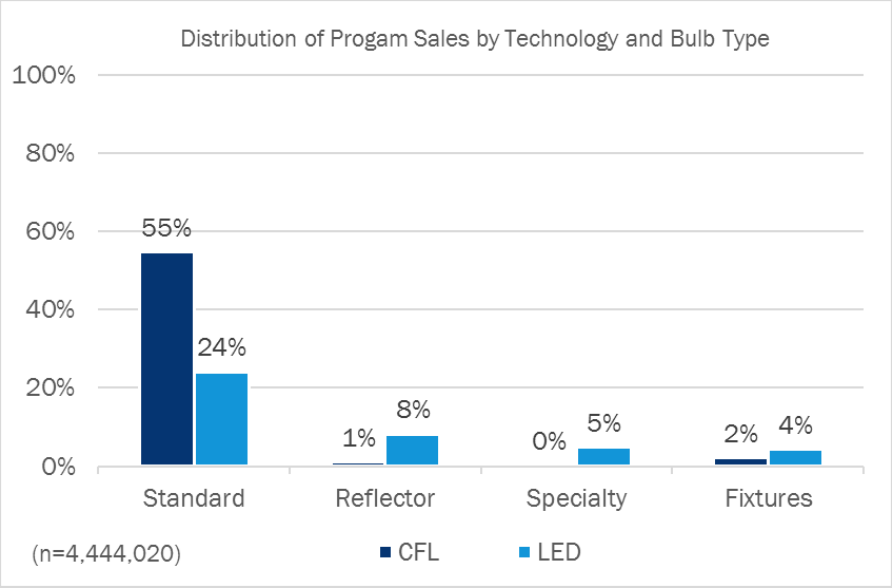
Standard lighting products accounted for the large majority of all program sales (79%), with standard CFLs making up more than half of all PY2015 sales (55%). While specialty and reflector bulbs made up only 2% of CFL sales, they accounted for more than 30% of LED sales. ENERGY STAR fixtures represented 6% of sales (Figure 7-2).

Figure 7-2. Program Participating Product Mix



Source: Program-tracking data.

The DEP EEL program discounted 573 different lighting products across a range of pack sizes and wattages. Figure 7-3 provides a breakdown of program sales by pack size. As can be seen in the figure, standard CFLs were sold in larger pack sizes, whereas reflector and specialty CFLs and LEDs were sold in smaller packs. For standard CFLs, 4-packs were most common, representing 53% of sales. Larger packs of standard CFLs were also common, with packs of six or more making up 30% of standard CFL sales. LEDs of all types were most often sold in 1-packs. Only six participating retailers sold packs of more than four bulbs, which program staff point to as a potential partial explanation for the decrease in overall sales through the program in PY2015 (over 4.4 million bulbs) from PY2014 (over 6.6 million bulbs).

Figure 7-3. Product Sales by Package Type

Distribution of Program Sales Across Pack Sizes by Technology

	1	2	3	4	5	6	7+	Total
Standard CFLs (n=503,901)	4%	8%	5%	53%	7%	17%	6%	100%
Standard LEDs (n=831,348)	85%	5%	7%	3%	0%	0%	0%	100%
Reflector and Specialty CFLs (n=29,327)	35%	46%	4%	6%	8%	0%	0%	100%
Reflector and Specialty LEDs (n=425,618)	74%	15%	9%	1%	0%	0%	0%	100%

Source: Program-tracking data.

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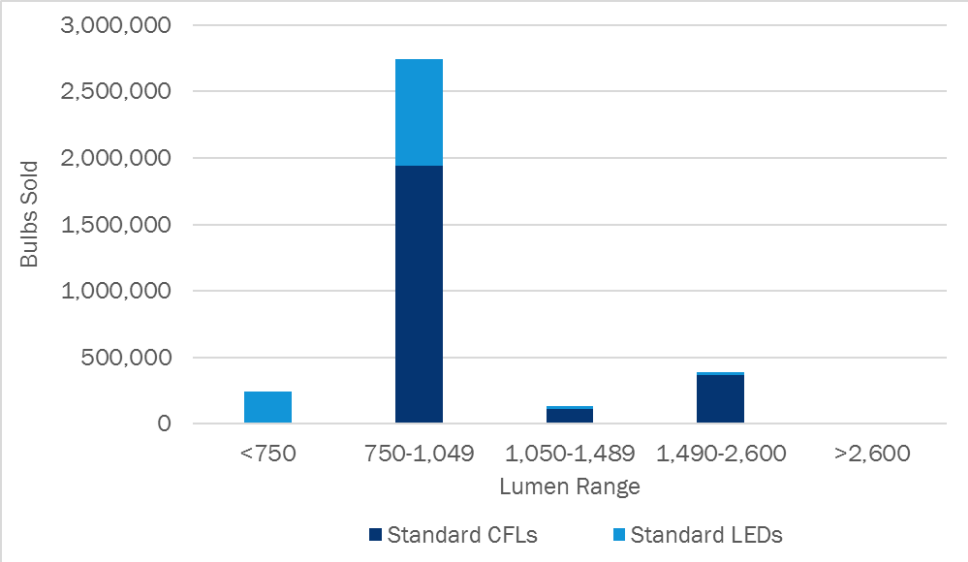
The product mix discounted through the program included a wide range of wattages and lumens. The most common standard CFL and LED wattages are 60-watt incandescent equivalents (750–1,049 lumens) accounting for 80% of standard CFLs and 75% of standard LED sales.

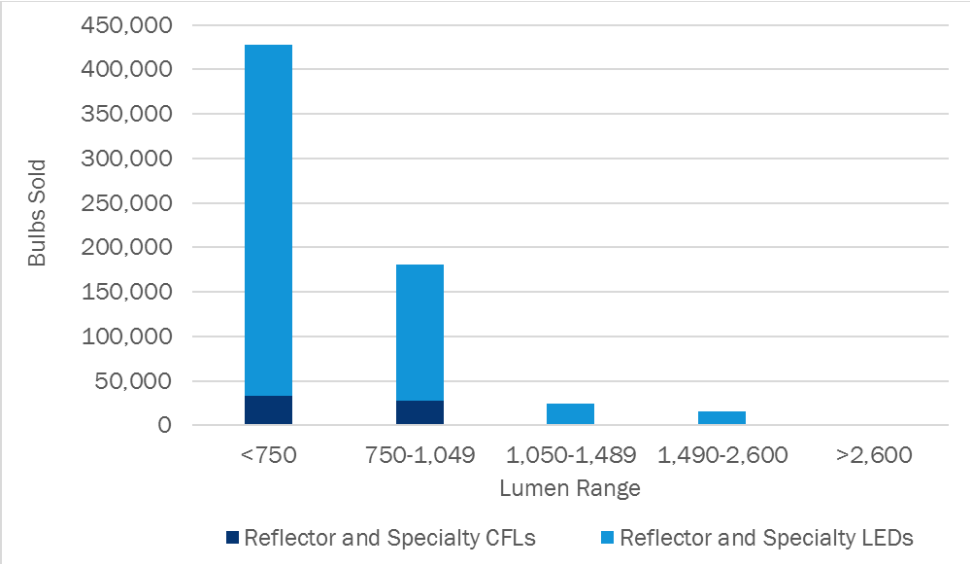
Figure 7-4. Program-Discounted Wattages for Standard Products



Source: Program-tracking data.

Most reflector and specialty CFLs and LEDs were in the lower lumen range (under 1,049). Approximately 66% fell below 750 lumens.

Figure 7-5. Program-Discounted Wattages for Reflector and Specialty Products



Source: Program-tracking data.

Average program discounts ranged from $1.27 for standard CFLs to $10.03 for CFL fixtures. The average program discount across all product categories was $3.33. LED discounts were much higher than CFL discounts as a result of the technology being newer and generally more expensive. Average LED discounts

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ranged from $4.52 for specialty LEDs to $9.58 for LED fixtures. Although LEDs generally received larger discounts than CFLs, CFL fixtures received the highest discount of any product category at $10.03. Average program discounts ranged from 42% to 70% of MSRPs by product type. Table 7-1 provides a detailed overview of the program discounts by product type in PY2015.

Table 7-1. Program Bulb Discounts and Pricing

Product Type	Minimum Discount	Maximum Discount	Average Discount	Discount as Average % of MSRP	Average MSRP
Standard CFLs	$0.50	$3.00	$1.27	42%	$2.19
Specialty CFLs	$1.25	$3.50	$1.49	70%	$4.95
Reflector CFLs	$1.17	$3.15	$1.41	69%	$4.55
CFL fixtures	$10.00	$12.00	$10.03	45%	$18.39
Standard LEDs	$1.00	$10.00	$5.07	48%	$9.84
Specialty LEDs	$1.33	$10.00	$4.52	51%	$9.15
Reflector LEDs	$1.50	$12.00	$6.50	56%	$14.82
LED fixtures	$3.00	$10.00	$9.58	58%	$22.85
Total	**$1.06**	**$6.28**	**$3.33**	**46%**	**$6.71**

Source: Program-tracking data.

As compared to PY2014, program discounts decreased in PY2015 across all product categories. Average per-bulb discount however is higher in PY2015 as compared to PY2014, primarily due to a considerable shift of the program sales from CFLs to LEDs, for which program discounts are considerably higher. Changes in the pricing of program-discounted products between PY2014 and PY2015, however, is mixed, with reported MSRP increasing for CFLs and specialty LEDs, and decreasing for all other product categories (see Table 7-2 below). Interestingly, average MSRP for standard LEDs dropped only slightly from $10.58 in PY2014 to $9.84 in PY2015. This is different than the results of the shelf stocking survey described later in this section which shows considerable changes in non-discounted LED bulb pricing.

Table 7-2. Year-Over-Year Pricing and Discount Comparisons

Product Type	Average Per-Bulb Discount			Average Per-Bulb MSRP		
	PY2015	PY2014	Difference	PY2015	PY2014	Difference
Standard CFLs	$1.27	$1.44	-$0.17	$2.19	$2.08	$0.11
Specialty CFLs	$1.49	$1.78	-$0.29	$4.95	$4.68	$0.27
Reflector CFLs	$1.41	$2.05	-$0.64	$4.55	$4.36	$0.19
CFL fixtures	$10.03	$10.68	-$0.65	$18.39	$22.23	-$3.84
Standard LEDs	$5.07	$5.80	-$0.73	$9.84	$10.58	-$0.74
Specialty LEDs	$4.52	$4.94	-$0.42	$9.15	$7.49	$1.66
Reflector LEDs	$6.50	$7.59	-$1.09	$14.82	$17.53	-$2.71
LED fixtures	$9.58	$9.62	-$0.04	$22.85	$25.48	-$2.63
Total	**$3.33**	**$2.51**	**$0.82**	**$6.71**	**$4.42**	**$2.29**

Source: Program-tracking data.

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Program Retailer Mix

Similar to previous program years, the retailer mix in PY2015 included a range of retailer channels. Specifically, the program engaged 22 unique retailers across 269 storefronts. The number of storefronts participating in the program in PY2015 decreased somewhat from 381 in PY2014 (29% decrease). Club stores, DIY stores, and Big Box stores cumulatively captured 74% of program sales (Table 7-3).

Table 7-3. Participating Retailer Mix

Retailer Channel	Retailers	Storefronts	% of Measures Sold
Club store	3	12	31%
DIY	2	39	26%
Big box	2	57	17%
Discount	3	98	18%
Hardware	4	46	7%
Grocery	6	15	0%
Other	2	2	1%
Total	**22**	**269**	**100%**

Source: Program-tracking data.

Program administrators must balance providing all customers with easy access to the program with minimizing sales to non-DEP customers who live near stores participating in the DEP program (i.e., leakage). The program maintained good coverage of the DEP service territory in PY2015, ensuring equitable customer access to discounted products. Figure 7-6 displays customer access to participating retailers by census block group across DEP territory. Residents of 18% of census block groups had somewhat limited access to participating stores in PY2015 compared to 12% in PY2014. The only one sizable gap in coverage was on the eastern side of DEP's service territory.

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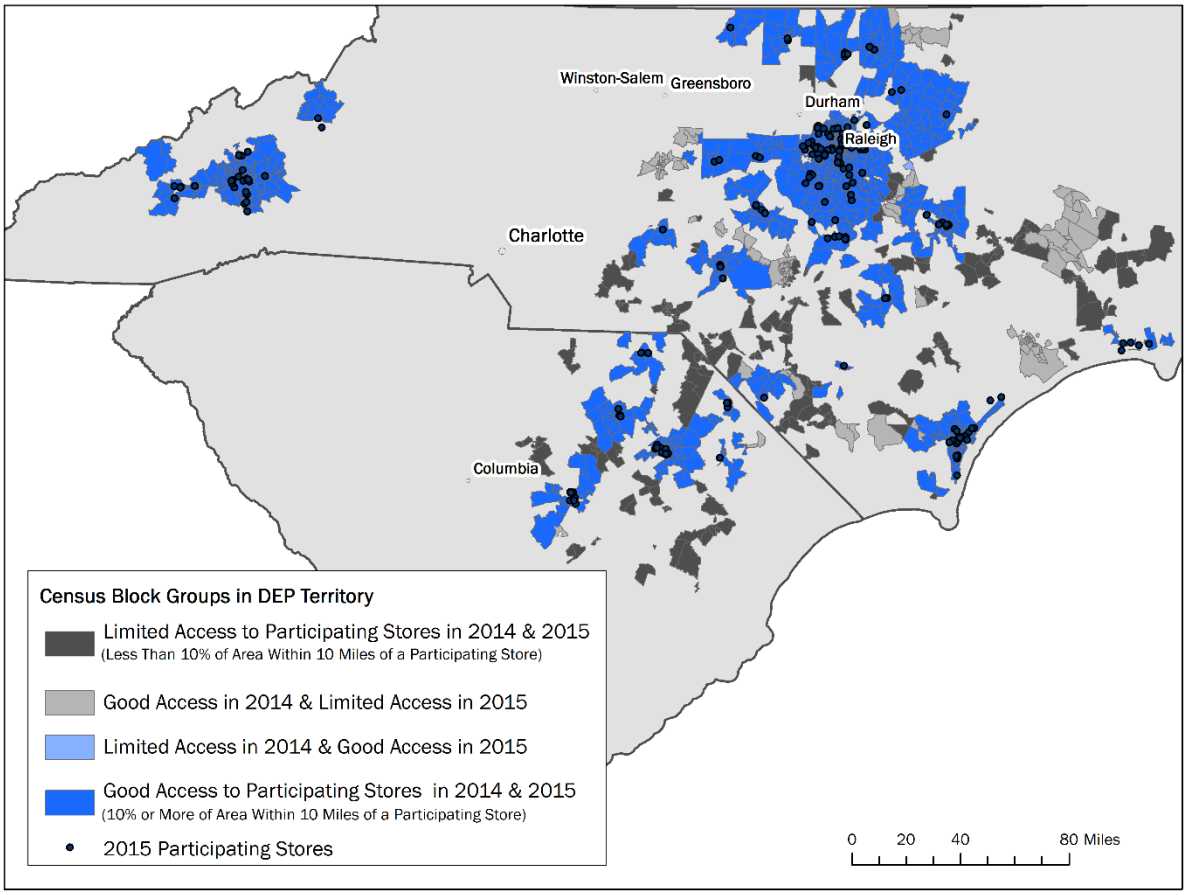
Figure 7-6. Participating Retailer Coverage of the DEP Service Territory



Source: Program-tracking data.

Program Marketing and Outreach

Over the course of PY2015, the DEP EEL program relied on a range of marketing and outreach tactics.

- **In-store events and special promotions.** In conjunction with DEP marketing, Ecova performed a total of 161 in-store events and demonstrations in PY2015 across 35 unique storefronts, with an average of 13 events per month. Ecova held the events at storefronts that were top-sellers for the program. The 35 unique storefronts where events were held accounted for a total of 35% of program sales in PY2015. During these events, Ecova field staff promoted program products and discounts and educated customers about the benefits of energy-efficient lighting products. Five of these events were designated big events at large DIY stores (three locations in May and two in October). These big events were preceded by direct mail and email marketing campaigns and featured special discounts and a prize wheel with giveaways, drawing large crowds. The program also ran a 10-day special online offer, which was accompanied by an email blast.
- **Store visits and POP marketing material placement.** Over the course of the year, Ecova completed a total of 2,635 store visits, during which field staff checked for the presence and proper placement of program POP materials, updated materials as necessary, and checked for sufficient levels of inventory of program-discounted lighting products. The frequency of store visits varied by retailer based on sales

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volumes. This enabled team members to concentrate their visits on stores that have higher sales volumes and also tended to discount more products.

- **Community events.** Over the course of the program year, Ecova completed a total of 14 community events in which the program field representatives visited community centers to provide educational materials.
- **Direct mail, mass media, and other marketing.** Other sources of program marketing in PY2015 included targeted bill inserts, direct mailers, email blasts, web promos, radio spots, and billboards.
- **POP marketing material presence.** Evaluators verified the presence of POP marketing materials as part of their visits to 15 participating retailers. POP marketing materials were present at all but one location, but only two of the stores had more than one type of marketing material present. Shelf wobblers were the most common type of marketing material, found at 9 of the 15 retailers, and several other locations had special pricing stickers or "Was…Now" price tags.

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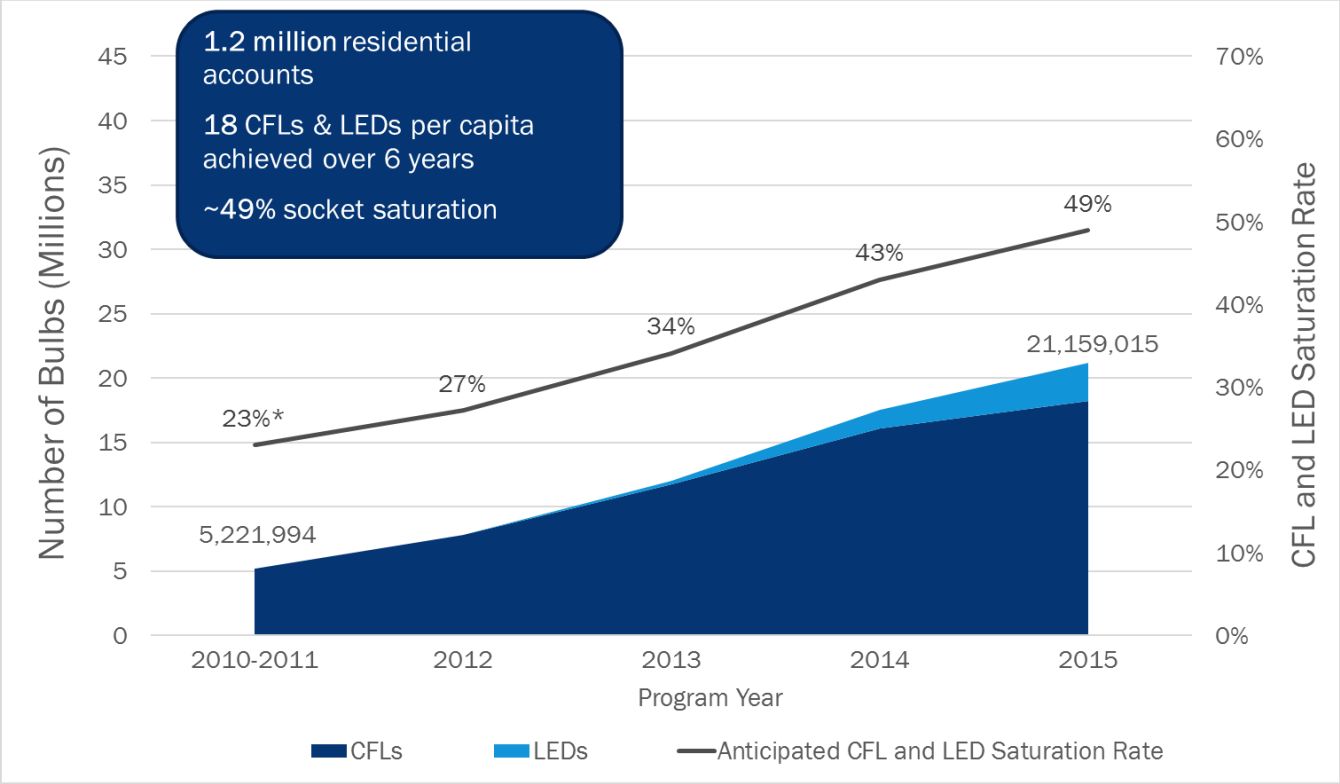
Program Impact in the DEP Service Territory and Market Trends

The DEP EEL program has had a large impact on efficient bulb use. Between 2010 and 2015, the program sold more than 21 million lighting products to DEP residential customers.[12] If the 1.2 million DEP residential customers equally purchased these bulbs, each would have purchased 18 bulbs. We estimate that the program has had a large impact on efficient bulb saturation. At the end of 2011, 23% of standard sockets contained an efficient bulb (PY2010–PY2011 Navigant Consulting Evaluation Report).[13] Given the number of CFLs and LEDs sold through the program between 2012 and 2015 and an estimated 53 standard sockets in the average home, efficient bulb saturation would be at around 49% at the end of 2015 (see Figure 7-7).[14]

Figure 7-7. DEP EEL Program Impact on Efficient Bulb Saturation



*PY2010-PY2011 Navigant Evaluation Report

Source: Program-tracking data and previous evaluation reports.

[12] This number has been adjusted to remove bulbs that were estimated to be leaking out of the DEP service territory, as well as bulbs that were sold to commercial customers.

[13] This saturation estimate is based on the in-home lighting audits of 100 homes and more than 5,000 sockets.

[14] Note that this saturation estimate assumes that all sold bulbs are installed.

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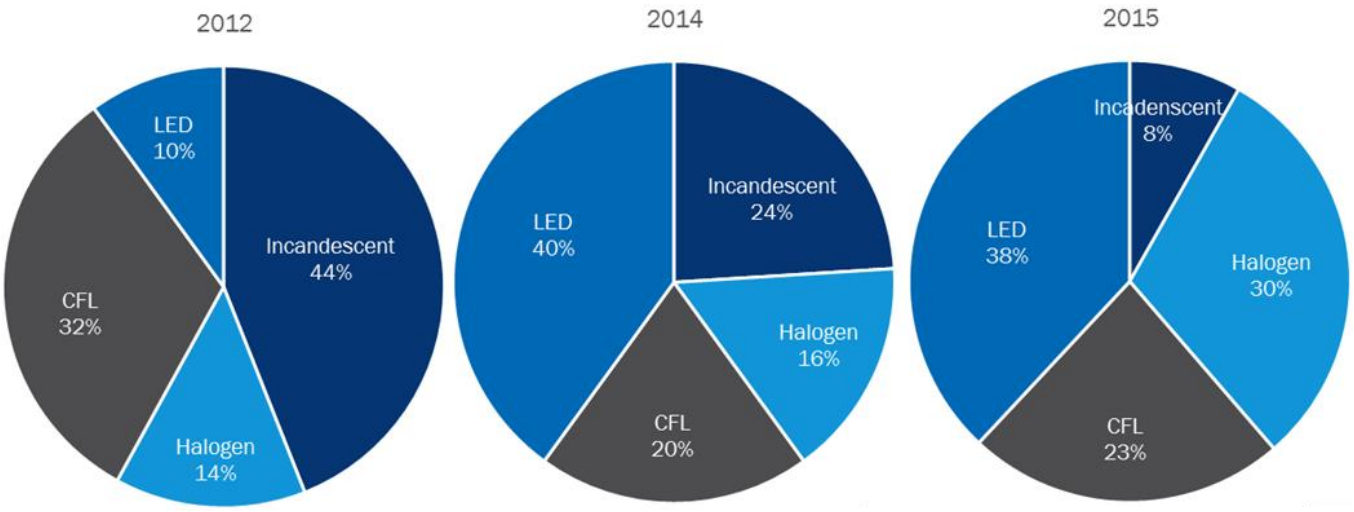
Retailers have dramatically changed the lighting products that they stock over the past 4 years. In 2012, incandescent and halogen bulbs occupied a majority of shelf space (58%). There were three times as many CFL products than LEDs in 2012. By 2014, efficient products held the majority of shelf space (60%), with twice as many LED products on shelves than CFLs. There was little change in shelf space devoted to efficient products or the prominence of LEDs between 2014 and 2015. The bigger change occurred among less-efficient lighting products. Incandescents were still the most common less-efficient product in 2014, but by 2015, there were three times as many halogen products than incandescents (see Figure 7-8).

Figure 7-8. Changes in Percentage of Shelf Space by Technology over Time



Source: DEP 2012 and 2014 Shelf Stocking Survey (Navigant Consulting). Opinion Dynamics 2015 Shelf Stocking Survey.

The availability of different bulb technologies differs somewhat for standard versus reflector bulbs. Efficient products occupy a similar percentage of shelf space for each bulb type (60% for reflectors versus 62% for standard bulbs), but LEDs are more common among reflectors than standard bulbs. Incandescents occupy slightly more shelf space in the standard category than reflectors (see Figure 7-9).

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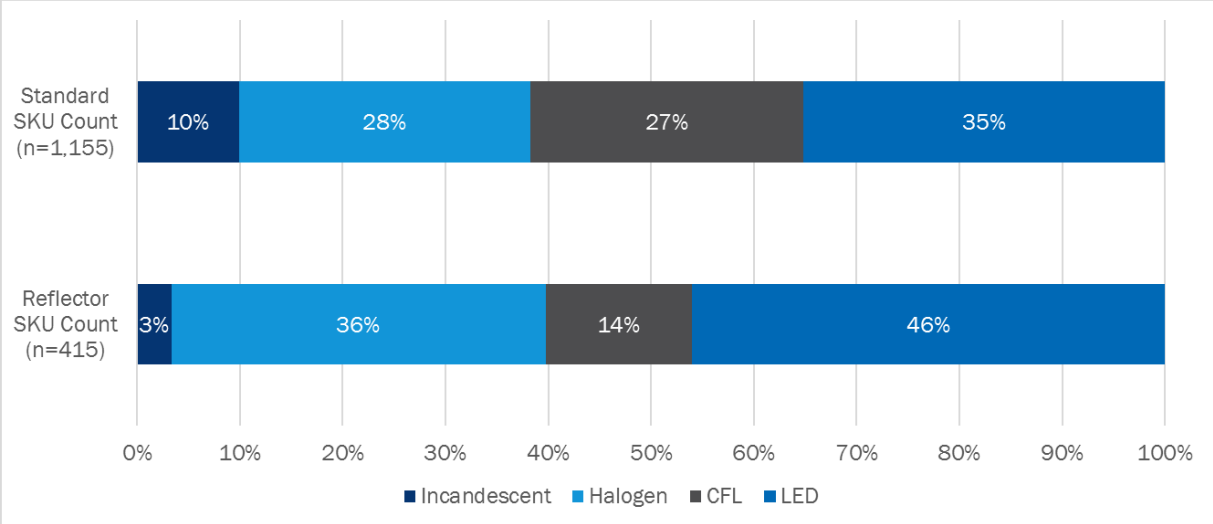
Figure 7-9. Percent of Total General Service and Reflector Products by Type



Source: Opinion Dynamics 2015 Shelf Stocking Survey.

Product availability varied substantially across retail channels. As shown in Table 7-4, Club stores stocked more LED products than other retail channels (74% across standard and reflector products). Club stores also carried only three halogens and no incandescent products across all six locations visited. This was true for both standard and reflector products. Only hardware retailers stocked incandescent reflector bulbs, and only 14 SKUs were carried in total across all the stores visited. None of the three Discount stores carried any reflector products at the time of our visit.

Table 7-4. General Service and Reflector Product Presence by Technology and Retail Channel

Channel	Big Box (2 stores)	Club Store (6 stores)	DIY (6 stores)	Discount (3 stores)	Hardware (3 stores[A])	Total (20 stores)
Standard Products						
Number of products	*n=50*	*n=44*	*n=739*	*n=38*	*n=284*	*n=1,155*
Incandescent	14%	0%	6%	16%	20%	10%
Halogen	24%	7%	33%	26%	20%	28%
CFL	30%	23%	26%	34%	27%	27%
LED	32%	70%	35%	24%	33%	35%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Reflector Products						
Number of products	n=12	n=14	n=274	N/A	n=115	n=415
Incandescent	0%	0%	0%	N/A	12%	3%
Halogen	50%	0%	38%	N/A	37%	36%
CFL	8%	14%	16%	N/A	10%	14%
LED	42%	86%	46%	N/A	41%	46%
Total	**100%**	**100%**	**100%**	**N/A**	**100%**	**100%**

[A] Because the sample size is small, results should be treated with caution and not extrapolated beyond this one store.
Source: Opinion Dynamics 2015 Shelf Stocking Survey.

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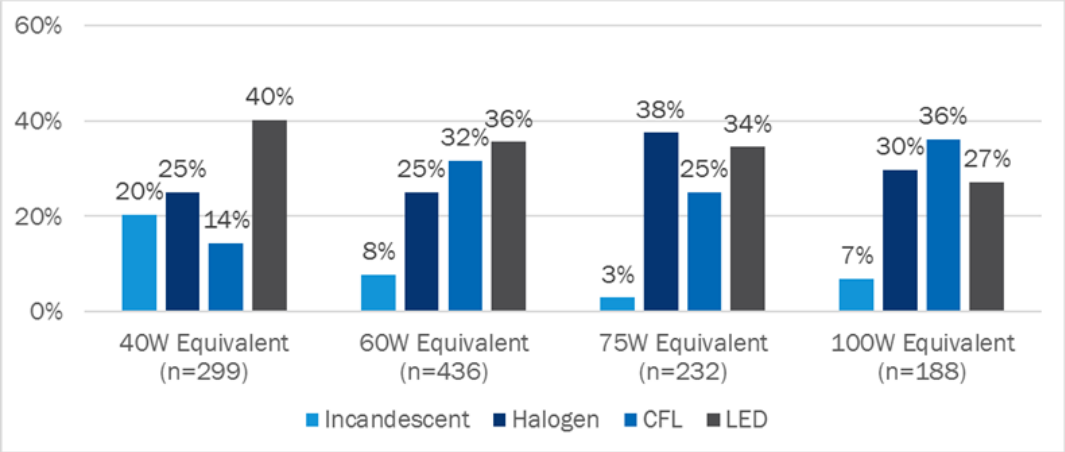
The mix of bulb technologies varied somewhat across wattages. Among standard products, incandescents were more likely to be found among the 40-watt equivalent category than other wattages, likely due to the phase-out schedule of EISA legislation affecting these bulbs last. LEDs were somewhat more common among the lower wattage categories (see Figure 7-10).

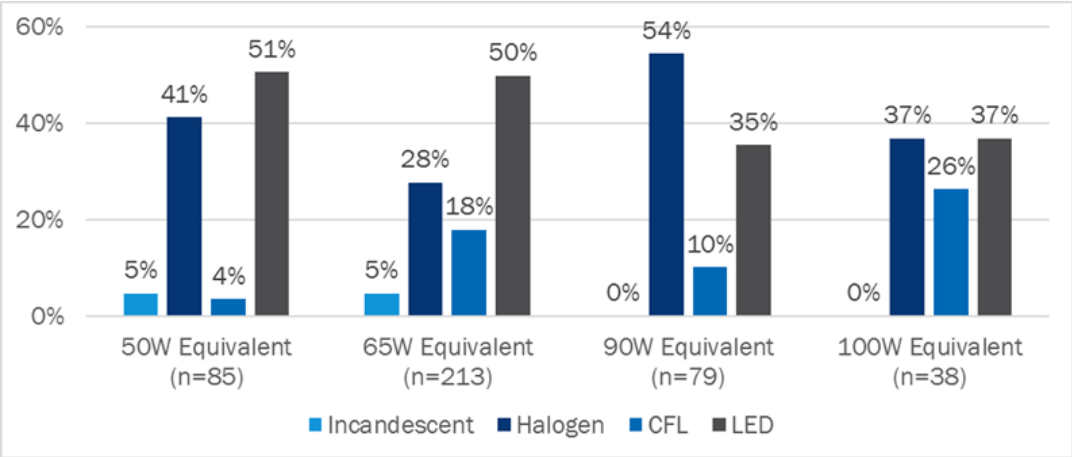
Figure 7-10. Standard Product Presence by Technology and Equivalent Wattage



Source: Opinion Dynamics 2015 Shelf Stocking Survey.

LEDs were also more common among lower wattage reflector products than higher wattage products. CFLs were less common, and comprised only a sizable percentage of higher wattage products (see Figure 7-11).

Figure 7-11. Reflector Product Presence by Technology and Equivalent Wattage



Source: Opinion Dynamics 2015 Shelf Stocking Survey.

Based on the results from the shelf survey research conducted in PY2014 and PY2015 at program participating retailers, the price of non-discounted standard and reflector LEDs dropped dramatically between 2014 and 2015, though LEDs still cost nearly twice as much as CFLs. Among non-discounted bulbs, the average price of a standard LED fell nearly $5 to $10.36 per bulb, while the average reflector price fell almost $8 to $15.25 per bulb. CFL prices increased slightly between 2014 and 2015. The average non-discounted reflector CFL prices increased from $7.07 in PY2014 to $7.75 in PY2015, and the average standard CFL prices increased from $4.36 in PY2014 to $5.21 in PY2015 (see Figure 7-12).

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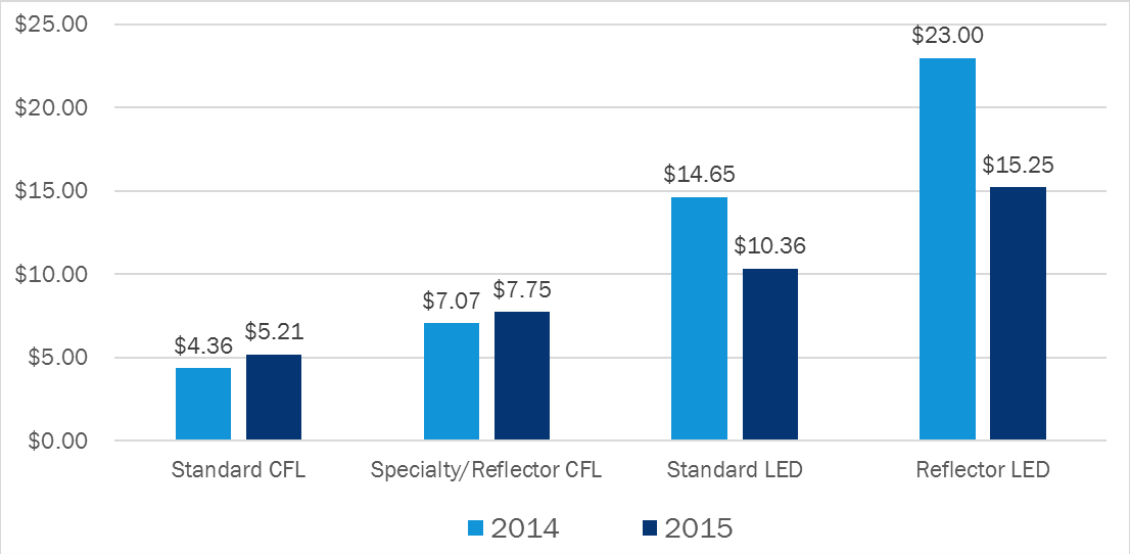
Figure 7-12. Non-Discounted Pricing of Different Lighting Products



Source: DEP 2014 Shelf Stocking Survey (Navigant Consulting). Opinion Dynamics 2015 Shelf Stocking Survey.
Note: Pricing data presented in this graph is for non-discounted products at participating retailers only. Opinion Dynamics only collected data for reflector CFLs whereas Navigant collected data for specialty CFL products including reflectors.

To minimize leakage, program administrators have chosen to exclude select store locations of participating retailers because of their proximity to DEP territory borders. Our shelf stocking survey included both participating and non-participating stores of the same retailer. By comparing the lighting products stocked and product pricing of participating and non-participating stores, we can assess the influence of the program on stocking and pricing. The results suggest that the DEP program is not affecting the products that most retailers stock. The share of efficient versus less efficient products is similar at participating and non-participating retailers (see Figure 7-13). Except for one retailer where there is greater availability of LEDs at participating stores, the relative percentage of different bulb technology products is quite similar between participating and non-participating stores of the same retailer.

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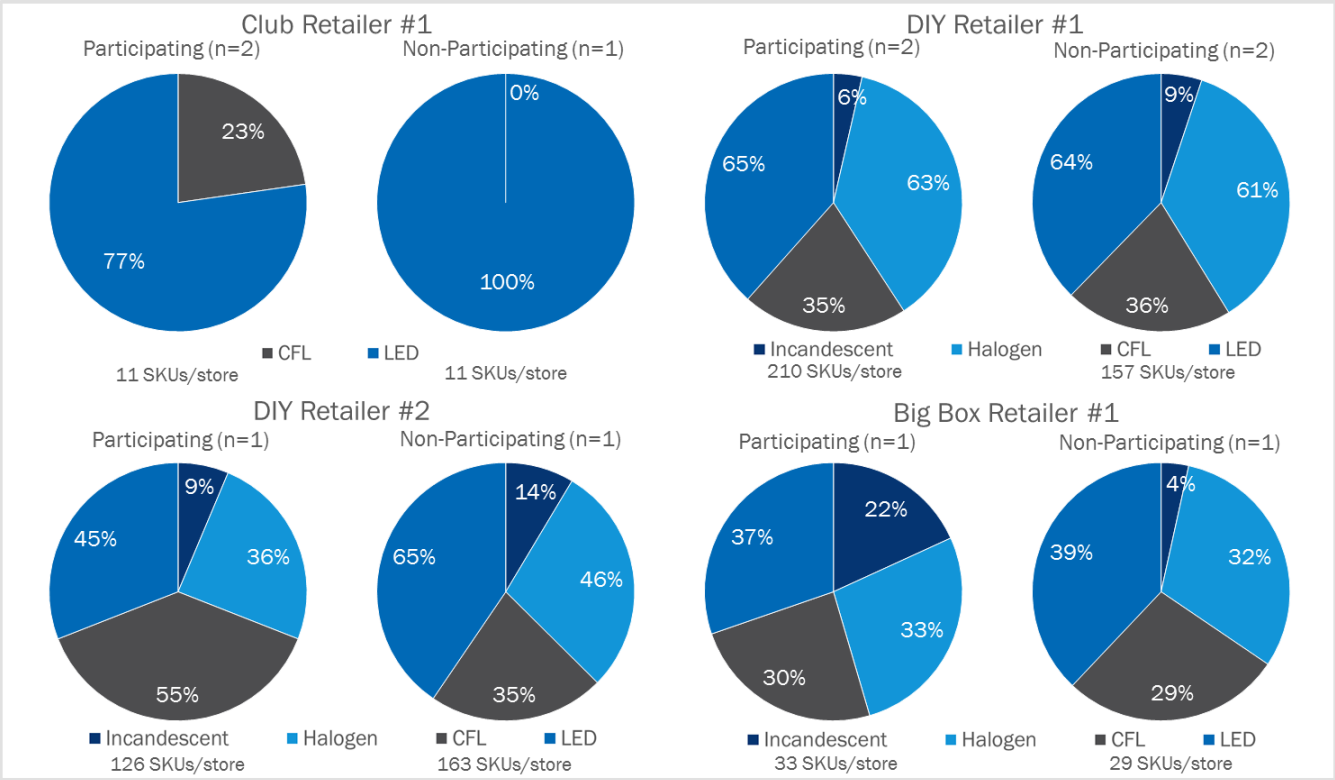
Figure 7-13. Lighting Products Stocked at Participating and Non-Participating Store Locations



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8. Conclusions and Recommendations

The DEP EEL program continued its sixth year of successful deployment. The program continues to further the adoption of energy efficient lighting. Over the course of 2015, DEP discounted more than 4.4 million lighting products, resulting in 66,378 MWh in net energy savings, 10.7 MW in summer peak demand savings, and 3.4 MW in winter peak demand savings. Program implementation processes were smooth and effective, resulting in high levels of stakeholder and market actor satisfaction. The program had 269 participating retail storefronts across the DEP service territory providing equitable customer access to program discounts.

Since 2010, the program discounted more than 21 million light bulbs. According to our conservative estimates, which are based on past research on CFL and LED saturation, analysis of sales data, and the number of customers in DEP's service territory, energy-efficient lighting products were in 49% of sockets in customer homes at the end of PY2015. This high level of socket saturation is due, in large part, to the DEP EEL program.

The lighting market is in a state of transition. LEDs are dropping in price and are an increasingly attractive alternative to CFLs. Based on the shelf survey research, the price of non-discounted standard and reflector LEDs dropped dramatically between 2014 and 2015, though LEDs still cost nearly twice as much as CFLs. A comparison of the products at participating and non-participating stores of the same retailer suggests that the DEP program is not affecting the products that most retailers stock. The share of efficient versus less efficient products is similar at participating and non-participating retailers.

These findings indicate that the key barriers to energy efficient lighting adoption, such as product availability and price, at least for CFLs, have been largely mitigated, which may signal diminishing program effects moving forward. The NTG ratio remained steady at 38% (the NTG ratio was 37% in PY2014). The relatively low NTG ratio is a likely signal of further diminishing effects of the program. NTG is not the only area of diminished program effects. As CFLs and LEDs saturate more sockets, customers are likely to install newly purchased CFLs and LEDs in sockets that previously contained a high efficiency product, resulting in limited future opportunities for savings. The long life of CFLs and LEDs may also lead to customers to purchase more products than they need and put extra bulbs in storage for much later use, which will delay the realization of program savings.

With these conclusions in mind, Opinion Dynamics provides the following recommendations:

- Evaluation results suggest that the lighting market is changing rapidly and has begun to transform. There are still cost-effective lighting savings to be had, but a change in program design may be required. Given the rapid pace of change in the lighting market, the mass market design may not be cost-effective in the near future. Energy Star 2.0 lamp specifications will accelerate the change. The DEP program has been correctly transitioning to LEDs. In addition, program administrators should reconsider the prominent role that standard bulbs play in the program. The existing mass market retail design targets all customers regardless of their existing use of efficient bulbs. Strategic targeting of underserved customers and/or underserved sockets would be a method to meet the remaining program potential while achieving high net positive savings. The evaluation team sees two potential program design options that DEP could pursue:
  - **A mass market program design focused on specialty and reflector LED products.** Specialty LED products are unaffected by EISA legislation. Efficient bulb socket saturation is also typically lower than standard sockets. Specialty and reflector CFLs never caught on with consumers, primarily because they did not fit well in these applications. Specialty and reflector LEDs are a better performing product, but they are significantly more expensive than standard LEDs. By offering

larger discounts on specialty products in the context of the mass market program at point of sale, DEP can accelerate the transformation of the specialty LED market.

- **A more targeted program focus that would reach** underserved customer segments. Such a design could include a targeted offering of free products or products for purchase through an online store or other avenue. Our PY2014 analysis of saturation rates by customer segment revealed that while efficient bulb saturation is relatively evenly distributed across the DEP population, there are still some demographic groups that lag behind in their use of CFLs and LEDs. Customers residing in mobile homes and multifamily residences, transient customers (less than 4-year tenure), renters, and customers with lower incomes are significantly more likely to have no CFLs or LEDs in their homes than their counterparts. These segments could be the primary program target. The scale of this program will likely be much smaller and the program is likely to be more costly than the streamlined upstream delivery model due to costs associated with tailored customer targeting. Given the expected higher net-to-gross ratio of this targeted design, the program should still be cost-effective.

- Given the program's successes to-date, DEP may want to consider conducting a market effects study to assess unclaimed savings from the program's impact on the larger market to date. The Evaluation Team believes that the program is at least, in part, responsible for changes to the lighting market in DEP's service territory by increasing customer awareness of efficient lighting technologies, influencing the products sold in retail stores, and changing customer lighting preferences.

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9. Summary Form

Energy Efficient Lighting Program

Completed EMV Fact Sheet

Duke Energy Progress partners with retailers and manufacturers across North and South Carolina to provide automatic price markdowns on customer purchases of efficient lighting. The program promotes customer awareness and purchase of the program-discounted products through a range of marketing and outreach strategies and provides training to store staff. Product mix includes standard and specialty CFLs, LEDs, and ENERGY STAR fixtures, with a wide range of products across these technologies. Participating retailers include a variety of channel types, including Big Box, Do-It-Yourself, Club, and Discount stores.

Date	August 12, 2016
Region(s)	Duke Energy Progress
Evaluation Period	January 1, 2015 – December 31, 2015
Gross Annual kWh Impact	174,679 MWh 73% realization rate
Coincident kW Impact	75% realization rate (summer) 34% realization rate (winter)

Evaluation Methodology

The evaluation team reviewed reported savings assumptions and verified that the inputs used to calculate those assumptions were in line with the previous evaluation's recommendations. The Evaluation Team also performed an engineering analysis of energy and demand savings to develop evaluated savings estimates, conducted a commercial lighting logger study to update commercial hours of use (HOU), and estimated a net-to-gross ratio (NTGR) using sales data modeling. The Evaluation Team conducted a program process evaluation that made use of retailer shelf audits and interviews with program staff.

Impact Evaluation Details

- North Carolina Utilities Commission requires that evaluations of DEP's Energy Efficient Lighting program include Carolinas-specific data.
- North Carolina Utilities Commission require that evaluations of DEP's Energy Efficient Lighting program include a discussion of the impacts of LEDs, the Energy Independence and Security Act (EISA), and other innovations in lighting technology on the calculations of measure impacts and the baseline measures used in those calculations
- The evaluation team used the most recent available Carolinas-specific energy savings estimates
- The evaluation team used the Uniform Methods Project (UMP) recommended approach to estimate gross energy savings and incorporated additional adjustments as necessary
- The evaluation team developed evaluated savings assumptions using detailed product information provided as part of the program tracking data extract
- The evaluation team used a 'discounted savings approach' to claiming savings from future installations
- Assessment of program attribution relied on a sales data modeling approach

Appendix A. DSMORE Tables

Excel spreadsheets with DS More Tables for Duke Energy Analytics are provided as separate files.

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Appendix B. Survey Instruments

Shelf audit data collection instrument and commercial lighting logger data collection instruments are provided as separate files.

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Appendix C. Impact Calculation Tables

Impact calculation tables are provided as a separate file.

Appendix D. Comparison of PY2015 Evaluation Recommended, Claimed/Ex Ante, and Evaluated/Ex Post Savings Assumptions

Table D-1. Comparison of PY2013 Evaluation Recommended, Claimed/Ex Ante, and Evaluated/Ex Post Savings Assumptions

	PY2015 Evaluation Recommended Savings Assumptions		Claimed/Ex Ante Savings Assumptions		Evaluated/Ex Post Savings Assumptions	
Assumption	Residential	Commercial	Residential	Commercial	Residential	Commercial
Sales to residential/ commercial customers	0.823	0.10	0.823	0.10	0.823	0.10
Leakage rate	0.077	0.077	0.077	0.077	0.077	0.077
Delta watts	Baseline wattage – actual bulb wattage		Baseline wattage – actual bulb wattage (in 97% of cases for energy savings and >99% of cases for peak demand savings; in a small percent of cases baseline wattages were used in place of delta watts)		Baseline wattage – actual bulb wattage	
Hours of use	2.922	6.930 (CFLs) 5.783 (LEDs)	2.922 (CFLs, LEDs, and indoor fixtures) 4.5 (Outdoor fixtures)	10.855	2.922	6.930 (CFLs) 5.783 (LEDs)
Coincidence factor	Summer: 0.1138 Winter: 0.0960	Summer: 0.497 (CFLs) 0.547 (LEDs) Winter: 0.174 (CFLs) 0.120 (LEDs)	0.1138 (Summer peak demand savings) 0.0960 (Winter peak demand savings)	0.8166 (Summer) 0.6644 (Winter)	Summer: 0.1138 Winter: 0.0960	Summer: 0.497 (CFLs) 0.547 (LEDs) Winter: 0.174 (CFLs) 0.120 (LEDs)
Interactive effects	0.94 (Energy savings) 1.27 (Summer peak demand savings) 0.50 (Winter peak demand savings)	1	1	1.06 (Energy savings) 0.787 (Summer peak demand savings) 2.0 (Winter peak demand savings)	0.94 (Energy savings) 1.27 (Summer peak demand savings) 0.50 (Winter peak demand savings)	1
In-service rate and carryover savings	0.795 (CFLs) 0.744 (LEDs) 1.00 (Fixtures)	0.879 (CFLs) 0.979 (LEDs) 1.00 (Fixtures)	0.795 (CFL energy savings) 0.790 (CFL peak demand savings) 0.744 (energy savings for >99% of LED bulbs) 1.00 (energy savings for <1% of LED bulbs) 1.00 (LED peak demand savings) 1.00 (Fixtures)		0.795 (CFLs) 0.744 (LEDs) 1.00 (Fixtures)	0.879 (CFLs) 0.979 (LEDs) 1.00 (Fixtures)

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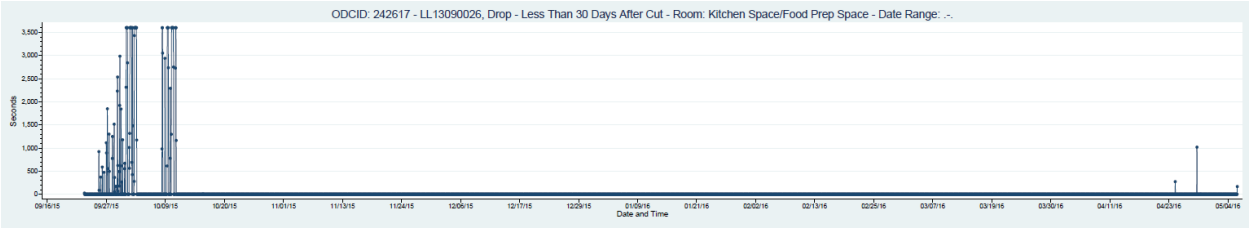
Appendix E. Commercial Lighting Logger Study Methodology

Logger Data Preparation and Cleaning

We deployed 282 loggers across 88 sites. We were unable to retrieve 20 loggers. In addition, prior to completing additional analysis and cleaning steps, we eliminated another 20 loggers for the following reasons.

- **Corrupted/Failed Loggers.** Our initial review of the logger files identified loggers that were corrupted or failed to log the data properly. Logger failure is often indicated by the inspector during the retrieval process (e.g., "dead battery") or by the analyst when downloading the logger data (e.g., "error – unable to retrieve data"). Corrupted/failed loggers consisted of either those that did not contain any logs falling within the valid logging time frame or those that did not collect any data after a certain period. **Error! Reference source not found.** presents an example of a lighting logger with little to no data p resent. In this particular example, the logger shows that there was activity during the first few weeks but then goes completely silent until the time of retrieval.

Figure E-1 Example of a Corrupted or Failing Lighting Logger.



- **Deployed on Exterior Lighting.** Exterior lighting was not part of the study scope and a few loggers were inadvertently deployed on exterior lighting.

The data from the remaining 242 loggers underwent a rigorous quality assurance and cleaning process. Initial cleaning steps included validating that each logger was retrieved from the room where it was originally installed. We resolved any changes in location by comparing logger room designators recorded during the deployment process to those recorded during the retrieval process.

Once we completed the initial cleaning steps, we restructured the logger data into hourly and daily formats to facilitate further cleaning and subsequent analysis. For each logger, we also created hourly and daily histograms that visually showed lighting usage patterns. To determine if additional loggers should be dropped from the analysis, we went through a series of "trimming steps." These steps include the following:

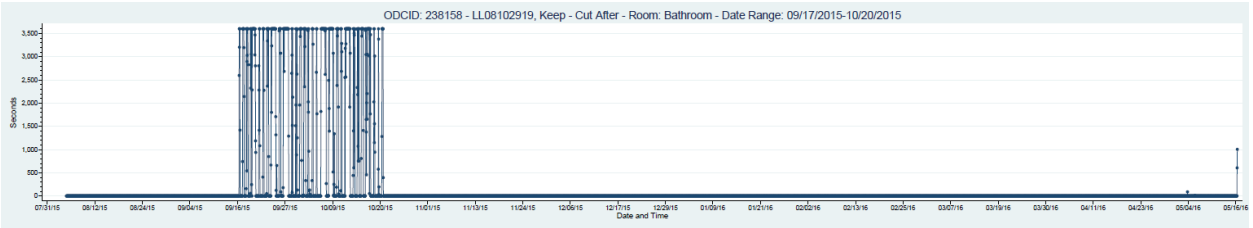
- **"Start" date and "End" date trimming.** This step is necessary to ensure that extraneous observations were not a part of the analysis. Logger data were "trimmed" to remove all logs before the logger installation date, as well as on or after the logger retrieval date. To determine and validate deployment and retrieval dates, we used data recorded by field staff as part of the deployment and retrieval process. For each logger, we trimmed the start date to be the first full day of logging and the end date to be the last full day of logging. For loggers received in the mail and therefore missing a clear indicator of the logging end period,[15] we carefully reviewed each individual logger's log patterns to determine

[15] Those loggers were removed and mailed to us by customers; thus, the retrieval process did not follow standard retrieval procedures.

an appropriate end date. Comparing the selected end date to the ship date of the package validated this assumption.

- **Periods of high activity followed by periods of low or no activity.** We flagged loggers that exhibited a drastic drop in logging activity. Most of the time, neither the customer nor the inspector noted anything in the survey. However, due to the high incidence of this occurring (45 loggers), we suspect some unintentional tampering with the loggers that resulted in the logger not capturing lighting activities properly. Therefore, we trimmed these loggers to include only periods where there was a consistent pattern of activity.

Figure E-2. Example of Logger with a Drop in Logging Activity



Once we "trimmed" the data, we took a number of analysis steps to determine whether to keep or drop a given logger. These "drop" steps included:

- **Review of Overall Logging Periods.** We calculated logging periods for each logger. Some loggers may have failed or been removed by the customer during the early part of the logging period and therefore contained only logging data for a small fraction of the period. To increase the reliability of the HOU estimates, loggers logging for less than 1 month[16] were excluded from the analysis. This resulted in dropping 15 loggers.
- **Analysis of Unexpected/Suspicious Usage Patterns.** To ensure proper operation of the loggers throughout the logging period, we performed an expansive analysis of logger usage patterns and flagged loggers with unusual or unexpected patters for further review and validation. We explored a variety of patterns:
  - **No "On" Periods and Very Low Activity.** Loggers with no "on" periods (i.e., the logged light was never turned on) also underwent review and validation. While it is feasible that the fixture on which the logger was placed was not turned on at all during the log period, it was important to confirm this hypothesis and ensure that logger malfunction was not the cause. We also looked at loggers with low activity and compared them to the space type that they were deployed and retrieved from. We also compared these low activity loggers with other loggers in the same facility or in the same space type, if applicable, for further verification. In general, if the low activity was not justifiable by the space type, we dropped the logger from analysis. We dropped 11 loggers due to no or low activity.

[16] We defined this period as less than 30 days.

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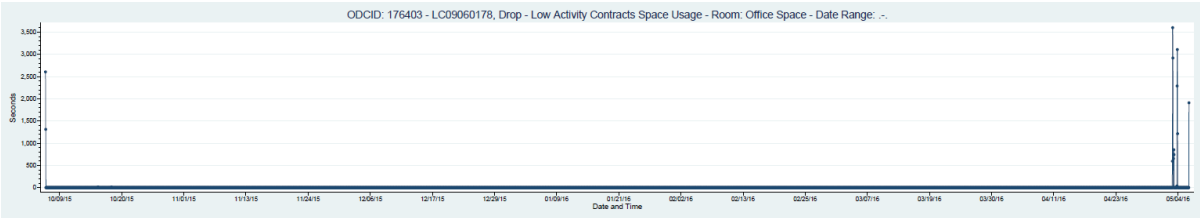
Figure E-3. Example of Logger with No "On" Periods or Very Low Activity



- **High Variance in Usage and Usage Changes.** For each logger, we calculated variance in usage across the log period. We also divided each logger's logging period into five sub-periods (cuts made at the 20th, 40th, 60th, and 80th percentiles). We then reviewed the variance in usage and compared the sub-periods to one another to identify any erratic or dramatic changes in usage over time. When unusual or unexpected patterns of use were discovered, we flagged loggers for further review and investigation. No loggers were dropped as a result of this process.

Figure E-4. Example of Logger with Highly Variable Usage Patterns

- **Analysis of Logger Flickering.** We also thoroughly explored logger flickering and its impact on the HOU estimates. Logger flickering can be caused by an external stimulus, such as sunlight or moisture interference. Flickering commonly manifests itself in short "flicks" or "on" and "off" periods. Flickering is generally difficult to identify and correct for because it is hard to determine whether the short-interval "on/off" periods are false positives or false negatives. By adding together all of the "on" and "off" flickering times, we determined that it could potentially affect the HOU estimate by a maximum of .006 hours per day or 2.1 hours per year. We concluded that this had minimal, if any, impact on the overall HOU estimate, and, as a result, we decided not to correct the data and no loggers were dropped as a result.

As a part of the follow-up analysis, we manually reviewed individual logger usage patterns of flagged loggers. We also compared the changes in usage patterns of a specific logger to the other loggers installed in the same business to gain more insight into the reasons for changes. We supplemented the review with investigation of the data collected during the retrieval survey and field staff notes. As a general rule, we tried to retain as much of the logger data in the analysis as possible. Therefore, when feasible, we set periods of suspicious logging activity to missing within our data set, so that they would not be included in the analysis and would not artificially deflate HOU estimates.

Upon performing the above-described data cleaning and validation steps, we dropped an additional 26 loggers and trimmed inadequate usage patterns for another 46 loggers. As previously indicated, 216 loggers (in 79 facilities) were ultimately included in our HOU and CF analysis. Table 4-6 provides a summary of logger attrition due to these steps and the initial steps previously described. As can be seen in the table, we dropped 40 loggers because they could not be retrieved, failed, contained corrupted data, or were inadvertently deployed on exterior lighting. We dropped an additional 26 loggers through the additional data cleaning and analysis

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process. As a result, 216 of the 282 originally deployed loggers (covering 79 facilities) were included in our HOU and CF analysis.

Estimation of Hours of Use and Coincidence Factors

Loggers were (on average) deployed for about 8 months from August/September through April/May—meaning the loggers were deployed across three seasons but not during the summer. Generally, we expect to see some variation in usage based on the amount of sunlight available during a given day/season. Thus, we tend to see (especially in residential applications) higher usage (i.e., lights on for more hours per day) during periods (such as the winter) when there are fewer daylight hours. Therefore, we needed to decide on the best method for estimating summer operating characteristics for each logger. To do this, we considered four different estimation methods, each of which is briefly described below.

Observed HOU	Used actual observed HOU data. By using this method, we assumed the average operating hours did not vary by the amount of daylight present. This involved generating an HOU value for each full day a switch was logged and averaging across all days for each logger.
Modeled HOU	Used separate weekday vs. weekend ordinary least squares (OLS) regression models for each individual logger to estimate HOU for the summer periods that were not logged.[17] In most cases, the individual models provided a poor fit—defined as no significant correlation between HOU and hours of daylight. A reasonable fit was found for just 12 loggers.
Combination of Observed and Modeled HOU.	Used a combination of the Observed HOU and Modeled HOU estimation methods. We used the observed HOU estimate when the Modeled HOU provided a poor fit. All but 12 loggers were estimated using the Observed HOU.
Pooled HOU.	Used a pooled fixed effects sinusoidal model. This model brings different loggers from the same room type together. In general, pooled models should provide a more accurate HOU for a given room type. The principal reason for running this model is to provide a check against the other three model types (i.e., to ensure that the other three models are both robust and stable).

