Evaluation, Measurement, and Verification Report for Virginia Electric and Power Company (Dominion Energy)

Case No. PUR-2017-00129 (Virginia)
Docket No. E-22 Sub 556 (North Carolina)

VOLUME 1 OF 3
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Date: May 1, 2019
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1 EXECUTIVE SUMMARY

The purpose of this report is to present performance indicators of Virginia Electric and Power Company's (Dominion Energy Virginia, Dominion Energy North Carolina, or the Company) demand-side management (DSM) programs and to comply with the Virginia State Corporation Commission (SCC) Order to Virginia Electric and Power Company[1] issued on March 24, 2010 ("the Order") in Case PUE-2009-00081, as later modified, to provide a detailed evaluation, measurement, and verification (EM&V) report on an annual basis. It is also intended to meet the EM&V reporting requirements as ordered by the SCC in Case No. PUR-2017-00047 (issued on November 9, 2017) for newly-approved DSM programs or renewals of existing DSM programs since November 9, 2017.

In addition, this report presents performance indicators of Dominion Energy's North Carolina DSM and Energy Efficiency (EE) programs from program launch (mid-2011) through December 31, 2018, in accordance with the North Carolina Utilities Commission's (NCUC) Orders approving DSM and EE programs in North Carolina, as well as the NCUC's subsequent direction regarding the filing of EM&V plans in North Carolina through its Orders issued in Docket No. E-22, Sub 473; and finally the NCUC's instruction to align its EM&V filing schedule with that in Virginia, annually on April 1 of each year (Docket No. E-22, Sub 524).

This report is being filed on May 1, 2019 pursuant to a permanent extension granted by the SCC in Case No. PUR-2017-00129 on March 8, 2018.

This EM&V report, prepared by DNV GL Energy (DNV GL), focuses on DSM program impacts, and covers program activity through December 31, 2018. It includes Virginia and North Carolina DSM Phases I through VI programs.

[1] Hereinafter, Virginia Electric and Power Company will be referred to as "Dominion Energy" or "Company" and may also include North Carolina operations depending on the context.

1.1 Summary of Energy Efficiency Programs

This section presents key indicators of progress to date for the following nine EE programs:

Figure 1-1. Programs reported in this document.

Residential Energy Efficiency	Non-residential Energy Efficiency	Demand Response
• **Residential Income and Age Qualifying Home Improvement** (DSM Phase IV in VA and NC)	•**Non-residential Lighting Systems & Controls** (DSM Phase III in VA and NC)	•**Residential AC Cycling Program** (DSM Phase I in VA and NC)
• **Residential Retail LED Lighting** (DSM Phase V in NC only)	•**Non-residential Heating & Cooling Efficiency** (DSM Phase III in VA and NC)	•**Non-residential Distributed Generation** (DSM Phase II in VA only)
	•**Non-residential Window Film** (DSM Phase III in VA and NC)	
	•**Non-residential Small Business Improvement** (DSM Phase V in VA and NC)	
	•**Non-residential Prescriptive** (DSM Phase VI in VA and NC)	

The key metrics for tracking EM&V indicators of program progress are the following:


Expenditures

Program expenditures include operations and maintenance and capital spending (e.g. control switches in the Smart Cooling Rewards Program). Operations and maintenance spending are separated by direct rebate, direct implementation, direct EM&V, other indirect or administrative spending.


Participation

Participation is defined as the total number of participants served through the program.


Net Annualized Energy Savings

Net installed annualized energy savings in kilowatt hours per year (kWh/year) is the amount of annual energy savings delivered by the program after accounting for annual savings that would have occurred in the absence of the program.

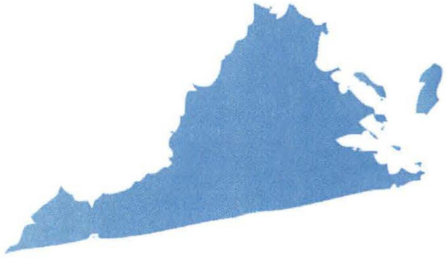
Key EM&V performance indicators for EE programs (spending, participation, annualized incremental net energy savings, and net demand reductions) are shown in Table 1-1 for Virginia and Table 1-2 for North Carolina, as well as the months of participation from program launch through December 31, 2018. The detailed summaries of these results for each program are available in Appendices A and B. Cumulative

participation, net energy savings, and net demand reductions for each program are provided in Appendices C and D. Those values are used as inputs for integrated resource planning, lost revenue recovery (if pursued), program performance incentives, and other calculations requiring cumulative net energy savings over time for each program.

Note that this is the last EM&V report where the DSM Phase III programs will be reported in the main sections of the report. In future annual reports, these programs will be reported in the closed programs section because they have retired as designed. They were available to customers in Virginia for approximately five years, and to customers in North Carolina for approximately four years.

A few of the major highlights of these programs are listed:

1.1.1 Virginia Highlights



Net annualized energy savings, participation, and program spending from inception to the current program reporting year (end of 2018) are shown in Table 1-1. This table only presents these indicators of program progress for the programs that were active and available to Dominion Energy customers in Virginia, as of 2018.

Note that the SCC has approved existing DSM program budgets by DSM phases, and by the residential and non-residential program categories. This allows the Company to allocate spending among the various programs as appropriate, while managing spending against the overall approved total budget.

Of the residential EE programs, the Residential Income and Age Qualifying Home Improvement program (DSM Phase IV) was the only program that was available to customers in Virginia in the 2018 program year. This program was dormant for the majority of 2018, until its extension was approved by the SCC in the later part of the year. This program exceeded 2018 net annualized energy savings targets in Virginia at 204%. And over the four-year program life, it's ahead of the net energy savings target by 159%. Participation fell short of the program's 2018 planned target in Virginia at 57%, and over the program life (2015-2018) it exceeded the participation target at 148% of plans.

In the non-residential sector, the DSM Phase III program (three non-residential EE programs) are in their last full program year. They are closing completely, as planned, in the first quarter of 2019. Of these programs, the Non-residential Lighting Systems and Controls has been most successful in Virginia. Over the four-year program life, it exceeded its net annualized energy savings target at 121% of goal. However, in terms of participation, it fell short at 58% of the four-year target. This indicates on a per-participant basis, savings were larger than planned. The Non-residential Heating and Cooling Efficiency and Non-residential Window Film programs both fell short of their four-year targets for net energy savings and participation. The Non-residential Heating and Cooling Efficiency Program achieved 29% of the four-year net energy savings target, and 11% of the four-year participant goal. The Non-residential Window Film Program achieved 12% of the five-year net energy savings goal and 10% of participation goal. Participation grew almost every year, since year one.

The Small Business Improvement Program (DSM Phase V) has reached its stride in its third program year. In 2018, it continued to exceed net annualized energy savings target at 258%, though falling short of the

participation goal at 65%. In reviewing the program progress over the past three program years (2016-2018), it exceeded net energy savings target at 257% and reached very close to the expected participation levels at 93% of goal. Similar to the Non-residential Lighting Systems and Controls Program, the per-participant savings for this program are larger than initially anticipated in the program design. A large portion of the savings from this program are from lighting measures. Other measures that have been implemented in 2018 include duct sealing and AC tune-ups. The Company anticipates that similar to the Small Business Improvement Program, the per participant average energy savings will continue to increase as customers begin to adopt additional measures available in the program.

In its second year in Virginia, the Non-residential Prescriptive Program (DSM Phase VI) did not meet net annualized energy savings target, at 21% of the 2018 goal. However, it exceeded its 2018 participation target at 203%. This indicates that compared to the initial program design expectations, on a per-participant basis these early program participants have smaller savings than expected. In 2018, the top three measures in terms of savings were door gaskets, duct sealing, and strip curtains. Other measures that were implemented in 2018 include: AC tune-up, night covers, and door closers.

Table 1-1. Annualized Program Progress for Energy Efficiency Programs (Cumulative from Program Start through December 31, 2018) in Virginia

Program	Expenditures	Gross Participants	Net Energy Savings kWh/year	Months Since First Participation
Residential Programs				
Residential Income and Age Qualifying Home Improvement – Virginia (DSM IV)				
Actual	[redacted]	17,037	5,951,388	39
Planned (Year End Total)		11,538	3,749,708	
Cumulative % Toward Plan	94%	148%	159%	
Non-Residential Programs				
Non-Residential Lighting Systems and Controls – Virginia (DSM III)				
Actual	[redacted]	4,079	166,345,821	51
Planned (YE Total)		7,083	137,480,402	
Cumulative % Toward Plan	119%	58%	121%	
Non-Residential Heating and Cooling Efficiency – Virginia (DSM III)				
Actual	[redacted]	389	30,505,864	50
Planned (YE Total)		3,393	106,207,832	
Cumulative % Toward Plan	74%	11%	29%	
Non-Residential Window Film – Virginia (DSM III)[2]				
Actual	[redacted]	472,465	5,280,563	51
Planned (YE Total)		4,788,181	43,944,759	
Cumulative % Toward Plan	27%	10%	12%	

[2] Non-Residential Window Film program participation value is in square feet rather than participant count.

