Dominion Energy Efficiency Potential Study: 2020 to 2029

Dominion Energy

Date: September 17, 2021

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Glossary

Achievable potential: The amount of savings that would occur in response to specific program funding and measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.

Applicability factor: The percentage of the building stock that has a particular type of equipment or for which an efficiency measure applies. For example, the applicability factor for a tankless electric water heater (compared to a base standard electric water heater) is the percentage of homes with electric water heaters. The applicability factor for high-efficiency clothes washers as an electric water heating measure is the percentage of homes with electric water heating that also have a clothes washer. For base measures, this is sometimes referred to as the equipment saturation.

Business-as-usual (BAU): Represents a continuation of current activities or trends. For utility programs, it denotes a scenario in which program marketing and administrative budgets are kept constant in real terms, and incentive levels are kept constant as a percentage of incremental costs.

Base+: Denotes an achievable potential scenario where budgets are maintained as in the BAU scenario, but unlike the BAU scenario all measures that passed the economic screening are included in the analysis, not just measures currently in programs. Added measures receive an incentive level comparable to existing program measures.

Baseline analysis: Characterizes how energy consumption breaks down by sector, building type, and end use.

Base measure: The equipment against which an efficiency measure is compared.

C&I: Commercial and industrial.

CBECS: US Energy Information Agency (EIA) Commercial Buildings Energy Consumption Survey

CFL: Compact fluorescent lamp.

CDA: Conditional Demand Analysis.

Coincidence factor: Utility coincidence factors are the ratio of actual demand at utility peak to the average demand, as calculated from the load shape. These factors vary by market segment or building type, end use, and by time-of-use period.

Cumulative annual: Savings occurring in a particular year that are due to cumulative program activities over time. For example, if a program installs one high-efficiency widget in year 1 of the program, two in year 2, and five in year 3, the cumulative annual savings in year three would be the savings accruing on all eight surviving units in place in year 3, regardless of what year they were installed. Cumulative annual savings does account for equipment retirement. In the example above, widgets are assumed to have an effective useful life of more than three years. If the equipment in the above example were doohickeys, which only have a two-year effective useful life, the year 1 doohickey would have retired at the end of year 2, so only the units sold in years 2 and 3 would contribute to year 3 cumulative annual savings.

Demand-side management (DSM): An electric system must balance the supply of electricity with the demand for electricity. Demand-side management (DSM) programs focus on managing the demand side of this balance through energy-efficiency and load management.

DOE: U.S. Department of Energy.

Economic potential: The technical potential of those energy conservation measures that are cost effective when compared to supply-side alternatives.

Effective useful life (EUL): A measure of the typical lifetime of an efficiency measure. Technically, it is the age at which half of the units have failed and half survive. In DNV's ASSYST™ model, all measures are assumed to remain in place until the end of their effective useful lives and then retire.

End-use energy intensity (EUI): Energy use per unit of building stock having a specific end use. For example, the EUI for commercial electric heating is the amount of electricity used for heating divided by the number of square feet of floor space that are electrically heated. EUI differs from EI in that it accounts for the equipment type's saturation. If the saturation of the equipment type is low, the EUI will be much higher than the EUI.

Energy intensity (EI): Energy use per unit of building stock. For example, the EI for commercial electric heating is the amount of electricity used for heating divided by the total square feet. EI differs from EUI in that it does not account for the saturation of the equipment. If the saturation for the equipment type is low, EI will be much lower than the EUI.

EUI adjustment factor: Because equipment efficiencies can change over time independent of program activities, due to either naturally occurring technological changes or external intervention, such as appliance standards, the efficiency of new equipment may differ from the typical efficiency of the equipment stock. The EUI adjustment factor is the ratio of new standard efficiency equipment's energy use to the average energy use of units in the equipment stock.

Feasibility factor: The fraction of the applicable floor space, or households, that is technically feasible to convert to a DSM technology, from an engineering perspective.

Free rider: A program participant who would have invested in an energy efficiency measure even without the intervention of the program. Free riders add to program costs but do not contribute to net energy savings.

Free-rider energy savings: The subset of naturally occurring energy savings for which the utility pays incentives or provides other program benefits. These savings are included in gross program savings but not in net program savings.

Gross program savings: The total savings for all measures installed under the program, including those that would have been installed even without program intervention (free riders). Gross program savings equals net program savings minus free ridership.

HP: Horsepower. A metric for the power of a motor.

HVAC: Heating, ventilation, and air conditioning. These space-conditioning measures are often discussed as a group and are referred to by the abbreviation HVAC, usually pronounced H-vac.

Incomplete factor: The fraction of the applicable floor space, or households, that has not yet been converted to the particular energy-efficiency technology.

Incremental cost: The additional cost required to purchase an efficiency measure compared to base equipment.

kW: kilowatts, 1,000 watts. A measure of electric power or electricity demand.

kWh: kilowatt-hour. A measure of electrical energy.

LED: light-emitting diode. LEDs are semiconductor light sources. They have been in use for decades as indicator lights; they are increasingly being used for general-purpose lighting. They are highly efficient compared to incandescent lamps.

Line losses: When electricity is transmitted over the transmission and distribution system, some of the electricity is dissipated as heat due to resistance in the transmission lines or inefficiencies in transformers in the distribution system. As a result, the amount of electricity delivered to consumers is less than the amount produced at the generator. These are referred to as line losses or transmission and distribution losses.

MW: Megawatt, one million watts. A measure of electric power or electricity demand.

MWh: Megawatt-hour, equal to 1,000 kWh. A measure of electrical energy.

NAICS: The North American Industry Classification System is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

Naturally occurring energy savings: The amount of savings estimated to occur as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

Net program savings: Program savings above and beyond naturally occurring levels. Net savings exclude free-rider energy savings.

Net-to-gross: The ratio of net program savings to gross program savings.

Program potential: This term is used interchangeably with achievable potential.

RASS: Residential Appliance and Saturation Survey.

RECS: EIA Residential Energy Consumption Survey.

Replace on burnout (ROB): A measure that is installed when the previous equipment reaches the end of its useful life. ROB measures penetrate the market gradually as the existing stock of equipment turns over due to equipment age and eventual failure.

Retrofit: A measure that is installed to achieve energy savings independent of the condition of the existing equipment. This includes measures that affect the energy use of other equipment, such as insulation to reduce heating costs. It also includes replacing equipment with higher efficiency equipment before the end of existing equipment's useful life, for example replacing T12 fluorescent lighting in an office with higher efficiency T8s. Retrofits can be done at any time and therefore have the potential to penetrate the market more quickly than ROB measures.

Technical potential: The savings that would result from complete penetration of all analyzed measures in applications where they were deemed technically feasible, from an engineering perspective.

Technology saturation: A factor that relates the cost units used in the model for a measure to its savings units. For example, the cost of a chiller may be expressed in dollars per ton, though the savings are in kWh per square foot. The technology saturation then represents the number of tons of cooling per square foot.

Time-of-use (TOU) period: The Assyst model can analyze energy use by up to six time-of-use periods. These periods are used to characterize the relationship between energy and peak demand, which varies over both season and time of day, and to capture differences in avoided costs and rates over different time periods. TOU periods usually capture differences between summer/winter and peak/off-peak but can also capture shoulder season, mid-peak, or super peak demand, depending on the needs of a utility.

Total resource cost test (TRC): A benefit-cost test that compares the value of avoided energy production and power plant construction to the costs of energy efficiency measures and the program activities necessary to deliver them. The values of both energy savings and peak-demand reductions are incorporated in the TRC test.

UEC: Unit energy consumption.

1 SUMMARY

Dominion Energy (Dominion) engaged DNV to assess the potential for electric energy (kWh) and demand (kW) savings from company-sponsored demand side management (DSM) programs over a 10-year horizon from 2020 to 2029 in its Virginia and North Carolina service territories. The assessment produced:

- Estimates of the magnitude of potential savings on an annual basis
- Estimates of the costs associated with achieving those savings
- Calculation of the cost-effectiveness of the programs based on the estimates above.

DNV used its proprietary model, DSM ASSYST™, to produce these outputs.

DNV used data collected under previous studies in 2013, 2016, and 2017, and newly updated data for 2020. Those studies included mail surveys of residential and commercial customers; a residential conditional demand analysis; and review, interpretation, and analysis of data provided to DNV by Dominion staff.

1.1 Scope and Approach

The study reviews new and existing residential and commercial buildings during a 10-year timeframe, from 2020 through 2029. The energy efficiency potential elements of the study sought to identify and develop baseline end-use and measure data, then complete estimates of future energy-efficiency impacts under varying levels of program effort. DNV compared the estimates against a business-as-usual baseline scenario. The analysis leveraged DNV's DSM ASSYST™ model, which provides a thorough, clear, and transparent estimate of technical, economic, and achievable potential for energy efficiency impacts. The study also considered potential impacts across service territory located in both Virginia and North Carolina.

1.2 Energy Efficiency Potential

This study estimated three basic types of energy efficiency potential:

- Technical potential: The complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective.
- Economic potential: The technical potential of those energy efficiency measures that are cost-effective when compared to supply-side alternatives.
- Achievable program potential: The amount of savings that would occur in response to specific program funding, marketing, and measure incentive levels. In this study, we looked at the potential available under two funding scenarios: 50% and 75% incentivization of measure costs.[1] The achievable scenarios also included an expansion of Dominion's Income and Age-Qualifying Home Improvement program to comply with the requirements of the Virginial Clean Economy Act (VCEA).[2] Incentives for the Income and Age-Qualifying program were set to 100% for all incentive scenarios.

DSM ASSYST™ develops an estimate of naturally occurring savings, i.e., those savings that are projected to result from normal market forces in the absence of any intervention by utility sponsors. These savings are not included in the estimate of achievable program potential.

The method used for estimating potential is a "bottom-up" approach, in which energy efficiency costs and savings are assessed at the customer segment and energy efficiency measure-levels. For cost-effective measures based on the total resource cost (TRC) test, program savings potential was estimated as a function of measure economics, incentive levels,

[1] These scenarios reflect the percentage of incremental measure cost that is assumed to be paid in customer incentives.

[2] The bill states, "Each incumbent investor-owned electric utility shall develop proposed efficiency programs…At least 15 percent of such proposed costs of energy efficiency programs shall be allocated to programs designed to benefit low-income, elderly, or disabled individuals or veterans." VCEA full text is at https://lis.virginia.gov/cgi-bin/legp604.exe?201+ful+HB1526ER.

and program marketing and education efforts. The modeling approach was implemented using DNV's DSM ASSYST™ model. This model allows for efficient integration of large quantities of measure, building, and economic data to determine energy efficiency potential.

As noted above, DNV estimated the results of program efforts under two incentive scenarios. One scenario assumed that 50% of incremental measure costs (50% scenario) are paid out by Dominion in customer incentives. The second scenario allowed for incentives covering 75% of incremental measure costs (75% scenario). Program marketing costs were scaled upward across scenarios to reflect increasing program effort, and program administration costs were adjusted across scenarios proportional to achievable program energy savings. Program energy and peak-demand savings, as well as program cost effectiveness, were assessed for each of these funding scenarios. Each of the scenarios was run separately for Dominion's service areas located in Virginia and North Carolina.

Estimating energy efficiency potential for Virginia is complicated by the existence of multiple legislatively-defined categories of customers given different treatment with respect to Virginia's energy efficiency rider and program eligibility:

- Non-jurisdictional customers include state and local government entities. These customers do not pay the energy efficiency rider and are not eligible for programs.
- Federal customers (military and federal agencies) pay the same benefits charge, but the funds go into a separate pool rather than being comingled with the funds from other customer types. The federal pool of funds is used only for federal customer and federal projects are only accepted up to the level of that funding. Federal customers participate under the same programs; only the source of incentive funds differs.
- Under the Virginia Clean Economy Act of 2020 (VCEA), non-residential electricity customers with demand of more than 1 MW[3,4] may apply for an exemption from energy efficiency programs if they independently implement energy efficiency at their own expense. Throughout this report, we will refer to customers using more than 1 MW as "opt-out eligible" and customers receiving the exemption as "opt-out customers."
- All other customers (jurisdictional, opt-out ineligible) pay the public benefits charge and are included in energy efficiency programs.

The study treats non-jurisdictional customers and federal customers together as a building type for modeling purposes. These customers are excluded from all potential estimates.

Customers submitted applications for exemption from March 30 to April 9, 2021. Dominion reviewed the applications for completeness and to confirm eligibility, and a total of 17 customers were accepted for opt out. These customers represented 75 accounts and together consumed 4,547 MWh between July 2020 and June 2021. This represented approximately 33% of the total consumption for customers eligible to opt-out.

Some applications were rejected for being incomplete, and those customers may reapply next year. In addition, the time window between when eligibility criteria, rules, and the application process were finalized and applications were due was short, so additional customers may choose to apply with additional time. As a result, the eventual number of, and consumption of, opt-out customers may increase in the future. To address this uncertainty, we developed a set of sensitivity scenarios with different percentages (50%, 75%, and 100%) of opt-out-eligible customers receiving the exemption. We present the three sensitivity scenarios with the current 33% opt-out level in our high-level results, but only the 33% opt-out case as our primary reporting case for detailed results. In our primary reporting, the 67% of eligible customers who do not

[3] The VCEA defines large general service customers as having "a verifiable history of having used more than one megawatt of demand from a single site." https://legiscan.com/VA/text/SB851/2020

[4] Non-jurisdictional and federal customers are separate categories under Virginia's energy efficiency legislation. The opt-out process applies only to non-federal jurisdictional customers.

choose to or do not meet additional requirements[5] to opt out will be included with ineligible customers and characterized simply as non-residential.

1.3 Results

Table 1-1 presents the overall results of the energy efficiency potential analysis for the 2020-2029 period. All efficiency results include line losses.[6]

Table 1-1. Summary of Cumulative Energy Efficiency Savings

Energy Efficiency 2020-2029	Technical Potential	Economic Potential	Program Savings Potential: 50% Scenario	Program Savings Potential: 75% Scenario
Virginia*				
Energy Savings (GWh)	23,428	10,732	2,516	3,498
Demand Savings (MW)	2,469	1,408	192	268
Program Costs – Real ($Million)			$1,230	$1,824
North Carolina				
Energy Savings (GWh)	1,445	800	89	129
Demand Savings (MW)	136	78	6	11
Program Costs – Real ($Million)			$28	$41

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Key takeaways from this study are as follows:

- Dominion has a lower range of program savings potential (achievable potential) as a percent of base load compared to other potential studies conducted by DNV. This is mainly driven by Dominion's low avoided costs, which make a challenging environment for DSM programs and measures to demonstrate cost-effectiveness.
- Compared to the 2017 Dominion potential study conducted by DNV, technical and economic potential are lower as proportion of base, as is achievable potential for both the 50% and 75% incentive scenarios. This is due to a decrease in avoided costs and reduced opportunities for lighting savings due to rapid market transformation of the lighting market to LEDs.
- Cost-effective residential cooling savings declined 19% due a decrease in the avoided cost benefit for summer capacity reduction compared to the previous studies. The prior study calculated all avoided capacity benefits based on summer peak reductions. The current study calculates avoided generation capacity based on summer peak reductions, avoided transmission costs based on winter peak reductions, and avoided distribution costs based on the average of the summer and winter reductions. These avoided costs are in line with how Dominion currently incurs costs for these three types of capacity.
- For residential measures, forecasts of lighting savings have decreased substantially since 2017 due in part to the rapid adoption of higher-efficiency LED bulbs. Space cooling now has the highest savings among residential end uses. Lighting savings potential now also lags behind the potential for several other residential end-uses, including furnace fans, space heating, refrigeration, behavioral measures, and new construction.
- Indoor and outdoor lighting, ventilation, and cooling are key areas of potential energy savings in the commercial sector.

[5] The VCEA additionally requires that to qualify for exemption, customers must demonstrate that they have implemented energy efficiency programs at their own expense that have delivered measured and verified savings within the prior five years. The VCEA tasks the Virginia State Corporation Commission with establishing specific rules and procedures to establish compliance with this requirement.

[6] When electricity is transmitted over the transmission and distribution system, some of the electricity is dissipated as heat due to resistance in the transmission lines or inefficiencies in transformers in the distribution system. As a result, the amount of electricity delivered to consumers is less than the amount produced at the generator. Adding line losses to the customer savings give the greater reduction in electricity that needs to be generated, before transmission and distribution.

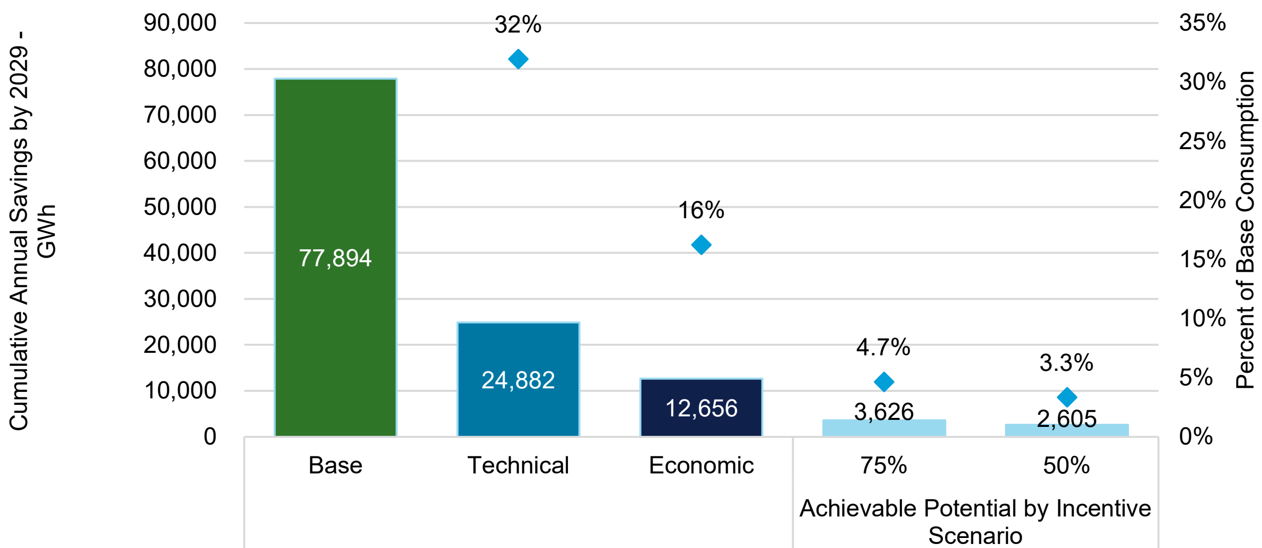
- ENERGY STAR® servers are also a significant opportunity for non-residential technical and economic energy savings potential, reflecting the increasing importance of data centers to energy consumption and management. Even when opt-out customers, who have historically included Dominion's largest data center customers, are removed from the analysis, ENERGY STAR servers remain the top-saving measure, reflecting the many servers located in networking closets and server rooms in offices and other commercial building types.

1.3.1 Aggregate Base Energy-Efficiency Potential Results

Estimates of electric energy savings potential are presented in Figure 1-1 below. These savings reflect cumulative annual savings potential over a 10-year period, which is the annual savings potential in 2029 of all installations from 2020 through 2029. Estimates of energy savings were calculated for technical potential and economic potential and for two program scenarios: achievable potential at 50% incentivization and achievable potential at 75% incentivization.

Technical potential is estimated at 24,882 GWh by 2029. Economic potential is estimated at 12,656 GWh by 2029. Achievable program potentials range from 2,605 GWh in the 50% scenario up to 3,262 GWh in the 75% incentive scenario. Economic potential for energy savings is estimated to be 16% of base 2029 energy use; achievable potentials range from 3.3% of base consumption in the 50% scenario to 4.7% of base energy consumption in the 75% scenario.[7]

Figure 1-1. Estimated Electric Energy-Efficiency Savings Potential, 2020-2029, Virginia and North Carolina Combined*



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

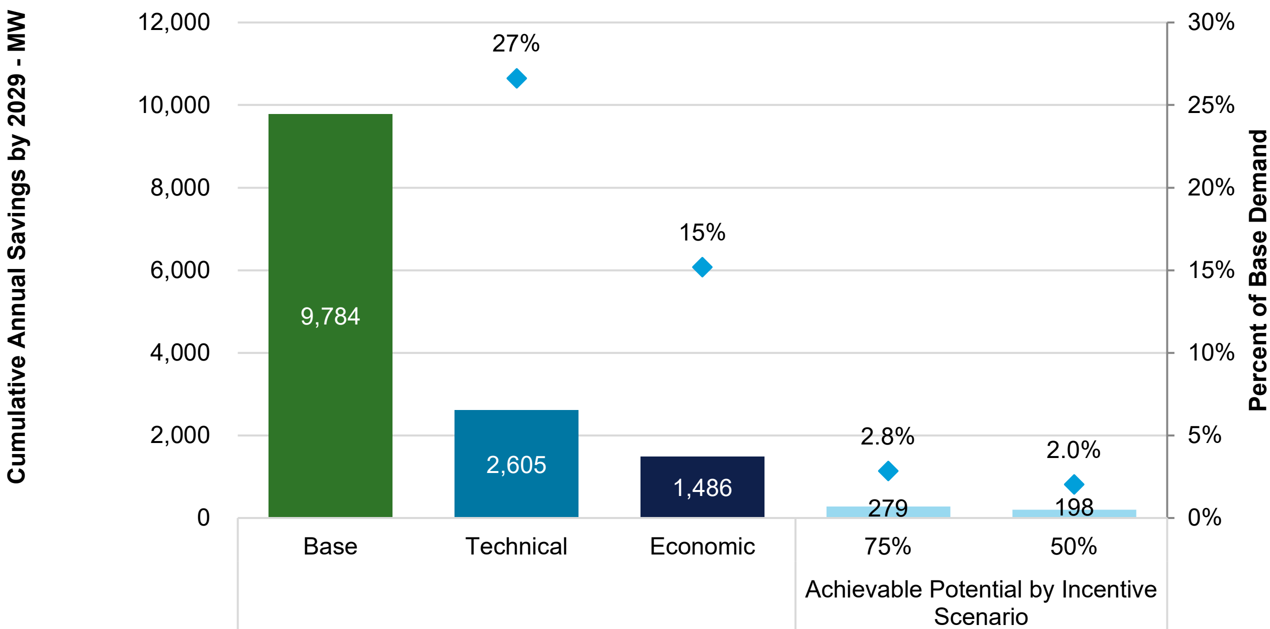
Cumulative 10-year peak demand savings potential estimates are provided in Figure 1-2. The study only estimated peak demand potential from the installation of energy efficiency measures and did not include an assessment of demand savings from demand response technologies such as direct load control or dynamic pricing.

Technical potential is estimated at 2,605 MW and economic potential is estimated at 1,486 MW. Achievable program potential ranges between 198 MW in the 50% incentive scenario to 279 MW in the 75% incentive scenario. Economic potential for peak demand savings is estimated to be 15% of base 2029 peak demand; achievable potentials range from

[7] Savings from the 50% scenario are 1.9% of non-residential (excluding opt-out eligible consumption) and 5.1% of residential base consumption.

2.0% of base peak demand in the 50% scenario to 2.8% of base peak demand in the 75% scenario. All results include line losses.

Figure 1-2. Estimated Peak Demand Savings Potential, 2020-2029*



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 1-3 shows how energy savings potential for Virginia will vary depending on the number and consumption of customers who successfully opt out of energy efficiency programs (Figure 1-1 and Figure 1-2 above assume opt-outs remain at current levels of 33% of eligible consumption). The opt-out rate (percent of eligible) has the biggest impact on economic potential, with a 15% increase in potential from a 33% opt-out rate (current level) to a 100% opt-out rate (lowest participation). Technical potential increases 9%, while the change in incentive scenario potentials range from 5.3% in the 50% incentive scenario to 4.8% in the 75% incentive scenario. Unlike other potential results in this report, these values are expressed as a percent of total C&I base consumption; elsewhere we adjust the base consumption to account for opt-outs before calculating potential as a percent of base consumption.

Figure 1-3. Virginia Energy Savings Potential as a Percent of Total 2029 C&I Base Consumption, by Opt-Out Rate, 2020-2029

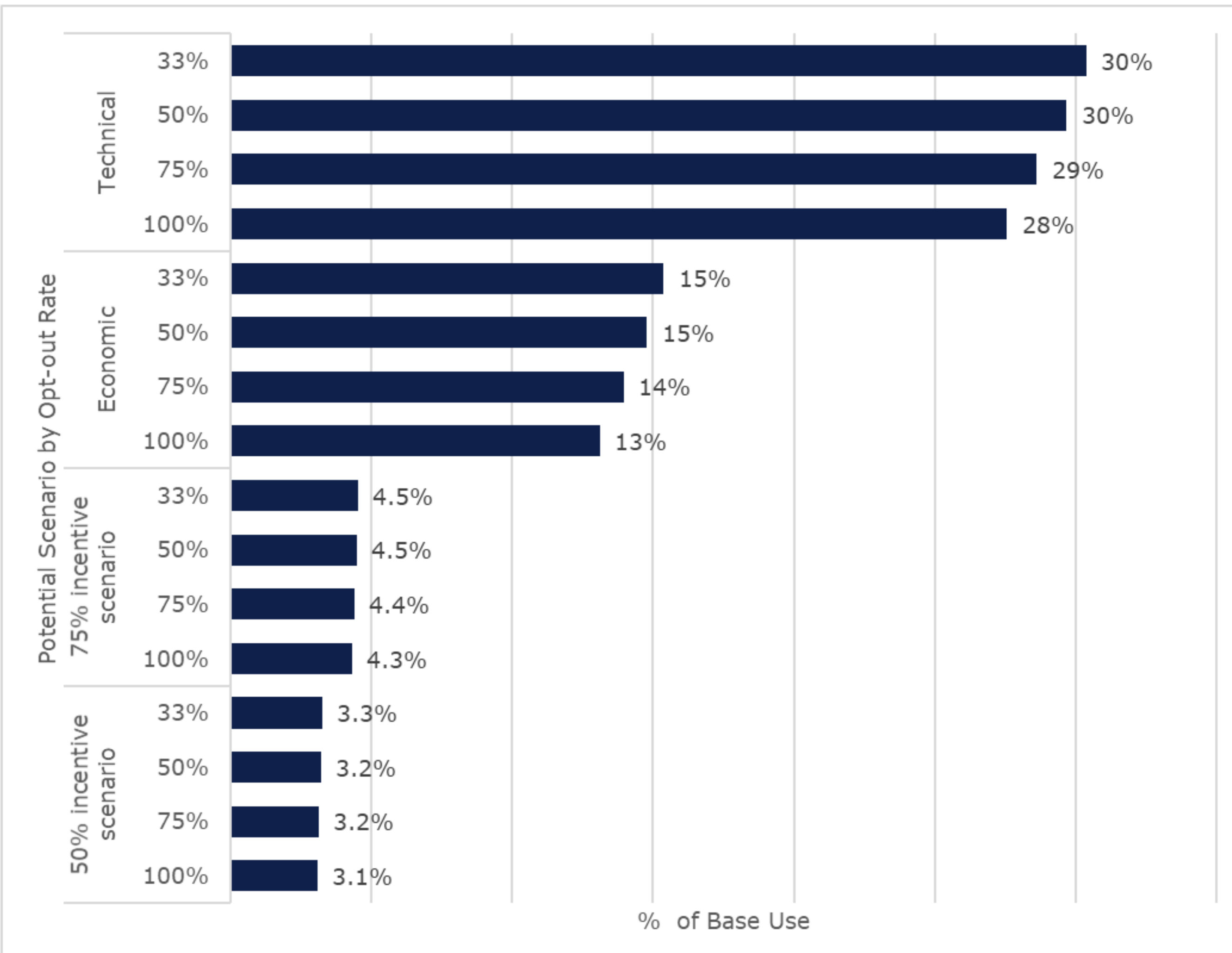
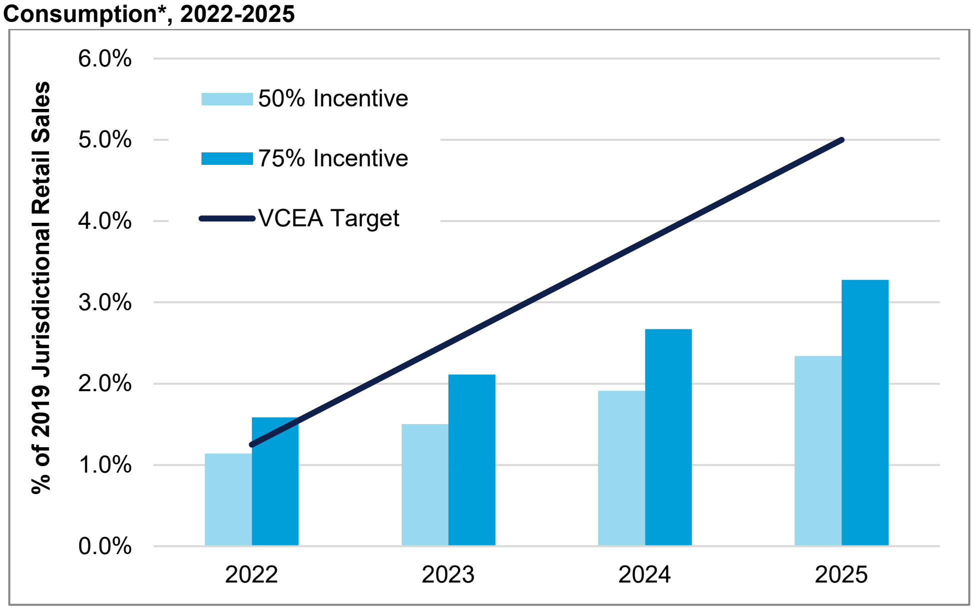


Figure 1-4 compares achievable potential for Virginia against savings targets set under the VCEA. The only year where either scenario meets the VCEA target is 2022, and only in the 75% incentive scenario. This suggests that the VCEA targets are very aggressive given Dominion's low avoided costs and the projected decreased savings potential for lighting going forward. Note that the VCEA targets are set as a percent of 2019 base consumption (excluding non-jurisdictional and federal customers) and the achievable potentials are expressed relative to this base for this chart only. Elsewhere, achievable potentials are presented as a percent of projected base consumption in 2029, excluding non-jurisdictional and federal customers and 33% of opt-out-eligible customers.

Figure 1-4. Comparison of Achievable Potential to VCEA Savings Targets as a Percentage of 2019 Base Consumption*, 2022-2025



*Note that the base consumption for the VCEA targets (2019 jurisdictional retail sales without federal customers) differs from the base consumption used elsewhere in the report (projected 2029 no-energy-efficiency jurisdictional retail sales excluding federal customers and 33% of customers over 1 MW demand that are assumed to opt out). Achievable potentials are net savings. For consistency with the base consumption used for the chart, achievable potentials presented in this chart assume zero opt outs.

DNV

Table 1-2 compares the results of potential studies recently conducted by DNV in other jurisdictions with the DSM ASSYST™ model.[8,9,10] Achievable energy savings potential as a percent of base consumption available in Dominion's territory is low (as a percent of base consumption) compared to estimates from other jurisdictions that analyzed savings from a similar range of scenarios. This is due in part to Dominion's low avoided costs and rates. Low avoided costs result in fewer measures passing the cost effectiveness screening, while low rates reduce the customer's benefits from adopting a measure, resulting in lower measure penetrations. Savings from screw-based LED lighting provided a boost to achievable potential in the earlier studies, as these measures could be rapidly deployed to replace short-lived incandescent lighting. By 2020 the market had largely transformed, shrinking the lighting savings potential.

Table 1-2. Comparison of Energy Savings Potential as a Percentage of Base Consumption†

Jurisdiction	Years of Analysis	Sectors	Economic Potential	Achievable Potential Scenario	
				50% Incentive Scenario	75% Incentive Scenario
NGRID Massachusetts	2016-2025		43%	14%	16%
Xcel MN Updated	2014-2023		18%	9%	10%
Dominion	2014-2027	Residential, Nonresidential	22%	3%	6%
Xcel Minnesota	2011-2020	Residential, Commercial, Industrial	20%	10%	11%
Xcel Colorado	2010-2020	Residential, Commercial	23%	5.5%	8.5%
Austin Energy	2012-2020	Residential, Commercial, Industrial	20%		9.8%
Dominion	2018-2027	Residential, Nonresidential	19%	4%	6%
NGRID Upstate New York	2018-2027	Residential, Nonresidential	29%	9%	13%
Dominion*	2020-2029	Residential, Nonresidential	16%	3.3%	4.7%

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.
†For each study, base consumption was projected consumption in the last year of the forecast absent energy efficiency programs.