We found very little difference between the HOU estimates provided by each of the models. In the end, we decided to use the "Combination" method. This method, as described above, uses: (1) actual observed HOU values when there is no strong correlation between HOU and hours of daylight (204 loggers) and (2) OLS regression modeling in those cases where there is a strong correlation between HOU and hours of daylight (12 loggers).

In addition to "annualizing" or extending the data collected to represent all 365 days in a given year, we needed to make decisions for those cases where, given our logger deployment strategy, not all switches that control at least one CFL or LED were logged for a given facility.[18] As a result, we needed to develop a methodology to estimate the HOU or CF for switches controlling CFLs or LEDs that we were unable to log (as well as for switches that we logged that ended up having bad logger data). We tested various methods of doing this and found very little difference by method on the overall HOU or CF estimates. Given this, we selected the method we thought

[17] We also ran the OLS not distinguishing between weekday and weekends and found that there were no significant differences.

[18] We deployed a maximum of seven loggers per facility. As a result, for facilities that had more than seven switches containing at least one CFL or LED, we were not able to log every switch.

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would provide, on average, the best estimate of HOU or CF. For CFLs or LEDs on switches that were not logged (or the logged data were bad), we prioritized our assignments as indicated below.

1. If available, we estimated HOU and CF using logger data from another switch within the same room within the same facility.
2. If #1 was not possible, we estimated HOU and CF from another switch within the same room type within the same facility.
3. If #2 was not possible, we estimated HOU and CF from other switches within the same room type across all other facilities.

For all 79 facilities, the preceding steps established an HOU for every switch that controls CFLs or LEDs (or both). To compute the actual HOU across all 79 facilities, it is necessary to assign the HOU established for a given switch to all the bulbs (CFLs, LEDs) that are controlled by that switch. **Error! Reference source not found.** i llustrates the distribution of bulbs by room type. As illustrated in the table, 57% of all CFLs and LEDs were found in customer service areas/retail spaces. Office spaces accounted for another 13%, followed by bathrooms (8%) and stairwells/hallways/corridors (9%). Businesses appear to use CFLs and LEDs somewhat differently. LEDs are more likely to be used in customer service areas or retails spaces, whereas CFLs are more likely to be used in offices and bathrooms.

Table E-1. CFL and LED Bulb Distribution by Room Type

Room Type	Bulbs	% Share	CFLs	% Share	LED	% Share
Customer service area/retail space	753	57%	456	51%	297	71%
Bathroom	100	8%	83	9%	17	4%
Office space	164	13%	122	14%	42	10%
Storage space	44	3%	39	4%	5	1%
Stairwell/hallway/corridor	119	9%	84	9%	35	8%
Kitchen space/food prep space	54	4%	42	5%	12	3%
Front desk/reception space	15	1%	10	1%	5	1%
Other	62	5%	56	6%	6	1%
Total	**1,311**	**100%**	**892**	**100%**	**419**	**100%**

Analysis Results

Hours of Use

The overall average daily HOU estimate is 6.6 (±9.9% at the 90% confidence level). As expected, HOU varies by room type, with the overall HOU estimate of 6.6 heavily influenced by the HOU estimate for customer service areas/retail spaces (6.5) and office spaces (5.1), as these two space types collectively accounted for 70% of all CFLs/LEDs in the 79 facilities

As illustrated in Table E-2, some of the lowest HOU estimates are—not surprisingly—found in storage spaces and bathrooms (3.9 and 5.5, respectively), which collectively account for 11% of all CFLs/LEDs in the 79 facilities. HOU values were highest in kitchen space/food prep areas (7.6) and “other” areas (10.3). However, these areas collectively account for just 9% of all CFLs/LEDs in the 79 facilities.

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Table E-2. DEP Average Daily HOU by Room Type (and Overall)

Room Type	Overall		CFLs		LEDs	
	Final HOU	Std Error	Final HOU	Std Error	Final HOU	Std Error
Customer service area/retail space	6.5	0.6	7.0	0.8	5.9	0.9
Bathroom	5.5	1.1	6.1	1.3	2.7	1.3
Office space	5.1	1.0	5.3	1.3	4.7	1.0
Storage space	3.9	1.1	3.7	1.2	6.1	2.1
Stairwell/hallway/corridor	8.1	1.4	8.3	1.3	7.7	3.1
Kitchen space/food prep space	7.6	1.2	8.1	1.5	5.8	1.3
Front desk/reception space	6.5	2.2	7.2	3.1	5.3	2.5
Other	10.3	1.9	10.6	2.2	6.9	1.5
Total	**6.6**	**0.4**	**6.9**	**0.5**	**5.8**	**0.6**

We compared the HOU measured through the logger deployment process with what business owners/managers told us about the operating hours of the facility. We found very little correlation between the average daily HOU of CFLs/LEDs as measured through the logger study to the average daily facility operating hours reported by the business owners/managers. We believe that this is because the use of CFLs/LEDs within a given space type may be very different from how other (e.g., linear) lighting is used within that space type. As a result, facility operating hours are not a good predictor of CFL/LED operating hours.

Figure E-5 provides a graphical representation of the relationship between the logged HOU for a given room type and the operating hours reported by the facility owner/manager. If the logged HOU and reported HOU for a given room were perfectly correlated, all the "dots" within the figure would fall along the diagonal red line. However, as illustrated in the graphic, very few of the "dots" actually fall close to the red line. This tells us that there is also, for the most part, little relationship between the HOU of CFLs/LEDs and the reported facility operating hours by room type.

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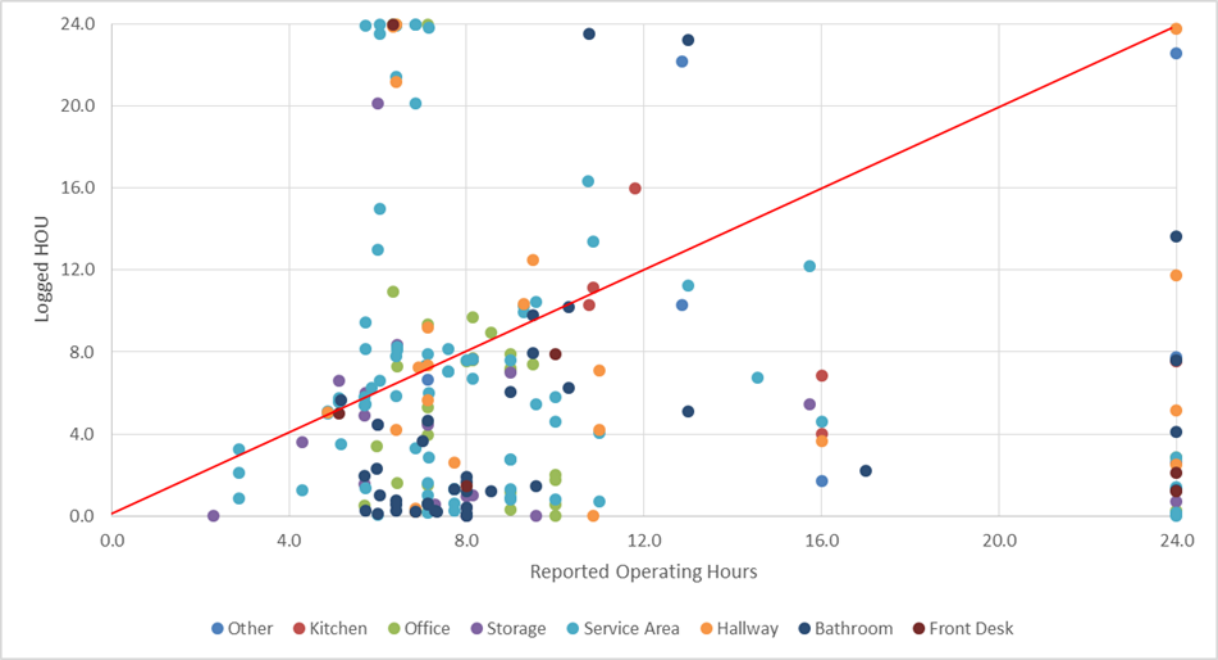
Figure E-5. Logged Average Daily HOU Compared to Reported Facility HOU by Room Type



Coincidence Factors

We also computed the summer and winter peak CF for CFLS, LEDs, and overall. Summer peak is defined as weekdays from 3 p.m. to 5 p.m. from June through August (not including weekends and holidays). Winter peak is defined as weekdays from 7 a.m. to 9 a.m. from December through February (not including weekends and holidays). The overall summer CF, as illustrated in Table E-3, is 0.51 (±7.9% at the 90% confidence level).

Table E-3. DEP Summer Coincidence Factor by Room Type

Room Type	Overall		CFLs		LEDs	
	Final CF	Std Error	Final CF	Std Error	Final CF	Std Error
Customer service area/retail space	0.55	0.04	0.53	0.05	0.60	0.06
Bathroom	0.32	0.05	0.35	0.06	0.18	0.08
Office space	0.41	0.06	0.38	0.07	0.49	0.11
Storage space	0.32	0.08	0.28	0.08	0.68	0.16
Stairwell/hallway/corridor	0.63	0.07	0.71	0.07	0.42	0.15
Kitchen space/food prep space	0.64	0.06	0.67	0.08	0.53	0.07
Front desk/reception space	0.45	0.10	0.45	0.14	0.44	0.17
Other	0.43	0.03	0.44	0.04	0.34	0.04
Total	**0.51**	**0.02**	**0.50**	**0.03**	**0.55**	**0.04**

The overall winter CF, as illustrated in Table E-4, is 0.16 (±18.7% at the 90% confidence level).

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Table E-4. DEP Winter Coincidence Factor by Room Type (and Overall)

Room Type	Overall		CFLs		LEDs	
	Final CF	Std Error	Final CF	Std Error	Final CF	Std Error
Customer service area/retail space	0.13	0.03	0.14	0.03	0.11	0.04
Bathroom	0.18	0.05	0.20	0.06	0.10	0.05
Office space	0.15	0.04	0.18	0.06	0.05	0.02
Storage space	0.11	0.04	0.12	0.05	0.08	0.09
Stairwell/hallway/corridor	0.17	0.07	0.15	0.07	0.23	0.14
Kitchen space/food prep space	0.13	0.04	0.13	0.04	0.15	0.09
Front desk/reception space	0.22	0.10	0.26	0.14	0.14	0.09
Other	0.49	0.08	0.49	0.09	0.42	0.03
Total	**0.16**	**0.02**	**0.17**	**0.02**	**0.12**	**0.03**

Table E-5 compares the overall study results (HOU estimate, summer CF, and winter CF) to values from the 2013 EM&V Report, which are the current savings assumptions as reflected in the program database. As illustrated in the table, all our estimates are significantly lower than the values published in the 2013 EM&V report. However, our review of the 2013 EM&V report indicates that the specific estimates (i.e., HOU = 10.85, Summer CF = 0.82, Winter CF = 0.66) are based on KEMA 2008 work papers.[19] We surmise that the work-paper estimates likely pertain to commercial lighting in general (predominantly linear fixtures) rather than CFLs or LEDs.

For comparison purposes, we reviewed a 2010 California report[20] that provides metered data for CFLs in small commercial buildings. HOU estimates were provided for three investor-owned utilities (Pacific Gas and Electric, Southern California Edison, San Diego Gas and Electric) and range from 6.0 to 7.4. The same study provided Summer Peak CFs ranging from 0.36 to 0.44. Both the HOU and CF estimates from the California study align fairly well with the DEP results presented in Table E-5.

Table E-5. Average Daily HOU and CF Summary

Statistic	Overall	CFL	LED	EM&V 2013
HOU	6.6	6.9	5.8	10.85
Summer CF	0.51	0.50	0.55	0.82
Winter CF	0.16	0.17	0.12	0.66

[19] Final EM&V Report for the 2013 Energy Efficient Lighting Program, August 13, 2014, prepared by Navigant Consulting, Inc. and Apex Analytics, Inc. Table 3-2 (page 19) indicates that the HOU estimate (10.85) and Summer CF (0.82) are based on "KEMA 2008 ComEd work-paper, weighted by reported businesses." The same table indicates that Winter CF (0.66) is based on "KEMA 2008 work-paper extrapolation."

[20] Final Evaluation Report: Upstream Lighting Program Volume 1, February 8, 2010, prepared by KEMA Inc. Table 19 (page 43) provided annual CFL HOU estimates of 2,710 for PG&E; 2,517 for SCE; and 2,191 for SDG&E. It also provides Summer Peak CF estimates of 0.44 for PG&E; 0.39 for SCE, and 0.36 for SDG&E.

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Appendix F. Sales Data Modeling Outputs

This section contains final sales data model outputs.

Table F-6. CFL Model Results

ln_bulbs	Robust Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_discp2	-.4187273	.0260542	-16.07	0.000	-.4697939	-.3676608
eventyn	.0003142	.0156117	0.02	0.984	-.030285	.0309134
model_2	.2496135	.1543515	1.62	0.106	-.0529175	.5521446
model_3	.2929747	.1514673	1.93	0.053	-.0039031	.5898526
model_4	.9703842	.0492226	19.71	0.000	.8739074	1.066861
model_5	.3326747	.0299843	11.09	0.000	.2739051	.3914444
model_6	-.223822	.1005933	-2.23	0.026	-.4209862	-.0266577
model_7	.798265	.1610468	4.96	0.000	.4826112	1.113919
model_8	1.8815	.0514387	36.58	0.000	1.780679	1.982321
model_9	.2333317	.1503689	1.55	0.121	-.0613932	.5280567
model_10	1.061026	.028874	36.75	0.000	1.004432	1.117619
model_11	1.114281	.0428562	26.00	0.000	1.030282	1.19828
model_12	.8863427	.0424174	20.90	0.000	.803204	.9694815
model_13	2.513146	.0542486	46.33	0.000	2.406818	2.619474
model_14	.7994066	.0436476	18.31	0.000	.7138566	.8849565
model_15	.4246118	.0366856	11.57	0.000	.3527076	.496516
model_16	.106287	.0272013	3.91	0.000	.0529721	.1596019
model_17	.7358051	.040475	18.18	0.000	.6564736	.8151366
model_18	.0352184	.1436271	0.25	0.806	-.2462927	.3167294
model_19	1.154933	.1605122	7.20	0.000	.8403265	1.469538
model_20	1.272647	.0345926	36.79	0.000	1.204845	1.340449
model_21	-.006176	.2045942	-0.03	0.976	-.4071834	.3948314
model_30	5.187448	.074946	69.22	0.000	5.040553	5.334343
model_31	.6485137	.4038396	1.61	0.108	-.1430173	1.440045
model_32	3.541808	.05721	61.91	0.000	3.429676	3.653941
model_34	.1761802	.1463667	1.20	0.229	-.1107005	.4630608
model_35	.1427035	.1164315	1.23	0.220	-.0855038	.3709108
model_36	-.8346736	.0164229	-50.82	0.000	-.8668627	-.8024846
model_37	.9613245	.0462599	20.78	0.000	.8706545	1.051994
model_38	-.2859808	.0252326	-11.33	0.000	-.3354371	-.2365246
model_39	-.157113	.2381782	-0.66	0.509	-.6239454	.3097193
model_40	-.2829427	.2457858	-1.15	0.250	-.7646861	.1988007
model_41	-.119979	.0347353	-3.45	0.001	-.1880607	-.0518973
model_42	-.5527522	.0091645	-60.31	0.000	-.5707148	-.5347895
model_43	.9955631	.1403432	7.09	0.000	.7204886	1.270638
model_44	-.0075898	.0312987	-0.24	0.808	-.0689358	.0537562
model_45	-.4763042	.1277541	-3.73	0.000	-.7267041	-.2259044
model_46	-.5527522	.0091645	-60.31	0.000	-.5707148	-.5347895
model_47	-.4710132	.0370347	-12.72	0.000	-.5436017	-.3984247
model_48	-.376665	.0424167	-8.88	0.000	-.4598022	-.2935278
model_49	-.4317661	.0016365	-263.83	0.000	-.4349737	-.4285585
model_50	-.0099505	.1835083	-0.05	0.957	-.3696292	.3497283
model_57	3.261515	.1765866	18.47	0.000	2.915403	3.607627
model_61	1.291404	.3082203	4.19	0.000	.6872883	1.89552

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model_62	3.618141	.1514205	23.89	0.000	3.321355	3.914928
model_63	.5972143	.3311246	1.80	0.071	-.0517943	1.246223
model_64	.4036525	.3890397	1.04	0.299	-.3588705	1.166175
model_65	4.111041	.4811484	8.54	0.000	3.167984	5.054099
model_66	.7887018	.2458867	3.21	0.001	.3067606	1.270643
model_67	1.66825	.1598023	10.44	0.000	1.355036	1.981465
model_68	.8768177	.1104505	7.94	0.000	.6603333	1.093302
model_69	.754057	.118695	6.35	0.000	.5214132	.9867008
model_70	1.687814	.1168241	14.45	0.000	1.458837	1.91679
model_72	-.8932221	.0127799	-69.89	0.000	-.9182708	-.8681734
model_74	-.197411	.1075013	-1.84	0.066	-.4081151	.013293
model_76	2.830565	.3172541	8.92	0.000	2.208743	3.452387
model_82	.7719677	.4190576	1.84	0.065	-.0493907	1.593326
model_85	2.592287	.0566522	45.76	0.000	2.481248	2.703326
model_87	1.31441	.0417483	31.48	0.000	1.232583	1.396238
model_90	-.2758864	.0332148	-8.31	0.000	-.340988	-.2107849
model_92	.8126999	.0356591	22.79	0.000	.7428077	.8825922
model_94	.6070676	.0359232	16.90	0.000	.5366577	.6774774
model_96	1.293531	.041352	31.28	0.000	1.212481	1.374582
model_109	.3995229	.0844635	4.73	0.000	.2339733	.5650726
model_113	-.3780997	.0265649	-14.23	0.000	-.4301672	-.3260322
model_114	1.195801	.1377038	8.68	0.000	.9258995	1.465702
model_117	.0325475	.1006403	0.32	0.746	-.1647088	.2298039
model_123	.052668	.0939733	0.56	0.575	-.131521	.2368569
model_130	-.0038188	.0492489	-0.08	0.938	-.1003473	.0927097
model_132	.4974667	.0970823	5.12	0.000	.3071841	.6877493
model_136	-.5371038	.0388209	-13.84	0.000	-.6131932	-.4610144
model_139	.2396087	.0270241	8.87	0.000	.1866411	.2925764
model_142	.0899568	.0295064	3.05	0.002	.0321238	.1477898
model_145	-.0398606	.0381035	-1.05	0.296	-.114544	.0348229
model_146	1.121531	.0524031	21.40	0.000	1.018821	1.224242
model_147	.7956445	.0440837	18.05	0.000	.7092399	.8820491
model_148	.5948098	.0288246	20.64	0.000	.5383133	.6513064
model_149	.8174763	.0390272	20.95	0.000	.7409825	.8939701
model_150	-.0247624	.0186024	-1.33	0.183	-.0612234	.0116985
model_152	.012132	.0908683	0.13	0.894	-.1659711	.190235
model_154	.3083999	.0275643	11.19	0.000	.2543735	.3624263
model_156	1.328405	.0674385	19.70	0.000	1.196224	1.460585
model_157	1.511981	.0764122	19.79	0.000	1.362212	1.66175
model_158	1.262236	.0385445	32.75	0.000	1.186689	1.337784
model_165	-.0207839	.0644483	-0.32	0.747	-.1471035	.1055356
model_166	.1350045	.0229697	5.88	0.000	.0899835	.1800254
model_167	1.49073	.0299232	49.82	0.000	1.43208	1.54938
model_168	.8515964	.0204251	41.69	0.000	.8115629	.8916299
model_171	.3609482	.0236536	15.26	0.000	.3145869	.4073095
model_174	3.760438	.069561	54.06	0.000	3.624098	3.896779
model_175	-.1189706	.0239551	-4.97	0.000	-.1659229	-.0720182
model_178	2.567972	.1290627	19.90	0.000	2.315007	2.820937
model_179	-.118143	.0222027	-5.32	0.000	-.1616605	-.0746254
model_180	.913254	.0261929	34.87	0.000	.8619155	.9645924
model_183	3.743087	.1101312	33.99	0.000	3.527228	3.958946
model_185	-.2264766	.0265208	-8.54	0.000	-.2784577	-.1744955
model_187	.9272046	.0399881	23.19	0.000	.8488274	1.005582
model_188	-1.168182	.0374808	-31.17	0.000	-1.241645	-1.094719

model_189	.3792972	.0344818	11.00	0.000	.3117123	.446882
model_190	-1.332023	.0334116	-39.87	0.000	-1.39751	-1.266536
model_191	-.0931227	.0300417	-3.10	0.002	-.1520049	-.0342404
model_192	-1.501866	.0291444	-51.53	0.000	-1.558989	-1.444742
model_193	-.0985426	.0422811	-2.33	0.020	-.1814142	-.0156711
model_195	-.0811322	.0450571	-1.80	0.072	-.1694446	.0071802
model_196	-.2167365	.0413418	-5.24	0.000	-.2977669	-.135706
model_198	-.3998066	.024235	-16.50	0.000	-.4473075	-.3523056
model_199	-1.180451	.0050922	-231.81	0.000	-1.190432	-1.170471
model_203	-.1886365	.0242741	-7.77	0.000	-.2362141	-.1410589
model_207	-.3863963	.0249982	-15.46	0.000	-.435393	-.3373995
model_213	-.1051137	.0757978	-1.39	0.166	-.2536785	.043451
model_214	-.3670565	.0502211	-7.31	0.000	-.4654906	-.2686224
model_215	-.2443265	.0100264	-24.37	0.000	-.2639784	-.2246746
model_237	-.5973637	.0241914	-24.69	0.000	-.6447793	-.5499482
model_243	.0574216	.0278716	2.06	0.039	.0027928	.1120504
model_245	-.0449163	.0224865	-2.00	0.046	-.0889902	-.0008425
model_246	-.0377579	.0405762	-0.93	0.352	-.1172877	.0417719
model_247	-.0639841	.0291083	-2.20	0.028	-.1210368	-.0069313
model_248	.344275	.1420771	2.42	0.015	.065802	.622748
model_249	-.1266332	.0266471	-4.75	0.000	-.1788619	-.0744045
model_250	.1081646	.0488308	2.22	0.027	.0124556	.2038735
model_252	.7381748	.0375291	19.67	0.000	.6646173	.8117323
model_253	-.1421008	.0250298	-5.68	0.000	-.1911596	-.0930421
model_255	1.503729	.0464273	32.39	0.000	1.412731	1.594727
model_262	.1107721	.0451623	2.45	0.014	.0222533	.1992908
model_291	1.036947	.0967555	10.72	0.000	.8473045	1.226589
model_399	-.7214808	.0196632	-36.69	0.000	-.760021	-.6829406
model_401	-.5185247	.0322638	-16.07	0.000	-.5817622	-.4552872
_cons	1.703819	.0376574	45.25	0.000	1.63001	1.777628

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Table F-7. LED Model Results

ln_bulbs	Robust Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_discp2	-.1491682	.0110908	-13.45	0.000	-.1709061	-.1274303
eventyn	-.0110172	.0163982	-0.67	0.502	-.0431575	.0211231
model_22	-2.095347	.1141166	-18.36	0.000	-2.319015	-1.87168
model_23	-2.189061	.1155754	-18.94	0.000	-2.415588	-1.962534
model_24	-2.308804	.1155157	-19.99	0.000	-2.535214	-2.082395
model_25	-2.498304	.184361	-13.55	0.000	-2.85965	-2.136959
model_26	-.4768646	.220527	-2.16	0.031	-.9090954	-.0446338
model_27	-2.262686	.2152527	-10.51	0.000	-2.684579	-1.840793
model_28	-1.469914	.1249076	-11.77	0.000	-1.714732	-1.225097
model_29	-1.686183	.1176762	-14.33	0.000	-1.916827	-1.455539
model_33	-.0913724	.1256266	-0.73	0.467	-.3375993	.1548545
model_51	-2.150845	.1424755	-15.10	0.000	-2.430096	-1.871595
model_52	.150619	.2406895	0.63	0.531	-.3211301	.622368
model_53	-.4539293	.1887352	-2.41	0.016	-.8238485	-.0840101
model_54	-.9577862	.2518486	-3.80	0.000	-1.451407	-.4641655
model_55	-1.895497	.227534	-8.33	0.000	-2.341462	-1.449533
model_56	-2.623683	.1452632	-18.06	0.000	-2.908397	-2.338968
model_58	-2.370833	.1204857	-19.68	0.000	-2.606984	-2.134683
model_59	-2.365883	.1207715	-19.59	0.000	-2.602594	-2.129172
model_60	-1.855367	.1142693	-16.24	0.000	-2.079334	-1.631401
model_71	-.5137276	.1641662	-3.13	0.002	-.8354917	-.1919634
model_73	-1.894233	.2663003	-7.11	0.000	-2.416179	-1.372287
model_75	-1.366894	.1592092	-8.59	0.000	-1.678943	-1.054846
model_77	-.634583	.3191924	-1.99	0.047	-1.260197	-.008969
model_78	.5026789	.1108629	4.53	0.000	.2853888	.7199691
model_79	-1.722258	.1602425	-10.75	0.000	-2.036332	-1.408184
model_80	-2.740142	.267753	-10.23	0.000	-3.264935	-2.215349
model_81	-1.463799	.139006	-10.53	0.000	-1.736249	-1.191349
model_84	-1.940403	.1101535	-17.62	0.000	-2.156303	-1.724504
model_86	-2.137376	.1094337	-19.53	0.000	-2.351865	-1.922887
model_88	-2.54251	.1119646	-22.71	0.000	-2.761959	-2.32306
model_89	-.6528424	.1153046	-5.66	0.000	-.8788384	-.4268465
model_91	-2.296156	.1116842	-20.56	0.000	-2.515056	-2.077256
model_93	-1.317891	.1308812	-10.07	0.000	-1.574417	-1.061365
model_95	-2.207412	.1107918	-19.92	0.000	-2.424562	-1.990261
model_97	-2.278757	.1660543	-13.72	0.000	-2.604222	-1.953292
model_98	-1.462113	.1161685	-12.59	0.000	-1.689802	-1.234423
model_99	-2.658833	.1288665	-20.63	0.000	-2.911411	-2.406256
model_100	-2.870445	.1124146	-25.53	0.000	-3.090777	-2.650113
model_101	-2.566574	.1094377	-23.45	0.000	-2.781071	-2.352078
model_102	-2.574484	.1126442	-22.86	0.000	-2.795266	-2.353703
model_103	-2.569581	.1147897	-22.39	0.000	-2.794568	-2.344594
model_104	-1.119776	.1380956	-8.11	0.000	-1.390443	-.8491104
model_105	-2.824904	.1083496	-26.07	0.000	-3.037269	-2.61254
model_106	-2.287764	.1099644	-20.80	0.000	-2.503293	-2.072235
model_107	-.5048215	.1461419	-3.45	0.001	-.7912582	-.2183848
model_108	-1.938418	.1098941	-17.64	0.000	-2.153809	-1.723026
model_110	.1163785	.1142134	1.02	0.308	-.1074786	.3402357
model_111	-2.763108	.1110324	-24.89	0.000	-2.980731	-2.545486
model_112	-1.638976	.125343	-13.08	0.000	-1.884647	-1.393305

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model_115	-1.616584	.1165556	-13.87	0.000	-1.845031	-1.388136
model_116	-1.789886	.131613	-13.60	0.000	-2.047846	-1.531926
model_118	-2.797362	.1085257	-25.78	0.000	-3.010071	-2.584652
model_119	-1.455783	.1458897	-9.98	0.000	-1.741725	-1.16984
model_120	-2.80882	.1115048	-25.19	0.000	-3.027369	-2.590272
model_121	-2.055428	.1603905	-12.82	0.000	-2.369792	-1.741065
model_122	-2.592951	.2249343	-11.53	0.000	-3.03382	-2.152082
model_124	-3.06637	.1070316	-28.65	0.000	-3.276151	-2.856589
model_125	-2.677141	.1475361	-18.15	0.000	-2.96631	-2.387971
model_126	-2.650389	.1468823	-18.04	0.000	-2.938277	-2.362501
model_127	-2.611692	.1090549	-23.95	0.000	-2.825438	-2.397945
model_128	-2.078442	.1342506	-15.48	0.000	-2.341572	-1.815312
model_129	-2.160553	.1372554	-15.74	0.000	-2.429572	-1.891533
model_131	-2.529883	.1532419	-16.51	0.000	-2.830236	-2.229531
model_133	-1.260576	.1150999	-10.95	0.000	-1.486171	-1.034981
model_134	-2.480291	.1100604	-22.54	0.000	-2.696009	-2.264574
model_135	-2.752438	.1098184	-25.06	0.000	-2.967681	-2.537195
model_137	-3.055565	.1083897	-28.19	0.000	-3.268008	-2.843122
model_138	-2.51817	.1085967	-23.19	0.000	-2.731018	-2.305321
model_140	-2.396267	.1094815	-21.89	0.000	-2.610849	-2.181684
model_141	-2.305279	.1103484	-20.89	0.000	-2.521561	-2.088997
model_143	-2.811893	.1087067	-25.87	0.000	-3.024957	-2.598829
model_144	-2.568716	.112471	-22.84	0.000	-2.789158	-2.348274
model_151	-2.476029	.1211789	-20.43	0.000	-2.713539	-2.23852
model_153	-2.732993	.1481933	-18.44	0.000	-3.023451	-2.442536
model_155	-2.025673	.3027523	-6.69	0.000	-2.619064	-1.432281
model_159	-2.518359	.121487	-20.73	0.000	-2.756472	-2.280246
model_160	-2.669231	.1271838	-20.99	0.000	-2.91851	-2.419952
model_161	-2.560118	.1242551	-20.60	0.000	-2.803657	-2.316579
model_162	-.5474621	.1138525	-4.81	0.000	-.770612	-.3243122
model_163	-1.922998	.1151572	-16.70	0.000	-2.148705	-1.697291
model_164	-.9570438	.1127292	-8.49	0.000	-1.177992	-.7360957
model_169	-.5718858	.1299784	-4.40	0.000	-.8266423	-.3171293
model_170	.0578403	.1244023	0.46	0.642	-.1859871	.3016677
model_172	.6579348	.1166264	5.64	0.000	.4293482	.8865214
model_173	-1.165602	.1195074	-9.75	0.000	-1.399836	-.9313689
model_176	1.788775	.1222696	14.63	0.000	1.549127	2.028422
model_177	1.037756	.1314314	7.90	0.000	.7801519	1.29536
model_181	2.183747	.1542578	14.16	0.000	1.881403	2.486091
model_182	.1063579	.1292263	0.82	0.410	-.1469243	.3596401
model_184	-.3782141	.1152355	-3.28	0.001	-.6040746	-.1523536
model_186	1.035957	.1457793	7.11	0.000	.7502311	1.321683
model_194	2.92093	.1305947	22.37	0.000	2.664965	3.176894
model_197	-.695233	.1168658	-5.95	0.000	-.9242889	-.4661771
model_200	2.790957	.1603953	17.40	0.000	2.476584	3.105331
model_201	-2.151108	.1173405	-18.33	0.000	-2.381094	-1.921122
model_202	1.703604	.1314147	12.96	0.000	1.446033	1.961175
model_204	.734783	.20996	3.50	0.000	.3232634	1.146302
model_205	3.174426	.1216128	26.10	0.000	2.936066	3.412786
model_206	3.641334	.1242521	29.31	0.000	3.397801	3.884867
model_208	-.4588406	.1273473	-3.60	0.000	-.7084401	-.2092412
model_209	-3.086502	.1069677	-28.85	0.000	-3.296157	-2.876846
model_210	-1.751384	.1142794	-15.33	0.000	-1.975371	-1.527398
model_211	-.7182584	.1285856	-5.59	0.000	-.9702849	-.4662319

model_212	-1.090796	.127701	-8.54	0.000	-1.341089	-.8405035
model_216	-1.866216	.1180584	-15.81	0.000	-2.09761	-1.634823
model_217	-2.516947	.1644348	-15.31	0.000	-2.839238	-2.194656
model_218	-.7608816	.1156816	-6.58	0.000	-.9876164	-.5341468
model_219	.0767053	.150761	0.51	0.611	-.2187848	.3721953
model_220	.4196304	.1200409	3.50	0.000	.1843514	.6549094
model_221	-2.335034	.1663615	-14.04	0.000	-2.661101	-2.008967
model_222	.3600395	.1242998	2.90	0.004	.1164132	.6036658
model_223	-1.053653	.142523	-7.39	0.000	-1.332996	-.7743089
model_224	-1.873851	.1398089	-13.40	0.000	-2.147875	-1.599827
model_225	-2.292636	.1130187	-20.29	0.000	-2.514152	-2.071121
model_226	-1.706624	.1192039	-14.32	0.000	-1.940262	-1.472985
model_227	-2.202661	.113114	-19.47	0.000	-2.424364	-1.980959
model_228	-2.282347	.1137568	-20.06	0.000	-2.505309	-2.059385
model_229	-2.209501	.1127903	-19.59	0.000	-2.430569	-1.988433
model_230	-1.269717	.1172371	-10.83	0.000	-1.499501	-1.039934
model_231	-2.645316	.1091542	-24.23	0.000	-2.859257	-2.431375
model_232	-2.889639	.1083057	-26.68	0.000	-3.101917	-2.677361
model_233	-2.716823	.1096513	-24.78	0.000	-2.931739	-2.501908
model_234	-1.328426	.1187724	-11.18	0.000	-1.561218	-1.095633
model_235	-2.748504	.1243716	-22.10	0.000	-2.992271	-2.504737
model_236	-1.95054	.1140132	-17.11	0.000	-2.174005	-1.727076
model_238	-1.979198	.1139212	-17.37	0.000	-2.202482	-1.755914
model_239	-2.712945	.1098982	-24.69	0.000	-2.928344	-2.497545
model_240	-.3482484	.1164782	-2.99	0.003	-.5765446	-.1199523
model_241	-2.533815	.11	-23.03	0.000	-2.749414	-2.318216
model_242	-1.059078	.1156441	-9.16	0.000	-1.28574	-.8324171
model_244	.0513419	.1154053	0.44	0.656	-.1748514	.2775352
model_251	-2.564942	.1089231	-23.55	0.000	-2.77843	-2.351454
model_254	-2.822986	.1086888	-25.97	0.000	-3.036015	-2.609957
model_256	-2.831091	.1092374	-25.92	0.000	-3.045195	-2.616987
model_257	-1.749809	.1259173	-13.90	0.000	-1.996605	-1.503012
model_258	-2.492954	.1193902	-20.88	0.000	-2.726957	-2.25895
model_259	-2.657727	.1087082	-24.45	0.000	-2.870794	-2.44466
model_260	-.5621976	.1254534	-4.48	0.000	-.808085	-.3163101
model_261	-1.105502	.1115324	-9.91	0.000	-1.324104	-.8868994
model_263	-2.774918	.1087076	-25.53	0.000	-2.987984	-2.561852
model_264	-2.817926	.1137568	-24.77	0.000	-3.040889	-2.594964
model_265	-2.356303	.1143077	-20.61	0.000	-2.580345	-2.132261
model_266	-.8446464	.1136906	-7.43	0.000	-1.067479	-.6218138
model_267	-.2724396	.1147212	-2.37	0.018	-.497292	-.0475871
model_268	-2.822185	.1106561	-25.50	0.000	-3.03907	-2.605301
model_269	-2.866394	.1148113	-24.97	0.000	-3.091423	-2.641365
model_270	-2.813864	.1186158	-23.72	0.000	-3.04635	-2.581378
model_271	-2.85161	.1143737	-24.93	0.000	-3.075781	-2.627438
model_272	-2.705582	.1100714	-24.58	0.000	-2.921321	-2.489843
model_273	-2.881911	.112263	-25.67	0.000	-3.101946	-2.661877
model_274	-2.890399	.1115311	-25.92	0.000	-3.108999	-2.671799
model_275	-2.678723	.1136181	-23.58	0.000	-2.901414	-2.456033
model_276	-2.754507	.1090519	-25.26	0.000	-2.968247	-2.540766
model_277	-2.82245	.1095941	-25.75	0.000	-3.037253	-2.607646
model_278	-2.88484	.1088398	-26.51	0.000	-3.098165	-2.671515
model_279	-2.794362	.1126539	-24.80	0.000	-3.015162	-2.573561
model_280	-2.714283	.1128522	-24.05	0.000	-2.935472	-2.493094

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model_281	-2.376711	.1135891	-20.92	0.000	-2.599344	-2.154077
model_282	-1.746572	.1139877	-15.32	0.000	-1.969987	-1.523157
model_283	-1.630853	.1166616	-13.98	0.000	-1.859509	-1.402198
model_284	-1.440837	.1161358	-12.41	0.000	-1.668462	-1.213212
model_285	-1.424191	.1140764	-12.48	0.000	-1.64778	-1.200602
model_286	-1.543228	.116885	-13.20	0.000	-1.772322	-1.314135
model_287	.7115623	.1155671	6.16	0.000	.4850519	.9380726
model_288	.5792939	.1114729	5.20	0.000	.3608082	.7977797
model_289	-1.679638	.1145667	-14.66	0.000	-1.904187	-1.455088
model_290	-.4170867	.1166076	-3.58	0.000	-.6456365	-.1885368
model_292	-1.903258	.1975473	-9.63	0.000	-2.290449	-1.516067
model_293	-2.598853	.1241642	-20.93	0.000	-2.842214	-2.355493
model_294	-2.409937	.1130483	-21.32	0.000	-2.63151	-2.188363
model_295	-1.760892	.1145942	-15.37	0.000	-1.985496	-1.536289
model_296	-1.077291	.1154043	-9.33	0.000	-1.303483	-.8510999
model_297	-1.730264	.1135209	-15.24	0.000	-1.952764	-1.507764
model_298	-2.208051	.1241844	-17.78	0.000	-2.451452	-1.964651
model_299	-1.653858	.1133006	-14.60	0.000	-1.875926	-1.43179
model_300	-.1256868	.1148263	-1.09	0.274	-.3507453	.0993717
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model_302	-1.467728	.1135821	-12.92	0.000	-1.690348	-1.245109
model_303	-2.033464	.1146541	-17.74	0.000	-2.258185	-1.808743
model_304	-.6185257	.1115308	-5.55	0.000	-.8371249	-.3999264
model_305	-1.804648	.1173007	-15.38	0.000	-2.034556	-1.574739
model_306	-.9087831	.116476	-7.80	0.000	-1.137075	-.6804912
model_307	-2.20996	.1148529	-19.24	0.000	-2.435071	-1.98485
model_308	-2.599587	.1303154	-19.95	0.000	-2.855004	-2.34417
model_309	-1.93261	.1134532	-17.03	0.000	-2.154978	-1.710243
model_310	-1.594863	.1111294	-14.35	0.000	-1.812675	-1.37705
model_311	-1.66208	.1089904	-15.25	0.000	-1.8757	-1.44846
model_312	-2.821939	.1093872	-25.80	0.000	-3.036336	-2.607541
model_313	-2.549115	.2079534	-12.26	0.000	-2.956702	-2.141528
model_314	.034325	.1134303	0.30	0.762	-.1879973	.2566473
model_315	.2923209	.1130156	2.59	0.010	.0708113	.5138305
model_316	-.6443191	.1133068	-5.69	0.000	-.8663993	-.4222389
model_317	-2.121814	.1085055	-19.55	0.000	-2.334483	-1.909144
model_318	-1.391729	.115829	-12.02	0.000	-1.618753	-1.164705
model_319	-.940017	.1108505	-8.48	0.000	-1.157283	-.722751
model_320	-2.145275	.1090513	-19.67	0.000	-2.359015	-1.931536
model_321	-2.041581	.1130948	-18.05	0.000	-2.263246	-1.819917
model_322	-1.097995	.1159925	-9.47	0.000	-1.325339	-.8706506
model_323	-.999652	.1121192	-8.92	0.000	-1.219405	-.7798995
model_324	-2.790804	.203844	-13.69	0.000	-3.190336	-2.391272
model_325	-1.540022	.1098731	-14.02	0.000	-1.755373	-1.324672
model_326	-2.294346	.1099896	-20.86	0.000	-2.509924	-2.078767
model_327	-2.224669	.1114444	-19.96	0.000	-2.443099	-2.006239
model_328	-1.358954	.113295	-11.99	0.000	-1.581011	-1.136897
model_329	-2.814906	.1113627	-25.28	0.000	-3.033176	-2.596636
model_330	-1.493576	.1082945	-13.79	0.000	-1.705832	-1.28132
model_331	-2.810829	.1153464	-24.37	0.000	-3.036907	-2.584751
model_332	-2.893182	.1110986	-26.04	0.000	-3.110934	-2.67543
model_333	-2.849137	.1089597	-26.15	0.000	-3.062697	-2.635577
model_334	-2.828863	.1087593	-26.01	0.000	-3.04203	-2.615695
model_335	-2.879296	.1110158	-25.94	0.000	-3.096886	-2.661706

model_336	-2.848462	.1116662	-25.51	0.000	-3.067327	-2.629598
model_337	-2.784691	.1096307	-25.40	0.000	-2.999566	-2.569816
model_338	-1.635886	.1224735	-13.36	0.000	-1.875933	-1.395839
model_339	-1.947293	.1109086	-17.56	0.000	-2.164672	-1.729913
model_340	-1.101542	.116826	-9.43	0.000	-1.33052	-.8725644
model_341	-1.233908	.114949	-10.73	0.000	-1.459207	-1.008609
model_342	-1.264097	.1303901	-9.69	0.000	-1.51966	-1.008533
model_343	-1.694899	.1268133	-13.37	0.000	-1.943452	-1.446347
model_344	-1.479385	.1119363	-13.22	0.000	-1.698779	-1.259991
model_345	-1.698091	.1146353	-14.81	0.000	-1.922775	-1.473407
model_346	-2.17629	.1132686	-19.21	0.000	-2.398296	-1.954285
model_347	-1.963272	.1105235	-17.76	0.000	-2.179897	-1.746647
model_348	-2.107597	.1146646	-18.38	0.000	-2.332339	-1.882856
model_349	-1.841807	.1137016	-16.20	0.000	-2.064661	-1.618953
model_350	-2.096783	.1136336	-18.45	0.000	-2.319504	-1.874063
model_351	-1.828405	.1135573	-16.10	0.000	-2.050976	-1.605833
model_352	-1.667598	.1135433	-14.69	0.000	-1.890142	-1.445054
model_353	-2.100014	.1140869	-18.41	0.000	-2.323624	-1.876405
model_354	-2.55674	.1592118	-16.06	0.000	-2.868794	-2.244687
model_355	-2.668793	.1112355	-23.99	0.000	-2.886814	-2.450773
model_356	-1.569571	.1148362	-13.67	0.000	-1.794648	-1.344493
model_357	-1.17655	.1131647	-10.40	0.000	-1.398352	-.954748
model_358	-1.650504	.1145814	-14.40	0.000	-1.875082	-1.425925
model_359	-1.804258	.1184319	-15.23	0.000	-2.036383	-1.572132
model_360	-2.036588	.1911074	-10.66	0.000	-2.411157	-1.66202
model_361	-2.276477	.1722124	-13.22	0.000	-2.614011	-1.938942
model_362	-.6934051	.1211995	-5.72	0.000	-.9309549	-.4558553
model_363	-.8231225	.152279	-5.41	0.000	-1.121588	-.524657
model_364	-1.77663	.2899764	-6.13	0.000	-2.344981	-1.208279
model_365	-2.107819	.1415796	-14.89	0.000	-2.385314	-1.830325
model_366	-1.613436	.13496	-11.95	0.000	-1.877956	-1.348915
model_367	-2.730172	.1131594	-24.13	0.000	-2.951964	-2.508381
model_368	-.1510788	.3998537	-0.38	0.706	-.9347881	.6326306
model_369	-1.833421	.1992386	-9.20	0.000	-2.223926	-1.442915
model_370	-1.593233	.1712675	-9.30	0.000	-1.928916	-1.257551
model_371	-1.984316	.1476237	-13.44	0.000	-2.273658	-1.694975
model_372	-1.820114	.1168986	-15.57	0.000	-2.049234	-1.590994
model_373	-2.866686	.1151177	-24.90	0.000	-3.092315	-2.641056
model_374	-2.726043	.1450812	-18.79	0.000	-3.010401	-2.441685
model_375	-2.839747	.1127503	-25.19	0.000	-3.060737	-2.618758
model_376	-2.388535	.1899813	-12.57	0.000	-2.760896	-2.016173
model_377	-.2467408	.2226515	-1.11	0.268	-.6831356	.1896539
model_378	-1.488452	.3890805	-3.83	0.000	-2.251046	-.725858
model_379	-2.783661	.1423708	-19.55	0.000	-3.062706	-2.504616
model_380	-1.031861	.2401068	-4.30	0.000	-1.502468	-.5612544
model_381	-.1269592	.1300272	-0.98	0.329	-.3818113	.1278929
model_382	-.9790272	.1306178	-7.50	0.000	-1.235037	-.7230176
model_383	-2.626127	.2042134	-12.86	0.000	-3.026384	-2.225871
model_384	-.5961772	.2393825	-2.49	0.013	-1.065364	-.1269899
model_385	-1.611681	.1891344	-8.52	0.000	-1.982382	-1.240979
model_386	-.5778148	.1209795	-4.78	0.000	-.8149335	-.3406961
model_387	-1.994396	.1289456	-15.47	0.000	-2.247129	-1.741664
model_388	-1.351811	.1228833	-11.00	0.000	-1.592661	-1.110961
model_389	-1.139033	.1286956	-8.85	0.000	-1.391275	-.8867907

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model_390	-1.605087	.1275948	-12.58	0.000	-1.855172	-1.355002
model_391	-1.886175	.1741873	-10.83	0.000	-2.22758	-1.544769
model_392	-2.037435	.1504168	-13.55	0.000	-2.332251	-1.74262
model_393	1.048251	.1344638	7.80	0.000	.7847027	1.311798
model_394	.1718319	.1272737	1.35	0.177	-.0776232	.4212871
model_395	-1.231032	.4231697	-2.91	0.004	-2.06044	-.4016235
model_396	.010984	.134046	0.08	0.935	-.2517448	.2737128
model_397	-.5866661	.1293278	-4.54	0.000	-.8401473	-.3331848
model_398	1.162322	.1304413	8.91	0.000	.9066578	1.417985
model_400	-3.040217	.116623	-26.07	0.000	-3.268797	-2.811637
model_402	-3.083495	.1342501	-22.97	0.000	-3.346624	-2.820367
model_403	-3.170139	.1069265	-29.65	0.000	-3.379714	-2.960564
model_404	-.4003031	.2890126	-1.39	0.166	-.9667649	.1661587
model_405	-1.794543	.241716	-7.42	0.000	-2.268304	1.320782
model_406	-1.819232	.1728339	-10.53	0.000	-2.157985	1.480479
model_407	-1.310312	.2037314	-6.43	0.000	-1.709624	.9110006
model_408	-2.044483	.294534	-6.94	0.000	-2.621767	1.467199
model_409	-.9378824	.3021755	-3.10	0.002	-1.530143	.3456214
model_410	-1.391212	.2802371	-4.96	0.000	-1.940474	.8419496
model_411	-2.423395	.2953897	-8.20	0.000	-3.002356	1.844434
model_412	-2.951032	.150376	-19.62	0.000	-3.245768	2.656296
model_413	2.538648	1.176912	2.16	0.031	.2319123	4.845384
model_414	-1.947444	.40348	-4.83	0.000	-2.738261	-1.156627
_cons	3.376557	.1083629	31.16	0.000	3.164166	3.588947

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EM&V Report for the Duke Energy Multifamily Energy Efficiency Program

Prepared for:

Duke Energy Progress, Duke Energy Carolinas

DUKE ENERGY®

October 4, 2016

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NAVIGANT

EM&V Report for the Duke Energy Multifamily Energy Efficiency Program

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1. EVALUATION SUMMARY

1.1 Program Summary

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment to multifamily housing properties at no cost to the property managers or tenant end-users. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. The program consists of lighting and water measures.

- **Lighting measures:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

For this evaluation cycle, Navigant assessed the following:

Duke Energy Progress: lighting and water measures installed between 1/1/15 and 2/29/16
Duke Energy Carolinas: lighting measures installed between 1/1/14 and 2/29/16[1]

Franklin Energy is the implementation contractor for the program. Customers (i.e., property managers) have the option to choose self-installation or direct installation through Franklin Energy. Duke Energy informed Navigant that most customers choose the direct install route by Franklin Energy. Duke Energy also informed Navigant that third-party quality control inspections are completed on 20 percent of properties in any given month. Within a selected property, the quantity of units to inspect is based on property size as defined by the number of housing units.

1.2 Evaluation Objectives and Program-Level Findings

Duke Energy selected Navigant to provide independent Evaluation, Measurement, and Verification (EM&V) for the Multifamily Energy Efficiency Program in the Duke Energy Progress (DEP) and Duke Energy Carolinas (DEC) jurisdictions. EM&V is a term used to describe the process of evaluating a program to assess the impacts as well as the program structure and delivery. For this EM&V effort, the evaluation approach and objectives can be described as follows:

- **Impact evaluation:** To quantify the net and gross energy and coincident demand savings associated with program activity at both the measure level and program level
- **Process evaluation:** To assess program delivery and customer satisfaction

By performing both components of the EM&V effort, Navigant is able to provide Duke Energy with verified energy and demand impacts, as well as a set of recommendations that are intended to aid Duke Energy with improving or maintaining the satisfaction with program delivery while meeting energy and demand reduction targets in a cost-effective manner.

[1] Navigant completed an evaluation report in November of 2015 for water measures in DEC.

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Overall, Navigant found that the Multifamily Energy Efficiency Program is being delivered effectively, customer satisfaction is generally favorable, and the reported measure installations are accurate.

For the evaluation period covered by this report, there were a total of 26,492 housing units at 262 participating properties managed by 85 different property management companies in the DEP jurisdiction. There were 21,937 housing units at 210 properties managed by 99 different property management companies in the DEC jurisdiction. The program-level evaluation findings are presented in Table 1 though Table 4. For the DEP jurisdiction, Navigant found the realization rate for gross energy savings to be 101 percent, meaning that total verified gross energy savings were found to be slightly higher than claimed in the tracking database provided by Duke Energy. For DEC, the realization rate for gross energy savings was 103 percent. Navigant found the net-to-gross (NTG) ratio to be 0.94, meaning that for every 100 kWh of reported energy savings, 94 kWh can be attributed directly to the program. These findings will be discussed in greater detail throughout this report.

Table 1. Program Claimed and Evaluated Gross Energy Impacts

	Claimed	Evaluated	Realization Rate
DEP Gross Energy Impacts (MWh)	21,133	21,398	101%
DEC Gross Energy Impacts (MWh)	7,299	7,546	103%

Source: Navigant analysis, totals subject to rounding.

Table 2. Program Claimed and Evaluated Gross Peak Demand Impacts

	Claimed	Evaluated	Realization Rate
DEP Gross Summer Peak Demand Impacts (MW)	1.99	2.10	106%
DEP Gross Winter Peak Demand Impacts (MW)	3.32	3.72	112%
DEC Gross Summer Peak Demand Impacts (MW)	0.68	0.71	104%
DEC Gross Winter Peak Demand Impacts (MW)	0.68	0.90	132%

Source: Navigant analysis, totals subject to rounding.

Table 3. Program Net Energy Impacts

	MWh
DEP Net Energy Impacts	20,215
DEC Net Energy Impacts	7,129

Source: Navigant analysis, totals subject to rounding.

Table 4. Program Net Peak Demand Impacts

	MW
DEP Net Summer Peak Demand Impacts	1.98
DEP Net Winter Peak Demand Impacts	3.52
DEC Net Summer Peak Demand Impacts	0.67

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DEC Net Winter Peak Demand Impacts	0.85

Source: Navigant analysis, totals subject to rounding.

1.3 Evaluation Parameters and Sample Period

To accomplish the evaluation objectives, Navigant performed an engineering review of measure savings algorithms, field verification to assess installed quantities and characteristics, as well as surveys with tenants and property managers to assess satisfaction and decision-making processes. The evaluated parameters are summarized in Table 5. For field verification, the expected sampling confidence and precision was 90 percent ± 10 percent, and the achieved was 90 percent ± 9 percent.

Table 5. Evaluated Parameters

Evaluated Parameter	Description	Details
Efficiency Characteristics	Inputs and assumptions used to estimate energy and demand savings	1. CFL wattage 2. CFL operating hours 3. Aerator flow rates (gpm) 4. Showerhead flow rates (gpm) 5. Water temperature (F) 6. Pipe wrap length (ft) 7. Baseline characteristics
In-Service Rates	The percentage of program measures in use as compared to reported	1. CFL, aerator, and showerhead quantities 2. Pipe wrap length
Satisfaction	Customer satisfaction	1. Satisfaction with program 2. Satisfaction with contractor 3. Satisfaction with program measures
Free Ridership	Fraction of reported savings that would have occurred anyway, even in the absence of the program	
Spillover	Additional, non-reported savings that occurred as a result of participation in the program	

This evaluation covers program participation from January 1, 2015 through February 29, 2016 in DEP, and from January 1, 2014 through February 29, 2016 in DEC. Table 6 shows the start and end dates of Navigant's sample period for evaluation activities.

Table 6. Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification	April 4, 2016	April 15, 2016
Tenant Phone Surveys	April 21, 2016	April 30, 2016
Property Manager Interviews	April 30, 2016	May 18, 2016

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1.4 Evaluation Recommendations

Navigant developed a series of recommendations during the EM&V effort. These recommendations are intended to assist Duke Energy with enhancing the program delivery and customer experience, as well as to support future EM&V activities and possibly increase program impacts. Further explanation for each recommendation can be found later in this report.

1. Navigant recommends that Duke Energy should adopt the ex post, per-unit energy and demand impacts from this evaluation and use them going forward (with the possible exception of making an appropriate adjustment for the lighting measure baseline as discussed in Section 4 of this report).
2. Navigant recommends that no more than the first three feet of cold water inlet pipes be insulated for the water heater pipe wrap measure.
3. Duke Energy should consider adding LEDs to the program.

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2. PROGRAM DESCRIPTION

2.1 Design

The Multifamily Energy Efficiency Program is designed to provide energy efficiency to a sector that is often underserved or difficult to reach via traditional, incentive-based energy efficiency programs. This market can be difficult to penetrate because multifamily housing units are often tenant-occupied rather than owner-occupied, meaning that the benefits of participation may be realized by the tenant whereas the incremental costs of participating in the program are absorbed by the owner.

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment to multifamily housing properties at no cost to the property managers or tenant end-users. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. The program consists of lighting and water measures.

- **Lighting measures:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

2.2 Implementation

Franklin Energy is the implementation contractor for the program. To recruit participants, Franklin Energy conducts onsite visits, in combination with internet searches, and SalesGenie[2] lists, to identify properties, property managers, or property management companies that it believes are likely to participate. Franklin Energy then sends an outreach team of energy advisors to coordinate with property managers and explain the program delivery and benefits. This is considered an Energy Assessment. This is also an opportunity for energy advisors to determine the type of measures along with associated quantities that can be installed. One potential delay in committing to the program is the need for the property manager to get approval to participate from their corporate office.

Once a property has been fully assessed and a service agreement has been signed, the project is handed over to a different group at Franklin Energy to schedule the installations. The installation crew performs the work as scheduled, while displaying Duke Energy branded clothing, badges, and vehicle decals as directed. The installation crews record the quantities and locations of installed measures for each housing unit via a tablet device, which are eventually entered into a tracking database.

When energy efficient program measures are installed, Franklin Energy removes the existing or baseline equipment and generally disposes of it onsite. If the property management previously requested to keep the existing equipment, Franklin Energy will package it up and leave it behind with property management or maintenance personnel. In general, Franklin Energy does not record specific information about the

[2] SalesGenie is a business and consumer lead generation tool that sales and marketing professionals can use to search for targeted leads, get contact names and phone numbers, and view detailed information. The tool also provides marketing and data solutions designed to help businesses reach their intended audiences more effectively.

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efficiency characteristics of the equipment being removed, although Franklin Energy indicated they are experimenting with the idea of doing so.[3]

There can be logistical complications associated with performing these types of retrofits at multifamily housing properties. Franklin Energy indicated that some units may be skipped at a property due to safety issues, lack of access to equipment, pet barriers, or refusal from tenants.

Franklin Energy indicated that they have internal and external forms of quality control (QC) to ensure consistent measure installation. On the internal side, a Franklin Energy supervisor may accompany installation crews to ensure quality work. On the external side, a third-party inspector, High Performance Building Solutions, conducts inspections on a least five percent of participating housing units each year. The QC inspections are required to happen within 22 business days of installation. If a property is selected for a QC inspection, at least 20 percent of the units at the property are targeted for inspection.

During each month of QC inspections, Franklin Energy is provided with a discrepancy report that indicates when measures were missing, installed incorrectly, or if there were missed opportunities. Franklin Energy attempts to address the discrepancies, and subsequently updates the tracking data to reflect the QC findings. The tracking data is ultimately provided to Duke Energy, and subsequently to Navigant for EM&V.

[3] During the property assessment phase, Franklin Energy determines that housing units selected for participation contain lower efficiency light bulbs (incandescents) and standard aerators and showerheads.

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3. KEY RESEARCH OBJECTIVES

As outlined in the Statement of Work, the key research objectives were to conduct impact and process evaluations, as well as a net-to-gross (NTG) analysis. The evaluation covers both lighting and water measures in DEP, and lighting measures only in DEC.

The primary purpose of the evaluation, measurement, and verification (EM&V) assessment is to estimate net annual energy and demand impacts associated with participation from January 1, 2015 through February 29, 2016 in DEP, and January 1, 2014 through February 29, 2016 for DEC. Secondary objectives include the following:

- Estimate net and gross impacts by measure
- Perform detailed review of deemed savings estimates for each measure, and provide updates if necessary
- Assess the installed quantities and efficiency characteristics of program measures
- Evaluate the strengths and weaknesses of current program processes and customer perceptions of the program offering and delivery
- Recommend improvements to program rules and processes that support greater savings, enhanced cost-effectiveness, and improved customer satisfaction
- Update measure life assumptions, if applicable

Key impact and process research questions to be explored include:

- Is the program achieving targeted energy and demand savings at the measure level?
- How do customers learn about the program, and can participation be increased?
- How is the persistence of savings impacted by participant removal of measures installed through the program?
- Are there opportunities for additional measure offerings through the program?
- Provide the effect on baseline lamp wattage from EISA, including some discussion on the projected degradation of baseline lamp wattage in future years.

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4. IMPACT EVALUATION

4.1 Impact Results

Figure 1**Error! Reference source not found.** shows the program-level results for gross energy savings. Table 7 shows a more complete list of program-level findings. The evaluation team calculated the results in Table 7 by multiplying the measure quantities found in the tracking database by the verified energy and demand savings estimated during the EM&V process for each measure. The net impacts were found by multiplying the gross impacts by the NTG ratio of 0.94. The NTG methodology and results are discussed in detail in Section 5 of this report.