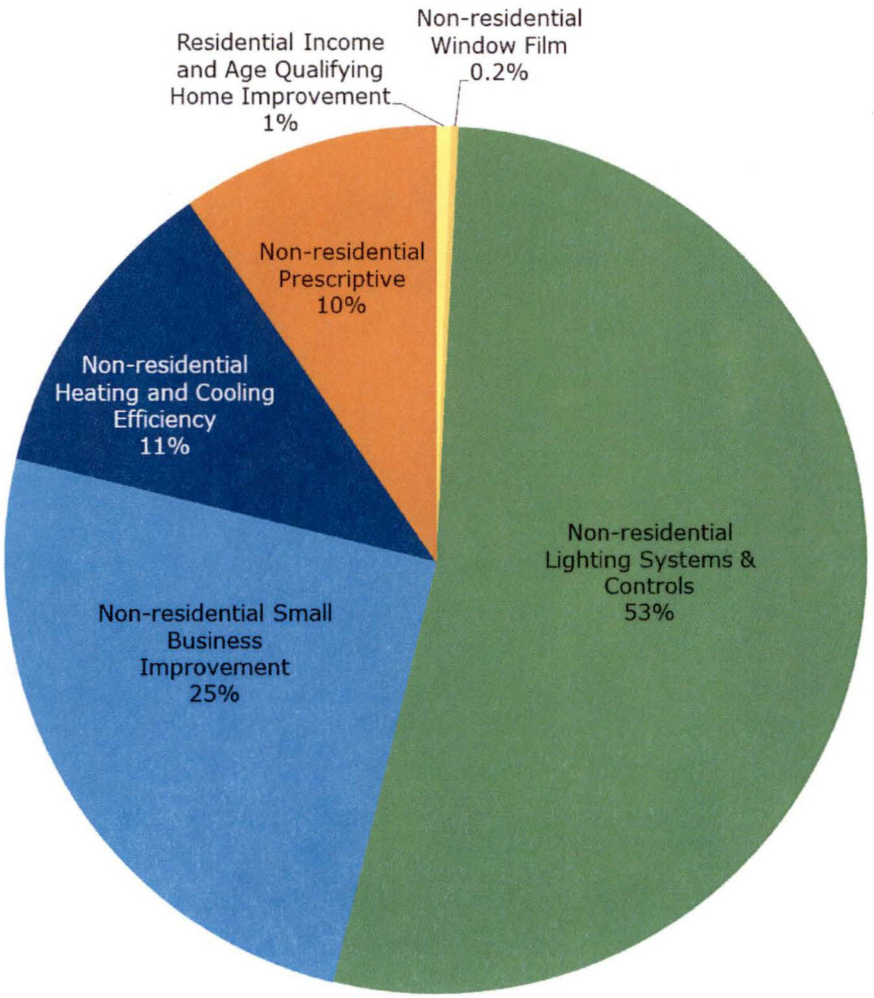
Program	Expenditures	Gross Participants	Net Energy Savings kWh/year	Months Since First Participation
Non-Residential Small Business Improvement – Virginia (DSM V)				
Actual	[redacted]	1,514	29,159,889	
Planned (YE Total)		1,631	11,339,952	27
Cumulative % Toward Plan	56%	93%	257%	
Non-Residential Prescriptive – Virginia (DSM VI)				
Actual	[redacted]	869	5,738,236	
Planned (YE Total)		693	32,799,312	13
Cumulative % Toward Plan	75%	125%	17%	
Portfolio Total[3]				
Actual	[redacted]	23,888	242,981,763	
Planned (YE Total)		24,338	335,521,963	
Cumulative % Toward Plan	84%	98%	72%	

[3] Excludes Non-Residential Window Film participation values because it is measured in square feet rather than participant count.

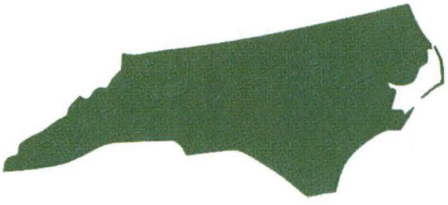
Figure 1-2 shows the distribution of net annualized energy savings across the Virginia portfolio, in program year 2018. Non-residential programs contributed significantly toward the overall portfolio's energy savings (approximately 99%), while residential programs account for about 1%.

In program year 2018, the top three performing programs by the energy savings all serve the non-residential section (in decreasing order): Non-residential Lighting Systems & Controls Program, Non-residential Small Business Improvement Program, and Non-residential Heating and Cooling Efficiency Program.

Figure 1-2. Percent of Installed Net Annualized Energy Savings Across the VA Energy Efficiency Program Portfolio in 2018 (Active Programs)



1.1.2 North Carolina Highlights



Net annualized energy savings, participation, and program spending from inception to the current program reporting year (end of 2018) are shown in Table 1-2. This table only presents these indicators of program progress for the programs that were active and available to Dominion Energy customers in North Carolina, as of 2018.

When reviewing the North Carolina results, it is helpful to note that the NC programs are operated under a cost allocation formula as a subset of the overall system-level program budget. The allocation is approximately 6% NC and 94% VA. This necessitates that Dominion Energy manages the North Carolina programs so as to not exceed the cost allocation.

In North Carolina, the 2018 residential EE programs include the Residential Income and Age Qualifying Home Improvement Program (DSM Phase IV) and the Residential Retail LED Lighting Program (DSM Phase V). Similar to in Virginia, the Residential Income and Age Qualifying Home Improvement Program was dormant for the majority of 2018, until its extension was approved by the SCC and subsequently the NCUC. The program did not enroll any new participants in 2018. 2018 is the last program year of the Residential Retail LED Program. By design, it was only intended to be available for two years (2017-2018) in North Carolina. The Residential Retail LED Program concluded at 113% of target for net annualized energy savings and 87% of participation target, over the two-year period. Participation and net energy savings both exceeded 2018 goals (130% of net energy savings target, 120% of participation target).

In the non-residential sector, the DSM Phase III program (three non-residential EE programs) are in their last full program year. They are closing, as planned, in 2019. Of these programs, the Non-residential Lighting Systems and Controls has been most successful in North Carolina. Over the four-year program life, it was very close to meeting its net annualized energy savings target at 92% of goal. However, in terms of participation, it fell short at 29% of the four-year target. This indicates on a per-participant basis, savings were larger than planned. The Non-residential Heating and Cooling Efficiency and Non-residential Window Film programs both fell short of their four-year targets for net energy savings and participation. The Non-residential Heating and Cooling Efficiency Program achieved 7% of the four-year net energy savings target, and 7% of the four-year participant goal. The Non-residential Window Film Program has only enrolled one participant in North Carolina in its four-year life span.

The Small Business Improvement Program (DSM Phase V) is performing at a similar level to the same program in Virginia. In 2018, it continued to exceed net annualized energy savings target at 242%, though falling short of the participation goal at 68%. In reviewing the program progress over the past two program years (2017-2018), it exceeded net energy savings target at 161% but reached less than half the expected participation levels at 45% of goal. Similar to the Non-residential Lighting Systems and Controls Program, the per-participant savings for this program are larger than initially anticipated in the program design. Like in Virginia, a large portion of the savings from this program are from lighting measures. Other measures that have been implemented in 2018 include duct sealing and AC tune-ups.

2018 is the first year that the Non-residential Prescriptive Program (DSM Phase VI) is available to customers in North Carolina. As we have seen in all first program years, the program is ramping up and did not meet net annualized energy savings target (10% of the 2018 goal). It also fell short of participation target for the

year, at 72%. In this first year, three measures were implemented. They were all refrigeration: door gaskets, door closers, and strip curtains.

Table 1-2. Annualized Program Progress for Energy Efficiency Programs (Cumulative from Program Start through December 31, 2018) in North Carolina (Active Programs)

Program	Expenditures	Gross Participants	Net Energy Savings kWh/year	Months Since First Participation
Residential Programs				
Residential Income and Age Qualifying Home Improvement – North Carolina (DSM IV)				
Actual	[redacted]	288	173,518	30
Planned (Year End Total)		511	118,239	
Cumulative % Toward Plan	77%	56%	147%	
Residential Retail LED Lighting – North Carolina (DSM V)[4]				
Actual	[redacted]	334,497	6,913,336	30
Planned (Year End Total)		385,000	6,125,543	
Cumulative % Toward Plan	87%	87%	113%	
Non-residential Programs				
Non-residential Lighting Systems and Controls – North Carolina (DSM III)				
Actual	[redacted]	122	7,565,635	45
Planned (YE Total)		421	8,254,118	
Cumulative % Toward Plan	69%	29%	92%	
Non-residential Heating and Cooling Efficiency – North Carolina (DSM III)				
Actual	[redacted]	15	482,573	45
Planned (YE Total)		206	6,834,368	
Cumulative % Toward Plan	47%	7%	7%	
Non-residential Window Film – North Carolina (DSM III)[5]				
Actual	[redacted]	402	3,613	12
Planned (YE Total)		312,301	2,772,773	
Cumulative % Toward Plan	19%	0%	0%	
Non-residential Small Business Improvement – North Carolina (DSM V)				
Actual	[redacted]	43	1,085,517	19
Planned (YE Total)		95	673,122	
Cumulative % Toward Plan	36%	45%	161%	
Non-residential Prescriptive – North Carolina (DSM VI)				
Actual	[redacted]	21	188,512	2

[4] Residential Retail LED Lighting program participation value is in lamps purchased rather than participant count.