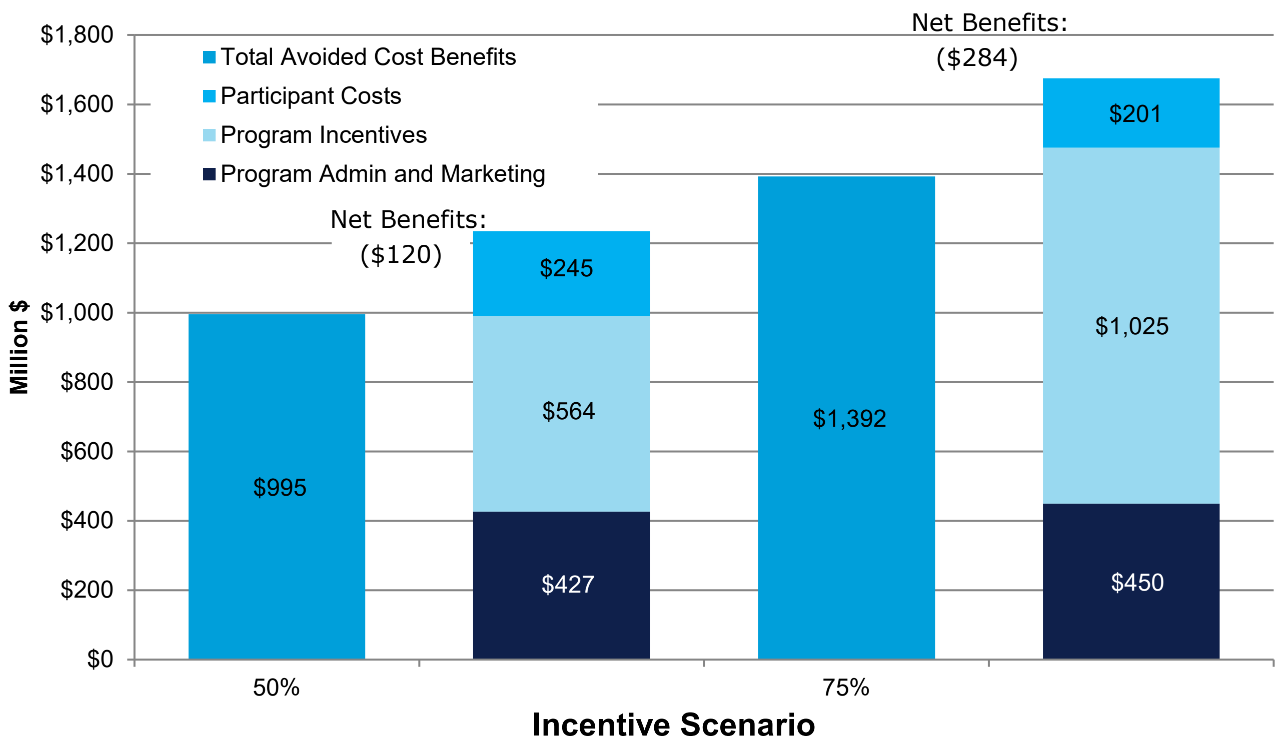
[8] Xcel Minnesota: http://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/MN-DSM/MN-DSM-Market-Potential-Assessment-Vol-1.pdf

[9] Xcel Colorado: https://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/CODSM-Report.pdf

[10] Austin Energy: https://austinenergy.com/wps/wcm/connect/15a83f48-4741-41f9-af6d-ff27a064bd03/2012DSMmarketPotentialAssessment.pdf?MOD=AJPERES

Figure 1-5 depicts the estimated costs and benefits under each funding scenario from 2020 to 2029 for Virginia, while Figure 1-6 depicts the analogous values for North Carolina. In Virginia, total costs (incentives, administrative and marketing costs, and net participant costs) exceed benefits for both program scenarios. In the 50% scenario costs exceed benefits by $121 million and the gap is $284 million in the 75% scenario. In North Carolina, net benefits are positive for both incentive scenarios, with net benefits of $3.6 million in the 50% scenario and $13.4 million in the 75% scenario. We discuss the reasons for the Virginia programs lack of cost effectiveness later in this section.

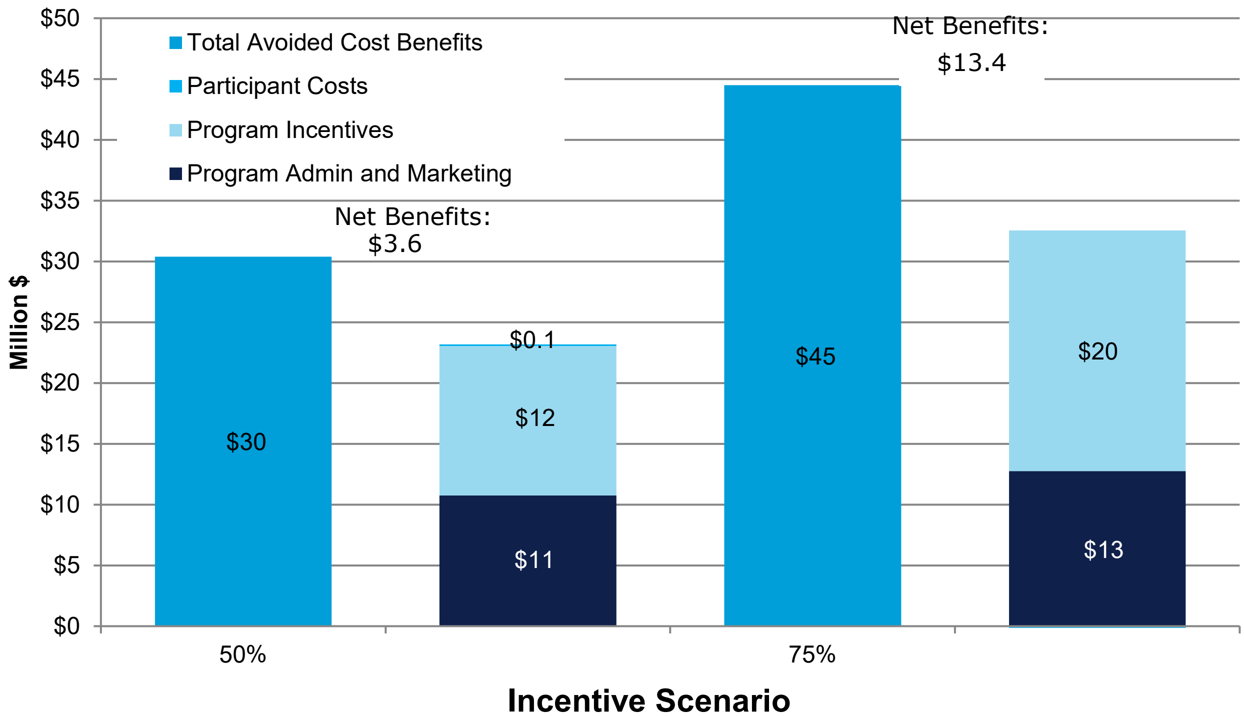
Figure 1-5. Benefits and Costs of Energy Efficiency Savings, 2020-2029*, Virginia†



*PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%

†Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 1-6 Benefits and Costs of Energy Efficiency Savings, 2020-2029*, North Carolina



*PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%. Participant costs are net of O&M benefits.

The TRC benefit-cost ratios for Dominion's Virginia service territory are 0.81 for the 50% scenario and 0.83 under the 75% scenario.[11] TRCs less than one indicate that the costs of the program exceed the benefits. Because measures are included in the achievable analysis based on measure economics alone, the added hurdle of program marketing and administrative costs can make a modelled program cost-ineffective even when individual measures are cost-effective. With the addition of those costs, Virginia's modelled portfolio falls significantly below the TRC threshold when all costs are included in the analysis. North Carolina's programs are cost effective in both scenarios, with TRCs of 1.31 and 1.43 in the 50% and 75% incentive scenarios, respectively.

TRC ratios declined from the 2017 study, due primarily to the switch from a summer-only valuation of demand savings to a more balanced valuation of summer and winter demand reductions. This changed the relative avoided cost-benefits of weather-sensitive measures and reduced the number of measures passing the TRC screening. Also contributing to the low portfolio TRC is an expansion of programs that target hard-to-reach customers, which requires greater outreach and therefore greater overhead expense. The VCEA requires that Dominion allocate at least 15% of proposed energy-efficiency program costs to programs designed to benefit low-income, elderly, disabled individuals or veterans, and the funding scenarios for this study incorporated a significant expansion of Dominion's Income and Age Qualifying Program. Age and income qualifying programs are not required to be cost-effective in Virginia.

[11] This report presents TRC as the cost-benefit test. Under Virginia Law, the ratepayer impact measure, utility cost test, and participant cost test are also considered for regulatory approval.

Key results of our efficiency scenario forecasts from 2020 to 2029 are summarized in Table 1-3 for Virginia Table 1-4 for North Carolina.

Table 1-3. Summary of Achievable Potential Results—2020-2029, Virginia*†

Result – Programs	Program Scenario:	
	50% Incentivization	75% Incentivization
Total Market Energy Savings - GWh (year 10 annual)	3,068	4,052
Total Market Peak Demand Savings - MW (year 10 annual)	292	367
Program Energy Savings - GWh (year 10 annual)	2,433	3,417
Program Peak Demand Savings - MW (year 10 annual)	192	268
Program Costs - Real, $ Million		
Administration (10-year total)	$338	$388
Marketing (10-year total)	$194	$169
Incentives (10-year total)	$698	$1,268
Total Program Costs (10-year total)	$1,230	$1,824
PV Avoided Costs (PV 10-year cost)	$995	$1,392
PV Annual Program Costs (Adm/Mkt) (PV 10-year cost)	$427	$450
PV Net Measure Costs (PV 10-year cost)	$808	$1,226
Net Benefits (PV 10-year cost)	($240)	($284)
TRC Ratio‡	0.81	0.83

*PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.307%, utility discount rate = 6.307%, inflation rate = 1.98%; GWh and MW savings are cumulative through 2029.
†Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.
‡TRCs less than one indicate that the program, with the added burden of marketing and administrative costs, is not cost effective, even though the individual measures in the program are cost effective based on measure costs and savings alone.

Table 1-4. Summary of Achievable Potential Results—2020-2029, North Carolina*

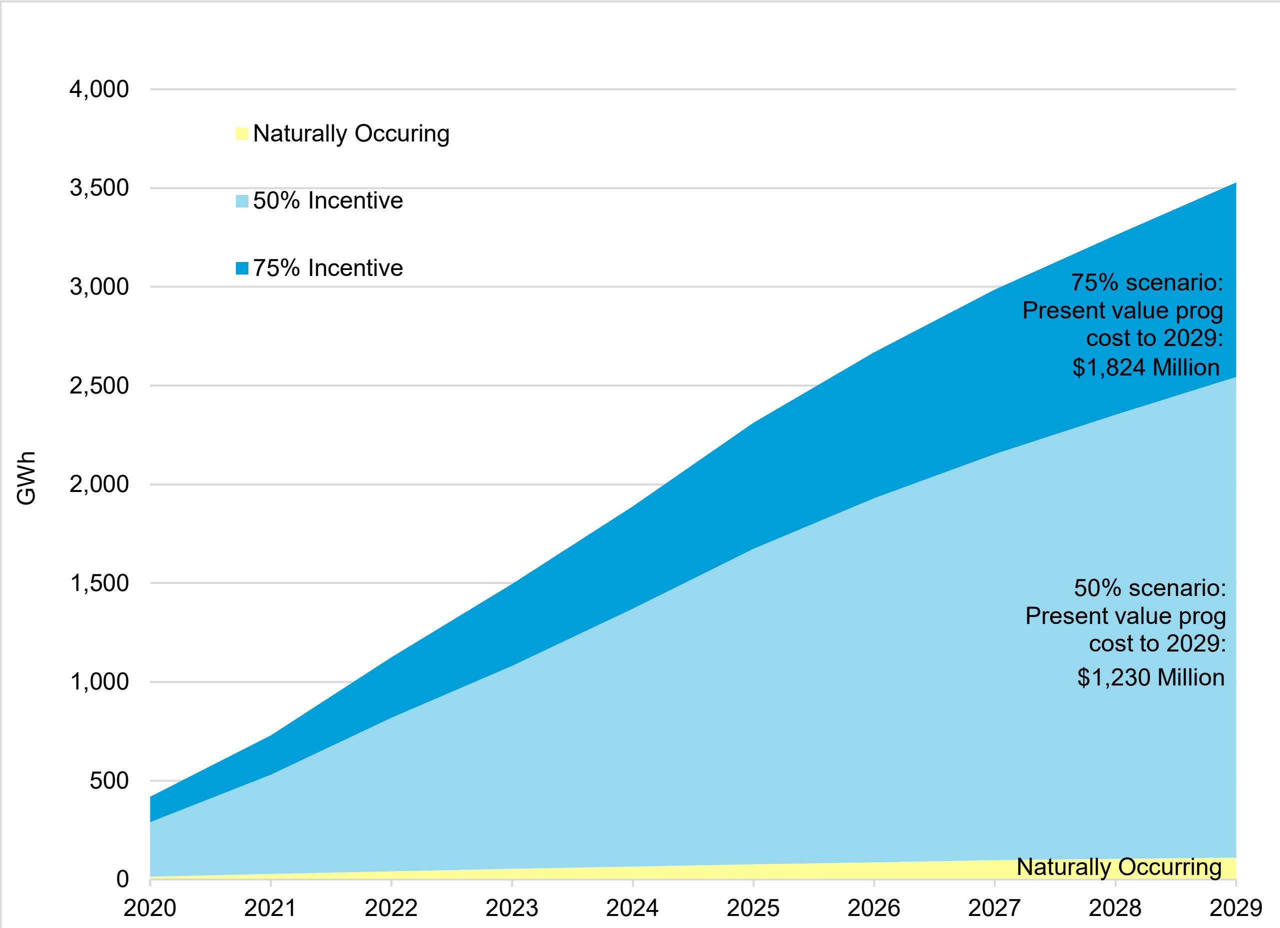
Result - Programs	Program Scenario:	
	50% Incentivization	75% Incentivization
Total Market Energy Savings - GWh (year 10 annual)	143	182
Total Market Peak Demand Savings - MW (year 10 annual)	13	17
Program Energy Savings - GWh (year 10 annual)	85	125
Program Peak Demand Savings - MW (year 10 annual)	6	11
Program Costs - Real, $ Million		
Administration (10-year total)	$9	$10
Marketing (10-year total)	$4	$5
Incentives (10-year total)	$15	$25
Total Program Costs (10-year total)	$28	$41
Present Value Avoided Costs (PV 10-year cost)	$30	$45
Present Value Annual Program Costs (Adm/Mkt) (PV 10-year cost)	$11	$13
Present Value Net Measure Costs (PV 10-year cost)	$12	$18
Net Benefits (Present Value 10-year cost)	$7	$13
TRC Ratio†	1.31	1.43

*PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.307%, utility discount rate = 6.307%, inflation rate = 1.98%; GWh and MW savings are cumulative through 2029.

†TRCs less than one indicate that the program, with the added burden of marketing and administrative costs, is not cost effective, even though the individual measures in the program are cost effective based on measure costs and savings alone.

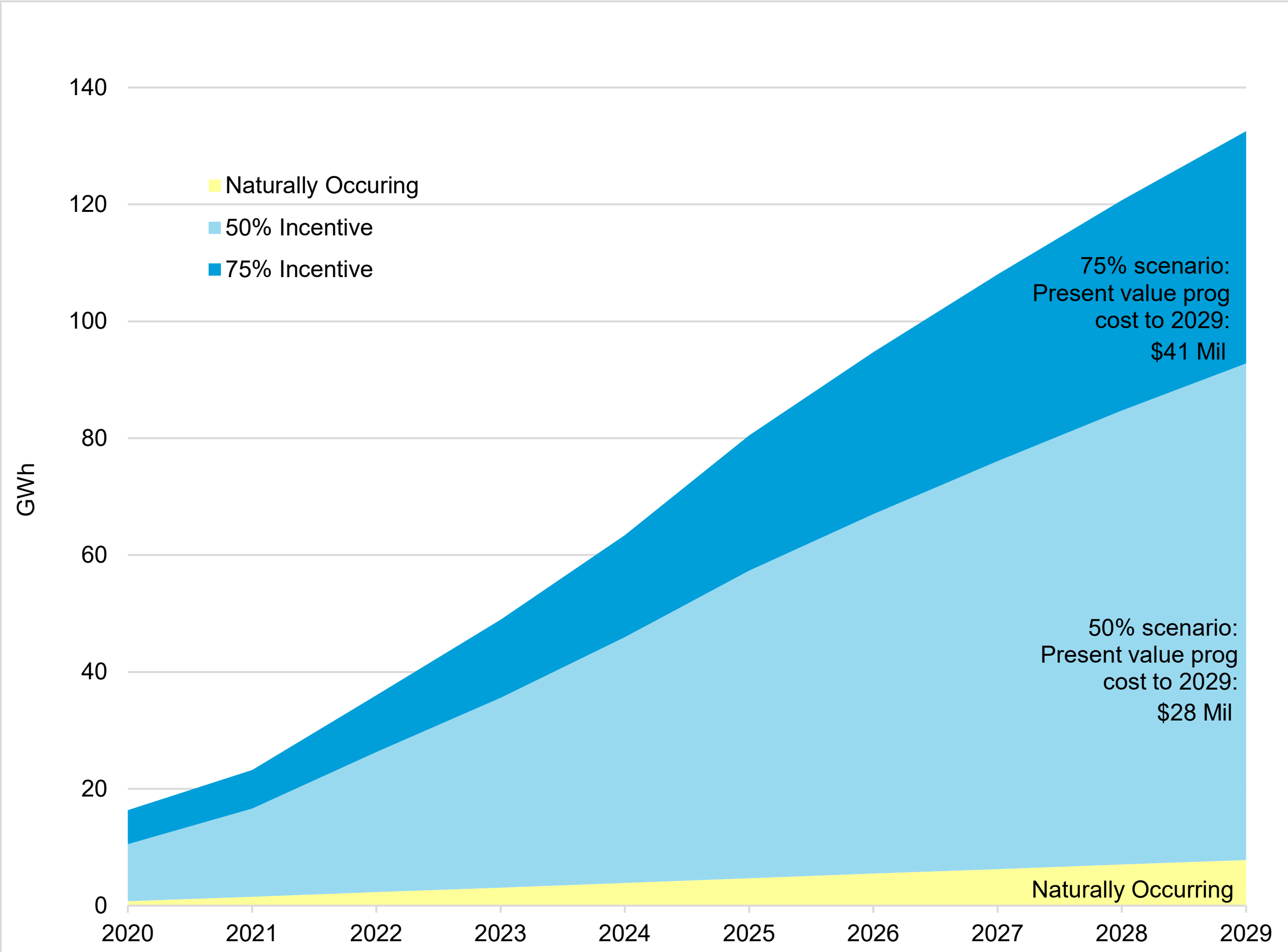
Figure 1-7 and Figure 1-8 show estimates of achievable program potential energy savings over time for Virginia and North Carolina, respectively (peak demand savings follow a similar pattern but are not shown). Naturally occurring savings are also shown to provide a picture of total market potential. Savings are tracked cumulatively over the study's reporting period.

Figure 1-7. Achievable Electric Energy Savings: All Evaluated Sectors, Virginia*



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 1-8. Achievable Electric Energy Savings: All Evaluated Sectors, North Carolina

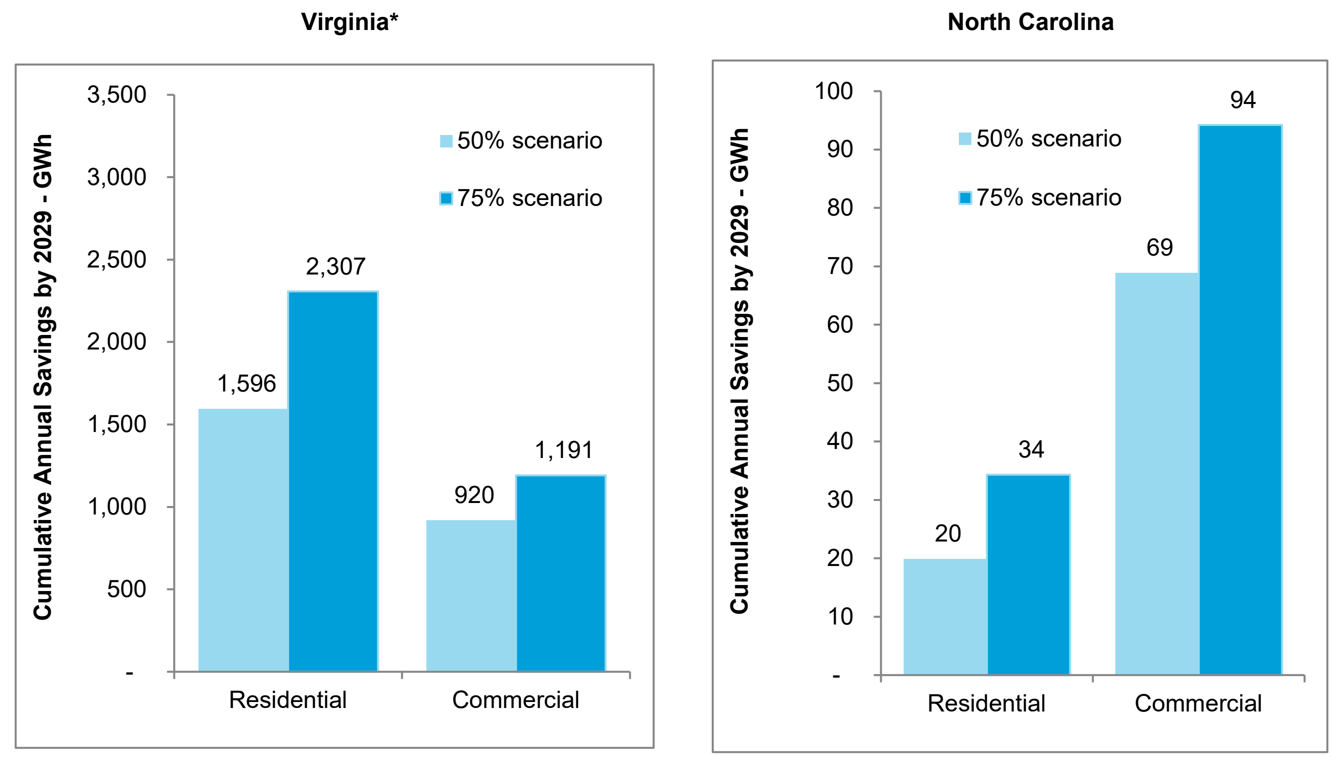


1.3.2 Energy-Efficiency Results by Sector

Cumulative net achievable potential estimates by sector for the period of 2020-2029 are presented in Figure 1-9 for energy potential and Figure 1-10 for peak demand potential. In both figures, Virginia estimates are in the left graph and North Carolina's in the right graph. These figures compare the residential and commercial sector results for each funding scenario.

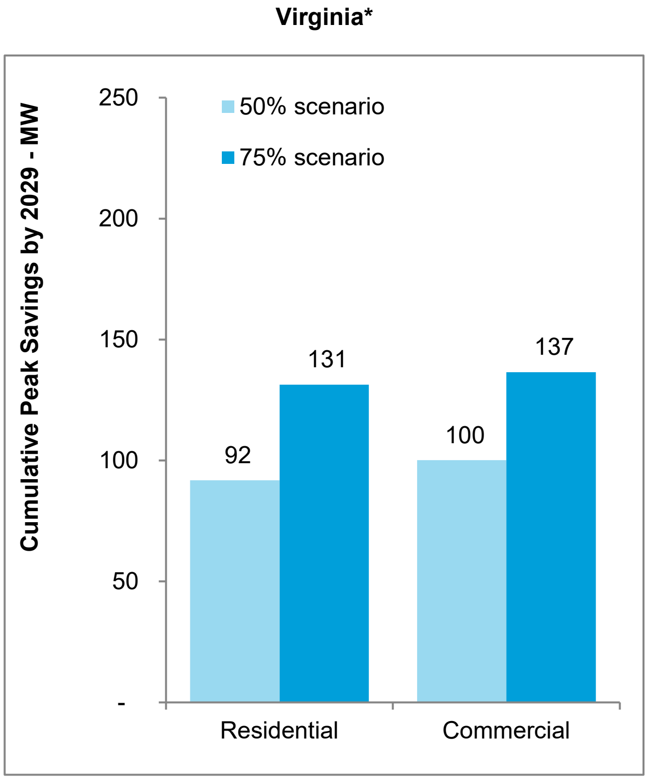
Under the program assumptions developed for this study, achievable energy under the 50% and 75% scenarios are highest for the residential sector in Virginia, and for the non-residential sector in North Carolina. Achievable demand savings were more balanced across the two sectors in Virginia but skewed non-residential for North Carolina.

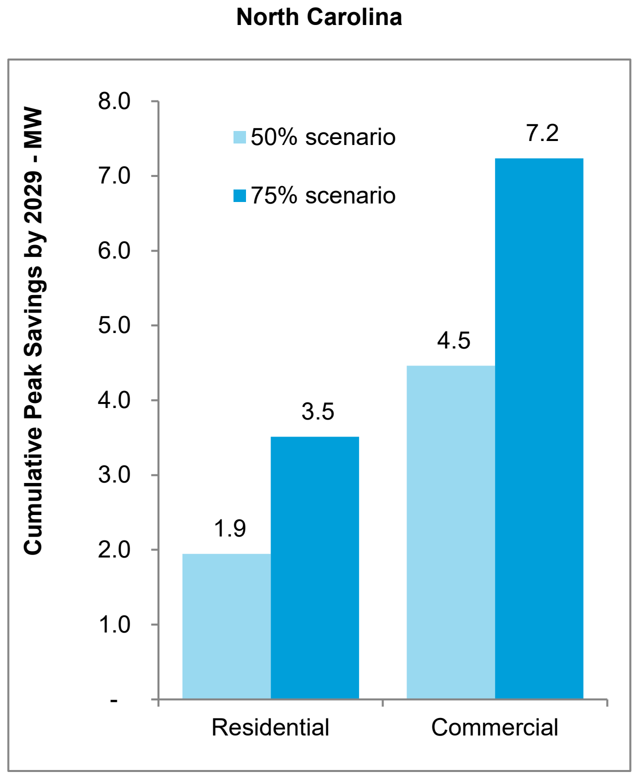
Figure 1-9. 2029 Net Achievable Energy Savings by Sector



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 1-10. 2029 Net Achievable Peak-Demand Savings by Sector

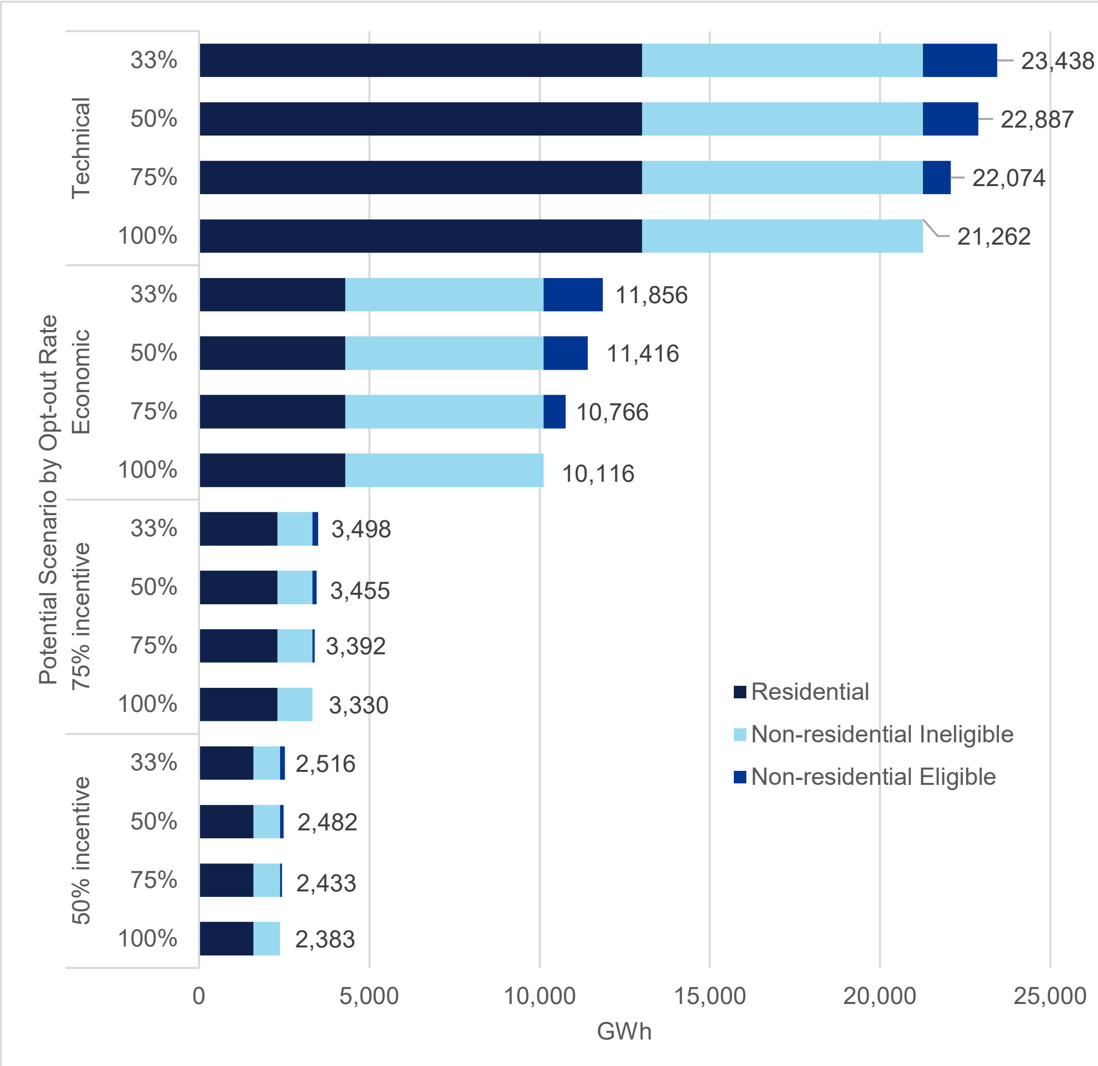




*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

While Figure 1-9 and Figure 1-10 show the primary opt-out case for Virginia (reflecting the 2021 opt-out rate of 33% among eligible customers), Figure 1-11 shows how potential will vary depending on the number and consumption of customers who successfully apply to opt out. Non-residential customers are broken out into opt-out eligible (greater than 1 MW demand) and opt-out ineligible for this chart.

Figure 1-11. Virginia Net Achievable Energy Potential by Sector and Opt-Out Proportion*

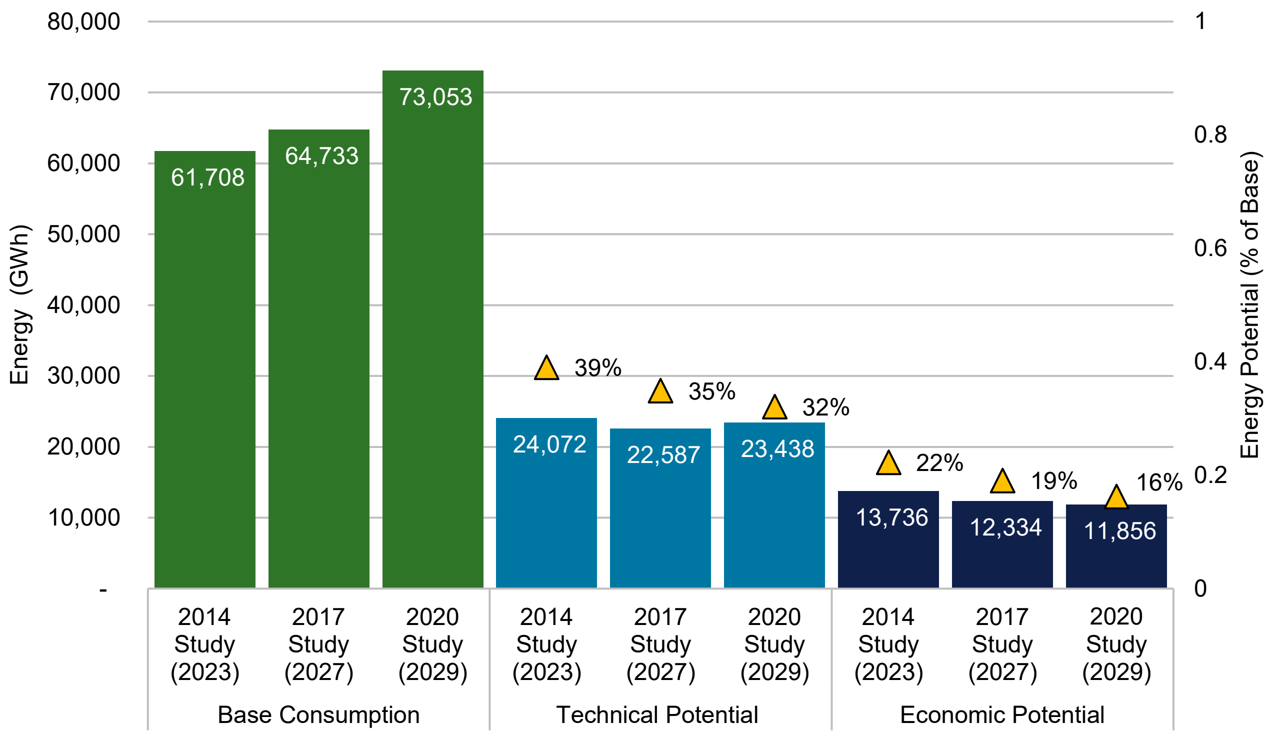


*Excludes Virginia non-jurisdictional and federal customers

1.3.3 Trends in Potential Over Time

Figure 1-12 compares the results of the 2014 and 2017 potential studies to the current study. Base energy consumption, technical potential, and economic potential are all shown (plotted on left axis). The yellow triangles indicate the percent of base energy consumption represented by the potential estimates (plotted on right axis).