Figure 1. Reported and Verified Program-Level Impacts

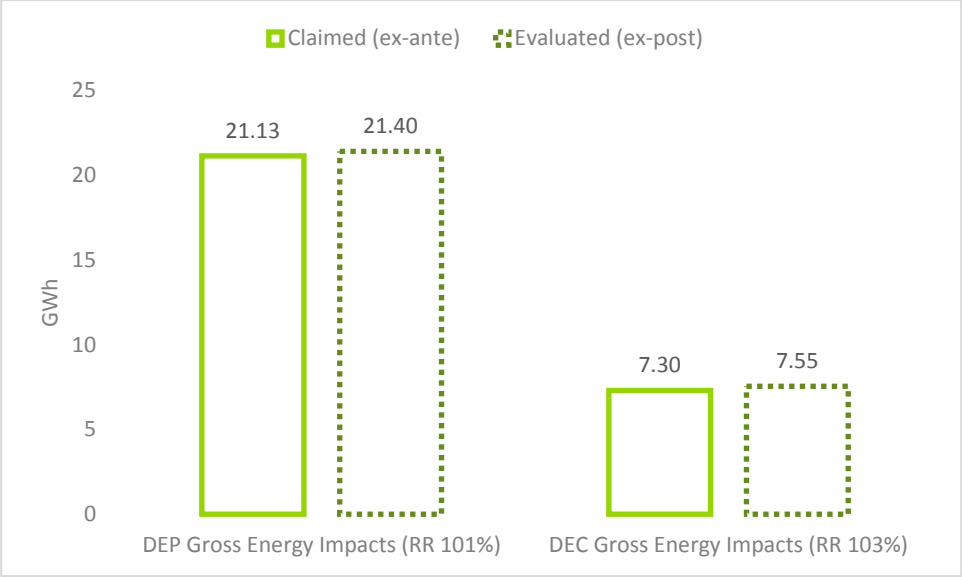

Table 7. Summary of Program Impacts

	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
DEP Verified Gross Impacts	21,398	2.10	3.72
DEP Verified Net Impacts	20,215	1.98	3.52
DEC Verified Gross Impacts	7,546	0.71	0.90
DEC Verified Net Impacts	7,129	0.67	0.85

Source: Navigant analysis

A summary of each measure's contribution to program savings and realization rate between reported savings and verified savings is shown in Table 8 for DEP, and Table 9 for DEC. Compact Fluorescent Light (CFL) bulbs account for just under half of the energy savings for DEP. By dividing the total verified

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savings by the total reported savings in the tracking data in Table 8, Navigant calculates a gross realization rate of 101 percent for energy savings at the program level for DEP. The corresponding realization rate for DEC is 103 percent, as shown in Table 9.

Table 8. Distribution of Program Energy Savings by Measure (DEP)

Measure	Measure Count from Tracking Data	Total Ex Ante Savings from Tracking Data (MWh)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MWh)	Realization Rate
CFLs	238,783	9,718	46%	10,047	103%
Bathroom Faucet Aerators	28,710	1,239	6%	1,134	92%
Kitchen Faucet Aerators	18,862	1,715	8%	1,629	95%
Showerheads	24,743	5,741	27%	5,857	102%
Pipe Wrap (ft)	73,338	2,720	13%	2,731	100%
Total	384,436	21,133	100%	21,398	101%

Source: Navigant analysis

Table 9. Distribution of Program Energy Savings by Measure (DEC)

Measure	Measure Count from Tracking Data	Total Ex Ante Savings from Tracking Data (MWh)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MWh)	Realization Rate
CFLs	179,338	7,299	100%	7,546	103%

Source: Navigant analysis

The realization rate for summer coincident demand is 106 percent at the program level for DEP, as shown in Table 10. The realization rate for summer coincident demand is 104 percent at the program level for DEC, as shown in Table 11. The realization rate for winter coincident demand is 112 percent for DEP and 132 percent for DEC, as shown in Table 12 and Table 13, respectively. These realization rates include adjustments to the estimated savings for each measure which will be discussed during the remainder of this report. On a measure level, the largest adjustments were made to the energy savings for bathroom faucet aerators due to the in-service rates found during field verification.

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Table 10. Distribution of Summer Coincident Demand Savings by Measure (DEP)

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.907	46%	0.941	104%
Bathroom Faucet Aerators	0.163	8%	0.149	92%
Kitchen Faucet Aerators	0.226	11%	0.214	95%
Showerheads	0.472	24%	0.481	102%
Pipe Wrap (ft)	0.217	11%	0.312	143%
Total	1.99	100%	2.10	106%

Source: Navigant analysis

Table 11. Distribution of Summer Coincident Demand Savings by Measure (DEC)

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.681	100%	0.707	104%

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Table 12. Distribution of Winter Coincident Demand Savings by Measure (DEP)

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.907	27%	1.199	132%
Bathroom Faucet Aerators	0.143	4%	0.131	92%
Kitchen Faucet Aerators	0.197	6%	0.187	95%
Showerheads	1.856	56%	1.893	102%
Pipe Wrap (ft)	0.217	7%	0.312	143%
Total	3.32	100%	3.72	112%

Source: Navigant analysis

Table 13. Distribution of Winter Coincident Demand Savings by Measure (DEC)

Measure	Total Savings from Tracking Data (MW)	Share of Total Savings from Tracking Data	Total Verified Ex Post Gross Savings (MW)	Realization Rate
CFLs	0.681	100%	0.901	132%

Source: Navigant analysis

4.2 Impact Evaluation Methodology

Navigant's methodology for evaluating the gross and net energy and demand impacts of the program included the following components:

1. Detailed review of deemed savings estimates including: engineering algorithms, key input parameters, and supporting assumptions.
2. Onsite field verification to assess measure characteristics and in-service rates (ISRs)
3. Net-to-gross (NTG) analysis
4. Incorporating supplemental impact findings from tenant surveys

4.2.1 Detailed Review of Ex Ante Deemed Savings

Navigant reviewed the ex-ante savings and supporting documentation used to estimate ex ante program impacts. For the compact fluorescent lighting measure in both DEP and DEC, Navigant believes the

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deemed savings are well-documented in the previous EM&V report and that the algorithms and assumptions used to estimate savings are reasonable.[4]

The deemed savings for the 13 watt CFLs are shown in Table 14 below. The baseline lamp is assumed to be a 60 watt incandescent.

Table 14. Ex Ante Savings and Parameters for CFLs

Program measure	kWh savings	Non-coincident kW savings	Coincident kW savings	Coincidence factor	Average baseline wattage	EE wattage	Average daily hours of use
13 watt CFL	40.7	0.0469	0.0038	0.081	55.33	13	2.89

Navigant was able to trace all of these findings to the previous EM&V report provided by Duke Energy. The impacts were calculated using the following algorithms:

Equation 1. Energy Savings Algorithm for CFLs

$$kWh\ savings = ISR\ x \left[\frac{(Watts_{base}\ x\ HOU_{base}) - (Watts_{EE}\ x\ HOU_{EE})}{1000}\right] x\ 365\ x\ (1 + HVAC_C)$$

Equation 2. Coincident Demand Savings Algorithm for CFLs

$$kW\ savings^{5} = ISR\ x \left[\frac{Watts_{base} - Watts_{EE}}{1000}\right] x\ CF\ x\ (1 + HVAC_d)$$

Where the parameters are defined as:

ISR = in-service rate
$Watts_{base}$ = wattage of baseline lamp removed
$Watts_{EE}$ = wattage of CFL lamp installed
HOU_{base} = daily operating hours of baseline lamp removed
$HOUs_{EE}$ = daily operating hours of CFL lamp installed
$HVAC_C$ = HVAC interaction factor for energy
$HVAC_D$ = HVAC interaction factor for demand
CF = coincidence factor

[4] *Process and Impact Evaluation of Duke Energy's Residential Smart $aver: Property Manager CFLs in the Carolinas*, TecMarket Works, 2013.

[5] To calculate winter coincident demand savings, the HVAC interaction factor, $HVAC_d$, is subtracted instead of added. This conservative assumption accounts for a mix participants who will have electric heat pumps for heating, as well as those who may use auxiliary electric heating to supplement gas during winter coincident peak periods.

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For water measures, the deemed savings for DEP were based on Navigant's recent EM&V of water measures in the DEC, so little review was needed.[6]

4.2.2 Onsite Field Verification

Navigant performed onsite field verification at 123 housing units across 16 properties. Field verification efforts were designed to assess the measure characteristics as reported in the tracking data and to assess measure parameters that can be used to verify inputs and assumptions used to estimate energy and demand savings for individual measures. Table 15 shows a summary of the parameters assessed by Navigant during field verification, and Table 16 shows the field verification sample.

Table 15. Parameters Evaluated During Field Verification

	CFLs	Faucet Aerators	Water-saving Showerheads	Hot Water Pipe Wrap
Installed quantity	x	x	x	x
Installed wattage	x			
Flow rates (gpm)		x	x	
Water heating system characteristics		x	x	x
Water Temperatures		x	x	x
Pipe length				x
Measure location	x	x	x	x
Baseline information (where available)	x	x	x	x

Table 16. Field Verification Sample

Program Measure	Number of Housing Units in Sample[a]	Number of Measures Reported in Sample
CFLs	123	1,181
Bathroom Faucet Aerators	73	97
Kitchen Faucet Aerators	76	76
Showerheads	76	91
Pipe Wrap	31	162 ft

a. Totals exceed 123 because many sites had multiple measures

Source: Navigant analysis

A summary of findings from field verification is included in Section 4.3.

[6] Please refer to Navigant's report, titled "Multifamily Energy Efficiency Program, Evaluation, Measurement, and Verification for Duke Energy Carolinas", dated 11-3-15 for more information.

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4.2.3 Tenant Surveys

Navigant incorporated supplemental findings from 150 tenant phone surveys to inform the impact analysis where applicable. The findings from the tenant surveys will be addressed later in this report.

4.3 Impact Evaluation Findings

The impact evaluation findings for lighting measures and water measures are discussed separately.

4.3.1 Compact Fluorescent Light Bulbs

Table 17 shows a summary of Navigant's ex-post, verified findings for CFLs. The energy savings per bulb increased slighted from the 40.7 kWh provided in the deemed savings to 42.1 kWh. To calculate verified energy and demand impacts, Navigant assessed the parameters that were used in the algorithms to estimate ex-ante savings. Table 18 lists all parameters used to calculate ex-post savings.

Table 17. Summary of CFL findings

	Ex-Post	Ex-Ante
In-Service Rate[1]	84.6%	94.7%
Daily Operating Hours	2.64	2.89
Gross Energy Savings Per Bulb (kWh)	42.1	40.7
Gross Summer Coincident Demand Savings Per Bulb (kW)	0.0039	0.0038
Gross Winter Coincident Demand Savings Per Bulb (kW)	0.0050	N/A

1. *Navigant did not account for vacant housing units, so the actual number of CFLs in use may be lower.*

Source: Navigant analysis

Table 18. Calculation parameters for ex post CFL impacts

Program measure	ISR	Average baseline wattage	EE wattage	Average daily hours of use for baseline lamps	Average daily hours of use for CFLs	Summer coincidence factor	Winter coincidence factor	Energy HVAC interaction factor[a]	Demand HVAC interaction factor[a,b]
13 watt CFL	84.6%	60	13	2.64	2.64	0.082	0.32[c]	1.1	1.21

a. Sourced from 2016 Mid-Atlantic TRM

b. The demand HVAC interaction factor is added for summer coincident demand impacts, and subtracted for winter. Navigant also adjusted the interaction factor for winter demand to account for 50% of participants having gas heating per the 2013 Duke Energy Residential Appliance Saturation Survey.

c. Source: *Coincidence Factor Study, Residential and Commercial & Industrial Lighting Measures*, prepared for: New England State Program Working Group

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4.3.1.1 In-Service Rate

At the 123 housing units inspected by Navigant that had CFLs, there were a total of 1,181 reported program CFLs in the tracking database. During the inspections, Navigant found 844 CFLs. Additionally, during phone surveys with tenants, 13 respondents indicated they had removed a total of 41 CFLs. The predominant reason for removing CFLs was burnout. Navigant used a weighted average to combine the ISR from field verification with the ISR from phone surveys to calculate a final ISR.

4.3.1.2 Wattage

Navigant assessed the wattage of CFLs inspected during the onsite verification and found them to be 13 watts as reported. However, there is potential uncertainty in the wattages of lamps removed during the retrofit process, or at least whether that wattage should be the baseline going forward. The time period covered by this evaluation is January of 2014 through February of 2016. The Energy Independence and Security Act (EISA) of 2007 established that as of January 1st, 2014, 60 watt incandescent bulbs could no longer be manufactured or imported. The new, EISA compliant wattage was 43. However, Navigant's experience has shown that there was considerable lag between the EISA compliance schedule and actual market activity, and potential back stocking of incandescents by multifamily maintenance staff. Because Duke Energy's Multifamily Energy Efficiency Program is a retrofit program (rather than replace on burnout), it is important to consider the actual characteristics of the lamps removed because they likely had remaining useful life. Franklin Energy has indicated that they only remove incandescent lamps during the retrofit process.

Figure 2**Error! Reference source not found.** shows the results of customer self-reporting from tenant phone surveys with regards to the wattage of lamps removed during participation in the program. It can be seen that a large number of respondents were not sure, but more than half (51 percent) of respondents indicated that the lamps were 60 watts or higher. Additionally, during Navigant's field verification efforts, seven tenants were able to recall the lamps removed, and all seven indicated they were 60 watt incandescents. High rates of tenant turnover at multifamily housing units could explain why so many customers did not know what type of lamps were removed.

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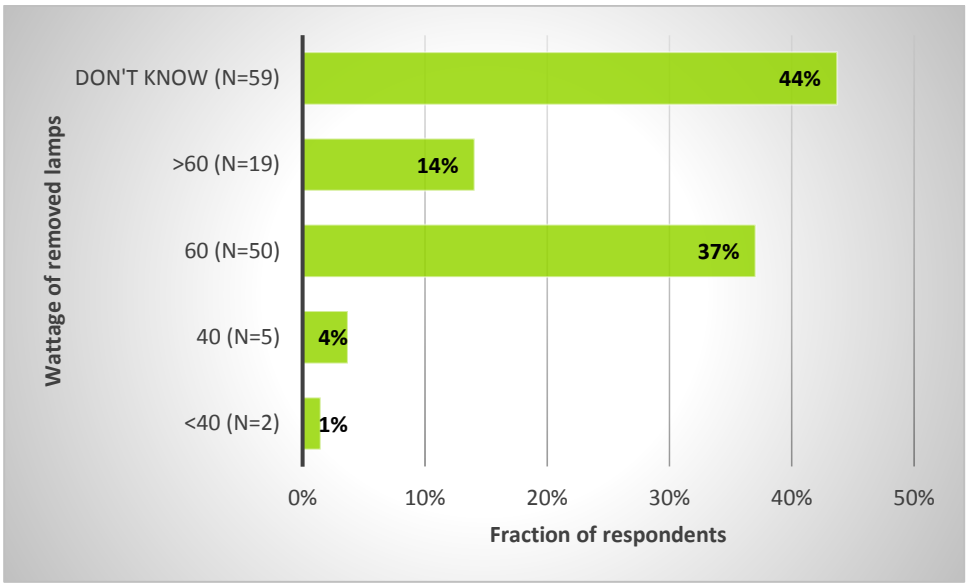
Figure 2. Customer self-reporting of wattage of lamps removed



Given that the period of time covered by this evaluation coincides with important EISA compliance dates that may have experienced a lag in market uptake, along with the results shown in Figure 2, Navigant believes that a baseline wattage assumption of 60 watts was appropriate for this evaluation cycle. However, as will be discussed later in this report, Navigant suggests further research be conducted to understand the lighting baseline for future evaluation cycles.

4.3.1.3 HVAC Interaction and Coincidence Factors

Navigant reviewed the ex-ante assumptions for HVAC interaction factors and summer coincidence factors and chose to replace them with updated values from the 2016 Mid-Atlantic TRM. For a winter coincidence factor, Navigant used a secondary literature source.[7]

4.3.1.4 Lighting Hours of Use

The hours of use for CFLs are an important parameter input to the energy savings algorithm, however the scope and budget of this evaluation did not support a full metering study to quantify operation hours. Navigant assessed the lighting operation hours via the following methods:

1. Collected self-report data from program participants during tenant phone surveys
2. Performed extensive review of the previous estimates for deemed savings
3. Performed a literature review to assess estimates from secondary sources

[7] RLW Coincidence Factor Study for New England State Program Working Group, https://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/National%20Grid/116_RLW_CF%20Res%20C&I%20ltg.pdf

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Navigant collected self-reported hours of use estimates from participants during the tenant phone surveys with 150 participants. The average self-reported estimate was 2.64 hours per day. Navigant recognizes that significant uncertainty exists in customer ability to estimate hours of use. For that reason, the evaluation team compared the self-report estimate of 2.64 with other sources.

Table 19 shows a comparison of estimated CFL operating hours from several sources. The previous assumptions used for ex-ante savings were based on a self-report results from customer phone surveys, which were then corrected for self-reporting bias by using the results of a different study.[8] The evaluation team also compared the self-report hours of use with other studies, and believes that the self-reported value of 2.64 is appropriate for this evaluation.

Table 19. Comparison of CFL Operating Hours

Estimated Daily CFL Usage Hours	Method	Source
2.89	Customer self-report, bias corrected	TecMarket Works, previous EM&V study for Property Manager CFL Program for Duke Energy[8]
2.21	Metering study	Navigant metering study for similar multifamily program in Southwestern U.S.
1.5-1.6	Meta data analysis	U.S. Department of Energy *Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates* (2012)[9]

Source: Navigant analysis

4.3.1.5 Effect of Baseline Wattage Requirements for EISA

It is important to address the topic of CFL baseline in more detail. The Energy Independence and Security Act (EISA) was enacted to increase the availability of reduced wattage lighting options, and hence shift the lighting market toward higher efficiency. In theory, this would eventually cause the program CFL baseline to eventually shift to a lower wattage as 60 watt incandescents become less-prominent. There is still uncertainty around what the exact baseline is in Duke Energy's service territories.

Navigant believes that EISA standards should be applied to new construction applications or replace-on-burnout scenarios. However, the Multifamily Energy Efficiency Program is primarily a direct install retrofit program targeting existing homes where the existing lamps likely have remaining useful life. The program implementer requires that all lamps being removed are incandescents. Furthermore, some program participants have reported that the lamps removed were higher than 60 watts. Due to the changing market for residential lighting, Navigant suggests that further research be conducted in future evaluation years to assess the baseline.

[8] *Process and Impact Evaluation of Duke Energy's Residential Smart $aver: Property Manager CFLs in the Carolinas*, TecMarket Works, 2013.

[9] http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf

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4.3.2 Water Flow Regulation Measures

For field verification of program water measures, Navigant collected information to validate the efficiency characteristics of the equipment. This included verifying the reported number of measures and measuring actual flow rates of the retrofit equipment.

4.3.2.1 In-Service Rate

The ISRs for water measures are shown in Table 20. These were calculated using a weighted average of results from the onsite field verification inspections and the tenant phone surveys.

Table 20. In-Service Rates for Water Measures

Measure	ISR
Kitchen aerators	94%
Bathroom aerators	92%
Showerheads	95%
Pipe wrap	93%

Source: Navigant analysis

4.3.2.2 Energy Savings

The deemed savings for water measures in DEP are based on a recent EM&V report by Navigant for DEC, which was completed in November of 2015. The evaluation team used a similar approach for DEP, but supplemented or replaced inputs with data gathered during field verification. To calculate verified savings for aerators and showerheads, Navigant used a standard engineering equation taken shown in Equation 3, Equation 4, and Equation 5. Navigant subsequently applied inputs collected during field verification or assumptions as listed below in Table 21. The resulting estimates for impacts of aerators and showerheads are presented in Table 22.

Equation 3. Algorithm for Estimating Energy Savings for Faucet Aerators

$$kWh\ savings\ for\ faucet\ aerators = ISR \times \left[\frac{(GPM_{base} - GPM_{low}) \times T_{home/day} \times 365\frac{days}{yr} \times DF \times (T_{out} - T_{in}) \times 8.3\frac{Btu}{gal \cdot °F}}{\#_{faucets} \times 3412\frac{Btu}{kWh} \times RE}\right]$$

Equation 4. Algorithm for Estimating Energy Savings for Low Flow Showerheads

$$kWh\ savings\ for\ low\ flow\ showerheads = ISR \times \left[\frac{(GPM_{base} - GPM_{low}) \times T_{home/day} \times N_{showers/day} \times 365\frac{days}{yr} \times (T_{out} - T_{in}) \times 8.3\frac{Btu}{gal \cdot °F}}{\#_{showers} \times 3412\frac{Btu}{kWh} \times RE}\right]$$

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Equation 5. Algorithm for Estimating Coincident Demand Savings for Aerators and Showerheads

$$\Delta kW_{peak} = \Delta\, kWh/yr \times CF/365$$

Table 21. Input Parameters and Assumptions for Aerator Savings Calculations

Input	Definition	Value	Source
ISR	In-service rate	Refer to Table 20	Navigant field verification and phone surveys
GPM_{base}	Baseline flow rate	Aerators 2.2 Shower 2.5	Deemed savings assumptions from Duke Energy
GPM_{low}	Retrofit flow rate	Aerators 1 Shower 1.5	Deemed savings assumptions from Duke Energy[a]
$T_{home/day}$	Avg hot water use per day per home (minutes)	Kitchen 4.7 Bath 2.4 Shower 8.4	Building America Benchmark
$N_{showers/day}$	Number of showers per person per day	1	Navigant assumption
DF	Percent of water going down drain	Kitchen 75% Bath 90%	Navigant assumption
T_{out}	Temp of water flowing from faucets (F) Temp of water flowing from showerheads (F)	90[b] 105	Navigant field verification 2016 Mid-Atlantic TRM
T_{in}	Temp of water entering water heater (F)	66	Navigant field verification
#faucets/showers	Number of faucets in home (used to distribute minutes of use between different faucets)	Kitchen 1 Bathroom 1.33 Shower 1.2	Navigant field verification
RE	Recovery efficiency of water heater	0.98	Ohio TRM
CF (aerators)	Coincidence Factor	Summer 0.048 Winter 0.042	Building America Benchmark
CF (showerheads)	Coincidence Factor	Summer 0.03 Winter 0.118	Building America Benchmark

a. *Navigant measured flow rates during onsite field verification and they were lower than the reported flow rates for the measures installed. However, this was likely due to calcification or water pressure characteristics and suggests that baseline flow rates may also have been lower. Because we did not measure flow rates for baseline units, we chose to use the reported flow rates in both cases.*

b. *The actual measured hot water temperature was 109F. For analysis purposes, Navigant assumed that customers use water at a temperature of 90 degrees, or the average of 109F and 70F.*

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Table 22. Verified Estimates of per Unit Impacts for Aerators and Showerheads[10]

Measure	Annual Energy Savings per Unit (kWh)		Annual Summer Coincident Demand Savings per Unit (kW)		Annual Winter Coincident Demand Savings per Unit (kW)	
	Ex Post	Ex Ante	Ex Post	Ex Ante	Ex Post	Ex Ante
Kitchen aerator (1.0 GPM)	86	91	0.0114	0.0120	0.0099	0.010
Bathroom aerator (1.0 GPM)	40	43	0.0052	0.006	0.0045	0.005
Low flow showerhead (1.5 GPM)	237	232	0.0195	0.0190	0.0765	0.0750

Source: Navigant analysis

4.3.3 Water Heater Pipe Wrap

During field verification, Navigant found that some of the water heater pipe wrap was installed on the cold water inlet pipe to the water heater. Industry standards are to install pipe wrap on all hot water pipes, and only the first three feet of the cold water pipe because savings are minimal from insulating cold water pipes.[11] Therefore, when calculating the ISR, Navigant did not count savings from pipe wrap of greater than three feet installed on cold water pipes.

To estimate impacts from the pipe wrap measure, Navigant used algorithms from the 2016 Mid-Atlantic TRM shown in Equation 6 and Equation 7 below.[12] The ex-post impacts are shown in Table 23.

Equation 6. Energy savings for water heater pipe wrap

$$\Delta kWh = \left(\frac{1}{R_e} - \frac{1}{R_n}\right) \times (L \times C) \times \Delta T \times 8760 \div nDHW \div 3413$$

Equation 7. Demand savings from water heater pipe wrap

$$\Delta kW = \Delta kWh \div 8760$$

The following list defines the parameters used in the equations above:

R_e = R-value of existing, uninsulated pipe (R = 1)
R_n = insulation R-value of pipe after retrofit (R = 1.5)
L = length of pipe (per foot)
C = circumference of pipe (Navigant assumed average of 0.5" and 0.75" diameter pipe)
ΔT = temperature difference between water in pipe and ambient air (65F)
nDHW = heat recovery efficiency (0.98)
3413 = conversion from Btu to kWh

[10] The program offers aerators and showerheads at other flow rates. However, the tracking data indicated that 100 percent of the water measures installed during the period covered by this evaluation cycle were the flow rates shown in Table 22, so a verified savings are shown here for only those measures. A full list of savings is shown in Section 9

[11] http://www.energy.gov/energysaver/projects/savings-project-insulate-hot-water-pipes-energy-savings

[12] http://www.neep.org/mid-atlantic-technical-reference-manual-v6

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Table 23. Verified Impacts for Water Heater Pipe Wrap

Measure	Annual Energy Savings per Unit (kWh)	Annual Summer Coincident Demand Savings per Linear Foot (kW)	Annual Winter Coincident Demand Savings per Linear Foot (kW)
Ex Post	37	0.0043	0.0043
Ex Ante	37	0.0030	0.0030

Source: Navigant analysis

4.3.4 Measure Life

Navigant reviewed the measure life assumptions for all program measures and compared them to other sources from secondary literature research. The evaluation team believes all program measure lives are appropriate and not in need of an update.

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5. NET-TO-GROSS ANALYSIS

Navigant conducted an NTG analysis to estimate the share of program savings that can be attributed to participation in or influence from the program. Table 24 shows the results of Navigant's NTG analysis. Navigant anticipated low free ridership and spillover given that the program is structured to offer energy efficient equipment at no cost to multifamily housing units, which are typically not owner-occupied. The results shown here are in line with expectations. Navigant chose to present a program-level NTG ratio rather than measure level due to the limited sample size of property managers and the fact that it is difficult to estimate spillover by measure. Navigant believes it is more appropriate to present the NTG ratio in aggregate.

Table 24. NTG Results

Estimated Free Ridership	7.5%
Estimated Spillover	2.0%
Estimated NTG	0.94

Source: Navigant analysis

5.1 Overview of Net-to-Gross Methodology

As indicated in the evaluation plan, Navigant used a survey-based, self-report methodology to estimate free ridership and spillover for the Multifamily Energy Efficiency Program. A self-report approach is outlined in the Universal Methods Protocol (UMP), and Navigant has previously used this method to estimate a NTG ratio for several other Duke Energy programs in the Carolinas. Navigant primarily targeted property managers for the NTG surveys, because they are the decision makers for participation in the program.[13] Navigant also incorporated supplemental data gathered during tenant phone surveys into the analysis.

5.1.1 Definitions of Free Ridership, Spillover, and NTG Ratio

The methodology for assessing the energy savings attributable to a program is based on a NTG ratio. The NTG ratio has two main components: free ridership and spillover.

Free ridership is the share of the gross savings that is due to actions participants would have taken anyway (i.e., actions that were not induced by the program). This is meant to account for naturally occurring adoption of energy efficiency measures. The Multifamily Energy Efficiency Program and most other Duke Energy programs cover a wide range of energy efficiency measures and are designed to advance the overall energy efficiency market. However, it is likely that, for various reasons, some participants would have wanted to install some high-efficiency measures even if they had not participated in the program or been influenced by the program in any way.

[13] Navigant recognizes that some property managers may have been instructed to participate by higher-level decision makers at the corporate level. Although we do not think this was the case very often, we do think that the local property managers were still privy to the decision making process.

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Spillover captures program savings that go beyond the measures installed through the program. Also called market effects, the term spillover is often used because it reflects savings that extend beyond the bounds of the program records. Spillover adds to a program's measured savings by incorporating indirect (i.e., non-incentivized) savings and effects that the program has had on the market above and beyond the directly incentivized or directly induced program measures.

The overall NTG ratio accounts for both the net savings at participating projects and spillover savings that result from the program but are not included in the program's accounting of energy savings. When the NTG ratio is multiplied by the estimated gross program savings, the result is an estimate of energy savings that are attributable to the program (i.e., savings that would not have occurred without the program). The NTG formula is shown in Equation 8:

Equation 8. Net-to-Gross Formula

$$NTG = 1 - \text{free ridership} + \text{spillover}$$

The underlying concept inherent in the application of the NTG formula is that only savings caused by the program should be included in the final net program savings estimate but that this estimate should include all savings caused by the program.

5.1.2 Estimating Free Ridership

Data to assess free ridership was gathered through the self-report method using a series of survey questions asked to the property managers at participating properties. The survey assessed free ridership using both direct questions, which aimed to obtain respondent estimates of the appropriate free ridership rate that should be applied to them, and supporting or influencing questions, which could be used to verify whether the direct responses were consistent with participants' views of the program's influence.

Each respondent to the survey provided perspectives on the measures that they had installed through the program. The core set of questions addressed the following three categories:

- **Likelihood:** To estimate the likelihood that they would have incorporated measures "of the same high level of efficiency," if not for the assistance of the program. In cases where respondents indicated that they might have incorporated some but not all of the measures, they were asked to estimate the share of measures that would have been incorporated anyway at high efficiency. This flexibility in how respondents could conceptualize and convey their views on free ridership allowed respondents to give their most informed response, thus improving the accuracy of the free ridership estimates.
- **Prior planning:** To further estimate the probability that a participant would have implemented the measures without the program. Participants were asked the extent to which they had considered installing the energy efficient measure prior to participating in the program. The general approach holds that if customers were not definitively planning to install all of the efficiency measures prior to participation then the program can reasonably be credited with at least a portion of the energy savings resulting from the high-efficiency measures. Strong free ridership is reflected by those participants who indicated they had already allocated funds for the purchase and selected the equipment and an installer.
- **Program importance:** To clarify the role that program components (e.g., information, incentives) played in decision-making and to provide supporting information on free ridership.

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Responses to these questions were analyzed for each respondent, not just in aggregate, and were used to identify whether the direct responses on free ridership were consistent with how each respondent rated the influence of the program.

Free ridership scores were calculated for each of the three categories.[14] Navigant then calculated a weighted average from each respondent based on their share of sample energy savings, and divided by 10 to convert the scores into a free ridership percentage. Next, a timing multiplier was applied to the average of the three scores to reflect the fact that respondents indicating that their energy efficiency actions would not have occurred until far into the future may be overestimating their level of free ridership. Participants were asked when they would have installed the equipment without the program. Respondents who indicated that they would not have installed the equipment for at least two years were not considered free riders and received a timing multiplier of 0. If they would have installed at the same time as they did, they received a timing multiplier of 1; within one year, a multiplier of 0.67; and between one and two years, a multiplier of 0.33. Participants were also asked when they learned about the financial incentive; if they learned about it after the equipment was installed then they received a timing multiplier of 1.

5.1.3 Estimating Spillover

The basic method for assessing participant spillover was an approach that asked a set of questions to determine the following:

- **Whether spillover exists at all.** These were yes-or-no questions that asked, for example, whether the respondent incorporated energy efficiency measures or designs that were not recorded in program records and did not receive any rebates from Duke Energy.
- **The savings that could be attributed to the influence of the program.** Participants were asked to list the extra measures they installed, and the evaluation team assigned a savings value. See below for the method of assigning savings.
- **Program attribution**. Estimates were derived from a question asking the program importance on a 0 to 10 scale. Participants were also asked how the program influenced their decisions to incorporate additional energy efficiency measures.

[14] Scores were calculated by the following formulas:

- Likelihood: The likelihood score is 0 for those that "definitely would NOT have installed the same energy efficient measure" and 1 for those that "definitely WOULD have installed the same energy efficient measure." For those that "MAY HAVE installed the same energy efficient measure," the likelihood score is their answer to the following question: "On a scale of 0 to 10, where 0 is DEFINITELY WOULD NOT have installed and 10 is DEFINITELY WOULD have installed the same energy efficient measure, can you tell me the likelihood that you would have installed the same energy efficient measure?" If more than one measure was installed in the project, then this score was also multiplied by the respondent's answer to what share they would have done.
- Prior Planning: If participants stated they had considered installing the measure prior to program participation, then the prior planning score is the average of their answers to the following two questions: "On a scale of 0 to 10, where 0 means you 'Had not yet planned for equipment and installation' and 10 means you 'Had identified and selected specific equipment and the contractor to install it,' please tell me how far along your plans were" and "On a scale of 0 to 10, where 0 means 'Had not yet budgeted or considered payment' and 10 means 'Already had sufficient funds budgeted and approved for purchase,' please tell me how far along your budget had been planned and approved."
- Program Importance: This score was calculated by taking the maximum importance on a 0 to 10 scale of the four program importance questions and subtracting from 10 (i.e., the higher the program importance, the lower the influence on free ridership).

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If respondents said no, they did not install additional measures, they were assigned a 0 score for spillover. If they said yes, then Navigant estimated the energy spillover savings on a case-by-case basis. It is important to note that although free ridership questions were only asked of property managers, Navigant surveyed both property managers and tenants for spillover.[15]

5.1.4 Combining Results Across Respondents

The evaluation team determined free ridership estimates for each of the following:

- Individual respondents, by evaluating the responses to the relevant questions and applying the rules-based approach discussed above.
- The program as a whole, by taking a weighted average of the individual results based on each respondent's share of reported energy savings.

5.2 Results for Free Ridership, Spillover, and Net-to-Gross

5.2.1 Review of Data Collection Efforts for Attribution Analysis

Surveys were conducted with decision makers to provide the information to estimate free ridership, and thus, NTG ratios. A total of 21 property managers were surveyed. These 21 property managers managed 39 total properties in the program. This sample represents about 10 percent of the total reported energy savings, as shown in Table 25.

Table 25. Property Manager Sample Representation

	Program Total	Sample Total	% of Program
Properties	449	39	9%
CFLs	418,121	39,942	10%
Bathroom faucet aerators	28,710	2,737	10%
Kitchen faucet aerators	18,862	1,948	10%
Showerheads	24,743	1,964	8%
Pipe wrap (ft)	73,338	10,189	14%
Total Energy Savings			**10%**

Source: Navigant analysis

5.2.2 Free Ridership Results

[15] The reason for not assessing free ridership at the tenant level is because tenants generally participated in the program via their property managers rather than personal choice. It is possible that tenants would have installed the same measures themselves, but Navigant does not believe they should be considered free riders to the program because the timing of those installations would have been difficult to evaluate and tenants would still have the ability to install CFLs in non-retrofitted fixtures. If a tenant already had equivalent measures in place, it is unlikely that the implementer would have replaced them with program measures.

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As described above, surveyed participants responded to a series of questions intended to elicit explicit estimates of free ridership, as well as ratings of program influence. Estimates are based on questions regarding the likelihood, scope, and timing of the investments in energy efficiency if the respondent had not participated in the program. For the Multifamily Energy Efficiency Program, free ridership was estimated at 7.5 percent, which is a relatively low value as anticipated by Navigant.

Navigant developed the free ridership estimate presented above based on responses to a variety of questions that related to survey respondents' intentions prior to participating in the program and to the influence of the program itself. Below are summaries by scoring component.

Prior Planning: Fourteen of the respondents did not have any prior plans for installing any of the energy efficient measures. The other seven respondents indicated that they did have plans, but for the most part, their plans were not very far along. These results indicate low free ridership.

Program Importance: Respondents stated that the program was very important in having the measures installed. Several property managers noted that their decision to participate was influenced by helping their tenants save energy and money.

Likelihood: Respondents were asked in the absence of the program, if they would have had at least some of the work done. Twelve respondents stated they "definitely would not have" installed the measures in the absence of the program, and six said they "may have".

Timing: 11 of 21 respondents stated they would have done the installation within two years or less in the absence of the program. The other 10 stated they would have done the installation after two years or never if not for the program. These findings are suggestive of low free ridership.

In summary, respondents indicated that the program was very important in their decisions to have the energy efficient measures installed. Some indicated that they did have some prior plans to install the measures, but their plans were not very far along.

5.2.3 Spillover Results

Three of the 21 surveyed property managers indicated that the program influenced him/her to install additional, non-incentivized energy efficiency measures at the property. The additional measures included LEDs in outdoor or common spaces, attic insulation, and water heater insulation wraps. In addition to the three property managers reporting spillover, eight tenants reported installing a small number of LEDs and other efficient lights after participating in the program.

Navigant estimated spillover from the equipment reported by property managers and tenants by applying simple engineering equations along with the self-reported measure quantities and characteristics. Navigant calculated the total spillover to be 2.0 percent.

5.2.4 NTG Results

The NTG ratio was calculated as written in Equation 9:

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Equation 9. Net-to-Gross Ratio

$$NTG = 1 - free\ ridership + spillover = 1 - 0.075 + 0.0197 = 0.9447$$

This suggests that for every one kWh reduced from program measures, about 0.94 kWh of savings can be directly attributed to the program.

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6. PROCESS EVALUATION

Navigant conducted a process evaluation of the Multifamily Energy Efficiency Program to assess program delivery and customer satisfaction. The process findings summarized in this section are based on the results of customer surveys with 150 program participants, detailed surveys with 21 property managers representing 39 properties, an interview with the Duke Energy Program Manager, and a high level review of the program documents and functionality. The property manager interviews and tenant surveys were also used to inform the NTG analysis.

6.1 Key Findings

- The program appears to be effectively addressing many key challenges that are inherent to delivering energy efficiency programs to non-owner-occupied multifamily housing facilities.
- Over half of the property managers learned about this program through outreach by a program representative. This onsite marketing approach seems to be a successful way of gaining participants. Most tenants learned of this program through their property managers.
- Property managers indicated they chose to participate in the program to provide a service and save money for their tenants and owners as well as to capitalize on the free installation to save on internal labor costs
- 75 percent of DEP tenants and 83 percent of DEC tenants noticed savings on their energy bills since the installation of the measures.
- 55 percent of tenants stated that the program CFLs were installed in the light fixtures used most in the home. Incandescent bulbs were listed as the most commonly removed type of bulb.
- A majority of program participants were satisfied with the program. On a scale of 0 to 10, where 0 indicates “not satisfied at all” and 10 indicates “extremely satisfied”:
    - Over 65 percent of participants indicated 8-10 for satisfaction with the overall program
    - Over 80 percent of participants indicated 8-10 for satisfaction with the installer’s quality of work
    - Over 70 percent of participants indicated 8-10 for satisfaction with Duke Energy
- High satisfaction ratings by tenants were often associated with money savings as the primary benefit. Low satisfaction ratings were often associated with complaints about the equipment.
- Satisfaction was higher for CFLs than for showerheads and aerators.
- During the tenant phone surveys, several participants expressed dissatisfaction with the low water pressure in their showers and sinks. Additionally, some property managers indicated that they had received tenant complaints about low water pressure.

6.2 Documentation Review

Navigant requested program documentation and tracking data to conduct a complete review of current processes. The program tracking data was sufficient to identify the measure characteristics and quantities of installed measures for each tenant at the participating properties.

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6.3 Property Manager Interviews

The evaluation team conducted interviews with property managers from the participating properties to assess decision-making (which will ultimately feed into the NTG analysis) and overall satisfaction with the program. The evaluation team interviewed twenty-one property managers who were responsible for 39 properties representing over 56,000 measures or 10% of the program measures.

Overall, property managers indicated that their experience with the program was very favorable. Some key findings from the property manager interviews are listed below:

- Property managers expressed high satisfaction with the free program measures and free installation by an external contractor. Property manager's noted the contractor's quality of work as "well done and professional" and "impressive."
- Over 60% of property managers responsible for their energy bills noticed a decrease in the property energy bills since participating in the program.
- Over 95% of property managers are very likely to recommend this program to other property managers. Provided are a subset of property manager responses on how the program influenced their decision to install the energy efficient measures:
    - "The program made it happen, otherwise it never would have."
    - "The program made it easy, so why not do it."
    - "[Duke Energy] did all the work and we just made the appointments available to get the efficient measures installed. Overall the cost and the work was done quickly."
    - "I didn't have to do anything. We just scheduled the appointment and they just came and did the installs."
    - "[I] saw that it would save move – just the electricity costs and everything it just made sense."
- One property's maintenance staff communicated that after 90 days, over 40% of the installed showerheads started leaking due to dirt buildup. The maintenance staff was able to clean the showerheads after discovering the root problem.
- One property's maintenance staff indicated that some tenants are confiscating program lightbulbs, showerheads, and aerators upon apartment turnover.
- A small number of property managers stated that they were not satisfied with the responsiveness of program staff if any rescheduling or additional follow-up work was needed.
- General suggestions for program improvement from property managers and maintenance staff include adding the following measures/material to the program: window weather stripping, outside or porch lights, and a reminder sticker below the thermostat to display a suggested air conditioner temperature.

6.4 Overall Marketing and Outreach

Customer outreach is a key driver to program participation. Navigant recognizes the importance of marketing and outreach with regards to continued participation and satisfaction, so several questions in the tenant survey and property manager interviews were included to address this.

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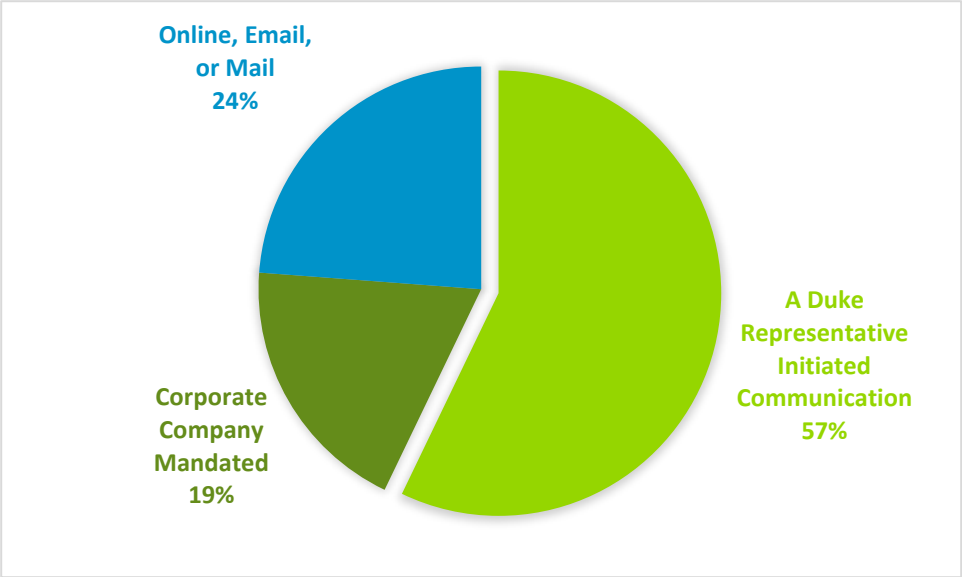
Table 26 and Figure 3 show how tenants and property managers learned about the program, respectively. Tenant participants were asked to indicate all of the sources through which they learned about the program, and about 70 percent indicated they had learned about the program through property managers as would be expected given the program model. Tenants also indicated having received notice via a Duke Energy mailing or bill stuffer. Property managers indicated that they were approached in-person by a program representative, or received a mail or email with program details.

Table 26. How Tenants Learned About the Program

How Tenants Learned About the Program (n=150)	
Through property manager	70%
Duke Energy mailing or bill stuffer	13%
Duke Energy website	5%
Through family, friend or neighbor	4%
Marketing by trade ally, vendor or contractor	1%
Duke Energy email	1%
Don't Know	6%

Source: Navigant analysis

Figure 3. How Property Managers Learned About the Program (n=21)



Source: Navigant analysis

6.5 Tenant Surveys

Navigant conducted phone surveys with 150 residential tenants to assess program satisfaction. The surveys contained a number of questions to assess satisfaction with program participation, satisfaction

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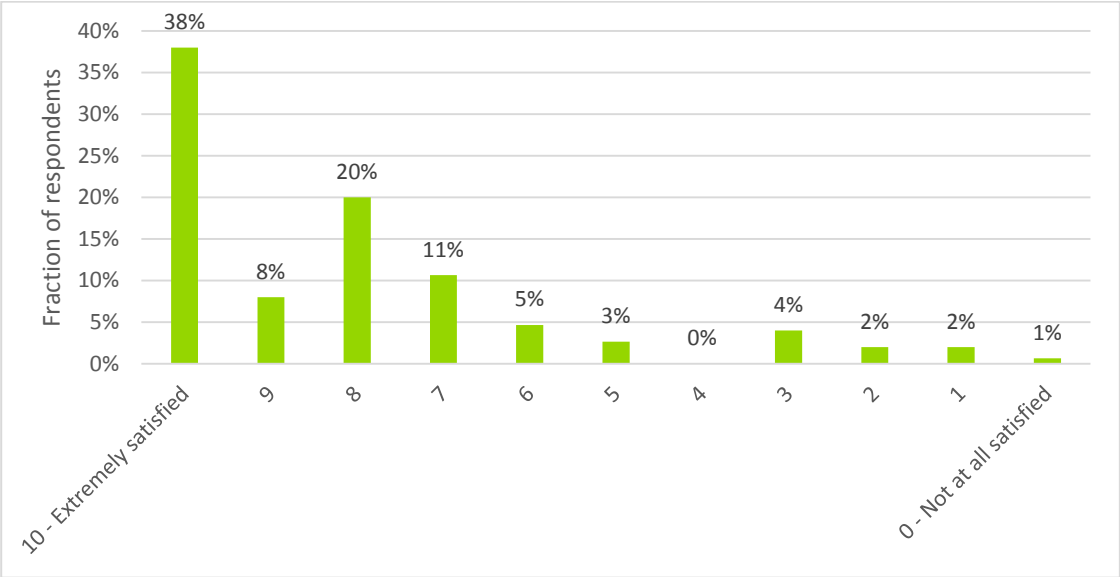
with new equipment, as well as questions to assess measure baseline and any measures removed by the tenant after participation.

Customer satisfaction with the program is high. On a scale of 0 to 10, where 0 indicates "not satisfied at all" and 10 indicates "extremely satisfied," two-thirds of customers rated satisfaction with the program as an 8-10 as shown in Figure 4. Participants who ranked their overall satisfaction low did so because they disliked the products or did not experience any energy savings. This chart includes data from both DEP and DEC territories as there were no significant satisfaction differences.

Figure 4. Tenant Satisfaction with Overall Program Experience (n=150)



Source: Navigant analysis

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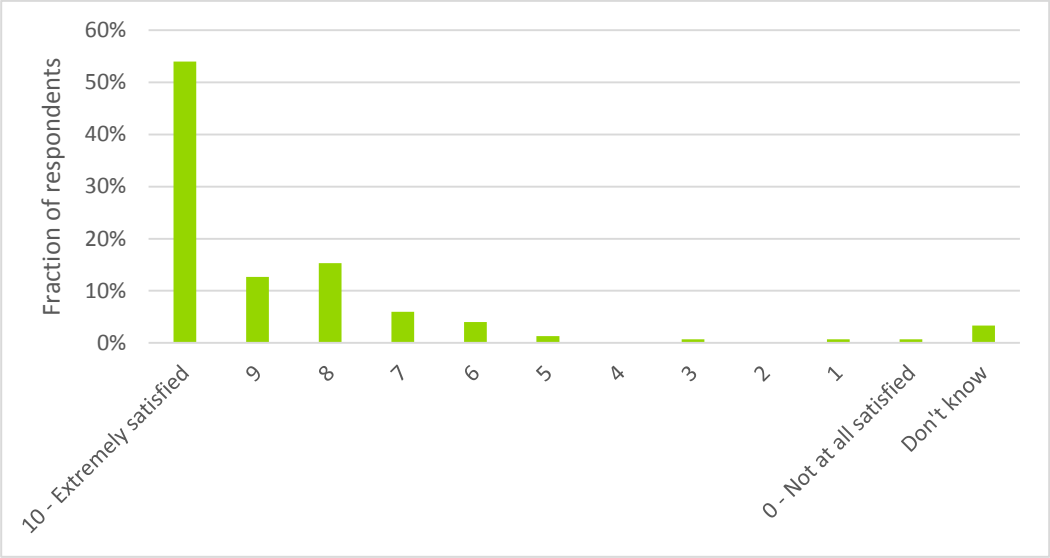
Customer satisfaction with the contractor quality of work was also high, as shown by Figure 5.

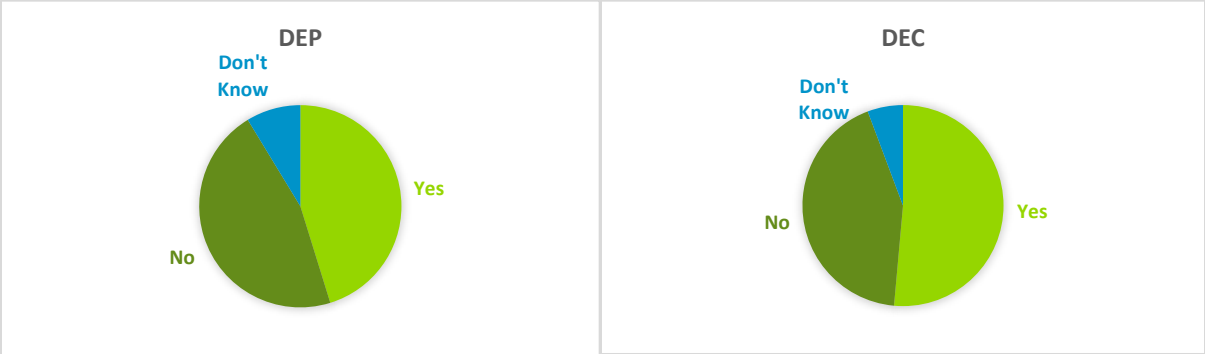
Figure 5. Tenant Satisfaction with Contractor's Quality of Work (n=150)



Source: Navigant analysis

As shown in Figure 6, about half of participants noticed a decrease in their energy bills after the new measures were installed.

Figure 6. Participants Who Noticed a Decrease in Their Energy Bill After Installing Program Measures (n=150)



Source: Navigant analysis

While a majority of participants were satisfied with the new measures, some were not. Navigant asked the participants to rate their satisfaction for each measure installed at their home. Average satisfaction ratings ranged from as high as 8.09 out of 10 for Pipe Wrap, to as low as 6.97 out of 10 for bathroom faucet aerators as shown in Figure 7.

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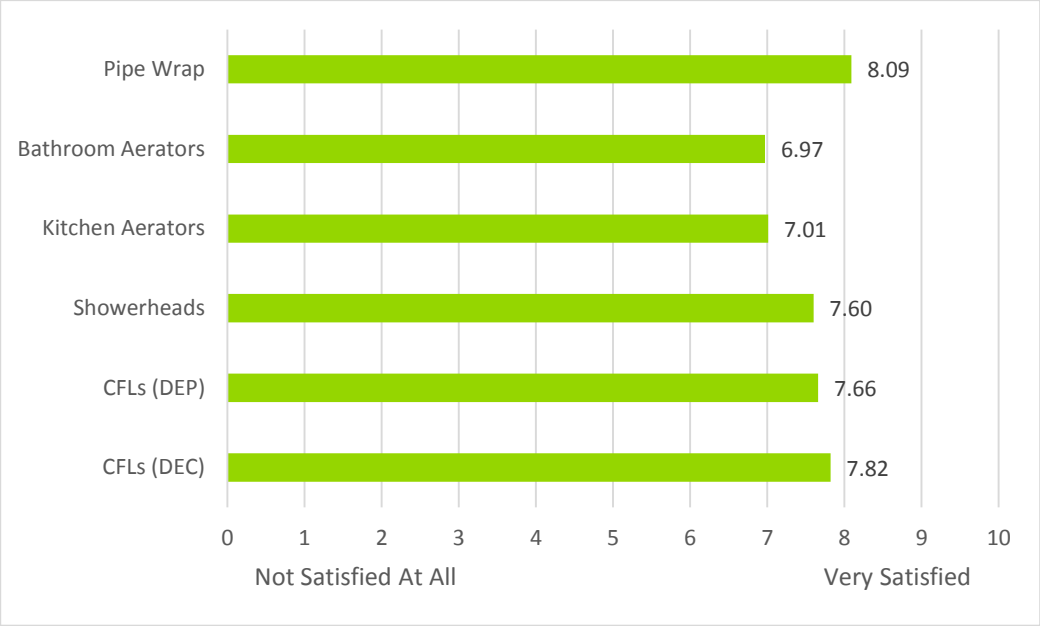
Figure 7. Tenant Satisfaction Rating for Each Measure (n=150)



Source: Navigant analysis

A small percentage of tenants removed the installed measure as shown in Figure 8. In the DEC territory, 100 percent of the CFLs removed by tenants were bulbs that had burned out. In the DEP territory, 57 percent of the CFLs removed by tenants were due to burnout, and the remainder were removed due to poor product quality. Participants indicated they removed bathroom faucet areators because of poor water pressure. Showerheads and kitchen faucet areators were removed because of leakage or excess water spray.

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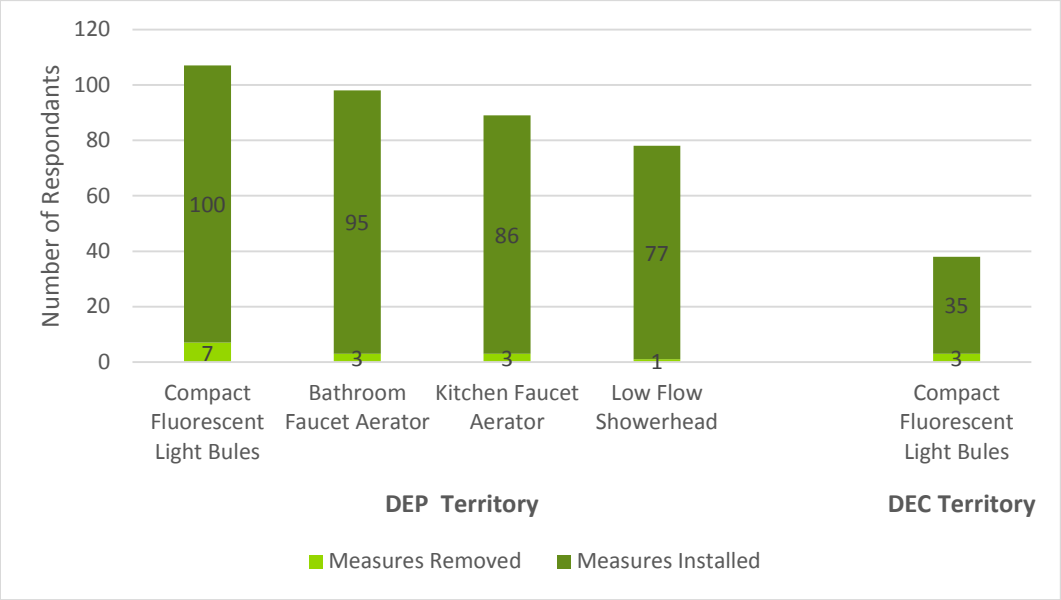
Figure 8. Participants Who Removed Any Installed Measures



Source: Navigant analysis

6.5.1.1 Participant Suggestions

Navigant also included a question in the tenant satisfaction survey that allowed respondents to offer suggestions for improving the program. One-fourth of the respondents offered suggestions, which were as follows:

- Several respondents asked for a better quality of equipment, including the quality of CFLs, showerheads, and aerators
- Several participants asked for better notification of installation date and time
- Two participants requested LEDs instead of CFLs
- One respondent requested offering motion sensors

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7. SUMMARY FORM

Multifamily Energy Efficiency Program

Completed EMV Fact Sheet

Description of program

Duke Energy's Multifamily Energy Efficiency Program provides energy efficient equipment to multifamily housing properties at no cost to the property managers or tenant end-users. The program is delivered through coordination with property managers and owners. Tenants are provided with notice and informational materials to inform them of the program and potential for reduction in their energy bills. Typically, measures are installed directly by the implementation contractor rather than tenants or onsite maintenance staff.

The program consists of lighting and water measures.

- **Lighting measures:** Compact fluorescent light (CFL) bulbs installed in permanent fixtures
- **Water measures:** Bathroom and kitchen faucet aerators, water-saving showerheads, hot water pipe wrap

Date:	October 4, 2016
Region:	Duke Energy Progress Duke Energy Carolinas
Evaluation Period	DEP 1/1/15 – 2/29/16 DEC 1/1/14 – 2/29/16
Annual kWh Savings	DEP 21,398,188 DEC 7,546,028
Per Participant kWh Savings	DEP 808 DEC 344
Net-to-Gross Ratio	0.94

Evaluation Methods

The evaluation team used engineering analysis and onsite field inspections as the primary basis for estimating program impacts. Additionally, telephone surveys were conducted with tenants and multifamily housing units to assess customer satisfaction and spillover. Detailed interviews were conducted with property managers to assess their decision-making process, and ultimately to estimate a net-to-gross ratio.

Impact Evaluation Details

- **Field inspections were conducted at 123 housing units.** The evaluation team inspected program equipment at 123 housing units to assess measure quantities and characteristics to be compared with the program tracking database.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 85% for CFLs to 95% for low flow showerheads.
- **Participants achieved an average of 808 kWh of energy savings per year in DEP, and 344 kWh in DEC.** The evaluation for DEC only included lighting measures, whereas the evaluation for DEP included lighting and water measures. Therefore, the two should not be compared directly.
- **The type of lamp removed during retrofit that was most commonly reported by participants was 60W incandescents.** Of the tenants who could recall what type of lamps were removed during lighting retrofits, the majority reported 60W incandescents. The evaluation team believes that evaluation periods covering dates beyond the end of this cycle will include a lower baseline wattage for retrofitted lamps.

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8. CONCLUSIONS AND RECOMMENDATIONS

Navigant's findings in this report suggest that Duke Energy's Multifamily Energy Efficiency Program is being delivered and tracked effectively in the DEC and DEP jurisdiction. Customer satisfaction is generally high, and the program measure installations appear to be tracked appropriately. Navigant presents the following list of recommendations that may help improve program delivery and impacts:

1. **Navigant recommends that Duke Energy should adopt the per-unit energy and demand impacts from this evaluation and use them going forward.** The engineering analysis and data collection described in this report provide support for updating the estimated impacts for each program measure. Duke Energy should consider additional research to investigate the baseline for CFLs for future evaluation cycles.
2. **Navigant recommends that no more than the first three feet of cold water inlet pipes be insulated for the water heater pipe wrap measure.** The U.S. Department of Energy recommends only insulating the first three feet of cold water inlet pipes. Beyond that, savings are likely negligible. During field verification, Navigant found that over half of the reported water heater pipe wrap was installed on cold water pipes (with just under 10 percent of those installations greater than three feet on the cold water heater pipes).
3. **Duke Energy should consider adding LEDs to the program.** Because of EISA, the baseline for the 13 watt CFL measure will eventually reach 40 watts instead of 60 watts. This will diminish the cost-effectiveness of program CFLs. LED options may provide increased savings and improved customer satisfaction.

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9. MEASURE-LEVEL INPUTS FOR DUKE ENERGY ANALYTICS

Navigant used the findings from field verification, surveys, and review of Duke Energy's deemed savings to estimate an updated set of deemed savings for Duke Energy to use for tracking program activity. Table 27 provides the measure-level inputs that can be used by Duke Energy Analytics for estimates of future program savings. Impacts for water measures apply to the DEP jurisdiction only, whereas impacts from CFLs apply to both DEP and DEC.