[5] Non-Residential Window Film program participation value is in square feet rather than participant count.

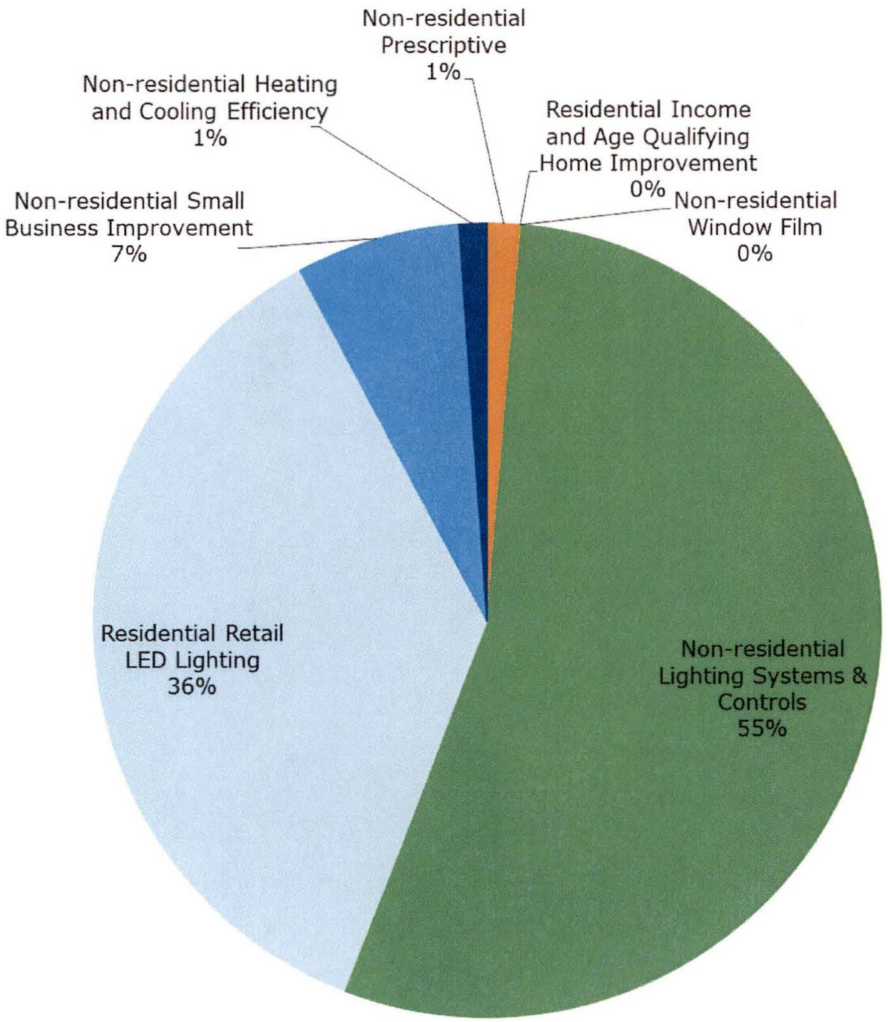
Program	Expenditures	Gross Participants	Net Energy Savings kWh/year	Months Since First Participation
Planned (YE Total)	[redacted]	29	1,822,814	
Cumulative % Toward Plan		72%	10%	
Portfolio Total[6]				
Actual	[redacted]	489	16,412,702	
Planned (YE Total)		1,262	26,600,977	
Cumulative % Toward Plan	66%	39%	62%	

[6] Excludes Non-Residential Window Film participation values because it is measured in square feet rather than participant count and excludes Residential Retail LED Lighting participation value because it is measured in lamps purchased rather than participant count.

Figure 1-3 shows the distribution of net annualized energy savings across the North Carolina portfolio for the 2018 program year. The non-residential programs contributed to 64% of the portfolio's savings. The Non-residential Lighting Systems and Controls Program contributed the most savings in 2018, at 55% of the 2018 North Carolina total.

The second and third highest savings programs were the Residential Retail LED Program (36%) and Non-residential Small Business Improvement Program (7%).

Figure 1-3. Percent of Installed Net Annualized Energy Savings Across the NC Energy Efficiency Program Portfolio in 2018 (Active Programs)



1.2 Summary of Peak Shaving Programs

The following sections present key performance indicators of progress to-date for two peak shaving programs, the Residential AC Cycling (or Smart Cooling Rewards) Program offered in Virginia and North Carolina, and the Non-residential DG Program, offered in Virginia only. DNV GL conducted EM&V impact evaluations for both programs (provided in Appendices N-1 and O-1).

The key metrics for evaluating performance indicators are:

- Expenditures
- Net participation
- Net peak shaving potential in kilowatts (kW)

Key EM&V performance indicators for peak shaving programs are shown in Table 1-3.

Table 1-3. Portfolio Spending and Net Peak Shaving Potential by Program (Cumulative through December 31, 2018)

Program	Expenditures	Number of Participants	Peak Shaving Potential kW	Months Since First Participation
Residential AC Cycling—Virginia				
Actual	[redacted]	80,209	50,567	103
Planned (Year End Total)		90,267	61,419	
Cumulative % Toward Plan	75%	89%	82%	
Residential AC Cycling—North Carolina				
Actual	[redacted]	3,062	1,925	89
Planned (Year End Total)		4,733	3,220	
Cumulative % Toward Plan	62%	65%	60%	
Non-residential Distributed Generation—Virginia				
Actual	[redacted]	6.13	5,946	84
Planned (Year End Total)		8.15	8,149	
Cumulative % Toward Plan	45%	75%	73%	
Total				
Actual	[redacted]	-	58,438	
Planned (Year End Total)		-	72,788	
Cumulative % Toward Plan	72%	-	80%	

Most of the planned peak shaving potential (84%) was expected from the Residential AC Cycling program in Virginia (61,419 kW out of 72,788 kW) in 2018. The AC Cycling program reached 89% of its planned participation goal and 82% of its cumulative peak shaving potential in Virginia. North Carolina reached 65% of its planned participation goal and 60% of its cumulative peak shaving potential. Program expenditures for the Residential AC Cycling program in 2018 were 75% of the plan for Virginia and 62% for North Carolina.

The Non-residential DG Program achieved 75% of planned participation and 73% of planned peak shaving potential.

1.3 Study Approach

EM&V is an important part of a program's cycle because it can produce findings that are utilized during the program planning and design stage, allowing for continuous improvement as the program evolves, as illustrated in Figure 1-4.

Figure 1-4. Illustration of a Program Cycle

EM&V reports typically review and report on available program data that has been collected and validated, collect and report data from secondary or primary research activities, and offer recommendations for improvements to specific program designs where applicable. EM&V direct-measurement data can also be, and has been in previous years, integrated into Dominion Energy's long-term system planning process through the incorporation of more current data into its future Integrated Resource Plan (IRP) modeling when appropriate.

This EM&V report is organized by the following sections:

- Review and assessment of program tracking data for the entire program period of performance since May 1, 2010 (Appendices A, B, C, and D)
- Appendices A and B show screenshots of the program performance indicator table results for each of Dominion Energy's Virginia and North Carolina DSM active and closed programs from program inception to the end of this reporting year. Appendix A shows the Virginia performance indicator tables and Appendix B shows the North Carolina tables. Abbreviated versions of these tables for the current year are also included in the main body of this report, in each program's report section. They show the year-end program spending, participation, gross and net annualized energy savings and demand reductions compared against planning goals for the year.

- Appendix C and D show screenshots of the summary tables used for claiming lost revenue, program performance incentives, IRP modeling, and other purposes used in both states. Appendix C shows gross energy savings and demand reductions. Appendix D shows net energy savings and demand reductions. They are not referenced in the main body of the report, other than in this section.
- EM&V Plans for each active program for the following year, 2019 (Appendices G through P).
- Program Implementation Manual for the Residential Income and Age Qualifying Home Improvement Program, describing controls undertaken by the Company to verify proper installation of the measures, as appropriate (Appendix G-1).
- Impact analysis of the 2018 AC Cycling Program event season to assess the load reductions from a sample of participants, which in 2018 included all participants with advanced metering infrastructure (AMI) meters (Appendix N-1).
- The 2018 Impact evaluation for the Non-residential Distributed Generation Program (Appendix O-1).

2 INTRODUCTION

This report presents performance indicators of Dominion Energy's DSM programs in Virginia and North Carolina.