Figure 1-12. Comparison of Technical and Economic Potential, Virginia: 2020 Study versus 2017 Study and 2014 Study*

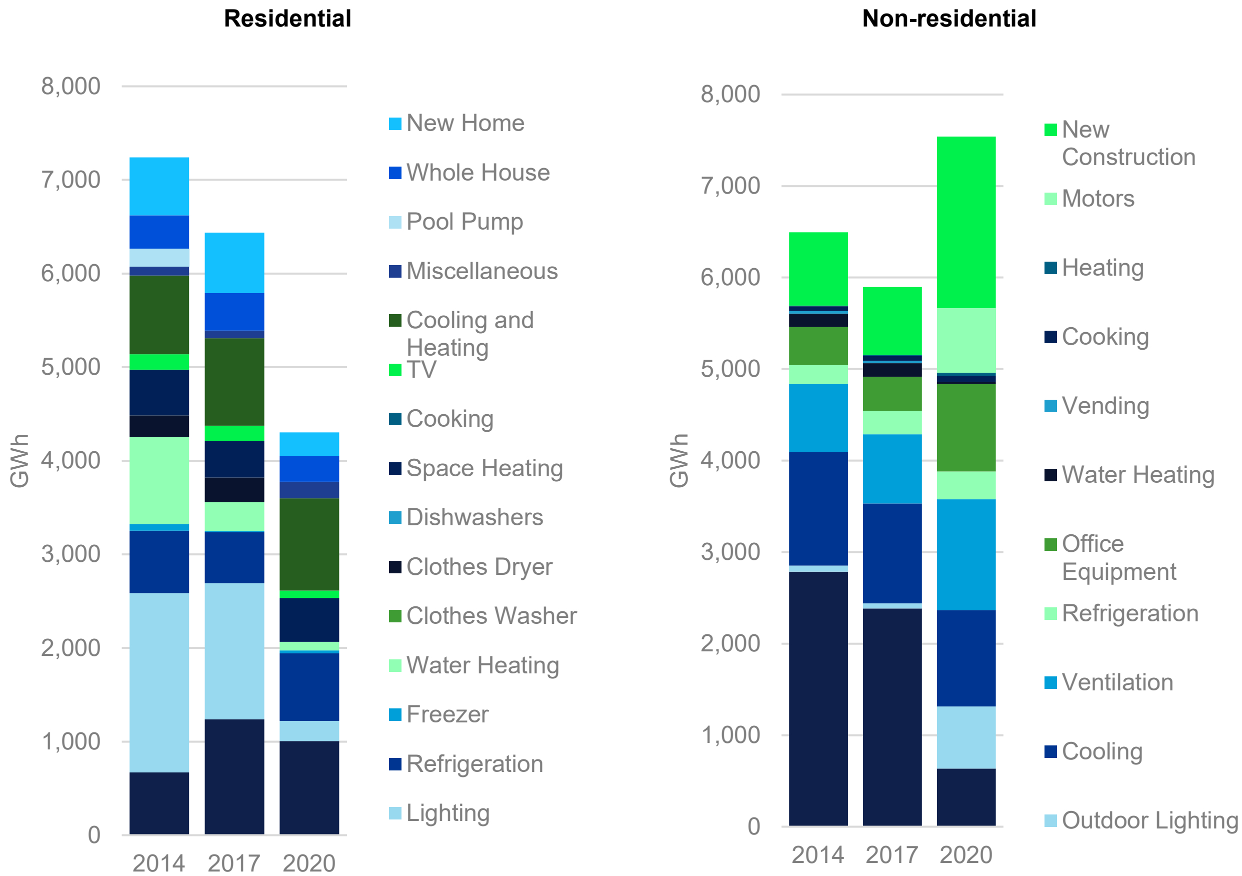


*2014 and 2017 studies exclude non-jurisdictional and actual opt-out/exempt customers. The 2020 study excludes non-jurisdictional and 33% of opt-out-eligible customers.

Base electricity consumption increased by 5% from the 2014 to the 2017 study and by 13% from the 2017 to the 2020 study. The 2020 study base consumption reflects the 33% of eligible customers who were approved to opt out in 2021 under the VCEA rules, while 2014 and 2017 bases reflect the opt-out rates that occurred under the opt-out rules in place at the time. Factors influencing the change include both changes to raw sector consumption, the size of opt-out consumption excluded, and changes to the growth forecast since base consumption is projected 10 years to the end of the forecast horizon and accounts for growth/decay in the building stock. Energy savings potential, however, has declined across all three studies as a percentage of base consumption.

To help understand these decreases, Figure 1-13 shows the breakout of economic potential by end use for the residential and non-residential sectors for the 2014 study, 2017 study, and 2020 study.

Figure 1-13. Comparison of Economic Potential by End Use, Virginia: 2020 Study vs 2017 Study and 2014 Study*



*2014 and 2017 studies exclude non-jurisdictional and actual opt-out/exempt customers. The 2020 study excludes non-jurisdictional and 33% of opt-out-eligible customers.

The 1,656 GWh increase in non-residential potential from 2017 to 2020 was more than offset by the 2,134 GWh decrease in the residential sector, for a net total decrease of 478 GWh. The decline in residential potential is concentrated in lighting, which makes up about 58% of the residential decline. Lighting potential has been reduced as the lighting market has largely transformed from incandescent lamps being the dominant technology to LEDs. Other measures contributing to the decline in residential potential include space cooling, water heating, clothes dryers, and new construction.

In the non-residential sector, indoor lighting decreased sharply from the 2017 study to the 2020 study due, as in the residential sector, to the LED transformation of the lighting market. An additional factor in the decline in commercial lighting potential was that the increase in LED lighting has reduced the number of cost-effective applications for lighting controls, since controls save less energy applied to LEDs than to fluorescent or incandescent lamps. Other end uses contributing to the decrease include water heating and space cooling

Potential for other categories increased. In both sectors, space heating benefitted from avoided costs that reflect an increase value placed on winter peak reduction. Outdoor lighting measures also benefited from the same trend, since increased hours of darkness mean that outdoor lighting measures now save peak demand (winter electricity normally peaks in the morning or evening, unlike summer use, which is typically highest in the hottest part of the afternoon). Improved cost effectiveness of LEDs in outdoor applications was also a factor in increased outdoor lighting savings. The increase in office equipment potential is due to the addition of ENERGY STAR servers to the model for 2020.

2 INTRODUCTION

Dominion retained DNV to conduct a demand-side management (DSM) market potential study that was based on existing and proposed customer end-use energy efficiency measures and programs. The study provides estimates of potential electricity and peak demand savings from energy efficiency measures in Dominion's Virginia and North Carolina service territories, including technical, economic, and achievable program potential. The analysis also presents the technical and economic potential associated with opt-out and non-jurisdictional customers in Dominion's service territory. These customers were not included in the estimation of program achievable potential as they do not participate in Dominion-sponsored programs. The study does not address natural gas equipment usage or savings.

2.1 Overview

The scope of this study includes new and existing residential and non-residential commercial buildings and covers a 10-year period spanning 2020-2029. Given the near- to mid-term focus, the base potential analysis was restricted to DSM measures that are presently commercially available, and only included codes and standards that are currently in place or will be effective within the next year. We did not make a prediction on the impact of future codes and standards.

Data for the study came from a number of different sources including data from the commercial saturation studies conducted by DNV in 2019-2020, a residential saturation study conducted by DNV in 2019, a residential conditional demand analysis conducted by DNV in the 2020, internal Dominion data, DNV's extensive energy efficiency database, and a variety of information from third parties.

2.2 Study Approach

The energy efficiency potential elements of the study involved identifying and developing baseline end-use and measure data, then developing estimates of future energy efficiency impacts under varying levels of program effort.

We performed a baseline characterization that allowed us to identify the types and approximate sizes of the various market segments that are the most likely sources of DSM potential in Dominion's service territory. These characteristics then served as inputs to a modelling process that incorporated Dominion's energy-cost parameters and specific energy efficiency measure characteristics (such as costs, savings, and existing penetration estimates) to provide more detailed potential estimates.

To aid in the analysis, we utilized the DNV's DSM ASSYST™ model. This model provides a thorough, clear, and transparent documentation database and an extremely efficient data processing system for estimating technical, economic, and achievable potential. We estimated technical, economic, and achievable program potential for the residential and commercial sectors, with a focus on energy efficiency impacts through 2029.

2.3 Organization of the Report

Section 3 provides a summary overview of the data collection activities conducted for this study. Additional, detailed results are provided in the attached appendices. The rest of the report is structured as follows:

- Section 3 reviews and summarizes the data collection and development process.
- Section 4 discusses the methodology and concepts used to develop the technical, economic, and achievable potential estimates.
- Section 5.1 provides baseline results developed for the study.
- Sections 5.2 and 5.3 discuss the results of the electric energy efficiency potential analysis by sector and over time, including technical and economic potential, as well as achievable or program results.

The report includes the following appendices:

- Appendix A, detailed methodology and model description
- Appendix B, measure descriptions
- Appendix C, economic inputs
- Appendix D, building and time-of-use factor inputs
- Appendix E, measure inputs
- Appendix F, non-additive measure level results (not adjusted to remove double counting)
- Appendix G, supply curve data
- Appendix H, measure level rankings by economic savings potential
- Appendix I, achievable program potential by sector

3 DATA COLLECTION AND DEVELOPMENT

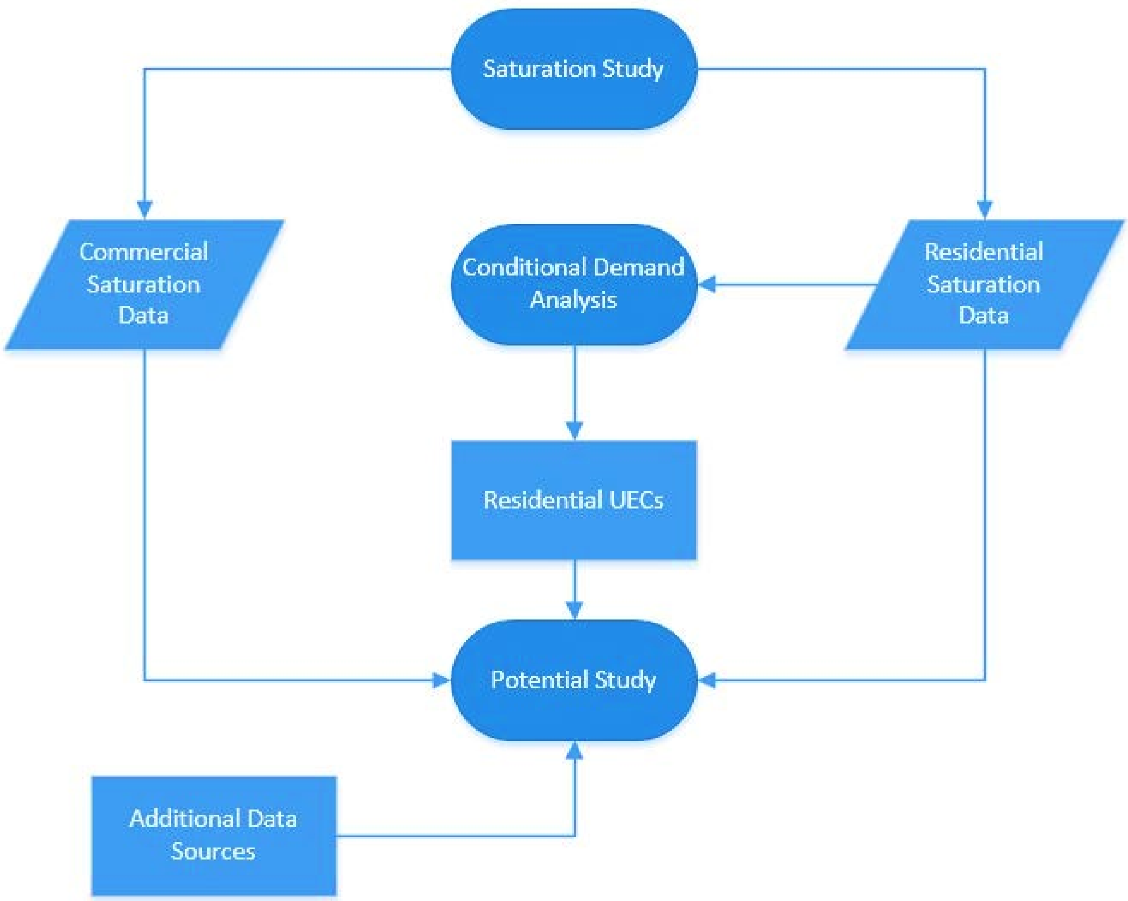
This section describes the efforts used by DNV to develop data inputs for this potential study. The main sources of this data were the residential and commercial saturation surveys, the residential conditional demand analysis (CDA), data provided by Dominion staff, and secondary data sources.

3.1 Dominion-Specific Data Collection Efforts

Dominion engaged DNV to collect end-use saturation and consumption data from residential and non-residential customers for use in load research and DSM planning operations. Data developed from the resulting studies were also used as direct inputs for the DSM Potential Study. The residential and commercial customer saturation surveys used for these efforts collected information on building characteristics, occupant characteristics, and the penetration and usage of various end uses throughout Dominion's service territory. The residential saturation survey data was then fed into the residential CDA model, which produced estimates of annual electricity consumption for many end-use categories. The CDA estimates, along with data from the saturation studies, were then used as inputs in the DSM ASSYST™ model. These data were combined with other data from Dominion and secondary data sources to fully populate the data inputs required for the modeling effort.

Figure 3-1 illustrates the relationship between the saturation studies, conditional demand analysis, additional data sources, and the DSM potential study.

Figure 3-1. Summary Flow Chart for the DSM Potential Study Process



3.1.1 Residential and Commercial Saturation Studies

This 2020 study used the results of the 2019 - 2020 DNV Residential Appliance Saturation Study (RASS) and 2020 DNV Commercial Saturation Study, and also considered or benchmarked against prior study versions that were previously completed by DNV. The goal of these studies was to estimate the saturation of end uses of electricity associated with appliances, HVAC, and electronics, as well as the usage patterns and related household and building characteristics. DNV also used the data gathered from the residential saturation study in a conditional demand analysis, which provided unit energy consumption (UEC) estimates for a range of electric end uses and market segments for the DSM potential study.

The sections below describe the sample selection, data collection and response rates for the residential and commercial saturation studies.

3.1.1.1 Residential Appliance Saturation Study

Sample Selection

A billing data file was obtained from Dominion at the design phase of this project and served as the sample frame for the study. The billing data file represented a complete census of all active residential accounts from January 1, 2018 to May 2, 2019. The initial sample was selected from among those accounts on the sample frame that had an email address and annualized usage greater than 1,200 kWh/year. Using a minimum annualized usage greater than 1,200 kWh/year ensured that auxiliary premises such as well-houses and barns were excluded.

The sample frame was stratified according to regions (7 levels) and annualized usage (3 levels). The usage levels were assigned based on the distribution of annualized consumption within each region. The regional assignments were kept consistent with those used in the 2016 RASS.

Once stratification was applied to the sample frame, a sample was randomly selected from within each stratum. The seven regions are:

- Northern Virginia
- Shenandoah Valley / Western Piedmont
- Richmond / Tri-Cities
- Southside
- Gloucester / Northern Neck
- Southeastern
- North Carolina

And the three annual usage levels are:

- Low consumption (below 33rd percentile)
- Medium consumption (33rd – 65th percentile)
- High consumption (66th percentile and above)

All saturation estimates developed from this study were correctly weighted so results would apply to the entire target population.

Data Collection

The survey launched on November 14, 2019 and remained open for nearly four months closing on March 9, 2020. Due to the magnitude of the sample, the survey was disseminated in batches. The strategy of the rollout was to avoid ever-evolving spam filters. The majority of popular email service providers use a variety of techniques that are constantly evolving to detect spam. DNV applied the following strategies and considerations to avoid this pitfall:

- Followed the "CAN-SPAM" anti-spam laws compliance guide
- Carefully crafted the email message content and subject line
- Used a Dominion sourced domain name (email account) and guided the IT team through the domain name registry process with our survey platform (WorldAPP/form.com).
- Emails were distributed in small waves over a long period of time
- The email campaign "warmed up" the newly assigned email domain name by sending only a few hundred emails per day for several days
- Once the email was 'warmed up' email batches would not exceed 3,001 customers

As a general rule, the data collection team avoided distribution on Friday through Monday afternoon with the thought that email could become buried deep in a recipient's inbox with less likelihood of response.

Response Rates

A total of 8,493 households responded to the survey. A total of 366 respondents were considered ineligible due to the fact that they did not pass the two screener questions signaling 1) an active account, and 2) residential occupancy. Data from the remaining 8,127 eligible respondents was used in the analysis to develop final study estimates.

The response rates are shown in Table 3-1.

Table 3-1. 2019 Residential Saturation Survey Count Metrics

Households emailed	124,817
Total responses	8,493
Failed screener questions	366
Completed survey	5,534
Partially completed survey	2,593
Total number of eligible respondents	8,127
Response rate	6.5%

3.1.1.2 Commercial Saturation Study

DNV used data from its 2020 Commercial Saturation Study to provide data for this study's commercial sector analysis. The methodology for that data collection effort is described in the report for our 2020 Commercial Saturation Survey Study.[12]

Sample Selection

The commercial study sample design featured a two-dimensional stratification, based on the Dominion operating region and customer annualized consumption. The first dimension included six mutually exclusive operating regions within the Company's service territory. This dimension was used to control for the geographical influences that may exist throughout the Dominion service territory. The second dimension was based on customer annualized electric energy usage. Dominion's commercial sector is diverse, and this manifests itself in customers with an extensive range of annual electric energy usages. The annual usage dimension was used to control for differences in types and magnitude of end uses, and the variation of firmographic characteristics.

During the project's development, a target sample size of 1,500 completes was qualitatively set to meet budget constraints and to be consistent with the previous 2013 commercial saturation study. On a simple random sampling basis, this sample size would provide a ±2.5% confidence interval at the 95% confidence level for saturations of 50%.

[12] DNV, 2020. Dominion Energy Efficiency Commercial Saturation Survey Report. Prepared by DNV. January, 2020.

The first step in the sample design was to define the population frame. DNV was provided a billing file, from Dominion, with 236,847 customer premises in six regions with 31 different rate codes. These customers were examined. Customers with low annualized usage (less than 1,200 kWh/year) and customers who did not have enough bills to estimate an annualized usage (less than 270 billing days during the last 365 days) were excluded from the final sampling frame. The sampling frame, based on these criteria, was a population of 211,831 customers.

Next, the distribution of annualized energy usage was examined. The largest customer used 335,000 times more energy than the smallest customer in the dataset. To control for this large variability, the top 258 customers by annualized energy usages (greater than 100 GWh/year) were placed in a “certainty stratum”, i.e., a stratum where every customer is included in the sample. The remaining 211,573 customers were allocated into 4 strata. The boundaries of the usage strata were qualitatively set.

The 1,500-target sample, less the 258 customers in the certainty stratum (1,242), was equally distributed among the 4 non-certainty usage strata in each geographic region (24 stratum). The final sample frame consisted of 1,498 customers.

Finally, the expected precision was calculated by usage stratum and region stratum. Stratification, and the inclusion of certainty strata helps reduce the overall expected variability. Ultimately the expected confidence interval at a 95% confidence level for a saturation of 50% would be ±2% at the region level and ±1% for the population.

Data Collection

The survey launched on January 30, 2020, with the dissemination of emails. As a general rule, the data collection team avoided distribution of emails on Friday through Monday afternoon with the thought that email could become buried deep in a recipient’s inbox with less likelihood of responses. The first wave of 5,000 printed letters was distributed in February. Data collection paused in March due to the start of the COVID pandemic and resumed in July. Data collection concluded on September 22, 2020, and the survey was closed to further participation.

Response Rates

A total of 1,781 commercial businesses responded to the survey and passed the screening question that confirmed they were familiar with their business’ energy using equipment. Data from these respondents was used in the analysis.

Table 3-2 shows the breakdown of survey responses.

Table 3-2. Survey Response Rate

	Email	Print	Total
Surveys distributed	4,987	30,001	34,988
Completed survey	88	1,347	1,435
Partially completed survey	41	305	346
Total number of eligible respondents	129	1,652	1,781
Response rate	2.6%	5.5%	5.1%

3.1.2 Residential Conditional Demand Analysis

The objective of a conditional demand analysis is to estimate a breakdown of energy consumption into different end-use categories, such as water heaters or refrigerators, accounting for weather and a number of customer and end-use attributes such as square footage of the home and vintage of the electrical end-use device.

The key data sources for CDA models are:

- Customer survey data – This study utilized the RASS conducted by DNV in 2019.
- Customer billing data – Monthly electricity consumption data from recent years specific to each RASS respondent from Dominion's customer billing database was used.
- Weather data – Hourly interval temperature data from the National Oceanic and Atmospheric Administration (NOAA) and sunrise and sunset data matched to the closest WBAN[13] station of RASS respondents.

The billing data and weather data were used to estimate normalized annual consumptions (NAC) for each respondent. DNV combined the NAC with the survey responses to develop statistical relationships between these data, through regression models.

Properly specified CDA models can account for major classes of end uses by residential customers, which include space heating, space cooling, and water heating, among other major end uses. Importantly, properly specified CDA models can also produce statistically significant data for end-use combinations. However, there are some limiting factors for this CDA model that warrants further discussion, as noted below:

CDA Limiting Factors:

- Near-saturation of the end-use across households (e.g., refrigerators or lighting).
- Collinearity among certain end uses across households (i.e., groups of two or more types of end uses which are found in those groups more often than individually). For example, set top boxes and TVs together, as opposed to TVs alone.
- Consumption that is not discernible in monthly billing consumption data among usage behavior variation across households (e.g., printers or toasters).
- Low saturation of the relatively newer end-use across households (e.g., LED tubes).

If some important end-use categories are not typically meaningful to estimate through a CDA alone, they are typically combined with relevant secondary source studies (e.g., refrigerators). CDA-based estimates on their own can give valuable insight into end-use consumption distributions across groups of customers, as is shown in several figures in this report.

3.2 Additional Data Sources

In addition to the saturation studies and CDA described above, DNV used additional data sources to inform certain inputs of the potential study model that could not be ascertained through the aforementioned data collection efforts. This section outlines those sources, and how they were used in the modelling process. Sources marked with an asterisk (*) in the following section are specific to Dominion's service territory.

3.2.1 Measure Data

Several secondary data sources provided insight on measure-level energy usage and savings potential, measure costs and lifetimes, and the current penetration of various efficiency measures. DNV reviewed a variety of data sources for this information with the aim to find data that was specific to Dominion's service territory or geographic location as much as possible. The sources listed below provided information for these inputs:

- Dominion Standard Tracking Engineering Protocols (STEP) Manual*

[13] WBAN is a five-digit station identifier used for digital data storage and general station identification purposes.

- U.S. Energy Information Administration (EIA) Commercial Buildings Energy Consumption Survey (CBECS)
- EIA Residential Energy Consumption Survey (RECS)
- ENERGY STAR Calculators
- EIA Data for Mid-Atlantic
- Mid-Atlantic Technical Reference Manual (TRM)
- Professional judgment of DNV engineers with experience in Dominion's service territory*
- Dominion's EM&V results*

3.2.2 Economic Data

Economic inputs from Dominion's service territory were used to provide a more accurate picture of the monetary cost and benefits associated with energy efficiency. Dominion provided data to support the following model requirements:

- Customer discount rate
- Inflation rate
- Utility discount rate
- Avoided cost and retail rate forecasts for low, base, and high avoided cost scenarios
- Line-loss estimates

3.2.3 Building Data

Information pertaining to customers as well as system load data was provided by Dominion:

- Billing data to identify consumption residential and commercial customers
- System Load Data
- EIA data for Virginia Electric & Power Co., Virginia to determine number of customers

3.2.4 Program Budgets

As part of the potential modeling process, past and projected program budgets were used to as a starting point for the achievable potential analysis, which estimates the market penetration of measures as a function of marketing, incentive levels, and other factors.[14] Dominion provided past and planned program budgets and savings that we used to help calibrate the achievable modelling efforts. Specifically, marketing and administrative dollars were two inputs into the model that were derived from the indicator tables compiled by DNV for Dominion.

[14] The methodology of calculation measure penetration is described in more detail in Section 4 and Appendix A

4 ENERGY EFFICIENCY METHODS

4.1 Energy Efficiency Potential Methods

This section provides a brief overview of the concepts, methods, and scenarios used to conduct this study. Additional methodological details are provided in Appendix A.

4.1.1 Characterizing the Energy Efficiency Resource

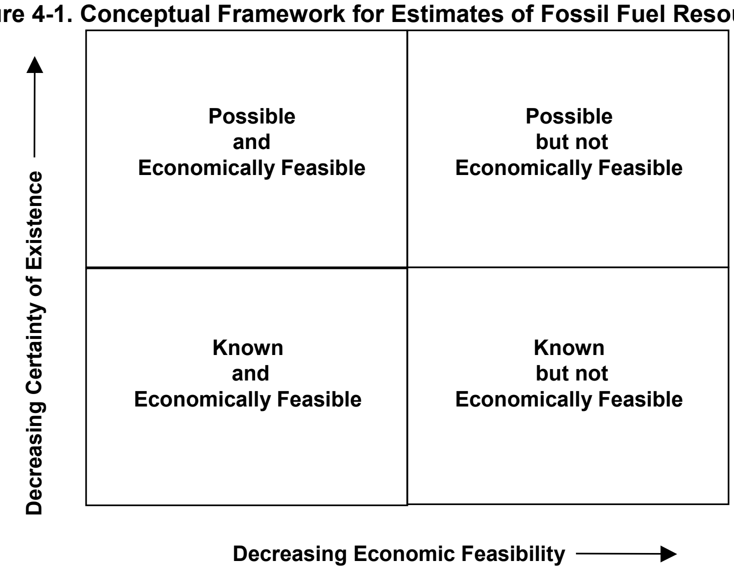
Energy efficiency has been characterized for some time now as an alternative to energy supply options, such as conventional power plants that produce electricity from fossil or nuclear fuels. In the early 1980s, researchers developed and popularized the use of a conservation supply-curve paradigm to characterize the potential costs and benefits of energy conservation and efficiency. Under this framework, technologies or practices that reduced energy use through efficiency were characterized as making the energy saved available to meet other demands, and could therefore be thought of as a resource and plotted on an energy supply curve. The energy efficiency resource paradigm argued simply that the more energy efficiency or "nega-watts"[15] produced, the fewer new plants would be needed to meet end-users' power demands.

4.1.2 Defining Energy Efficiency Potential

Energy efficiency potential studies became popular throughout the utility industry from the late 1980s through the mid-1990s. This period coincided with the advent of what was called least-cost or integrated resource planning (IRP). Energy efficiency potential studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

Like any resource, there are several ways in which the energy efficiency resource can be estimated and characterized. Definitions of energy efficiency potential are similar to definitions of potential developed for finite fossil fuel resources like coal, oil, or natural gas. For example, fossil fuel resources are typically characterized along two primary dimensions: the degree of geological certainty with which resources may be found, and the likelihood that extraction of the resource will be economic. This relationship is shown conceptually in Figure 4-1.

Figure 4-1. Conceptual Framework for Estimates of Fossil Fuel Resources

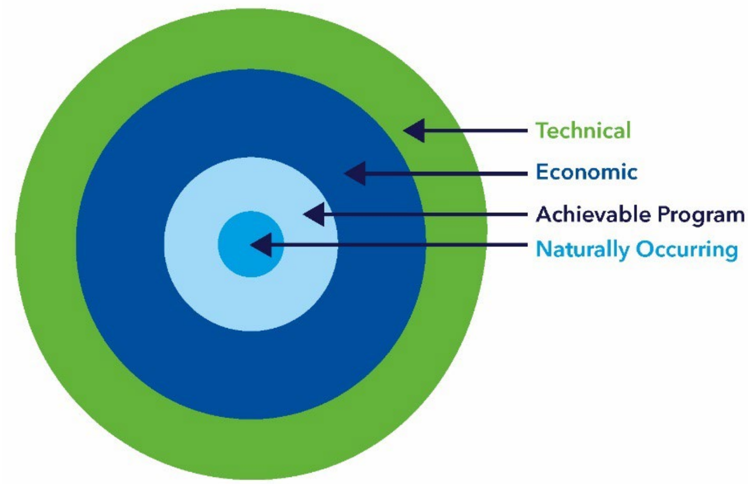


[15] Term coined by environmental scientist Amory Lovins in 1989.

Somewhat analogously, this energy efficiency potential study defines several different *types* of energy efficiency *potential*, namely technical, economic, achievable program, and naturally occurring. These potentials are shown conceptually in Figure 4-2 and described below:

- Technical potential is defined in this study as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective.
- Economic potential refers to the technical potential of those energy conservation measures that are cost effective when compared to supply-side alternatives.
- Achievable program potential refers to the amount of savings that would occur in response to specific program funding and measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.
- Naturally occurring potential refers to the amount of savings estimated to occur as a result of normal market forces; that is, in the absence of any utility or governmental intervention.

Figure 4-2. Conceptual Relationship among Energy Efficiency Potential Definitions



One metric of savings potential that we use is 'cumulative annual savings.' These are savings that occur in a year due to program activities from previous years that are still generating energy savings, demonstrated below in a hypothetical example in Table 4-1. In this example, the Widget Installation Program begins in 2020 and installs energy saving widgets which have a 5-year effective useful life. The following conditions make up the entire scenario:

- In 2020 (Year 1), widgets with total annual savings of 1.00 GWh are installed. There are no previous year program savings, so cumulative annual savings are equal to 2020 savings, or 1.00 GWh.
- In 2021 (Year 2), widgets with total annual savings of 1.50 GWh are installed. Widgets from 2020 are still installed, cumulative annual savings are 2020 and 2021 annual savings, or 2.50 GWh.
- In 2022 (Year 3), widgets with total annual savings of 1.75 GWh are installed. Widgets from 2020 and 2021 are still installed, cumulative annual savings are 2022, 2021, and 2020 annual savings, or 4.25 GWh.
- In 2025 (Year 6), widgets with total annual savings of 1.75 GWh are installed. Widgets from previous years are still installed. However, in Year 6 the widgets from Year 1 have passed their 5-year effective useful life and are no longer generating energy savings. Cumulative annual savings include savings from widgets installed in 2025, 2024, 2023, 2022, and 2021, *but not* those installed in 2020.

Cumulative annual savings account for equipment retirement is a performance metric and not an accounting metric. In the example, widgets are assumed to have an effective useful life of five years; 2025 savings include those measures generating savings in 2025 and do not include 2020 installations which have passed their effective useful life. Cumulative Annual Savings are often confused with what we can call "Total Accounting Savings."