Table 27. Gross Measure-Level Impacts

Measure	Annual Energy Savings Per Unit (kWh)	Annual Summer Coincident Demand Savings Per Unit (kW)[1]	Annual Winter Coincident Demand Savings Per Unit (kW)[2]
Faucet Aerators MF Direct 0.5 GPM - bath	55.99	0.153	0.007
Faucet Aerators MF Direct 1.0 GPM - bath	39.52	0.108	0.005
Faucet Aerators MF Direct 1.0 GPM - kitchen	86.40	0.237	0.011
Faucet Aerators MF DIY 0.5 GPM - bath	45.46	0.125	0.006
Faucet Aerators MF DIY 1.0 GPM - bath	32.09	0.088	0.004
Faucet Aerators MF DIY 1.0 GPM - kitchen	68.98	0.189	0.009
LF Showerhead MF Direct 0.5 GPM	473.56	1.297	0.039
LF Showerhead MF Direct 1.0 GPM	355.17	0.973	0.029
LF Showerhead MF Direct 1.5 GPM	236.78	0.649	0.019
LF Showerhead MF DIY 0.5 GPM	374.70	1.027	0.031
LF Showerhead MF DIY 1.0 GPM	281.03	0.770	0.023
LF Showerhead MF DIY 1.5 GPM	187.35	0.513	0.015
Pipe Wrap MF Direct	37.24	0.004	0.004
Pipe Wrap MF DIY	30.05	0.003	0.003
13W CFLs	42.10	0.048	0.004

1. *The summer coincident period for DEP and DEC is defined as weekdays in July, hour ending 17.*
2. *The winter coincident period for DEP and DEC is defined as weekdays in January, hour ending 8.*

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APPENDIX A. DETAILED SURVEY RESULTS

This appendix contains additional results from the property manager interviews and tenant surveys. It is meant as a supplement to other sections of the report.

A.1 Property Manager Interviews

Navigant conducted in-depth interviews with 21 property managers. As shown in Table 25, the sample of 21 property managers represented 39 properties. This section presents details of the interviews. The responses to each question shown are paraphrased to maintain confidentiality and summarize the key points.

Table 28. How did you learn about the Duke Energy Multifamily Energy Efficiency Program?

Respondent(s)	Response
1,2,5,7,10-12,14,16-18,21	Duke Energy online, mail or email
3,4,6,9	Corporate company mandated
8,13,15,19,20	Approached by a program representative

Source: Navigant analysis

Table 29. What were the primary reasons to participate in the program?

Respondent(s)	Response
1,7,10,	Energy Efficiency
3,4,14	Corporate mandated
5,8,9,12,13,15,18,21	To save money
2,6,11,16,17,19,20	To savings water cost for tenants

Source: Navigant analysis

Table 30. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied are you with your overall program experience?

Respondent(s)	Response
1-4,7,9-12,14,18,20	10
5,20	9
13,16,17,19	8
8	7
6	5

Source: Navigant analysis

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Table 31. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied are you with the tenant notification and program materials?

Respondent(s)	Response
3,4,6,10-12,14,16,18,21	10
1,2,5,7,15,20	9
8,9,13	8
19	7
17	5

Source: Navigant analysis

Table 32. On a scale of 0 to 10, with 0 being "not satisfied at all" and 10 being "extremely satisfied", how satisfied would you say your tenants are with the new energy efficient equipment?

Respondent(s)	Response
1,3,12	10
2,10,14	9
5-7,9,11,16,17,21	8 – because some of the tenants prefer the incandescent light bulbs because of look and color, but most really like the CFLs
8,15,19	7 – the kitchen aerators and showerheads are leaking and breaking, requiring equipment repairs
4,13,20	6
18	5 – water measures cut down water pressure noticeably

Source: Navigant analysis

Table 33. On a scale of 0 to 10, with 0 being "not likely at all" and 10 being "very likely", how likely are you to recommend the Multifamily Energy Efficiency Program to other property managers?

Respondent(s)	Response
1,7,9-12,14, 16,18,20,21	10
2,15,19	9
4,5	8
3,6,8,13,17,	7

Source: Navigant analysis

Table 34. Prior to participating in the program, had you considered installing the same energy efficient equipment at your facility?

Respondent(s)	Response
1-6,8,10-15,19	No
7, 16-18,20	Yes

9	Yes – for lighting measures, not the water measures
21	Yes, they considered installing CFLs and the water measures to save on energy bills

Source: Navigant analysis

Table 35. Did your experience with the program influence you to incorporate any additional energy efficiency equipment for which you did not receive a Duke Energy program rebate?

Respondent(s)	Response
1-4,6,9,11-20	No
5	Yes, installing LED
7	Yes, remodeling apartments
8	Yes, installed more energy efficiency exterior lighting
21	Yes, insulation blankets on water heaters, insulation on attic, and caulked windows at multiple properties

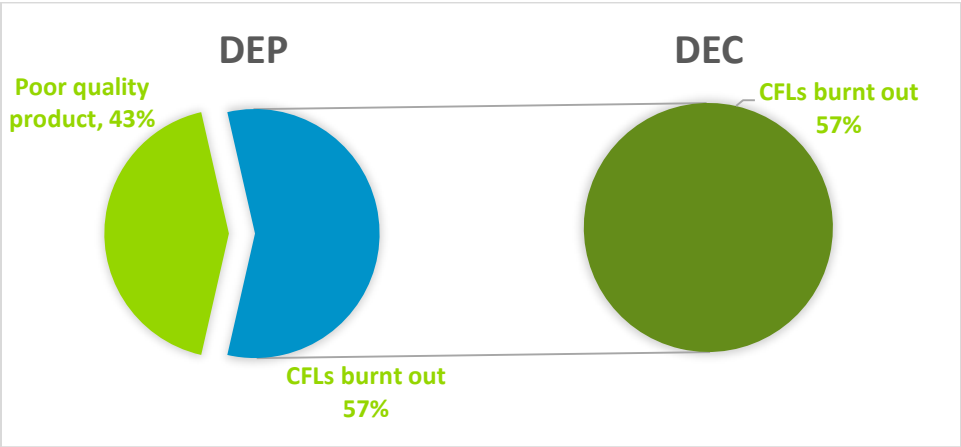
Source: Navigant analysis

A.2 Tenant Satisfaction Surveys

Satisfaction surveys were conducted with 150 program participants. Many of the results are presented in Section 6.5 of the main report, and this section serves as a supplement.

Figure 9 shows the reasons why tenants removed CFLs, the most common being burnout. For water measures, the most common reason for removal was low water pressure and leakage, although fewer measures had been removed.

Figure 9. Reasons Why Tenants Removed CFLs (DEP = 7; DEC=3)



Source: Navigant analysis

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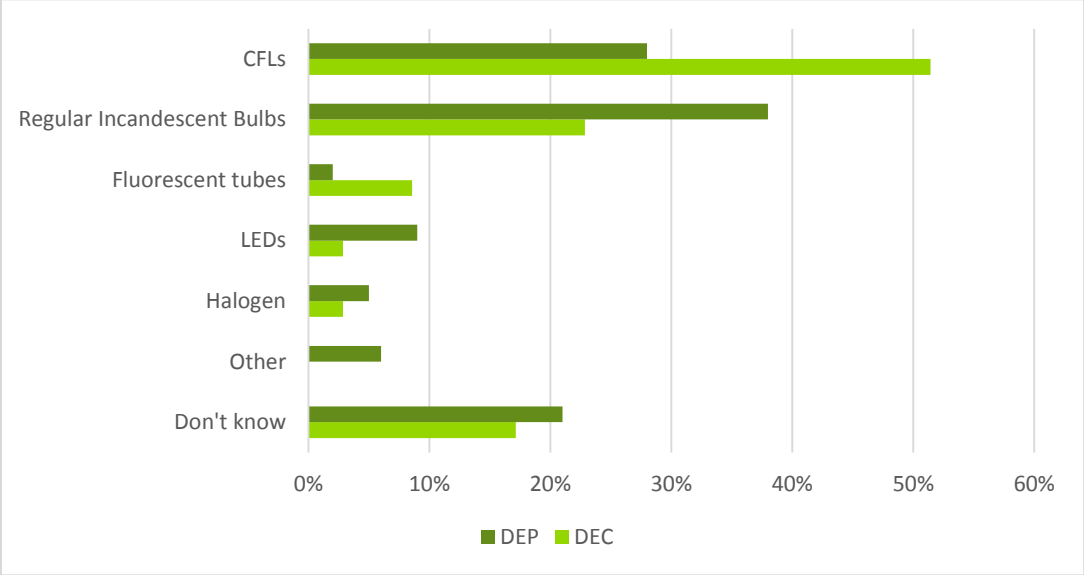
Figure 10 shows the types of light bulbs that tenants reported as being installed in the non-retrofitted fixtures in their homes. For the DEC territory, an important supplement to this figure is that just under 90 percent of tenants reported that program CFLs were installed in the fixtures used most in their homes, which demonstrates that the program is effective in reaching the fixtures with greatest savings potential. For the DEP territory, just under 50% of tenants reported that CFLs were installed in fixtures that are used most in the home. Additionally, for the DEP jurisdiction 60 percent of tenants reported that they were very likely to install CFLs in their home in the future; for the DEC jurisdiction 77 percent of tenants indicated they were very likely to purchase CFLs in the future.

Figure 10. Type of Bulbs Found in Non-Retrofitted Fixtures



Source: Navigant analysis

As noted earlier, overall tenant satisfaction with the program was very high for DEP and DEC jurisdictions, with an average rating of 8.05 on a scale of 0 to 10 with 10 as very satisfied. However, ten of the 150 tenants reported a satisfaction of five or less with the program for the following reasons:

- No money savings (n=7)
- Dislike products (n=1)
- Mandated program participation by property management (n=1)

Tenants also reported a few suggestions for improving the program:

- Improve the kitchen faucet aerator (n=4)
- Improve the quality of products (n=3)
- Improve the quality of CFLs (n=3)
- Provide LEDs instead of CFLs (n=2)
- Provide participants a discount (n=1)
- Offer motion sensors (n=1)

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Duke Energy Progress

Neighborhood Energy Saver Program Evaluation Report

January 17, 2017

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Opinion Dynamics

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1. Evaluation Summary

1.1 Program Summary

Duke Energy Progress's (DEP) Neighborhood Energy Saver (NES) program provides one-on-one energy education, on-site energy assessments, and appropriate packages of no-cost energy conservation measures to customers in income-qualified neighborhoods. The program is available to active DEP account holders who are individually metered homeowners or tenants living in predetermined low-income communities. Neighborhoods are eligible to participate in this program if at least 50% of the households in the community have incomes equal to or less than 150% of the federally set poverty level. Individual participants are limited to a one-time receipt of energy efficiency measures through the NES program.

The NES program aims to reach at least 4,500 customers annually in four to five communities throughout the DEP service territory. The goal is to offer persistent energy and demand savings to these customers through the direct installation of energy-saving measures and by educating customers about other ways that they can reduce their energy use. The program provides equipment and education at no cost to customers. When possible, the program works with community leaders to maximize the number of customers in each neighborhood benefiting from the program.

1.2 Evaluation Objectives and High-Level Findings

The objectives of the NES program evaluation are to:

- Verify and update deemed savings estimates through review of measure assumptions and calculations
- Verify measure installation and persistence
- Estimate program energy (kWh), summer and winter peak demand (kW) savings, and realization rates
- Further explore the potential for increasing the average per-household savings attributable to the program
- Identify ways that DEP may be able to improve the NES program in the future

To achieve these objectives, Opinion Dynamics completed a number of data collection and analytic activities, including interviews with program staff, a participant survey, an analysis of the survey results, an analysis of program-tracking data, a deemed savings review, an engineering analysis, and a billing analysis. The program period under evaluation is January 1, 2015 through December 31, 2015.

As part of the impact evaluation, we conducted an engineering analysis to provide insight into how each measure contributes to overall program savings. The engineering analysis also allows us to develop a ratio of overall kW to kWh savings, which we then apply to the net energy savings from the billing analysis to determine evaluated net demand savings for the program. Table 1-1 presents the total gross impacts for each measure installed through the program and the estimated individual measure contribution to the overall energy (kWh) savings from the engineering analysis.

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Table 1-1. Measure-Level Gross Impact Results from Engineering Analysis

Measure	Energy (MWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Percent of Total MWh
CFLs	752	87.9	66.6	35%
Efficient Faucet Aerator	337	55.6	111.0	16%
Efficient Shower Head	300	25.0	50.0	14%
Hot Water Temperature Setback	128	14.6	14.6	6%
Water Heater Blanket	115	13.1	13.1	5%
Hot Water Pipe Wrap	87	9.9	9.9	4%
Infiltration Reduction	325	84.5	84.9	15%
HVAC Filter	131	41.0	28.5	6%
Total	**2,174**	**331.5**	**378.8**	**100%**

Overall program net savings for the DEP NES program are primarily derived from the results of our billing analysis. The billing analysis provides average per-household net energy savings. Table 1-2 presents the net savings results of our billing analysis, which includes savings from equipment installed by program representatives, as well as savings from any additional behavioral changes and participant spillover attributable to the program. Demand savings are calculated from the ratios of engineering analysis kW to kWh savings, which are applied to the billing analysis net energy savings.

Table 1-2. Net Participant and Program Impact Results from Billing Analysis

Net Annual Participant-Level Savings			Net Annual Program-Level Savings		
Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
430	0.0655	0.0748	1,954	0.2980	0.3404

Per-participant annual net energy savings from the billing analysis (430 kWh) are slightly lower than those estimated in the engineering analysis (478 kWh). However, annual net savings determined from the billing analysis increased from 367 kWh to 430 kWh per home from 2014 to 2015, a 17% increase from the last evaluation.

Opinion Dynamics applied a robust billing analysis methodology that utilized a comparison group of DEP customers selected as future NES program participants to create a baseline of what would have occurred in the absence of NES program participation. Comparing the energy use of 2015 NES program participants to those who have been selected to participate in 2016, but who have not already done so, allows us to isolate the effect of NES program participation on savings between two comparable groups of participants. The same type of model was used in the evaluation of the 2014 NES program, as well as in the 2015 Duke Energy Carolinas' (DEC) Residential Neighborhoods Program (RNP) evaluation.

The use of a comparison group in a billing analysis typically provides a good estimate of the savings attributable to participating in a program. In addition, billing analyses, using an appropriate comparison group, incorporate the effects of both free-ridership and spillover, thus providing program net savings.

Overall participation in the NES program increased by 9% from the level achieved in 2014, as shown in Figure 1-1. While the program achieved its participation goal, the program staff reported having more difficulty selecting neighborhoods that met the income eligibility thresholds, as the program has matured and more of the available neighborhoods have been treated. Despite these difficulties, only six neighborhoods were

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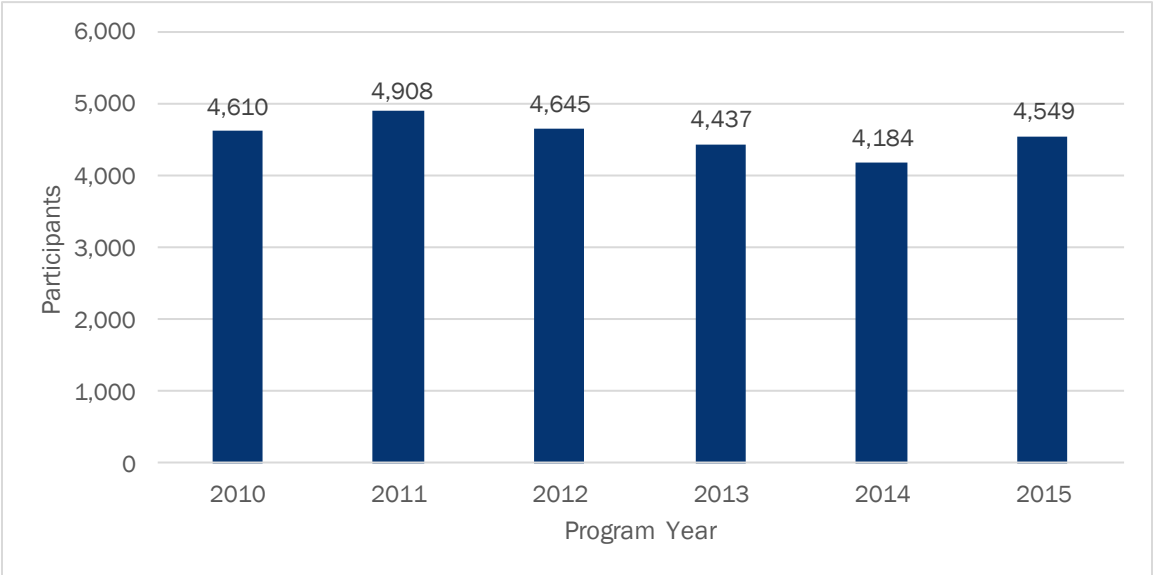
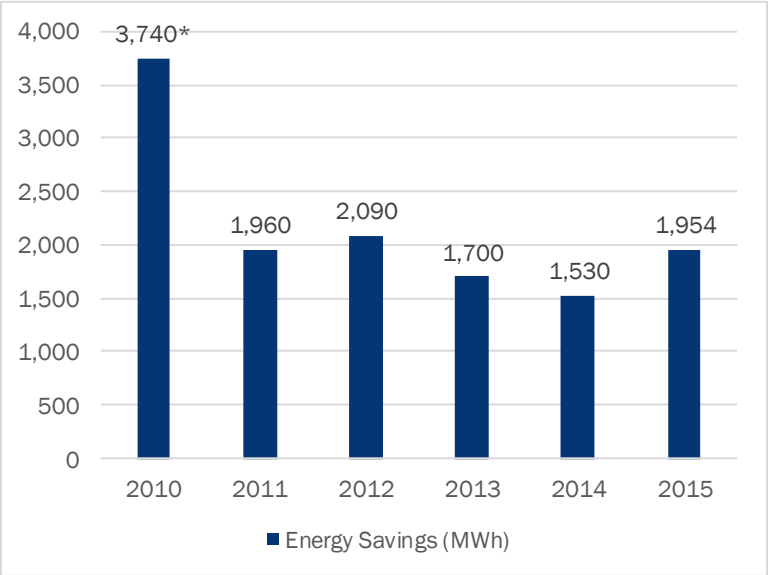
required to meet the participation goal in 2015, indicating that the program is also achieving high levels of participation among eligible customers within each neighborhood.

Figure 1-1. NES Program Participation, 2010–2015



Overall NES program annual net savings also increased, from 1,530 MWh to 1,954 MWh from 2014 to 2015, as shown in Figure 1-2.

Figure 1-2. Overall NES Program Net Savings, 2010–2015



* 2010 program savings not based on billing analysis results.

Overall, the program performed well in 2015 and showed increases in per-participant savings, total savings, and overall participation level compared to the 2014 program. Participants were also highly satisfied with their

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experience with the program. Ninety-two percent of participants said that they were satisfied with the program overall, and 97% said that they were satisfied with the program representative who visited their home. The majority of participants also received one-on-one energy education from the program representative and from written materials reinforcing the information conveyed by the one-on-one energy education. Ninety-four percent of participants also said that they were motivated to reduce their energy use after participating in the program.

1.3 Evaluation Recommendations

Opinion Dynamics has the following recommendations for maintaining and improving program performance and overall savings. We include more details on these recommendations in Section 7 and throughout this report.

- **Specialty Lighting and LED Lighting.** There may be opportunities to provide additional efficient lighting equipment. The program should evaluate the opportunities for specialty and LED lighting products. The increasing prevalence of efficient lighting technology may limit opportunities to install CFLs in standard high-use sockets and specialty lighting may be an opportunity for additional savings. Although the program installed the same average number of bulbs per home in 2015 compared to 2014, lighting opportunities will likely decrease as the lighting market and technology standards change in the near future. If the program transitions to LED bulbs in January 2017, pending approval of a new regulatory filing, additional opportunities may open up for the program where CFLs currently do not function well, such as dimmable fixtures and exterior lights.

- **ENERGY STAR® Appliances and Low-Level Weatherization.** DEP should assess the potential savings and costs of including additional measures frequently offered through income-qualified programs. The results of the participant survey show that there may be opportunities to replace older appliances in some homes. Replacing older and less-efficient equipment with ENERGY STAR equipment could generate increased savings for the program and may also increase program participation rates. Program staff have also expressed interest in opportunities for application of attic insulation and HVAC maintenance/tune-up work in the program. Additional data should be collected among DEP participants to determine what opportunities exist among this population for attic insulation, duct repair, and HVAC maintenance. These additional measures have the potential to increase programmatic savings, but practical application of them in the program and in the overall portfolio of energy efficiency programs would need to be considered carefully.

- **Reduce Eligibility Requirements to Include 50% of Residents at 200% of Poverty Level.** The program should continue to make efforts to reach the greatest number of participants in each selected neighborhood. Maximizing the number of treated homes in each neighborhood reduces the overall number of neighborhoods required to meet program-wide participation goals. In the past 2 years, the program has had success treating a large fraction of the eligible residents in each treated neighborhood. Maintaining this robust implementation approach over the long term will help ensure continued program success while reducing the costs associated with selecting and setting up operations in additional neighborhoods. Program staff noted that as the program has matured it has been increasingly difficult to identify neighborhoods meeting the requirement for 50% of residents at 150% of the poverty level. Moving the program to an eligibility level of 50% of residents at 200% of the poverty level, pending regulatory approval, would open opportunities in additional neighborhoods. This change would also bring the DEP NES program in line with the eligibility requirements of the NES program in Duke Energy's other territories.

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- **Continue to Improve and Expand Program Data Collection.** During the course of the evaluation, Opinion Dynamics encountered several data quality issues, including discrepancies between data collected by the implementer and data found in Duke Energy's data warehouse. The program and implementer should take additional steps to verify all data sources and ensure accuracy and completeness as a regular part of the program. It is our understanding that the DEP team has recently taken action to correct these data issues. Program implementer field staff are now collecting data on a tablet-based system, which should help with data collection consistency and accuracy. As of early 2016, the tablet-based system was not available to program staff to conduct quality assurance audits, and program staff reported that they still conducted audits using a paper-based system. The tablet-based system should be expanded to allow program staff to perform quality assurance audits using the same method.

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2. Program Description

2.1 Program Design

Duke Energy Progress's (DEP) Neighborhood Energy Saver (NES) program is a direct-install program that employs a neighborhood canvass approach to drive participation. The goal is to offer persistent energy and demand savings to low-income customers through the installation of low-cost energy-saving measures. The program also offers an extensive educational component that provides participating customers with information on the equipment that they received and additional suggestions on ways to lower energy use. The program provides the equipment and services at no cost to customers and works within each community's existing network of Community Assistance Agencies to maximize the number of customers benefiting from the program.

Neighborhoods are eligible to participate if at least 50% of the households in the community have incomes equal to or less than 150% of the federal poverty level. Individual participants are limited to a one-time receipt of energy efficiency measures through the program. The program aims to reach at least 4,500 customers each year in four or five pre-identified communities throughout the DEP service area.

2.2 Program Implementation

Honeywell Building Solutions implements the NES program, in partnership with Duke Energy program staff. Honeywell performs all assessments and installations, though DEP program staff are heavily involved in the selection of, and recruitment within, specific neighborhoods. Prior to participating in the program, residents in selected neighborhoods receive targeted mailings from the program that provide introductory information about how to participate; the benefits of participation; and a notice to keep an eye out for additional information from the program, including additional mailings and a neighborhood launch event. The implementation team organizes at least one community launch event in each targeted neighborhood, both to make residents aware of the program and to provide demonstrations of the equipment that the NES program will offer. Honeywell staff then canvass each neighborhood, performing assessments and installations when customers are available and leaving behind their contact information via door hangers when they are not. Honeywell's goal, as laid out in the statement of work between DEP and Honeywell, is to achieve 70% penetration in each neighborhood. Customers are encouraged to schedule a specific time for their assessment in the event that they were not available during the staff's first visit to their neighborhood. Based on a schedule determined by the NES program manager, the implementation team performs assessments and installations in one neighborhood at a time, thereby reaching the greatest number of eligible participants possible in each community served by the program. Honeywell staff aim to remain in a neighborhood for 8–12 weeks in order to treat as many customers as possible.

DEP tracks the dates that assessments were performed and the types and counts of equipment that were installed at each premise in its program-tracking database. According to DEP program staff, no fundamental changes were made to the program between 2014 and 2015, with the exception of modifying the leave-behind educational materials. The program continues to prioritize discussing the educational brochure with customers at the time of the visit to encourage additional energy savings.

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2.3 Program Performance

The program period under evaluation is January 1, 2015 through December 31, 2015. Over this time period, the program served 4,549 unique participants.[1] The program saved, on average, 430 kWh per household per year. Coincident demand savings per household were 0.0655 kW in summer and 0.0748 kW in winter.

[1] The program treated 3,342 homes in North Carolina and 1,207 homes in South Carolina during 2015.

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3. Key Research Objectives

The objectives of the 2015 NES program evaluation are to:

- Verify and update deemed savings estimates through review of measure assumptions and calculations
- Verify measure installation and persistence
- Estimate program energy (kWh), summer and winter peak demand (kW) savings, and realization rates
- Further explore the potential for increasing the average per-household savings attributable to the program
- Identify ways that DEP may be able to improve the NES program in the future

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4. Overview of Evaluation Activities

4.1 Program Staff Interview

Opinion Dynamics conducted an interview with DEP program staff responsible for the implementation of the program in 2015. The in-depth interview allowed us to identify any changes to the program's implementation over the past year, identify program successes and barriers to participation, and determine any risks for the program achieving its goals. We also discussed how the implementation contractor had performed in the 2015 program.

4.2 Program Materials Review

DEP staff provided Opinion Dynamics with information on the program, examples of marketing materials used by the program, and information about the implementation contractor's on-site auditing and direct installation procedures, as well as program standards and contractual documents between the program and implementation contractor. The materials we received and reviewed included:

- **Marketing materials:** the leave-behind brochure, the customer survey booklet, the pre-participation program informational brochure, the leave-behind door hanger, the energy efficiency brochure about other DEP programs, the introduction letter to the NES program and the informational session, the presentation shown at the informational sessions, and postcards sent to participants with information about how to participate.
- **Program documents:** the presentation about the NES program design, on-site procedures from the 2015 implementation contractor, and statements of work between Duke Energy and the implementation contractor.
- **Past five evaluation reports for the NES**, which covered 2010 through 2014, including the evaluation report that Opinion Dynamics completed for the 2014 NES program.

4.3 Participant Survey

Opinion Dynamics implemented a computer-assisted telephone interviewing (CATI) survey with 2015 NES program participants between May 5, 2016 and May 19, 2016. The average length of the interviews was just over 15 minutes. The survey sample frame consisted of a preliminary extract of 4,557 measure-level participant records. Our team removed 368 customer records that were missing phone numbers, 14 records that had issues with the phone numbers, 1,403 records that were on DEP's "Do Not Call" list, 30 records with business names, and 74 records that were duplicates. We then developed a simple random sample of the remaining 2,668 participant records. To meet precision targets for measure-level installation and persistence analyses, the evaluation team set quotas for each measure. Quotas were set at 68 completed interviews for each measure type to ensure that analyses met the industry-standard two-tail 90/10 criterion in terms of sampling error. This means that we would be 90% confident that our results are within 10% of the true value in the population.

4.4 Deemed Savings Review and Engineering Analysis

Opinion Dynamics conducted a review of the deemed savings values and assumptions for each of the NES program measures. The primary source for 2015 evaluated program savings is our billing analysis, but the

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deemed savings review was used to estimate demand savings from the billing analysis results and to provide estimates of savings at the measure level. The goal of the deemed savings review was to develop updated savings algorithms and input assumptions that are consistent with standard industry practice and comparable with applicable Technical Reference Manuals (TRMs).

To conduct our deemed savings review, we performed the following steps:

- Reviewed the unit savings estimates developed under Opinion Dynamics's previous evaluation of this program and the assumptions behind them.
- Reviewed all information received to date to decide if any of the current savings estimates or assumptions required updates.
- Reviewed latest TRMs and other recently published studies to determine if there was a need for additional updates.

Our evaluation also relied on data from the telephone survey to confirm measure installation and persistence, which were combined with engineering estimates for each measure to develop program-level savings by measure type. Appendix A provides more detail on the methods used in the deemed savings review and engineering analysis.

4.5 Billing Analysis

Opinion Dynamics conducted a billing analysis to determine the net savings attributable to the NES program in 2015. We used a linear fixed effects regression (LFER) model to estimate the overall net ex post program savings. The model allowed us to control for all household factors that do not vary over time by the individual constant terms in the equation. The billing analysis used participants from the second half of 2014 and first half of 2015 as the treatment group, while the comparison group consisted of participants from the second half of 2015 and first half of 2016. A summary of the billing analysis approach is provided in Section 5.1.2 and a detailed description of the billing analysis methodology is presented in Appendix B.

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5. Impact Evaluation

This section describes the process by which the evaluation team calculated NES program impacts through the engineering analysis and billing analysis

5.1 Methodology

5.1.1 Engineering Analysis

As part of our impact evaluation, Opinion Dynamics conducted an engineering analysis for each NES program measure installed in 2015. The purposes of the engineering estimates are to:

1. Provide a ratio of kW demand to kWh energy savings, which is then applied to the billing analysis net energy savings to estimate net demand savings
2. Provide insight into the individual measure contributions to the overall program savings

We used several resources and assumptions to conduct our engineering analysis. Since neither North Carolina nor South Carolina has a statewide TRM, we relied on other TRMs for algorithms and assumptions where appropriate and used DEP-specific assumptions whenever possible. The engineering analysis takes into consideration the measure in-service rates (ISRs) to ensure that program-level savings estimates reflect savings for installed measures only. We provide additional details and information on the engineering analysis in Appendix A.

Note that the billing analysis determines net evaluated energy (kWh) impacts for the program; this engineering analysis only supplements the billing analysis for the aforementioned reasons.

Installation Verification and Persistence

The participant survey instrument included questions designed to verify that participants received and installed program measures and that those measures remained in place and operational. We used the survey results to estimate measure-level ISRs. Our engineering estimates use the ISR values in calculations for annual per-household savings. Specifically, we asked sampled participants to confirm that they received the quantity of measures recorded in the program-tracking data and, when necessary, to update the quantity. We then divided the number of measures verified by the respondent by the quantity in the tracking database to calculate a verification rate. We then asked respondents how many of the verified quantity of measures had been installed to calculate an installation rate. Finally, we asked respondents how many of the installed measures remained in place and operating to calculate a measure persistence rate. We then created a measure-specific ISR by multiplying the three components.

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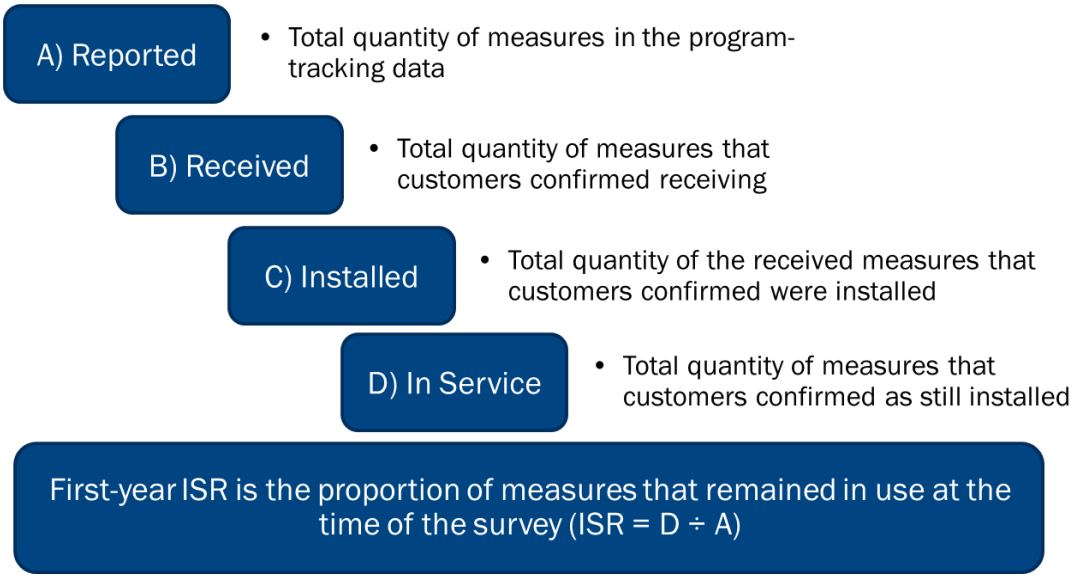
Figure 5-1. In-Service Rate Components



Our results showed relatively high ISRs for most measures in the NES program, as shown in Table 5-1. We strove to achieve a relative precision of 10% with 90% confidence. In some instances, participants were unaware that the program representative had installed specific equipment, such as a pipe wrap or a water heater wrap, and therefore were unable to verify its installation. For those measures, we have reverted to an ISR of 100% because the database quantities are likely more accurate than what the respondents were able to recall.

Table 5-1. ISRs for NES Program Measures

Measure Category	Verification Rate	Installation Rate	Persistence Rate	ISR
CFLs	98%	100%	96%	94%
Efficient Faucet Aerator	94%	100%	97%	91%
Efficient Shower Head	94%	100%	99%	93%
Hot Water Pipe Wrap*	100%	100%	100%	100%
Water Heater Blanket*	100%	100%	100%	100%
Hot Water Temperature Setback**	100%	100%	100%	100%
Infiltration Reduction***	98%	100%	99%	97%
Door Sweep	95%	100%	98%	93%
Weather Stripping	96%	100%	99%	95%
Coil Brush	100%	100%	100%	100%
Maintenance Calendar**	100%	100%	100%	100%
Thermometer**	100%	100%	100%	100%
HVAC Filter	85%	100%	98%	83%

* Participants were asked about pipe wrap and water heater wraps, but their ISRs were defaulted to 100% after consideration of the difficulty of verifying those measures.
** Verification, installation, persistence, and ISRs are not verified based on the results of the survey and are assumed to be 100%.
*** ISRs for infiltration reductions other than weather stripping and door sweeps are calculated as a weighted average of those two ISRs observed in the survey results and the ISRs assumed to be 100% for caulk, glass patch tape, foam spray, and winterization kit.

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We also compared the ISRs from the 2015 NES program against those of the 2014 NES program. Most ISRs increased from 2014 to 2015, as shown in Table 5-2. Note that the ISRs in Table 5-2 are only those that are calculated based on the results of the participant survey.

Table 5-2. Comparison of ISRs from the DEP NES Program, 2014–2015

Measure Category	2014 ISR	2015 ISR	Change from 2014 to 2015
CFLs	86%	94%	8%
HVAC Filter	89%	83%	−6%
Efficient Faucet Aerator	72%	91%	19%
Efficient Shower Head	85%	93%	8%
Door Sweep	83%	93%	10%
Weather Strip	85%	95%	10%
Infiltration Reduction	94%	97%	3%

5.1.2 Billing Analysis

Opinion Dynamics conducted a billing analysis to determine the overall evaluated net savings of the NES program. Due to the timing of the evaluation, and to ensure that we had a robust comparison group, we included participants from the second half of 2014 (July–December) through the first half of 2016 (January–June) in our analysis. Our method requires that participants in the treatment group have post-installation electricity usage data for at least 6 months after participating in the program. Therefore, participants from July 2014 through June 2015 comprise our treatment group, while the comparison group consists of households that participated in the program between July 2015 and June 2016. A comparison group allows us to establish a counterfactual, i.e., the baseline energy that participants in the treatment group would have used in the absence of the program. In addition, because the comparison group represents energy use in absence of the program, results from the billing analysis are net results, and application of a net-to-gross ratio (NTGR) is unnecessary.

The billing analysis employed a LFER model, which accounted for factors that are not expected to vary before and after participation in the constant terms of the equation, such as square footage, appliance stock, habitual behaviors, household size, and any other factors that do not vary over the longer term. The model also accounted for differences in weather and pre-program energy use between participants.

To improve our estimate of what baseline usage for participants would be absent the program, we added dummy variables for each calendar month, i.e., binomial terms with "1" signifying that the bill occurred in that month of year. Including these variables in the model helped control for monthly trends that were unrelated to the comparison group and allowed for a more accurate estimate of baseline usage absent the program. The model included weather terms, and interaction terms between weather and the post-participation period for the treatment group, to account for differences in weather patterns across years. We also included interaction terms to control for some differences seen in baseline usage between the treatment and comparison groups. Table 5-3 shows the breakdown of participants in the treatment and comparison groups.

Table 5-3. Accounts Included in Final Billing Analysis Model

Home Type	Treatment Group (July 2014–June 2015)	Comparison Group (July 2015–June 2016)	Total
Total Accounts	3,129	3,273	6,402

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A more detailed discussion of the billing analysis methodology, including data-cleaning steps, a comparison group assessment, and the final model, is provided in Appendix B.

5.2 Engineering Analysis Results

This section provides deemed energy and demand savings estimates for each measure offered by the NES program in 2015. Appendix A contains all detailed algorithms and assumptions used in the engineering analysis.

Table 5-4 provides a breakdown of estimated per-unit energy and demand savings across the measures installed through the NES program, as determined through our engineering analysis. As described in Section 5.1, we based the measure-level savings on secondary research and applied NES program-specific assumptions on housing characteristics, such as the portion of homes using electricity for heating, cooling, and hot water heating. These energy savings estimates also include the ISRs presented in Table 5-1 based on responses to the participant survey.

Table 5-4. Engineering Analysis Gross Impact Results*

Measure	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
9-Watt CFL	20.4	0.0024	0.0018
13-Watt CFL	16.3	0.0019	0.0014
14-Watt CFL	29.5	0.0035	0.0026
19-Watt CFL	34.6	0.0040	0.0031
20-Watt CFL	33.6	0.0039	0.0030
23-Watt CFL	49.9	0.0058	0.0044
Efficient Faucet Aerator	37.4	0.0062	0.0123
Efficient Shower Head	62.6	0.0052	0.0104
HVAC Filter	40.3	0.0126	0.0088
Hot Water Pipe Wrap	13.7	0.0016	0.0016
Water Heater Blanket	115	0.0131	0.0131
Hot Water Temperature Setback	81.6	0.0093	0.0093
Infiltration Reduction	73.0	0.0190	0.0190
Coil Brush	–	–	–
Per Household	**478**	**0.0729**	**0.0833**

* The deemed savings values presented in this table differ from those presented in Appendix A because of the inclusion of ISRs in this table.

Using the deemed savings values from Table 5-4, we calculated energy savings of 478 kWh per household, which is 26% higher than the engineering analysis from the 2014 program evaluation (379 kWh). Additionally, we calculated an overall kW per kWh savings ratio from the engineering analysis, as shown in Table 5-5, which we used to estimate net demand savings from the billing analysis results for both summer and winter peak savings.

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Table 5-5. Engineering Demand-to-Energy Ratios

	Summer Coincident Peak	Winter Coincident Peak
Average energy (kWh) savings per household	478	478
Average demand (kW) per household	0.0729	0.0833
Ratio multiplier (kW/kWh)	0.0001525	0.0001742

5.3 Billing Analysis Results

This section provides billing analysis results and savings estimates for the 2015 program year. Appendix B contains a detailed methodology for data cleaning and modeling used for this analysis, as well as complete results of the models. Table 5-6 shows the results of the billing model for each home type. The variable "Post (NES program participation)" represents our treatment effect, i.e., the change in average daily consumption (ADC) attributable to participation in the NES program.

Table 5-6. Results of Billing Analysis Models

Variable	Coefficient
Post (NES program participation)	−3.321***
Cooling Degree Days (CDD)	0.0525***
Heating Degree Days (HDD)	0.0408***
Post-participation period CDD	0.00463
Post-participation period HDD	0.00541***
Constant	23.1897***
Observations	207,132
R-Squared	0.654
Monthly Effects Included	YES
Post-Participation Period Interacted with Months Included	YES
Treatment Group Interacted with Months Included	YES

* p<0.1, ** p<0.05, *** p<0.01.

Due to post-participation period interaction terms in the model, it is necessary to recalculate the coefficient of the treatment effect "Post (NES program participation)" by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-participation period, separate of any effect of the included interaction terms. Making these adjustments (detailed in Appendix B), Opinion Dynamics found that 2015 NES program participants realized 1.2 kWh of daily energy savings, on average, or 2.8% of their overall usage. Table 5-7 shows the per-home and program-level savings for the program and participants in each state. Since customers in South Carolina used more energy than those in North Carolina, and to allow for an additional measure of comparison with the previous report, we show savings by annual kWh and the percent of energy saved compared to each state's baseline energy usage.

The estimate of percent savings is based on the baseline usage of the treatment group as a whole, since the model used does not separate customers by state. Applying that 2.8% savings to the baseline energy use for each state, we find that customers who participated in the NES program in North Carolina saved 420 kWh and participants from South Carolina saved 457 kWh. For the 2015 program year, the NES program realized 1,954 MWh of energy savings.

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Table 5-7. Annual Savings from Billing Analysis

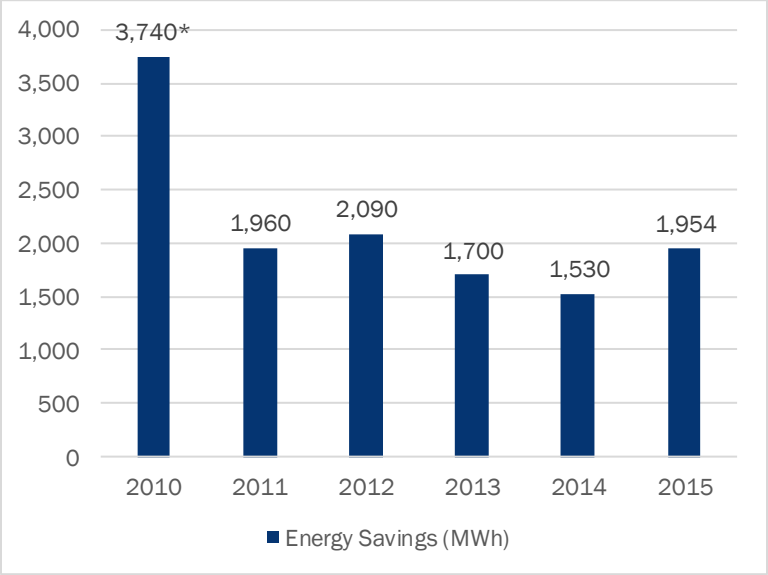
State	Participants	Annual Baseline Usage (kWh)	Savings (%)	Annual Energy Savings (kWh)	
				Per-Home Savings	2015 NES Program Savings
North Carolina	3,342	14,929	2.8%	420	1,402,090
South Carolina	1,207	16,279	2.8%	457	552,190
Total	**4,549**			**430***	**1,954,280**

* Total per-home energy savings is weighted by state.

5.4 Program Savings

The billing analysis results show that the NES program saved 1,954 MWh in 2015. In the 2014 evaluation, Opinion Dynamics estimated through billing analysis that the program saved participants 1,530 MWh, indicating an overall increase of 28% from the 2014 program to the 2015 program. Figure 5-2 shows the annual program savings from 2010 to 2015.

Figure 5-2. Overall NES Program Savings, 2010–2015



* 2010 program savings not based on billing analysis results.

The program served slightly more participants in 2015 than in 2014 and 2013, the two most recent program years, and the per-household kWh savings were also higher in 2015 than the preceding 2 years. The combination of these two factors—higher overall participation counts and higher per-household savings—generates the higher overall program savings. As a percentage, overall per-household savings is also slightly higher, increasing from 2.6% to 2.8% for 2014 participants.

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6. Process Evaluation

6.1 Researchable Questions

The Opinion Dynamics evaluation team conducted a process evaluation as part of the 2014 NES program evaluation, and this 2015 process evaluation aims to build on those findings. Based on the prior year's results and discussions with DEP program staff, the evaluation team developed the following process-related research questions:

- Are there specific ways that the program could be improved to be more effective in the future?
- Is the current list of measures offered appropriate? Or are there measures that the program could add to increase the program's effectiveness? Specifically, would opportunities for other measures, including specialty lighting, refrigerators, dehumidifiers, and window air conditioners, have any benefit.
- What are the limiting factors to achieving greater participation and realizing additional program attributable savings?
- Is the educational component of the NES program leading to persistent behavioral change?

6.2 Methodology

Our process evaluation relied primarily on our interviews with program staff, our review of program materials and NES program-tracking data, and our analysis of the participant survey results. Each of these activities is described in more detail in Section 4.

6.3 Key Findings

6.3.1 Program Participation

Participation increased in 2015 over the previous 2 years, and the program achieved its goal of treating at least 4,500 homes. The program treated 3,342 participants in North Carolina and 1,207 in South Carolina. Participants in 2015 were primarily drawn from six neighborhoods in the 2015 program; five in North Carolina and one in South Carolina. Nine percent of treated homes were manufactured housing, 20% were multifamily, and 71% were single-family. A comparison of program participation for the past 6 years is presented in Figure 6-1.

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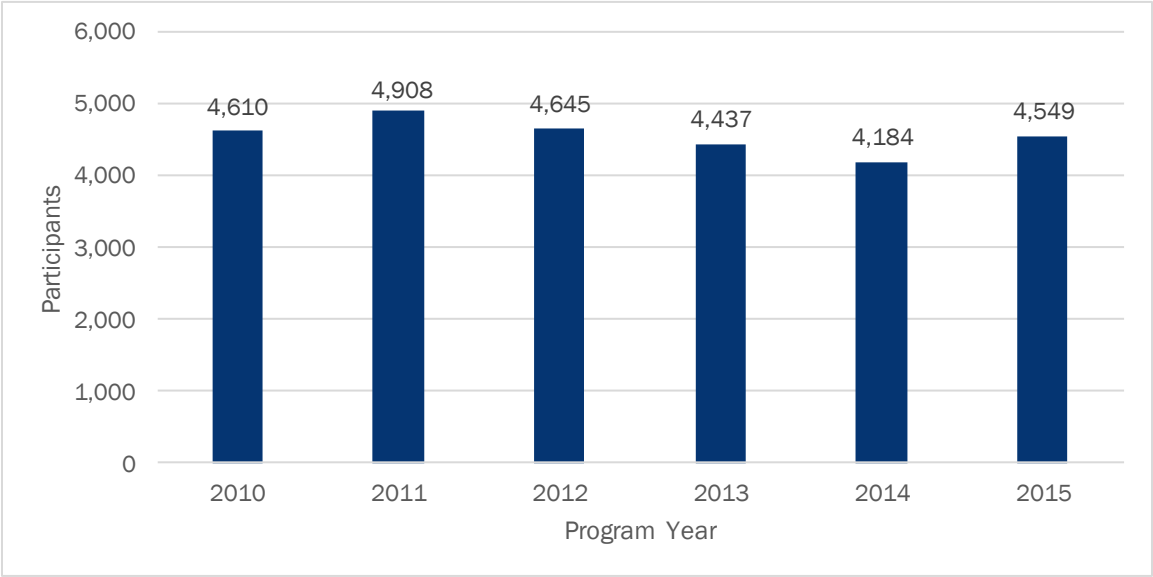
Figure 6-1. DEP NES Program Participation, 2010–2015



Most participants receive all of the measure types offered by the program. Table 6-1 shows the per-home average installation of each measure offered by the program and the percent of homes that receive at least one of each measure. The same table also shows the percent of homes that receive measures from each of four main categories: lighting, hot water, air infiltration, and HVAC filters/educational/other. Ninety-seven percent of homes treated by the program received CFLs. Ninety-nine percent received at least one hot water measure, 98% received at least one air infiltration measure, and 71% of homes received HVAC filters.

Table 6-1. 2015 Measure Installation Rates from Program-Tracking Data

Measure Category	Percent of Projects with Measure Category	Measure	Projects with Measures	
			Percent of Projects	Average Number
Lighting	97%	CFLs	97%	8.33
Hot Water	99%	Efficient Faucet Aerator	97%	2.04
		Efficient Shower Head	88%	1.20
		Hot Water Pipe Wrap	33%	5.01
		Hot Water Temperature Setback	34%	1.00
		Water Heater Blanket	22%	1.00
Air Infiltration	98%	Caulk	83%	1.54
		Door Sweep	71%	1.68
		Foam Spray	82%	1.65
		Glass Patch Tape	<1%	1.47
		Weather Stripping	80%	1.66
		Winterization Kit	29%	1.76
HVAC Filters/ Educational/Other	100%	Coil Brush	98%	1.01
		HVAC Filter	71%	11.47
		Maintenance Calendar	67%	2.01
		Thermometer	100%	3.15

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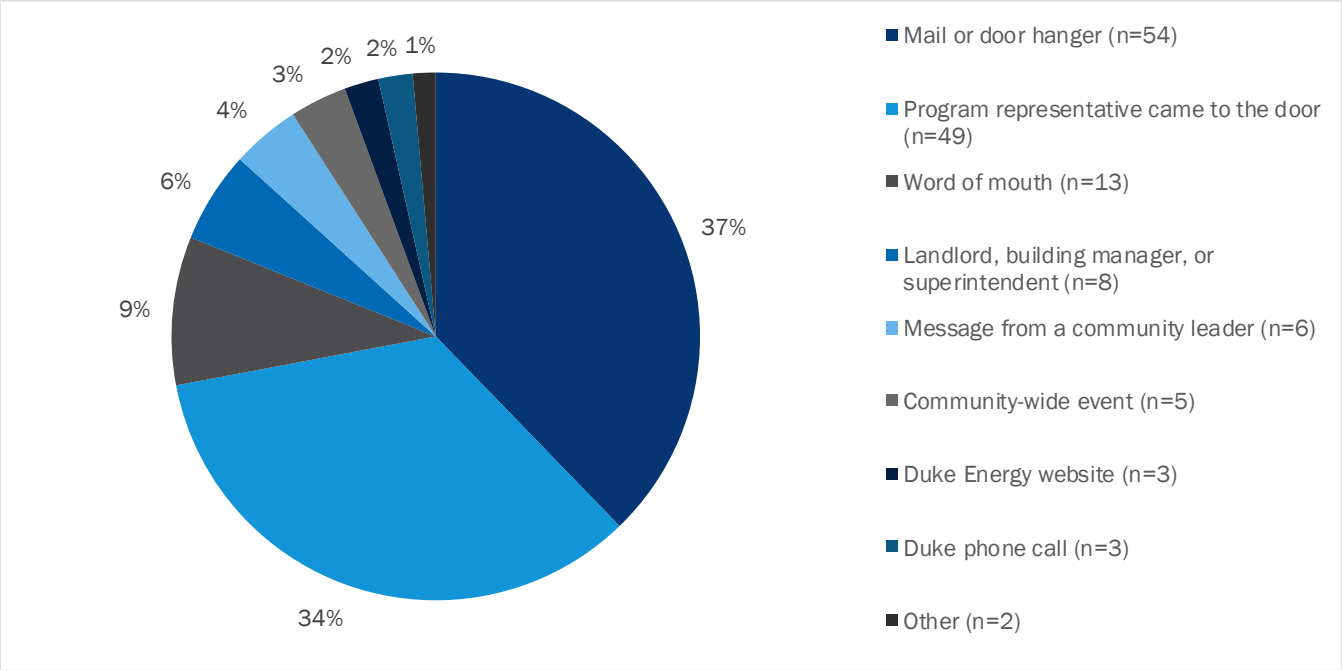
6.3.2 Marketing and Outreach

A key component of the NES program is the marketing and outreach that occurs at the outset of a program in each neighborhood. The program staff and implementation contractor perform this marketing and outreach to generate interest in the program and in saving energy. The program sends customized introduction letters to residents in preselected neighborhoods that provide information on the measures that the program offers, the monetary savings that participants can achieve through participation, and information on how to participate. The introduction letter also notes any community organizations that the NES program has partnered with to deliver the program and information about the kickoff event for the neighborhood. The program also sends follow-up postcards after the introductory letters, invitations to schedule an appointment, and flyers to remind residents about the opportunity to participate.

Figure 6-2 shows participant responses concerning how they first learned about the NES program. Thirty-seven percent first heard about the program through the mail or door hanger, while 34% heard about the program when a program representative visited their home. These responses indicate that the initial contacts made by the program are effective in getting the word to participants.

Figure 6-2. How NES Program Participants First Learned about the Program (multiple response)



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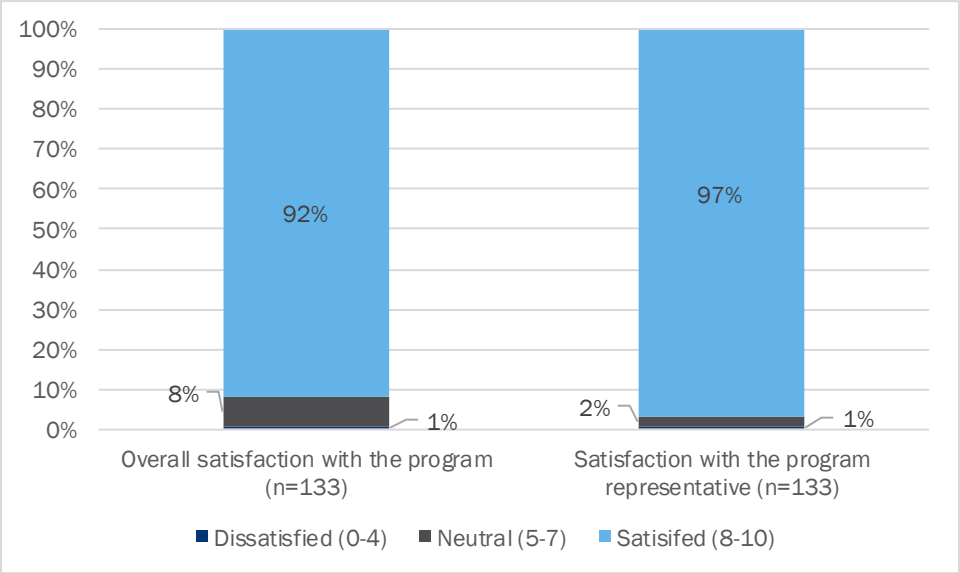
6.3.3 Program Satisfaction

Program participants were highly satisfied with the program, with 92% saying that they were satisfied with the program and 97% saying that they were satisfied with the program representative who visited their home.

Figure 6-3. Satisfaction with the NES Program and the Program Representative



6.3.4 Energy Education

An important component of the NES program is the energy education that it provides to participants at the time of the home visit. Prior to participation, customers receive some energy savings information through mailings and flyers left at their home and at the neighborhood launch event. During the program visit, the participants receive explanations from a program representative of the measures that will be installed in their home and how they can save them energy. At the same time, participants receive a brochure that reinforces the information that the program representative provides and that also provides tips on additional ways to save energy. The many touch-points reinforce the core message of the program and help lead to persistent behavior change that will help participants continue to save energy and money in the future.

Opinion Dynamics asked program participants about the educational components of the program and how they had affected their behavior and attitudes toward energy saving after participation. Ninety-six percent of participants reported that the program representative discussed ways to save energy in their home at the time of the appointment, and 93% reported that they received an informational brochure. Ninety percent reported that the program representative discussed the information in the brochure with them, and 80% felt that the educational materials and discussion helped them conserve energy.

Participants rated their knowledge of ways to save energy prior to participating an average of 6.9 (n=134) on a scale of 0 to 10, where 0 is not at all knowledgeable and 10 is very knowledgeable. On the same scale, participants rated their knowledge after participating as 8.9 (n=134).

The vast majority of program participants, 94%, reported that they are motivated to reduce their energy use after participating in the NES program, indicating that the program has lasting effects on participants.

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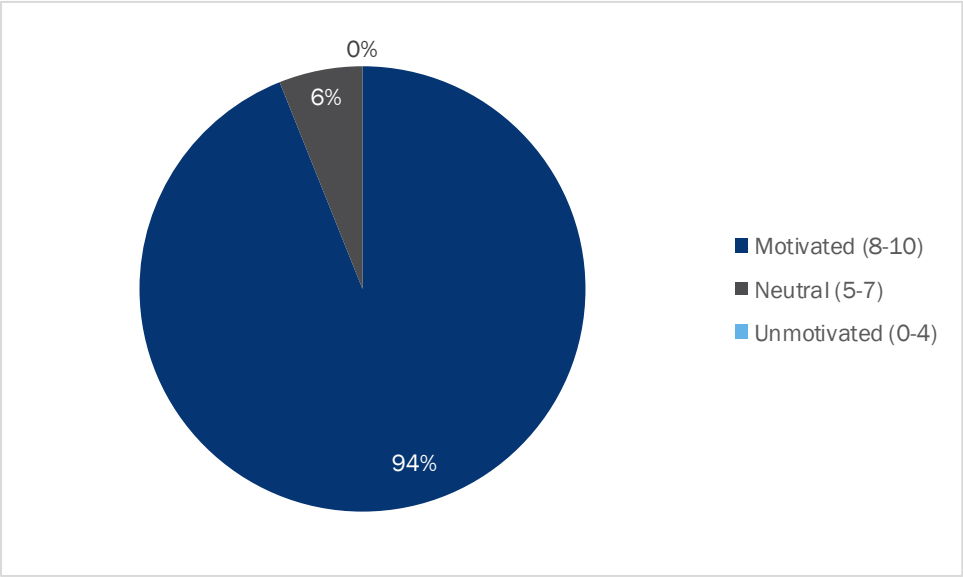
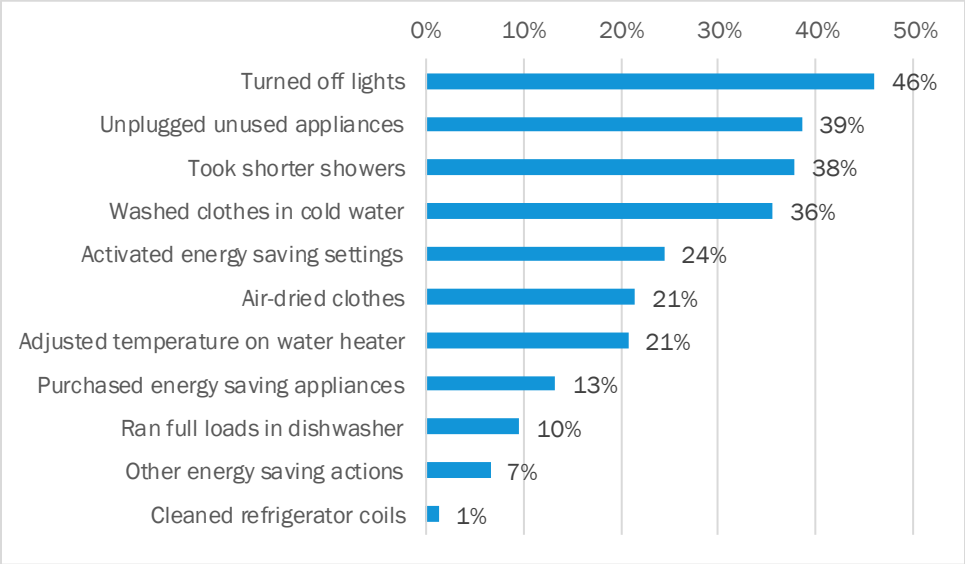
Figure 6-4. Motivation to Reduce Energy Use after NES Program Participation (n=132)



To determine if the education resulted in actual energy-saving behavioral changes, we asked survey respondents who recalled receiving written materials at the time of the NES program representative visit what energy-saving actions they had taken after participating in the program. Among the 63 participants who said that they had taken at least one energy-saving action, the most frequent responses were that they had turned off lights more frequently (46%), unplugged unused appliances (39%), taken shorter showers (38%), and washed clothes in cold water (36%).