In Virginia, it is in compliance with the SCC's Order requiring detailed EM&V reports following DSM program implementation, which states:

> *Furthermore, we conclude that the DSM Programs approved herein are in the public interest subject to the following requirements ... Third, the Company shall file detailed* [Measurement & Verification] *M&V reports in this proceeding, with service on Staff and all parties to this case, every six months beginning October 1, 2010.*
>
> *Finally, Virginia Power shall implement its commitment, as discussed during the hearing, to coordinate with the participants in this case and other interested parties in evaluating the M&V results and in developing further DSM Program proposals. For example, if the M&V data establishes that a program is not performing as expected, the Company and the participants to this case should address modifications to, or removal of, such program. These M&V reports, among other things, will provide significant information for purposes of subsequent evaluations as to whether certain programs warrant continuation thereof. Accordingly, we find that the M&V reports should be filed in this DSM proceeding.*[7]

In its April 30, 2012 Order, the SCC approved the Company's request to issue annual EM&V Reports on April 1, focusing on DSM program impacts from the previous calendar year. Again, the SCC granted a motion in Case No. PUR-2017-00129 to extend the filing date for the report due in 2018 and all future EM&V reports to May 1 of each year.[8] As required by the 2010 Order, the Company and DNV GL reviewed prior EM&V Reports with interested stakeholders at the annual Dominion Energy's Integrated Resource Planning Stakeholder Review Process meetings, the most recent of which was December 7, 2018.[9]

On September 1, 2010, Dominion Energy filed an application for the NCUC's approval of six DSM programs. On February 22, 2011, NCUC approved the same five DSM Phase I programs that were approved in Virginia. As a condition of approval, EM&V reports must be filed with the NCUC, which are to include the EM&V reports filed in Virginia, as well as information specific to the Company's North Carolina customers. The NCUC subsequently directed Dominion Energy to revise its annual EM&V reporting cycle to April 1 each year, which was then extended to May 1 consistent with the Virginia deadline.[10]

The SCC issued its order regarding new rules governing the EM&V of the effects of utility-sponsored DSM programs (Case No. PUR-2017-00047) on November 9, 2017. The new rules apply prospectively to new or renewing DSM programs starting from the order date. The Residential Income and Age Qualifying Home

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[7] *Virginia Electric and Power Company Petition for approval to implement new DSM programs and for approval of two rate adjustment clauses pursuant to 56-585.1 A 5 of the Code of Virginia*, Case No. PUE-2009-00081, Order Approving Demand Side Management Programs at 12 (March 24, 2010).

[8] *Virginia Electric and Power Company Petition for approval to extend an existing DSM program and for approval of two updated rate adjustment clauses pursuant to § 56-585.1 A 5 of the Code of Virginia,* Case No. PUR-2017-00129, Order Granting Motion (March 8, 2018).

[9] Previous stakeholder meetings DNV GL attended were October 6, 2010, February 24, 2011, October 20, 2011, October 19, 2012, October 24, 2013, November 3, 2014, September 8, 2015, September 6, 2016, and September 20, 2017.

[10] *In the Matter of Application of Virginia Electric and Power Company d/b/a Dominion North Carolina Power, for Approval of Demand Side Management and Energy Efficiency Cost Recovery Rider Pursuant to G.S. 62-133.9 and Commission Rule R8-69,* Order Approving DSM/EE Rider and Requiring Customer Notice at 13, Docket No. E-22, Sub 473 (December 13, 2011).

Improvement Program is the first program that is affected by this new rule, and is reported in accordance to it.

2.1 Programs Covered in This Report

This report covers five active and ongoing DSM programs, three programs that were retired as planned in 2018, and eleven programs that have been closed in Virginia by 2018. The report also covers four active and ongoing DSM programs, four programs that were retired as planned in 2018, and ten programs that have been closed in North Carolina by 2018. This report divides the DSM programs into four categories:

1. EE programs – residential
2. EE programs – non-residential
3. Peak shaving programs
4. Closed programs

Table 2-1 shows the specific programs included in this report and the SCC's or NCUC's Order Date for approval, suspension, reinstatement, and closure of each of these programs. It also shows updated key program values as a result of EM&V efforts conducted in 2018 and the average annualized kWh/year per participant before and after the update. The change in the average annualized kWh/year per participant values are a function of the following:

1. Updates to adjustment factors or values based on EM&V activities
2. Updates to deemed savings calculation methodology based on regular Standard Tracking and Engineering Protocol Manual (STEP Manual) updates
3. Variation in participant characteristics as inputs to the deemed savings calculations from year to year

Note that changes in deemed savings methods approaches that also drive changes in average participant values are not detailed here, but rather in Appendix F, STEP Manual.

Sections 2.1.1 through 2.1.4 give brief descriptions of all programs covered in this report.

Table 2-1. Categories and list of 2018 DSM programs in this report

Program	State	Date of Order	EM&V Update Description[11]	Updated Factor/ Value Source	Effective Date	Previous Factor/ Value	Updated Factor/ Value	Updated Participant kWh/year
Energy Efficiency—Residential								
Residential Appliance Recycling	VA	April 24, 2015	None					
Residential Income and Age Qualifying Home Improvement	VA	April 24, 2015 Extension: May 10, 2018	None					
	NC	October 6, 2015 Extension: June 26, 2018	None					
Residential Retail LED Lighting	NC	December 20, 2016	None					
Energy Efficiency—Non-residential								
Non-residential Heating & Cooling Efficiency	VA	April 29, 2014	None					
	NC	October 27, 2014	None					
Non-residential Lighting Systems & Controls	VA	April 29, 2014	None					
	NC	October 27, 2014	None					
Non-residential Prescriptive	VA	June 1, 2017	None					
	NC	October 16, 2017						
Non-residential Small Business Improvement	VA	April 19, 2016	None					
	NC	October 26, 2016	None					
Non-residential Window Film	VA	April 29, 2014	None					
	NC	October 27, 2014	None					
Peak Shaving Programs								
Residential AC Cycling	VA	March 24, 2010	Operability rate	Operability rate	2017	N/A	N/A	kW/ participant
		April 19, 2016	Opt-out rate	Opt-out rate	2017	2018	0.03%	
			Removal/ deactivation rate	Removal/ deactivation rate	2017	2018	-0.92%	
	NC	February 22, 2011	Operability rate	Operability rate	2017	2017	N/A	

[11] Changes to participant kWh/year are also partially driven by updates to the deemed annualized savings methodology as a result of regular updates made to the STEP Manual. To review those specific updates, refer to Appendix F.

Program	State	Date of Order	EM&V Update Description[11]	Updated Factor/ Value Source	Effec-tive Date	Previous Factor/ Value	Updated Factor/ Value	Updated Participant kWh/year
			Opt-out rate	Opt-out rate	2017	2018	0.03%	
			Removal/ deactivation rate	Removal/ deactivation rate	2017	2018	0.33%	
Non-residential Distributed Generation	VA	April 30, 2012 Extension: June 1, 2017	None					

2.1.1 Energy Efficiency Programs – Residential

Dominion Energy offers two residential EE programs, one of which – the Residential Low Income and Age Qualifying Home Improvement Program – is offered in both Virginia and North Carolina. The Residential Retail LED program is offered in North Carolina only.

1. Residential Income and Age Qualifying Home Improvement: This program is the updated version of the Residential Low-Income Program from DSM Phase I, and an extension of the program approved in DSM Phase IV. It provides low-income and age qualifying homeowners with a free energy check-up that identifies and installs energy conservation measures within their residences to help save energy.
2. Residential Retail LED Lighting (North Carolina): This program provides residential customers in the Company's North Carolina service territory with an instant discount for qualifying light-emitting diode (LED) light bulb purchases from a participating retailer.

2.1.2 Energy Efficiency Programs – Non-residential

All non-residential energy efficiency programs below are offered in both Virginia and North Carolina. The DSM Phase III programs have closed to new participants. This includes the Non-residential Lighting Systems & Controls, Non-residential Heating and Cooling Efficiency, and Non-residential Window Film programs. According to Dominion Energy, project assessments must have been submitted by October 26, 2018 and received approval before any work can be initiated. All projects must be completed with a participating contractor by December 28, 2018 with rebate applications submitted online or postmarked by February 11, 2019.

1. Non-residential Lighting Systems & Controls: This program provides non-residential customers with an incentive to retrofit their existing inefficient lighting system with a more cost-effective, energy efficient lighting system.
2. Non-residential Heating and Cooling Efficiency: This program provides incentives to non-residential customers to upgrade existing heating or cooling equipment or install new energy efficient technologies.
3. Non-residential Window Film: This program provides incentives to non-residential customers to install window film to reduce energy consumption and demand during the cooling season.
4. Non-residential Small Business Improvement: This program provides small business customers with on-site energy assessments of their facilities and incentives for direct install lighting, duct testing and sealing, HVAC upgrades, and prescriptive re-commissioning through participating contractors.
5. Non-residential Prescriptive: This program provides incentives to qualifying non-residential customers for cooking, refrigeration, and HVAC measures installed through participating contractors.

2.1.3 Peak Shaving Programs

Dominion Energy operates two peak shaving programs—the Residential AC Cycling Program and the Non-residential DG Program. The Residential AC Cycling program is offered in Virginia and North Carolina. The Non-residential DG Program is offered only in Virginia.

1. Residential AC Cycling: Participants receive a $40 on-bill credit in the December billing cycle in exchange for allowing the Company to reduce the operating cycle of their central air conditioning and

heat pumps on pre-planned weekdays between June 1–September 30 (excluding holidays). When cycling events are initiated, a paging signal is broadcast by the Company and received by load curtailment switches installed on the central air conditioners and heat pumps of participating customers. The page initiates a curtailment switch that reduces the duty cycle of the air conditioning units between 30%–50% while the event is in progress. A typical event lasts between 2–4 hours.

2. Non-residential Distributed Generation (Virginia): This program provides qualifying non-residential customers with an incentive to curtail load by operating on-demand backup generation for a limited number of hours per year. Eligible customers are those with at least 200 kW of demand and participant sites are those with an installed generator.