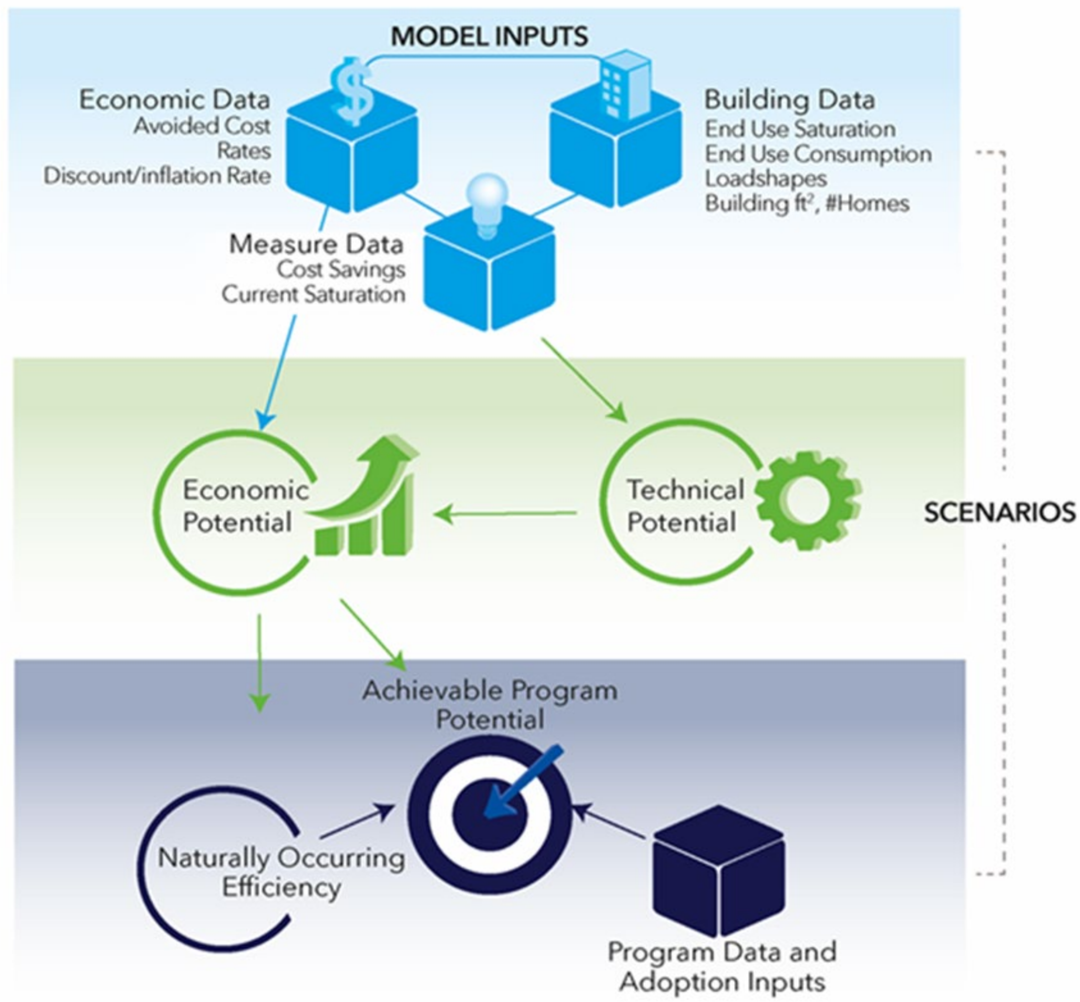
Table 4-1. Example of Cumulative Annual Savings for Widget Installation Program

Installation Year	Energy Savings Year (GWh)									
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
2020	1.00	1.00	1.00	1.00	1.00					
2021		1.50	1.50	1.50	1.50	1.50				
2022			1.75	1.75	1.75	1.75	1.75			
2023				1.75	1.75	1.75	1.75	1.75		
2024					1.75	1.75	1.75	1.75	1.75	
2025						1.75	1.75	1.75	1.75	1.75
2026							1.50	1.50	1.50	1.50
2027								1.25	1.25	1.25
2028									1.00	1.00
2029										0.50
Cumulative Annual Savings (GWh)	**1.00**	**2.50**	**4.25**	**6.00**	**7.75**	**8.50**	**8.5**	**7.00**	**7.25**	**6.00**
Total Accounting Savings (GWh)	**1.00**	**3.50**	**7.75**	**13.75**	**21.50**	**30.00**	**38.50**	**45.50**	**52.75**	**58.75**

4.1.3 Summary of Analytical Steps Used to Calculate Energy Efficiency Potential

The crux of this study involves carrying out several basic analytical steps to produce estimates of the energy efficiency potentials introduced above. The basic analytical steps for this study are shown in relation to one another in Figure 4-3. The bulk of the analytical process for this study was carried out in a model developed by DNV for conducting energy efficiency potential studies. Details on the steps employed and analyses conducted are described in Appendix A. The model used DSM ASSYST™, a Microsoft® Excel-based model that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system.

Figure 4-3. Conceptual Overview of Study Process



The key steps implemented in this study are:

Develop Initial Input Data

a) Develop a list of energy efficiency measure opportunities to include in scope. In this step, an initial draft measure list was developed and provided to Dominion. The final measure list was developed after incorporating comments.

b) Gather and develop technical data (costs and savings) on efficient measure opportunities. Data on measures were gathered from a variety of sources. Measure descriptions are provided in Appendix B and detail on measure inputs is provided in Appendix E.
c) Gather, analyze, and develop information on building characteristics, including total square footage or total number of households, energy consumption and intensity by end use, end-use consumption load patterns by time of day and year (i.e., load shapes), market shares of key electric consuming equipment, and market shares of energy efficiency technologies and practices. Section 5.1.1 of this report describes the baseline data developed for this study.
d) Collect data on economic parameters: avoided costs, electricity rates, discount rates, and inflation rate. These inputs are provided in Appendix C of this report.

Estimate Technical Potential and Develop Supply Curves

a) Match and integrate data on efficient measures to data on existing building characteristics to produce estimates of technical potential and energy efficiency supply curves.

Estimate Economic Potential

a) Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer).
b) Estimate total economic potential. (Note that at this stage of the analysis, program-related costs are not factored into the cost-effectiveness screening. Thus, the results reflect the theoretical estimate of the measure impacts, while disregarding the mode of delivery.)

Estimate Achievable Program and Naturally Occurring Potentials

a) Screen initial measures for inclusion in the program analysis. This screening may take into account factors such as cost effectiveness, potential market size, non-energy benefits, market barriers, and potentially adverse effects associated with a measure. For this study, measures were screened using the total-resource-cost test, with the exclusion of program costs and while considering only electric avoided-cost benefits.
b) Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings.
c) Develop estimates of customer adoption of energy efficiency measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention.
d) Estimate achievable program and naturally occurring potentials and associated program costs.

Scenario Analyses

a) Recalculate potentials under alternate program scenarios.

5 ENERGY EFFICIENCY RESULTS

5.1 Energy Efficiency Baseline Analysis

This section presents a baseline analysis of energy use in Dominion's Virginia and North Carolina service territories. The purpose of this analysis is to provide a breakout of energy use by sector, building type and end use to provide a foundation for estimating demand side management or energy efficiency potentials.

DNV completed a conditional demand analysis of the residential sector using the saturation survey results and billing data to develop energy consumption values for various end uses. That data was incorporated into this analysis.

The non-residential analysis was based on engineering calculations calibrated to Dominion's non-residential energy consumption (there was no non-residential conditional demand analysis) and used the best data available to inform those calculations. However, in some cases we used regional data, such as South Atlantic Census Division data from the U.S. Department of Energy (DOE) Commercial Buildings Energy Consumption Survey (CBECS), rather than those specific to Dominion's service territory. It was necessary to rely on such sources for inputs that could not be determined from the commercial survey data or from other Dominion data sources.

5.1.1 Summary of Baseline Energy Use by Sector

Energy usage by sector and business type was developed from data reported by the EIA. These data are presented in Table 5-1.

Table 5-1. Summary of Dominion MWh and Customers by Sector [16]

	Virginia		North Carolina	
Sector	**MWh**	**# of Customers**	**MWh**	**# of Customers**
Residential	30,437,245	2,220,797	1,701,284	102,865
Non-Residential	50,037,068	259,289	2,699,502	259,289
Total	80,474,313	2,480,086	4,400,786	362,154

Source: EIA, data for Virginia Electric & Power Co., Virginia and North Carolina, 2018

Note that these values include non-jurisdictional, exempt, and opt-out customers, and industrial customers. Exempt and opt-out customers will be broken out later. Industrial customers are not part of the potential study and will be excluded from the rest of the analysis.

5.1.2 Residential Baseline

We used the population weights from the applicable Dominion Residential Appliance Saturation Survey to divide residential customers into single-family, multifamily, and manufactured home households—the three residential segments being examined in this study. The survey did not provide separate values for Virginia and North Carolina, so the same splits were used for both states. Since Dominion has far more customers in Virginia than North Carolina, the breakout should be highly accurate for Virginia, but may be less accurate for North Carolina.

Table 5-2 shows the results.

[16] As available at https://www.eia.gov/electricity/data.php#sales, Tables 6-10

Table 5-2. Number of Residential Customers by Building Type

Building Type	Virginia		North Carolina	
	# of Customers	Percentage of Households	# of Customers	Percentage of Housing
Single Family	1,912,107	86%	88,567	86%
Multifamily	260,025	12%	12,044	12%
Manufactured Home	48,665	2%	2,254	2%
Total	**2,220,797**	**100%**	**102,865**	**100%**

5.1.2.1 Residential End-Use Saturations

The equipment saturations (percent of households having an end use) were calculated from the results of the residential saturation surveys. The survey did not have enough North Carolina data points to develop reliable state-level estimates, so DNV's analysts used the same saturation data for both states. These results are shown in Table 5-3. For lighting, the equipment saturations interact with the number of lamps per home by usage and type.

Table 5-3. Residential End-Use Saturations by Base Measure, Virginia and North Carolina

End-use Saturations	Single Family	Multifamily	Manufactured Housing
Base Split-System Air Conditioner	15%	20%	22%
Base Early Replacement Split-System Air Conditioner	25%	18%	16%
Base Heat Pump Cooling	16%	22%	12%
Base Early Replacement Heat Pump Cooling	38%	34%	22%
Base Room Air Conditioner	1.4%	0.8%	9.1%
Base Early Replacement Room Air Conditioner	4.3%	5.5%	18.4%
Base Dehumidifier	32%	5%	5%
Base Air Purifier	15%	5%	15%
Base Furnace Fans	94%	94%	72%
Base Heat Pump Space Heating	9.7%	16%	7%
Base Early Replacement Heat Pump Heating	26%	26%	17%
Base Resistance Space Heating (Primary)	18%	29%	53%
Base High-Efficiency Incandescent Lighting, 0.5 hrs/day	67%	66%	45%
Base High-Efficiency Incandescent Lighting, 2.5 hrs/day	67%	66%	45%
Base High-Efficiency Incandescent Lighting, 6 hrs/day	67%	66%	45%
Base Lighting 15 Watt CFL, 0.5 hrs/day	54%	50%	37%
Base Lighting 15 Watt CFL, 2.5 hrs/day	54%	50%	37%
Base Lighting 15 Watt CFL, 6 hrs/day	54%	50%	37%
Base Lighting 9 Watt LED, 0.5 hrs/day	70%	53%	56%
Base Lighting 9 Watt LED, 2.5 hrs/day	70%	53%	56%
Base Lighting 9 Watt LED, 6 hrs/day	70%	53%	56%
Base Specialty Incandescent Lighting, 0.5 hrs/day	67%	66%	45%
Base Specialty Incandescent Lighting, 2.5 hrs/day	67%	66%	45%
Base Specialty Incandescent Lighting, 6 hrs/day	67%	66%	45%
Base Fluorescent Fixture 1.8 hrs/day	34%	26%	18%

End-use Saturations	Single Family	Multifamily	Manufactured Housing
Base Refrigerator	67%	74%	76%
Base Early Replacement Refrigerator	33%	26%	24%
Base Second Refrigerator	37%	0%	12%
Base Freezer	29%	6%	42%
Base Early Replacement Freezer	8%	2%	7%
Base Second Freezer	2.5%	0.0%	0.0%
Base 40 gal. Water Heating	17%	20%	20%
Base Early Replacement Water Heating to Heat Pump Water Heater	34%	37%	69%
Base Clothes Washer	98%	89%	89%
Base Clothes Dryer (EF=3.01)	92%	79%	79%
Base Dishwasher (EF=0.65)	90%	82%	90%
Base Single Speed Pool Pump (RET)	5.5%	0.0%	0.0%
Base Plasma TV	8%	8%	8%
Base LCD TV	20%	20%	20%
Base LED TV	62%	62%	62%
Base Set-Top Box	84%	83%	84%
Base DVD Player	85%	65%	85%
Base Desktop PC	47%	25%	25%
Base Laptop PC	73%	70%	70%
Base Cooking	81%	87%	87%
Base Miscellaneous	100%	100%	100%
Base House Practices	100%	100%	100%

An initial estimate of the number of incandescent lamps, CFLs, and LEDs per home was made using the survey data. These self-reported data suggested a total of 35 lamps per single family home, 17 lamps per multifamily home, and 20 lamps per manufactured home. These values seem low when compared to lighting studies from more rigorous evaluations conducted on-site from other regions and taking into consideration the reported size of the homes. Self-reported values tend to underestimate lamp counts compared to on-site studies, since residents tend to forget about infrequently used lamps. The results of the CDA also suggested that the number of lamps was likely understated, since the lighting energy use from the CDA, combined with the reported number of lamps, implied an extremely high kWh usage per lamp—either very high wattage or very high average usage (or both). As a result of these concerns, when the model was calibrated so that lighting energy use would match the CDA results, the number of lamps per home was increased above the values found in the survey.

Also, to align the lighting saturation information with the lighting methodology used in DSM ASSYST™, the number of lamps was broken out into usage bins, as available from internal DNV databases (gleaned from previous potential studies and on-site data collection). The resulting breakouts are shown in Table 5-4. Average Number of Lamps per Home by Type and Usage, Virginia and North Carolina.

Table 5-4. Average Number of Lamps per Home by Type and Usage, Virginia and North Carolina

Lamp Type	Single Family	Multi-family	Manufactured Housing	All Homes
High-Efficiency Incandescent Lighting, 0.5 hrs/day	6.9	3.8	3.7	6.5
High-Efficiency Incandescent Lighting, 2.5 hrs/day	4.4	2.4	2.4	4.1
High-Efficiency Incandescent Lighting, 6 hrs/day	0.3	0.2	0.2	0.3
Lighting 15 Watt CFL, 0.5 hrs/day	3.1	1.4	1.7	2.9
Lighting 15 Watt CFL, 2.5 hrs/day	6.3	2.9	3.4	5.9
Lighting 15 Watt CFL, 6 hrs/day	3.1	1.4	1.7	2.9
Lighting 9 Watt LED, 0.5 hrs/day	2.6	1.0	1.6	2.4
Lighting 9 Watt LED, 2.5 hrs/day	13.5	5.1	8.6	12.4
Lighting 9 Watt LED, 6 hrs/day	10.9	4.1	6.9	10.0
Specialty Incandescent Lighting, 0.5 hrs/day	2.8	1.5	1.5	2.7
Specialty Incandescent Lighting, 2.5 hrs/day	2.3	1.3	1.3	2.2
Specialty Incandescent Lighting, 6 hrs/day	0.6	0.3	0.3	0.6
Fluorescent Fixture 1.8 hrs/day	2.5	1.0	1.0	2.3
Total	59.4	26.4	34.3	55.0

5.1.2.2 Residential End-Use Energy Intensities

Table 5-5 shows the end-use energy intensities for the residential sector by base measure for Virginia and North Carolina. End-use energy intensities represent the energy use per household for households that have that end-use. Most of these energy intensity values were derived from the conditional demand analysis, with lighting estimates supplemented by engineering calculations to support the usage bin breakouts. The rest were derived or calculated from a variety of sources, including:

- DOE's Home Energy Saver model
- The US Environmental Protection Agency (EPA) ENERGY STAR calculators

Note that the results shown below are presented on a per-household basis.

Table 5-5. Residential End-Use Energy Intensities (kWh/household with end-use), Virginia and North Carolina

kWh/household	Virginia				North Carolina			
	Single Family	Multi-family	Manu-factured Housing	All Homes	Single Family	Multi-family	Manu-factured Housing	All Homes
Base Split-System Air Conditioner	3,349	1,551	3,284	3,137	4,016	1,859	3,284	3,747
Base Early Replacement Split-System Air Conditioner	3,133	1,744	3,000	2,967	3,756	2,091	3,000	3,545
Base Heat Pump Cooling	3,495	1,833	3,159	3,293	4,191	2,198	3,159	3,935
Base Early Replacement Heat Pump Cooling	3,011	1,726	2,768	2,855	3,611	2,069	2,768	3,412
Base Room Air Conditioner	2,095	660	1,544	1,915	2,512	791	1,544	2,289
Base Early Replacement Room Air Conditioner	2,453	1,665	2,330	2,358	2,941	1,996	2,330	2,817
Base Dehumidifier	900	369	900	837	900	369	900	837
Base Air Purifier	407	300	407	394	407	300	407	394
Base Furnace Fans	1,143	475	1,143	1,065	1,330	634	1,330	1,248
Base Heat Pump Space Heating	4,757	2,193	4,157	4,444	5,704	2,630	4,157	5,310
Base Early Replacement Heat Pump Heating	3,744	1,902	2,565	3,503	4,490	2,281	2,565	4,189
Base Resistance Space Heating (Primary)	3,582	1,699	4,624	3,384	4,295	2,037	4,624	4,038
Base High-Efficiency Incandescent Lighting, 0.5 hrs/day	81	45	65	76	81	45	65	76
Base High-Efficiency Incandescent Lighting, 2.5 hrs/day	255	141	204	240	255	141	204	240
Base High-Efficiency Incandescent Lighting, 6 hrs/day	49	27	39	46	49	27	39	46
Base Lighting 15 Watt CFL, 0.5 hrs/day	15	8	12	15	15	8	12	15
Base Lighting 15 Watt CFL, 2.5 hrs/day	159	79	127	149	159	79	127	149
Base Lighting 15 Watt CFL, 6 hrs/day	315	157	252	295	315	157	252	295
Base Lighting 9 Watt LED, 0.5 hrs/day	7	4	6	7	7	4	6	7
Base Lighting 9 Watt LED, 2.5 hrs/day	231	116	185	217	231	116	185	217
Base Lighting 9 Watt LED, 6 hrs/day	622	311	498	583	622	311	498	583
Base Specialty Incandescent Lighting, 0.5 hrs/day	33	18	27	31	33	18	27	31
Base Specialty Incandescent Lighting, 2.5 hrs/day	136	75	109	128	136	75	109	128

kWh/household	Virginia				North Carolina			
	Single Family	Multi-family	Manu-factured Housing	All Homes	Single Family	Multi-family	Manu-factured Housing	All Homes
Base Specialty Incandescent Lighting, 6 hrs/day	90	50	72	85	90	50	72	85
Base Fluorescent Fixture 1.8 hrs/day	71	36	57	67	71	36	57	67
Base Refrigerator	616	616	2,595	659	616	616	2,595	659
Base Early Replacement Refrigerator	704	704	3,742	771	704	704	3,742	771
Base Second Refrigerator	1,342	0	439	1,165	1,342	0	439	1,165
Base Freezer	1,126	1,828	1,350	1,213	1,126	1,828	1,350	1,213
Base Early Replacement Freezer	777	2,676	1,682	1,019	777	2,676	1,682	1,019
Base Second Freezer	953	953	0	932	953	953	0	932
Base 40 gal. Water Heating	1,490	978	1,376	1,428	1,490	978	1,376	1,428
Base Early Replacement Water Heating to Heat Pump Water Heater	1,361	881	2,352	1,327	1,361	881	2,352	1,327
Base Clothes Washer	303	196	303	290	303	196	303	290
Base Clothes Dryer (EF=3.01)	826	535	826	792	826	535	826	792
Base Dishwasher (EF=0.65)	247	221	247	244	260	260	260	260
Base Single Speed Pool Pump (RET)	811	0	811	716	811	0	811	716
Base Plasma TV	193	193	193	193	193	226	193	197
Base LCD TV	270	127	270	253	270	149	270	256
Base LED TV	852	42	852	757	852	50	852	758
Base Set-Top Box	262	173	262	252	276	204	276	267
Base DVD Player	36	27	36	35	38	32	38	37
Base Desktop PC	670	799	670	685	670	799	670	685
Base Laptop PC	279	527	279	308	279	527	279	308
Base Cooking	333	321	333	332	333	321	333	332
Base Miscellaneous	552	226	643	516	1,000	226	643	902
Base House Practices	13,781	7,524	16,438	13,106	16,780	8,628	16,369	15,816

5.1.2.3 Residential Energy Use

Residential energy use was calculated as the product of the number of households, equipment saturation, and the end-use energy intensity. Energy use by building type and end-use is shown in Table 5-6.

Table 5-6. Residential Energy Use by Building Type and End-Use

	Virginia				North Carolina			
	Single Family	Multi-Family	Manu-factured Housing	Total	Single Family	Multi-Family	Manu-factured Housing	Total
Base Split-System Air Conditioner	985,194	80,260	35,935	1,101,389	143,722	8,396	2,868	154,986
Base Early Replacement Split-System Air Conditioner	1,498,938	79,754	23,738	1,602,431	-	-	-	-
Base Heat Pump Cooling	1,077,929	103,824	18,036	1,199,789	199,917	14,879	2,403	217,199
Base Early Replacement Heat Pump Cooling	2,172,448	154,465	29,654	2,356,568	-	-	-	-
Base Room Air Conditioner	55,649	1,425	6,807	63,881	12,751	601	957	14,309
Base Early Replacement Room Air Conditioner	203,648	23,699	20,912	248,258	-	-	-	-
Base Dehumidifier	548,926	4,795	2,189	555,909	25,426	222	101	25,749
Base Air Purifier	120,455	3,900	3,066	127,421	5,579	181	142	5,902
Base Furnace Fans	2,059,851	115,825	40,317	2,215,993	111,004	7,153	2,173	120,330
Base Heat Pump Space Heating	877,724	88,605	13,795	980,124	242,477	15,838	2,624	260,939
Base Early Replacement Heat Pump Heating	1,896,559	130,590	20,715	2,047,864	-	-	-	-
Base Resistance Space Heating (Primary)	1,245,191	127,581	120,022	1,492,794	69,157	7,086	5,559	81,802
Base High-Efficiency Incandescent Lighting, 0.5 hrs/day	103,742	7,708	1,428	112,878	4,805	357	66	5,228
Base High-Efficiency Incandescent Lighting, 2.5 hrs/day	326,526	24,260	4,496	355,282	15,124	1,124	208	16,456
Base High-Efficiency Incandescent Lighting, 6 hrs/day	62,693	4,658	863	68,214	2,904	216	40	3,160
Base Lighting 15 Watt CFL, 0.5 hrs/day	16,124	1,003	221	17,348	747	46	10	804
Base Lighting 15 Watt CFL, 2.5 hrs/day	165,277	10,280	2,267	177,823	7,655	476	105	8,237
Base Lighting 15 Watt CFL, 6 hrs/day	327,865	20,393	4,497	352,754	15,186	945	208	16,339
Base Lighting 9 Watt LED, 0.5 hrs/day	9,966	512	161	10,639	462	24	7	493

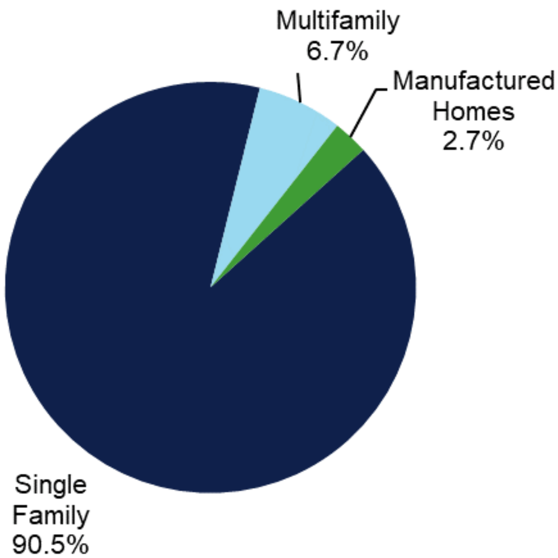
	Virginia				North Carolina			
	Single Family	Multi-Family	Manu-factured Housing	Total	Single Family	Multi-Family	Manu-factured Housing	Total
Base Lighting 9 Watt LED, 2.5 hrs/day	310,299	15,938	5,018	331,255	14,373	738	232	15,343
Base Lighting 9 Watt LED, 6 hrs/day	835,013	42,890	13,503	891,406	38,677	1,987	625	41,289
Base Specialty Incandescent Lighting, 0.5 hrs/day	42,463	3,155	585	46,203	1,967	146	27	2,140
Base Specialty Incandescent Lighting, 2.5 hrs/day	174,404	12,958	2,401	189,763	8,078	600	111	8,790
Base Specialty Incandescent Lighting, 6 hrs/day	115,258	8,564	1,587	125,408	5,339	397	74	5,809
Base Fluorescent Fixture 1.8 hrs/day	46,781	2,422	491	49,693	2,167	112	23	2,302
Base Refrigerator	784,984	118,235	96,089	999,309	36,360	5,477	4,451	46,287
Base Early Replacement Refrigerator	448,998	47,932	43,548	540,477	20,797	2,220	2,017	25,034
Base Second Refrigerator	953,944	-	2,658	956,603	44,186	-	123	44,309
Base Freezer	618,185	30,563	27,353	676,101	28,634	1,416	1,267	31,316
Base Early Replacement Freezer	112,933	11,745	5,488	130,166	5,231	544	254	6,029
Base Second Freezer	45,240	-	-	45,240	2,095	-	-	2,095
Base 40 gal. Water Heating	487,206	52,076	13,126	552,408	67,786	6,798	2,739	77,324
Base Early Replacement Water Heating to Heat Pump Water Heater	891,736	85,302	78,651	1,055,690	-	-	-	-
Base Clothes Washer	568,032	45,250	13,083	626,365	26,311	2,096	606	29,013
Base Clothes Dryer	1,452,315	110,091	31,830	1,594,236	67,270	5,099	1,474	73,843
Base Dishwasher	423,299	46,932	10,773	481,005	20,639	2,557	525	23,721
Base Single Speed Pool Pump (RET)	85,397	-	-	85,397	3,956	-	-	3,956
Base Plasma TV	31,123	4,222	792	36,136	1,442	230	37	1,708
Base LCD TV	105,537	6,747	2,686	114,970	4,888	368	124	5,380
Base LED TV	1,017,292	6,852	25,891	1,050,034	47,120	373	1,199	48,693
Base Set-Top Box	422,827	37,432	10,761	471,020	20,616	2,040	525	23,180
Base DVD Player	59,028	4,548	1,502	65,078	2,878	248	73	3,199
Base Desktop PC	605,821	52,044	8,168	666,033	28,061	2,411	378	30,850
Base Laptop PC	387,696	96,042	9,516	493,254	17,958	4,449	441	22,847

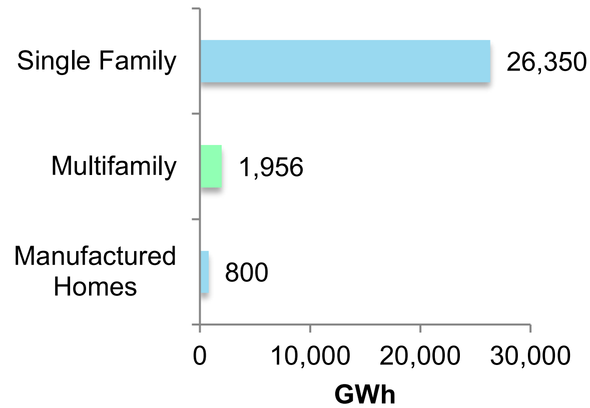
	Virginia				North Carolina			
	Single Family	Multi-Family	Manu-factured Housing	Total	Single Family	Multi-Family	Manu-factured Housing	Total
Base Cooking	514,119	72,253	14,028	600,400	23,813	3,347	650	27,810
Base Miscellaneous	1,055,483	58,766	31,292	1,145,540	88,567	2,722	1,449	92,738
Base House Practices	26,350,117	1,956,495	799,939	29,106,551	1,486,123	103,917	36,898	1,626,938
Total	26,350,117	1,956,495	799,939	29,106,551	1,486,123	103,917	36,898	1,626,938

Figure 5-1 and Figure 5-2 show the breakout of residential energy use by building type and end use, respectively. Space cooling and heating were by far the largest end uses in terms of total consumption.

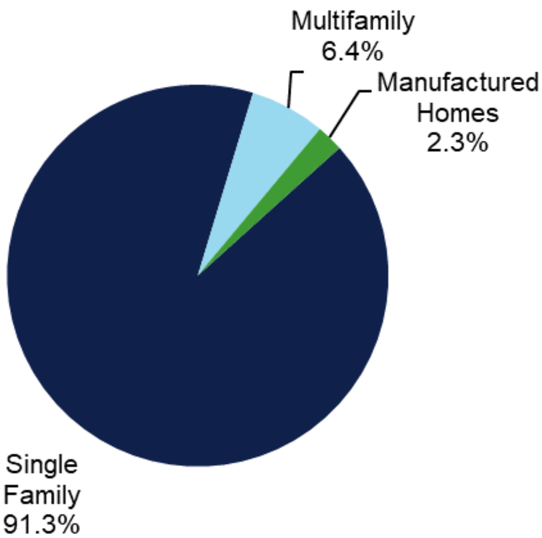
Figure 5-1. Residential Energy Use by Building Type

Virginia





North Carolina



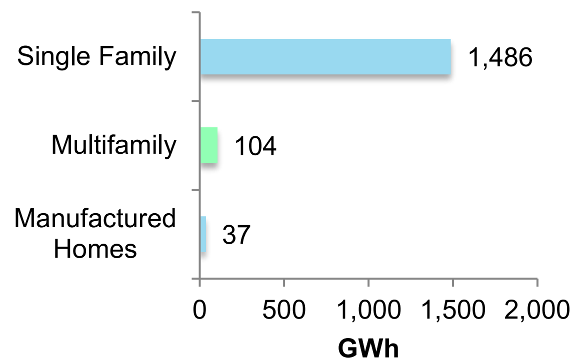
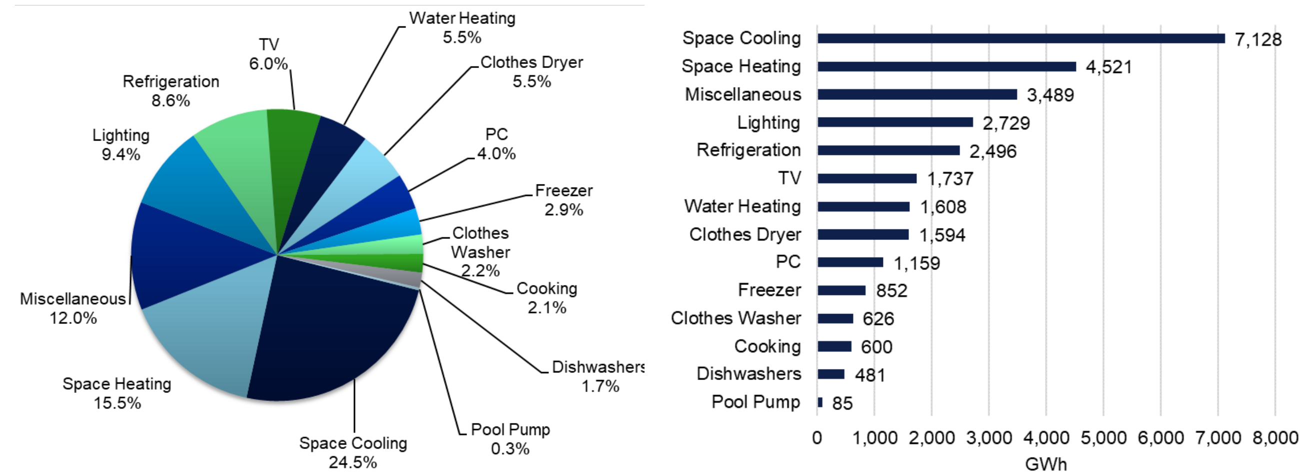
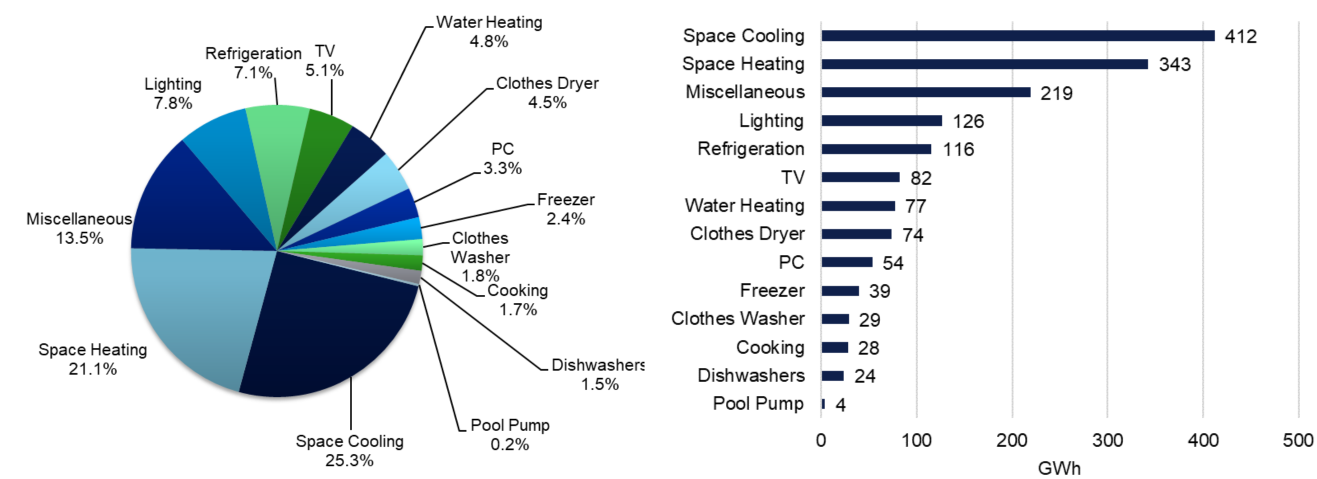


Figure 5-2. Residential Energy Use by End Use

Virginia



North Carolina



5.1.3 Commercial Baseline

For this potential study, opt-out-eligible customers were split apart from the non-eligible customers for Virginia. These groups, plus North Carolina (total) were broken down into building types, listed below, with non-jurisdictional customers additionally split out from the non-exempt customers:

- Office
- Restaurant
- Retail
- Grocery
- Warehouse
- Education
- Health
- Lodging
- Data Center
- Non-Jurisdictional (Virginia only)
- Religious Worship
- Other
- Industrial
- Agricultural

While we performed baseline analyses for both opt-out-eligible customers and non-eligible customers, this section presents results only for the non-exempt customers, as the exempt/opt-out customers do not contribute to program potential.