Figure 6-5. Energy-Saving Actions Taken (multiple responses)



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6.3.5 Additional Opportunities for Program Savings

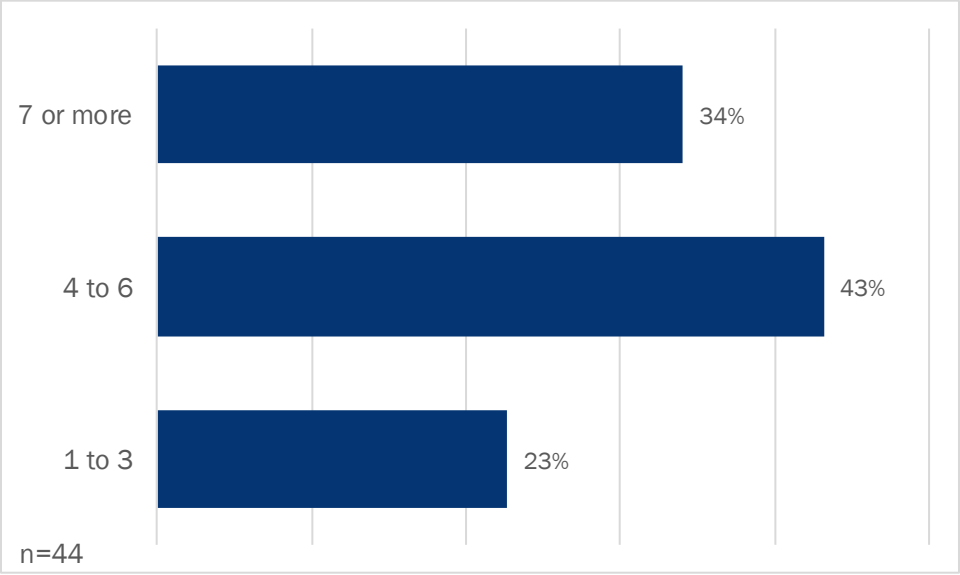
One objective of the process evaluation was to determine if there are opportunities for increasing program savings with additional types of measures. For example, some income-qualified programs provide energy-efficient replacements for older, inefficient appliances. Further, with the increasing efficiency of existing standard lighting, some programs are offering LEDs and other specialty lighting options.

To identify potential opportunities, Opinion Dynamics surveyed participants about their existing lighting and appliances. Specifically, we asked respondents about any light bulbs that were not replaced during the visit, as well as about the presence and age of refrigerators, dehumidifiers, and window air conditioners.

Lighting

With the rapid efficiency improvements in the standard lighting market that resulted from the 2007 Energy Independence and Security Act (EISA) and various lighting-related technological advances, the opportunities for direct-install programs to install high-efficiency bulbs in standard high-use sockets are becoming scarcer. Existing standard lighting is more efficient, reducing baseline energy use and associated energy savings from efficiency upgrades. Not as significantly affected by EISA, specialty lighting may be a source of additional savings opportunities for the NES program, which currently does not offer specialty lighting measures. To identify potential specialty lighting applications, we asked NES program participants about bulbs in their homes that were not replaced by the program representative. Thirty-three percent of participants reported that there were some bulbs not replaced during the visit. We asked participants who said that they had bulbs that were not replaced to estimate the number of bulbs that were not replaced. Thirty-four percent of those reporting that at least some bulbs were not replaced said that seven or more bulbs were not replaced, 43% said four to six bulbs were not replaced, and 23% said one to three bulbs were not replaced, as shown in Figure 6-6.

Figure 6-6. Number of Bulbs Not Replaced during Assessment



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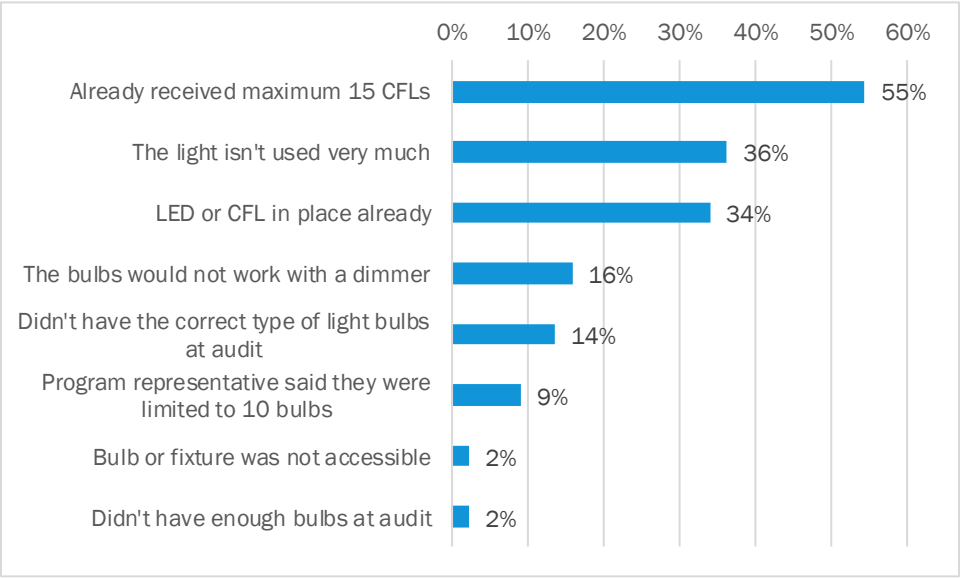
For those respondents who said that they had bulbs that were not replaced at the time of the visit, we asked them why they thought the bulbs were not replaced. Fifty-five percent said that they had already received the maximum of 15 CFLs. Thirty-six percent said that the light isn't used very much, so the bulb was not replaced, and 34% said that they already had an LED or CFL bulb in place. The percent of respondents with an LED or CFL already in place is one indicator that these types of bulbs are becoming more prominent in customers' homes as technology standards change. The results of this question are shown in Figure 6-7.

A combined 30% said that the bulbs offered by the program would not work with a dimmer or the program did not have the correct type of bulb at the time of the audit. These responses indicate that there may be opportunities for additional savings from specialty bulbs (e.g., dimmable bulbs, reflectors, candelabra, etc.) to be offered through the program. Additional research would be required to determine the extent of the opportunity for additional savings from lighting in the NES program. In the future, the NES program should consider collecting information about missed lighting opportunities in each participant's home or from a representative sample. This information would include the total number of sockets, how many of those sockets already have an efficient bulb, the number of bulbs that are not replaced at the time of the audit, and the wattages of all removed bulbs. This data collection could be performed by the implementer at the time of the assessment or as part of the next evaluation.

Figure 6-7. Reasons Bulbs Were Not Replaced (multiple responses)



During our interview, program staff indicated to the evaluation team that they have also observed fewer opportunities for the program to replace high wattage (100W) incandescent bulbs and that more customers have already installed some CFLs or LEDs in their home.

Refrigerators

Older model refrigerators, frequently found in low-income homes, can account for a significant portion of annual household energy use. Although they are high-cost measures, new ENERGY STAR refrigerators are being offered by some income-qualified programs cost-effectively. Refrigerators typically qualify for

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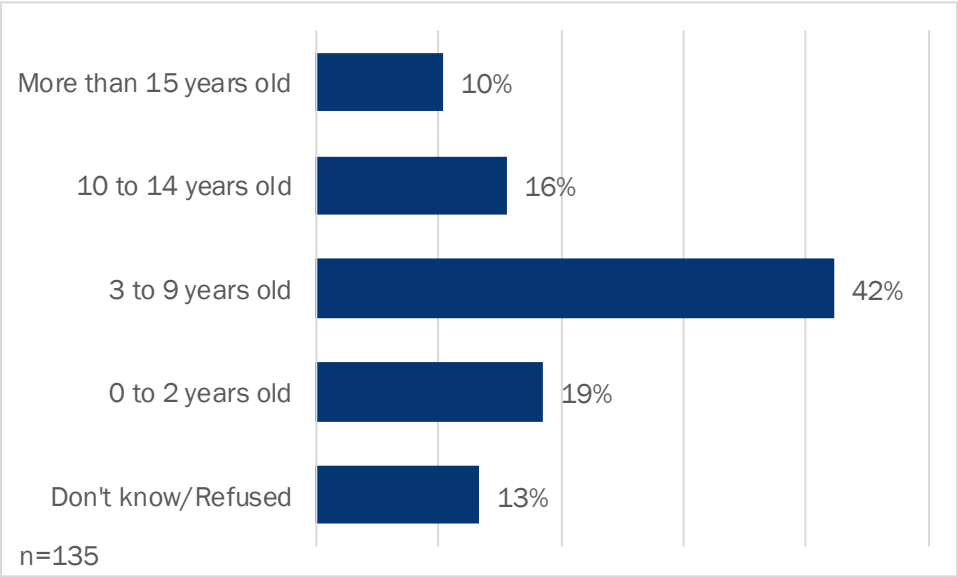
replacement based on their age or metered energy use. Typical annual deemed savings values for refrigerator replacement used in engineering analyses of similar programs range from 750 kWh to 940 kWh.[2]

To characterize the prevalence of older, inefficient refrigerators among the NES program participants, we asked participants to estimate the age of their refrigerator. The most recent U.S. Department of Energy efficiency standards for refrigerators went into effect in September 2014; prior standards were in effect from July 2001 to September 2014.[3] As shown in Figure 6-8, approximately 10% of the refrigerators among the population of NES program participants likely predate two of the last federal efficiency standards updates, and 26% of respondents reported that their refrigerator was 10 years old or more.

Figure 6-8. Approximate Age of Refrigerators among NES Program Participants



The percent of refrigerators qualifying for replacement in two similar income-qualified programs that Opinion Dynamics recently evaluated were in the range of 27%–30%. Program 1's installation percentage is based on the most recent 2015 results, and Program 2's installation percentage is based on results from the past 5 years of the program. Based on these results, we would estimate that a similar percent of refrigerators among NES program participants might qualify for replacement.

The results of this survey question show a similar distribution of ages as observed among the 2015 Duke Energy Carolinas' (DEC) Residential Neighborhoods Program (RNP) participants. Additional analysis would be necessary to determine actual savings, costs, and cost-effectiveness of providing this measure.

Dehumidifiers

Older and inefficient dehumidifiers are also the target of some income-qualified programs. Replacing these dehumidifiers with new ENERGY STAR units can save approximately 260–360 kWh per year.[4] We asked NES

[2] Opinion Dynamics calculation based on inputs from Illinois TRM Version 4.0, Mid-Atlantic TRM Version 4.0, Indiana TRM Version 2.2, and Pennsylvania TRM.

[3] See U.S. Department of Energy Standards for Refrigerators here: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=37&action=viewlive.

[4] Opinion Dynamics calculation based on inputs from Illinois TRM Version 4.0, Mid-Atlantic TRM Version 4.0, and Pennsylvania TRM.

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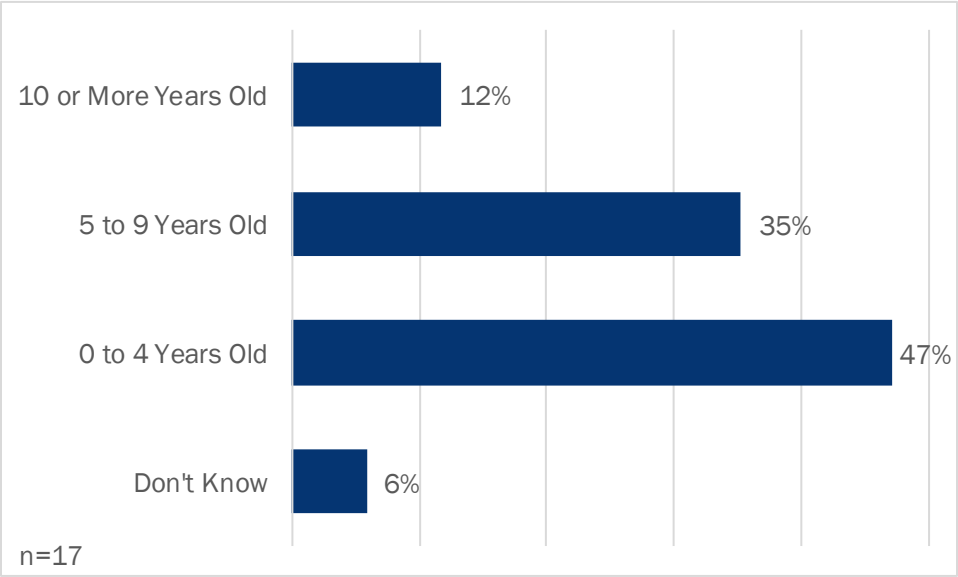
program participants if they have a dehumidifier and, if so, to estimate its age. Thirteen percent reported having a dehumidifier. This was slightly lower than the percentage of participants in the 2015 DEC RNP, where we observed that 19% had a dehumidifier. Nearly half (47%) of DEP NES program respondents who have a dehumidifier said that their dehumidifier was between 0 and 4 years old, as shown in Figure 6-9. A further 35% of respondents said that their dehumidifier is 5–9 years old, and 12% said that their dehumidifier is 10 years old or more. The most recent U.S. Department of Energy dehumidifier standards went into effect for products manufactured in or after October 2012. Participants' dehumidifiers that are 0–4 years old are likely up to date with the most recent standard, but those that are 5–9 years old were probably manufactured under the efficiency standard that was in place from October 2007 to October 2012.[5]

Figure 6-9. Approximate Age of Dehumidifier among NES Program Participants



For two similar income-qualified programs recently evaluated by Opinion Dynamics, we found that between 3% and 13% of program participants received energy-efficient dehumidifiers in exchange for an older unit that was less efficient but still functioning. Program 1[6] requires that a dehumidifier meet one of the following thresholds to be replaced by a more efficient unit:

- The dehumidifier uses Freon 11 or 12 refrigerant.
- The dehumidifier was manufactured before the year 2000.
- The dehumidifier has an energy factor of less than 0.8.

The dehumidifier must also be used enough to warrant replacement with an ENERGY STAR unit. This determination is made based on the equipment's wattage rating and the number of weeks it is operated annually.

[5] See U.S. Department of Energy Standards for Dehumidifiers here: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=24&action=viewcurrent.

[6] IESO Home Assistance Program Evaluation Report, 2015. http://www.ieso.ca/Pages/Conservation/Conservation-First-Framework/Evaluation-Measurement-and-Verification.aspx.

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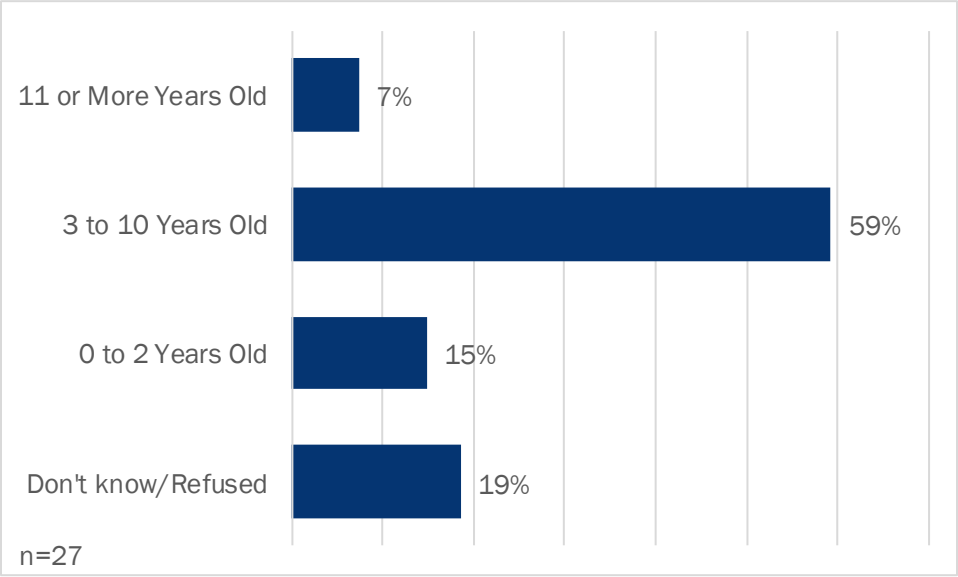
Program 2[7] uses different criteria to determine if a dehumidifier can be exchanged. In Program 2, a dehumidifier must be at least 5 years old and in working condition, unless the unit is an ENERGY STAR unit, in which case it must be at least 11 years old and operational to be exchanged for a more efficient unit. Additional research would be required to verify the age, condition, and efficiency levels of the existing stock of dehumidifiers among the NES program population and to determine if the extent of the opportunity would justify the cost and program changes necessary to offer this measure. However, these results suggest that approximately 1.5% (assuming all units 10 years old or more qualify) to 4.4% (assuming all units 5 years old or more qualify) of participants would qualify for a dehumidifier replacement.

Window Air Conditioners

To determine if there is potential for the NES program to offer efficient window air conditioner replacements, we asked participants if they have window air conditioners and, if so, to estimate their ages. Twenty percent of survey respondents reported that they have at least one window air conditioner. Of the 20% of survey respondents with window air conditioners, most (59%) are 3–10 years old. Only 7% are 11–15 years old, and approximately 15% are relatively new at 0–2 years old. The most recent U.S. Department of Energy room air conditioner standards went into effect in June 2014, when energy efficiency ratio (EER) levels increased for room air conditioners.[8] Prior to this most recent federal standard, a standard was in place from October 1, 2000 to May 31, 2014.[9] Therefore, among survey respondents, approximately 68% of the window air conditioner units were likely manufactured prior to the most recent efficiency standard. Figure 6-10 summarizes the ages of window air conditioners among survey respondents with this equipment in their home.

Figure 6-10. Approximate Age of Window Air Conditioner



[7] PSEG Long Island Efficiency Long Island and Renewable Energy Portfolio Evaluations, Residential Energy Affordability Partnership (REAP) program, 2009–2015. https://www.psegliny.com/page.cfm/AboutUs/CompanyProfile/DocumentLibrary/Reports/ELI.

[8] U.S. Department of Energy standards for room air conditioners apply to window air conditioners and those designed to be mounted through a wall.

[9] See U.S. Department of Energy Standards for Window Air Conditioners here: https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=52&action=viewlive.

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In Program 2[10], another income-qualified program that Opinion Dynamics recently evaluated, unit eligibility was determined according to the age of the unit. Non-ENERGY STAR window air conditioners that are 5 or more years old and operational are eligible to be exchanged, while ENERGY STAR units must be operational and at least 11 years old. Based on these criteria, we estimate that 1%–12% of NES program participants would qualify for window air conditioner replacement. These results indicate that there may be additional savings opportunities for the NES program by offering window air conditioner replacements to program participants. Additional research would be warranted to validate these assumptions about the age and condition of window air conditioners present in NES program participants' homes. As part of the program or during the next evaluation, on-site data could be collected about participants' window air conditioners at the time that they receive air conditioner winterization kits.

Insulation and HVAC

Program staff expressed interest in exploring additional measures as part of the program, including attic insulation, duct repair, and HVAC tune-ups. While these were not explored as topic areas in the participant survey, these areas would likely provide additional program savings that would not be achieved absent participation in the program. To determine the extent of opportunities for attic insulation and HVAC measures in the DEP NES program population, additional site visit studies could be performed by Duke Energy staff among a representative population of customers who would qualify as future NES program participants. Alternatively, the data could be collected among NES program participants in the course of implementing the program.

[10] PSEG Long Island Efficiency Long Island and Renewable Energy Portfolio Evaluations, Residential Energy Affordability Partnership (REAP) program, 2009–2015. https://www.psegliny.com/page.cfm/AboutUs/CompanyProfile/DocumentLibrary/Reports/ELI.

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7. Conclusions and Recommendations

Opinion Dynamics conducted a billing analysis of NES program participants to determine overall ex post net program savings. We also conducted an engineering analysis for each measure provided by the program, the purposes of which were to:

1. Provide a ratio of kW demand to kWh energy savings, which is then applied to the billing analysis energy savings to estimate demand savings
2. Provide insight into the individual measure contributions to the overall program savings

Table 7-1 presents a comparison of the estimated ex post results of analyses at both the per-household and the program-wide level.

Table 7-1. Comparison of 2015 Billing Analysis and Engineering Savings Estimates

Method	Net Annual Participant-Level Savings			Net Annual Program-Level Savings		
	Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (MWh)	Summer Coincident Demand (MW)	Winter Coincident Demand (MW)
Billing Analysis (evaluated)	430	0.0655	0.0748	1,954	0.2980	0.3404
Engineering Analysis	478	0.0729	0.0833	2,174	0.3315	0.3788

Key findings, which we discuss below, include:

- The program met its participation goal, serving 4,549 homes of a goal of 4,500, or 109% of the goal.
- Per-household savings increased 17% from the 2014 program, from 367 kWh in 2014 to 430 kWh in 2015. The program in 2015 achieved a realization rate of 117% on a per-household basis.
- Program participants are highly satisfied with the program.
- The program's educational component appears to be performing strongly, consistent with findings in the last evaluation. The program should continue to emphasize the educational component to maximize savings.

Program Participation

The program achieved strong participation in 2015, reaching its goal of treating at least 4,500 customer homes. The program treated six neighborhoods in reaching its goal. Most participants received measures from each category, and in many cases those measures were installed at higher rates than in the 2014 NES program. Despite these successes, the program staff have reported that there were challenges in identifying and treating neighborhoods where sufficient numbers of participants met the required income thresholds. In the past, the program was able to identify and serve neighborhoods where 70%–80% of the residents met the poverty threshold, but those easily identified and treated neighborhoods are increasingly difficult to find as the program has matured. Program staff have also reported that the income threshold for eligibility may be increased to 50% of residents at 200% of the federal poverty level, from 150%, as early as January 2017. This change would bring the DEP NES program in line with the low-income neighborhoods program offered by other Duke Energy jurisdictions and could generate additional opportunities for the program to treat neighborhoods that do not meet the more stringent DEP NES program eligibility level.

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Per-Home Savings

In 2015, the program achieved savings of 430 kWh per home per year, as determined by our billing analysis. The 2015 NES program participants realized 1.2 kWh of daily energy savings, on average, or 2.8% of their overall usage. Our engineering analysis estimated 478 kWh per home per year. It is not unusual for engineering analysis results to differ from those of billing analysis results. Engineering analyses are based on deemed savings assumptions from past studies that may not reflect the current characteristics of DEP's NES participants. Nevertheless, both the billing analysis and the engineering analysis savings values represent considerable increases over the previous year and reflect strong program performance in terms of measures installed. For many measures, the ISRs observed in 2015 were higher than in 2014, including those for CFLs, efficient faucet aerators, efficient shower heads, door sweeps, weather stripping, and infiltration reduction.

Opportunities for Additional Savings

In 2015, the program obtained approximately 35% of its savings through installation of standard CFLs, per our engineering analysis. As lighting baselines become more efficient, the program will need to adapt to continue to achieve significant energy savings. Other income-qualified programs that Opinion Dynamics has evaluated offer additional energy-saving measures that provide value to customers and help the program achieve savings from diversified sources. Some of the measures offered by other income-qualified programs include ENERGY STAR dehumidifier, window air conditioner, and refrigerator replacements. Our survey research among 2015 NES program participants showed that these types of measures may present opportunities for DEP to diversify its savings and rely less on the lighting end use. However, more research is needed to quantify the potential savings and their cost-effectiveness.

In addition, the program may consider diversifying its lighting offerings to include specialty bulbs, such as dimmables, non-A-line bulbs, and exterior bulbs. Survey research indicated that there may be additional high-use sockets in participating homes that cannot be retrofitted with the current lighting measures offered by the program. Program staff have indicated that, pending a regulatory filing, the program may offer LEDs as early as January 2017. The change to LEDs would allow the program to address some of these additional opportunities that are not feasible with standard CFLs because of the limitations of the technology.

Program staff have also expressed interest in exploring the addition of new measures, such as low-level weatherization and HVAC maintenance. These additional measures were recently added to the NES program in Duke Energy's Florida territory. Additional research would be necessary to determine if these measures could be applied to the DEP NES program in a cost-effective manner. Some considerations for these types of measures would be the additional equipment and expertise necessary among implementer staff to install insulation and perform HVAC maintenance, and the challenges of targeting these measures to customers who can benefit from them. Further, their addition would need to be coordinated with any other DEP programs offering these measures.

7.1 Recommendations

- **Specialty Lighting and LED Lighting.** There may be opportunities to provide additional efficient lighting equipment. The program should evaluate the opportunities for specialty and LED lighting products. The increasing prevalence of efficient lighting technology may limit opportunities to install CFLs in standard high-use sockets and specialty lighting may be an opportunity for additional savings. Although the program installed the same average number of bulbs per home in 2015 compared to 2014, lighting opportunities will likely decrease as the lighting market and technology standards change in the near future. If the program transitions to LED bulbs in January 2017, pending approval of a new

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regulatory filing, additional opportunities may open up for the program where CFLs currently do not function well, such as dimmable fixtures and exterior lights.

- **ENERGY STAR Appliances and Low-Level Weatherization.** DEP should assess the potential savings and costs of including additional measures frequently offered through income-qualified programs. The results of the participant survey show that there may be opportunities to replace older appliances in some homes. Replacing older and less-efficient equipment with ENERGY STAR equipment could generate increased savings for the program and may also increase program participation rates. Program staff have also expressed interest in opportunities for application of attic insulation and HVAC maintenance/tune-up work in the program. Additional data should be collected among DEP participants to determine what opportunities exist among this population for attic insulation, duct repair, and HVAC maintenance. These additional measures have the potential to increase programmatic savings, but practical application of them in the program and in the overall portfolio of energy efficiency programs would need to be considered carefully.

- **Modify Eligibility Requirements to Include 50% of Residents at 200% of Poverty Level.** The program should continue to make efforts to reach the greatest number of participants in each selected neighborhood. Maximizing the number of treated homes in each neighborhood reduces the overall number of neighborhoods required to meet program-wide participation goals. In the past 2 years, the program has had success treating a large fraction of the eligible residents in each treated neighborhood. Maintaining this robust implementation approach over the long term will help ensure continued program success while reducing the costs associated with selecting and setting up operations in additional neighborhoods. Program staff noted that as the program has matured it has been increasingly difficult to identify neighborhoods meeting the requirement for 50% of residents at 150% of the poverty level. Moving the program to an eligibility level of 50% of residents at 200% of the poverty level, pending regulatory approval, would open opportunities in additional neighborhoods. This change would also bring the DEP NES program in line with the eligibility requirements of the NES program in Duke Energy's other jurisdictions.

- **Continue to Improve and Expand Program Data Collection.** During the course of the evaluation, Opinion Dynamics encountered several data quality issues, including discrepancies between data collected by the implementer and data found in Duke Energy's data warehouse. The program and implementer should take additional steps to verify all data sources and ensure accuracy and completeness as a regular part of the program. It is our understanding that the DEP team has recently taken action to correct these data issues. Program implementer field staff are now collecting data on a tablet-based system, which should help with data collection consistency and accuracy. As of early 2016, the tablet-based system was not available to program staff to conduct quality assurance audits, and program staff reported that they still conducted audits using a paper-based system. The tablet-based system should be expanded to allow program staff to perform quality assurance audits using the same method.

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8. Summary Form

Neighborhood Energy Saver

Completed EMV Fact Sheet

The Neighborhood Energy Saver (NES) program provides a home energy assessment free of cost, and installs energy-saving measures in the homes of income-qualified customers living in DEP service territory. During the assessment, program representatives discuss what was installed and provide additional recommendations on ways participants can save energy in their homes.

Date	November 30, 2016
Region(s)	Duke Energy Progress territory, North Carolina and South Carolina
Evaluation Period	January 1, 2015 – December 31, 2015
Annual kWh Savings	1,954,280
Per Participant kWh Savings	430
Annual Coincident kW Impact	298 (Summer), 340 (Winter)
Measure Life	Not evaluated, so remains unchanged at 7 years
Net-to-Gross Ratio	N/A
Process Evaluation	Yes
Previous Evaluation(s)	January 2016

Evaluation Methodology

The evaluation team verified deemed savings estimates using an engineering analysis of savings assumptions and calculations. The evaluation team also leveraged a participant survey to verify installation and ISRs for each measure and characterized behavior change resulting from the program's educational component. The evaluation team conducted a billing analysis to estimate energy savings and a combination of billing analysis results and engineering analysis to estimate peak demand savings.

Impact Evaluation Details

- Neighborhoods in DEP service territory where at least 50% of residential customers are at or below 150% of the federal poverty guidelines are eligible to participate in the NES program.
- The engineering analysis applied deemed savings values to measures distributed and in service. In-service rates were calculated from a participant survey.
- Results from the billing analysis reflect savings associated with measures installed, assessment recommendations, spillover, and potential behavioral changes from energy-efficiency knowledge gained through participation in the NES program.

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Appendix A. Engineering Algorithms and Assumptions Overview of Deemed Savings Review

As outlined in the evaluation plan for the Duke Energy Progress (DEP) Neighborhood Energy Saver (NES) program, Opinion Dynamics conducted a review of the deemed savings values and assumptions for each of the NES program measures. The primary source for 2015 evaluated program energy savings will be the billing analysis, but the deemed savings review will be used to estimate demand savings from the billing analysis results and to provide estimates of savings at the measure level. The goal of the deemed savings review is to assess whether the savings algorithms and inputs used for the prior DEP NES program evaluation are still applicable and whether we can leverage any more recent data or published studies to update any of the current assumptions.

To conduct the deemed savings review, Opinion Dynamics performed the following steps:

- Reviewed the unit savings estimates developed under Opinion Dynamics's previous evaluation of this program and the assumptions behind them.
- Reviewed all information received to date to decide if any of the current savings estimates or assumptions required updates.
- Reviewed latest Technical Reference Manuals (TRMs) and other recently published studies to determine if there is a need for additional updates.

CFLs

CFL Results

Table A-1 documents the inputs and methodology for estimating savings from CFLs installed by the DEP NES program in 2015.

Table A-1. Algorithms and Inputs for CFLs

Algorithms Used		
kWh Savings	= (Baseline Watts – CFL Watts) / 1,000 * Hours * WHFe	
kW Savings	= (Baseline Watts – CFL Watts) / 1,000 * CF * WHFd	
Parameter	**Value**	**Source/Notes**
Baseline Watts	Varies	From ENERGY STAR website, converts CFL wattage to equivalent incandescent wattage and then adjusts based on EISA requirements. See Table A-2.
CFL Watts	Varies	Actual wattage of installed bulb (9, 13, 14, 19, 20, or 23 watts).
Hours	1,097	Weighted average between data collected during 2013 and 2014 DEP NES program evaluations.
WHFe	0.99	Applied weights to the Arkansas (AR) TRM waste heat factors based on presence of central air conditioning and heating fuel type from the 2015 DEP NES program participant survey.
WHFd	1.1	
Summer Coincidence Factor (CF)	0.1138	2013 Evaluation of DEP's Energy Efficient Lighting Program.
Winter CF	0.096	

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Table A-2 displays a crosswalk between installed CFL wattage and assumed baseline incandescent wattage taken from the ENERGY STAR website. We then adjust the incandescent wattages to account for EISA requirements[11] and use the reduced EISA baseline in our engineering estimates.

Table A-2. ENERGY STAR Equivalent Incandescent Wattages

CFL Wattage	Equivalent Incandescent Wattage[a]	EISA Baseline (Watts)
9–13 watts	40	29
13–15 watts	60	43
18–25 watts	75	53
23–30 watts	100	72

[a] http://goo.gl/XjRoUk.

Table A-3 displays the deemed savings values for CFLs installed by the DEP NES program in 2015.

Table A-3. Per-Measure Savings for CFLs

Measure (per Bulb)	Savings Unit	2015 Savings
9-Watt CFLs	Energy Savings (kWh)	21.7
	Summer Demand Savings (kW)	0.0025
	Winter Demand Savings (kW)	0.0019
13-Watt CFLs	Energy Savings (kWh)	17.3
	Summer Demand Savings (kW)	0.0020
	Winter Demand Savings (kW)	0.0015
14-Watt CFLs	Energy Savings (kWh)	31.4
	Summer Demand Savings (kW)	0.0037
	Winter Demand Savings (kW)	0.0028
19-Watt CFLs	Energy Savings (kWh)	36.8
	Summer Demand Savings (kW)	0.0043
	Winter Demand Savings (kW)	0.0033
20-Watt CFLs	Energy Savings (kWh)	35.7
	Summer Demand Savings (kW)	0.0042
	Winter Demand Savings (kW)	0.0032
23-Watt CFLs	Energy Savings (kWh)	53.1
	Summer Demand Savings (kW)	0.0062
	Winter Demand Savings (kW)	0.0047

CFL Recommendations

Moving forward, the program should consider collecting the wattage of the removed bulbs to provide a more accurate energy savings estimate. Alternatively, to minimize increased time spent in each home, these data

[11] EISA set in place standards for general service light bulbs, with the first phase going into effect in January 2012. The standard essentially eliminates the manufacture and sale of 40W, 60W, 75W, and 100W incandescent light bulbs and sets new standards as shown in the table.

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could be collected from a representative sample of participants in each neighborhood and the results could then be applied to the remaining participant population.

LEDs

While the NES program does not presently offer LEDs, Duke Energy has expressed interest in adding these measures in the future. The program may offer LEDs starting in 2017, pending a regulatory filing. This section provides deemed savings methods and estimates for LEDs as background information to help inform a decision on whether to include LEDs as a program measure.

LED Results

The following section documents the expected savings from LEDs, assuming an incandescent baseline and identical hours of use and CFs used in the CFL savings calculations.[12] Table A-4 documents the proposed inputs and methodology for estimating savings for LEDs.

Table A-4. Algorithms and Inputs for LEDs

Algorithms Used		
kWh Savings	= (Baseline Watts – LED Watts) / 1,000 * Hours * WHFe	
kW Savings	= (Baseline Watts – LED Watts) / 1,000 * CF * WHFd	
Parameter	**Value**	**Source/Notes**
Baseline Watts	Varies	Varies according to installed LED wattage. See Table A-5.
LED Watts	Varies	Actual wattage of installed bulb.
Hours	1,097	Weighted average between data collected during 2013 and 2014 DEP NES program evaluations.
WHFe	0.99	Applied weights to the AR TRM waste heat factors based on presence of central air conditioning and heating fuel type from the 2015 DEP NES program participant survey.
WHFd	1.1	
Summer CF	0.1138	2013 Evaluation of DEP's Energy Efficient Lighting Program.
Winter CF	0.096	

Table A-5 displays a crosswalk of wattages between incandescent bulbs and the equivalent CFL and LEDs.[13] Most resources provide a range of equivalent wattages for CFLs and LEDs since exact wattage comparisons with incandescent bulbs are not always accurate. We adjust the incandescent wattages to account for EISA requirements and use the reduced EISA baseline in our engineering estimates.

[12] While there is reason to believe that hours of use and CFs for LEDs may be different from CFLs, there currently are no LED-specific values that we recommend using. We propose to update these assumptions with LED-specific information, based on the forthcoming residential logging study planned for the DEP/DEC Residential Lighting Program.

[13] http://eartheasy.com/live_energyeff_lighting.htm.

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Table A-5. Equivalent CFL and LED Wattages

Incandescent (Baseline) Watts	CFL Watts	LED Watts	Lumens (Brightness)
40	8–12	6–9	400–500
60	13–18	8–12.5	650–900
75–100	18–22	13+	1,100–1,750
100	23–30	16–20	1,800+
150	30–55	25–28	2,780

To estimate savings from installing LED bulbs, we assume an equivalent LED wattage based on the CFL wattages currently installed through the program. Table A-6 provides this comparison between CFLs and LEDs in the first column. Table A-6 also displays the proposed deemed savings for LEDs, compared with the deemed savings of equivalent CFLs currently installed through the program.

Table A-6. Per-Measure Savings for LEDs

Measure (per Bulb)	Savings Unit	CFL Savings (per Bulb)	LED Savings (per Bulb)
7-Watt LEDs (9-Watt CFLs)	Energy Savings (kWh)	21.7	23.8
	Summer Demand Savings (kW)	0.0025	0.0028
	Winter Demand Savings (kW)	0.0019	0.0021
8-Watt LEDs (13-Watt CFLs)	Energy Savings (kWh)	17.3	37.9
	Summer Demand Savings (kW)	0.0020	0.0044
	Winter Demand Savings (kW)	0.0015	0.0034
14-Watt LEDs (19-Watt CFLs)	Energy Savings (kWh)	36.8	42.2
	Summer Demand Savings (kW)	0.0043	0.0049
	Winter Demand Savings (kW)	0.0033	0.0037
15-Watt LEDs (20-Watt CFLs)	Energy Savings (kWh)	35.7	61.7
	Summer Demand Savings (kW)	0.0042	0.0072
	Winter Demand Savings (kW)	0.0032	0.0055
16-Watt LEDs (23-Watt CFLs)	Energy Savings (kWh)	53.1	60.6
	Summer Demand Savings (kW)	0.0062	0.0071
	Winter Demand Savings (kW)	0.0047	0.0054

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Efficient Shower Heads

Efficient Shower Head Results

Table A-7 documents the inputs and methodology for estimating efficient shower head savings for the 2015 NES program participants.

Table A-7. Algorithms and Inputs for Efficient Shower Heads

Algorithms Used		
kWh Savings	= (Baseline gallons per minute [GPM] – Efficient GPM) * (Mins/shower) * (Showers/person) * (People/household) / (Shower fixtures/household) * 365 * (Tmix – Tinlet) * 8.33 / 3,412 / RE * %Elec	
kW Savings	= (Baseline GPM – Low-flow GPM) * 60 * 8.33 * (Tmix – Tinlet) / RE / 3,412 * CF * %Elec	
Parameter	**Value**	**Source/Notes**
Baseline GPM	2.3	Tennessee Valley Authority (TVA) TRM. Takes the average base flow rate from the following two references: • 2003, Mayer, Peter, William DeOreo. Pg. 38. • 2008 Schuldt. Table 3, Pg. 1–260.
Efficient GPM	1.9	Use value from database if available. In the absence of a database value, use the value from the TVA TRM (1.9 GPM), which takes the average of two studies. Through discussions with Duke, we confirmed that the program requires efficient shower heads to be 2.0 GPM or less.
Mins/shower	7.8	Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013 (Michigan Showerhead/Faucet Aerator Study). This is a more recent study than the studies used in the TVA TRM for this parameter (2003–2011).
Showers/person	0.6	Michigan Showerhead/Faucet Aerator Study. This is a more recent study than the study used in the TVA TRM for this parameter (from 1999).
People/household	2.5	2014 DEP NES program participant survey (n=250).
Shower fixtures/ household	1.6	Michigan Showerhead/Faucet Aerator Study. This is a more recent study than the study used in the TVA TRM for this parameter (from 2011). In addition, the Michigan study allows us to distinguish between single-family and multifamily.
Tmix	101 °F	Michigan Showerhead/Faucet Aerator Study. This is a more recent study than the study used in the TVA TRM for this parameter (from 1984).
Tinlet	66.03 °F	National Renewable Energy Laboratory (NREL) Domestic Hot Water Event Generator calculator for cities across DEP service territory. Used average for: Ashville, NC; Fayetteville, NC; Jacksonville, NC; Raleigh, NC; Wilmington, NC; and Florence, SC.
RE	0.98	Recovery efficiency for standard electric resistance water heaters (consistent assumption across Illinois (IL) TRM, Indiana (IN) TRM, and AR TRM). TVA TRM applies the overall efficiency of the water heater (0.89) as opposed to the recovery efficiency.
%Elec	72.4%	2015 DEP NES program participant survey (n=250).
Summer CF	0.00371	TVA TRM does not provide a CF. Use CF from IN TRM, which comes from Aquacraft Water Engineering and Management "Disaggregated Hot Water Use"; assumes 9% of showers take place during peak.
Winter CF	0.00742	Duke Energy's winter peak is from 7 AM to 8 AM. Reliable data do not exist for winter CFs for showers during the 7–8 AM hour. Customers are expected to use showers more frequently during the winter peak hour than during the summer peak hour (4–5 PM). We estimate the frequency is approximately double and, therefore, double the summer CF to estimate winter CF.

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Table A-8 displays the deemed savings for the 2015 evaluation.

Table A-8. Per-Measure Savings for Efficient Shower Heads

Measure (per Shower Head)	Savings Unit	2015 Savings
Efficient Shower Head	Energy Savings (kWh)	67.3
	Summer Demand Savings (kW)	0.0056
	Winter Demand Savings (kW)	0.0112

Efficient Shower Head Recommendations

The DEP NES program should consider documenting the new shower head flow rate (in GPM) and, if possible, the flow rate of the removed shower head to more accurately estimate savings. Alternatively, to minimize increased time spent in each home, these data could be collected from a representative sample of participants in each neighborhood and the results could then be applied to the remaining participants.

Efficient Faucet Aerators

Efficient Faucet Aerator Results

Table A-9 documents the inputs and methodology for estimating efficient aerator savings for the 2015 NES program participants. We estimate savings for bathroom faucet aerators and kitchen faucet aerators separately because the two measures are used differently and perform differently. For example, households tend to use kitchen faucets more than bathroom faucets throughout the day and they typically have a higher flow rate.

Table A-9. Algorithms and Inputs for Efficient Faucet Aerators

Algorithms Used		
kWh Savings	= (Baseline GPM – Efficient GPM) * (Mins/person/day) * (People/household) / (Faucets/household) * 365 * (Tmix – Tinlet) * 8.33 / 3,412 / RE * DF * %Elec	
kW Savings	= (Baseline GPM – Efficient GPM) * 60 * 8.3 * (Tmix – Tinlet) / RE / 3,412 * CF * DF * %Elec	
Parameter	**Value**	**Source/Notes**
Baseline GPM (bathroom)	2.25	IL TRM. The IL TRM distinguishes between kitchen and bath aerators, while the TVA TRM does not.
Baseline GPM (kitchen)	2.75	
Efficient GPM (bathroom)	1.0	Use value from database if available. In the absence of a database value, use 1.0 GPM for bathrooms and 1.5 GPM for kitchens, based on IN TRM. TVA TRM does not distinguish between kitchen and bath aerators.
Efficient GPM (kitchen)	1.5	
Minutes/person/day (bathroom)	1.6	Michigan Showerhead/Faucet Aerator Study
Minutes/person/day (kitchen)	4.5	
People/household	2.5	2015 DEP NES participant survey (n=250).
Faucets/household (bathroom)	2.0	TVA TRM. Assumes two bathroom and one kitchen.
Faucets/household (kitchen)	1.0	
Tmix (bathroom)	86 °F	Michigan Showerhead/Faucet Aerator Study.

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Tmix (kitchen)	93 °F	
Parameter	**Value**	**Source/Notes**
Tmix (unknown)	91 °F	Assumes that 70% of household water runs through kitchen faucet and 30% through the bathroom faucet.
Tinlet	66.03 °F	NREL Domestic Hot Water Event Generator calculator for cities across DEP service territory. Used average for: Ashville, NC; Fayetteville, NC; Jacksonville, NC; Raleigh, NC; Wilmington, NC; and Florence, SC.
RE	0.98	Recovery efficiency for standard electric resistance water heaters (consistent assumption across IL TRM, IN TRM, and AR TRM). TVA TRM applies the overall efficiency of the water heater (0.89) as opposed to the recovery efficiency.
%Elec	72.4%	2015 DEP NES participant survey (n=250).
Summer CF	0.00262	IN TRM.
Winter CF	0.00524	Duke Energy's winter peak is from 7 AM to 8 AM. Reliable data do not exist for winter CFs for aerators during the 7–8 AM hour. We expect customers to use sinks more frequently during the winter peak hour than during the summer peak hour (4–5 PM). We assume the frequency is approximately double, and therefore double the summer CF to estimate winter CF.
Drain Factor (DF) (bathroom)	90%	IL TRM. This represents the portion of the water that actually flows directly down the drain and that is not collected for another purpose. If the water is collected, it will not save any energy, as the volume is constant regardless of the flow rate.
DF (kitchen)	75%	

Table A-10 displays the deemed savings for the 2015 evaluation.

Table A-10. Per-Measure Savings for Efficient Faucet Aerators

Measure (per aerator)	Savings Unit	2015 Savings
Faucet Aerator (bathroom)	Energy Savings (kWh)	19.72
	Summer Demand Savings (kW)	0.0064
	Winter Demand Savings (kW)	0.0127
Faucet Aerator (kitchen)	Energy Savings (kWh)	62.41
	Summer Demand Savings (kW)	0.0072
	Winter Demand Savings (kW)	0.0143
Weighted Average	Energy Savings (kWh)	41.07
	Summer Demand Savings (kW)	0.0068
	Winter Demand Savings (kW)	0.0135

Efficient Faucet Aerator Recommendations

The implementation contractor should begin to record whether aerators are installed in the kitchen or in the bathroom, as they have significantly different associated savings. Additionally, the program should consider measuring and documenting the new aerator flow rate (in GPM) and, if possible, the flow rate of the removed aerator to more accurately estimate savings.

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Alternatively, to minimize increased time spent in each home, these measurements could be taken from a representative sample of participants in each neighborhood and the results could then be applied to the remaining participant population.

Infiltration Reductions

Infiltration Reduction Results

Table A-11 documents the inputs and methodology for estimating infiltration reduction savings for the 2015 NES program participants. This measure includes savings for all infiltration reduction measures associated with the NES program, including door sweeps, caulk, foam spray, glass patch tape, weather stripping, and winterization kits.

Table A-11. Algorithms and Inputs for Infiltration Reductions

Algorithms Used		
kWh Savings	Cooling Savings = (CFM50Exist – CFM50New) / Nfactor * 1,440 * CDD * DUA * 0.018 / 1,000 / nCool * AF * LM * %AC Heating Savings = (CFM50Exist – CFM50New) / Nfactor * 1,440 * HDD * 0.018 / 3,412 / nHeat * AF * %electric heat	
kW Savings (summer)	Cooling kWh Savings / FLHcool * CF	
kW Savings (winter)	Heating kWh Savings / FLHheat	
Parameter	**Value**	**Source/Notes**
Baseline ACH50	17.4	ENERGY STAR savings analysis assumptions for North Carolina (Climate Zone 4). Assume air sealing for "Windows, Doors and Walls." https://www.energystar.gov/ia/home_improvement/home_sealing/Measure_Upgrade_Assumptions.pdf?945a-eddc.
Upgrade ACH50	17.0	
Home volume (ft^3)	13,936	From U.S. Energy Information Administration, 2009 Residential Energy Consumption Survey (RECS), North Carolina. Average size of home in North Carolina is 1,742 ft^2. Assume ceiling height of 8 ft.
CFM50Exist	4,041	Converts ACH50 to CFM50 (= ACH50 * Volume / 60 minutes). http://www.pureenergyaudits.com/docs/Blower_Door_Handout_ACI_Baltimore.pdf.
CFM50New	3,949	
Nfactor	20	Mid-Atlantic TRM. Normal exposure. Lawrence Berkeley National Laboratory (LBNL) study.
Conversion	1,440	Converts ft^3/min to ft^3/day.
CDD	1,720	ASHRAE Fundamentals 2013. Assume average of cities across DEP service territory available in ASHRAE (Ashville, NC; Fayetteville, NC; Jacksonville, NC; Raleigh, NC; Wilmington, NC; and Florence, SC).
Discretionary Use Adjustment (DUA)	0.75	Common to most TRMs.
Heat capacity	0.018	Volumetric heat capacity of air.
Efficiency of air conditioning (nCool)	13	Assume 13 Seasonal Energy Efficiency Ratio (SEER) based on several TRMs. Assume equipment installed after 2006.
Latent multiplier (LM)	6.9	Most TRMs assume a LM to account for latent cooling demand. Use Mid-Atlantic TRM assumption.
%AC	49.6%	2015 DEP NES participant survey (n=250). 87% of respondents had air conditioning, 57% of whom had central air conditioning.
Cooling kWh Savings	40.7	Calculated.

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HDD	3,004	ASHRAE Fundamentals 2013. Assume average of cities across DEP service territory available in ASHRAE (Ashville, NC; Fayetteville, NC; Jacksonville, NC; Raleigh, NC; Wilmington, NC; and Florence, SC.
Parameter	**Value**	**Source/Notes**
nHeat	1.5	Calculated. Weighted average based on type of heating in North Carolina and South Carolina.
%electric heat	49%	2015 DEP NES participant survey (n=250).
% heat pump	46%	U.S. Energy Information Administration, 2009 RECS, North Carolina and South Carolina.
% resistance	49%	
Coefficient of performance (COP) heat pump	2.26	Mid-Atlantic TRM.
COP electric resistance	1.0	
Heating kWh Savings	35	Calculated.
FLHcool	1,386	U.S. Environmental Protection Agency (EPA) Calculator. Assume average of cities in or near DEP service territory available in EPA Calculator: Ashville, NC; Raleigh, NC; Wilmington, NC; and Columbia, SC.
Summer CF	0.7	Mid-Atlantic TRM. PJM CF for central air conditioning.
Winter CF	1.0	Review of several TRMs. Assume heating operates during peak winter hour.
FLHheat	1,741	EPA Calculator. Assume average of cities in or near DEP service territory available in EPA Calculator: Ashville, NC; Raleigh, NC; Wilmington, NC; and Columbia, SC.

Table A-12 displays the deemed infiltration reduction savings for the 2015 DEP NES program participants. We group all infiltration reduction measures together to calculate savings, as they all relate to air sealing and calculating savings for the individual measures can be imprecise.

Table A-12. Per-Measure Savings for Infiltration Reductions

Measure	Savings Units	2015 Savings
Infiltration Reductions (per home)	Energy Savings (kWh)	74.9
	Summer Demand Savings (kW)	0.0195
	Winter Demand Savings (kW)	0.0196

Infiltration Reduction Recommendations

The proposed methodology should be revisited and updated, as necessary, to determine if a more accurate protocol for estimating infiltration savings has become available.

HVAC Filters

HVAC Filter Results

Table A-13 documents the inputs and methodology for estimating HVAC filter savings for the 2015 DEP NES program participants. We based savings on RECS 2009 data and a study performed by LBNL that measures

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the effects of HVAC filters in residential homes.[14] The LBNL study states that regularly[15] replacing air filters reduces the energy consumption of HVAC equipment by 1%. We applied the 1% reduction to the average annual energy consumption for different types of HVAC equipment to arrive at average annual filter energy savings per home. The average annual energy consumption was determined using RECS 2009 data for North and South Carolina.

Table A-13. Algorithms and Inputs for HVAC Filters

Algorithms Used		
kWh Savings	= Annual kWh consumption * % savings	
kW Savings (summer)	= Cooling kWh * % savings * CF / FLHcooling	
kW Savings (winter)	= Heating kWh * % savings * CF / FLHheating	
Parameter	**Value**	**Source/Notes**
Annual kWh consumption	4,856	RECS 2009 data for North and South Carolina.
% savings	1%	LBNL study.
Cooling kWh	3,013	RECS 2009 data for North and South Carolina.
Heating kWh	1,843	
Summer CF	0.7	Mid-Atlantic TRM. PJM CF for central air conditioning.
Winter CF	1.0	Review of several TRMs. Assume heating operates during peak winter hour.
FLHcooling	1,386	EPA Calculator. Assume average of cities in or near DEP service territory available in EPA Calculator: Ashville, NC; Raleigh, NC; Wilmington, NC; and Columbia, SC.
FLHheating	1,741	

Table A-14 displays the deemed savings values for the 2015 DEP NES program participants.

Table A-14. Per-Measure Savings for HVAC Filters

Measure	Savings Unit	2015 Savings
HVAC Filters	Energy Savings (kWh)	48.6
	Summer Demand Savings (kW)	0.0152
	Winter Demand Savings (kW)	0.0106

HVAC Filter Recommendations

The proposed methodology should be revisited and updated, as necessary, to determine if a more accurate protocol for estimating savings from HVAC filters has become available.

[14] LBNL. "System Effects of High Efficiency Filters in Homes." March 2013. http://eetd.lbl.gov/sites/all/files/lbnl-6144e.pdf.

[15] Air filters should be replaced monthly or bimonthly (depending on frequency of use and the levels of dust or contaminants within the home) according to the U.S. Department of Energy. http://energy.gov/energysaver/articles/maintaining-your-air-conditioner.

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Hot Water Pipe Wraps

Hot Water Pipe Wrap Results

Table A-15 documents the inputs and methodology for estimating hot water pipe wrap savings for the 2015 DEP NES program participants.

Table A-15. Algorithms and Inputs for Hot Water Pipe Wraps

Algorithms Used		
kWh Savings	= (1/Rexist − 1/Rnew) * L * C * ΔT * 8,766 / nDHW / 3,412	
kW Savings	= kWh saved / 8,766	
Parameter	**Value**	**Source/Notes**
R-value of existing pipe (Rexist)	1	IL TRM. Assumed R-value of existing pipe. Navigant Consulting Inc., April 2009; "Measures and Assumptions for Demand Side Management (DSM) Planning; Appendix C Substantiation Sheets," pg. 77.
R-value of pipe and insulation (Rnew)	3	ASHRAE Fundamentals Chapter 23 - Table 2: 1. For a fluid design operating temperature range of 105–140 °F, the insulation conductivity is 0.22 – 0.28 Btu * in/h * ft² * °F. Assume midpoint (0.25). 2. To determine R-value, we need to divide the thickness of the insulation by the insulation conductivity (R-value = insulation thickness (inches) / thermal conductivity (Btu * in/h * ft² * °F). 3. Assume 0.5 inch insulation based on standard pipe insulation thickness. 4. R Value = 0.5 inch thickness / 0.25 Btu * in/h * ft² * °F = R-2. 5. This R-value is added to the existing (R-1) to get the total new R-value (R-3).
Length (L) in feet	1	Assume 1-foot length and multiply by total length for each project.
Circumference (C) in feet	0.131	Assume 0.5" diameter pipe. For 0.5" diameter pipe, circumference is 0.131 feet (C = 3.14 * 0.5 / 12).
Temperature difference (ΔT)	60 °F	From IL TRM. Assumes 125 °F water leaving the hot water tank and average temperature of 65 °F surrounding hot water tank.
Recovery efficiency of electric hot water heater (nDHW)	0.98	From IL TRM.
CF	1.0	Savings are realized 8,766 hours/year and through the full peak hours. There is no difference between summer and winter peak CFs.

Table A-16 displays the deemed savings for the 2015 DEP NES program participants.

Table A-16. Per-Measure Savings for Hot Water Pipe Wraps

Measure (per foot of pipe wrap)	Savings Unit	2015 Savings
Hot Water Pipe Wrap	Energy Savings (kWh)	13.7
	Summer Demand Savings (kW)	0.0016
	Winter Demand Savings (kW)	0.0016

Hot Water Pipe Wrap Recommendations

The proposed methodology should be revisited and updated, as necessary, in the future to determine if a more accurate protocol for estimating savings from hot water pipe wrap has become available.

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Hot Water Temperature Setback

Hot Water Temperature Setback Results

Table A-17 documents the inputs and methodology for estimating water heater temperature adjustment savings for the 2015 DEP NES program participants. If additional data on pre- and post-water temperatures becomes available from DEP or from the implementation team, we will revise assumptions and algorithms accordingly.

Table A-17. Algorithms and Inputs for Hot Water Temperature Setbacks

Algorithms Used		
kWh Savings	= (U * A * (Tpre – Tpost) * Hours) / (3,412 * RE_electric)	
kW Savings	= kWh saved / 8,766 * CF	
Parameter	**Value**	**Source/Notes**
U-value of tank (U)	0.083	IL TRM. Assumes R-12 or U-0.083.
Surface area of tank (A)	24.99	IL TRM. Will vary based on tank size. Currently assumes 50-gallon tank, but will be adjusted if additional data become available.
Tpre	135 °F	According to 2013 (DEP) Appendix B, 135 °F was the lower-bound threshold for hot water temperature setbacks.
Tpost	120 °F	Target temperature after adjustments, according to 2013 (DEP) evaluation, measurement, and verification (EM&V) report.
Hours	8,766	Hours in a year that the savings occur, assumed to be constant over the year (IL TRM).
RE_electric	0.98	Recovery efficiency of electric hot water heater (IL TRM).
CF	1	Savings are realized 8,766 hours/year and through the full peak hours. There is no difference between summer and winter peak CFs.

Table A-18 displays the deemed savings for the 2015 DEP NES program participants.

Table A-18. Per-Measure Savings for Hot Water Temperature Setbacks

Measure (per water heater)	Savings Unit	2015 Savings
Hot Water Temperature Setback	Energy Savings (kWh)	81.6
	Summer Demand Savings (kW)	0.0093
	Winter Demand Savings (kW)	0.0093

Hot Water Temperature Setback Recommendations

We recommend collecting the size of the hot water tanks, if possible, and the pre- and post-temperature adjustments to more accurately estimate savings. Alternatively, to minimize increased time spent in each home, these measurements could be taken from a random sample of participants in each neighborhood and the results could then be applied to the remaining participant population.

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Water Heater Blankets

Water Heater Blanket Results

Table A-19 documents the inputs and methodology for estimating water heater blanket savings for the 2015 DEP NES program participants. If additional data on tank size, R-values, and water temperatures become available from DEP or from the implementation team, we will revise assumptions and algorithms accordingly.

Table A-19. Algorithms and Inputs for Water Heater Blankets

Algorithms Used		
kWh Savings	= (Abase / Rbase – Ainsul / Rinsul) * ΔT * 8,766 / nDHW / 3,412	
kW Savings	= kWh saved / 8,766 * CF	
Parameter	**Value**	**Source/Notes**
Surface area of tank before wrap (Abase)	24.99	IL TRM. Assumes 50-gallon capacity tank and R-12 for baseline insulation, resulting in Abase of 24.99.
R-value of tank before wrap (Rbase)	12	Assumes 50-gallon capacity tank and R-12 for baseline insulation.
Surface area of tank after wrap (Ainsul)	27.06	Assumes 50-gallon capacity tank and R-12 for baseline insulation, resulting in Ainsul of 27.06.
R-value of tank after wrap (Rinsul)	20	Assumes 50-gallon capacity tank and R-12 for baseline insulation, resulting in Rinsul of 20.
ΔT	60 °F	IL TRM. Assumes 125 °F water leaving the hot water tank and average temperature of 65 °F surrounding hot water tank.
nDHW	0.98	Recovery efficiency of electric hot water heater (IL TRM).
CF	1	Adjustment is in place all hours of the year.

Table A-20 displays the deemed savings for the 2015 DEP NES program participants.

Table A-20. Per-Measure Savings for Water Heater Blankets

Measure (per water heater)	Savings Unit	2015 Savings
Water Heater Blanket	Energy Savings (kWh)	114.7
	Summer Demand Savings (kW)	0.0131
	Winter Demand Savings (kW)	0.0131

Water Heater Blanket Recommendations

We recommend collecting the size of the hot water tanks and the R-value of the insulation installed, if possible, to more accurately estimate savings. Alternatively, to minimize increased time spent in each home, these measurements could be taken from a representative sample of participants in each neighborhood and the results could then be applied to the remaining participant population.

Refrigerator Coil Brush

Attempts to quantify savings from cleaning refrigerator coils have been inconclusive according to secondary research and a Lawrence Berkeley website.[16] While savings may occur depending on various factors, such as

[16] http://www2.lbl.gov/Science-Articles/Archive/energy-myths3.html.

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how long since the previous cleaning, we believe any savings will be relatively small. Furthermore, any savings for this measure depend on the occupant using the brush and using it correctly. Previous research among DEP NES program participants indicated that relatively few regularly used the brush that they received. For these reasons, we do not quantify savings from refrigerator coil brushes.

Key References

Reference	Source
DEP EM&V Reports	2012, 2013, and 2014 DEP Evaluation Reports.
AR TRM	Arkansas Technical Reference Manual Version 4.0. Volume 1. August 29, 2014.
TVA TRM	Tennessee Valley Authority Technical Reference Manual Version 3.0. January 2015.
Michigan Showerhead/Faucet Aerator Study	Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study Memorandum. June 2013.
IN TRM	Indiana Technical Reference Manual. Version 2.2. July 28, 2015.
IL TRM	Illinois Technical Reference Manual. Version 4.0. February 24, 2015.
Mid-Atlantic TRM	Mid-Atlantic Technical Reference Manual. Version 4.0. June 2014.
RECS Data	U.S. Energy Information Administration, 2009 Residential Energy Consumption Survey, North Carolina and South Carolina.