2.1.4 Closed Programs

The following is a list of programs previously offered in Virginia and North Carolina. They are no longer offered in either state:

2.1.4.1 Residential

1. Residential Lighting (VA only. DSM Phase I): During this program's operation, Dominion Energy partnered with manufacturers and retailers to give residential participants an instant discount for high-efficiency compact fluorescent lamp (CFL) lighting purchases.
2. Residential Low-Income (VA and NC. DSM Phase I): This program, marketed as the Income Qualifying Home Improvement Program, provided low-income homeowners and renters with a free energy audit that identified and installed energy conservation measures within their residences to help save electricity. This program has been replaced with the Residential Income and Age Qualifying Home Improvement program in both states.
3. Residential Heat Pump Upgrade (VA and NC. DSM Phase II): This program provides incentives for residential heat pump (e.g., air and geothermal) upgrades to residential homeowners who may be interested in installing a new, higher efficiency, ENERGY STAR®-rated heat pump unit.
4. Residential Heat Pump Tune-Up (VA and NC. DSM Phase II): This program provides qualifying residential homeowners with an incentive to have a contractor tune-up their existing heat pumps once every five years in order to achieve maximum operating performance.
5. Residential Duct Sealing (VA and NC. DSM Phase II): This program promotes the repair of poorly performing duct- and air-distribution systems in residential homes. Qualifying customers with a heat pump receive an incentive for having a contractor seal ducts in their homes using program-approved methods and eligibility paths.
6. Residential Home Energy Check-Up (VA and NC. DSM Phase II): This program provides owners and occupants of single-family homes and townhomes an easy and low-cost home energy walk-through audit, which includes the direct installation of some energy saving measures and recommendations for additional home energy improvements.
7. Residential Appliance Recycling (VA only. DSM Phase IV): This program provides qualifying residential customers in the Company's Virginia service territory with an incentive to recycle their existing and operating refrigerators and freezers.

2.1.4.2 Non-residential

1. Commercial HVAC Upgrade (VA and NC. DSM Phase I): During its operation, this program provided non-residential customers with an incentive to upgrade inefficient HVAC units or to install new high-efficiency HVAC units and motor controls. High-efficiency HVAC installations helped ensure customers that their heating and cooling systems were running at maximum efficiency while minimizing energy consumption.
2. Commercial Lighting (VA and NC. DSM Phase I): During its operation, this program provided non-residential customers with an incentive to retrofit their existing inefficient lighting systems with more cost-effective, energy-efficient lighting equipment or to install new high-efficiency lighting equipment.
3. Non-residential Duct Testing and Sealing (VA and NC. DSM Phase II): This program promotes testing and general repair of poorly performing duct and air distribution systems in non-residential facilities. The program provides incentives to qualifying customers who have a contractor seal ducts in existing buildings using program-approved methods.
4. Non-residential Energy Audit (VA and NC. DSM Phase II): This program provides qualifying customers with an on-site energy audit by a contractor in Dominion Energy's contractor network in non-residential facilities. Customers receive a rebate once they provide documentation that recommended EE improvements have been made.

2.2 Report Structure

Section 3 of this report provides an overview of the methodology used in 2018 and the planned research activities for 2019. Sections 4 through 7 discuss the EM&V results of the different programs. In particular, Section 4 reviews the residential EE programs, Section 5 the non-residential EE programs, Section 6 the peak shaving programs, and Section 7 the closed programs. For each active program, DNV GL reports on the following:

1. Program description summary
2. Initial program-design planning assumptions
3. Methods used for the current reporting period
4. An assessment of program progress compared to plan, including:
    - cumulative indicators over time compared with planned indicators for program costs, participation, and resource savings (kWh/year and/or kW)
    - average indicators of program costs, participation, and resource savings

This report concludes with the following appendices:

1. Appendix A: Program Performance Indicator Tables for Virginia Programs 2010–2018
2. Appendix B: Program Performance Indicator Tables for North Carolina Programs 2011–2018
3. Appendix C: Program to Date Gross Energy Savings Tables for Virginia and North Carolina Programs 2010-2018
4. Appendix D: Program to Date Net Energy Savings Tables for Virginia and North Carolina Programs 2010-2018
5. Appendix E: Glossary of Terms
6. Appendix F: Standard Tracking and Engineering Protocols (STEP) Manual Version 9.0.0
7. Appendix G: Residential Income and Age Qualifying Home Improvement Program EM&V Plan

8. Appendix G-1: Residential Income and Age Qualifying Home Improvement Program Manual
9. Appendix H: Residential Retail LED Lighting Program EM&V Plan
10. Appendix I: Non-residential Lighting Systems & Controls Program EM&V Plan
11. Appendix J: Non-residential Heating and Cooling Efficiency EM&V Plan
12. Appendix K: Non-residential Window Film EM&V Plan
13. Appendix L: Non-residential Small Business Improvement Program EM&V Plan
14. Appendix M: Non-residential Prescriptive Program EM&V Plan
15. Appendix N: Residential Air Conditioner Cycling Program EM&V Plan
16. Appendix N-1: Residential AC Cycling Program, Impact Evaluation of 2018 Dispatch Events
17. Appendix O: Non-residential Distributed Generation Program EM&V Plan
18. Appendix O-1: Distributed Generation Program, Impact Evaluation of 2018 Dispatch Events

3 METHODOLOGIES

3.1 Calculation of the Value of Resources Saved

In the absence of a statewide protocol providing methods for calculating gross and net annual energy savings and demand reduction, Dominion Energy has contracted with DNV GL to develop the STEP Manual (Appendix F). The STEP Manual is a Dominion Energy-specific technical reference manual of engineering protocols for estimating gross annual electric energy savings and demand reductions.

The protocols are limited to per-unit annual energy savings and demand reductions at the measure level, and do not include the calculation for the value of resources saved. To calculate the value of the resource savings for reporting and other purposes, the energy savings are determined at the measure level, aggregated at the program level, and reported through this annual report. The savings are then increased by the amount of the transmission and distribution (T&D) losses to reflect the energy savings at the system level. Energy savings at the system level are then multiplied by the appropriate avoided costs to calculate the value of the benefits.

System savings = Savings at measure x T&D loss factor

Value of resources saved = System savings x System avoided costs

The durations of expected savings of installed measures are specified in terms of average expected measure life in years by program. They are discussed in more detail in Section 3.1.2, Measure Life, below.

3.1.1 Transmission and Distribution System Losses

These protocols calculate gross annual energy savings at the measure level, which should be increased by transmission and distribution (T&D) system losses in order to determine gross annual energy savings at the system level. The T&D loss factor multiplied by the savings calculated from the protocols will result in savings at the supply level.

The T&D electric loss factor is approximately 1.05 as a system-wide average (for both energy and demand), to be applied to savings at the customer meter. Dominion Energy provided this factor to DNV GL, which was developed internally for Dominion Energy's programs as part of its IRP process.

3.1.2 Measure Life

Program-level measure lives are provided in Table 3-1. They are also provided at the end of each section of the STEP Manual (Appendix F) for estimating lifetime savings for planning or in benefit-cost studies spanning more than one year. Measure lives were included in the initial planning assumptions as filed with the SCC and NCUC when each program was considered for approval. Program-level measure lives are a composite estimate of the associated measures that comprise the program.

Table 3-1. Measure life assumptions

Program	Measure Life (Years)
Residential Programs	
Residential Appliance Recycling	8.0
Residential Duct Testing and Sealing	18.0
Residential Heat Pump Tune-Up	5.0
Residential Heat Pump Upgrade	15.0
Residential Home Energy Check-up	10.0
Residential Income and Age Qualifying Home Improvement	15.0
Residential Lighting	9.4
Residential Low Income	13.6
Residential Retail LED Lighting	20.0
Non-residential Programs	
Non-residential Duct Testing and Sealing	25.0
Non-residential Energy Audit	7.0
Non-residential Heating and Cooling	15.0
Non-residential Lighting & Controls	9.0
Non-residential Prescriptive	6.3
Non-residential Small Business Improvement	14.0
Non-residential Window Film	10.0
Commercial HVAC Upgrade	15
Commercial Lighting	10
Peak Shaving Programs	
Residential AC Cycling	15.0
Non-residential Distributed Generation	N/A

3.1.3 Net Savings Estimation

The STEP Manual protocols are designed to estimate gross savings program impacts, or more specifically, the total amount of annual energy savings and demand reductions related to program activity. However, the amount of energy savings and demand reductions that can be attributed to the program is not the same as the estimated gross savings. This is because any given program's design can have intended and unintended outcomes. The amount of energy savings and demand reductions that can be attributed to the program is referred to as net savings, which is the magnitude of the impact of the program's intended outcomes.

The most common unintended outcomes of an energy efficiency (EE) or peak shaving program can be characterized as follows:

1. **Free-ridership:** program participants who consume the incentive, but were not influenced by the program through which the measure is delivered, thereby reducing gross savings.

2. **Participant "Like" Spillover:** past program participants who subsequently install those same program-eligible EE measures, but do not consume the incentive, having been already influenced by the program through which the measure is delivered, thereby increasing gross savings.
3. **Participant "Unlike" Spillover:** past program participants who subsequently install other EE measures not offered through the program, but who have been influenced by the original program, thereby increasing gross savings.
4. **Non-participant Spillover:** program non-participants who were influenced by the program through which the measure is delivered and implement the measure without consuming the program incentive, potentially increasing gross savings. The influence may happen upstream at the design or specification stage without the customer's input or knowledge. This is also commonly referred to as "free drivers."
5. **Leakage:** program non-participants who receive the measure and consume the incentive but install the measure outside of Dominion Energy's service territory, thereby reducing gross savings.
6. **Snapback:** program participants who receive the measure and consume the incentive, but alter behavior in such a way that the participants' or non-participants' energy and demand are higher than the baseline for the given measure.