5.1.3.1 Commercial Equipment Saturations

The equipment saturations (percent of commercial square feet having an end use) were calculated primarily from the results of the commercial saturation surveys. For a few measures, such as motors, data from internal DNV databases (gleaned from previous potential studies and on-site data collection) were used. The resulting saturations are shown in Table 5-7.

Table 5-7. Commercial Sector Equipment Saturations, Virginia and North Carolina

End Use	Office	Restau -rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus -trial	Agricul -tural
Base Fluorescent Fixture, T12	24%	18%	16%	18%	11%	22%	17%	4%	17%	24%	22%	25%	25%	10%
Base Fluorescent Fixture, T8	24%	6%	25%	17%	15%	21%	20%	7%	35%	22%	18%	20%	23%	9%
Base Fluorescent T5	3%	2%	2%	2%	3%	5%	3%	2%	0%	3%	5%	2%	2%	1%
Base LED Tube, 2 lamp fixture	14%	18%	16%	41%	33%	17%	19%	17%	21%	13%	13%	13%	15%	14%
Base Incandescent/ halogen	6%	9%	9%	2%	2%	2%	5%	5%	0%	8%	9%	9%	3%	12%
Base CFL	4%	4%	4%	1%	14%	4%	9%	12%	9%	4%	3%	3%	5%	9%
Base LED bulb	24%	37%	25%	12%	18%	26%	21%	49%	19%	24%	25%	24%	15%	35%
Base HID	0%	4%	3%	0%	0%	3%	1%	3%	0%	1%	3%	1%	11%	11%
Base CFL Exit Sign	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Base Outdoor LED bulb	38%	33%	41%	27%	46%	65%	28%	60%	57%	36%	43%	33%	24%	28%
Base Outdoor LED Tube	2%	1%	5%	15%	0%	1%	0%	2%	4%	2%	1%	1%	0%	0%
Base Outdoor Fluorescent Tube	2%	3%	3%	4%	2%	0%	4%	1%	26%	2%	5%	3%	1%	3%
Base Outdoor CFL	4%	4%	4%	2%	2%	4%	6%	1%	4%	3%	5%	2%	8%	6%
Base Outdoor HID	5%	13%	8%	2%	15%	8%	9%	9%	7%	10%	19%	14%	27%	12%
Base Outdoor Incandescent/ Halogen	21%	17%	10%	14%	8%	9%	20%	19%	1%	22%	16%	22%	19%	21%
Base Centrifugal Chiller	36%	0%	21%	0%	2%	43%	38%	14%	46%	20%	10%	5%	39%	0%
Base DX Packaged System	53%	53%	82%	90%	55%	88%	63%	61%	38%	61%	75%	69%	89%	15%
Base Heat Pump cooling	27%	43%	4%	9%	5%	42%	14%	17%	0%	21%	29%	15%	17%	12%
Base PTAC	1%	1%	5%	6%	1%	43%	5%	12%	15%	3%	15%	5%	14%	2%
Base Split-system, residential type	17%	39%	4%	3%	18%	48%	23%	26%	13%	14%	26%	11%	10%	2%
Base Ductless mini- or multi-split	1%	1%	5%	6%	1%	43%	5%	12%	15%	3%	15%	5%	14%	2%
Base Window/portable AC	0%	38%	1%	9%	25%	22%	9%	20%	1%	3%	11%	6%	5%	10%
Base Fan Motor, 5hp	42%	50%	43%	97%	30%	33%	19%	65%	19%	48%	54%	54%	54%	54%
Base Fan Motor, 15hp	7%	0%	2%	0%	0%	89%	65%	0%	65%	25%	43%	43%	43%	43%
Base Fan Motor, 40hp	5%	0%	2%	96%	10%	37%	69%	11%	69%	19%	0%	34%	34%	34%
Base Full-size Residential-type refrigerators/freezers	61%	47%	40%	38%	55%	88%	65%	75%	40%	62%	86%	63%	56%	62%

End Use	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agricul-tural
Base Compact refrigerators	36%	30%	44%	17%	37%	25%	60%	27%	44%	32%	15%	28%	48%	15%
Base Walk-in refrigeration/freezer units	2%	79%	7%	78%	18%	14%	5%	16%	0%	5%	6%	7%	2%	17%
Base Open refrigerated/freezer cases	1%	22%	3%	36%	0%	4%	0%	4%	24%	1%	0%	0%	1%	0%
Base Closed refrigerated/freezer cases	1%	43%	11%	64%	1%	31%	7%	11%	0%	6%	5%	11%	1%	0%
Base Commercial Ice Maker	4%	66%	3%	28%	9%	25%	10%	38%	25%	10%	30%	15%	15%	6%
Base Large Cold Storage Area	1%	24%	1%	17%	2%	1%	0%	2%	0%	1%	2%	2%	2%	6%
Base Desktop PC	82%	51%	71%	58%	67%	77%	88%	79%	100%	71%	82%	60%	88%	31%
Base Laptop PC	62%	24%	47%	26%	42%	70%	74%	50%	76%	59%	74%	56%	53%	22%
Base Computer Network Server	56%	35%	44%	22%	15%	50%	49%	40%	42%	45%	51%	35%	47%	20%
Base Monitor, CRT	4%	3%	2%	1%	0%	11%	10%	6%	0%	4%	3%	5%	6%	3%
Base Monitor, LCD	90%	58%	75%	85%	76%	83%	89%	77%	76%	80%	81%	70%	79%	36%
Base Imaging	97%	45%	87%	29%	89%	99%	99%	94%	95%	97%	98%	86%	86%	86%
Base Water Heating	88%	55%	66%	64%	92%	65%	63%	58%	27%	82%	72%	75%	74%	62%
Base Refrigerated Vending Machines	17%	21%	21%	41%	28%	36%	12%	48%	18%	20%	19%	23%	39%	9%
Base Non-Refrigerated Vending Machines	14%	11%	13%	36%	26%	30%	7%	34%	18%	14%	17%	15%	30%	7%
Base Convection Oven	8%	48%	5%	42%	14%	60%	8%	44%	35%	12%	39%	17%	4%	16%
Base Fryer	4%	49%	6%	28%	1%	16%	3%	20%	0%	6%	7%	9%	1%	4%
Base Steamer	1%	17%	3%	13%	0%	13%	2%	8%	0%	2%	5%	4%	0%	0%
Base Heat Pump heating	31%	0%	29%	3%	1%	5%	0%	1%	35%	16%	8%	2%	3%	0%
Base Heating, Rooftop/packaged unit	20%	27%	14%	30%	20%	21%	24%	35%	25%	22%	27%	23%	14%	6%
Base Heating, Electric Furnace	8%	1%	0%	8%	16%	6%	0%	3%	0%	7%	1%	6%	1%	2%
Base Heating, Electric Boiler	11%	9%	8%	18%	22%	3%	8%	23%	2%	9%	8%	7%	7%	11%
Base Process	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	55%	0%
Base Motors	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Base Miscellaneous	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

5.1.3.2 Commercial End-Use Energy Intensities

Table 5-8 and Table 5-9 show the end-use energy intensities (EUIs) for the Virginia and North Carolina commercial sectors by base measure, respectively. End-use energy intensities represent the energy use per square feet for businesses that have that end-use (for example, chiller annual kWh for commercial square feet with chillers). EUIs were developed from a variety of sources. At the base measure level, lighting and HVAC EUIs were developed from engineering calculations based on wattage or baseline efficiency and hours of use from the STEP Manual. For products covered by the ENERGY STAR program, the EPA's calculators were used. In addition, California's Commercial End-Use Survey (CEUS) was used for other non-weather-sensitive end uses.

At the end-use level, EUIs were obtained for the South Atlantic Census Division from the DOE's 2012 CBECS.[17] This provided concrete, survey-based, regionally appropriate values to use to calibrate the base measure-level EUIs. The resulting EUIs, when combined with the saturation data, produce intensities at the building type level.

[17] Consumption data for the 2018 CBECS were not yet available at the time of the analysis.

Table 5-8. Virginia Commercial End-Use Energy Intensities (kWh per End-Use Square Foot)

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural
Base Fluorescent Fixture, T12	1.3	2.1	3.1	4.0	2.6	1.3	5.8	1.2	4.5	1.5	2.1	1.7	1.7	1.7
Base Fluorescent Fixture, T8	1.2	1.9	2.7	3.6	2.2	1.2	5.2	1.1	4.0	1.4	1.9	1.5	1.5	1.4
Base Fluorescent T5	0.9	1.5	2.3	2.9	1.9	1.0	4.2	0.9	3.3	1.1	1.6	1.2	1.2	1.2
Base LED Tube, 2 lamp fixture	0.6	1.0	1.6	1.6	1.1	0.6	1.9	0.4	2.0	0.7	0.8	0.8	0.8	0.8
Base Incandescent/ halogen	4.4	1.4	4.2	1.8	0.0	0.1	2.6	1.4	15.4	2.1	1.70	1.7	1.7	1.7
Base CFL	1.5	0.5	1.4	0.6	0.0	0.0	0.9	0.5	5.2	0.7	0.58	0.6	0.6	0.6
Base LED bulb	1.0	0.3	0.9	0.4	0.0	0.0	0.6	0.3	3.5	0.5	0.39	0.4	0.4	0.4
Base HID	1.4	0.0	8.0	5.5	1.8	1.6	12.5	1.5	1.6	0.8	0.86	0.7	0.7	0.7
Base CFL Exit Sign	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.02	0.0	0.0	0.0
Base Outdoor LED bulb	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.2	0.2	0.2
Base Outdoor LED Tube	0.4	0.2	0.3	0.4	0.1	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.3	0.3
Base Outdoor Fluorescent Tube	0.6	0.4	0.4	0.7	0.2	0.2	0.3	0.1	0.3	0.4	0.3	0.4	0.4	0.5
Base Outdoor CFL	0.3	0.2	0.2	0.4	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.3
Base Outdoor HID	4.5	3.1	3.3	5.1	1.3	1.8	2.7	1.0	2.4	3.4	2.1	3.4	3.4	4.1
Base Outdoor Incandescent/ Halogen	0.9	0.7	0.7	1.1	0.3	0.4	0.6	0.2	0.5	0.7	0.4	0.7	0.7	0.9
Base Centrifugal Chiller	1.2	1.9	2.1	1.6	1.7	0.9	2.0	2.6	32.9	1.1	0.4	0.7	0.6	0.6
Base DX Packaged System	2.8	3.0	4.0	2.8	8.5	1.4	3.5	5.2	65.5	2.6	0.6	1.6	1.2	1.2
Base Heat Pump cooling	2.6	2.8	3.7	2.6	7.8	1.2	3.2	4.8	30.1	2.4	0.5	1.5	1.1	1.1
Base PTAC	0.000	0.000	0.000	0.000	7.722	1.070	0.000	3.483	32.481	0.000	0.515	1.459	1.060	1.060
Base Split-system, residential type	2.007	2.199	2.904	2.022	6.110	0.978	2.521	3.764	23.665	1.869	0.408	1.154	0.839	0.839
Base Ductless mini- or multi-split	1.756	1.924	2.541	1.769	5.346	0.856	2.206	3.293	41.413	1.635	0.357	1.010	0.734	0.734
Base Window/portable AC	1.102	1.207	1.594	1.357	5.032	0.635	1.661	1.771	12.992	1.026	0.336	0.950	0.691	0.691
Base Fan Motor, 5hp	6.004	4.750	5.473	2.752	1.328	0.563	12.685	2.178	1.338	1.575	0.550	0.430	0.033	0.033
Base Fan Motor, 15hp	2.765	2.608	26.395	0.000	0.000	1.135	7.306	0.000	12.328	0.725	1.012	0.792	0.061	0.061
Base Fan Motor, 40hp	20.491	0.000	38.008	0.000	1.695	0.238	0.000	0.000	45.675	5.374	2.698	2.113	0.162	0.162

	Office	Restau -rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus -trial	Agri-cultural
Base Full-size Residential-type refrigerators/freezers	0.3	0.5	0.1	0.6	0.1	0.1	0.1	0.2	0.0	0.7	0.1	1.1	0.7	0.1
Base Compact refrigerators	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0
Base Walk-in refrigeration/freezer units	0.0	30.5	0.3	40.9	11.5	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.6
Base Open refrigerated/freezer cases	0.0	1.1	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Closed refrigerated/freezer cases	0.0	1.3	0.1	4.5	0.0	0.1	0.2	0.0	0.0	0.2	0.0	0.4	0.0	0.0
Base Commercial Ice Maker	0.0	1.8	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.2	0.1	0.0
Base Large Cold Storage Area	0.0	10.2	0.0	1.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4
Base Desktop PC	0.3	0.1	0.2	0.3	0.1	0.2	0.7	0.0	0.1	0.1	0.18	0.2	0.2	0.1
Base Laptop PC	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.04	0.0	0.0	0.0
Base Computer Network Server	0.5	0.3	0.3	0.5	0.1	4.8	0.8	0.0	148.3	2.0	0.08	2.4	0.2	0.8
Base Monitor, CRT	0.3	0.1	0.2	0.2	0.0	0.2	0.6	0.0	0.1	0.1	0.16	0.2	0.1	0.1
Base Monitor, LCD	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.04	0.0	0.0	0.0
Base Imaging	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0
Base Water Heating	0.1	1.1	0.2	0.1	0.1	0.2	0.2	0.4	0.1	0.2	0.0	0.2	0.2	0.2
Base Refrigerated Vending Machines	0.024	0.015	0.015	0.081	0.015	0.015	0.021	0.018	0.005	0.030	0.009	0.014	0.014	0.014
Base Non-Refrigerated Vending Machines	0.002	0.001	0.000	0.003	0.002	0.001	0.001	0.001	0.002	0.001	0.00	0.001	0.001	0.001
Base Convection Oven	0.708	6.398	0.652	2.817	0.031	0.452	2.155	0.069	0.652	0.414	0.203	0.203	0.203	0.203
Base Fryer	0.658	7.580	0.391	4.948	0.057	0.193	4.370	0.112	0.391	0.411	0.438	0.438	0.438	0.438
Base Steamer	1.823	6.426	1.063	3.094	0.035	0.139	1.179	0.077	1.063	0.575	0.156	0.169	0.169	0.169
Base Heat Pump heating	1.3	2.4	3.0	2.4	2.4	1.9	2.1	6.3	3.8	1.7	0.3	1.4	1.4	1.4
Base Heating, Rooftop/packaged unit	3.2	5.7	7.1	5.9	5.8	4.7	5.1	15.2	9.2	4.1	0.8	3.3	3.3	3.3
Base Heating, Electric Furnace	3.2	5.7	7.1	5.9	5.8	4.7	5.1	15.2	9.2	4.1	0.8	3.3	3.3	3.3
Base Heating, Electric Boiler	3.2	5.7	7.1	5.9	5.8	4.7	5.1	15.2	9.2	4.1	0.8	3.3	3.3	3.3
Base Process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
Base Motors	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.237	0.000
Base Miscellaneous	2.2	2.6	2.2	2.4	0.9	0.6	6.0	1.4	40.0	1.5	1.7	1.7	1.7	3.0

Table 5-9. North Carolina Commercial End-Use Energy Intensities (kWh per End-Use Square Foot)

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural
Base Fluorescent Fixture, T12	1.3	2.1	3.1	4.0	1.7	1.3	5.8	2.1	4.5	1.5	2.2	1.7	1.7	1.7
Base Fluorescent Fixture, T8	1.2	1.9	2.7	3.6	1.5	1.2	5.2	1.9	4.0	1.4	2.0	1.5	1.5	1.4
Base Fluorescent T5	0.9	1.5	2.3	2.9	1.2	1.0	4.2	1.5	3.3	1.1	1.6	1.2	1.2	1.2
Base LED Tube, 2 lamp fixture	0.6	1.0	1.6	1.6	0.7	0.6	1.9	0.6	2.0	0.7	0.8	0.8	0.8	0.8
Base Incandescent/ halogen	4.4	1.4	4.2	1.8	0.0	0.1	2.6	2.3	15.4	2.1	1.72	1.7	1.7	1.7
Base CFL	1.5	0.5	1.4	0.6	0.0	0.0	0.9	0.8	5.2	0.7	0.59	0.6	0.6	0.6
Base LED bulb	1.0	0.3	0.9	0.4	0.0	0.0	0.6	0.5	3.5	0.5	0.39	0.4	0.4	0.4
Base HID	1.4	0.0	8.0	5.5	1.2	1.6	12.5	2.5	1.6	0.8	0.88	0.7	0.7	0.7
Base CFL Exit Sign	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.02	0.0	0.0	0.0
Base Outdoor LED bulb	0.2	0.1	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
Base Outdoor LED Tube	0.4	0.2	0.3	0.4	0.0	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.3	0.3
Base Outdoor Fluorescent Tube	0.6	0.4	0.4	0.7	0.1	0.2	0.3	0.2	0.3	0.4	0.3	0.4	0.4	0.4
Base Outdoor CFL	0.3	0.2	0.2	0.4	0.0	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Base Outdoor HID	4.5	3.1	3.3	5.1	0.6	1.8	2.7	1.6	2.4	3.4	2.4	3.4	3.4	3.4
Base Outdoor Incandescent/ Halogen	0.9	0.7	0.7	1.1	0.1	0.4	0.6	0.3	0.5	0.7	0.5	0.7	0.7	0.7
Base Centrifugal Chiller	1.4	2.2	2.4	1.8	0.7	1.1	2.4	5.0	32.9	1.3	0.6	0.8	0.4	0.4
Base DX Packaged System	3.2	3.6	4.7	3.3	3.6	1.6	4.1	10.1	65.5	3.0	0.8	1.9	0.8	0.8
Base Heat Pump cooling	3.0	3.3	4.3	3.0	3.3	1.5	3.7	9.3	30.1	2.8	0.7	1.7	0.7	0.7
Base PTAC	0.000	0.000	0.000	0.000	3.247	1.249	0.000	6.777	32.481	0.000	0.708	1.703	0.709	0.709
Base Split-system, residential type	2.344	2.568	3.392	2.360	2.569	1.143	2.944	7.324	23.665	2.182	0.560	1.347	0.561	0.561
Base Ductless mini- or multi-split	2.051	2.247	2.968	2.065	2.248	1.000	2.576	6.408	41.413	1.909	0.490	1.179	0.491	0.491
Base Window/portable AC	1.287	1.410	1.862	1.584	2.116	0.742	1.940	3.446	12.992	1.198	0.461	1.110	0.462	0.462
Base Fan Motor, 5hp	6.004	9.423	5.473	2.752	0.478	0.563	12.685	3.630	1.338	1.575	0.647	0.430	0.033	0.165
Base Fan Motor, 15hp	2.765	5.174	26.395	0.000	0.000	1.135	7.306	0.000	12.328	0.725	1.190	0.792	0.061	0.304

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural
Base Fan Motor, 40hp	20.491	0.000	38.008	0.000	0.610	0.238	0.000	0.000	45.675	5.374	3.174	2.113	0.162	0.812
Base Full-size Residential-type refrigerators/freezers	0.3	0.5	0.1	0.6	0.1	0.1	0.1	0.4	0.0	0.7	0.1	1.1	0.7	0.1
Base Compact refrigerators	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.0
Base Walk-in refrigeration/freezer units	0.0	30.5	0.3	40.9	1.1	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.6
Base Open refrigerated/freezer cases	0.0	1.1	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Closed refrigerated/freezer cases	0.0	1.3	0.1	4.5	0.0	0.1	0.2	0.0	0.0	0.2	0.0	0.4	0.0	0.0
Base Commercial Ice Maker	0.0	1.8	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.0
Base Large Cold Storage Area	0.0	10.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4
Base Desktop PC	0.3	0.1	0.2	0.3	0.1	0.2	0.7	0.0	0.1	0.0	0.18	0.2	0.1	0.1
Base Laptop PC	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.0	0.0	0.0
Base Computer Network Server	0.5	0.3	0.3	0.5	0.1	4.8	0.8	0.0	148.3	0.7	0.08	2.4	0.1	0.8
Base Monitor, CRT	0.3	0.1	0.2	0.2	0.0	0.2	0.6	0.0	0.1	0.0	0.16	0.2	0.0	0.1
Base Monitor, LCD	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.04	0.0	0.0	0.0
Base Imaging	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0
Base Water Heating	0.1	1.1	0.2	0.1	0.1	0.2	0.2	0.7	0.1	0.2	0.0	0.2	0.2	0.2
Base Refrigerated Vending Machines	0.024	0.015	0.015	0.081	0.015	0.015	0.021	0.030	0.005	0.030	0.009	0.014	0.014	0.014
Base Non-Refrigerated Vending Machines	0.002	0.001	0.000	0.003	0.002	0.001	0.001	0.001	0.002	0.001	0.00	0.001	0.001	0.001
Base Convection Oven	0.708	2.133	0.652	2.817	0.031	0.452	2.155	0.115	0.652	0.414	0.203	0.203	0.203	0.203
Base Fryer	0.658	2.527	0.391	4.948	0.057	0.193	4.370	0.186	0.391	0.411	0.438	0.438	0.438	0.438
Base Steamer	1.823	2.142	1.063	3.094	0.035	0.139	1.179	0.128	1.063	0.575	0.169	0.169	0.169	0.169
Base Heat Pump heating	0.9	3.2	2.0	1.6	0.6	1.3	1.4	7.1	3.8	1.1	0.3	0.9	0.9	0.9
Base Heating, Rooftop/packaged unit	2.1	7.6	4.7	3.9	1.4	3.1	3.4	17.0	9.2	2.7	0.6	2.2	2.2	2.2
Base Heating, Electric Furnace	2.1	7.6	4.7	3.9	1.4	3.1	3.4	17.0	9.2	2.7	0.6	2.2	2.2	2.2
Base Heating, Electric Boiler	2.1	7.6	4.7	3.9	1.4	3.1	3.4	17.0	9.2	2.7	0.6	2.2	2.2	2.2
Base Process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
Base Motors	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.237	0.000

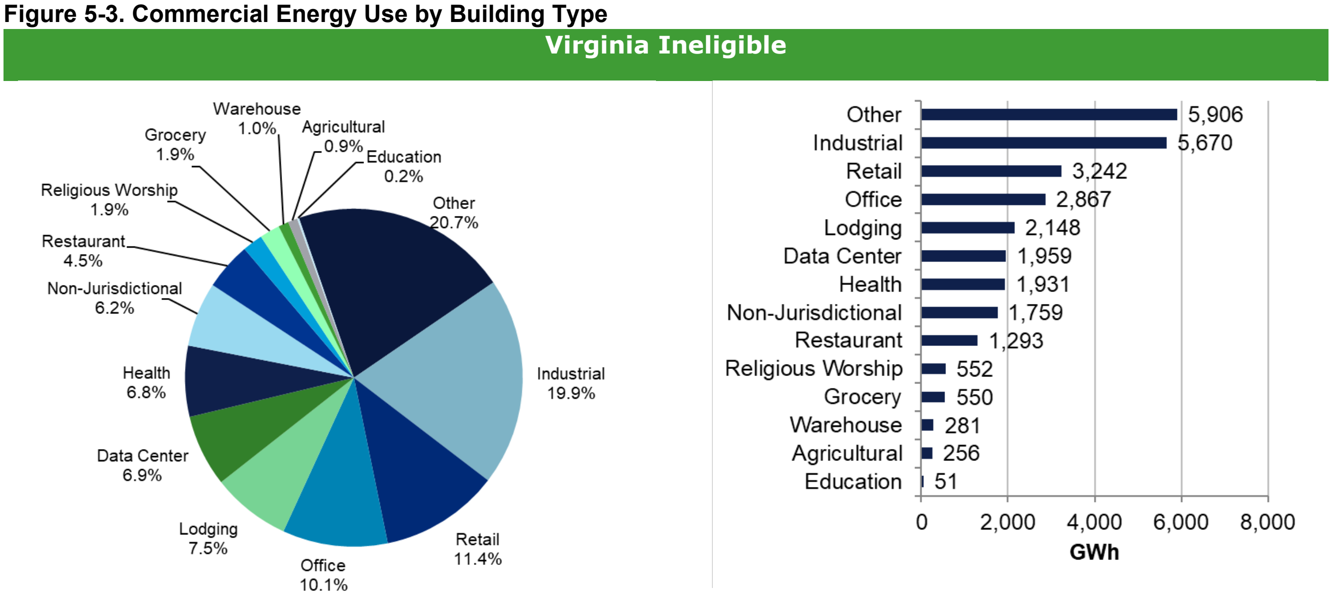
	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural
Base Miscellaneous	2.2	2.6	2.2	2.4	0.9	0.6	6.0	1.4	40.0	1.5	1.7	1.7	1.7	3.0

5.1.3.3 Commercial Building Stock and Energy Use

CBECS data from the South Atlantic Census Division was used to estimate the proportion of customers and the average floor space by building type. Energy use was then calculated as the product of the commercial floor space, equipment saturation, and the end-use energy intensity.

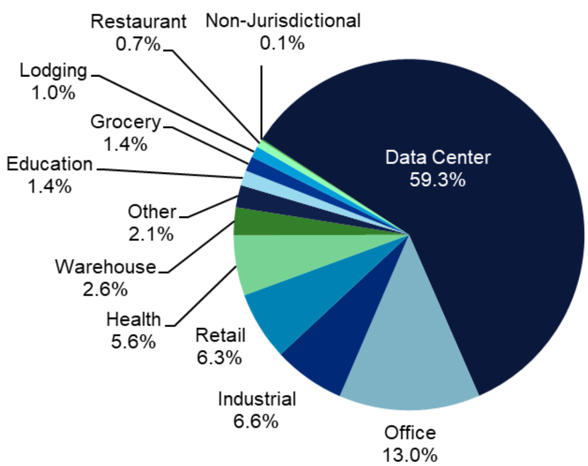
Figure 5-3 and Figure 5-4 show the breakout of energy use by building type and by end-use, respectively. Indoor lighting, cooling, miscellaneous, and ventilation end uses represent the largest shares of energy use. The results also include break-out summaries for Virginia opt-out eligible customers, because that category captures most of Virginia's data center energy use, and a large share of office and industrial customers. These data provide helpful context for understanding the distribution of the ineligible customers. For non-opt-out customers, miscellaneous buildings ("other") represent the largest share of energy use followed by industrial buildings.[18] Data centers represent by far the largest share of energy use among opt-out-eligible customers.

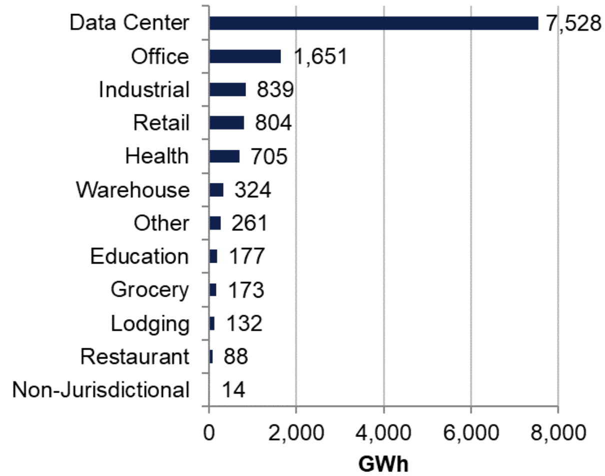
Figure 5-3. Commercial Energy Use by Building Type



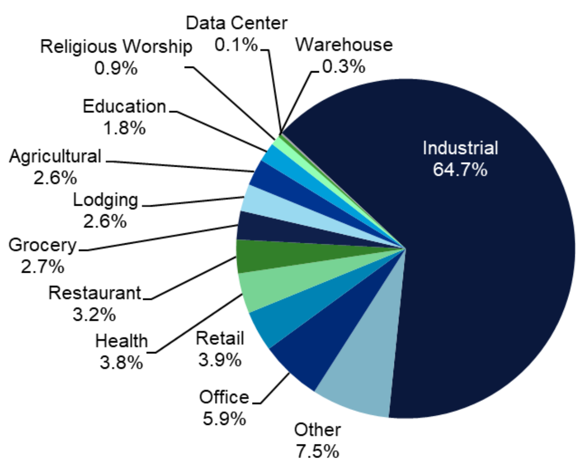
[18] Miscellaneous buildings include churches, public safety, services, community centers, recreation, entertainment, etc.