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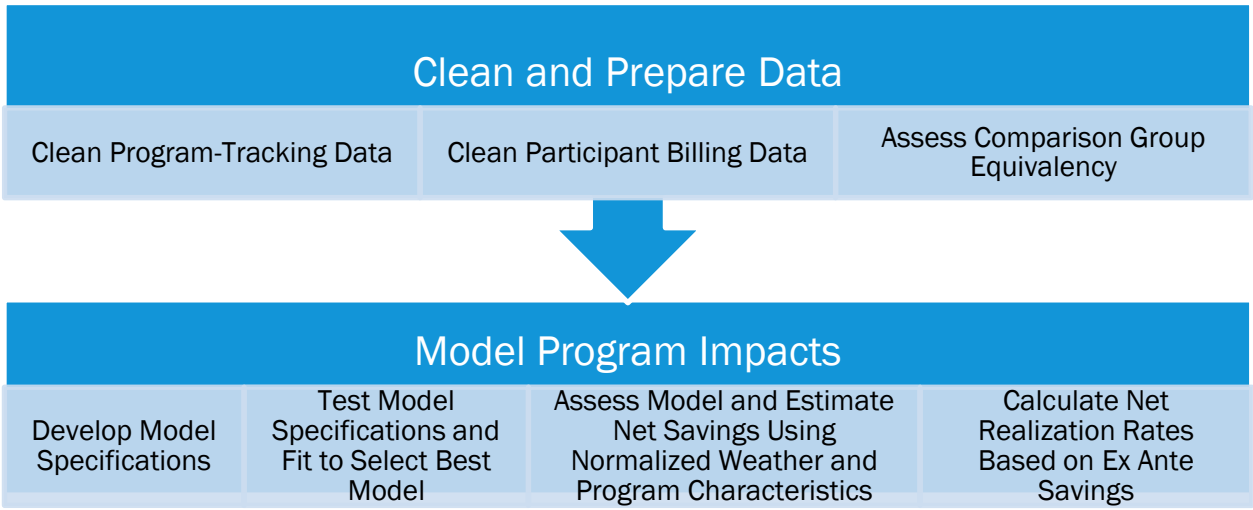
Appendix B. Detailed Methodology: Billing Analysis

The evaluation team conducted a billing analysis using a LFER model, with the goal of determining the overall ex post net program savings of the DEP NES program. The model allows all household factors that do not vary over time to be absorbed by (and therefore controlled for) the individual constant terms in the equation.

Data Collection

As part of the billing analysis of NES program participants, the evaluation team followed a standard series of steps for data collection, model specification, and analysis. Figure B-1 provides a summary of our billing analysis approach.

Figure B-1. Billing Analysis Approach



Data Quality

During our review of program-tracking and customer billing data provided by Duke Energy, we found significant inconsistencies in a customer's date of participation, home type, and heating fuel source between the various data sources. The issue most affecting our billing analysis was inconsistencies in participation dates. Accuracy within these data is critical, because we use a customer's date of participation as the indicator of treatment in this quasi-experiment. We noticed that participation dates in the Common Information Model (CIM) data were not consistent with measure installation dates in the program-tracking data. More specifically, dates in the CIM data were at least 8 days after the program-tracking participation date, and 51 days after on average. After discussions with Duke Energy and NES program staff, we determined that the participation date shown in the CIM data for a given customer was not directly tied to program tracking and that measure installation dates from program-tracking data should be used for the billing analysis.

Comparison Group Selection

A key challenge for estimating energy savings via a billing analysis is the identification of an appropriate comparison group or "counterfactual" to represent a baseline for what participants would have done (and how much energy they would have consumed) in the absence of the program. There are two key considerations in the design of a comparison group. A comparison group must: 1) have similar energy usage patterns (compared

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to participants) before participation (i.e., pre-participation period) and 2) effectively address self-selection bias (the correlation between the propensity to participate in a program and energy use).

Billing analyses, using an appropriate comparison group, incorporate the effects of both free-ridership and spillover, thus providing program net savings. For example, the energy use patterns of the members of the comparison group, during their pre-participation period, reflect equipment installations and behavioral changes that treatment group participants might have performed in the absence of the program. In addition, any measures installed during the evaluation period beyond program measures (spillover) are a factor in an increased coefficient for the participation variables.

Due to the timing of the evaluation, and to ensure we were able to have a robust comparison group, we utilized participants from the second half of 2014 through the first half of 2015 as our treatment group. Our method requires that participants in the treatment group have post-installation electricity usage data for at least 6 months after participating in the program. Therefore, participants from July 2014 to June 2015 act as our treatment group.

In an ideal experimental design, a comparison group would be identical to the treatment group in all aspects, save for the treatment being evaluated (participation in the NES program in our case). A match of this type is impossible when studying the effects of energy efficiency programs, since no two customers are exactly alike. Given this, we aim to use a comparison group that, on average, exhibits very similar usage patterns prior to participation. Achieving this ensures that estimates from our quasi-experiment are representative of the actual effects that the program has on a customer's energy use. Using future participants as a comparison group is attractive because we know that both groups will eventually participate, meaning that they are similar in many respects. To ensure that the groups are similar, we determined the overall average baseline and pre-period kWh consumption to be able to compare usage patterns of the treatment and comparison groups.

Weather is also of interest when selecting a comparison group, as stark differences in weather between the treatment and comparison groups can leave the model open to error. With the NES program, participants are located in different regions of North Carolina and South Carolina, which means that there will likely be differences in the weather experienced and potentially different reactions to changes in weather. Because of this potential, we examined differences in weather and energy use, between the states, and found that participants in South Carolina experienced slightly warmer summers and milder winters and showed higher energy usage overall. However, because of a limited number of South Carolina participants in the treatment group, we deemed it necessary to not separate the analysis by state.

Pre-participation energy usage of our comparison group does show some differences compared to the treatment group (see the section on baseline average daily energy consumption below). The evaluation team incorporated several adjustments into our fixed effects models to control for these differences in pre-period usage between treatment and comparison groups.

Data Cleaning and Preparation

This section summarizes how we cleaned and prepared the 2014, 2015, and 2016 program participant databases and billing data for the billing analysis.

Program-Tracking Data

As a first step in preparing the necessary data, the evaluation team prepared a master participant dataset that combined the program-tracking data, from each year, for the NES program with dates of participation in other Duke Energy energy efficiency programs. This master dataset is composed of customer information that includes:

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- **Participation date:** The date of participation determines the program year for each account. We also checked to see if there were any discrepancies in NES program participation dates, in relation to previous program-tracking data.
- **Participation in other programs:** Customers who participated in multiple energy efficiency programs during the time period being analyzed may skew the observed effect of the NES program if they are not accounted for or removed.
- **Location:** We used the address and zip code of each customer to incorporate regional weather data in a later step.

Participant Billing Data

The participant billing data used in the billing analysis come from monthly billing data from January 2011 to July 2016, obtained directly from Duke Energy. To develop the final dataset used for statistical analysis, we used a multi-step approach to combining and cleaning the data. We describe each billing data-cleaning step below.

- **Clean individual billing periods:** After adjusting billing periods based on flags in the data indicating "estimated" or "adjusted" meter reads, we removed billing periods with a duration of 0 days or missing information. Usage records for these billing periods recorded either 0 kWh or positive kWh; many were the first meter read in the available billing history or a "turn-on" read. Nearly all accounts had typical billing periods of around 30 days. Additionally, we:
  - Determined average usage for each observation (based on usage and number of billing days in the period)
  - Assigned seasonal dummy variables to each of the monthly observations:
    - Winter: December, January, February
    - Spring: March, April, May
    - Summer: June, July, August
    - Fall: September, October, November
- **Remove all duplicate billing records:** Due to the small number of duplicate records in each dataset used to create our final analysis file, we chose to drop all billing records that had duplicates at the account/date level with conflicting kWh values. A small number of duplicates were exactly the same, in which case we kept one of the records. Duplicate records represented fewer than 0.75% of the records in the data pulled from the CIM data warehouse.
- **Combine participant data with billing records:** We merged usage data with the customer-specific (account-level) data, including measure installation dates. We then assigned pre- and post-treatment billing periods based on those dates. We assigned billing periods before the first measure installation date to the pre-participation period, all bills following the last measure installation date as the post-participation period, and any bills occurring between installation dates (or in the month of the audit and measure installations) to a "dead-band" period that was not included in the analysis.

After individual billing records were cleaned and all data were combined, we removed accounts that did not meet certain criteria. We used these criteria to ensure that all accounts in the final analysis file had sufficient data to allow for robust analysis.

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- **Extremely high or low average daily consumption:** We removed customers with entire pre- or post-participation periods having very high or very low usage. This is to ensure that participants spent equivalent amounts of time in their homes in the months before and after program participation. We dropped households with average daily consumption at or below 2 kWh/day on average (across their billing history in both the pre- and post-participation periods). We also dropped customers with extremely high usage (over 300 kWh/day). These households with odd usage patterns are likely to be the result of factors that cannot easily be controlled for and could bias the results.

- **Inadequate billing history before or after program participation:** The primary savings measures are expected to generate energy savings throughout the year. To be able to assess changes in consumption due to program measures before and after installation, we included participants with a billing history covering, at a minimum, six billing records or 180 days before the first day of program participation, and the same amount of time after participation for our treatment group.

- **Inadequate billing history in the cooling season before and after program participation:** We included participants with a minimum of two billing records in the summer (cooling season). This is because we expect the measures installed to be generally weather sensitive both in terms of temperature and in terms of daylight hours. By ensuring that we have enough billing data in the months of June, July, and August, we allow for more rigorous savings estimates.

- **Participated in other Duke Energy program:** Due to a high rate of customers who participated in other programs, but received only free or discounted light bulbs, we defined cross-participation two ways: 1) cross-participants who received only light bulbs and 2) cross-participants who received other program benefits. These other program benefits included appliance rebates, direct install measures, and education. We chose to remove only those cross-participants who received those other program benefits from final analysis.

Table B-1 shows how many accounts were removed from the analysis overall for each reason.

Table B-1. Accounts Removed from Analysis

Reason for Dropping Account	Accounts	Percent of Total
Total Unique Accounts	9,416	100.0%
Cross-Participation	1,258	13.0%
High Overall ADC (> 300 kWh)	1	0.01%
Less Than 2 Summer Billing Post-Period (Treat)	86	1.0%
Less Than 2 Summer Billing Pre-Period	194	2.0%
Less Than 6 Months in Post-Period Days (Treat)	8	0.1%
Less Than 6 Months in Pre-Period Days	56	1.0%
Less Than 6 Pre-Billing Periods	926	10.0%
Less Than 6 Post-Billing Periods (Treat)	453	5.0%
Low Overall ADC (< 2 kWh)	20	0.2%
Low Overall Post-ADC (< 2 kWh)	6	0.1%
Low Overall Pre-ADC (< 2 kWh)	6	0.1%
Accounts Remaining for Analysis	6,402	68.0%

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Comparison Group Equivalency

The use of a comparison group is integral to our billing analysis methods, and is used to develop a counterfactual representative of the baseline energy used by participants in the absence of the program. Using an actual group of later participants mitigates self-selection bias that may be present when comparing 2015 participants to some non-participating group of customers. Due to the timing of the evaluation, and to ensure that we were able to have a robust comparison group, we utilized participants from the second half of 2014 (July–December) through the first half of 2016 (January–June) in our analysis. Participants from July 2014 to June 2015 act as our treatment group, and customers who participated between July 2015 and June 2016 are the comparison group. It is important to ensure that the two groups of participants are equivalent on as many dimensions as possible. Based on the information at our disposal, we analyzed three criteria to determine that treatment participants were equivalent to the comparison participants and could be used as a valid comparison group. These criteria are:

- **Weather:** Compared average monthly HDD and CDD.
- **Baseline period ADC:** Similarity in ADC before engaging with the program might be a general proxy for behavioral similarities. As such, the evaluation team compared the baseline monthly ADC of participants in each group.
- **State:** Compared the rate of customers residing in North Carolina and South Carolina, as well as the weather and energy consumption of customers in each state.

Because of the equivalency check, we determined that the treatment and comparison participant groups were comparable for analyzing the impacts of the program. We discuss each of these criteria in more detail below.

Weather

To include weather patterns in our model, we used daily weather data from numerous weather stations across the DEP territory, utilizing the site closest to each account's geographic location. By using multiple sites, we increase the accuracy of the weather data being applied to each account. We obtained these data from the National Climatic Data Center (NCDC).

The daily data are based on hourly average temperature readings from each day. We calculated CDD and HDD for each day (in the analysis and historical periods) based on average daily temperature using the same formula used in weather forecasting.[17] We merged daily weather data into the billing dataset so that each billing period captures the HDD and CDD for each day within that billing period (including start and end dates[18]). For analysis purposes, we then calculated average daily HDD and average daily CDD, based on the number of days within each billing period.

Participants in the treatment and comparison groups experienced similar weather over time. However, Figure B-2 and Figure B-3 show that the comparison group experienced slightly warmer temperatures during seasonal

[17] *A "degree-day" is a unit of measure for recording how hot or how cold it has been over a 24-hour period. The number of degree-days applied to any particular day of the week is determined by calculating the mean temperature for the day and then comparing the mean temperature to a base value of 65 (HDD) and 75 (CDD) degrees F. (The "mean" temperature is calculated by adding together the high for the day and the low for the day, and then dividing the result by 2.) If the mean temperature for the day is 5 degrees higher than 75, then there have been 5 cooling degree-days. On the other hand, if the weather has been cool, and the mean temperature is, say, 55 degrees, then there have been 10 heating degree-days (65 minus 55).* http://www.srh.noaa.gov/ffc/?n=degdays.

[18] Daily weather data are merged based on the given dates of the billing period. Assigning weather this way provides a more accurate representation of the weather experienced during the billing period than does using weather for the calendar month of the bill.

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peaks. Including monthly averages for HDD and CDD in the model helps control for differences in seasonal weather experienced by participants.

Figure B-2. Average HDD of Customers Included in Billing Analysis

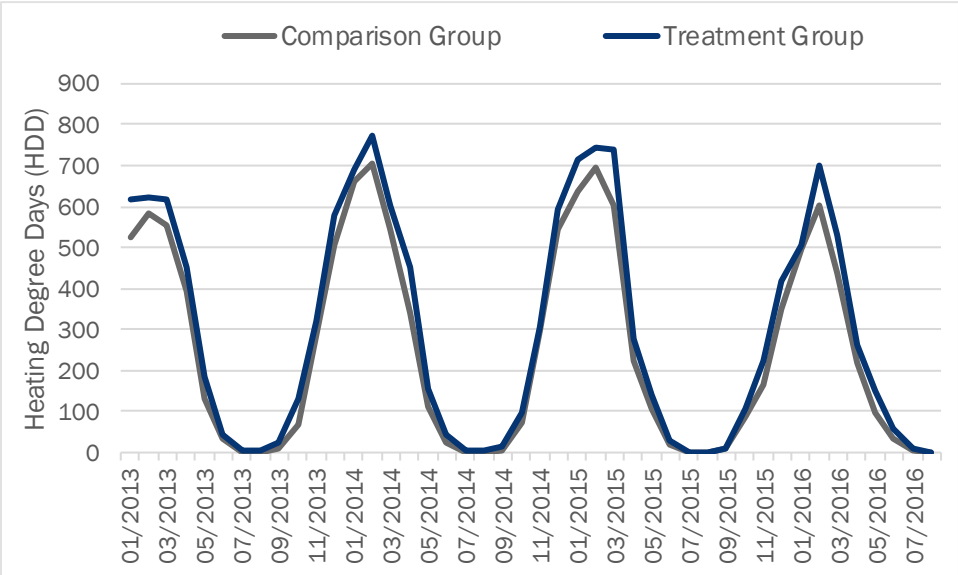
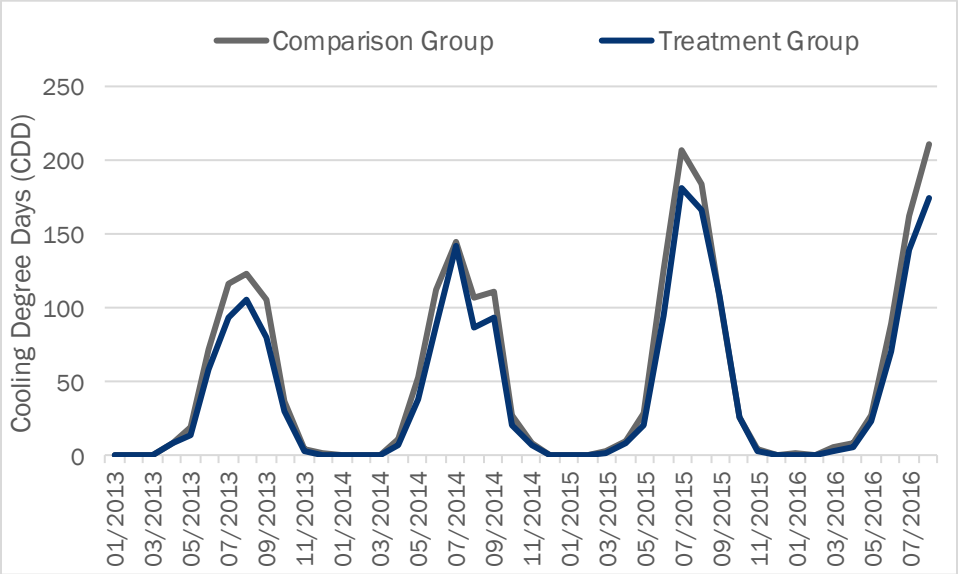


Figure B-3. Average CDD of Customers Included in Billing Analysis



Baseline Average Daily Electricity Consumption

Opinion Dynamics examined the average daily electricity consumption for months during each participant's pre-participation period to compare energy consumption patterns. As shown in Figure B-4, pre-participation energy usage for the comparison group follows a slightly different pattern than the treatment group in some of the months. Note where the curves overlap in the summer of 2013 and the spring of 2014. Differences in average energy consumption between the groups is cause for some concern. To account for these differences

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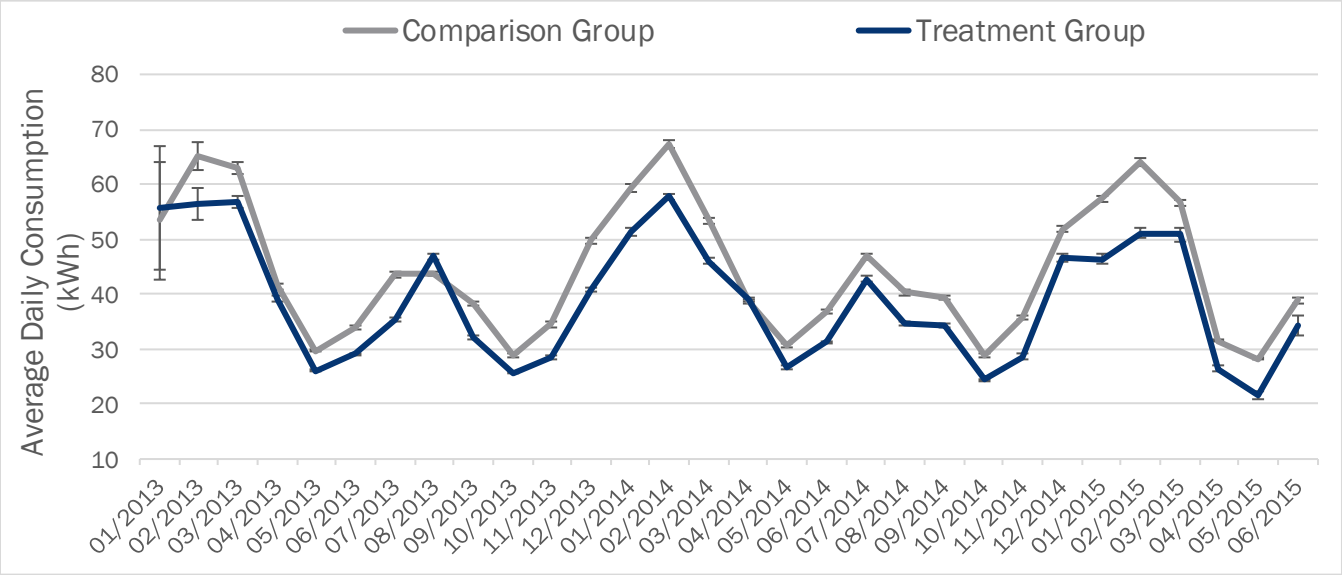
in pre-participation energy usage, the evaluation team incorporated several adjustments into our fixed effects models. Specifically, we incorporated monthly fixed effects in the model and added interactions between time (as measured by our month dummies) and the treatment group.

Figure B-4. Comparison of Average Baseline Monthly kWh Consumption between Treatment and Comparison Customers



Our final dataset used in the billing analysis consists of all data mentioned above for all participants in the treatment and comparison groups. We start with a dataset of clean and unique participants from the program, including the date of participation, and their location. We combine this with the cleaned dataset of monthly bills, which brings in the customers usage (in kWh) over time. Into this combined dataset, we add HDD and CDD for each customer based on the nearest weather station. Customers who do not meet the criteria necessary for accurate modeling are dropped.

State-by-State Comparison

Because the DEP service area spans two states, we also consider the potential effect of differences in weather and energy use by participants in each state. In general, South Carolina was subject to warmer temperatures, and their energy use was higher. Higher temperature are likely a major reason for the increased energy consumption, though we also note that South Carolina does have a slightly higher percentage of single-family homes, which are also likely to be contributors. Participants in the treatment and comparison groups, however, have very similar mix of homes. Table B-2 shows the breakdown of overall average pre-period ADC, CDD, and HDD for participants in each state. Since participants from South Carolina use more energy, we will consider the benefits of determining state-specific savings.

Table B-2. Overall Pre-Period Averages by State

	State	ADC (kWh)	CDD	HDD
Treatment Group	NC	37.02	34.43	309.77
	SC	40.29	69.97	200.42
Comparison Group	NC	41.42	45.20	253.09
	SC	44.44	63.33	234.13

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Model Specifications

To estimate savings for the NES program, Opinion Dynamics utilized a LFER model that incorporates weather and monthly changes in energy usage, as well as interaction terms that show the effect of these factors in the post-period. Our method utilizes a comparison group of future participants to construct a counterfactual baseline (what participants would have done during the post-program period absent the program) for the treatment group in the post-program period. In the process of determining the appropriate model for the analysis, we tested a multitude of possibilities, all of which utilized the comparison group.

Develop and Test Model Specifications

Our final model needed to fill a number of criteria. Primarily, we aimed to use a model that explained as much about changes in the dependent variable as possible. The most direct measure of this is the overall R-squared, which gives an estimate of how much the model explains. An R-squared of 1.0 would represent a model that explains 100% of the variance in the dependent variable, and an R-squared of 0.5 would explain 50%. In our quasi-experiment, R-squared will appear low because of our use of fixed effects. A higher R-squared relative to other potential models will still be a significant factor in selection of a final model. We also compared Akaike Information Criterion (AIC) values of each model specification within the same data. The AIC provides a measure of relative quality between models; a lower value indicates a relatively more robust model.

As previously mentioned, we did not include customers who participated in other programs, with the exception of customers who received only a small number of CFLs from some other program. We considered not removing these customers, and entering indicator variables for each of the other utility programs. Doing this could lead to interference between the influences of each program on energy use, making it difficult to draw valid conclusions about the effects of NES program participation separate of the other programs. As such, we believe it is more appropriate to remove those customers from the analysis.

In the development of our model, we investigated average energy consumption before and after participation, how changes in weather affected the amount of energy used, and differences in energy use in each month. In this investigation, we found a clear linear relationship between energy use and weather, and expected fluctuations in energy use through the year.

To control for seasonal changes in energy use, the prior evaluation utilized month-year fixed effects (through the inclusion of indicator variables for every individual month in the analysis). While this method is common, it can be subject to misrepresentation of the treatment effect when a comparison group is not used. Even with a comparison group, there is potential for error with the use of month-year fixed effects without including appropriate and adequate corrections for potential changes to a customer's weather dependence, post-participation. In lieu of monthly fixed effects, our model includes terms for each month of the year (January–December). This allows a month to be present in both the pre-participation period and the post-participation period, thus capturing the change in usage during that month. Our use of these monthly terms in conjunction with a comparison group creates an improved counterfactual and increases the accuracy of program savings estimates.

Acknowledging differences in pre-participation period energy use between our treatment and comparison groups, we tested models that included the interactions of the treatment with monthly terms to control for those inconsistencies. We also tested models that included terms that interact the effects of each month with the post-participation period. Additionally, we checked the effect of adding interaction terms of weather and the post-participation period to account for the relationship between weather and consumption following treatment. Failing to account for non-program-related changes that occur during the post-participation period, for example, the warmer summers that have been experienced, could undervalue the treatment effect. We

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tested different combinations of these potential interaction terms in an effort to determine the most representative model corrections across participants.

Final Model for Residential Neighborhood Program Participants

Our testing revealed that the overall savings estimates were robust across a number of model specifications, but found the model in Equation B-1 to have the best overall fit. The model takes into account changes in weather (HDD and CDD) for each bill, and includes an interaction term of weather and the post-period to account for increasingly warmer summers. The model also utilizes dummy variables for each calendar month to control for seasonal changes to energy use.

Interactions with monthly dummies are also included to account for differences that occur between our treatment and comparison groups. This approach allows the comparison group to more precisely represent the counterfactual. As shown in Figure B-4, pre-participation period usage differs slightly where participants in the treatment group appear to be more sensitive to some seasonal effects. By interacting the treatment group with monthly terms; we can control for the effect of that sensitivity on the treatment effect. This interaction term is present for records in both the pre- and post-period. To ensure that this correction does not adversely affect the effect of treatment in the post-period, we include additional interactions of the post-participation period. These additional interactions control for non-program changes that occur during the post-participation period, which could otherwise undervalue the effect of program participation.

Equation B-1. Model Specification

$$ADC_{it} = B_h + B_1 Post_{it} + B_2 HDD_{it} + B_3 CDD_{it} + B_4 Post \cdot HDD_{it} + B_5 Post \cdot CDD_{it} + B_t Month + B_{t1} Month \cdot Post + B_{t2} Month \cdot Treat + \varepsilon_{it}$$

Where:

ADC_{it} = Average daily consumption (in kWh) for the billing period

$Post$ = Indicator for treatment group in post-participation period (coded "0" if treatment group in pre-participation period or comparison group in all periods, coded "1" in post-participation period for treatment group)

HDD = Average daily heating degree days from NCDC

CDD = Average daily cooling degree days from NCDC

$Month$ = Month indicator

$Treat$ = Indicator for treatment group participants

B_h= Average household-specific constant

B_1= Main program effect (change in ADC associated with being a participant in the post-program period)

B_2= Increment in ADC associated with one unit increase in HDD

B_3= Increment in ADC associated with one unit increase in CDD

B_4= Increment in ADC associated with each increment increase of HDD for participants in the post-program period (the additional program effect due to HDD)

B_5= Increment in ADC associated with each increment increase of CDD for participants in the post-program period (the additional program effect due to CDD)

B_t= Coefficients for each month

B_{t1}= Coefficients for each month in the post-participation period

B_{t2}= Coefficients for each month for treatment groups participants

ε_{it} = Error term

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Estimated Savings and Realization Rate

This section contains the observed net savings and realization rates resulting from the billing analysis of 2015 participants. The results account for free-ridership and reflect savings associated with installed measures, spillover, and potential behavioral changes from energy efficiency knowledge gained during the assessment.

Estimated Savings

The regression model results presented in Table B-3 shows a reduction in electricity use after customers participate in the NES program, controlling for weather, time, and the household characteristics (reflected in the constant term).

Table B-3. Final Model

Variable	Coefficient
Post (NES program participation)	−3.321***
CDD	0.0525***
HDD	0.0408***
Post-participation period CDD	0.00463
Post-participation period HDD	0.00541***
January	2.7287***
February	8.8123***
March	2.6004***
April	−5.5921***
May	−5.5637***
June	1.6534***
July	8.6991***
August	7.0656***
September	3.7092***
October	−4.6812***
November	−5.7063***
December	*(omitted)*
Constant	23.1897***
Observations	207,132
R-squared	0.654
Monthly effects included	YES
Post-participation period interacted with months included	YES
Treatment group interacted with months included	YES

* p<0.1, ** p<0.05, *** p<0.01.

Due to the weather and monthly interaction terms in the model, it is necessary to recalculate the coefficient of the treatment effect (Treatment) by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-treatment period, including any reduction caused by milder temperatures. Utilizing a simple linear equation, shown in Equation B-2, which combines the coefficients of those interaction terms with the average post-participation period values for each, we can estimate the overall savings associated with the program itself.

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Equation B-2. Model Specification

$$\Delta ADC = B_1 Post + AvgPostHDD_t \cdot (B_2 Post \cdot HDD) + AvgPostCDD_t \cdot (B_3 Post \cdot CDD) + B_t Month_t$$

Where:

ΔADC = Change in Average Daily Consumption
$AvgPostHDD_t$ = Average number of HDD during month *t* of the post period
$AvgPostCDD_t$= Average number of CDD during month *t* of the post period

Table B-4. Adjusted Estimate of Daily Program Savings

NES Program Estimate	Standard Error	T	P>|t|	90% Confidence Interval	
				Lower	Upper
−1.219	0.152	−7.995	0.000	−1.470	-0.968

The value of the new NES program estimate seen in Table B-4 represents 1.2 kWh reduction in ADC associated with moving from pre-treatment to post-treatment. There is a 90% probability, or confidence, that overall program savings range between 0.97 kWh and 1.5 kWh per day for NES program participants. These savings estimates are extrapolated to the overall net program savings for DEP NES program participants. Because we saw differences in energy usage for participants in each state, and to remain consistent with the previous evaluation, we provide savings as a percentage of the baseline usage (Table B-5). We calculate baseline usage using a similar equation to Equation B-2, but include coefficients from models that do not feed directly into the treatment effect. Doing this shows the energy that customers would have used on average if they did not participate, i.e., the counterfactual. To estimate the percent savings from participant's baseline energy consumption, we divide the coefficient for NES, representing the change in daily usage, by the mean baseline ADC to arrive at the percentage of savings.

Table B-5. Estimated Savings from Billing Analysis Compared to Baseline Usage

	Baseline Usage (kWh)	Standard Error	90% Confidence Interval		Savings (kWh)	Savings (%)
Overall Daily*	42.7	0.144	42.5	43.0	1.2	2.8%

* Daily savings estimate is the inverse of the coefficient for the NES program shown in Table B-4.

To best represent the kWh savings for participants in North and South Carolina we apply the 2.8% savings to each state's individual baseline usage and multiply the state-specific annual per-home savings by the total number of participants in each state, as shown in Table B-6.

Table B-6. Savings for 2015 NES Program in Each State

State	Participants	Annual Baseline Usage (kWh)	Savings (%)	Annual Energy Savings (kWh)	
				Per Home Savings	2015 NES Program
North Carolina	3,342	14,929	2.8%	420	1,402,090
South Carolina	1,207	16,279	2.8%	457	552,190
Total	**4,549**			**430***	**1,954,280**

* Total per-home energy savings is weighted by state.

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Complete Model Results

Linear regression, absorbing indicators

Number of observations	207,132
F(38, 6401)	443.72
Probability > F	0.0000
R-squared	0.6648
Adjusted R-squared	0.654
Root MSE	15.554

(Std. Err. Adjusted for 6,402 clusters in acct)

ADC	Coefficient	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]	
Participation	-3.321327	0.820901	-4.05	0.000	-4.930567	-1.712088
HDD	0.040850	0.000972	42.03	0.000	0.038944	0.042755
CDD	0.052546	0.003017	17.42	0.000	0.046632	0.058460
Post-Period HDD	0.004625	0.004081	1.13	0.257	-0.003375	0.012625
Post-Period CDD	0.005414	0.001614	3.36	0.001	0.002251	0.008577
Month						
January	2.728736	0.202623	13.47	0.000	2.331528	3.125945
February	8.812319	0.309965	28.43	0.000	8.204683	9.419955
March	2.600423	0.223266	11.65	0.000	2.162746	3.038100
April	-5.592050	0.274586	-20.37	0.000	-6.130331	-5.053770
May	-5.563652	0.404447	-13.76	0.000	-6.356503	-4.770802
June	1.653418	0.502553	3.29	0.001	0.668246	2.638590
July	8.699104	0.632614	13.75	0.000	7.458969	9.939239
August	7.065630	0.540955	13.06	0.000	6.005177	8.126084
September	3.709198	0.493971	7.51	0.000	2.740850	4.677546
October	-4.681210	0.422361	-11.08	0.000	-5.509179	-3.853242
November	-5.706356	0.265345	-21.51	0.000	-6.226520	-5.186191
December	*(ommitted)*					
Months * Post-Period						
January	-3.537081	0.405618	-8.72	0.000	-4.332229	-2.741934
February	-2.048506	0.595472	-3.44	0.001	-3.215830	-0.881183
March	-1.088170	0.366680	-2.97	0.003	-1.806985	-0.369355
April	-1.980083	0.375739	-5.27	0.000	-2.716658	-1.243509
May	1.367617	0.573738	2.38	0.017	0.242899	2.492335
June	3.241594	0.752358	4.31	0.000	1.766720	4.716468
July	0.446450	0.896549	0.50	0.619	-1.311087	2.203986
August	-1.682739	0.921235	-1.83	0.068	-3.488668	0.123190
September	3.876768	0.825623	4.70	0.000	2.258270	5.495265
October	4.332450	0.665995	6.51	0.000	3.026877	5.638024
November	2.631730	0.416436	6.32	0.000	1.815377	3.448084
December	*(ommitted)*					
Months * Treatment Group						
January	-0.405032	0.337854	-1.20	0.231	-1.067339	0.257276
February	-2.747312	0.459785	-5.98	0.000	-3.648645	-1.845978
March	0.926384	0.355352	2.61	0.009	0.229776	1.622992
April	5.743203	0.372511	15.42	0.000	5.012957	6.473450

May	4.784988	0.504706	9.48	0.000	3.795596	5.774380
June	4.240955	0.595029	7.13	0.000	3.074499	5.407412
July	4.840211	0.664681	7.28	0.000	3.537214	6.143209
August	9.321929	0.662389	14.07	0.000	8.023425	10.620430
September	5.880688	0.604412	9.73	0.000	4.695838	7.065538
October	5.048374	0.552133	9.14	0.000	3.966008	6.130739
November	2.727329	0.379320	7.19	0.000	1.983736	3.470923
December	*(ommitted)*					
_cons	23.189740	0.509887	45.48	0.000	22.190190	24.189290
account absorbed						*(6,402 categories)*

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EM&V Report for the EnergyWise Home Demand Response Program

Winter PY2015/2016

Prepared for:

Duke Energy Progress

DUKE ENERGY®

August 22, 2016

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NAVIGANT

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EVALUATION SUMMARY

The EnergyWise Home ("EnergyWise") demand response program offers Duke Energy Progress (DEP) residential customers the opportunity to earn credits on their electricity bill by allowing DEP to remotely control air conditioners (A/C) in the summer months and space- and water-heating equipment in winter during times of seasonal peak consumption. This report covers the evaluation, measurement, and verification (EM&V) activities for the winter of 2015-2016. At the time of the single event called by Duke in the winter of 2015/2016, there were over 6,500 participants with water heaters and over 3,800 participants with sets of heat pump auxiliary heat strips enrolled in the program.

As shown in Table 1, the estimated program-level impact for the EnergyWise Winter PY2015/2016 demand response program was 5.08 MW. The system impact and per customer impact by device type are also presented in Table 1, below.

Table 1: Summary of Average Estimated Impacts

Device Curtailed	DR Impact (kW/participant)	System Impact (MW)
Auxiliary Heat Strips	0.72	2.75
Electric Water Heater	0.35	2.33
Total System Impact:		**5.04**

Source: Navigant Analysis, PY2015/2016 weather and PY2014/2015 modeling results

Evaluation Methods

Navigant estimated DR impacts for auxiliary heat strips by applying the regression coefficients estimated as part of the PY2014/2015 evaluation[1], and the proportion of auxiliary heat strips that were fully responsive or partially responsive to Duke Energy Progress' curtailment signal, as observed in the PY2014/2015 evaluation[2], to the hourly observed heating degree hours in the appropriate quarter-hour of the PY2015/2016 DR event.

Navigant estimated DR impacts for water heaters by applying the regression coefficients estimated as part of the PY2014/2015 evaluation to the appropriate quarter-hour of the PY2015/2016 DR event.

Evaluated Impacts

The principal EM&V findings regarding the winter event demand impacts for PY2015/2016 are as follows:

- **Auxiliary heat strips delivered an average DR impact of 0.72 kW per household.** The total estimated program impact of the 3,847 participating households was 2.75 MW.
- **Auxiliary heat strip impacts were lower on average for PY2015/2016 than PY2014/2015 due to the single PY2015/2016 event occurring on a relatively mild weather day.** In PY2014/2015, there were three events in which the average event temperature was at or below

[1] Navigant Consulting, Inc., on behalf of Duke Energy Progress, *EM&V Report for the EnergyWise Home Program: Winter 2014/2015,* June 2015.

[2] In that evaluation, as in the PY2011/2012 winter evaluation, Navigant, based on a visual examination of logger data divided auxiliary heat strips into "fully responsive", "partially responsive", "unused" and "unresponsive" categories, referred to as dispositions. Separate equations were used to estimate impacts for fully and partially responsive devices.

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approximately five degrees Fahrenheit. In contrast, for the PY2015/2016 event the average event temperature was approximately 20 degrees Fahrenheit.

- **Water heaters delivered an average DR impact of 0.35 kW per household.** The total program impact of the 6,573 participating households was 2.33 MW.
- **Water heater impacts were slightly lower on average for PY2015/2016 than PY2014/2015 due the fact that the PY2015/2016 event began and ended earlier in the morning than the PY2014/2015 events.** Most PY2014/2015 events began at 6:30 a.m. and lasted until 9:00 a.m. By contrast, the PY2015/2016 event ran from 6:00 a.m. to 8 a.m. Regression-estimated impacts from PY2014/2015 indicate that impacts increase steadily as the morning progresses until 9:00 a.m., possibly reflecting underlying patterns of shower use.

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1. INTRODUCTION

The EnergyWise program provides residential customers the opportunity to earn credits on their electricity bill by allowing DEP to remotely control air conditioning (in the summer) and water heater and heat pump auxiliary heating strips (in the winter) during times of seasonal peak consumption. This report covers the evaluation, measurement, and verification (EM&V) activities for the winter of PY2015/2016.

EM&V is a term adopted by DEP and refers generally to the assessment and quantification of the energy and peak demand impacts of an energy efficiency or demand response program. For demand response (DR), estimating reductions in peak demand is the primary objective, as energy impacts are generally negligible. EM&V also can encompass an evaluation of program processes and customer feedback, typically conducted through participant surveys. The winter PY2015/2016 EM&V cycle did not include a process evaluation.

1.1 Objectives of the Evaluation

This EM&V report is intended to verify program impacts as per the requirements established by the North Carolina Utilities Commission and the Public Service Commission of South Carolina. Since no data loggers were deployed to participating homes in the winter of PY2015/2016, the principal objective of the PY2015/2016 evaluation is to apply the results of the PY2014/2015 EM&V report to PY2015/2016 weather and participation data to estimate the impact of direct load control on residential demand in the winter.

1.2 Program Overview

The EnergyWise program was developed in response to DEP's determination that a curtailable load program would be a valuable resource for the company, and would provide an opportunity to engage directly with customers to help reduce costly seasonal peak demand. The program seeks to attract DR resources by incenting residential customers to allow DEP to remotely control two of the most important drivers of winter peak demand typically found in the home – auxiliary heat strips and water heaters.

The program offers an annual bill credit of $25 (per appliance type controlled) to customers that choose to allow DEP to control their electric auxiliary heat strips and/or water heaters.

Eligibility. In order to be eligible to participate in the winter component of the EnergyWise program, a household must meet the following criteria:

- Participants must occupy the residence at which the controls are installed. Renters must complete a Tenant Authorization Form and landlord / property owner must approve.
- Residential electricity service must be in the name of the participant.
- Participants must be in an area that can receive the EnergyWise Home paging signal.

  Participation also requires that participants have an electric water heater and/or a centrally ducted heat pump (for auxiliary heat strip control).

Incentives. Each participant receives a $25 bill credit per appliance or load type upon joining the program, and then an additional $25 bill credit every 12 months per appliance or load type to encourage continued participation.

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Marketing. DEP is responsible for all marketing of the EnergyWise Home program. Participant enrollments are generated through a mix of direct mail, bill inserts, email, outbound calling, and door-to-door canvassing.

1.3 Reported Program Participation

This sub-section reports the overall program participation for the winter EnergyWise program in the winter of PY2015/2016.

DEP called one DR event in winter PY2015/2016, on February 11, 2016. There were a total of 3,847 auxiliary heat strip participants and 6,573 water heater participants during the winter PY2015/2016 event.

The number of participants and number of appliances controlled by appliance program are shown in Table 2, below. Both types of devices were curtailed from 6:00 a.m. to 8:00 a.m. using a 100% cycling strategy. All winter EnergyWise participants are located in DEP's Western Region.

Table 2: Overall Winter PY2015/2016 Program Participation by Appliance

Appliance	Number of Participants	Number of Appliances Controlled
Auxiliary Heat Strips	3,847	4,187
Electric Water Heater	6,573	6,708

Source: DEP EW Control Event Tracking Report

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2. EVALUATION METHODS

This chapter of the EM&V report describes the approach used to estimate the DR and snapback impacts of the EnergyWise program for PY2015/2016.

2.1 Impact Estimation

Navigant estimated DR impacts from auxiliary heat strip DR impacts by applying the regression coefficients estimated as part of the PY2014/2015 evaluation[3] and the device responsiveness shares as observed in the PY2014/2015 evaluation[4] to the hourly observed heating degree hours in the appropriate quarter-hour of the PY2015/2016 DR event.

Navigant estimated DR impacts from water heaters by applying the regression coefficients estimated as part of the PY2014/2015 evaluation to the appropriate quarter-hour of the PY2015/2016 DR event.

This section is divided into two sub-sections:

1. **Demand Reduction Impacts** – a description of how the demand reduction impacts were estimated based on regression-estimated parameters obtained from the PY2014/2015 evaluation report other technology-specific variables.
2. **Snapback Impacts –** a description of how the snapback impacts were estimated, using the coefficients estimated in the PY2014/2015 analysis.

2.1.1 Demand Reduction Impacts

This section details methodology for demand reduction impacts for both the auxiliary heat strip and water heater programs.

2.1.1.1 Auxiliary Heat Strip Demand Reduction Impacts

Navigant estimated DR impacts from auxiliary heat strip DR impacts by applying the regression coefficients estimated as part of the PY2014/2015 evaluation[5] and the device responsiveness shares as observed in the PY2014/2015 evaluation[6] to the hourly observed heating degree hours in the appropriate quarter-hour of the PY2015/2016 DR event.

The demand response parameters estimated for auxiliary heat strip in the PY2014/2015 evaluation provide an estimate of the relationship between the observed outdoor heating degree hours (HDH) during a given quarter-hour of the day and the demand reduction impact in that same quarter-hour, when a DR

[3] Navigant Consulting, Inc., on behalf of Duke Energy Progress, *EM&V Report for the EnergyWise Home Program: Winter 2014/2015,* June 2015.

[4] In this evaluation as in the PY2011/2012 winter evaluation, Navigant, based on a visual examination of logger data divided auxiliary heat strips into “fully responsive”, “partially responsive”, “unused” and “unresponsive” categories, referred to as dispositions. Separate equations were used to estimate impacts for fully and partially responsive devices.

[5] Navigant Consulting, Inc., on behalf of Duke Energy Progress, *EM&V Report for the EnergyWise Home Program: Winter 2014/2015,* June 2015.

[6] In this evaluation as in the PY2011/2012 winter evaluation, Navigant, based on a visual examination of logger data divided auxiliary heat strips into “fully responsive”, “partially responsive”, “unused” and “unresponsive” categories, referred to as dispositions. Separate equations were used to estimate impacts for fully and partially responsive devices.

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event is called. Navigant estimated PY2015/2016 impacts of each auxiliary heat strip "disposition type" (see below for more details) by applying this relationship to the heating degree hours observed in the appropriate quarter hour of the day for the PY2015/2016 event.

The PY2015/2016 DR event began thirty minutes earlier than any of the PY2014/2015 DR events. Since no events were called for this period in PY2014/2015, there are no estimated parameters for these two fifteen minute intervals. Impacts for these two fifteen minute intervals were estimated taking the average estimated parameter over the earliest hour of DR curtailment from PY2014/2015 and applying it the temperature variable in the appropriate fifteen minute interval.

The average per device impacts were estimated based on a weighted average of disposition-specific estimated impacts. The weights were derived from the average distribution of device dispositions observed during the PY2014/2015 evaluation.

Customers can have more than one set of auxiliary heat strips or more than one water heater controlled. As a result, the Navigant team multiplied auxiliary heat strip impact by the average number of devices controlled per participant (1.09 devices per participant) and multiplied the water heater impact by the average number of water heaters controlled per participant (1.02 per participant) to obtain an estimate of the average impact per participant.

2.1.1.2 Water Heater Demand Reduction Impact

Navigant estimated DR impacts from water heaters by applying the regression coefficients estimated as part of the PY2014/2015 evaluation to the appropriate quarter-hour of the PY2015/2016 DR event.

The PY2015/2016 DR event began thirty minutes earlier than any of the PY2014/2015 DR events. Since no events were called for this period in PY2014/2015, there are no estimated parameters for these two fifteen minute intervals. Impacts for these two fifteen minute intervals were estimated taking the average estimated parameter over the earliest hour of DR curtailment from PY2014/2015 and applying it the temperature variable in the appropriate fifteen minute interval.

2.1.2 Snapback Impact

Snapback refers to the increase in demand observed in the hours immediately following a DR event. During a winter demand response event, space-heating or water heating is curtailed. When curtailed, the home or water tank cools beyond the customer's preferred settings, reducing electricity demand during the event. Snapback refers to the incremental electricity required to restore the water tank or home to the set-point temperature in the period immediately following the event.

2.1.2.1 Auxiliary Heat Strip Snapback Impact

In PY2014/2015, Navigant estimated auxiliary heat strip snapback impacts as a function of the total HDH observed *during* the DR event, and the number of periods that had elapsed since the end of the event (i.e., the relative quarter-hour of snapback). In PY2015/2016, Navigant estimated snapback impacts by aligning the relative quarter-hour estimated parameters with the appropriate quarter hours following the PY2015/2016 event and then applying event-period weather data.

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As with DR impacts, snapback impacts were weighted by disposition for per-device impacts and scaled by number of devices per participant to get per-participant impacts.

2.1.2.2 Water Heater Snapback Impact

In PY2014/2015, Navigant estimated water heater snapback impacts as a function of the number of periods that had elapsed since the end of the event (i.e., the relative quarter-hour of snapback). In PY2015/2016, Navigant estimated snapback impacts by aligning the relative quarter-hour estimated parameters with the appropriate quarter hours following the PY2015/2016 event.

Snapback impacts were constrained such that the total energy recovered during the snapback could not exceed the average proportion of the energy saved during the PY2014/2015 DR periods that was “taken back” by the snapback. The logic used calculate snapback may be observed directly in the Excel spreadsheet that accompanies this report (Appendix A)

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3. IMPACT FINDINGS

This chapter of the report provides the estimated demand reduction and snapback impacts for the EnergyWise Home program for the winter of PY2015/2016. These impacts were estimated as described in Chapter 2.1. Impacts are based on the results of the PY2014/2015 evaluation report, and PY2015/2016 weather and participation, as applicable.

The estimated average DR impact by equipment type is shown below in Table 3.

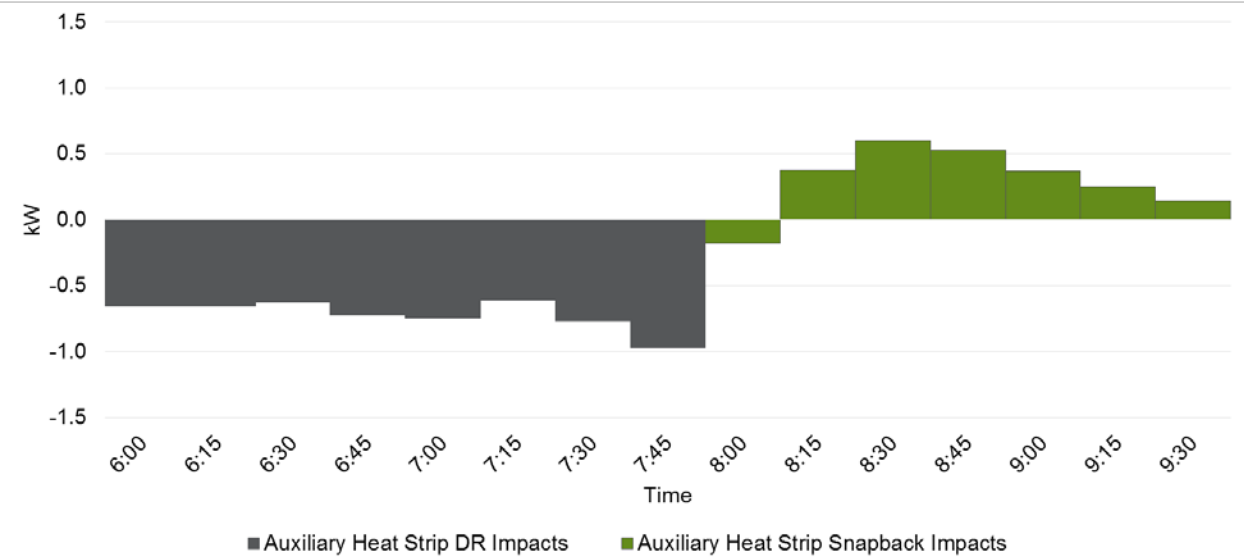
Table 3: Average Demand Reduction Impact by Technology, PY2015/2016

Device Curtailed	DR Impact (kW)	System Impact (MW)
Auxiliary Heat Strips	0.72	2.75
Electric Water Heater	0.35	2.33
Total System Impact:		**5.08**

Source: Navigant Analysis, PY2015/2016 weather and PY2014/2015 modeling results

Hour-by-hour results are shown graphically in Figure 1 and Figure 2, below. In this graphic, the convention used is to represent DR impacts as a negative number (i.e., demand reduction) and snapback as a positive (i.e., an increase in demand).

Figure 1: Auxiliary Heat Strip Demand Response Impact



Source: Navigant Analysis, PY2015/2016 weather and PY2014/2015 modeling results

The PY2015/2016 auxiliary heat strip demand response impact, 0.72 kW, is approximately half the average demand response impact reported for auxiliary heat strips in PY2014/2015 (1.37 kW). This is due to the much lower temperatures observed during the PY2014/2015 DR events. In that program year, the average outdoor event temperature was less than sixteen degrees Fahrenheit, and for three of the ten

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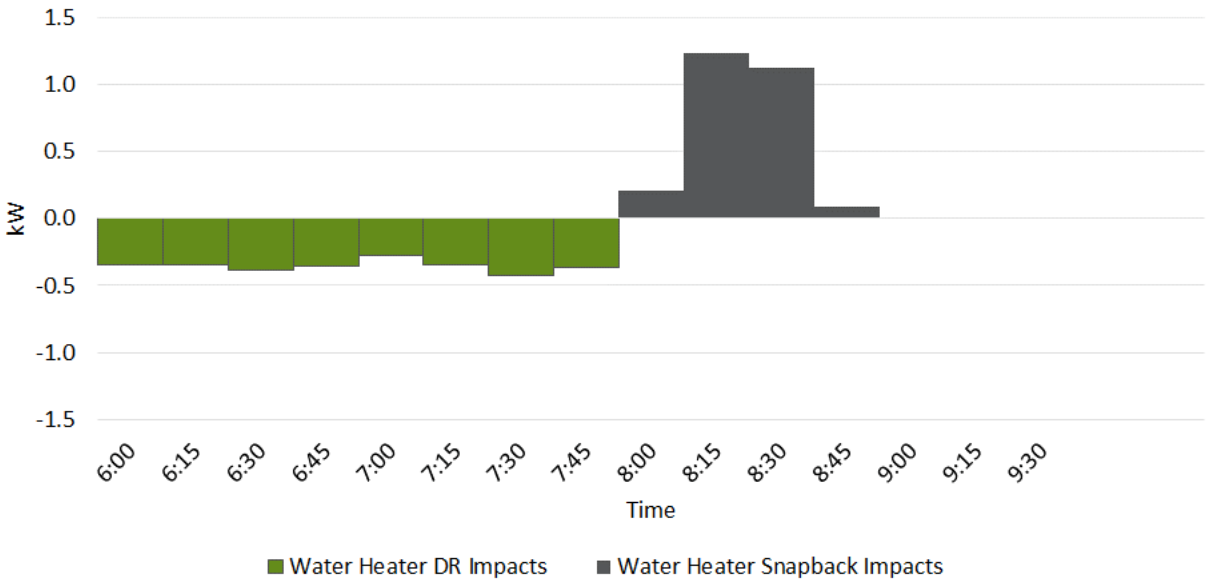
events was less than six degrees. In PY2015/2016 in contrast, the average outdoor temperature observed during the single event was approximately 20.5 degrees Fahrenheit.

The most suitable event from PY2014/2015 with which to compare the impacts of the single PY2015/2016 event is that which occurred on March 6, 2015. For this event, the average outdoor temperature during the event was 20.2 degrees Fahrenheit, and the estimated DR impact for that event was 0.75 kW.

Figure 2: Water Heater Demand Response Impact



Source: Navigant Analysis, PY2015/2016 weather and PY2014/2015 modeling results

The PY2015/2016 auxiliary heat strip demand response impact, 0.35 kW, is slightly lower than the average demand response impact reported for water heaters in PY2014/2015 (0.4 kW). This is due to the fact that the PY2015/2016 event ends earlier (at 8 a.m.) than all of the PY2014/2015 events (9 a.m. or 9:30 a.m.). As may be seen in Figure 3, below, the estimated DR impacts climb steadily through the morning, peaking in the period between 8 a.m. and 9 a.m. Since the magnitude of water heater DR impacts reflects the underlying hot water usage patterns, this suggests that a high proportion of the EM&V participants in the PY2014/2015 study shower at or slightly after 8 a.m. Since the PY2015/2016 event ends before this apparent peak period, impacts are lower than in PY2014/2015.

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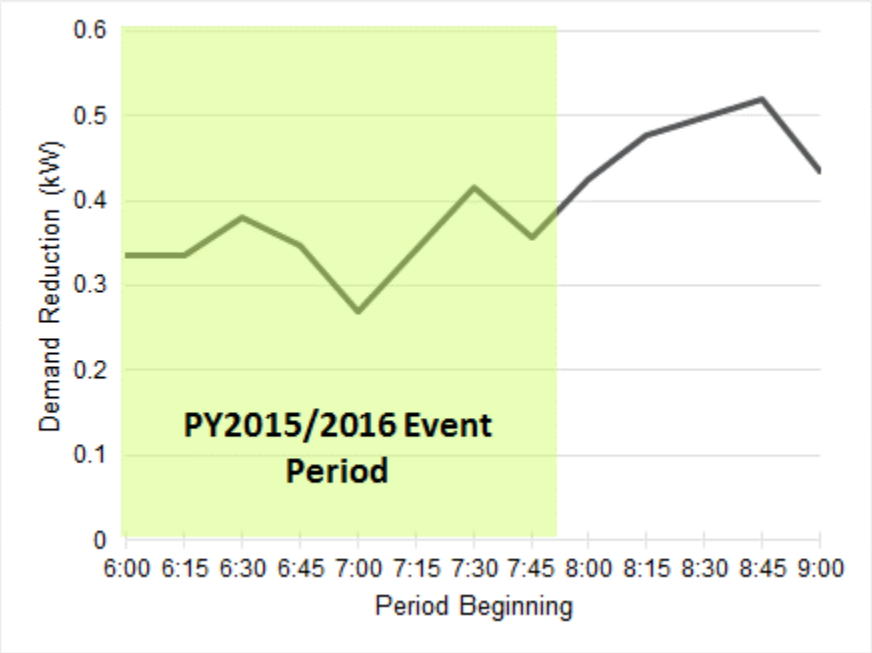
Figure 3: Water Heater DR Impacts by Quarter Hour



Source: Navigant Analysis, PY2015/2016 weather and PY2014/2015 modeling results

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4. SUMMARY FORM

EnergyWise Home
Winter PY2015/2016
Completed EMV Fact Sheet

Description of program

Duke Energy's EnergyWise Home program is a demand response program offered to residential customers in the Duke Energy Progress territory.

EnergyWise is a direct load control program. Participants receive an incentive to allow Duke Energy to control their air-conditioners (in the summer) their heat pump auxiliary heat strips (in the winter) or their electric water heaters (winter or summer). Only participants in the Western region are curtailed in the winter.

This report evaluates the impact of the program in the winter of 2015/2016. Only a single event was called, on February 11, 2016.

Date:	**June 15, 2016**
Region:	Duke Energy Progress
Evaluation Period	Winter PY2015/2016
DR Event Impact per Participant (kW)	
Water Heaters	0.35
Aux. Heat Strips	0.72
DR Event Program Impact (MW)	
Water Heaters	2.33
Aux. Heat Strips	2.75
Net-to-Gross Ratio	1

Evaluation Methods

Navigant estimated DR impacts for auxiliary heat strips by applying the regression coefficients estimated as part of the PY2014/2015 evaluation[1], and the proportion of auxiliary heat strips that were fully responsive or partially responsive to Duke Energy Progress' curtailment signal, as observed in the PY2014/2015 evaluation[1], to the hourly observed heating degree hours in the appropriate quarter-hour of the PY2015/2016 DR event.

Navigant estimated DR impacts for water heaters by applying the regression coefficients estimated as part of the PY2014/2015 evaluation to the appropriate quarter-hour of the PY2015/2016 DR event.

Impact Evaluation Details

- **Auxiliary heat strips delivered an average DR impact of 0.72 kW per household.** The total estimated program impact of the 3,847 participating households was 2.75 MW.
- **Auxiliary heat strip impacts were lower on average for PY2015/2016 than PY2014/2015 due to the single PY2015/2016 event occurring on a relatively mild weather day.** In PY2014/2015, there were three events in which the average event temperature was at or below approximately five degrees Fahrenheit. In contrast, for the PY2015/2016 event the average event temperature was approximately 20 degrees Fahrenheit.
- **Water heaters delivered an average DR impact of 0.35 kW per household.** The total program impact of the 6,573 participating households was 2.33 MW.
- **Water heater impacts were slightly lower on average for PY2015/2016 than PY2014/2015 due the fact that the PY2015/2016 event began and ended earlier in the morning than the PY2014/2015 events.** Most PY2014/2015 events began at 6:30 a.m. and lasted until 9:00 a.m. By contrast, the PY2015/2016 event ran from 6:00 a.m. to 8 a.m. Regression-estimated impacts from PY2014/2015 indicate that impacts increase steadily as the morning progresses until 9:00 a.m., possibly reflecting underlying patterns of shower use.

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5. CONCLUSION

The principal EM&V findings regarding the winter event demand impacts for PY2015/2016 are as follows:

- **Auxiliary heat strips delivered an average DR impact of 0.72 kW per household.** The total estimated program impact of the 3,847 participating households was 2.75 MW.
- **Auxiliary heat strip impacts were lower on average for PY2015/2016 than PY2014/2015 due to the single PY2015/2016 event occurring on a relatively mild day.** In PY2014/2015, there were three events in which the average event temperature was at or below approximately five degrees Fahrenheit. In contrast, for the PY2015/2016 event the average event temperature was approximately 20 degrees Fahrenheit.
- **Water heaters delivered an average DR impact of 0.35 kW per household.** The total program impact of the 6,573 participating households was 2.33 MW.
- **Water heater impacts were slightly lower on average for PY2015/2016 than PY2014/2015 due the fact that the PY2015/2016 event began and ended earlier in the morning than the PY2014/2015 events.** Most PY2014/2015 events began at 6:30 a.m. and lasted until 9:00 a.m. By contrast, the PY2015/2016 event ran from 6:00 a.m. to 8 a.m. Regression-estimated impacts from PY2014/2015 indicate that impacts increase steadily as the morning progress until 9:00 a.m., likely reflecting underlying patterns of shower use.