Table 3-2 summarizes which unintended outcomes are included in DNV GL's impact evaluations.

Table 3-2. Status of Unintended Outcome Included in DNV GL Impact Evaluations

Unintended Outcome Category	Status of Impact Evaluations
Free-ridership	Included in all previous impact evaluations
Participant "Like" Spillover	Included only in the previous Non-residential Energy Audit program impact evaluation
Participant "Unlike" Spillover	Not included at this time
Non-participant Spillover	Not included at this time
Leakage	Not included at this time
Snapback	Not included at this time

The combination of all adjustments described above is typically referred to as the net-to-gross (NTG) factor. The NTG factor is summarized by program in

Table 3-3. In this report, default NTG ratios are the ex ante values specified by Dominion Energy. These values will be updated over time as NTG is measured for each program. NTG factors typically change as programs mature and extend beyond the early adopters to the mass market.

NTG factors may be estimated a number of ways. The energy efficiency evaluation industry discussions around various approaches are described in Chapter 21, Estimating Net Savings – Common Practices, [12] produced under the Uniform Methods Project: Methods for Determining Energy Efficiency Savings for

[12] Chapter 21: Estimating Net Savings – Common Practices. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. October 2017. https://www.nrel.gov/docs/fy17osti/68578.pdf. Accessed March 26, 2019.

Specific Measures,[13] for the U.S. Department of Energy and the general public. This document also references the Energy Efficiency Program Impact Evaluation Guide, which provides additional details.

Table 3-3. Net-to-Gross Factors and Sources by Program

Program	Net-to-Gross Factor	Source
Residential Programs		
Residential Income and Age Qualifying Home Improvement	80%	DNV GL, April 2015 for Dominion Virginia Power
Residential Retail LED Lighting	85%	Dominion Energy program design assumption
Residential Appliance Recycling	77%	Dominion Energy program design assumption
Residential Duct Sealing	80%	Dominion Energy program design assumption
Residential Heat Pump Tune-Up	90%	Dominion Energy program design assumption
Residential Heat Pump Upgrade	45%	DNV GL, April 2016 for Dominion Virginia Power
Residential Home Energy Check-up	82%	DNV GL, April 2016 for Dominion Virginia Power
Residential Lighting	65%	Dominion Energy program design assumption
Residential Low Income	94%	KEMA, April 2011 for Dominion Virginia Power
Non-residential Programs		
Non-residential Heating and Cooling	70%	Dominion Energy program design assumption
Non-residential Lighting Systems & Controls	70%	Dominion Energy program design assumption
Non-residential Prescriptive	85%	Dominion Energy program design assumption
Non-residential Small Business Improvement	93%	Program design assumption
Non-residential Window Film	80%	Program design assumption
Non-residential Duct Testing and Sealing	97%	DNV GL, April 2015 for Dominion Virginia Power
Non-residential Energy Audit	98%	DNV GL, April 2015 for Dominion Virginia Power
Commercial Lighting	50%	KEMA, October 2011 Commercial Lighting Program: Load Shape and Net Savings Analysis Evaluation Report
Commercial HVAC	45%	KEMA, April 2012 Commercial HVAC Program: Load Shape and Net Savings Analysis Evaluation Report
Peak Shaving Programs		
Residential AC Cycling	100%	KEMA, October 2011 Operability Study replaced net-to-gross. Required by PJM and not applicable in 2017

[13] Uniform Methods Project for Determining Energy Efficiency Program Savings. U.S. Department of Energy. https://www.energy.gov/eere/about-us/ump-home. Accessed March 26, 2019.

Program	Net-to-Gross Factor	Source
Non-residential DG	100%	

3.2 Data Quality and Validation

3.2.1 Methodologies

In cooperation with Dominion Energy, DNV GL has developed data quality and validation procedures to help ensure program data are consistent and accurate. Importantly, participant counts, gross annualized energy savings, and demand reduction result from engineering equations that use these validated data from the Company as inputs.

Program data used to calculate gross annualized energy savings must meet predefined data requirements as agreed upon by DNV GL, the Company, and the program implementation vendor. The data requirements are developed after a program is approved by the SCC or NCUC and before the program is launched. The program implementation vendor is responsible for program data collection and data entry. This data is then transferred to the Company's Business Intelligence (BI) database for quality control and verification. The Company then transfers EM&V-specific data to DNV GL. The data requirements define:

1. Variable name
2. Variable description
3. Data type (e.g., numeric, character, and date)
4. Maximum field length
5. Validation range (where appropriate)
6. Necessity of variable to compute savings

The validation range comes in the form of a structured list of acceptable text variables or a range for numeric variables. If the data contain a text variable that does not match the values defined in the structured list, then that record will not be processed. If the data contain a numeric variable that does not fall within the validation range, then that data is removed by the Company. The validation ranges were carefully constructed to exclude unrealistic records while not excluding unusual records.

Each month the data is reviewed for the following:

1. **Are the correct data being collected for EM&V purposes?** This would include the data containing the requisite database fields for calculations using the STEP Manual (Appendix F) and for future sampling needs for data analysis, modeling, and survey research.
2. **Are the data well populated?** Large databases are rarely completely populated, but some data are critical and cannot be overlooked.
3. **Are the data generally consistent with expectations according to range and consistency checks?** Any exceptionally large or small values are noted and verified where appropriate.

At least annually, DNV GL conducts two types of quality checks on the code and the results to confirm that they are consistent with engineering expectations and the STEP Manual protocols. These activities check for

outliers in the data at a macro level and individual record level results for consistency with the intentions of the protocols.

Additionally, DNV GL and the Company work closely together to review DSM program participant data on a monthly basis. DNV GL also has all of the Company's historic DSM program data and results since program inception, which are further utilized to check and audit historic calculations annually when the STEP Manual is updated and make corrections as necessary in the year-end reporting.

All of these activities are intended to ensure the highest level of data integrity.

3.2.2 Adjustments and/or Corrections to Prior Year Calculations

DNV GL made adjustments and corrected savings calculations that affected the reported savings for program year 2017 for the Residential Retail LED Lighting Program that were reported in the May 1, 2018 EM&V report. These corrections were substantial, and warranted correcting the 2017 program data retroactively. These corrections were resubmitted to Commissions in Virginia and in North Carolina in 2018. The following tables summarizes those changes:

1. Table 3-4 describes the adjustments that were made, the location in the May 1, 2018 EM&V report, and a brief explanation of the reason for the correction.
2. Table 3-5 describes the impacts of the adjustments made to values reported in the May 1, 2018 version of the EM&V report.

Table 3-4. Explanation of Adjustments

Appendix Section and Title in May 1, 2018 EM&V Report	Location of Correction	Reason for Correction
1. Adjustments to the Residential Retail LED Lighting Program annual hours of use value in the 2017 deemed savings equation, and net-to-gross factor in the 2017 net adjusted savings calculations.		
Appendix F. Section 17, Residential Retail LED Lighting Program	Table 128. Input Parameter for LED Lighting Savings	Adjusted hours of use per year (HOU) value from 1,059 hours/year referenced in the Opinion Dynamics "Evaluation of the PH2015 Duke Energy Progress Energy Efficient Lighting Program" report (Dec. 5, 2016) to 920 hours/year referenced in the Northeast Energy Efficiency Partnership Mid-Atlantic Technical Reference Manual Version 7.0 (May 2017)
Appendix B.6. North Carolina Residential Retail LED Lighting Program 2017	Net-to-Gross (NTG) Adjustment Factor	Error correcting for the misapplication of the Non-residential Small Business Improvement NTG factor of 93% to the Residential Retail LED Lighting Program. Corrected NTG to 85%, per program initial design assumptions, as documented in Table 3-3. Net-to-Gross Factor and Sources by Program, and Table 4-20. Residential LED Lighting Program Planning Assumptions in North Carolina of the EM&V report.
2. Results from the adjustments in North Carolina.		
B.6. North Carolina Residential Retail LED Lighting Program 2017	2017 Total Net Adjusted Savings (kWh/year) and Total Net Adjusted Demand Reduction (kW) values and all other values that are derived from them	These are the updated savings that resulted from edits to the Appendix F, Residential Retail LED Lighting Program HOU value, and the residential retail lighting program NTG factor value as mentioned above.
3. Cumulative results from the adjustments in North Carolina.		
C.7. Residential Retail LED Lighting Program 2017	All Table 1-5, 2017 Net kWh and Net kW values, and all other values that are derived from them.	Same reason as for B.6 above.
D.7. Residential Retail LED Lighting Program 2017	Same as for C.7 above.	Same reason as for B.6 above.