Virginia Opt-out Eligible





North Carolina



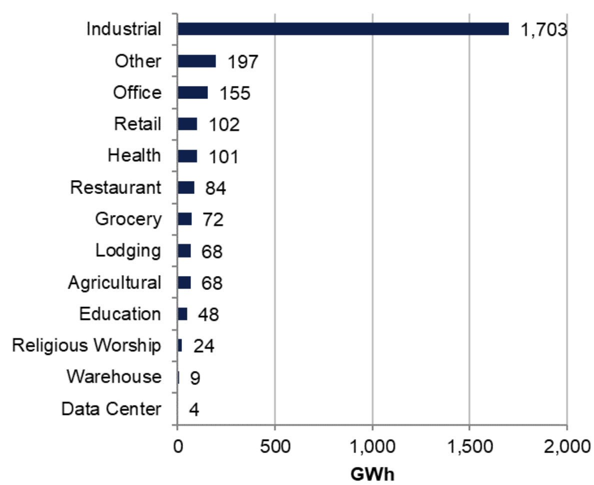


Figure 5-4. Commercial Energy Use by End-Use

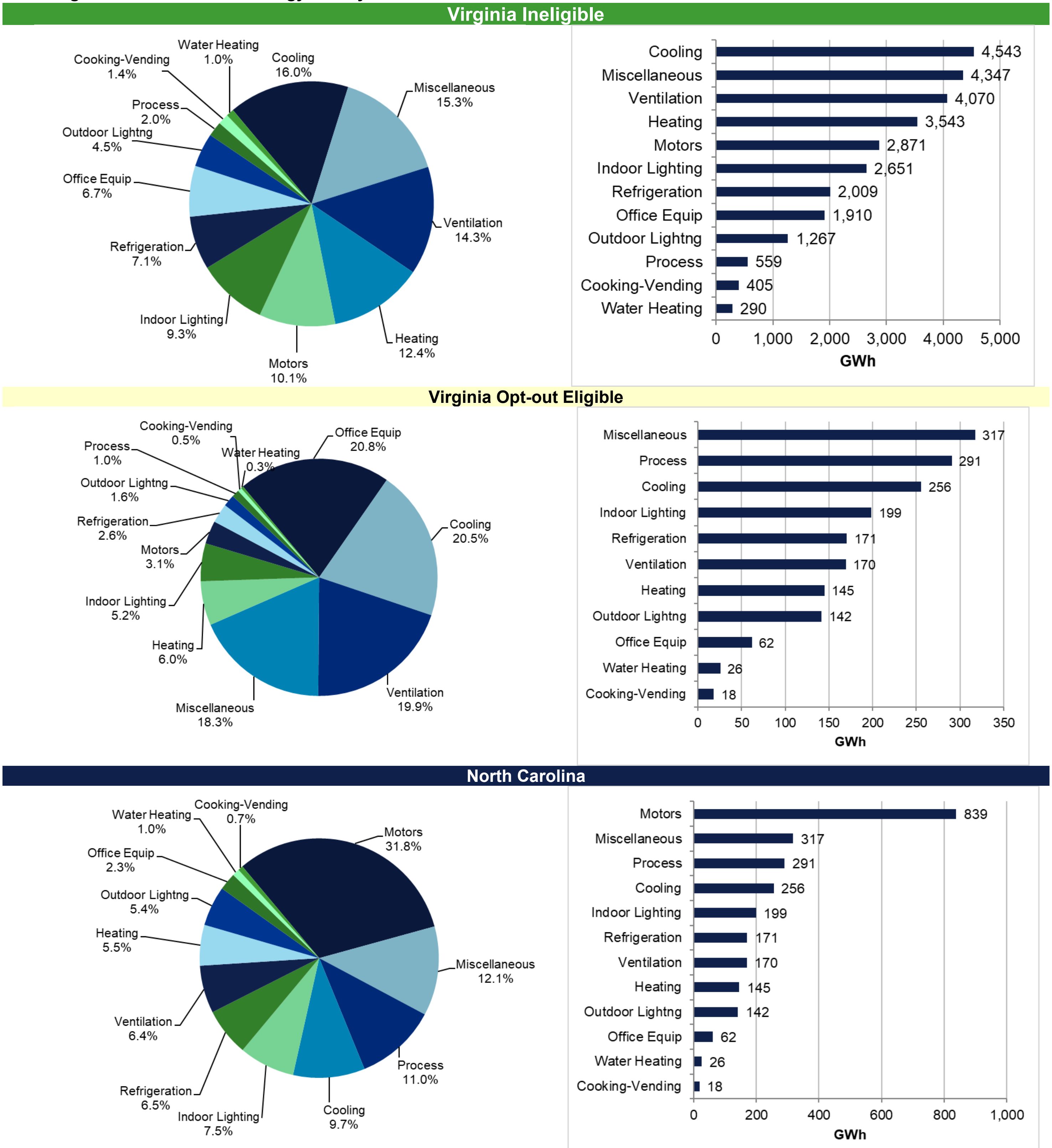


Table 5-10 and Table 5-11 on the next page show commercial floor space by building type and resulting energy use by building type and equipment type for Virginia and North Carolina, respectively.

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Table 5-10. Virginia Commercial Sector Floor space (1,000 sf) and Energy Use (MWh) by End-Use and Building Type

	Office	Restau rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Industrial	Agri-cultural	Total
Floor Space (1000 sf)	224,492	26,123	221,956	10,116	49,574	4,909	82,229	116,913	10,100	162,343	95,043	626,548	310,832	40,821	3,342,978
MWh by End Use															
Base Fluorescent Fixture, T12	67,347	9,934	113,255	7,364	9,364	1,481	82,532	6,316	7,478	59,375	45,733	263,770	129,525	6,597	810,072
Base Fluorescent Fixture, T8	61,256	3,101	147,138	6,323	11,270	1,256	84,910	9,382	14,125	48,525	33,465	192,652	107,295	5,336	726,034
Base Fluorescent T5	6,895	810	8,088	608	1,887	240	10,301	1,910	20	5,105	7,676	18,585	9,046	300	71,471
Base LED Tube, 2 lamp fixture	18,129	4,845	54,773	6,521	11,639	521	30,331	7,168	4,225	15,431	9,844	64,111	38,446	4,505	270,489
Base Incandescent/ halogen	59,984	3,486	83,595	332	0	5	10,144	8,840	0	26,607	14,596	103,084	18,750	8,208	337,630
Base CFL	13,949	572	12,748	73	0	4	6,435	6,518	4,678	4,318	1,909	12,043	9,741	2,136	75,123
Base LED bulb	54,011	3,197	52,473	498	0	18	10,473	17,991	6,676	18,634	9,106	58,859	18,814	5,625	256,374
Base HID	1,216	42	52,135	71	187	201	12,641	4,660	0	936	2,400	4,213	22,607	2,941	104,249
Base CFL Exit Sign	9,567	1,554	4,883	169	203	70	7,235	2,351	1,033	3,727	1,695	11,328	5,620	738	50,173
Base Outdoor LED bulb	18,541	1,283	14,224	678	613	283	2,995	3,302	668	9,446	4,040	34,568	12,259	2,254	105,154
Base Outdoor LED Tube	1,826	72	2,671	616	8	7	82	140	86	714	199	1,706	291	23	8,442
Base Outdoor Fluorescent Tube	2,590	324	2,786	296	88	0	1,032	165	818	1,736	1,273	8,103	830	632	20,673
Base Outdoor CFL	2,760	245	2,056	58	44	26	960	116	77	1,145	715	3,090	6,394	671	18,356
Base Outdoor HID	54,995	10,598	55,993	792	4,090	770	20,029	10,228	1,830	52,395	37,827	294,202	286,946	20,890	851,587
Base Outdoor Incandescent/ Halogen	44,229	2,826	15,911	1,564	493	168	9,135	4,523	56	25,033	6,587	102,125	42,970	7,503	263,124
Base Centrifugal Chiller	95,381	183	97,699	0	556	1,945	63,961	40,635	152,429	36,897	3,987	21,868	70,380	0	585,921
Base DX Packaged System	332,347	42,362	729,253	25,402	84,111	5,879	181,569	374,477	250,090	257,295	40,464	692,925	321,611	7,273	3,345,059
Base Heat Pump cooling	156,904	31,381	29,300	2,445	6,391	2,536	36,795	94,416	1,480	81,709	14,135	137,620	57,221	5,046	657,381
Base PTAC	0	0	0	0	1,360	2,243	0	48,141	49,039	0	7,332	42,501	47,172	803	198,590

	Office	Restau rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Industrial	Agri-cultural	Total
Base Split-system, residential type	75,865	22,171	22,607	557	20,051	2,319	46,969	113,508	30,065	42,192	10,210	79,337	27,291	583	493,724
Base Ductless mini-or multi-split	5,007	414	26,463	1,062	942	1,795	8,630	45,520	62,525	7,859	5,076	29,424	32,657	556	227,929
Base Window/portable AC	508	12,085	3,513	1,273	22,909	691	12,539	41,950	773	4,803	3,420	33,111	10,294	2,786	150,657
Base Fan Motor, 5hp	572,606	62,552	526,372	26,907	7,280	924	196,206	166,601	2,543	122,790	27,994	144,539	5,510	724	1,863,547
Base Fan Motor, 15hp	45,690	0	88,463	0	0	4,982	392,803	0	81,403	29,479	41,078	212,095	8,086	1,062	905,141
Base Fan Motor, 40hp	213,445	0	127,387	0	3,081	436	0	0	320,469	168,106	0	448,828	17,111	2,247	1,301,111
Base Full-size Residential-type refrigerators/freezers	46,040	6,514	4,659	2,480	1,454	483	6,528	22,006	199	73,775	6,689	445,288	120,064	1,496	737,674
Base Compact refrigerators	2,993	688	4,199	94	371	29	2,321	1,066	387	1,553	26	3,996	27,568	22	45,314
Base Walk-in refrigeration/freezer units	89	633,162	4,878	324,657	10,323	18	132	1,964	0	696	163	7,486	23	4,171	987,762
Base Open refrigerated/freezer cases	1	6,063	262	20,912	0	2	0	13	114	3	0	16	0	0	27,386
Base Closed refrigerated/freezer cases	12	14,407	2,786	29,145	0	140	1,336	281	0	1,904	76	27,341	0	0	77,430
Base Commercial Ice Maker	210	30,966	192	951	280	47	443	2,244	45	1,991	1,439	22,365	3,160	102	64,435
Base Large Cold Storage Area	7	63,138	108	3,165	26	0	0	2	0	82	32	940	176	1,026	68,703
Base Desktop PC	54,266	861	32,577	1,535	1,713	829	50,357	2,542	697	11,231	13,812	82,062	42,315	929	295,727
Base Laptop PC	783	77	3,270	204	57	10	1,807	42	322	7,529	2,737	11,815	4,046	102	32,801
Base Computer Network Server	67,746	2,419	26,382	1,219	412	11,854	32,690	914	627,817	149,073	3,942	528,056	23,292	6,568	1,482,383
Base Monitor, CRT	2,091	49	746	15	0	106	5,314	167	0	579	436	5,669	2,422	77	17,671
Base Monitor, LCD	10,278	229	7,011	575	333	137	8,373	370	301	12,841	3,112	19,729	6,520	132	69,941
Base Imaging	1,011	85	1,215	50	61	7	829	91	50	1,403	997	3,467	1,720	75	11,060
Base Water Heating	19,803	15,871	29,366	902	2,515	642	11,479	28,472	271	24,162	2,720	102,571	50,177	5,557	294,509

	Office	Restaurant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Industrial	Agri-cultural	Total
Base Refrigerated Vending Machines	886	84	673	335	206	26	211	1,006	9	970	160	1,997	1,667	50	8,280
Base Non-Refrigerated Vending Machines	64	2	9	12	22	1	8	53	3	27	5	76	73	2	358
Base Convection Oven	13,190	80,358	7,009	11,996	216	1,325	14,748	3,580	2,290	8,368	7,551	21,142	2,335	1,303	175,413
Base Fryer	5,857	96,107	5,231	13,971	16	148	10,099	2,602	0	4,327	2,881	24,669	1,997	660	168,565
Base Steamer	2,410	29,273	6,963	4,031	5	92	1,644	678	0	2,169	681	4,281	231	0	52,457
Base Heat Pump heating	93,247	0	187,339	657	456	484	0	10,233	13,659	44,999	2,629	14,196	13,290	0	381,189
Base Heating, Rooftop/packaged unit	147,260	40,291	221,495	17,594	20,839	4,700	100,038	629,567	23,700	142,786	20,465	469,280	145,512	8,681	1,992,207
Base Heating, Electric Furnace	58,178	1,305	2,076	4,719	17,131	1,468	1,933	45,669	0	44,947	1,048	113,975	11,930	2,061	306,440
Base Heating, Electric Boiler	76,388	13,125	130,206	10,629	22,694	671	32,575	411,731	1,493	58,864	6,094	148,700	66,677	14,989	994,836
Base Process	0	0	0	0	0	0	0	0	0	0	0	0	559,373	0	559,373
Base Motors	0	0	0	0	0	0	0	0	0	0	0	0	2,871,192	0	2,871,192
Base Miscellaneous	493,882	67,921	488,304	24,277	44,617	2,945	493,376	163,678	403,988	236,636	161,573	1,065,131	528,414	122,464	4,297,207
Total	**3,011,739**	**1,317,033**	**3,440,744**	**557,733**	**310,315**	**54,963**	**2,004,948**	**2,337,830**	**2,067,932**	**1,855,171**	**570,029**	**6,138,938**	**5,791,044**	**259,907**	**29,718,323**

Table 5-11. North Carolina Commercial Sector Floor space (1,000 sf) and Energy Use (MWh) by End-Use and Building Type

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural	Total
Floor Space (1000 sf)	224,492	26,123	221,956	10,116	49,574	4,909	82,229	116,913	10,100	162,343	95,043	626,548	310,832	40,821	3,342,978
	MWh by End Use														
Base Fluorescent Fixture, T12	67,347	9,934	113,255	7,364	9,364	1,481	82,532	6,316	7,478	59,375	45,733	263,770	129,525	6,597	810,072
Base Fluorescent Fixture, T8	61,256	3,101	147,138	6,323	11,270	1,256	84,910	9,382	14,125	48,525	33,465	192,652	107,295	5,336	726,034

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural	Total
Base Fluorescent T5	6,895	810	8,088	608	1,887	240	10,301	1,910	20	5,105	7,676	18,585	9,046	300	71,471
Base LED Tube, 2 lamp fixture	18,129	4,845	54,773	6,521	11,639	521	30,331	7,168	4,225	15,431	9,844	64,111	38,446	4,505	270,489
Base Incandescent/ halogen	59,984	3,486	83,595	332	0	5	10,144	8,840	0	26,607	14,596	103,084	18,750	8,208	337,630
Base CFL	13,949	572	12,748	73	0	4	6,435	6,518	4,678	4,318	1,909	12,043	9,741	2,136	75,123
Base LED bulb	54,011	3,197	52,473	498	0	18	10,473	17,991	6,676	18,634	9,106	58,859	18,814	5,625	256,374
Base HID	1,216	42	52,135	71	187	201	12,641	4,660	0	936	2,400	4,213	22,607	2,941	104,249
Base CFL Exit Sign	9,567	1,554	4,883	169	203	70	7,235	2,351	1,033	3,727	1,695	11,328	5,620	738	50,173
Base Outdoor LED bulb	18,541	1,283	14,224	678	613	283	2,995	3,302	668	9,446	4,040	34,568	12,259	2,254	105,154
Base Outdoor LED Tube	1,826	72	2,671	616	8	7	82	140	86	714	199	1,706	291	23	8,442
Base Outdoor Fluorescent Tube	2,590	324	2,786	296	88	0	1,032	165	818	1,736	1,273	8,103	830	632	20,673
Base Outdoor CFL	2,760	245	2,056	58	44	26	960	116	77	1,145	715	3,090	6,394	671	18,356
Base Outdoor HID	54,995	10,598	55,993	792	4,090	770	20,029	10,228	1,830	52,395	37,827	294,202	286,946	20,890	851,587
Base Outdoor Incandescent/ Halogen	44,229	2,826	15,911	1,564	493	168	9,135	4,523	56	25,033	6,587	102,125	42,970	7,503	263,124
Base Centrifugal Chiller	95,381	183	97,699	0	556	1,945	63,961	40,635	152,429	36,897	3,987	21,868	70,380	0	585,921
Base DX Packaged System	332,347	42,362	729,253	25,402	84,111	5,879	181,569	374,477	250,090	257,295	40,464	692,925	321,611	7,273	3,345,059
Base Heat Pump cooling	156,904	31,381	29,300	2,445	6,391	2,536	36,795	94,416	1,480	81,709	14,135	137,620	57,221	5,046	657,381
Base PTAC	0	0	0	0	1,360	2,243	0	48,141	49,039	0	7,332	42,501	47,172	803	198,590
Base Split-system, residential type	75,865	22,171	22,607	557	20,051	2,319	46,969	113,508	30,065	42,192	10,210	79,337	27,291	583	493,724
Base Ductless mini- or multi-split	5,007	414	26,463	1,062	942	1,795	8,630	45,520	62,525	7,859	5,076	29,424	32,657	556	227,929
Base Window/portable AC	508	12,085	3,513	1,273	22,909	691	12,539	41,950	773	4,803	3,420	33,111	10,294	2,786	150,657
Base Fan Motor, 5hp	572,606	62,552	526,372	26,907	7,280	924	196,206	166,601	2,543	122,790	27,994	144,539	5,510	724	1,863,547
Base Fan Motor, 15hp	45,690	0	88,463	0	0	4,982	392,803	0	81,403	29,479	41,078	212,095	8,086	1,062	905,141
Base Fan Motor, 40hp	213,445	0	127,387	0	3,081	436	0	0	320,469	168,106	0	448,828	17,111	2,247	1,301,111

	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural	Total
Base Full-size Residential-type refrigerators/freezers	46,040	6,514	4,659	2,480	1,454	483	6,528	22,006	199	73,775	6,689	445,288	120,064	1,496	737,674
Base Compact refrigerators	2,993	688	4,199	94	371	29	2,321	1,066	387	1,553	26	3,996	27,568	22	45,314
Base Walk-in refrigeration/freezer units	89	633,162	4,878	324,657	10,323	18	132	1,964	0	696	163	7,486	23	4,171	987,762
Base Open refrigerated/freezer cases	1	6,063	262	20,912	0	2	0	13	114	3	0	16	0	0	27,386
Base Closed refrigerated/freezer cases	12	14,407	2,786	29,145	0	140	1,336	281	0	1,904	76	27,341	0	0	77,430
Base Commercial Ice Maker	210	30,966	192	951	280	47	443	2,244	45	1,991	1,439	22,365	3,160	102	64,435
Base Large Cold Storage Area	7	63,138	108	3,165	26	0	0	2	0	82	32	940	176	1,026	68,703
Base Desktop PC	54,266	861	32,577	1,535	1,713	829	50,357	2,542	697	11,231	13,812	82,062	42,315	929	295,727
Base Laptop PC	783	77	3,270	204	57	10	1,807	42	322	7,529	2,737	11,815	4,046	102	32,801
Base Computer Network Server	67,746	2,419	26,382	1,219	412	11,854	32,690	914	627,817	149,073	3,942	528,056	23,292	6,568	1,482,383
Base Monitor, CRT	2,091	49	746	15	0	106	5,314	167	0	579	436	5,669	2,422	77	17,671
Base Monitor, LCD	10,278	229	7,011	575	333	137	8,373	370	301	12,841	3,112	19,729	6,520	132	69,941
Base Imaging	1,011	85	1,215	50	61	7	829	91	50	1,403	997	3,467	1,720	75	11,060
Base Water Heating	19,803	15,871	29,366	902	2,515	642	11,479	28,472	271	24,162	2,720	102,571	50,177	5,557	294,509
Base Refrigerated Vending Machines	886	84	673	335	206	26	211	1,006	9	970	160	1,997	1,667	50	8,280
Base Non-Refrigerated Vending Machines	64	2	9	12	22	1	8	53	3	27	5	76	73	2	358
Base Convection Oven	13,190	80,358	7,009	11,996	216	1,325	14,748	3,580	2,290	8,368	7,551	21,142	2,335	1,303	175,413
Base Fryer	5,857	96,107	5,231	13,971	16	148	10,099	2,602	0	4,327	2,881	24,669	1,997	660	168,565
Base Steamer	2,410	29,273	6,963	4,031	5	92	1,644	678	0	2,169	681	4,281	231	0	52,457
Base Heat Pump heating	93,247	0	187,339	657	456	484	0	10,233	13,659	44,999	2,629	14,196	13,290	0	381,189
Base Heating, Rooftop/packaged unit	147,260	40,291	221,495	17,594	20,839	4,700	100,038	629,567	23,700	142,786	20,465	469,280	145,512	8,681	1,992,207
Base Heating, Electric Furnace	58,178	1,305	2,076	4,719	17,131	1,468	1,933	45,669	0	44,947	1,048	113,975	11,930	2,061	306,440

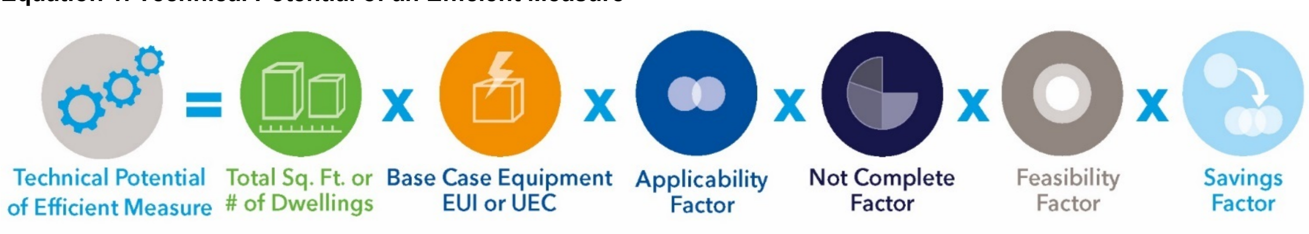
	Office	Restau-rant	Retail	Grocery	Ware-house	Edu-cation	Health	Lodging	Data Center	Non-Juris-dictional	Religious Worship	Other	Indus-trial	Agri-cultural	Total
Base Heating, Electric Boiler	76,388	13,125	130,206	10,629	22,694	671	32,575	411,731	1,493	58,864	6,094	148,700	66,677	14,989	994,836
Base Process	0	0	0	0	0	0	0	0	0	0	0	0	559,373	0	559,373
Base Motors	0	0	0	0	0	0	0	0	0	0	0	0	2,871,192	0	2,871,192
Base Miscellaneous	493,882	67,921	488,304	24,277	44,617	2,945	493,376	163,678	403,988	236,636	161,573	1,065,131	528,414	122,464	4,297,207
Total	**3,011,739**	**1,317,033**	**3,440,744**	**557,733**	**310,315**	**54,963**	**2,004,948**	**2,337,830**	**2,067,932**	**1,855,171**	**570,029**	**6,138,938**	**5,791,044**	**259,907**	**29,718,323**

5.2 Technical and Economic Potential Results

This section contains a summary of findings from the analysis of technical and economic savings potential of electric energy efficiency efforts in Dominion's service territory. Technical potential is defined as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective. Economic potential is defined as the technical potential of those energy conservation measures that are cost-effective when compared to supply-side alternatives. All measures with a total resource cost (TRC) greater than one are considered to have economic potential.

In our bottom-up modeling approach, we first estimate technical potential for energy savings by integrating key measure and market segment parameters using Equation 1:

Equation 1. Technical Potential of an Efficient Measure



Where:

- **Square Feet** is the total floor space for all buildings in the market segment. For the residential analysis, the number of dwelling units is substituted for square feet.
- **Base Case Equipment Energy Use Intensity** (EUI) is the energy used per square foot by each base case technology in each market segment. This is the consumption of the energy-using equipment that the efficient technology replaces or affects. For example, if the efficient measure were a CFL, the base EUI would be the annual kWh per square foot of an equivalent incandescent lamp. For the residential analysis, unit energy consumption (UECs), energy used per dwelling, are substituted for EUIs and were developed as part of the Conditional Demand Analysis.
- **Applicability Factor** is the fraction of the floor space (or dwelling units) that is applicable for the efficient technology in a given market segment; for the example above, the percentage of floor space lit by incandescent bulbs. This input was developed through results of the 2013 residential and commercial saturation surveys and the Conditional Demand Analysis and Baseline Analysis.
- **Not Complete Factor** is the fraction of applicable floor space (or dwelling units) that has not yet been converted to the efficient measure; that is, one minus the fraction of floor space that already has the EE measure installed. DNV relied on the results of Dominion's saturation surveys to estimate this value when possible and utilized other recent saturation surveys and internal databases for other measures not included in the saturation surveys.
- **Feasibility Factor** is the fraction of the applicable floor space (or dwelling units) that is technically feasible for conversion to the efficient technology from an engineering perspective. DNV engineers familiar with Dominion's service territory reviewed these values to ensure they were consistent with Dominion's building stock.
- **Savings Factor** is the reduction in energy consumption resulting from application of the efficient technology. DNV estimated energy savings through the use of sources including the STEP manual, LBNL Home Energy Savers Model, and other engineering calculations.

Technical potential for peak demand reduction is calculated analogously.

Economic potential is then assessed by first developing a supply-curve analysis. This analysis eliminates double counting of measure savings. On a market segment and end-use/technology basis, measures are stacked in order of cost-effectiveness, and the energy consumption of the system being affected by the efficiency measures reduces as each measure is applied. As a result, the savings attributable to each subsequent measure decrease if the measures are interactive. After eliminating double counting of savings, the benefits and costs associated with a given measure and market segment are compared using the Total Resource Cost (TRC) test or other cost relevant cost effectiveness test. Measures with a TRC ratio greater than 1.0 will be passed on to our achievable potential analysis.

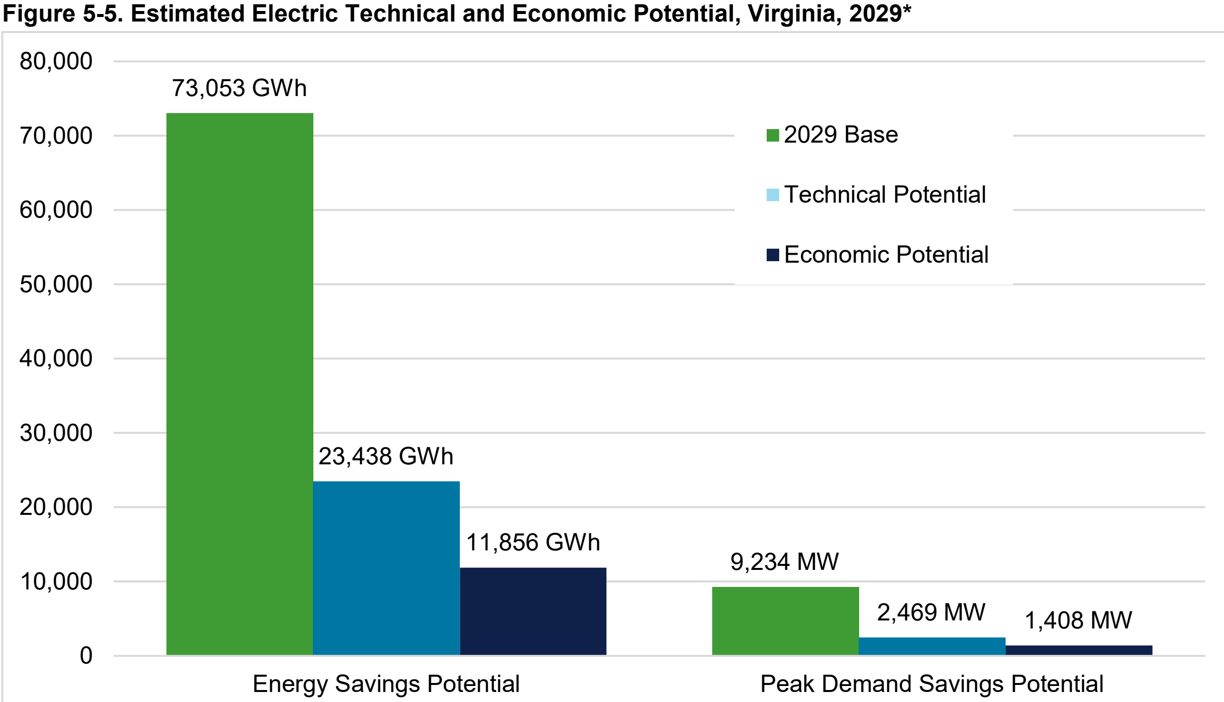
5.2.1 Electric Energy Efficiency Potential Results

In this section, we present the technical and economic potential results for all electric measures considered in the study. Economic potential shown in the majority of this report is for the base avoided cost scenario. Results breakdowns are provided for both Virginia and North Carolina.

5.2.2 Overall Technical and Economic Potential

Figure 5-5 presents our overall estimates of total technical and economic potential for electrical energy and peak demand savings for Dominion's Virginia service territory. These results are for our primary reporting case, excluding non-jurisdictional and federal customers and assuming a 33% opt-out rate among customers with more than 1 MW demand. Figure 5-6 shows the same data for North Carolina (opt-out and non-jurisdictional categories do not apply in North Carolina).

Figure 5-5. Estimated Electric Technical and Economic Potential, Virginia, 2029*



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-6. Estimated Electric Technical and Economic Potential, North Carolina, 2029

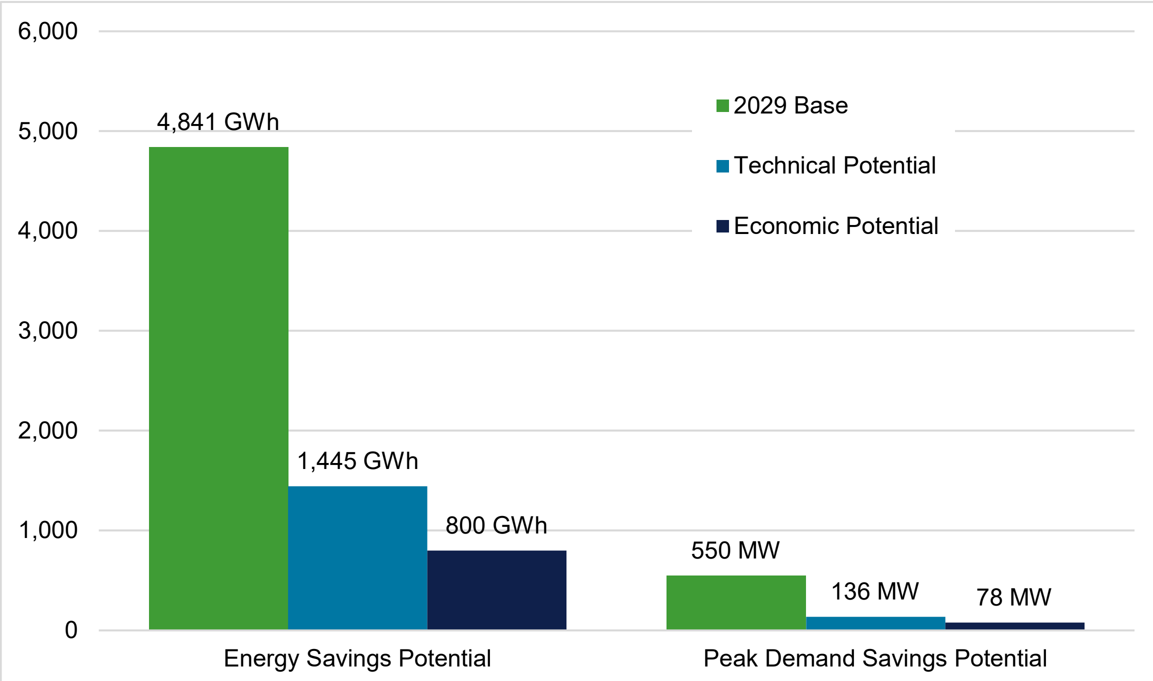


Table 5-12 shows technical and economic potential for energy and demand, respectively, for both Virginia (including opt-outs) and North Carolina. The values of both energy savings and peak-demand reductions are incorporated into the measure TRC test.

Virginia's technical potential energy savings is estimated at 23,438 GWh per year, and economic potential at 11,856 GWh per year by 2029 (about 32% and 16% of base 2029 usage, respectively). North Carolina's technical potential energy savings is estimated at 1,445 GWh and economic potential at 800 GWh by 2029 (about 30% and 17% of base 2029 demand, respectively). The corresponding demand savings for Virginia are 2,469 MW technical and 1,408 MW economic (27% and 15%, respectively) and for North Carolina, 136 MW technical and 78 MW economic (25% and 14%, respectively).