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NAVIGANT

EM&V Report for the Small Business Energy Saver Program

Duke Energy Progress and Duke Energy Carolinas

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1. EVALUATION SUMMARY

1.1 Program Summary

The Small Business Energy Saver (SBES) Program is part of a portfolio of energy efficiency programs operated by Duke Energy. Duke Energy selected Lime Energy to implement the SBES program again in the Duke Energy Progress (DEP) jurisdiction, as well as the Duke Energy Carolinas (DEC) jurisdiction for this evaluation cycle. The program caters specifically to small business customers and offers a performance-based incentive up to 80 percent of the total project cost, inclusive of both materials and installation, on high-efficiency lighting and refrigeration equipment.

The SBES Program generates energy savings and peak demand reductions by offering eligible customers a streamlined service including marketing outreach, technical expertise, and performance incentives to reduce equipment and installation costs from market rates on high-efficiency lighting, refrigeration, and HVAC equipment. The SBES Program seeks to bundle all eligible measures together and sell them as a single project in order to maximize the total achievable energy and demand savings, while working with customers to advise equipment selection to meet their unique needs.

1.2 Evaluation Objectives and High Level Findings

Evaluation, Measurement, and Verification (EM&V) involves the use of a variety of analytic approaches, including on-site verification of installed measures and application of engineering models. EM&V also encompasses an evaluation of program processes and customer feedback, typically conducted through participant surveys and program staff interviews. This report details the EM&V activities that Navigant Consulting, Inc. (Navigant) performed on behalf of Duke Energy for the SBES Program.

This report covers EM&V activities performed for projects covering the following periods, referenced simply as PY2015 for the remainder of this report:

- January 1, 2015 through February 29, 2016 (DEP)
- August 1, 2014 (program start) through February 29, 2016 (DEC)

The primary purpose of the evaluation assessment is to estimate net annual energy and peak demand impacts associated with SBES activity. Net savings are calculated as the reported “gross” savings from Duke Energy, verified and adjusted through EM&V, and netted for free ridership (i.e., savings that would have occurred even in the absence of the program) and spillover (i.e., additional savings attributable to the program but not captured in program records).

The EM&V assessment of the SBES program included impact and process evaluations.

- The impact evaluation consisted of engineering analysis and on-site field verification and metering to validate energy and demand impacts of reported measure categories, as well as a customer survey to assess net impacts.
- The process evaluation used customer surveys with 151 participants and interviews with program staff and the implementation contractor to characterize the program delivery and identify opportunities to improve the program design and processes. The customer survey data also formed the basis of the evaluation team’s estimation of free ridership and spillover, used to calculate an NTG ratio.

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The evaluation team verified gross energy savings at 111 percent of deemed reported energy savings for DEP and 112 percent for DEC, and gross peak demand reductions at 96 percent for DEP and DEC. A net-to-gross (NTG) ratio was estimated at 1.04, yielding total verified net energy savings of 56,491 megawatt-hours (MWh) for DEP and 90,375 MWh for DEC, and net peak demand reductions of 11.6 megawatts (MW) for DEP and 20.6 MW for DEC (Table 1-1 through Table 1-4).

Table 1-1. Program Claimed and Evaluated Gross Energy Impacts

	Jurisdiction	Claimed	Evaluated	Realization Rate
Gross Energy Impacts (MWh)	DEP	48,772	54,318	1.11
Gross Energy Impacts (MWh)	DEC	77,269	86,899	1.12

Source: Navigant analysis and Duke Energy tracking data.

Table 1-2. Program Claimed and Evaluated Gross Peak Demand Impacts

	Jurisdiction	Claimed	Evaluated	Realization Rate
Gross Summer Peak Demand Impacts (MW)	DEP	11.7	11.2	0.96
Gross Winter Peak Demand Impacts (MW)	DEP	11.7	6.2	0.53
Gross Summer Peak Demand Impacts (MW)	DEC	20.5	19.8	0.96
Gross Winter Peak Demand Impacts (MW)	DEC	20.5	10.9	0.53

Source: Navigant analysis and Duke Energy tracking data.

Table 1-3. Program Net Energy Impacts

	Jurisdiction	MWh
Net Energy Impacts (MWh)	DEP	56,491
Net Energy Impacts (MWh)	DEC	90,375

Source: Navigant analysis.

Table 1-4. Program Net Peak Demand Impacts

	Jurisdiction	MW
Net Summer Peak Demand Impacts (MW)	DEP	11.6
Net Winter Peak Demand Impacts (MW)	DEP	6.4
Net Summer Peak Demand Impacts (MW)	DEC	20.6
Net Winter Peak Demand Impacts (MW)	DEC	11.3

Source: Navigant analysis.

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1.3 Evaluation Parameters and Sample Period

To accomplish the evaluation objectives, Navigant performed a variety of primary and secondary research activities including:

- Engineering review of measure savings algorithms
- Field verification and metering to assess installed quantities and characteristics
- Participant surveys with customers to assess satisfaction and decision-making processes.

Table 1-5 summarizes the evaluated parameters. The targeted sampling confidence and precision for both DEP and DEC was 90 percent ± 10 percent, and the achieved was 90 percent ± 7.0 percent for energy savings, 8.5 percent for summer and 12.4 percent for winter peak demand reductions.[1]

Table 1-5. Evaluated Parameters

Evaluated Parameter	Description	Details
Efficiency Characteristics	Inputs and assumptions used to estimate energy and demand savings	1. Lighting wattage 2. Operating hours 3. Coincidence factors 4. HVAC interactive effects 5. Baseline characteristics
In-Service Rates	The percentage of program measures in use as compared to reported	1. Measure quantities found onsite
Satisfaction	Customer satisfaction with various stages of their project	1. Overall satisfaction with program 2. Satisfaction with implementation and installation contractors 3. Satisfaction with program equipment
Free Ridership	Fraction of reported savings that would have occurred in the absence of the program	
Spillover	Additional, non-reported savings that occurred as a result of participation in the program	

Source: Navigant analysis

[1] Navigant designed the impact sample to achieve 90/10 confidence and precision using the industry-standard coefficient of variation of 0.5 and results from previous (PY2013 and PY2014) SBES program evaluations in the DEP jurisdiction. The sample quotas were met as planned, and the final precision was different due to natural variation in individual site level characteristics.

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This evaluation covers program participation from August 2014 through February 2016. Table 1-6 shows the start and end dates of Navigant's sample period for evaluation activities.

Table 1-6. Sample Period Start and End Dates

Activity	Start Date	End Date
Field Verification and metering	March 15, 2016	April 22, 2016
Participant Phone Surveys	May 3, 2016	May 5, 2016

Source: Navigant analysis

1.4 Recommendations

The evaluation team recommends five discrete actions for improving the SBES Program, based on insights gained through the comprehensive evaluation effort. These recommendations provide Duke Energy with a roadmap to fine-tune the SBES Program for continued success and include the following broad objectives. Table 1-7 summarizes these program recommendations.

Table 1-7. Summary of PY2015 SBES Recommendations

	Increasing Program Participation
1.	Continue to emphasize non-energy benefits of program participation, such as increased lighting quality, comfort for both business employees and customers, environmental benefits, and reduced maintenance. Now that the program has transitioned primarily to LED measures, increased education on the benefits that LED measures offer should enhance participation.
	Increasing Customer Satisfaction
2.	Continue to prioritize customer satisfaction through installation contractor training and customer follow-up services. The IC has improved in this area from PY2014, but a minority of customers are still reporting issues with installation and communication. Additionally, some customers are not perceiving savings on their electric bill, so managing this expectation would enhance customer satisfaction.
3.	Phase out fluorescent T8 lighting systems. Linear LED lighting offers substantial savings above high-performance/reduced wattage T8 lamps and ballasts, which may be perceived as outdated.
	Improving Accuracy of Reported Savings
4.	Add HVAC interactive effects and update coincidence factors for lighting measures. This is the key impact finding to improve the accuracy of savings estimates. The IC should apply relevant HVAC interactive effects and coincidence factors to lighting measures as is appropriate, and ensure that outdoor lighting measures on daylight sensors do not accrue peak demand reductions during summer daylight hours.
5.	Ensure that efficient lighting power ratings for linear LED systems are accurate. Navigant did not perform live measurements of connected linear LED systems to determine power draw, and upon review of manufacturer specifications for lighting power there are different wattages that the system may draw depending on the specific configuration. As the share of savings attributed to linear LED systems grow, this should be quantified to reduce EM&V risk in future years.

Source: Navigant analysis

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2. PROGRAM DESCRIPTION

The Small Business Energy Saver (SBES) Program is part of a portfolio of energy efficiency programs operated by Duke Energy. The program began as a pilot in early 2013 in South Carolina before expanding into the remainder of the Duke Energy Progress (DEP) jurisdiction. The program further expanded into the Duke Energy Carolina (DEC) jurisdiction in August 2014. In 2015, the program showed continued growth compared to 2014 measured by both participant count and claimed energy savings and peak demand reductions.

2.1 Program Design

The SBES Program is available to qualifying commercial customers with less than 100 kilowatts (kW) demand service. The SBES Program recognizes that customers with lower savings potential may benefit from a streamlined, one-stop, turnkey delivery model and relatively high incentives to invest in energy efficiency. Additionally, small businesses may lack internal staffing dedicated to energy management and can benefit from energy audits and installations performed by an outside vendor.

The program offers incentives in the form of a discount for the installation of measures, including high-efficiency lighting and refrigeration equipment. These incentives increase adoption of efficient technologies beyond what would occur naturally in the market. In PY2015, the SBES Program (IC) achieved the majority of program savings from lighting measures, which tend to be the most cost-effective and easiest to market to potential participants. The IC also achieved program savings from refrigeration measures at a similar level to PY2014.

The program offers a performance-based incentive up to 80 percent of the total project cost, inclusive of both materials and installation. Multiple factors drive the total project cost, including selection of equipment and unique installation requirements.

2.2 Reported Program Participation and Savings

Duke Energy maintains a tracking database that identifies key characteristics of each project, including participant data, installed measures, and estimated energy and peak demand reductions based on assumed (“deemed”) savings values. In addition, the IC maintains a tracking database that contains additional measure level details that are useful for EM&V activities. For PY2015 Navigant only reviewed the IC database. Duke Energy ensured that the IC database savings accurately represent all claimed program savings.

Table 2-1 provides a summary of the gross reported energy and demand savings and participation for PY2013 through PY2015. Note the significant year over year growth for PY2015, along with an increase in average measures installed per project and average savings per project.

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Table 2-1. Reported Participation and Gross Savings Summary

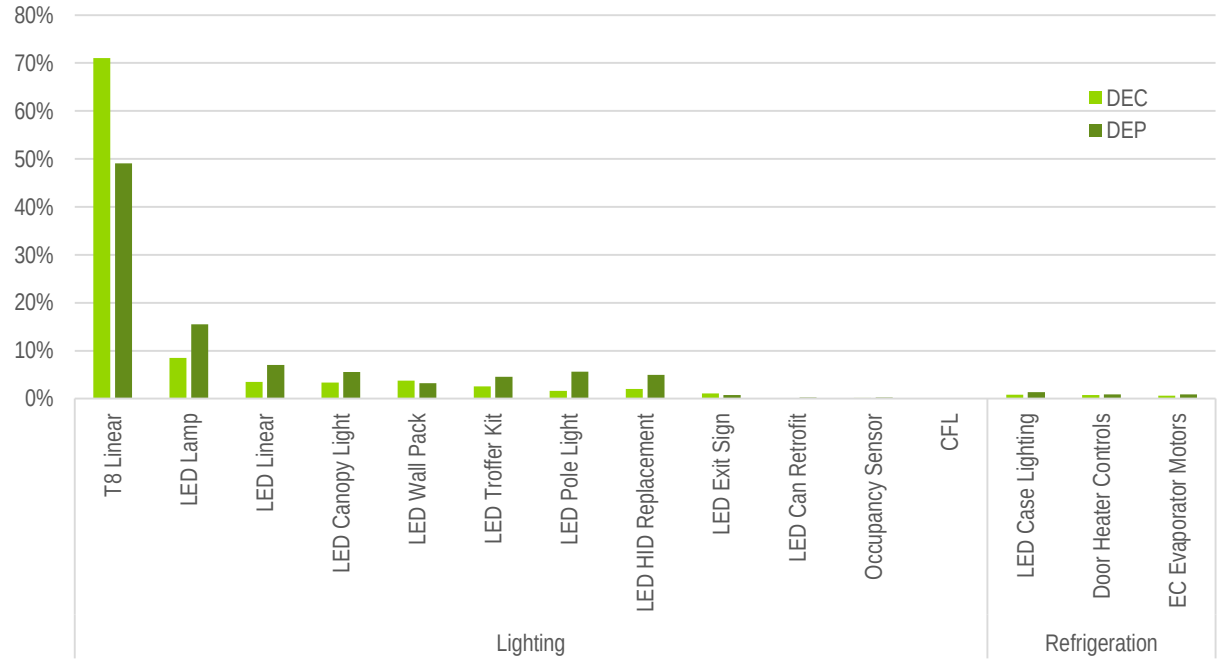
Reported Metrics	PY2013 (DEP)	PY2014 (DEP)	PY2015 (DEP)	PY2015 (DEC)
Participants	675	1,759	1,790	3,080
Measures Installed	42,537	108,816	132,977	234,788
Gross Annual Energy Savings (MWh)	14,242	38,665	48,772	77,269
Average Quantity of Measures per Project	63	62	74	76
Average Gross Savings Per Project (MWh)	21.1	22.0	27.2	25.1

Source: SBES Tracking Database

2.2.1 Program Summary by Measure

Efficient T8 lighting retrofits were the highest contributor to program energy savings in PY2015 across both jurisdictions, followed by a variety of LED lighting measures. In addition, refrigeration measures, compact fluorescent lamps (CFLs), and occupancy sensors also contributed to savings. Navigant found a higher share of savings from T8 fluorescent retrofits in the DEC jurisdiction, likely due to the fall and winter 2014 projects that were part of this evaluation cycle. The SBES program has rapidly adopted LED lighting products in PY2015. Figure 2-1 shows the reported gross savings by measure category as reported by Duke Energy.

Figure 2-1. Reported Gross Energy Savings by Measure Category and Jurisdiction



Source: SBES Tracking Database

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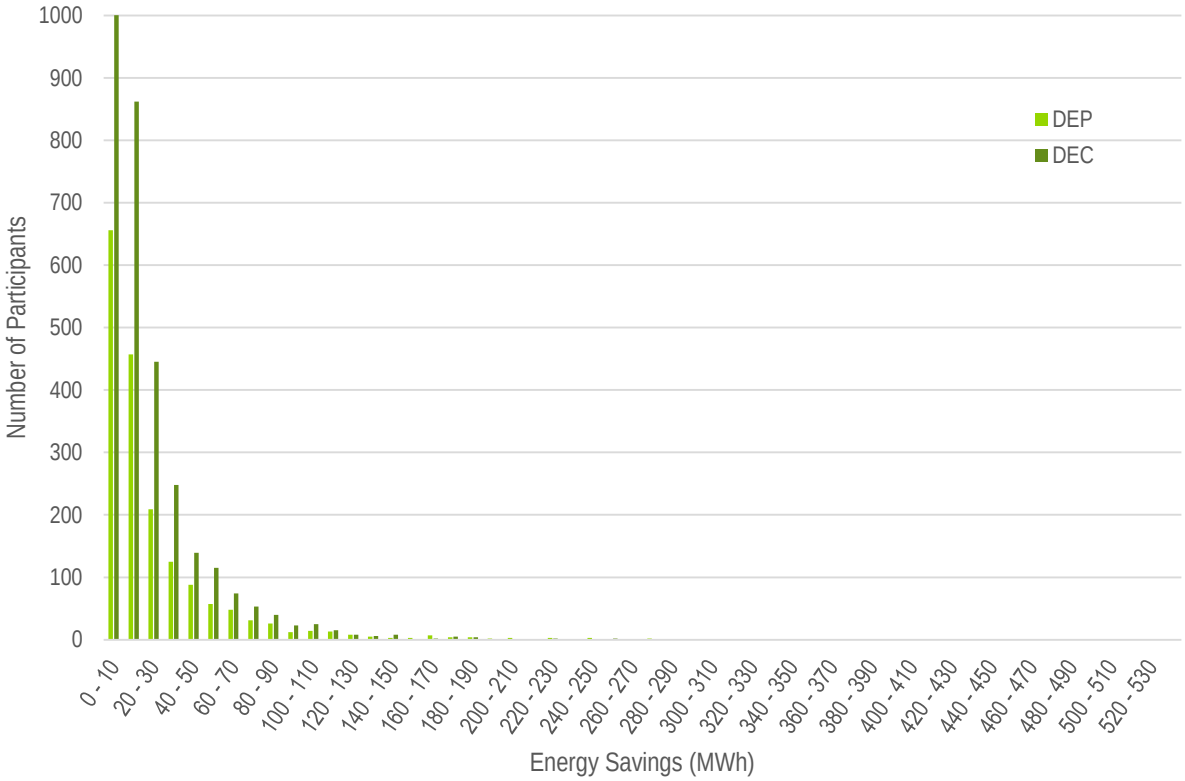
2.2.2 Savings by Project

Because the SBES program is limited to small business customers only, the variations in project energy and peak demand savings and the quantity of measures installed exhibit less spread than typical large business program offerings. Nevertheless, there is still a mix of various project sizes, as shown in Figure 2-2, with very few project sites reporting savings over 200 MWh per year. The largest site reported savings of over 500 MWh per year.

Figure 2-2. Histogram of Reported Energy Savings per Project



Source: SBES Tracking Database

The evaluation team reviewed the business type data in the tracking database as well, but found that there was not a facility type field that could be easily mapped to deemed savings values for HVAC interactive effects and coincidence factors, which will be explored further in this report.

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3. KEY RESEARCH OBJECTIVES

As outlined in the Statement of Work (SOW), the primary purpose of the EM&V activities is to estimate verified net annual energy and peak demand impacts associated with program activity for PY2015. Additional research objectives include the following:

3.1 Impact Evaluation

The impact evaluation focuses on quantifying the magnitude of verified energy savings and peak demand reductions. Objectives include:

- Verify deemed savings estimates through review of measure assumptions and calculations.
- Perform on-site verification of measure installations, and collect data for use in an engineering analysis.
- Estimate the amount of observed energy and peak demand savings (both summer and winter) by measure via engineering analysis.

3.2 Net-to-Gross Analysis

The net-to-gross analysis focuses on estimating the share of energy savings and peak demand reductions that can be directly attributed to the SBES program itself. Objectives include:

- Assess the Net-to-Gross ratio by addressing spillover and free-ridership in customer surveys.

3.3 Process Evaluation

The process evaluation focuses on the program implementation and the customer experience. Objectives include:

- Perform interviews with program management and Implementation Contractor.
- Perform participant surveys with customers.
- Identify barriers to participation in the program, and how the program can address these barriers.
- Identify program strengths and the potential for introducing additional measures.

3.4 Evaluation Overview

Figure 3-1 outlines the high-level approach used for evaluating the SBES Program, which is designed to address the research objectives outlined above. The impact, net-to-gross, and process sections provide further detail for each of the individual EM&V activities.

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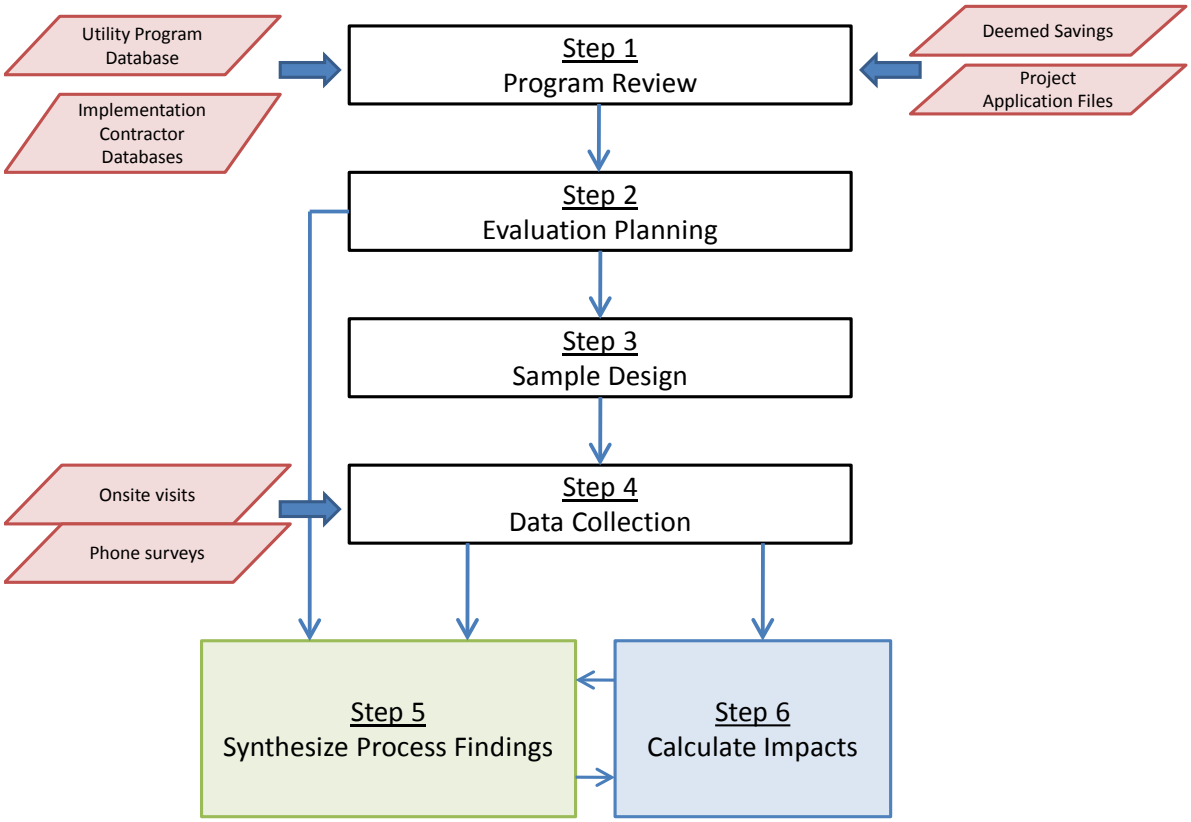
Figure 3-1. Evaluation Process Flow Diagram



Source: Navigant

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4. IMPACT EVALUATION

The purpose of this impact evaluation is to quantify the verified energy and demand savings estimates for the SBES Program in both the DEP and DEC jurisdictions. Table 4-1 and Table 4-2 show high-level program results of Navigant's impact analysis. Ultimately, Duke Energy can use these results as an input to system planning.

Table 4-1. PY2015 SBES Summary of Program Impacts for DEP

DEP	Energy Savings (MWh)	Summer Peak Demand Reductions (MW)	Winter Peak Demand Reductions (MW)
Reported Gross Savings	48,772	11.7	11.7
Realization Rate	1.11	0.96	0.53
Verified Gross Savings	54,318	11.2	6.2
NTGR	1.04	1.04	1.04
Verified Net Savings	56,491	11.6	6.4

Source: Navigant analysis

Table 4-2. PY2015 SBES Summary of Program Impacts for DEC

DEC	Annual Energy Savings (MWh)	Summer Peak Demand Reductions (kW)	Winter Peak Demand Reductions (kW)
Reported Gross Savings	77,269	20.5	20.5
Realization Rate	1.12	0.96	0.53
Verified Gross Savings	86,899	19.8	10.9
NTGR	1.04	1.04	1.04
Verified Net Savings	90,375	20.6	11.3

Source: Navigant analysis

4.1 Impact Methodology

The methodology for assessing the gross energy savings and peak demand reductions follows IPMVP Option A (Retrofit Isolation: Key Parameter Measurement). This involves an engineering-based approach for estimating savings, supplemented by key parameter measurements. This included using time-of-use lighting loggers to directly measure operating hours and coincidence factors for program- incented lighting measures. Note that for the limited set of refrigeration measures, verification activities were performed on-site to assess installation and operation.

The evaluation team employed the following steps to conduct the impact analysis:

1. **Review Field Data and Design Sample** – First, the team analyzed the tracking data to determine the most appropriate sampling methodology. The team created four strata (small, medium, and large lighting, and refrigeration) to ensure that a variety of different businesses and

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measures were captured in the site visits. A subset of each strata was selected for more detailed logging (19 of 57 total sites visits were logged).

2. **Pull Sample** – Next, the team pulled a sample from the four strata and scheduled site visits, including several backup sites in the event that a visitation could not be arranged.
3. **Perform Participant Site Visits** – The evaluation team used an electronic data collection system in the field to ensure consistency and decrease data processing time. For all site visits, Navigant field technicians uploaded all collected site data to the online system as soon as they were completed. Navigant performed quality control verifications for all field data collection forms and online data entry. This included a thorough inspection of each site's building characteristic inputs, operating schedules, measure-level in-service rates, and descriptions. The following steps were taken at each participant site:
    a. At each customer site, the team first determined the in-service rate (ISR) of the equipment for each measure found. The field technicians accomplished this by visually verifying and counting all equipment included in the project documentation at each site.
    b. The team then calculated the difference in watts between the base-case fixtures and the energy-efficient fixtures for each fixture type installed on-site. The team verified efficient fixture wattage through visual inspection, while deriving base-case fixture wattage from customer-provided data found in the documentation review, if available, or from information found by field technicians during the site visits. There is typically little to no information about the specifications of base-case equipment that has been removed from a site. If both customer data and field data were insufficient, the team utilized the IC tracking data and assessed the reasonableness of their assumptions.
    c. Operating hours were determined from a detailed customer interview for each unique lighting schedule in the building, and adjusted for holiday building closures. For the subset of sites that received logging, the EM&V team left time-of-use loggers in place for roughly three weeks and then returned to retrieve the logging equipment.
    d. Coincidence factors were taken from prior EEB program findings[2] and previous SBES reports[3] for similar building types for the verification only sites. For logged sites, the team calculated both summer and winter coincidence factors from the logger data.
4. **Calculate Site-Level Savings** – The team calculated site-level energy and demand savings for each site in the sample based on operational characteristics found on site and engineering-based parameter estimates.
5. **Calculate Program-Level Savings** – The team calculated verification rates for all sites and applied a ratio, representing the adjustment based on the logger data, resulting in final verified savings for each sampled site. Lastly, the team calculated stratum-level realizations rates, applied those realization rates to the projects that fell into their respective strata, and arrived at final program-level realization rates. Navigant utilized the stratified ratio estimation method to determine program-level verified gross savings for each jurisdiction by applying strata-level realization rates to the projects within each jurisdiction.

[2] PY2013 DEP EEB EM&V Report

[3] PY2013 and PY2014 DEP SBES EM&V Report

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4.2 Sample Design

After reviewing the Duke Energy and IC tracking data, the evaluation team opted to split up the population of projects into four strata based on the projects' estimated energy savings to ensure that the sample represented both small, medium and large customers, and that field verification assessed a large percentage of program savings. The strata were designed according to the following guidelines:

1. First, all projects with refrigeration measures were assigned to a single stratum.
2. The remaining projects were sorted from highest claimed savings to lowest claimed savings.
3. The team then examined the reported savings and selected criteria that would result in three strata, each containing an approximately equal share of total claimed savings:
    - Lighting Large – greater than 65,000 kWh reported savings;
    - Lighting Medium – between 25,000 kWh and 65,000 kWh reported savings;
    - Lighting Small – less than 25,000 kWh savings;
    - Refrigeration – all projects with refrigeration savings.

Note that the stratum cutoff points for PY2015 are higher than in PY2014 due to the larger average per-project savings in this evaluation. The limits in PY2014 were 20,000 kWh and 40,000 kWh.

In order to achieve a 10 percent relative precision at a 90 percent confidence interval, the evaluation team targeted 57 total sites, which were spread roughly equally among the three lighting strata and a smaller refrigeration stratum.

The evaluation team conducted on-site verification at 57 sites during the summer of 2016. While on-site, the team conducted customer interviews and visual verification to collect data on building operation, HVAC system details, and seasonal and holiday schedules. Key evaluation parameters came primarily from on-site data; however, where this data was lacking or was deemed unusable, customer application data was used in its place. As there are many parameter inputs to the savings calculation for each site, this approach ensures that the best available data are used for each site's savings estimation. Table 4-3 below details the final site visit disposition.

Table 4-3. Onsite Sample Summary

Strata	Population Size	Onsite Verification Sample Size	Onsite Metering Sample Size (Subset of Verification Sample)
Lighting Large	328	16	6
Lighting Medium	1025	18	7
Lighting Small	3,327	17	6
Refrigeration	195	6	0
Total	4,875	57	19

Source: Navigant analysis

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4.3 Algorithms and Parameters

Navigant used data collected from the field and the engineering review to calculate site-level energy and demand savings, using the following algorithms. Table 4-4 shows the algorithms that the evaluation team used to calculate verified savings for lighting measures. The impact evaluation effort focused on verifying the inputs for these algorithms.

Table 4-4. Verified Savings Algorithms for Lighting Measures

Measure	Energy Savings Algorithm	Coincident Peak Demand Savings Algorithm
Lighting Measures	kWh_Verified = Qty_Verified x HOU x Verified_Watts_Reduced x IF_Energy	kW_Verified = Verified x CF x Verified_Watts_Reduced x IF_Demand
Refrigeration	kWh_Verified = Unit_Savings x Qty_Verified	kW_Verified = Unit_Savings x Qty_Verified

ISR = in-service rate (not in calculation, calculated to provide context)
Fixture_Quantity_Verified = quantity of equipment verified on-site
HOU = verified operating hours
CF = coincidence factor
IF_Energy = heating, ventilating, and air conditioning (HVAC) interaction factor for energy savings calculations
IF_Demand = interaction factor for demand savings calculations
Verified Watts Reduced = watts of baseline equipment - watts of energy-efficient equipment.
Unit_Savings = deemed per unit savings appropriate for measure.

Source: Navigant analysis

The detailed description of each parameter and any related assumption are as follows:

4.3.1 Fixture Quantity Verified and In-Service Rate (ISR)

The Navigant evaluation team visually counted fixtures on-site to quantify the quantity and type of lighting equipment installed. The team calculated the ISR as the ratio between the findings from the on-site verification compared to the quantity reported in the program-tracking databases. On-site verifications determined the total number of installed measure-level equipment.

4.3.2 Verified Watts

The team calculated base and efficient watts at the measure level. Efficient nameplate wattages were determined using manufacturer specifications based on fixture-level data collected on-site. The project documentation contained in the IC tracking database determined base wattages. In the cases where efficient fixture data were unavailable, due to inaccessible fixtures, the wattages found in the IC database values were applied.

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4.3.3 HVAC Interactive Effects

Reductions in lighting energy generally increase a building's heating requirements (load) and decrease cooling requirements. The HVAC interactive effects accounts for these secondary effects on the HVAC system energy use and acts as a multiplier in the energy savings algorithms. The team applied the HVAC interactive effects used in prior EEB and SBES program evaluations (both 2013 and 2014) for consistency, which were sourced from a 2011 Navigant study (including over 120 buildings) in Maryland that used building energy models of field-verified building characteristics (i.e., HVAC, lighting, and envelope) and actual billing data to assess the interactive effects of lighting energy reductions on HVAC system energy use. The resulting interaction factors are specific to both building type (e.g., office, warehouse) and heating/cooling systems.

4.3.4 Annual Operating Hours

Measure-level annual operating hours were determined from a detailed interview with the SBES customer. Hours used per day or week were rolled up to annual hours of use and corrected for holidays, seasonal variations in use, and any other change in operating characteristics. For logged sites, the team extrapolated the time of use logger data to develop annual hours of operation.

4.3.5 Coincidence Factor (CF)

Coincidence factors represent the portion of installed lighting that is operational during the utility peak performance hours. These were determined similarly to HVAC interactive effects by using deemed values by building type in addition to data collected on-site. For example, light-emitting diode (LED) exit signs that are on all day receive a CF on 1.0, while exterior lights on daylight sensors receive a CF of 0.0. For logged sites, the team extrapolated the time of use logger data to develop coincidence factors.

4.3.6 Unit Savings

For refrigeration measures, the engineering analysis follows a deemed savings methodology based on the NY Technical Reference Manual (TRM) unit savings. The assumptions and parameters used to estimate reported energy savings and peak demand reductions were deemed appropriate by the evaluation team. The team verified that the measures were installed and operational during on-site visits to projects that installed efficient refrigeration equipment.

4.4 Key Impact Findings

The energy realization rates by strata are shown in Table 4-5. This shows the verification realization rate, the metering realization rate, and the final realization rate by strata. Note that strata-level realization rates are derived from both DEP and DEC projects, and are applied to each jurisdiction separately to calculate program level verified energy savings and peak demand reductions.

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Table 4-5. Energy Impacts by Strata

Strata	Verification Realization Rate (kWh)	Metering Realization Rate Adjustment (kWh)	Total Realization Rate (kWh)
Lighting Large	0.94	1.12	1.06
Lighting Medium	1.09	1.03	1.12
Lighting Small	1.20	1.00	1.20
Refrigeration	1.05	n/a	1.05
Total	1.08	1.04	1.12

Source: Navigant analysis

The summer and winter peak demand reductions are shown in Table 4-6 and Table 4-7. Contrary to the energy adjustments based on metering, there is a more substantial reduction in the realization due to application of measure-specific coincidence factors based on logger data for both the summer and winter periods. A winter coincidence factor was calculated based on the logged data, with the summer coincidence factors used as the basis for statistical comparison given the lack of more appropriate parameters.

Table 4-6. Summer Peak Demand Impacts by Strata

Strata	Verification Realization Rate (kW)	Metering Realization Rate Adjustment (kW)	Total Realization Rate (kW)
Lighting Large	1.09	1.01	1.11
Lighting Medium	1.04	0.93	0.96
Lighting Small	1.27	0.72	0.91
Refrigeration	0.58	n/a	0.58
Total	1.10	0.87	0.96

Source: Navigant analysis

Table 4-7. Winter Peak Demand Impacts by Strata

Strata	Verification Realization Rate (Winter kW)	Metering Realization Rate Adjustment (Winter kW)	Total Realization Rate (Winter kW)
Lighting Large	0.83	0.70	0.58
Lighting Medium	0.77	0.72	0.56
Lighting Small	0.94	0.50	0.47
Refrigeration	0.47	n/a	0.47
Total	0.82	0.64	0.53

Source: Navigant analysis

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Overall, the verification realization rates are slightly above 1.0 for energy savings and summer peak demand reduction. This indicates that the program is accurately reporting impacts at the aggregate program level, despite varying realization rates for each individual stratum. The winter peak demand reductions were not characterized specifically by Duke Energy, so in turn Navigant compared verified winter savings with deemed reported summer savings.

4.5 Detailed Impact Findings

This section examines findings from the evaluation of lighting measures in order to identify the main drivers of the verified savings values. The evaluation team uses the Field Verification Rate (FVR) to describe the overall verified savings relative to the reported savings for each measure. FVRs reflect differences between the quantity of equipment installed on-site and the quantity reported in the tracking database, as well as differences between operating characteristics verified in the field and assumed operating characteristics in the program deemed savings estimates. The team calculates the field verification rate as the verified savings divided by the reported savings by measure, which is driven by a combination of the in-service rate, the hours of use adjustment rate, the lighting power adjustment rate, the HVAC interactive effect adjustment rate, and the coincidence factor, described as follows:

1. **In-Service Rate**[4] **(ISR)** is the ratio of the verified (i.e., installed) quantity to the reported quantity.
2. **Hours of Use (HOU) Adjustment Rate** reflects discrepancies between reported and verified operating hours.
3. **Lighting Power Adjustment Rate** is a ratio of the verified wattage difference between the efficient and baseline equipment to the reported wattage difference between the efficient and baseline equipment.
4. **HVAC Interactive Effect (IE) Adjustment Rate** is a multiplier that reflects HVAC interactive effects due to space heating and cooling loads due to a reduction in heat output from efficient lighting. Note that the IC did not deem HVAC IE for any measures so this adjustment is equal to the average HVAC IE itself. There are separate adjustments for energy savings and peak demand reduction.
5. **Coincidence Factor** represents the portion of installed lighting that is on during the peak utility hours. This affects only summer and winter peak demand reductions, not energy savings.

Figure 4-1 below shows the relative effect of each of the aforementioned adjustment rates on the measure-level FVR for energy savings, which the following subsections describe in further detail. Note that FVR cannot be used to derive program level realization rates. This is because the contributions of each parameter update are described relative to their reported value, while the program analysis was structured to stratify savings by participant energy savings per site rather than by individual measures.

[4] In-Service Rate is an industry-standard term that describes verified quantities of installed equipment relative to reported quantities.

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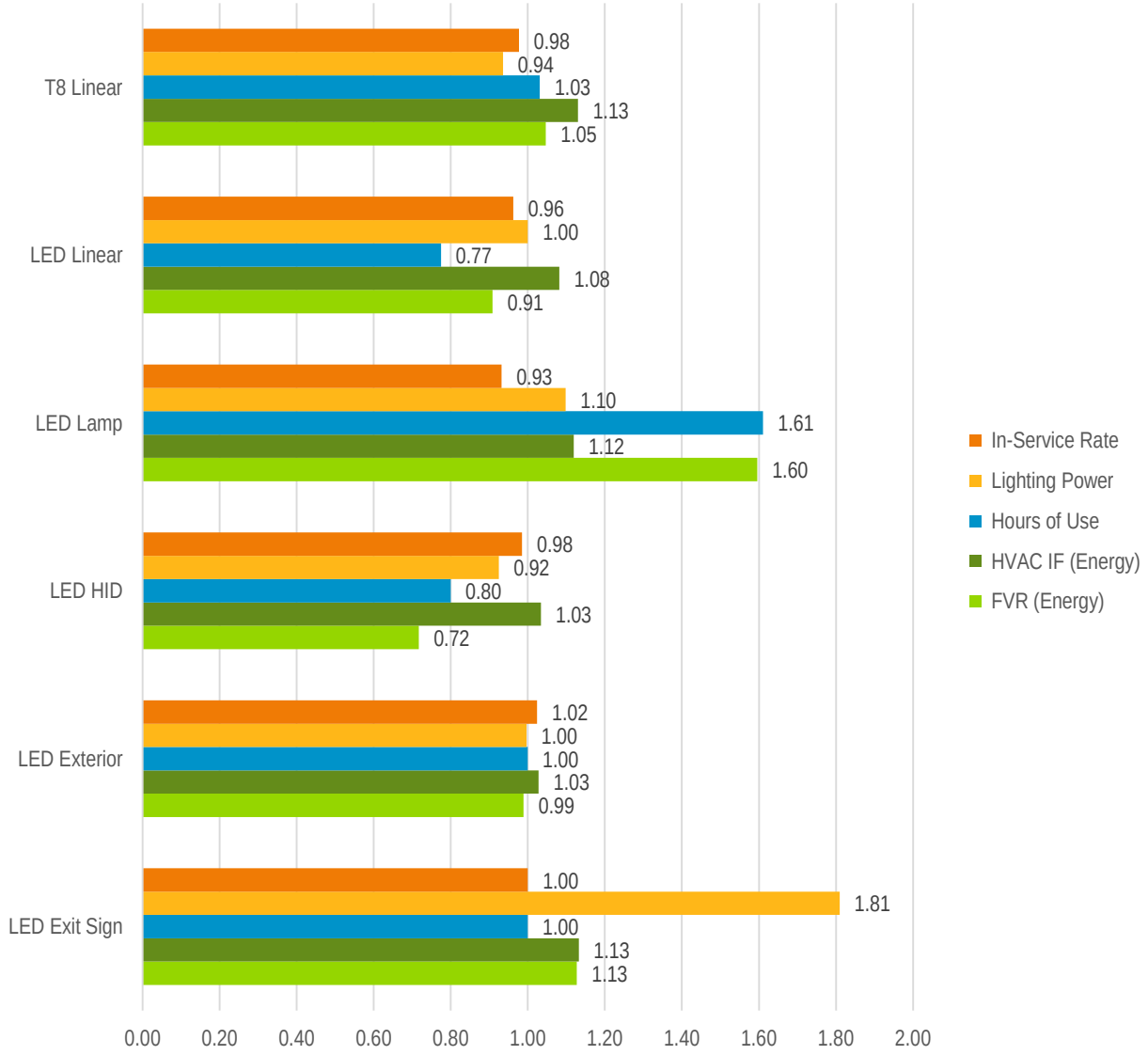
Figure 4-1. Gross Energy Savings Field Verification Rates



Source: Navigant analysis

Figure 4-2 below shows the relative effect of each of the aforementioned adjustment rates on the measure-level FVR for summer peak demand reductions, which the following subsections describe in further detail.

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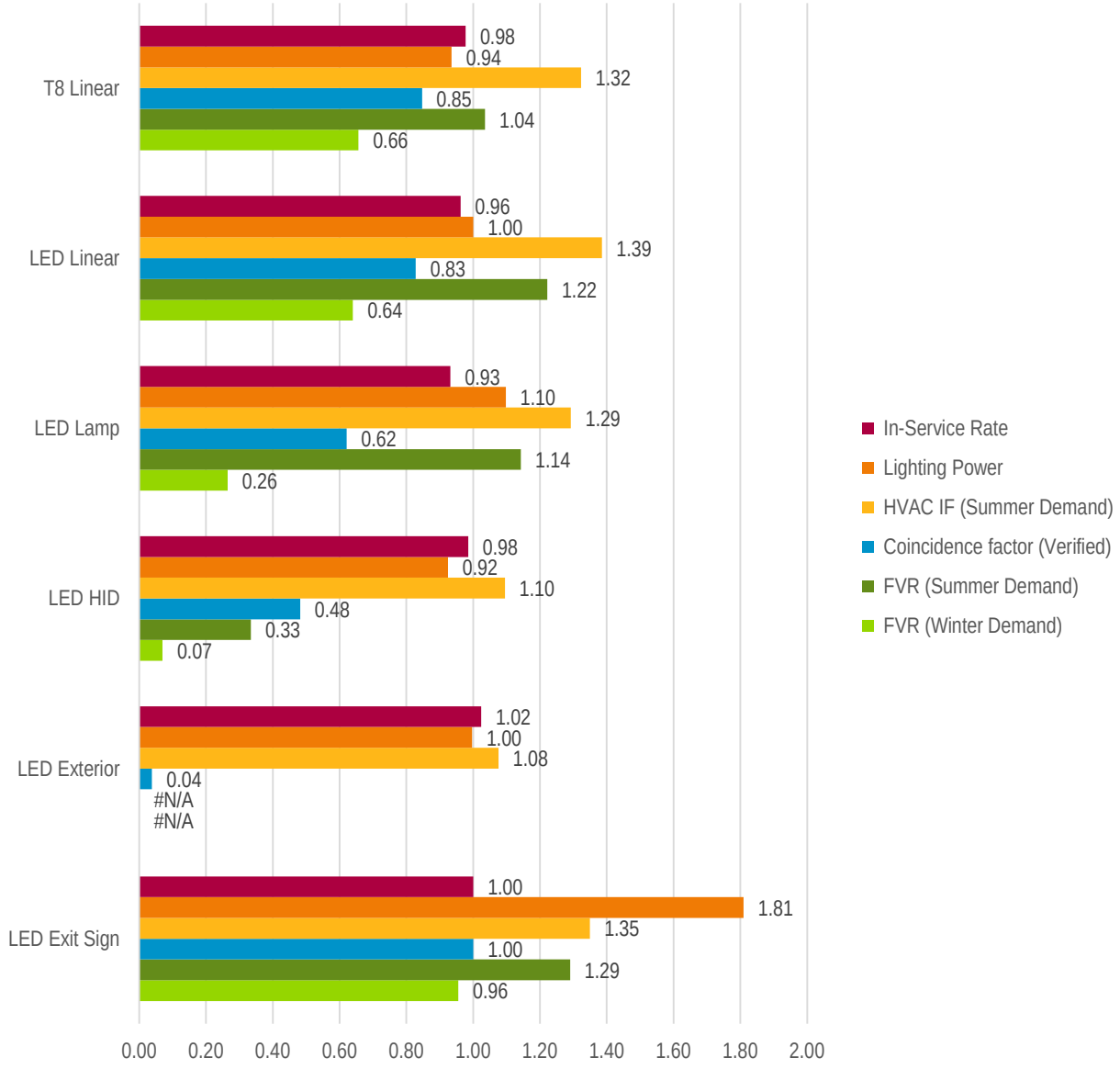
Figure 4-2. Gross Peak Demand Reductions Field Verification Rates



Source: Navigant analysis

The final adjustment to develop site-specific verified gross savings is the ratio of metered HOU and CF compared to estimated (or deemed) HOU and CF used for verification. The results of these adjustments, analogous to FVR, are shown in Figure 4-3 below. The metered data results in a downward adjustment for both HOU and CF, but this effect is more pronounced for CF due to the high rigor of the HOU estimates compared to the CF estimates in the tracking data.

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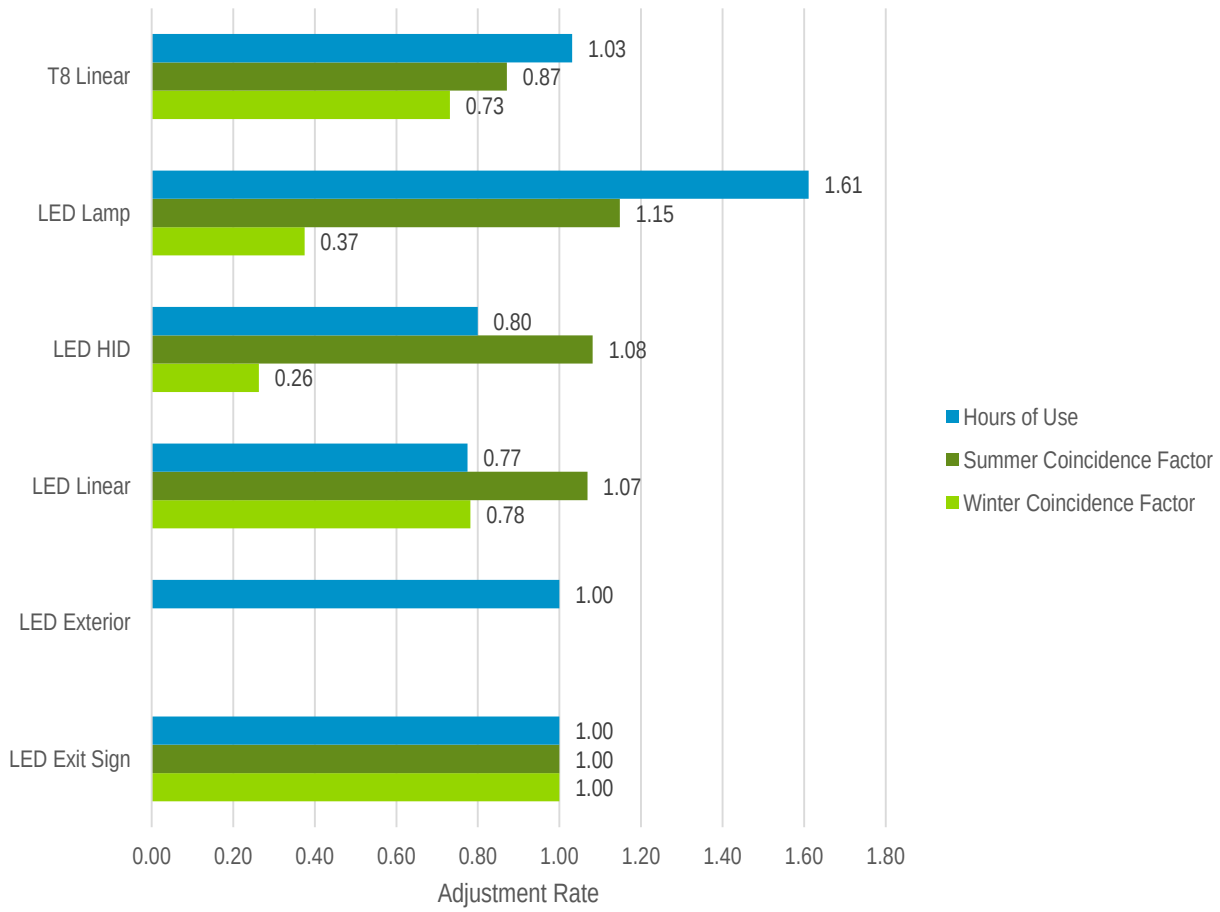
Figure 4-3. HOU and CF Adjustments from Metered Data



Source: Navigant analysis

The remainder of this section discusses in more detail the parameters that are part of the energy and peak demand savings algorithms: ISR, HOU, lighting power, HVAC interactive effects and coincidence factors.

4.5.1 In-Service Rates

One of the primary functions of evaluation, particularly for lighting measures, is to verify the quantity of the installed equipment relative to the reported quantity. The resulting ratio is the ISR. As shown in Figure 4-1 above, the ISR for each measure varies from 0.93 for LED screw-in lamps and 1.02 for LED exterior fixtures.

4.5.2 Hours-of-Use Adjustments

HOU is another key parameter for estimating lighting energy savings. The evaluation team estimated this parameter through customer interviews for each unique lighting schedule, similar to the approach taken by the IC. During the on-site customer interviews, the team found that the hours of use that site technicians reported was very close to the HOU reported in the tracking database. The team notes that

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overall the IC is accurately characterizing hours of use based on both customer interviews and, the metered data.

4.5.3 Lighting Power

The evaluation team based the lighting power parameter on the actual power draw of the baseline and efficient equipment. The baseline equipment is assumed to be as-found lighting installed and in use at the time of the audit; however, because the baseline equipment was no longer present at the participant sites, the team could not verify the baseline power draw and defaulted to the IC-provided value.

The evaluation team verified the efficient equipment wattage from manufacturer specification sheets to provide a more accurate lighting power figure than the deemed values that the IC used. Overall lighting power level differences were minor across the measure categories, between 0.92 for LED HID replacements and 1.81 for LED Exit Signs. This is an improvement from PY2014 and contributes to a higher realization rate for PY2015. The high wattage adjustment resulted overall in a small increase in savings due to the relative contributions of this measure.

The evaluation team would like to note that newer linear LED systems can be configured in a variety of ways, including with or without an electronic ballast. The manufacturer specifications for these systems typically do not account for every installation scenario with different ballast brands, models, and configurations possible. The team did not perform power measurements as part of this evaluation, but encourages the IC team to ensure that the power consumption of these systems is accurately characterized as their contribution to total program savings grows.

4.5.4 HVAC Interactive Effects

The evaluation team applied HVAC interactive effects for both energy, summer and winter peak demand. The deemed values are based on the building type and the heating and cooling system types as verified in the field for the sample sites. However, the IC did not apply HVAC IE for any of the lighting measures claimed in PY2015, as in previous evaluations. This adjustment is between 1.03 and 1.13 for energy and 1.08 and 1.39 for summer peak demand. Deemed values are described in Section 9 below for energy and summer peak demand; winter peak demand interactive effects were assumed to be 1.0 for all measures.

4.5.5 Coincidence Factors

Similar to the HVAC interactive effects, the team applied coincidence factors consistent with the deemed values used in the EEB Program. This factor takes into account that not all lights are on for the duration of the peak demand period. Coincidence factors range from 0.42 to 0.99, based on building type. The IC applied a coincidence factor of 1.0 for all lighting measures with the exception of occupancy sensors. Deemed values are shown in Section 8 below. The metered data further validates the deemed coincidence factors, but a sufficient sample size was not developed to determine new deemed coincidence factors at this time.

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5. NET-TO-GROSS ANALYSIS

The impact analysis described in the preceding sections addresses *gross program savings*, based on program records, modified by an engineering review, field verification, and metering of measure installations. *Net savings* incorporate the influence of free ridership (savings that would have occurred even in the absence of the program) and spillover (additional savings influenced by the program but not captured in program records) and are commonly expressed as a NTG ratio applied to the verified gross savings values.

Table 5-1 shows the results of Navigant's NTG analysis. Navigant anticipated low free ridership and spillover based on previous findings from the PY2013 and PY2014 SBES evaluations. The estimated free-ridership shown for PY2015 is similar to the findings from the previous evaluations, while estimated spillover is slightly higher.

Table 5-1. Net-to-Gross Results

	PY2013 (DEP)	PY2014 (DEP)	PY2015 (DEP & DEC)
Estimated Free Ridership	0.04	0.04	0.05
Estimated Spillover	0.02	0.07	0.09
Estimated NTG	0.98	1.03	1.04

Source: Navigant analysis

The results are consistent with the program theory and delivery model, whereby the Implementation Contractor (IC) actively recruits participants and presents a suite of energy efficiency measures to potential customers. Customers are not eligible to retroactively claim incentives under this program, which reduces the potential for free ridership significantly.

This report provides definitions, methods, and further detail on the analysis and findings of the net savings assessment. The discussion is divided into the following three sections:

- Defining free ridership, spillover, and net-to-gross (NTG) ratio
- Methods for estimating free ridership and spillover
- Results for free ridership, spillover, and NTG ratio

5.1 Defining Free Ridership, Spillover, and Net-to-Gross Ratio

The methodology for assessing the energy savings attributable to a program is based on a NTG ratio. The NTG ratio has two main components: free ridership and spillover.

Free ridership is the share of the gross savings that is due to actions participants would have taken even in the absence of the program (i.e., actions that the program did not induce). This is meant to account for naturally occurring adoption of energy efficient technology. The SBES Program covers a range of energy efficient lighting and refrigeration measures and is designed to move the overall market for energy efficiency forward. However, it is likely that some participants would have wanted to install, for various reasons, some high efficiency equipment (possibly a subset of those installed under the SBES Program), even if they had not participated in the program or been influenced by the program in any way.

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Spillover captures program savings that go beyond the measures installed through the program. Also called "market effects," the term "spillover" is often used because it reflects savings that extend beyond the bounds of the program records. Spillover adds to a program's measured savings by incorporating indirect (i.e., non-incentivized) savings and effects that the program has had on the market above and beyond the directly incentivized or directly induced program measures.

Total spillover is a combination of non-reported actions to be taken at the project site itself (*within-facility spillover*) and at other sites (*outside-facility spillover*). Each type of spillover is meant to capture a different aspect of the energy savings caused by the program, but not included in program records.

The **overall NTG ratio** accounts for both the net savings at participating projects and spillover savings that result from the program but are not included in the program's accounting of energy savings. When the NTG ratio is multiplied by the estimated gross program savings, the result is an estimate of energy savings that are attributable to the program (i.e., savings that would not have occurred without the program).

The basic equation is shown in Equation 1.

Equation 1. Net-to-Gross Ratio

$$NTG = 1 - Free\ Ridership + Spillover$$

The underlying concept inherent in the application of the NTG formula is that *only* savings caused by the program should be included in the final net program savings estimate but that this estimate should include *all* savings caused by the program.

5.2 Methods for Estimating Free Ridership and Spillover

5.2.1 Estimating Free Ridership

Data to assess free ridership were gathered through the self-report method—a series of survey questions asked of SBES participants. Free ridership was asked in both direct questions, which aimed at obtaining respondent estimates of the appropriate free ridership rate that should be applied to them, and in supporting or influencing questions, which could be used to verify whether the direct responses are consistent with participants' views of the program's influence.

Respondents were asked three categories of program-influence questions:

- **Likelihood:** to estimate the likelihood that they would have incorporated lighting measures "of the same high level of efficiency," if not for the assistance of the SBES Program. In cases where respondents indicated that they might have incorporated some, but not all, of the measures, they were asked to estimate the share of measures that would have been incorporated anyway at high efficiency. This flexibility in how respondents could conceptualize and convey their views on free ridership allowed respondents to give their most informed response, thus improving the accuracy of the free-ridership estimates.
- **Prior planning:** to further estimate the probability that a participant would have implemented the measures without the program. Participants were asked the extent to which they had considered installing the same level of energy-efficient lighting prior to participating in the program. The general approach holds that if customers were not definitively planning to install all of the

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efficiency lighting prior to participation, then the program can reasonably be credited with at least a portion of the energy savings resulting from the high-efficiency lighting. Strong free ridership is reflected by those participants who indicated they had already allocated funds for the purchase and selected the lighting and an installer.

- **Program importance:** to clarify the role that program components (e.g., information, incentives) played in decision-making, and to provide supporting information on free ridership. Responses to these questions were analyzed for each respondent, not just in aggregate, and were used to identify whether the direct responses on free ridership were consistent with how each respondent rated the "influence" of the program.

Free-ridership scores were calculated for each of these categories[5] and then averaged and divided by 100 to convert the scores into a free-ridership percentage. Next, a timing multiplier was applied to the average of the three scores to reflect the fact that respondents indicating that their energy efficiency actions would not have occurred until far into the future may be overestimating their level of free ridership. Participants were asked, without the program, when they would have installed the equipment. Respondents who indicated that they would not have installed the lighting for at least two years were not considered free riders and had a timing multiplier of 0. If they would have installed at the same time as they did, they had a timing multiplier of 1; within one year, 0.67; and between one and two years, 0.33. Participants were also asked when they learned about the financial incentive; if they learned about it after the equipment was installed, then they had a free ridership ratio of 1.

5.2.2 Estimating Spillover

The basic method for assessing participant spillover (both within-facility and outside-facility) was an approach that asked a set of questions to determine the following:

- **Whether spillover exists at all.** These were yes/no questions that asked, for example, whether the respondent incorporated energy efficiency measures or designs that were not recorded in program records. Questions related to extra measures installed at the project site (within-facility spillover) and to measures installed in non-program projects (outside-facility spillover) within the service territory.
- **The share of those savings that could be attributed to the influence of the program.** Participants were asked if they could estimate the energy savings from these additional extra

[5] Scores were calculated by the following formulas:

» Likelihood: The likelihood score is 0 for those that "definitely would NOT have installed the same energy efficient measure" and 1 for those that "definitely WOULD have installed the same energy efficient measure." For those that "MAY HAVE installed the same energy efficient measure," the likelihood score is their answer to the following question: "On a scale of 0 to 10 where 0 is DEFINITELY WOULD NOT have installed and 10 is DEFINITELY WOULD have installed the same energy efficient measure, can you tell me the likelihood that you would have installed the same energy efficient measure?" If more than one measure was installed in the project, then this score was also multiplied by the respondent's answer to what share they would have done.

» Prior planning: If participants stated they had considered installing the measure prior to program participation, then the prior planning score is the average of their answers to the following two questions: "On a scale of 0 to 10, where 0 means you 'Had not yet planned for equipment and installation' and 10 means you 'Had identified and selected specific equipment and the contractor to install it', please tell me how far along your plans were" and "On a scale of 0 to 10, where 0 means 'Had not yet budgeted or considered payment' and 10 means 'Already had sufficient funds budgeted and approved for purchase', please tell me how far along your budget had been planned and approved."

» Program importance: This score was calculated by taking the maximum importance on a 0 to 10 scale of the four program importance questions and subtracting from 10 (i.e., the higher the program importance, the lower the influence on free ridership).

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measures to be less than, similar to, or more than the energy savings from the SBES program equipment.