Table 3-5. Impact of adjustments

Program	State and Appendix Number in May 1, 2018, report and this report	Category	May 1, 2018, Reported 2017 Year-End Gross Value	Adjusted 2017 Gross Year-End Value (Should match 2017 Gross Year-End Value)	Difference	Difference in %, from May 1, 2018, Reported Value
Residential Retail LED Lighting Program 2017	North Carolina Appendix B.6.	Total Net Adjusted Savings (kWh/year)	2,371,259 kWh/year	1,882,812 kWh/year	-488,447 kWh/year	-21%
		Total Net Adjusted Reduction (kW)	225 kW	206 kW	-19 kW	8%

3.3 Research Activities through 2018

The EM&V approach incorporates deemed annualized energy savings and demand reduction calculations outlined in the STEP Manual (Appendix F), customer surveys, billing analyses using customer data, and on-site evaluations at customer homes and businesses. Each year, as scheduled in the EM&V plans, DNV GL undertakes various research activities across the Company's DSM programs to evaluate each program through impact evaluations. The following research activities are used to evaluate the DSM programs:

- **Data Quality Review:** DNV GL reviews the program tracking data to ensure they have all the necessary information to compute savings and to feed into potential future evaluation research data requirements. DNV GL performs data quality review on a monthly basis throughout the year for all programs and performs an in-depth data quality check at least twice a year for all programs. Section 3.2 provides more details about the data quality reviews that DNV GL conducts.
- **Deemed Savings Calculations:** DNV GL estimates energy savings and demand reductions across programs with standardized calculations and assumptions outlined in the STEP Manual. DNV GL tracks deemed estimates for all programs on a monthly basis throughout the year and reports draft deemed estimates to Dominion Energy each month.
- **Satisfaction Surveys:** Satisfaction survey questions help the Company determine how satisfied its customers are with the programs it offers. These questions generally cover satisfaction with the program as a whole, the rebate application and payments, and, if applicable, the contractors used. This survey is often combined with an NTG estimation or verification survey (sometimes both) to reduce the number of interactions with, and burden on the participant.
- **Billing Analysis:** This approach applies Company-specific customer usage data to actual participating households or facilities to quantify annualized energy savings and demand reductions for a program. DNV GL analyzes monthly billing data from households or facilities for at least a 12-month period before and after the audit/install date of a program measure. The savings calculated from this method allow DNV GL to create an adjustment factor to the engineering algorithms known as a realization rate. This realization rate is then applied to future deemed calculations for savings.
- **NTG Estimation Surveys:** Depending on the program design and the evaluation methodology used, survey research methods can be used to estimate the NTG factor, which is the percentage of savings that are attributable to the program because participants would not have performed the program measures in the absence of the program. This survey is often combined with the satisfaction and verification surveys, and conducted during a single interaction with the participant and/or contractor.
- **Verification Surveys:** Survey verification questions help verify the customer did participate in the program and install any or all measures as recorded in the tracking data. The survey results are used to calculate a verification rate that is applied to the deemed savings. This survey is often combined with the satisfaction survey and NTG-estimation survey and conducted during a single interaction with the participant.
- **On-site Verification:** This occurs when a member of the evaluation team visits a random selection of sites and verifies that the measures are actually installed. This may be used in conjunction with or in place of verification surveys to help the Company verify program participation and measure installation. The savings calculated from this method, in combination with other activities, allow DNV GL to create an adjustment factor to the engineering algorithms known as a realization rate. This realization rate is then applied to future deemed calculations for savings.

- **On-site Measurement:** This is physical verification of an installed measure's power load and energy usage through the use of metering equipment. The measurement results help make deemed savings calculations more accurate and precise. The savings calculated from this method, in combination with other activities, allow DNV GL to create an adjustment factor to the engineering algorithms known as a realization rate. This realization rate is then applied to future deemed calculations for savings.
- **Building Simulation Modeling:** When on-site measurement is not available at the measure-level, or where interactive effects of multiple installed measures cannot be determined, modeling is used to more accurately determine measured power load and energy usage of multiple measures installed at a single site. Like on-site measurement, the results of modeling help the Company to adjust its deemed savings calculations through a realization rate adjustment.
- **Load-Shape Analysis:** The Company conducts a load-shape analysis using data from a combination of data inputs (e.g., on-site verification, on-site measurement, and modeling) to determine each program's annual power load profile for the Company-specific system peak and for PJM-defined performance periods.[14]

Table 3-6 provides an overview of the research activities conducted for each program through the end of 2018. The years listed in the table represent the year that the EM&V study report was published. All programs undergo data quality review and evaluation using deemed calculations.

[14] PJM is the Company's regional transmission organization (www.pjm.com).

Table 3-6. EM&V Research Activities Conducted Through 2018 by Program

Program	Data Quality Review	Deemed Savings Calcu-lations	Billing Analysis	Satis-faction Survey	Verifi-cation Survey	NTG Studies	On-Site Verifi-cation	On-Site Meas-ureme nt	Building Simula-tion Modeling	Load-Shape Analysis	Other
Residential Programs											
Residential Income and Age Qualifying Home Improvement	2016-present	2016-present								2016-present	
Residential Retail LED Lighting	2017-present	2017-present								2017-present	
Non-residential Programs											
Non-residential Heating & Cooling	2015-present	2015-present								2015-present	
Non-residential Lighting Systems & Controls	2015-present	2015-present								2015-present	
Non-residential Prescriptive	2017	2017								2017-present	
Non-residential Small Business Improvement	2016 - present	2016 - present								2016 - present	
Non-residential Window Film	2015-present	2015-present								2015-present	
Peak Shaving Programs											
Residential AC Cycling	2010-present	2010-present	2012-present				10/2011			2015-present	
Non-residential Distributed Generation	2013-present	2013-present	2013-present							2015-present	
Closed Programs											
DSM Phase I											
Commercial HVAC (Closed)	2010-2013, 2015	2010-2013, 2015				4/2012	4/2012	4/2012			
Commercial Lighting (Closed)	2010-2013, 2015	2010-2013, 2015				4/2012	4/2012	4/2012			
Residential Lighting (Closed)	2010-2012	2010-2012									Retail sales survey (4/2011)
Residential Low Income (Closed)	2010-2016	2010-2016	4/2012-2014	4/2011		4/2011					
DSM Phase II											
Residential Duct Sealing (Closed)	2012-present	2012-present		2015	2015					2015-present	
Residential Heat Pump Tune-Up (Closed)	2012-present	2012-present		2015	2015					2015-present	

Program	Data Quality Review	Deemed Savings Calcu-lations	Billing Analysis	Satis-faction Survey	Verifi-cation Survey	NTG Studies	On-Site Verifi-cation	On-Site Meas-ureme nt	Building Simula-tion Modeling	Load-Shape Analysis	Other
Residential Heat Pump Upgrade (Closed)	2012-present	2012-present		2015, 2016	2015, 2016	2015, 2016	2015, 2016	2015, 2016		2015-present	
Residential Home Energy Check-Up (Closed)	2012-present	2012-present	2015-2016	2015, 2016	2015, 2016	2016				2015-present	
Non-residential Duct Testing and Sealing (Closed)	2012-present	2012-present		2015	2015	2015	2015			2015-present	
Non-residential Energy Audit (Closed)	2012-present	2012-present		2015	2015	2015	2015	2015		2015-present	
DSM Phase IV											
Residential Appliance Recycling (Closed)	2016-present	2016-present								2016-present	

3.4 Planned Research Activities in 2019

In 2019, DNV GL will begin a new cycle of EM&V activities for all of Dominion Energy's active programs. Those activities will be the same as the activities conducted for 2018, as shown above in Table 3-6. An in-depth description of the planned activities for each program is provided in Appendices G through O of this report.

The SCC issued its order regarding new rules governing the EM&V of the effects of utility-sponsored DSM programs (Case No. PUR-2017-00047) on November 9, 2017. The new rules apply prospectively to new or renewing DSM programs starting from the order date. As of this EM&V report, the DSM Phase IV Residential Income and Age Qualifying Home Improvement Program is the only program that is affected by this new rule.

4 ENERGY EFFICIENCY PROGRAMS – RESIDENTIAL

This section reports on 2018 program progress for two residential energy efficiency programs. The Residential Income and Age Qualifying Home Improvement Program (DSM Phase IV) was available to customers in both Virginia and North Carolina. The Residential Retail LED Lighting Program (DSM Phase V) was only available in North Carolina. This will be the last EM&V report that will report on program progress for the Retail LED program, because it will be closed as intended. The program was available to customers for two years.

Of the active programs in 2018, the 2018 residential EE programs accounted for the following proportions out of the portfolio of EE programs:

- 99% of all program participants across the Company's program year 2018 active residential and non-residential programs (excluding the Residential Retail LED Lighting program, because participation in that program is measured in lamps rather than households);
- 7% of net annualized savings across all active program year 2018 programs; and

10% of spending Figure 4-1 and Figure 4-2 show the cumulative count of residential EE program participation and gross annualized energy savings in the two states, at the county level, and for the programs that were active in program year 2018. The participation map does not include the Residential Retail LED Lighting program.[15] The deeper the color, the greater the participation and gross annualized energy savings.

The top three jurisdictions in Virginia with the highest participation are Chesapeake City, Henrico, and Fairfax, in decreasing order. In North Carolina, the top three jurisdictions (in decreasing order) with the highest participation are Halifax, Northampton, Martin.

In terms of energy savings, the top three jurisdictions in Virginia with the highest gross annualized energy savings (in decreasing order) are Henrico, Chesapeake City, Newport News City. And in North Carolina the top three jurisdictions (in decreasing order) with the highest energy savings are Dare, Hertford, Pasquotank.