Table 5-12. Estimated Electric Technical and Economic Potential, 2029

	2029 Base Consumption (GWh)	Technical GWh	Economic GWh	2029 Base Demand (MW)	Technical MW	Economic MW
Virginia*						
Total	73,053	23,438	11,856	9,234	2,469	1,408
% of Base	N/A	32%	16%	N/A	27%	15%
North Carolina						
Total	4,841	1,445	800	550	136	78
% of Base	N/A	30%	17%	N/A	25%	14%

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

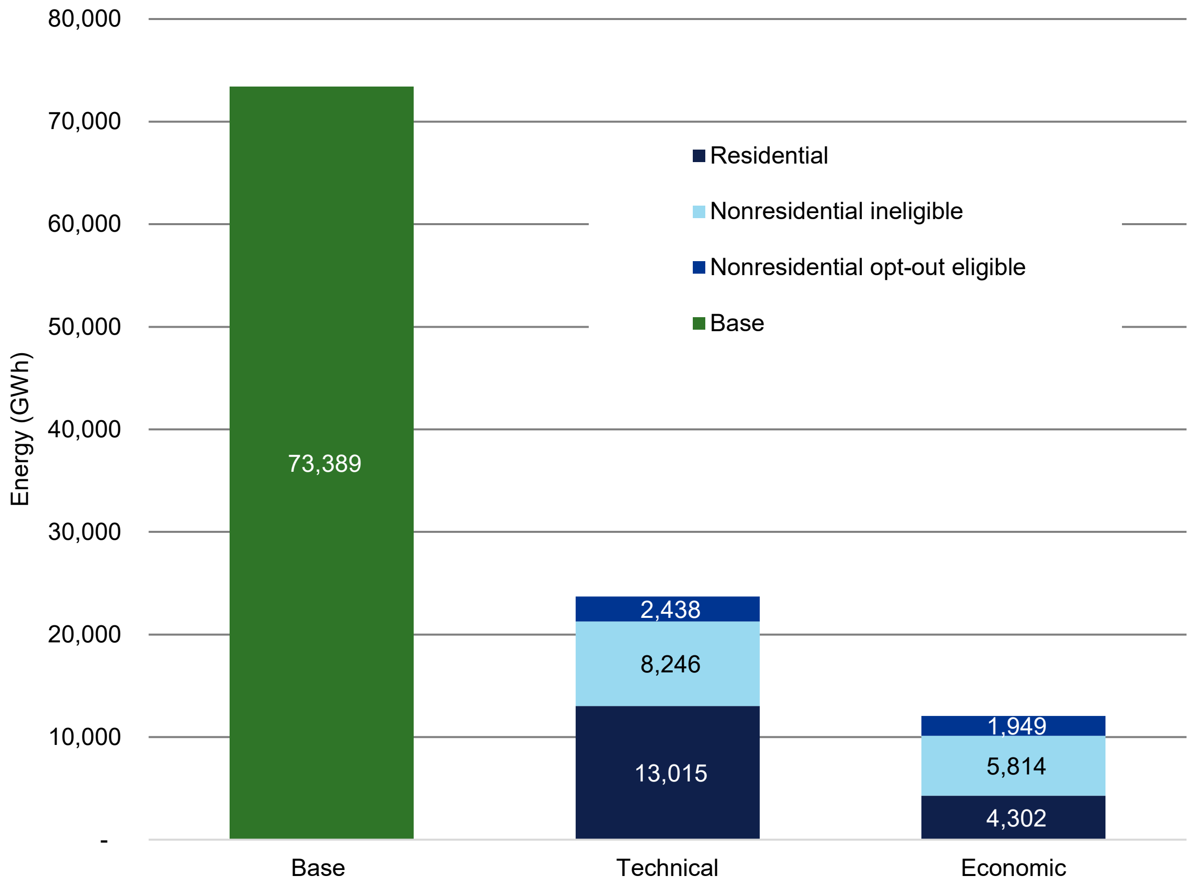
5.2.3 Base-Case Technical and Economic Potential Detail

This section summarizes the identified technical and economic potential in more detail for the base avoided cost case, and further describes potentials by sector, state, building type, and by end use.

5.2.4 Potentials by Sector

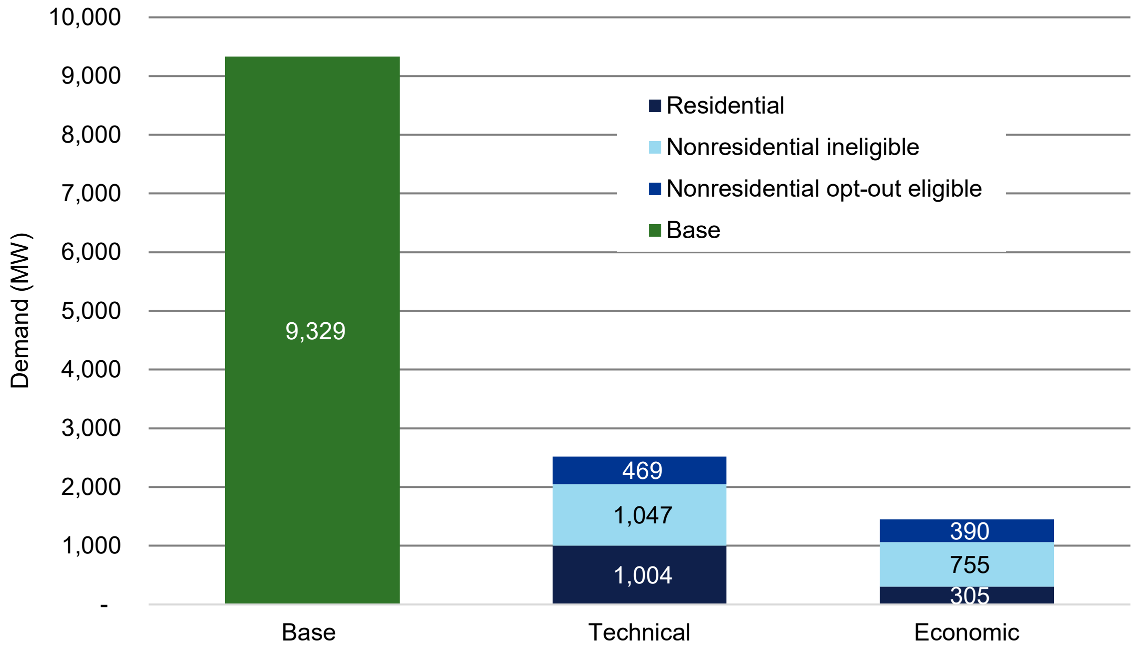
Figure 5-7 and Figure 5-8 show the breakdown of technical and economic potential by sector, as compared to the total base consumption and demand in 2029, for Virginia (primary reporting scenario). The residential sector represents 56% of technical energy savings, and 36% of economic energy savings. The residential sector is 41% of technical demand potential, and 22% of the corresponding economic potential.

Figure 5-7. Technical and Economic Energy Savings by Sector, Virginia (GWh)



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-8. Technical and Economic Peak Demand Savings by Sector, Virginia (MW)



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-9 and Figure 5-10 show the same results for North Carolina. The residential sector represents 48% of technical energy savings, and 27% of economic energy savings. The residential sector is 36% of technical demand potential, and 16% of the corresponding economic potential.

Figure 5-9. Technical and Economic Energy Savings by Sector, North Carolina (GWh)

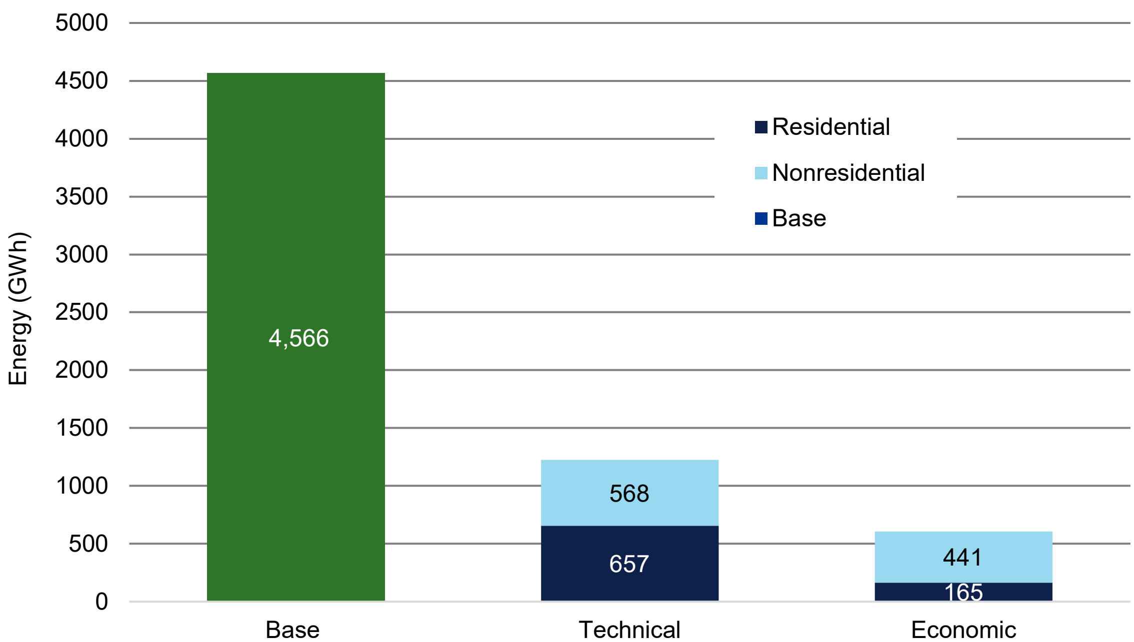


Figure 5-10. Technical and Economic Peak Demand Savings by Sector, North Carolina (MW)

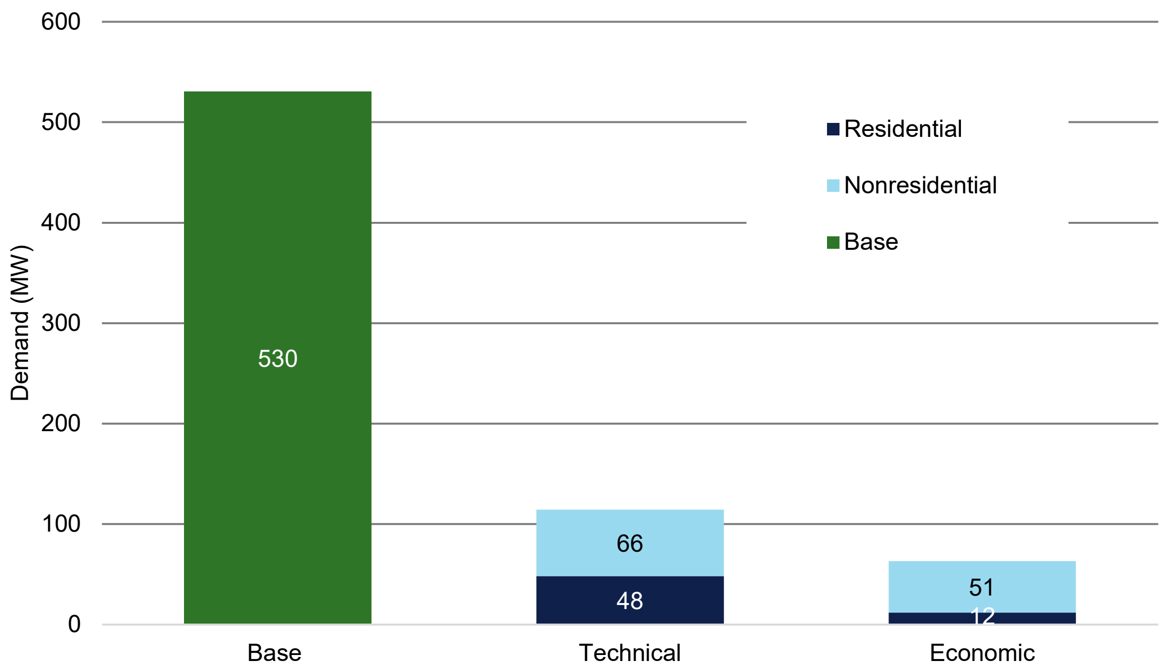


Table 5-13 (energy) and Table 5-14 (demand) show the contribution of technical and economic potential from each sector in the current study (forecast 2020-2029, showing 2029 base consumption) for Virginia in comparison to the 2017 study (2018-2027 forecast, showing 2027 base consumption). These tables also compare the potential savings of each sector to base consumption and demand. The residential sector has higher technical savings potential than the commercial sector, in both percentage and absolute terms, but lower economic potential. The nonresidential sector has lower technical and economic potential than in 2017.

The peak demand changed dramatically with a shift from summer to winter peak. The shift is due primarily to the effects of distributed solar reducing system load during summer peak hours. The new base winter peak demand is much lower than the base summer peak demand from the 2017 study, and demand savings potential is correspondingly lower.

Table 5-13. Technical and Economic Potential Energy Savings by Sector, Virginia

Sector	2029 Base Energy Consumption (GWH)	Ten Year Cumulative Potential - GWh		2027 Base Energy Consumption (GWH)	Ten Year Cumulative Potential – GWh	
		Technical Potential (Current)	Economic Potential (Current)		Technical Potential (2017 Study)	Economic Potential (2017 Study)
Residential						
Existing	28,296	12,592	4,054	28,843	13,373	5,790
New	2,953	424	248	2,930	646	646
Subtotal	31,249	13,015	4,302	31,773	14,018	6,436
% of Base	**N/A**	**42%**	**14%**	**N/A**	**44%**	**20%**
Nonresidential*						
Existing	31,277	7,822	5,677	35,824	9,306	6,301
New	10,527	2,600	1,877	5,144	1,271	1,031
Subtotal	41,804	10,422	7,554	40,969	10,576	7,332
% of Base	**N/A**	**25%**	**18%**	**N/A**	**26%**	**18%**
Total	73,053	23,438	11,856	72,742	24,595	13,768
% of Base	**N/A**	**32%**	**16%**	**N/A**	**34%**	**19%**

*Excludes Virginia non-jurisdictional and federal customers. The 2017 study excluded opt-outs (actuals), while the current study uses the current 33% opt-out rate among eligible customers. Values may not total due to rounding.

Table 5-14. Technical and Economic Potential Demand Savings by Sector, Virginia

Sector	2029 Base Demand (MW)	Ten Year Cumulative Potential – MW		2027 Base Demand (MW)	Ten Year Cumulative Potential – MW	
		Technical Potential (Current)	Economic Potential (Current)		Technical Potential (2017 Study)	Economic Potential (2017 Study)
Residential						
Existing	2,099	962	280	7,892	3,893	1,730
New	291	42	24	726	58	58
Subtotal	2,390	1,004	305	8,618	3,951	1,788
% of Base	**N/A**	**42%**	**13%**	**N/A**	**46%**	**21%**
Nonresidential*						
Existing	5,128	1,041	783	10,601	2,172	1,614
New	1,716	424	320	1,068	264	219
Subtotal	6,844	1,465	1,103	11,669	2,436	1,833
% of Base	**N/A**	**21%**	**16%**	**N/A**	**21%**	**16%**
Total	9,234	2,469	1,408	20,287	6,387	3,622
% of Base	**N/A**	**27%**	**15%**	**N/A**	**31%**	**18%**

*Excludes Virginia non-jurisdictional and federal customers. The 2017 study excluded opt-outs (actuals), while the current study uses the current 33% opt-out rate among eligible customers. Values may not total due to rounding.

Table 5-15 and Table 5-16 present the corresponding energy and demand results for North Carolina, with comparisons to the 2014 study results (the most recently completed study date for North Carolina). The North Carolina residential sector has lower technical and economic savings potential than the 2014 study, corresponding with a lower estimate of base residential energy use. In the nonresidential sector, base energy consumption increased from 2014 to 2020, with technical and economic potential both increasing in absolute terms. This is due in part to the inclusion of industrial customers in the current analysis, where the 2014 study focused only on commercial. In percentage terms, both technical and economic potential declined in the nonresidential sector.

Table 5-15. Technical and Economic Potential Energy Savings by Sector, North Carolina

Sector	2029 Base Energy Consumption (GWH)	Ten-Year Cumulative Potential – GWh		2023 Base Energy Consumption (GWH)	Ten-Year Cumulative Potential - GWh	
		Technical Potential (Current)	Economic Potential (Current)		Technical Potential (2014)	Economic Potential (2014)
Residential						
Existing	1,588	698	215	1,475	740	354
New	164	24	13	153	21	21
Subtotal	1,752	772	228	1,628	760	375
% of Base	N/A	39%	12%	N/A	47%	23%
Nonresidential						
Existing	2,318	562	429	947	300	205
New	772	191	158	94	24	21
Subtotal	3,089	753	587	1,041	323	226
% of Base	N/A	24%	19%	N/A	31%	22%
Total	4,841	1,445	800	2,669	1,084	601
% of Base	N/A	30%	17%	N/A	41%	23%

*Values may not total due to rounding.

Table 5-16. Technical and Economic Potential Demand Savings by Sector, North Carolina

Sector	2029 Base Demand (MW)	Ten-Year Cumulative Potential - MW		2023 Base Demand (MW)	Ten-Year Cumulative Potential - MW	
		Technical Potential (Current)	Economic Potential (Current)		Technical Potential (2014)	Economic Potential (2014)
Residential						
Existing	117	53	15	343	183	80
New	16	2	1	38	2	2
Subtotal	133	55	17	381	185	82
% of Base		37%	9%	N/A	49%	21%
Commercial						
Existing	309	60	44	279	75	51
New	108	27	22	19	6	6
Subtotal	417	87	66	298	81	56
% of Base		21%	16%	N/A	27%	19%
Total	550	136	78	1,312	437	271
% of Base		25%	14%	N/A	33%	21%

*Values may not total due to rounding.

5.2.5 Potentials by Building Type

This section presents technical and economic potential by residential and commercial building type to provide more detail about where potential savings exist in Dominion's service territory.

5.2.5.1 Residential

Figure 5-11 and Figure 5-12 show Virginia potentials in the residential sector by building type. We have included behavioral savings on the charts separately, without a breakout, because we analyzed behavioral programs by consumption rather than by building type. Single family homes (including behavioral) account for 92% of the economic potential for energy and 93% for demand.

Figure 5-11. Energy Savings Potential (GWh) by Residential Building Type, Virginia

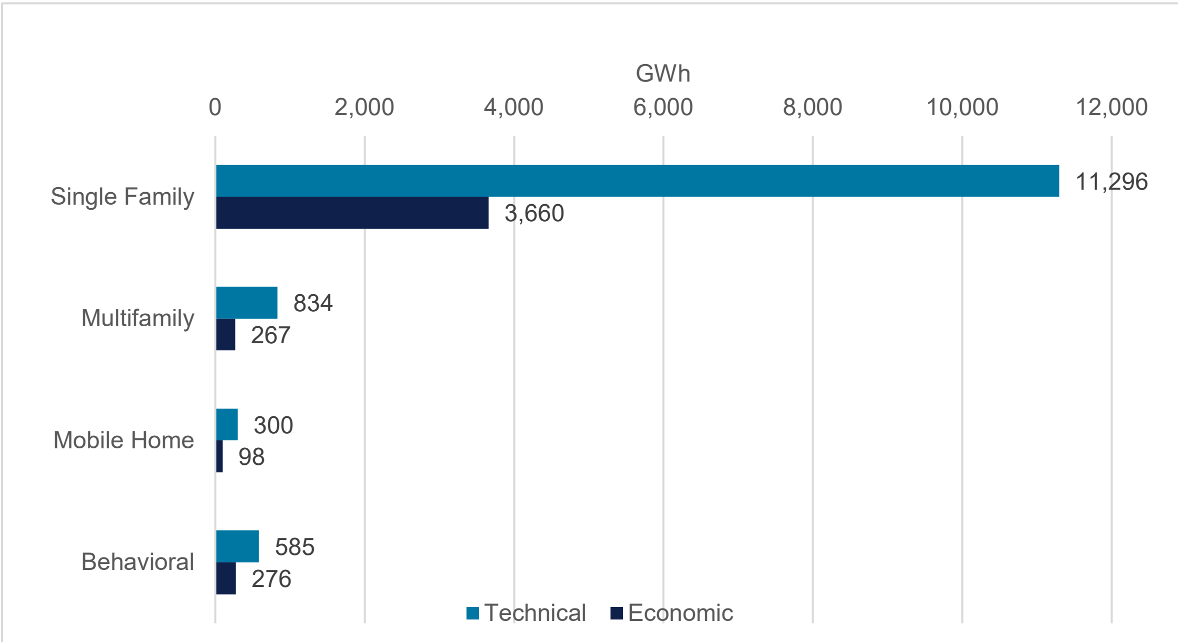


Figure 5-12. Demand Savings Potential (MW) by Residential Building Type, Virginia

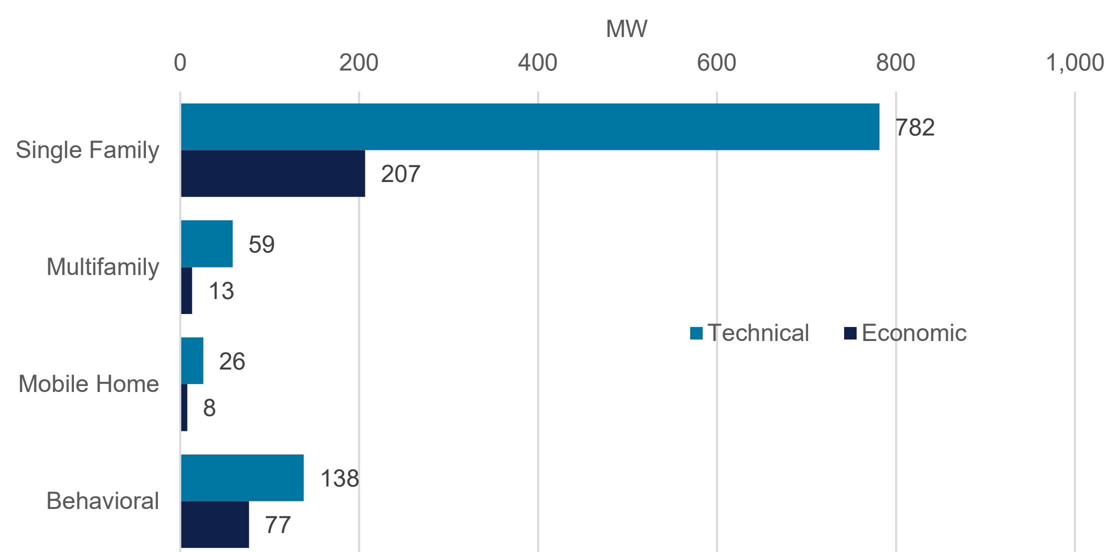


Figure 5-13 and Figure 5-14 show North Carolina potentials in the residential sector by building type. Due to schedule and budget restrictions, we did not perform a behavioral analysis for North Carolina. Single family homes (including behavioral) account for 92% of the economic energy potential and 94% of the economic demand potential.

Figure 5-13. Energy Savings Potential (GWh) by Residential Building Type, North Carolina

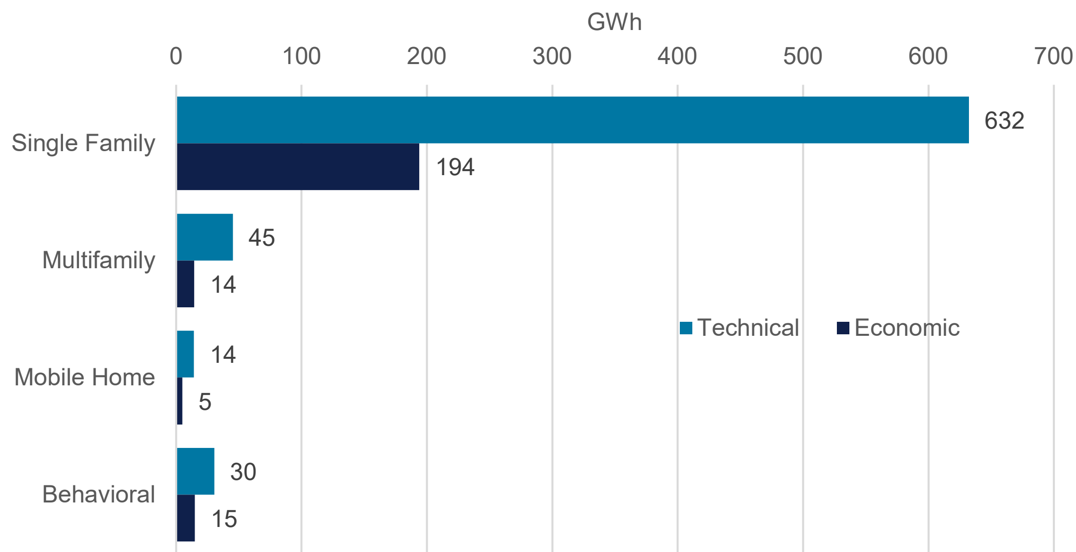
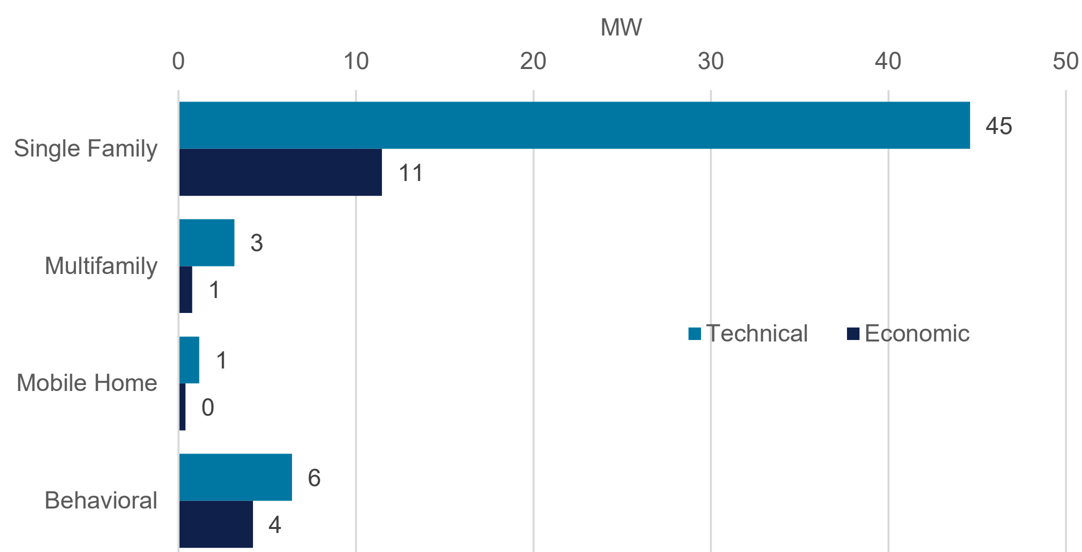


Figure 5-14. Demand Savings Potential (MW) by Residential Building Type, North Carolina

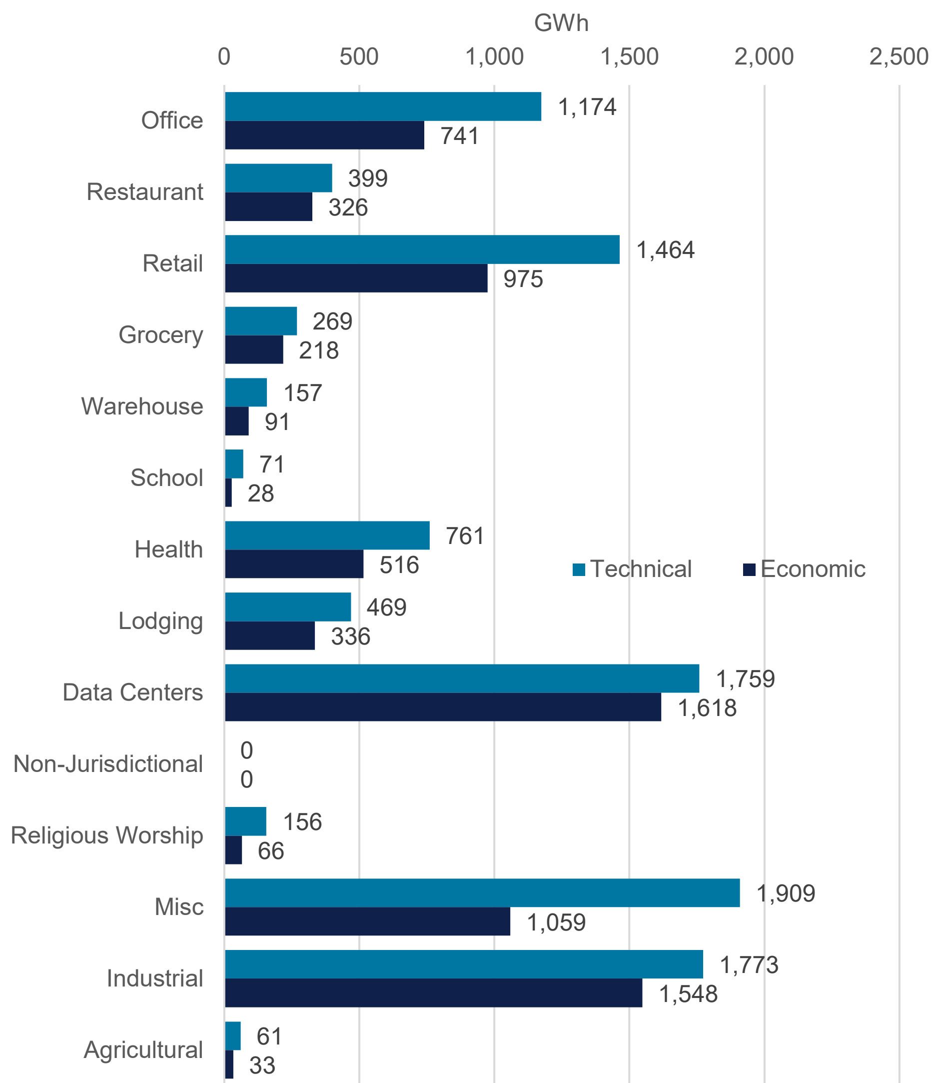


5.2.5.2 Non-Residential

Figure 5-15 and Figure 5-16 show the building type breakdown for non-residential building potential in Virginia. Data centers make up 21% of economic energy potential, followed by industrial, miscellaneous, and retail. The top four ranking is the same for demand potential, but data centers make up a much larger share by demand at 37%

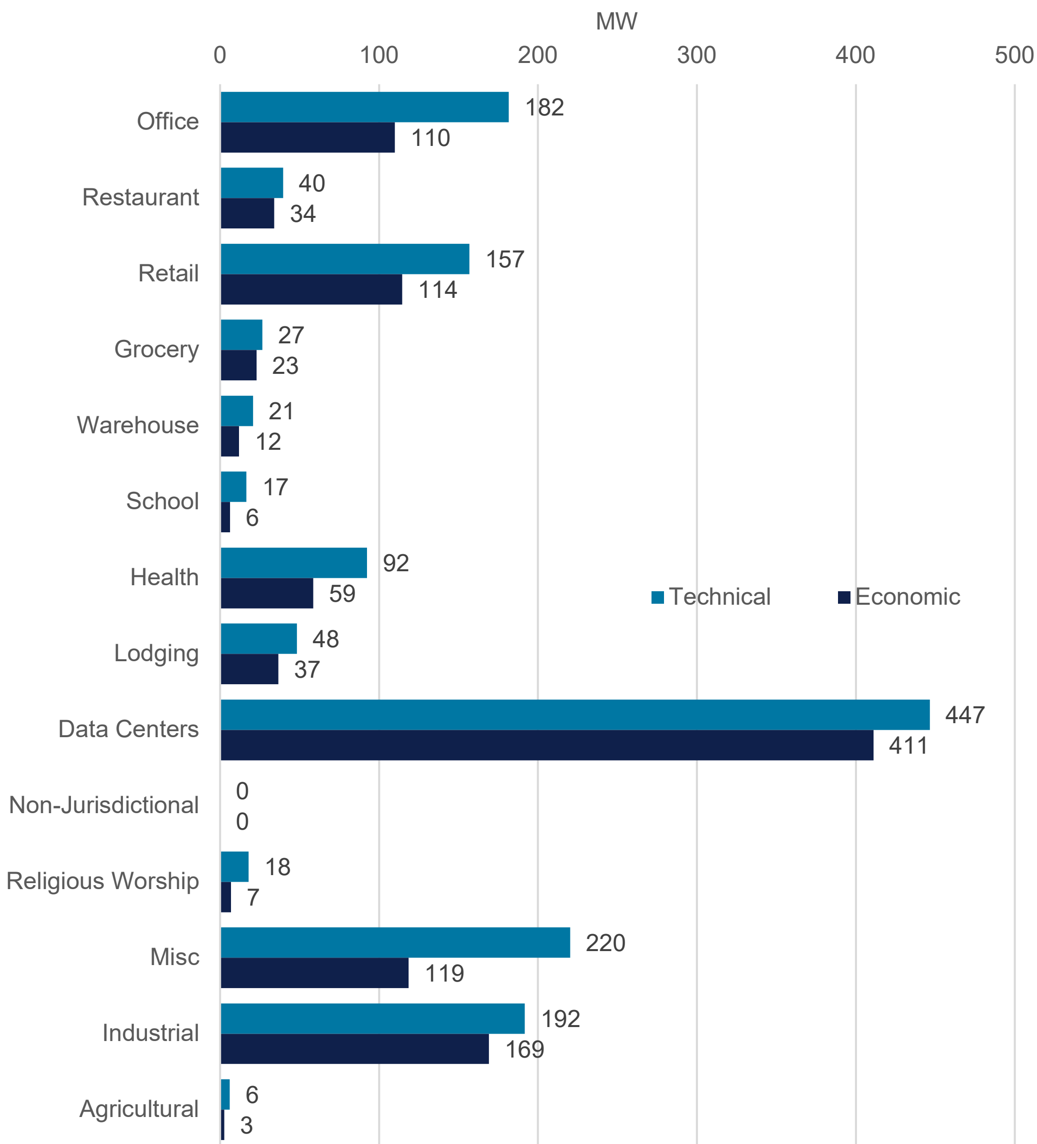
The miscellaneous "building type" encompass all the customer accounts that were left over after the other building types were broken out. Although we refer to it as a building type in the study, it includes not only buildings not explicitly categorized but also all non-residential energy use not associated with building (for example, cell towers, area lighting in a park or surface parking lot, or irrigation pumping not associated with a building account). The category also captures a broad range of less common building types, including sports arenas, community centers, fitness centers, gas stations (without quick marts), parking garages, etc. In North Carolina, the category also includes fire stations and police stations (in Virginia, these buildings would be non-jurisdictional). Individually, these building types represent too little energy use to justify collecting and developing building-type specific model inputs, so we model them as a group using broad averages for the various data inputs required by the model.