- **Program importance.** Estimates were derived from a question asking the program importance, on a 0 to 10 scale. Participants were also asked how the program influenced their decisions to incorporate additional energy efficiency measures.

If respondents said no, they did not install additional measures; they had a zero score for spillover. If they said yes, then the individual's spillover was estimated as the self-reported savings as a share of project savings, multiplied by the program-influence score. Then, a 50 percent discount was applied to reflect uncertainty in the self-reported savings and divided by 10 to convert the score to a spillover percentage.

5.2.3 Combining Results across Respondents

The evaluation team determined free ridership and spillover estimates for each of the following:

- Individual respondents, by evaluating the responses to the relevant questions and applying the rules-based approach discussed above
- Measure categories:
  - For free ridership: by taking the average of each respondent's score within each category
  - For spillover: by taking the sum of the individual spillover results for each measure category and weighting each category by the population
- The program as a whole, by combining measure-level results
  - For free ridership: measure category results were subsequently weighted by each category's share of total savings
  - For spillover: measure category results were summed and then weighted by the sum of the reported savings for the sample (which were also weighted by the population)

5.3 Results for Free Ridership, Spillover, and Net-to-Gross

This section presents the results of the attribution analysis for the SBES Program. Specifically, results are presented for free ridership and spillover (within-facility and outside-facility), which are used collectively to calculate an NTG ratio.

5.3.1 Review of Data Collection Efforts for Attribution Analysis

The EM&V team conducted 151 surveys with SBES participants to estimate free ridership, spillover, and NTG ratios. Table 5-2 shows the number of completions, by measure group.

Table 5-2. Attribution Survey Completes by Project Type

Measure Category	DEP Surverys	DEC Surveys	Total Surveys
Lighting	45	91	136
Refrigeration	7	8	15
Total	52	99	151

Source: Navigant analysis

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5.3.2 Free-Ridership Results

The evaluation team asked participants a series of questions regarding the likelihood, scope, and timing of the investments in energy-efficient lighting if the respondent had not participated in the program. The purpose of the surveys was to elicit explicit estimates of free ridership and perspectives on the influence of the program. The evaluation team estimates free-ridership for the SBES Program at 5 percent of program-reported savings.

5.3.3 Spillover Results

The SBES Program influenced approximately 15 percent of participants to install additional energy efficiency measures on-site (up from 9 percent in PY2014) and influenced 12 percent of participants (up from 6 percent in PY2014) to install additional measures at other locations. Based on the survey findings, the evaluation team estimates the overall program spillover to be 9 percent of program-reported savings. Participants reported a variety of spillover measures installed, including AC units, additional lighting, and appliances.

5.3.4 Net-to-Gross Ratio

As stated above, the NTG ratio is defined as follows in Equation 2 below.

Equation 2. Net-to-Gross Ratio

$$NTG = 1 - \text{free ridership} + \text{spillover}$$

Using the overall free ridership value of 4 percent and the overall spillover value of 9 percent, the NTG ratio is 1 – 0.05 + 0.09 = 1.04. The estimated NTG ratio of 1.04 implies that for every 100 megawatt-hours (MWh) of realized savings recorded in SBES records, 104 MWh is attributable to the program.

Table 5-3. SBES Free Ridership, Spillover, and NTG Ratio

	Free Ridership	Spillover	NTG Ratio
SBES Program Total	0.05	0.09	1.04

Source: Navigant analysis

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6. SUMMARY FORM

Program Name

Completed EMV Fact Sheet

Description of program

Duke Energy's Small Business Energy Saver Program provides energy efficient equipment to eligible small business customer at up to an 80 percent discount. The program is delivered through an implementation contractor that coordinates all aspects of the program, from the initial audit, ordering equipment, coordinating installation, and invoicing.

The program consists of lighting and refrigeration measures.

- **Lighting measures:** LED lamps and fixtures, T8 fluorescent fixtures, occupancy sensors.
- **Refrigeration measures:** LED case lighting, EC motor upgrades, compressor and fan motor controls.

Date	July 15, 2016
Region(s)	Duke Energy Progress; Duke Energy Carolinas
Evaluation Period	DEP 1/1/15 – 2/29/16 DEC 8/1/14 – 2/29/16
Annual kWh Savings	DEP 56,490,635 kWh DEC 90,374,674 kWh
Per Participant kWh Savings	DEP 27,247 DEC 25,087
Coincident kW Impact	DEP 11,650 DEC 20,603
Net-to-Gross Ratio	1.04
Process Evaluation	Annual
Previous Evaluation(s)	2013 and 2014 (DEP)

Evaluation Methodology

The evaluation team used engineering analysis, onsite field inspections, and time-of-use metering as the primary basis for estimating program impacts. Additionally, telephone surveys were conducted with participants to assess customer satisfaction and determine a net-to-gross ratio. Interviews were conducted with program and implementation team staff to understand program operational changes and enhancements.

Impact Evaluation Details

- **Onsite visits were conducted at 57 participant sites, while 19 of those sites were logged.** The evaluation team inspected program equipment to assess measure quantities and characteristics to compare with the program tracking database, and installed lighting loggers to verify hours of use and coincidence factors.
- **In-Service rates (ISRs) varied by equipment type.** The evaluation team found ISRs ranging from 0.93 for LED screw-in lamps to 1.02 for exterior LED fixtures.
- **Participants achieved an average of 27,247 kWh of energy savings per year in DEP, and 25,087 kWh in DEC.** The program is accurately characterizing energy and demand impacts.

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7. PROCESS EVALUATION

The purpose of the process evaluation is to understand, document and provide feedback on the program implementation components and customer experience for the Small Business Energy Saver (SBES) Program in the DEP and DEC jurisdictions.

The feedback received indicates that **the SBES Program is a successful, mature program for PY2015, but could benefit from continuous improvements** as in previous years. Customer satisfaction with the implementer and contractor are very high, but there are instances where the installation contractor was responsible for a negative customer experience.

7.1 Process Methodology

The evaluation team conducted in-depth interviews with SBES Program staff, IC staff, and customer participant surveys, as noted previously. In addition, the team gathered information from interactions with participants during the site verification visits. The interviews with program and IC staff focused on program changes for PY2015 and included a review of program processes to provide the evaluation team with an understanding of the program's operations, nuances and qualitative and quantitative questions on customer satisfaction, participation, marketing, and outreach.

The process findings summarized in this document are based on the results of:

- Participant surveys with 151 program participants;
- Onsite visits at 57 program participant sites;
- Interviews with the Duke Energy Program Manager and the Implementation Contractor (IC) staff; and
- A review of the program documentation.

7.2 Sampling Plan and Achievements

The participant survey targeted a random sample of all PY2015 program participants broken out by measure family. The two measure families are lighting and refrigeration. Navigant weighed customer responses by their stratum savings for net-to-gross findings as described in the preceding section.

The survey effort targeted 150 participants and successfully completed surveys with 151 customers, of which 136 were participants that only installed lighting measures and 15 were participants that installed some refrigeration measures. The survey targets were loosely designed to achieve 90/10 confidence and precision, with significant oversampling due to the relatively inexpensive per-survey cost.

7.3 Program Review

The evaluation team designed the program review task to understand changes and updates to the program design, implementation and energy and demand savings assumptions. The key program characteristics include the following:

- **Program Design** – The SBES program is designed to offer high incentives (up to 80 percent of the total cost of the project) on efficient equipment to reduce energy use and peak demand. It specifically targets small business customers that are difficult to reach and often do not pursue

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energy efficiency on their own. In PY2015 the program rolled out new marketing materials centered around case studies for various types of small business customers.

- **Program Implementation** – A third-party contractor administers the SBES program on Duke Energy's behalf. The IC handles all aspects of the program, including customer recruitment, facility assessments, equipment installation (through independent installers contracted by the IC), and payment and incentive processing. The IC reports energy and peak demand reduction estimates to Duke Energy. The IC has continued to refine their processes to ensure that savings estimates are reasonable, customer complaints are handled in a timely manner.
- **Incentive Model** – The IC offers potential participants a recommended package of energy efficiency measures along with equipment pricing and installation costs. The incentive is proportional to estimated energy savings and can be as high as 80 percent of the total cost of the project.
- **Savings Estimates** – Energy and peak demand savings are estimated on a per-fixture basis, taking into account existing equipment, proposed equipment, and operational characteristics unique to each customer.

7.4 Key Process Findings

The following sections detail the process findings from all relevant sources of program information, including interviews with Duke Energy and IC staff, interactions with customers during verification site visits, and the results of the customer surveys, organized by topic. This discussion addresses 1) marketing and outreach; 2) customer experience; 3) implementation contractor; 4) installation contractor; 5) program incentives; 6) lighting equipment; and 7) participant suggested improvements.

The feedback received indicates that the SBES Program continues to be a successful program in PY2015, has expanded into the DEC jurisdiction effectively, and is a mature program in Duke Energy portfolio. The Duke Energy program management team and the IC staff and management have made several improvements to the program in PY2015, especially concerning installation contractor training, automated checks in the auditing tool, marketing, and new LED measures. Key findings are as follows:

- The primary channel through which customers hear about the program is Duke Energy (38 percent), followed by the implementation contractor (28 percent).
- Participants listed energy savings, reduced energy bills, and better quality equipment as the primary reasons for participating in the SBES Program.
- A majority of SBES participants were satisfied with the program. On a scale of 0 to 10, where 0 indicates "not satisfied at all" and 10 indicates "extremely satisfied":
    - 87 percent of participants indicated 8-10 for satisfaction with overall program experience.
    - 87 percent of participants indicated 8-10 for satisfaction with the contractor's quality of work.
    - 91 percent of participants indicated 8-10 for satisfaction with their new equipment.
- Eighty-nine percent of participants stated that equipment offered through the program allowed them to upgrade all of the equipment they wanted at the time.
- Eighty-seven percent of participants said they plan to participate in other Duke Energy programs in the future.

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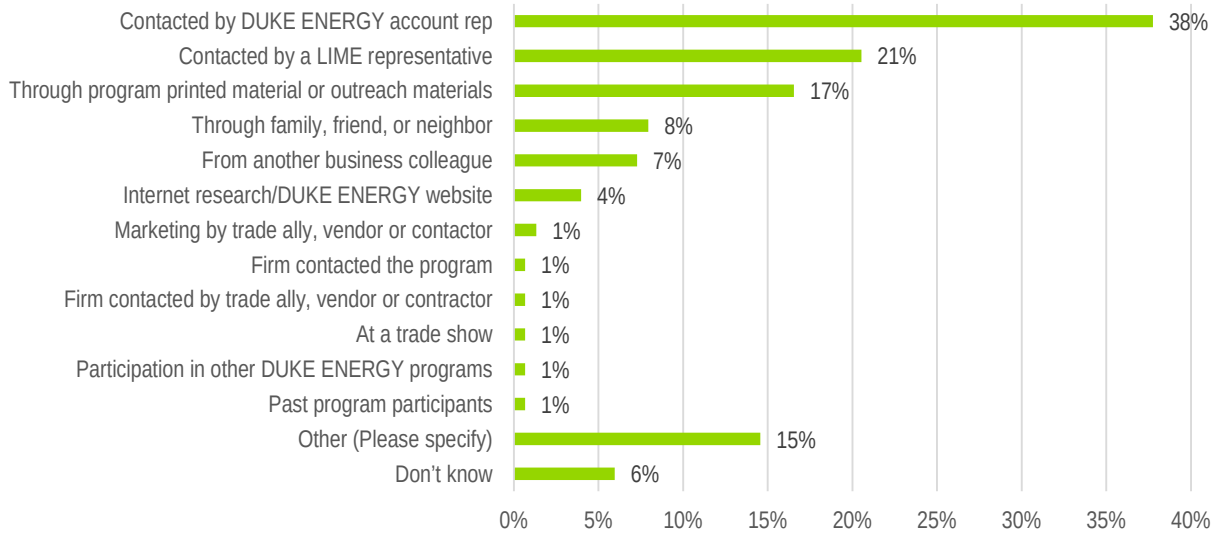
The following sections detail the process findings and addresses the following topics:

1. Marketing and outreach;
2. Customer experience;
3. Implementation contractor;
4. Installation contractor;
5. Measure incentives;
6. Upgraded equipment; and
7. Suggested improvements.

7.4.1 Marketing and Outreach

Duke Energy markets the program to eligible customers primarily through direct contact that Duke Energy and the IC initiate. Participants were asked to indicate all the sources through which they learned about the program. Over half of the participants indicated that they learned about the program directly from the IC staff (either through direct contact or outreach materials), and an additional quarter indicated they had learned about the program through Duke Energy themselves. Figure 7-1 shows the range of ways in which customers found out about the program. Significantly more customers reported that they learned about the program through Duke Energy directly (38 percent in PY2015 compared to 26 percent in PY2014)

Figure 7-1. How Program Participants First Learned About the SBES Program (n = 151)



Source: Navigant analysis

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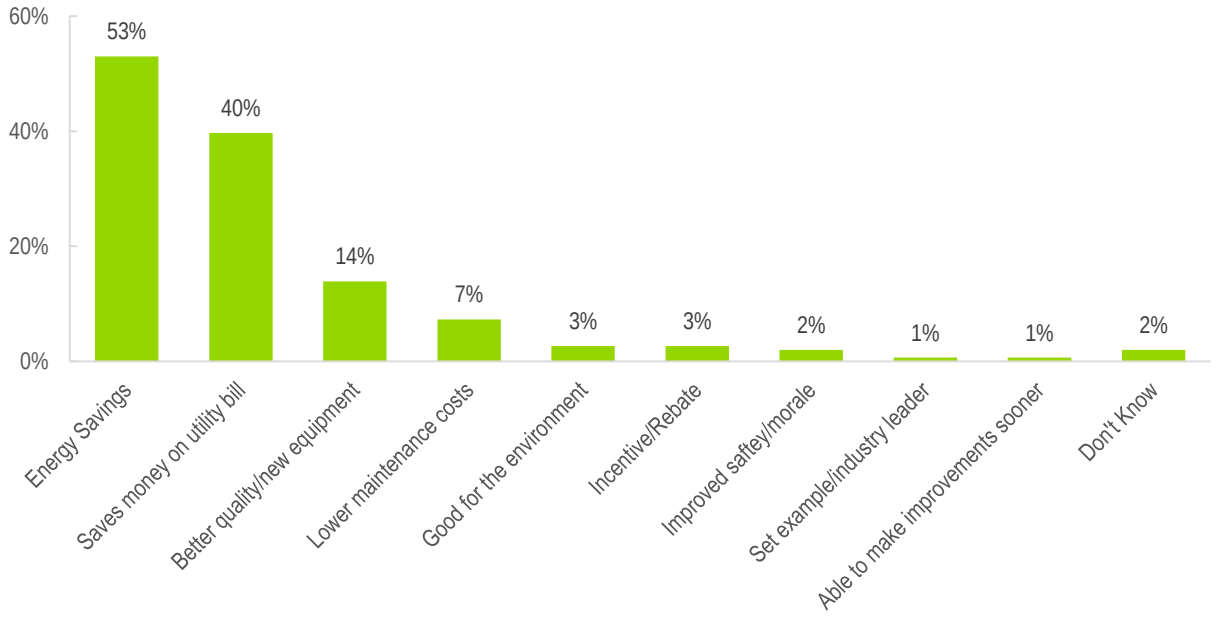
When asked about the main benefits of participating in the program, over 50 percent of survey respondents cited energy savings as a reason they decided to participate in the program (see Figure 7-2 below). Beyond energy savings and, in turn, utility bill savings, participants cited higher-quality equipment, and the lower maintenance costs associated with new equipment as reasons to participate in the program. Coordinated efforts to market all of the benefits of program participation are key to enhancing participation across the variety of small business customer that Duke Energy serves.

Figure 7-2. Primary Reasons for Deciding to Participate in the Program[6] (n = 151)



Source: Navigant analysis

[6]Totals exceed 100% because respondents could offer more than one answer.

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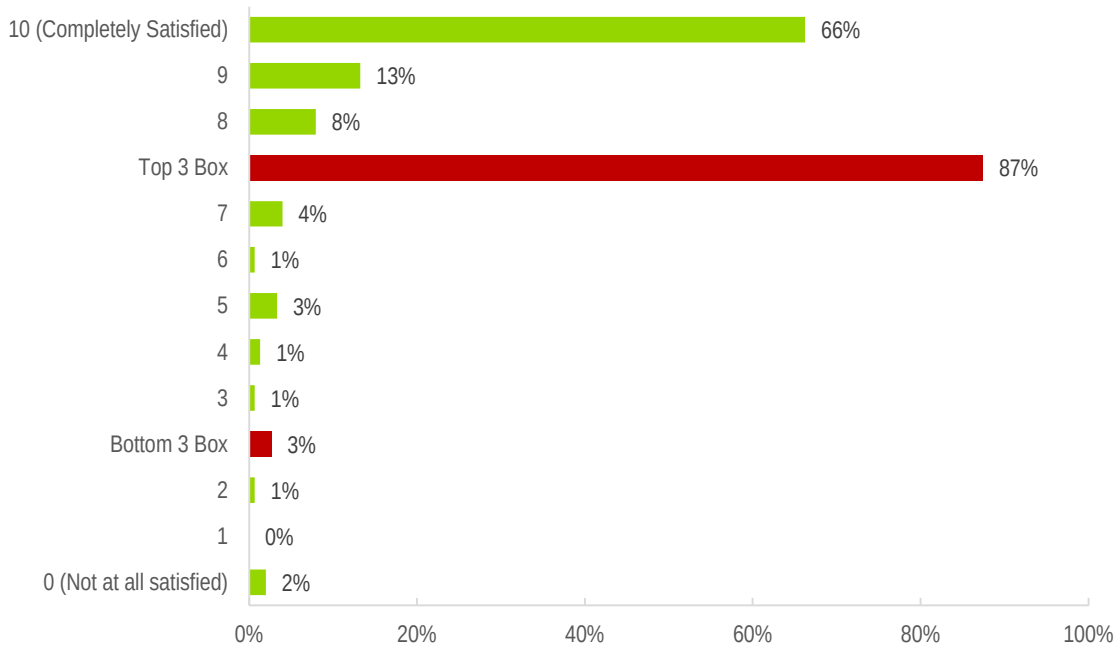
7.4.2 Customer Experience

Customers reported very high satisfaction with their overall program experience in PY2015 through both the participant survey and informal polling conducted on-site during verification visits. On a scale of 0 to 10, where 0 is “not satisfied at all” and 10 is “extremely satisfied”, 87 percent of participants scored their overall experience with the program as an 8, 9, or 10, with 66 percent responding that their experience was a 10 (see Figure 7-3). Participants who assigned low scores to their overall experience did so because typically they did not perceive monetary savings on their bill. One customer reported that they thought their new lights were already outdated, and another was not happy with the installation. Overall satisfaction remains similar to PY2014 levels.

Figure 7-3: Customer Satisfaction with Overall Program (n=151)



Source: Navigant analysis

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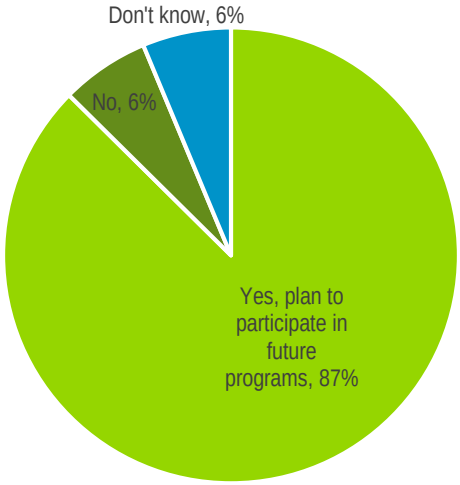
Eighty-seven percent of participants said they plan to participate in other Duke Energy programs in the future (see Figure 7-4), compared to 83 percent in PY2014. This indicates increased satisfaction as well, and a continued opportunity to market the program to previous participants as a wider range of measures become available and cost-effective.

Figure 7-4. Participants Who Plan to Participate in Other Duke Energy Programs in the Future (n = 151)



Source: Navigant analysis

7.4.3 Implementation Contractor

Customer survey results indicate that the IC plays a critical role in all program processes in line with the program design, including program marketing, outreach, recruiting, auditing, billing and customer service, and providing detailed tracking data to Duke Energy.

Navigant found that the measure installation tracking data is thorough, accurate, and detailed. This enabled the field verification team to locate specific measure installations quickly. The IC conducted consistent and thorough audits for most completed projects and generally covered all of the lighting fixtures in a facility that were not already energy efficient. The auditor's intentions were clear in the tracking data and demonstrated an understanding of the lighting that would best serve the customer's needs while providing substantial energy savings. Navigant found some discrepancies between the final work as recorded by the implementation contractor in the database and what was found onsite (such as some fixtures that were not retrofitted), but overall the accuracy was found to be very high.

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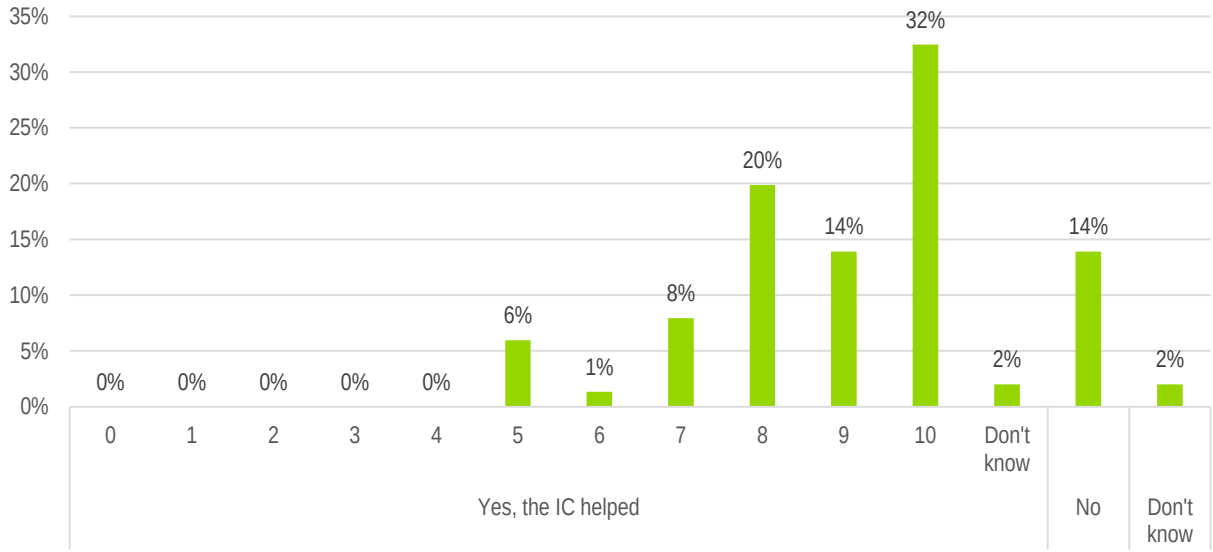
The IC helped 81 percent of SBES Program participants with their choice of lighting, and 66 percent stated that a recommendation from the IC was important (score of 8-10) in their decision to install the energy-efficient equipment (see Figure 7-5). Results are similar to PY2014.

Figure 7-5. Participants Whom the IC Helped in Their Equipment Decision (n = 151)



Source: Navigant analysis

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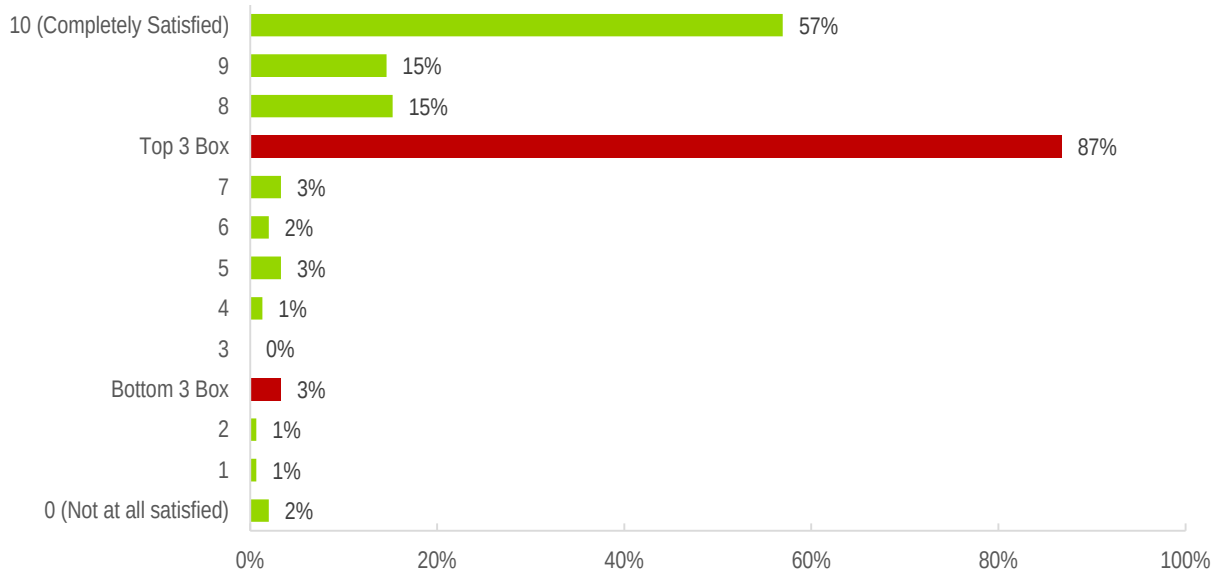
7.4.4 Installation Contractors

Customer satisfaction with contractor quality of work is high, and has improved slightly from PY2014 as well. Figure 7-6 shows that 87 percent of survey respondents ranked their satisfaction with contractor work as an 8, 9, or 10, compared to 84 percent in PY2014.

Figure 7-6: Customer Satisfaction with Contractor Quality of Work (n=151)



Source: Navigant analysis

A few customers indicated that they experienced installation issues that required follow-up visits, or that work took longer than expected. Other participants were impressed by the speed the installation contractors were able to get the work done. This indicates that the customer experience varies between installation contractors, but overwhelmingly participants are satisfied with this portion of the program.

7.4.5 Measure Incentives

The incentives offered through the SBES program appear to sufficiently motivate customers to upgrade to energy-efficient lighting and refrigeration. From discussions with decision makers on site, the incentive levels were appropriate. Several customers also expressed interest in efficient HVAC equipment, but this was not available to them at the time.

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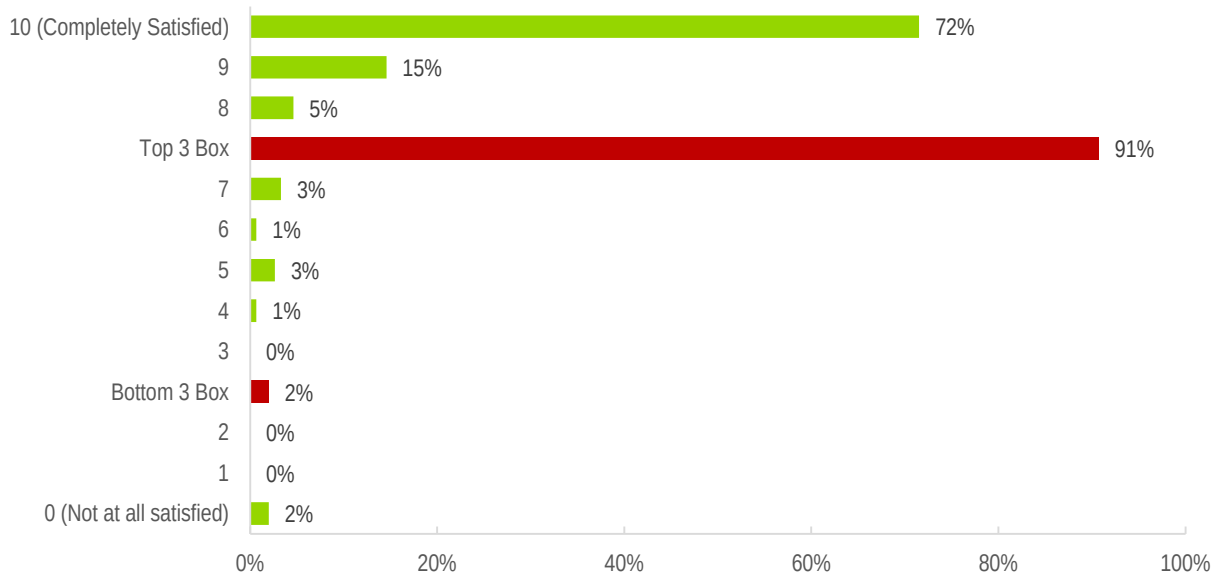
7.4.6 Upgraded Equipment

The majority of customers agreed that the new lighting measures were a significant improvement in light quality, and that the auditors were willing to work with customers to make sure that the new lighting fit their needs. Almost all participants (91 percent) indicated they were satisfied with their new equipment (see Figure 7-7), similar to previous findings. A higher percentage of customer reported a top satisfaction score of 10 in PY2015 at 72 percent, compared to 67 percent in PY2014.

Figure 7-7: Participant Satisfaction with New Equipment (n=151)



Source: Navigant analysis

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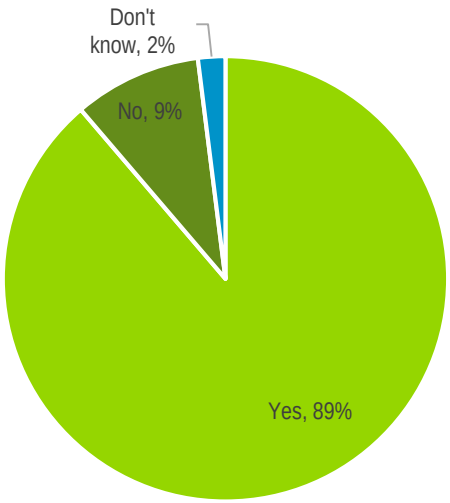
Another important survey finding was that 89 percent of participants stated that equipment offered through the program allowed them to upgrade all of the lighting equipment they wanted at the time of the project, rather than piecing together the upgrades in multiple phases (see Figure 7-8). This is an increase from 82 percent in PY2014, which indicates that auditors are getting better at capturing all possible measures at a site, or also that as LED prices have come down and savings have increased more lighting measures have become cost-effective.

Figure 7-8. Participants Who Stated that Equipment Offered Through the Program Allowed Them to Upgrade All of the Equipment They Wanted at the Time (n = 151)



Source: Navigant analysis

7.4.7 Suggested Improvements

Some customers reported difficulties they faced and provided suggested improvements in the survey's open-ended questions. The list below summarizes a few key points; responses that are more detailed will appear in the final SBES evaluation report.

Summary of Improvements Mentioned by Customers

- Higher incentives on eligible equipment;
- More equipment offerings, such as AC and motors;
- Greater publicity for the program and other Duke Energy offerings;
- More up-to-date equipment;
- Opportunity for savings for new construction

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8. CONCLUSIONS AND RECOMMENDATIONS

The evaluation team performed extensive on-site work, telephone surveys, and analysis to determine gross and net verified savings. Overall conclusions and recommendations appear in the following sections.

8.1 Conclusions

Overall, the SBES Program is a well performing, mature program in the DEP jurisdiction that has successfully expanded into the DEC jurisdiction. The key to continued success is working through quality and training issues as they arise.

- **Participants continue to be overwhelmingly satisfied with the SBES Program and Duke Energy**, including overall service, pricing, installation, and efficient equipment quality.
- **Duke Energy has successfully expanded into the DEC jurisdiction** in PY2015. The program had no apparent issues scaling up operations in the DEC service territory, and there are no meaningful differences in the EM&V team's findings between the two jurisdictions.
- **The program has increased average project savings substantially** compared to PY2014. This is driven by new LED measures that have higher per-unit savings, and targeting of larger customers that are able to generate more savings per site.
- The Duke Energy program management team and the IC have **demonstrated a commitment to quality** by quickly implementing program changes based on evaluation feedback provided in the PY2014 evaluation. Additionally, the IC team has created new branded marketing materials with case studies for a variety of small business facilities.
- The **installation of high–efficiency equipment continues to be the key selling point**. The SBES Program successfully added linear LED retrofit measures to the suite of program offerings for PY2015, replacing T8 fluorescent fixtures. LED measures have grown considerably as a share of total program savings, while refrigeration has remained stable from PY2014 at under 10 percent.
- The **energy savings realization rate is 1.11 for DEP and 1.12 for DEC,** and is driven by several EM&V adjustments that roughly balanced out. The key adjustments the EM&V team made were the in-service rates and HVAC interactive effects. The **peak demand realization rate is lower at 0.96 for DEP and DEC** and is driven by HVAC interactive effects and coincidence factors.
- The evaluation effort estimated **free ridership for the SBES Program at 5 percent and spillover at 9 percent**, which drives an **NTG ratio of 1.04**. This indicates that the SBES Program is successfully reaching customers that would have not completed energy efficiency upgrades in the absence of the program. Spillover has increased from PY2014 and indicates that the program is showcasing the benefits of energy efficiency.

8.2 Recommendations

The evaluation team recommends five actions for improving the SBES Program, based on insights gained through the comprehensive evaluation effort for PY2015. These recommendations provide Duke

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Energy with a roadmap to fine-tune the SBES Program for continued success and include the following broad objectives:

Increasing Program Participation

1. **Continue to emphasize non-energy benefits** of program participation, such as increased lighting quality, comfort for both business employees and customers, environmental benefits, and reduced maintenance. Now that the program has transitioned primarily to LED measures, increased education on the benefits that LED measures offer should enhance participation.

Increasing Customer Satisfaction

2. **Continue to prioritize customer satisfaction through installation contractor training and customer follow-up services.** The IC has improved in this area from PY2014, but a minority of customers are still reporting issues with installation and communication. Additionally, some customers are not perceiving savings on their electric bill, so managing this expectation would enhance customer satisfaction.
3. **Phase out fluorescent T8 lighting systems.** Linear LED lighting offers substantial savings above high-performance/reduced wattage T8 lamps and ballasts, which may be perceived as outdated.

Improving Accuracy of Reported Savings

4. **Add HVAC interactive effects and update coincidence factors for lighting measures**. This is the key impact finding to improve the accuracy of savings estimates. The IC should apply relevant HVAC interactive effects and coincidence factors to lighting measures as is appropriate, and ensure that outdoor lighting measures on daylight sensors do not accrue peak demand reductions during summer daylight hours.
5. **Ensure that efficient lighting power ratings for linear LED systems are accurate.** Navigant did not perform live metering of connected linear LED systems, but upon review of manufacturer specifications for lighting power there are different wattages that the system may draw depending on the specific configuration. As the share of savings attributed to linear LED systems grow, this should be quantified to reduce EM&V risk in future years.

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9. MEASURE-LEVEL INPUTS FOR DUKE ENERGY ANALYTICS

The SBES program estimates deemed savings on a per-fixture basis that takes into account specific operational characteristics. This approach differs from a more traditional prescriptive approach that applies deemed parameters by measure type and building type only.

For the lighting measures, the EM&V team applied HVAC interactive effects and coincident factors in the analysis that differed from those used by the IC; the values used are shown in Table 9-1 and Table 9-2. Note that for the PY2015 SBES evaluation the EM&V team applied the summer coincidence factors for both summer and winter peak demand reductions, with additional adjustments based on logger data for each of the corresponding peak periods, as in previous years.

Table 9-1. HVAC Interactive Effects[7]

Building Type	Cooling Type	Heating Type	Energy HVAC Interactive Effect	Demand HVAC Interactive Effect
Grocery	Electric	Electric Resistance	1	1.43
Grocery	Electric	Electric HP	1.08	1.43
Grocery	Electric	Not Electric	1.22	1.42
Grocery	No Cooling	Electric Resistance	0.77	1
Grocery	No Cooling	Electric HP	0.86	1
Grocery	No Cooling	Not Electric	1	1
Grocery	DK	DK	1.14	1.36
Lodging	Electric	Electric Resistance	1.11	1.18
Lodging	Electric	Electric HP	1.11	1.18
Lodging	Electric	Not Electric	1.11	1.18
Lodging	No Cooling	Electric Resistance	1.11	1.18
Lodging	No Cooling	Electric HP	1.11	1.18
Lodging	No Cooling	Not Electric	1.11	1.18
Lodging	DK	DK	1.14	1.36
Manufacturing	Electric	Electric Resistance	1.1	1.29
Manufacturing	Electric	Electric HP	1.1	1.29
Manufacturing	Electric	Not Electric	1.1	1.29
Manufacturing	No Cooling	Electric Resistance	1.1	1.29
Manufacturing	No Cooling	Electric HP	1.1	1.29
Manufacturing	No Cooling	Not Electric	1.1	1.29

[7] PY2013 DEP EEB EM&V Report

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Manufacturing	DK	DK	1.14	1.36
Medical	Electric	Electric Resistance	1.05	1.44
Medical	Electric	Electric HP	1.12	1.44
Medical	Electric	Not Electric	1.22	1.43
Medical	No Cooling	Electric Resistance	0.83	1
Medical	No Cooling	Electric HP	0.89	1
Medical	No Cooling	Not Electric	1	1
Medical	DK	DK	1.14	1.36
Office	Electric	Electric Resistance	1.05	1.44
Office	Electric	Electric HP	1.12	1.44
Office	Electric	Not Electric	1.22	1.43
Office	No Cooling	Electric Resistance	0.83	1
Office	No Cooling	Electric HP	0.89	1
Office	No Cooling	Not Electric	1	1
Office	DK	DK	1.14	1.36
Other	Electric	Electric Resistance	1.05	1.44
Other	Electric	Electric HP	1.12	1.44
Other	Electric	Not Electric	1.22	1.43
Other	No Cooling	Electric Resistance	0.83	1
Other	No Cooling	Electric HP	0.89	1
Other	No Cooling	Not Electric	1	1
Other	DK	DK	1.14	1.36
Restaurant	Electric	Electric Resistance	1	1.43
Restaurant	Electric	Electric HP	1.08	1.43
Restaurant	Electric	Not Electric	1.22	1.42
Restaurant	No Cooling	Electric Resistance	0.77	1
Restaurant	No Cooling	Electric HP	0.86	1
Restaurant	No Cooling	Not Electric	1	1
Restaurant	DK	DK	1.14	1.36
Retail	Electric	Electric Resistance	1	1.43
Retail	Electric	Electric HP	1.08	1.43
Retail	Electric	Not Electric	1.22	1.42
Retail	No Cooling	Electric Resistance	0.77	1
Retail	No Cooling	Electric HP	0.86	1
Retail	No Cooling	Not Electric	1	1
Retail	DK	DK	1.14	1.36

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School	Electric	Electric Resistance	1.05	1.44
School	Electric	Electric HP	1.12	1.44
School	Electric	Not Electric	1.22	1.43
School	No Cooling	Electric Resistance	0.83	1
School	No Cooling	Electric HP	0.89	1
School	No Cooling	Not Electric	1	1
School	DK	DK	1.14	1.36
Warehouse	Electric	Electric Resistance	1.1	1.29
Warehouse	Electric	Electric HP	1.1	1.29
Warehouse	Electric	Not Electric	1.1	1.29
Warehouse	No Cooling	Electric Resistance	1.1	1.29
Warehouse	No Cooling	Electric HP	1.1	1.29
Warehouse	No Cooling	Not Electric	1	1
Warehouse	DK	DK	1.14	1.36

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Table 9-2. Coincidence Factors[8]

Building Type	Summer Coincidence Factor
OFFICE	0.81
SCHOOL	0.42
COLLEGE/UNIVERSITY	0.68
RETAIL/SERVICE	0.88
RESTAURANT	0.68
HOTEL/MOTEL	0.67
MEDICAL	0.74
GROCERY	0.81
WAREHOUSE	0.84
LIGHT INDUSTRY	0.99
HEAVY INDUSTRY	0.99
AVERAGE/MISC	0.77
AGRICULTURAL	0.50

[8] PY2013 Savings Basis and Changes, December 10, 2013. EEB Program Documentation.

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10. APPENDICES

One additional spreadsheet document details project level findings, and is embedded below:

- PY2014 DEP SBES Impact Summary.xlsx

PY2015 DEP_DEC
SBES Impact Summa

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Duke Energy Progress, LLC

Industrial and Commerical Accounts that have Opted-Out (12-31-2016)

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Customer Name	DSM	EE	Grand Total
A V M INDUSTRIES,	5	5	10
ABB POWER DISTRIBUTION INC,	2	2	4
ACCURIDE EMI LLC,	2	2	4
ADP TAX CREDIT SRVC INC,	1	1	2
AGRIUM US INC,	2	2	4
AGRU AMERICA INC,	4	4	8
ALADDIN MANUFACTURING CORP,	7	7	14
AMERICAN LIGHT BULB MFG INC,	4	4	8
APEX TOOL GROUP LLC,	1	1	2
AQUA CITY BOTTLING, INC,	1	1	2
ASSURANT SPECIALTY PROPERTY,	2	2	4
AU'SOME LLC,	1	1	2
BARRINGTON MYRTLE BEACH LLC,	2	2	4
BECTON DICKINSON & CO,	5	5	10
BETHUNE NONWOVENS INC,	6	6	12
BI-LO LLC,	11	11	22
BISHOPVILLE TOWN OF,	4	4	8
BLUE CROSS/BLUE SHIELD OF SC,	4	4	8
BVP HOLDING LLC,	2	2	4
CALHOUN FARMS,	4	4	8
CAROLINA CANNERS INC,	7	7	14
CAROLINA FURNITURE WORKS INC,	3	3	6
CAROLINAS HOSPITAL SYSTEM,	8	8	16
CHARLES CRAFT INC,	2	2	4
CHARLES INGRAM LUMBER CO INC,	17	17	34
CHERAW TOWN OF,	1	1	2
CHESTERFIELD COUNTY SCHOOLS,	1		1
CHESTERFIELD GENERAL HOSPITAL,	12	12	24
CITI TRENDS INC,	1	1	2
CITY OF FLORENCE,	4	4	8
CLARENDON MEMORIAL HOSPITAL,	6	6	12
CLOVERLEAF COLD STORAGE CO,	3	3	6
COKER COLLEGE,	27	27	54
CONBRACO INDUSTRIES INC,	3	3	6
CONTINENTAL TIRE THE AMER LLC,	6	6	12
COVIDIEN LP,	1	1	2
CROWN CORK & SEAL USA INC,	7	7	14
DARLINGTON CO SCHOOL DIST,	2	2	4
DARLINGTON SHREDDING CO INC,	3	3	6
DAVID C POOLE COMPANY INC,	3	3	6
DEROYAL TEXTILES INC,	3	3	6
DILLON YARN CORPORATION,	6	6	12
DIXIE CONSUMER PRODUCTS LLC,	12	12	24
DIXIE PIPELINE COMPANY,	3	3	6
DOMTAR PAPER COMPANY LLC,	1	1	2

DSM NUTRITIONAL PRODUCTS LLC,	32	32	64
EATON CORPORATION,	2	2	4
ENERSYS DELAWARE INC,	5	5	10
ESAB GROUP,	1		1
EVANS READYMIX INC,	4	4	8
EVANS, REAMER	4	4	8
EZ PRODUCTS LLC,	1	1	2
FIRESTONE BUILDING PRODUCTS,	7	7	14
FLO DARL TECHNICAL COLLEGE,	16	16	32
FLOCO FOODS INC,	14	14	28
FLORENCE CITY COUNTY CIVIC CTR,	1		1
FLORENCE CO SCHOOL DIST #2,	1	1	2
FLORENCE COUNTY,	4	1	5
FLORENCE POLE, INC,	6	6	12
FLORENCE SCHOOL DISTRICT 1,	11	11	22
FOOD LION LLC,	18	19	37
FORMED FIBER TECHNOLOGIES INC,	6	6	12
FRANCIS MARION UNIVERSITY FDN,	1	1	2
FRANCIS MARION UNIVERSITY,	33	33	66
FRANCO MFG CO INC,	3	3	6
FRASIER TIRE SERVICE INC,	2	2	4
G E MEDICAL SYSTEM,	1	1	2
GALEY & LORD LLC,	5	5	10
GENERAL ELECTRIC COMPANY,	3	3	6
GEORGIA-PACIFIC WOOD PRODUCTS,	5	5	10
GILDAN APPAREL USA INC,	2	2	4
GRAND STRAND WATER & SEWER,	1	1	2
GREEN FENCE RECYCLING CORP,	1	1	2
H B D INDUSTRIES INC,	2	2	4
HAIER AMERICA REFRIGERATORS CO,	8	8	16
HARRIS TEETER INC,	1		1
HARTSVILLE LLC,	11	11	22
HARTSVILLE OIL MILL,	8	8	16
HARVIN PACKING COMPANY INC,	1	1	2
HENGST OF NORTH AMERICA INC,	1	1	2
HIGHLAND INDUSTRIES INC,	4	4	8
HONORAGE NURSING HOME,	2	2	4
INDUSTRIAL FABRICATORS,	1	1	2
INTERNATIONAL KNIFE & SAW,	1	5	6
INTERNATIONAL PAPER COMPANY,	2	2	4
INVISTA S A R L,	21	21	42
ITW ANGLEBOARD,	2	2	4
J L ANDERSON CO INC,	7	7	14
JOHNSON CONTROLS BATTERY GROUP,	7	7	14
JOHNSONVILLE CITY OF,	1	1	2
KAYDON CORPORATION,	5	5	10

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KINGSTREE TOWN OF,	2	1	3
KOPPERS INC,	3	3	6
KOPPERS INDUSTRIES INC,	1	1	2
LAKE CITY CITY OF,	1	1	2
LAKE CITY COMMUNITY HOSPITAL,	15	15	30
LEE COUNTY SCHOOL DISTRICT,	4	4	8
LEWIS MOLA LLC,	1	1	2
LOCKAMY SCRAP METAL INC,	3	3	6
LOWES COMPANIES INC,	4	4	8
LYNCH, KIM R	1	1	2
MANCOR-SC INC,	2	2	4
MANNING CITY OF,	1	1	2
MARION COUNTY MEDICAL CENTER,	2	2	4
MARION COUNTY SCHOOL DISTRICT,	3	3	6
MARLEY COMPANY THE,	2	2	4
MARSH LUMBER COMPANY,	1	1	2
MCCALL FARMS INC,	10	10	20
MCLEOD HEALTH CHERAW,	17	17	34
MCLEOD REG MED CTR OF PEE DEE,	52	52	104
MEDFORD PLACE,	1	1	2
METHODIST MANOR,	1		1
MORRELL NURSING CENTER LLC,	1	1	2
NATIONAL HEALTHCARE CORPORATIO,	1	1	2
NEIGHBORHOOD GROCER LLC,	1	1	2
NESTLE WATERS NORTH AMERICA IN,	2	2	4
NORTHEASTERN TECHNICAL COLLEGE,	4	4	8
NSLC DARLINGTON INC,	8	8	16
NUCOR CORPORATION,	6	6	12
OTIS ELEVATOR COMPANY,	5	5	10
PACIFIC MDF PRODUCTS INC,	1	1	2
PAGELAND SCREEN PRINTER INC,	2	2	4
PALMETTO GROCER INC,	1	1	2
PALMETTO HEALTH TUOMEY,	5	5	10
PATHEON API SERVICES INC,	3	3	6
PEACE TEXTILE AMERICA INC,	2	2	4
PERDUE FARMS INC,	4	4	8
PIGGLY WIGGLY BISHOPVILLE INC,	1	1	2
PIGGLY WIGGLY CALHOUN INC,	1	1	2
PIGGLY WIGGLY CHESTER #39 INC,	1	1	2
PIGGLY WIGGLY DARLINGTON INC,	1	1	2
PIGGLY WIGGLY EAST INC,	2	2	4
PIGGLY WIGGLY LAKE CITY INC,	1	1	2
PIGGLY WIGGLY NO 93 INC,	1	1	2
PIGGLY WIGGLY OF HARTSVILLE SC,	2	2	4
PIGGLY WIGGLY OF MANNING INC,	1	1	2
PIGGLY WIGGLY OF SUMTER INC,	2	2	4

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PIGGLY WIGGLY OF WESMARK INC,	1	1	2
PILGRIMS PRIDE CORPORATION,	11	11	22
PILOT CORPORATION #337,	1		1
POLYQUEST INC,	4	4	8
PROTECTIVE PACKAGING INC,	1	1	2
REXAM BEVERAGE CAN COMPANY,	4	4	8
RIVERSIDE ELEC MOTORS,	1	1	2
ROCHE CAROLINA,	2	2	4
ROLLER BEARING CORP OF AMERICA,	7	7	14
S & W MANUFACTURING CO,	3	3	6
SANTEE PRINT WORKS INC,	6	6	12
SC DEPT OF CORRECTIONS,	23	23	46
SC GOVERNORS SCHOOL,	3	3	6
SCHAEFFLER GROUP USA INC,	12	12	24
SCHOOL DIST OF GEORGETOWN CO,	5	5	10
SLI LIGHTING CORPORATION 01,	2	2	4
SMURFIT-STONE CONTAINER,	4	4	8
SONOCO PRODUCTS CO,	20	20	40
SO-PAK-CO INC,	1	1	2
SOUTH ATLANTIC CANNERS INC,	4	4	8
SOUTH EAST EXPRESS INC,	3	2	5
SOUTHERN GRAPHICS SYSTEMS INC,	1	1	2
SPORT HORSE SHAVINGS LLC,	1	1	2
STANLEY TOOLS DIV OF,	2	2	4
STATE OF S C GOVENOR'S SCHOOL,	1	1	2
STEELFAB OF SC,	1	1	2
SUMTER COUNTY,	4	4	8
SUMTER FOODS INC,	1	1	2
SUMTER PACKAGING CORP,	4	4	8
T B FOODS INC,	1	1	2
TALLEY METALS TECHNOLOGY INC,	13	13	26
TARGET PARKING LOT LIGHTS,	1	1	2
TARGET STORES,	2	1	3
THE BROTHERS OF NORTH CAROLINA,	1	1	2
TRAVELCENTERS OF AMERICA,	1	1	2
TREBOL USA LLC,	3	3	6
TUPPERWARE CO INT,	1	1	2
UNIFIRST CORPORATION,	1	1	2
UNIMIN CORPORATION,	2	2	4
UNITED METHODIST MANOR PEE DEE,	5	5	10
US AIR FORCE,	14	14	28
VESUVIUS USA CORPORATION,	2	2	4
VULCRAFT CORP #2, 480VAC, 2500,	1	1	2
VULCRAFT CORP,	3	3	6
VULCRAFT DECK PLANT,	1	1	2
W LEE FLOWERS CO INC,	1	1	2

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Duke Energy Progress, LLC

Industrial and Commerical Accounts that have Opted-Out (12-31-2016)

WALLACES OLD FASH SKINS,	1	1	2
WALMART STORES INC,	17	17	34
WEYLCHEM US INC,	2	2	4
WHITE PINE LAND CO INC,	1	1	2
WILLIAMSBURG REGIONAL HOSPITAL,	2		2
YOUNG PECAN SHELLING CO,	3	3	6
ZIMACS INCORPORATED,	4	4	8
Grand Total	**889**	**880**	**1,769**

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Duke Energy Progress, LLC

"Industrial and Commerical Accounts that have Opted-In (2016)
in Order to Participate in Program"

Customer Name	EE	Grand Total
CHESTERFIELD COUNTY SCHOOLS,	12	12
FLORENCE COUNTY,	2	2
PILOT CORPORATION #337,	1	1
Grand Total	**15**	**15**

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Exhibit 14

Duke Energy Progress
Changes to DSM/EE Cost Recovery Vintage 2016 True Up January 1, 2016 - December 31, 2016
Changes from Prior Filing Due to Application of M&V and Participation
System kWh and kW Impacts Net Free Riders at the Plant
Docket 2017-XX-E

Residential Programs

Program Name	Filed in Docket 2016 - 289 -E		Filed in Docket 2017 - XX -E		Overall Variance		Filed in Docket 2016 - 289 -E	Filed in Docket 2017 - XX -E	Delta	Variance due to Change in Impacts and Measure Mix		Variance due to Change in Participation		Sum of Variances	
	kWh	kW	kWh	kW	kWh	kW	System Participation		Participation	kWh	kW	kWh	kW	kWh	kW
Appliance Recycling Program	4,181,891	553	206,569	27	(3,975,322)	(526)	7,000	342	(6,658)	2,254	(0)	(3,977,576)	(526)	(3,975,322)	(526)
Energy Education Program for Schools	1,997,741	198	2,242,237	222	244,496	24	8,800	9,877	1,077	(0)	-	244,496	24	244,496	24
Energy Efficient Lighting	46,244,468	6,662	41,649,479	6,006	(4,594,989)	(656)	2,230,952	2,892,937	661,985	(18,316,988)	(2,633)	13,721,999	1,977	(4,594,989)	(656)
Home Energy Improvement Program	2,403,273	882	6,290,162	1,904	3,886,888	1,022	6,498	19,466	12,968	(909,081)	(737)	4,795,969	1,759	3,886,888	1,022
Neighborhood Energy Saver	1,734,973	305	1,992,091	304	257,117	(1)	4,500	4,412	(88)	291,046	5	(33,928)	(6)	257,117	(1)
ResEE Multi-Family	10,993,185	1,078	13,354,259	1,337	2,361,074	259	211,656	240,435	28,779	866,324	112	1,494,750	147	2,361,074	259
Residential Energy Assessments	1,281,870	214	4,141,847	692	2,859,976	477	10,385	27,614	17,229	733,458	122	2,126,519	356	2,859,976	477
Residential New Construction	8,954,806	3,872	11,092,839	4,769	2,138,033	897	4,500	5,731,320	5,726,820	(11,393,986,324)	(4,927,015)	11,396,124,357	4,927,912	2,138,033	897
Save Energy and Water Kit	12,758,074	1,021	16,214,719	1,298	3,456,645	277	257,688	325,146	67,458	116,805	9	3,339,840	267	3,456,645	277
Residential Home Advantage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
My Home Energy Report	133,916,899	36,390	128,280,914	34,858	(5,635,986)	(1,532)	682,300	673,285	(9,015)	(3,866,587)	(1,051)	(1,769,399)	(481)	(5,635,986)	(1,532)
EnergyWise ® Home	-	22,811	-	34,059	-	11,248	11,433	18,465	7,032	-	(2,782)	-	14,030	-	11,248
Residential Programs Total	224,467,181	73,987	225,465,114	85,476	997,933	11,488	3,435,713	9,943,298	6,507,586	(11,415,069,095)	(4,933,971)	11,416,067,028	4,945,459	997,933	11,488

Non-Residential Programs

Program Name	Filed in Docket 2016 - 289 -E		Filed in Docket 2017 - XX -E		Overall Variance		d in Docket 2016 - 28	d in Docket 2017 - XX -I	Delta	Variance due to Change in Impacts and Measure Mix		Variance due to Change in Participation		Sum of Variances	
	kWh	kW	kWh	kW	kWh	kW	System Participation		Participation	kWh	kW	kWh	kW	kWh	kW
Business Energy Reports	4,183,518	681	4,546,814	740	363,296	59	12,532	163,493	150,961	(50,031,539)	(8,147)	50,394,835	8,206	363,296	59
Energy Efficiency for Business	60,753,513	9,608	71,161,894	10,202	10,408,381	594	147,560	20,877,826	20,730,266	(8,524,690,045)	(1,349,165)	8,535,098,425	1,349,759	10,408,381	594
Energy Efficient Lighting	22,196,918	4,572	12,180,303	2,818	(10,016,615)	(1,754)	270,957	351,511	80,554	(16,615,675)	(3,113)	6,599,060	1,359	(10,016,615)	(1,754)
Small Business Energy Saver	39,581,136	7,546	50,286,062	8,751	10,704,926	1,205	40,500,000	42,784,494	2,284,494	8,472,262	779	2,232,663	426	10,704,926	1,205
EnergyWise ® for Business	648,806	1,549	1,062,193	1,402	413,387	(147)	781	697	(84)	482,815	18	(69,428)	(166)	413,387	(147)
Commercial Industrial Governmental Demand Response	-	12,927	-	(5,344)	-	(18,272)	12,300	(5,085)	(17,385)	-	5,344	-	(18,272)	-	(12,927)
Non-Residential Programs Total	127,363,892	36,884	139,237,266	18,569	11,873,375	(18,315)	40,944,129	64,172,936	23,228,807	(8,582,382,182)	(1,354,283)	8,594,255,556	1,341,313	11,873,375	(12,970)

Distribution System Demand Response

DSDR	48,723,374	308,314	33,941,086	281,372	(14,782,288)	(26,942)	-	-	-	(14,782,288)	(26,942)	-	-	(14,782,288)	(26,942)
Total Residential and Non-Residential Programs	400,554,446	419,185	398,643,466	385,416	(1,910,980)	(33,769)	44,379,842	74,116,235	29,736,393	(20,012,233,565)	(6,315,197)	20,010,322,584	6,286,772	(1,910,980)	(28,424)

NOTE - The actual per unit impacts are reflective of the following EM&V reports:

Program Name As Filed	Docket	Report Reference	Effective Date
Neighborhood Energy Saver	E-2, Sub 952	Duke Energy Progress Neighborhood Energy Saver Program Evaluation Report	1/1/2015
Small Business Energy Saver	E-2, Sub 1022	EM&V Report for the Small Business Energy Saver Program: Duke Energy Progress and Duke Energy Carolinas	3/1/2016
Energy Efficient Lighting	E-2, Sub 950	Evaluation of the PY2015 Duke Energy Progress Energy Efficient Lighting Program	1/1/2015
ResEE Multi-Family	E-2, Sub 1059	EM&V Report for the Duke Energy Multifamily Energy Efficiency Program: Duke Energy Progress and Duke Energy Carolinas	1/1/2015
EnergyWise ® Home	E-2, Sub 927	EM&V Report for the EnergyWise Home Demand Response Program: Winter PY2015/2016	9/1/2015

Duke Energy Progress

Estimate - January 1, 2017 - December 31, 2017

Docket No. 2017-XX-E

Projected Program/Portfolio Cost Effectiveness - Vintage 2018

Program	UCT	TRC	RIM	PCT
Residential Programs				
· **Appliance Recycling Program**	1.30	1.75	0.65	
· **Energy Education Program for Schools**	1.45	2.04	0.72	
· **Energy Efficient Lighting**	2.73	4.73	0.91	8.59
· **Home Energy Improvement**	1.07	0.78	0.69	1.29
· **Multi-Family**	4.15	7.56	1.06	
· **Neighborhood Energy Saver**	0.70	1.96	0.47	
· **Residential Energy Assessments**	2.70	3.06	0.99	
· **Residential New Construction**	2.56	1.42	1.16	1.85
· **Residential Home Advantage**				
· **Save Energy and Water Kit**	9.59	24.20	1.14	
· **My Home Energy Report**	1.68	1.68	0.11	
· **EnergyWise Home**	10.06	94.65	10.06	
Residential Total	**3.40**	**3.50**	**0.79**	**10.44**
Non-Residential Programs				
· **Energy Efficient Lighting**	7.06	12.23	2.35	8.59
· **Non-Residential Smart $aver Performance (Custom)**	4.77	1.19	1.49	1.30
· **Non-Residential Smart $aver Performance (Prescriptive)**	3.17	1.43	1.24	1.75
· **Non-Residential Smart $aver Performance Incentive**	0.66	0.49	0.50	1.54
· **Small Business Energy Saver**	3.80	2.42	1.38	2.78
· **EnergyWise ® for Business**	2.09	2.70	1.46	
· **Commercial Industrial Governmental Demand Response**	2.67	4.33	2.67	
Non-Residential Total	**3.36**	**2.07**	**1.47**	**2.32**
Overall Portfolio total	**3.39**	**2.77**	**0.95**	**5.82**

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