[15] Program data not available in the format required to be included in maps.

Figure 4-1. VA and NC Residential Energy Efficiency Program Participation Map, by County, Inception to December 31, 2018

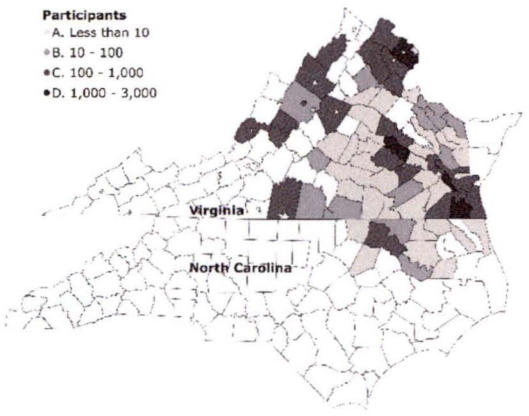
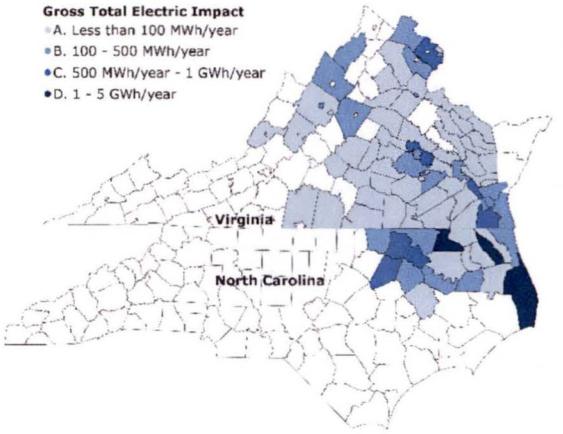


Figure 4-2. VA and NC Residential Energy Efficiency Program Gross Annualized Energy Savings Map, by County, Inception to December 31, 2018



4.1 Residential Income and Age Qualifying Home Improvement – Virginia and North Carolina

The Residential Income and Age Qualifying Home Improvement Program provides direct-install EE improvements to eligible age- and income-qualifying homeowners to reduce electric usage in Dominion Energy's service territory. To qualify for the Program, a customer must meet the following eligibility requirements:

- Customer must be a current Dominion Energy or a new service customer intending to receive electric services on a residential rate schedule; and either
- Customer must have a total household income that does not exceed 60% of the Virginia Median Income; or
- Customer is 60 years or older with a total household income that does not exceed 120% of the Virginia Median Income.

Both owner - occupied and renter - occupied households are eligible to participate in the Program. Eligible customers must be responsible for the electric bill and either own the home or be able to secure permission from the owner to perform the Program-qualifying installations or improvements.

Customer measures receiving incentives through this Program are not eligible to receive incentives through any other programs offered by Dominion Energy. In addition, only one application may be submitted per household. Eligible customers must be living in single family residences, townhomes, mobile homes, and separately-metered multi-family dwellings (apartments and condominiums) with electric or non-electric

heating and electric cooling. Multi-family facilities owned by local housing authorities are not eligible under the Income and Age Qualifying Home Improvement Program.

To participate in the Program, Dominion Energy customers can contact Dominion Energy-approved weatherization service providers. These weatherization service providers also go door-to-door in some areas of the Dominion Energy service territory to promote the Program. The energy-saving products may include:

- Maximum of 6 ENERGY STAR® qualified LED light bulbs (screw base) replacing incandescent (CFL's are not eligible)
- Energy-saving showerhead(s)
- High-efficiency faucet aerators
- Pipe wrap insulation for hot water pipes
- Added attic insulation

The official program start dates were May 1, 2015 for the Virginia Program and January 1, 2016 for the North Carolina Program. The participation tracking did not begin until July of the program start year in both states because of the lag between enrollment and becoming a tracked participant, which may take several months. This program was designed to expire in Virginia in early 2018. On May 10, 2018, the Virginia State Corporation Commission approved this program to be extended for three years (Case No. PUR-2017-000129), and later it was approved in North Carolina to restart on July 1, 2018 (Docket No. E-22, Sub 523). The assessment of this program used the algorithms and assumptions specified in the STEP Manual (Appendix F). This year is a transition year where the final 2017 customer applications and tracking data made their way into the EM&V stream in January 2018. There were a period of months with no activities, and once the program extension was approved participation began to grow again at the end of 2018.

This is the first reporting year (2018) and the first DSM program that must meet reporting requirements outlined in the recently adopted EM&V Rule, in Virginia.[16] Table 4-1 maps the applicable sections in this report to reporting requirements listed in the EM&V Rule section 50, "Standard Requirements for Evaluation, Measurement, and Verification Reporting"

Table 4-1. Residential Income and Age Qualifying Home Improvement Program Compliance with EM&V Rule Section 50

Subsection within 20 VAC 5-318-50	Location in This Report and Description
A. EM&V Plan	Appendix G. EM&V Plan
B. Utilizing utility-specific data or other data	**Per 20 VAC 5-318-40 A and B** 1. See Appendix F. STEP Manual v 9.0.0 for a description of all data or estimates used as inputs for this program and the measures within it. 2. See the Methodologies section (section 3) of this report for a description of the overarching EM&V methodologies used to report results in this report. **Per 20 VAC 5-3-18-40 C**

[16] 20 VAC 5-318-10

Subsection within 20 VAC 5-318-50	Location in This Report and Description
	3. See subsections of this report section, and Table 4-5. for measure-level estimates of kilowatt and kilowatt-hour, before and after adjustments for free-ridership, as appropriate.
C. Changes to measure-level inputs and assumptions, and inputs to cost/benefit estimates	1. See Table 4-2 for program planning assumptions 2. See documents filed with the Virginia State Corporation Commission fo Docket PUR-2017-00129 for approved measure-level inputs and assumptions, and the impact of such changes on original cost/benefit estimates for DSM programs or measures.
D. Measure-level data collection methodology	See response to A. and B. above.
E. Explanation of eligibility requirements for each rate schedule that program is offered	See program description above.
F. Comparison of measured annual measure or program savings estimates to the annual usage of the average rate schedule usage, and eligible customer in each rate schedule	See section 0, Comparison of Savings with Usage in Virginia
G. Explanation of controls undertaken by utility	See Appendix G-1, "Dominion Energy Income and Age Qualifying Home Improvement Program Manual"

4.1.1 Methods for the Current Reporting Period

DNV GL developed an EM&V Plan for this program, which is included in Appendix G. For the current period, the approach included reviewing the tracking data and then estimating net energy savings and demand reduction using STEP Manual calculations. Table 4-2 outlines Dominion Energy's initial program planning assumptions that were used to design the program in the first iteration of the program, and in the most recent program extension.

Table 4-2. Residential Income and Age Qualifying Home Improvement Program Planning Assumptions System-wide

Item	Description (Original)	Description (Extension)
Target Market	Income and age-qualifying residential customers	Income and age-qualifying residential customers
NTG Factor	80%	80%
Measure Life	14 years	15 years
Average Energy Savings (kWh) per Participant per Year	873 kWh/year·participant	464 kWh/year·participant
Average Coincident Peak Demand Reduction (kW) per Participant	0.21 kW/participant	0.09 kW/participant
Average Rebate (US $) per Participant	n/a	n/a

4.1.2 Assessment of Program Progress Towards Plan

The next section describes the program's progress towards planned participants, energy savings, and demand reductions.

4.1.2.1 Key Virginia Program Data

Key data highlights for enrollment, energy savings, demand reduction and program costs for Virginia in 2018 are provided below. Following this summary, Table 4-3 provides performance indicator data from 2015 through December 31, 2018. Detailed program indicators by year and month are provided in Appendix A.1.

Enrollment in the extended program began late in the year (September 2018). Therefore, annual participation rates were lower than planned. Despite lower than planned participation, the net annualized energy savings (kWh/year), and net demand reduction (kW) were higher than planned in the first year since program extension approval, and cumulatively after four years of program implementation.[17]

- From August 2018 onward, after the program was extended, the program enrolled 1,141 participants, achieving 57% of its participation goal.
- In total, from 2015 through 2018, program participation has exceeded goals, at 148% of plans.

- Total annual net energy savings in 2018 were 358,220 kWh/year, which was 204% of plans. Total annual net demand reduction was 28 kW, where no demand reductions were expected for 2018.
- Total annual net energy savings from 2015 through 2018 were 5,951,388 kWh/year, which was 159% of plans. Total annual net demand reduction over the same period was 593 kW, 74% of plans.
- Average annual gross energy savings and demand reduction per participants were 437 kWh/year and 0.03 kW.
- Average annual net savings per participant, in 2018, was 314 kWh/year, which is less than initially assumed. Average demand reduction per participant over the same period was 0.03 kW. The net savings was calculated by applying the realization rate of 100% and the assumed NTG ratio of 80% to the gross savings. Both rates are from the initial program planning assumptions.
- Average annual net savings per participant from 2015 through 2018 was 349 kWh/year, which is less than initially assumed. Average demand reduction per participant over the same period was 0.03 kW.

[17] Enrollment in January of 2018 are a result of 2017 year-end participants whose applications and tracking data from the first itineration of the program entered the EM&V stream in January.