Figure 5-15. Energy Savings Potential by Non-Residential Building Type, Virginia



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-16. Demand Savings Potential by Non-Residential Building Type, Virginia



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-17 and Figure 5-18 show the building type breakdown of non-residential potential in North Carolina. Industrial potential accounts for 66% of the economic energy and 64% of economic demand, followed by miscellaneous buildings and retail.

Figure 5-17. Energy Savings Potential by Non-Residential Building Type, North Carolina

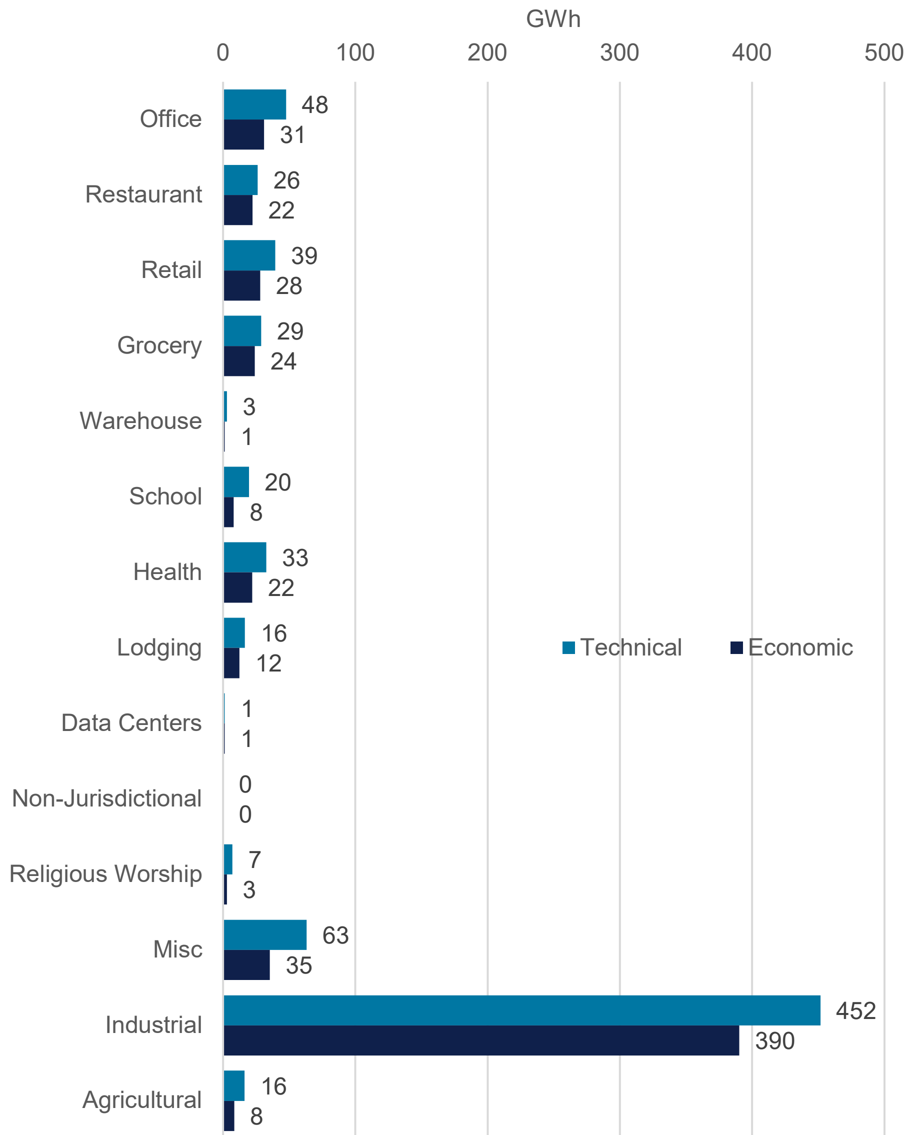
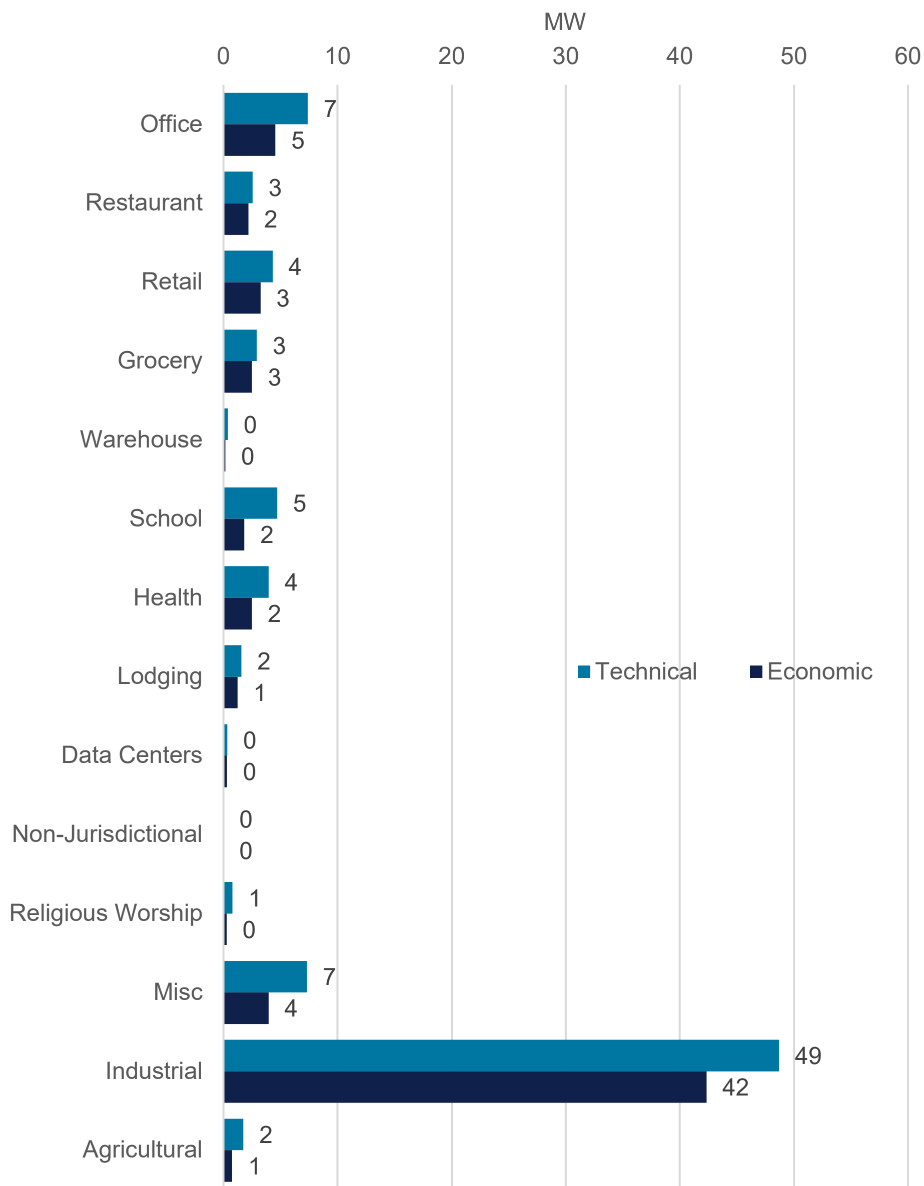


Figure 5-18. Demand Savings Potential by Non-Residential Building Type, North Carolina

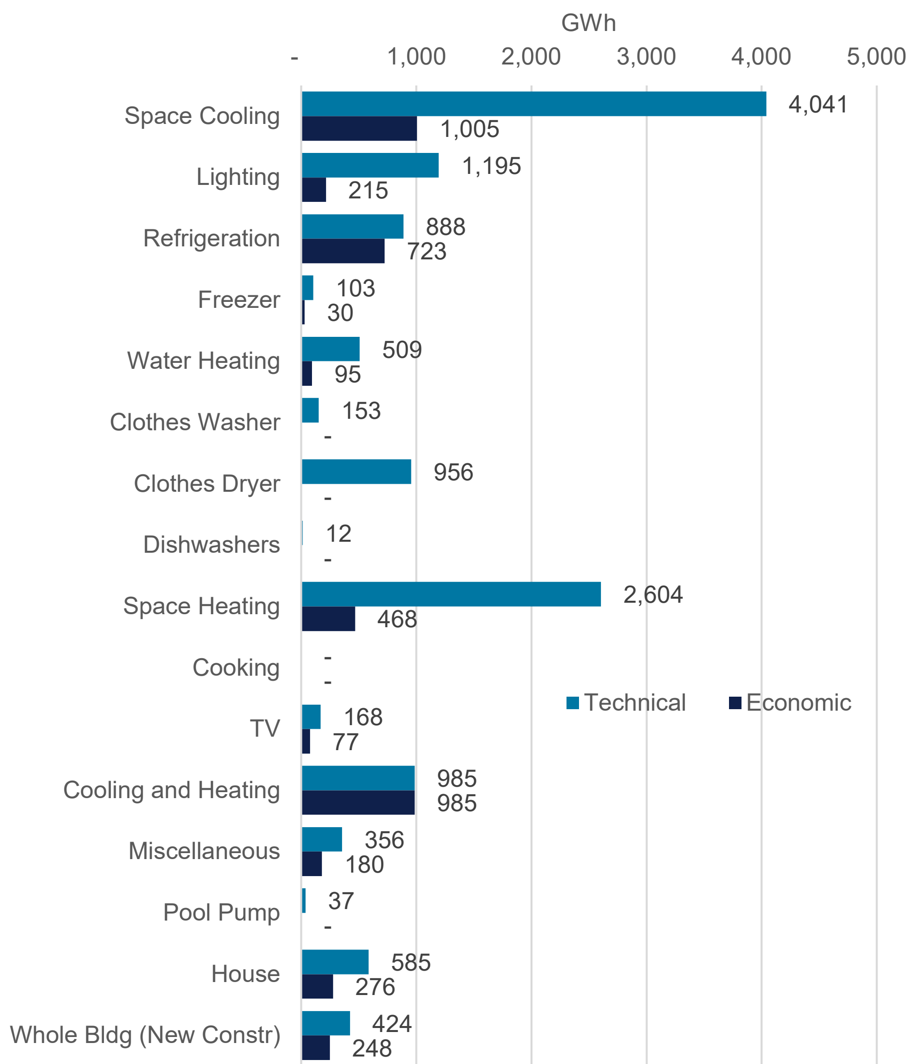


5.2.6 Potentials by End Use

5.2.6.1 Residential

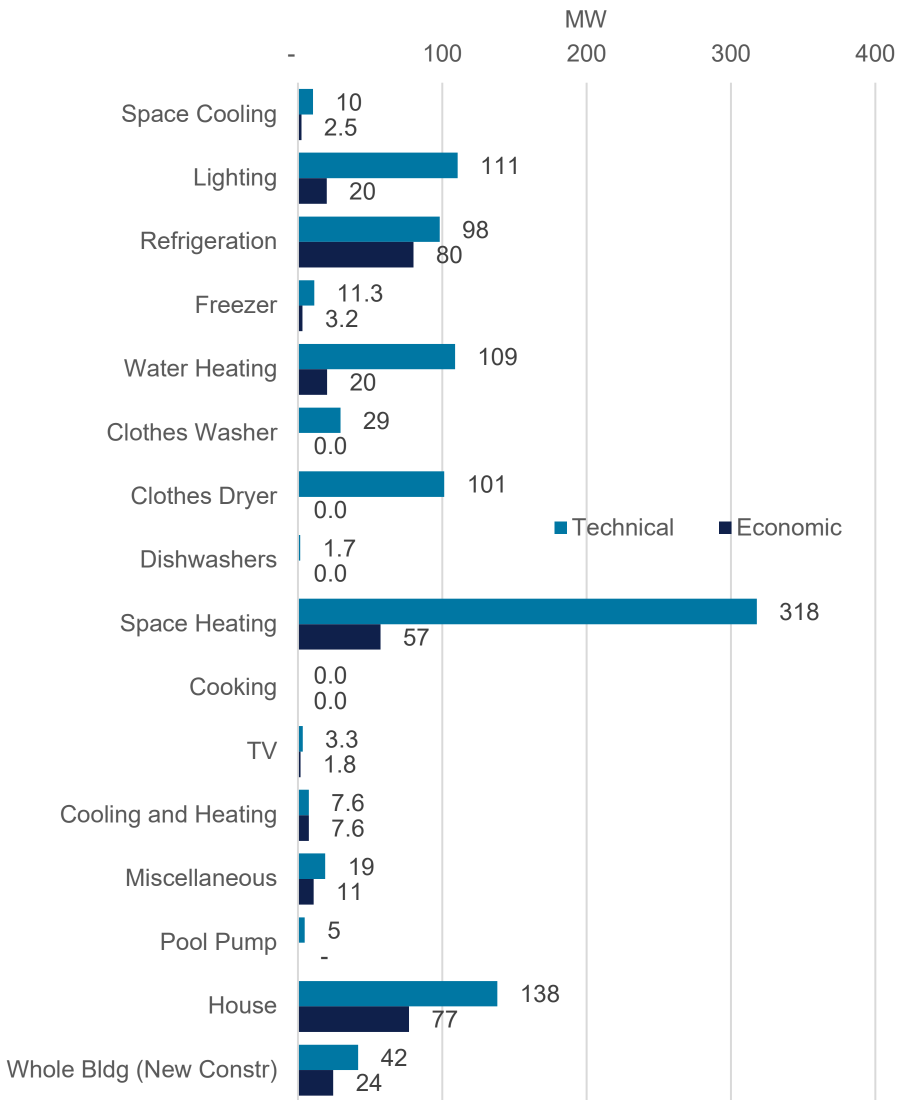
Figure 5-19 and Figure 5-20 show the end-use breakdown of residential potential for Virginia. Space cooling makes up 31% of technical energy savings potential, followed by space heating at 20%. Looking at economic potential tells a different story: furnace fans (the "cooling and heating" end use) make up the largest share of economic energy potential followed by refrigeration and space heating. On the demand side, space heating (based on a winter peak) makes up 32% of technical potential and 19% of economic potential. Refrigeration, however, makes up an even larger share of economic demand potential, at 26%.

Figure 5-19. Energy Savings Potential by Residential End Use, Virginia



Note: The residential miscellaneous category includes air purifiers and home office equipment, and plug-load controls.

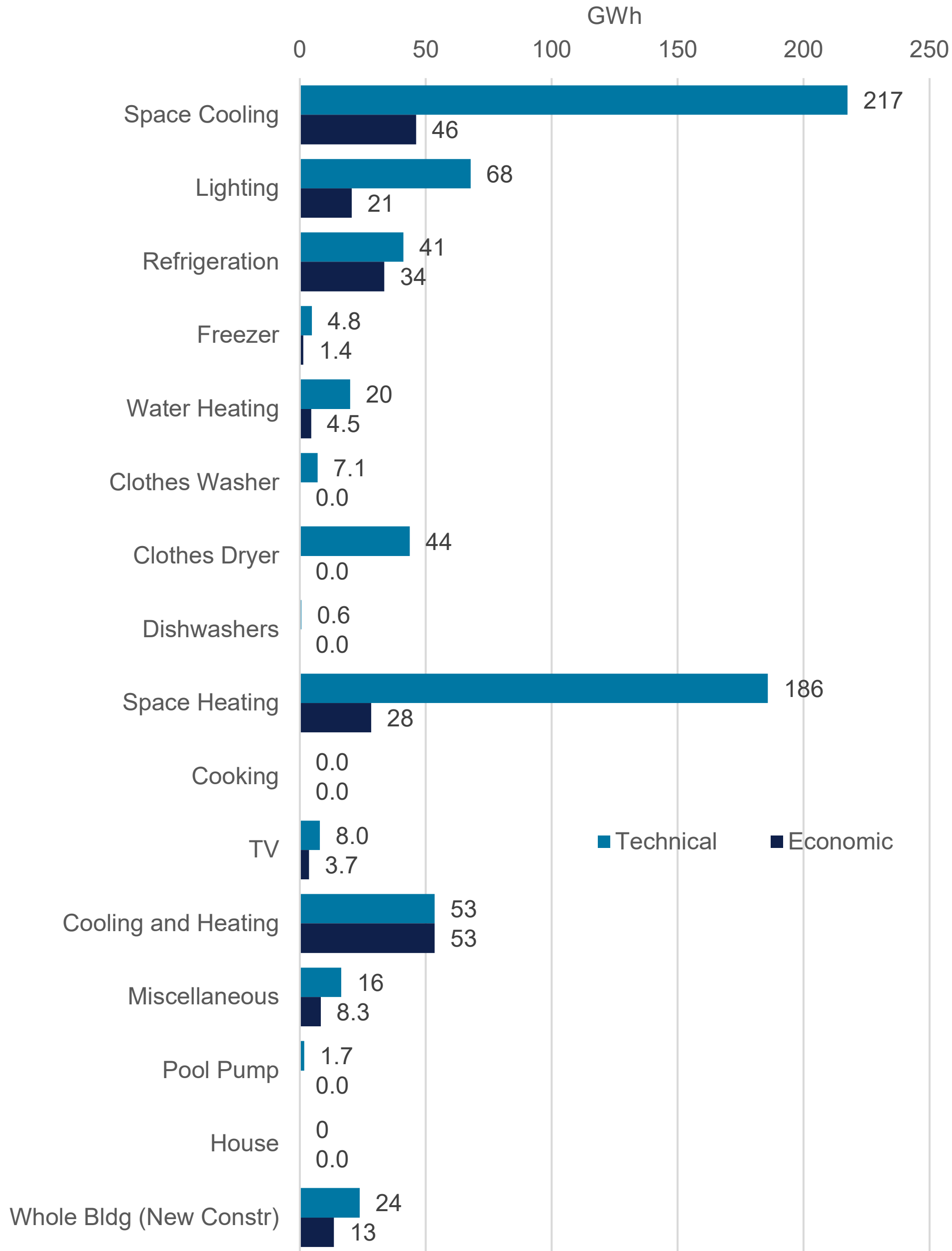
Figure 5-20. Demand Savings Potential by Residential End Use, Virginia



Note: The residential miscellaneous category includes air purifiers and home office equipment, and plug-load controls

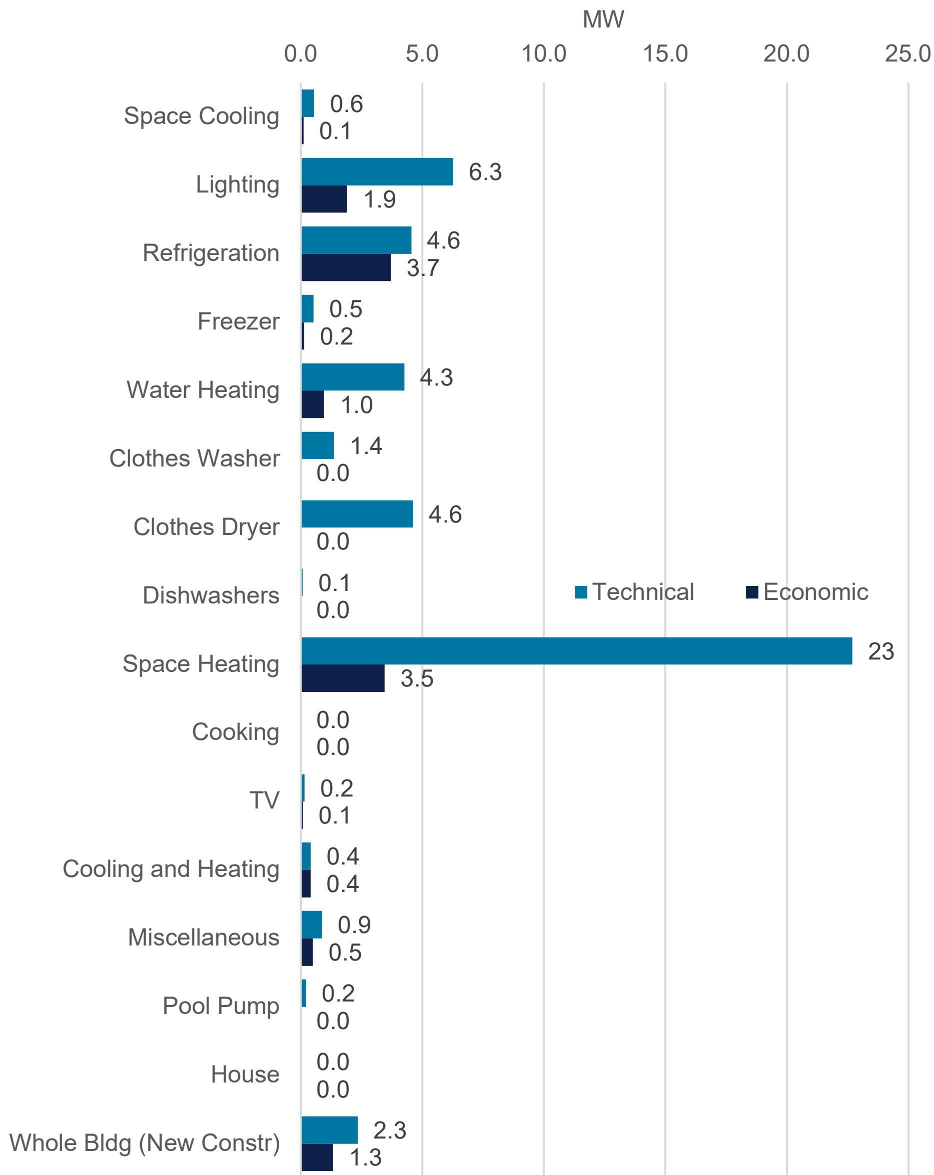
Figure 5-21 and Figure 5-22 show the end-use breakdown of residential potential for North Carolina. Space cooling makes up 31% of technical energy savings potential, followed by space heating at 27%. Looking at economic potential tells a different story: furnace fans (the cooling and heating end-use) comprise the largest share of economic energy potential (25%) followed by space cooling (22%) and refrigeration (16%). On the demand side, space heating (based on a winter peak) makes up 46% of technical potential and 27% of economic potential. Refrigeration, however, makes up the largest share of economic demand potential at 29%.

Figure 5-21. Energy Savings Potential by Residential End Use, North Carolina



Note: The residential miscellaneous category includes air purifiers and home office equipment, and plug-load controls.

Figure 5-22. Demand Savings Potential by Residential End Use, North Carolina

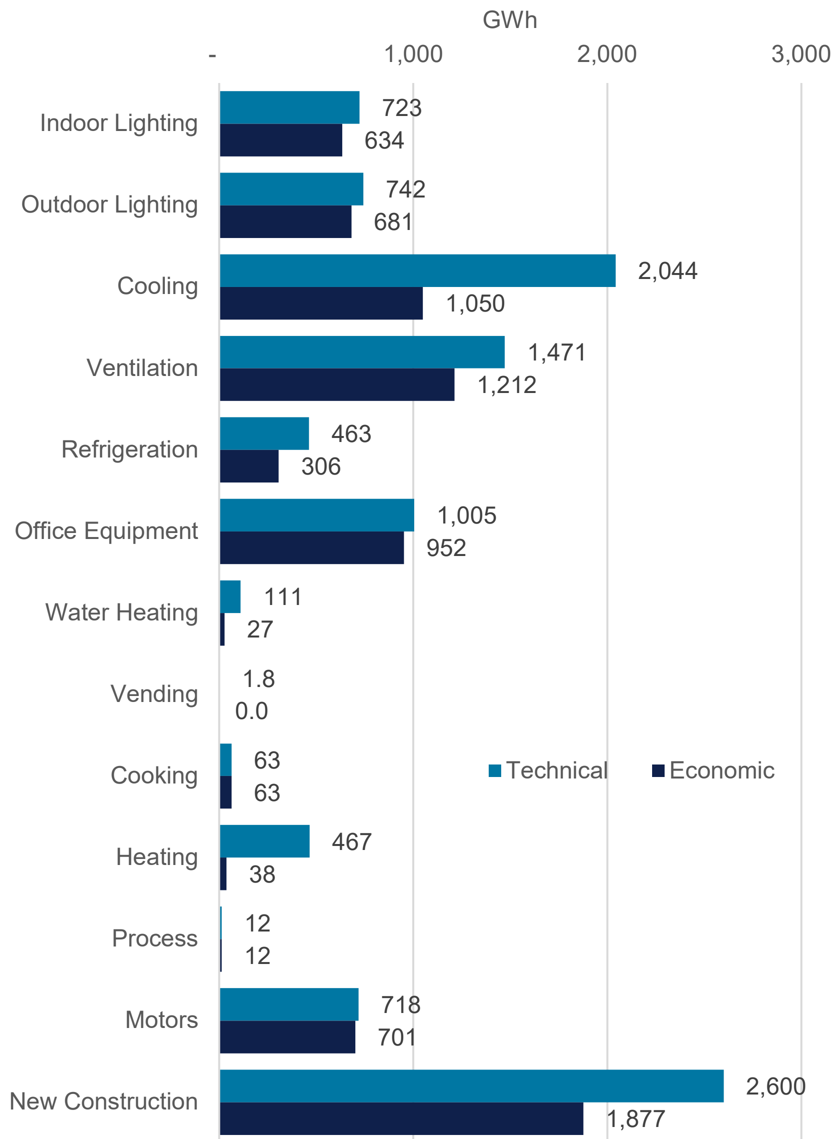


Note: The residential miscellaneous category includes air purifiers and home office equipment, and plug-load controls.

5.2.6.2 Non-residential

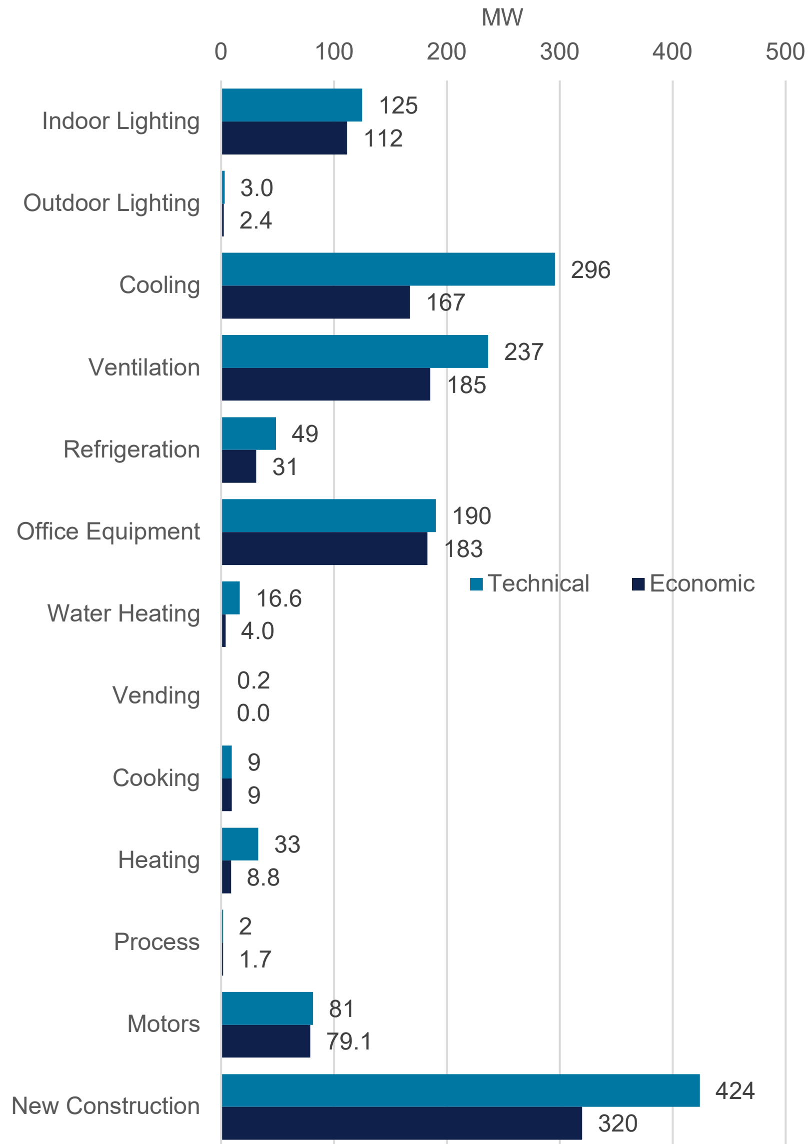
Figure 5-23 and Figure 5-24 show energy and demand savings by commercial end use for Virginia, with potential for opt-out eligible customers shown separately from ineligible customers. New construction makes up the largest share of economic potential at 25% for energy and 29% for demand. It is followed in energy use by ventilation and cooling and in demand by ventilation and office equipment.

Figure 5-23. Energy Savings Potential by Non-Residential End Use, Virginia



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-24. Demand Savings Potential by Non-Residential End Use, Virginia



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-25 and Figure 5-26 show energy and demand savings by non-residential end use for North Carolina, with potential for opt-out eligible customers shown separately from ineligible customers. Motors make up the largest share (32%) of economic energy potential, followed by new construction (27%), outdoor lighting, and indoor lighting. New construction comprises the largest share of economic demand savings (33%), followed by motors, indoor lighting, and ventilation.

Figure 5-25. Energy Savings Potential by Non-Residential End Use, North Carolina

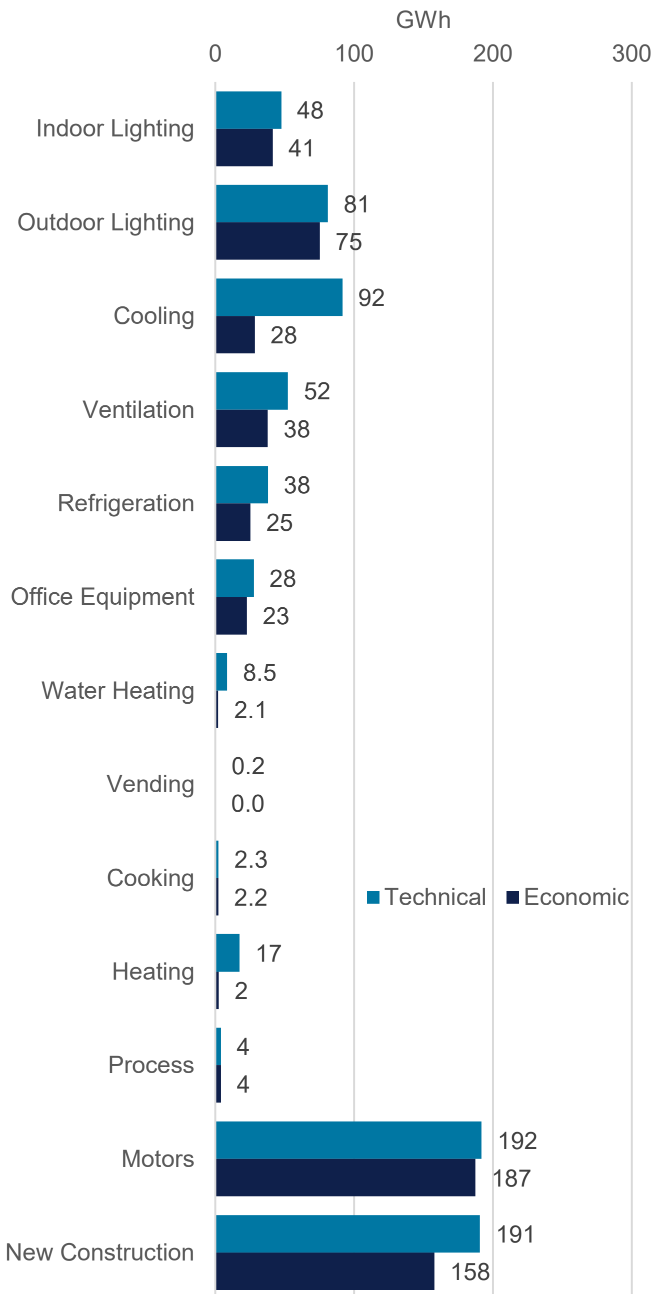
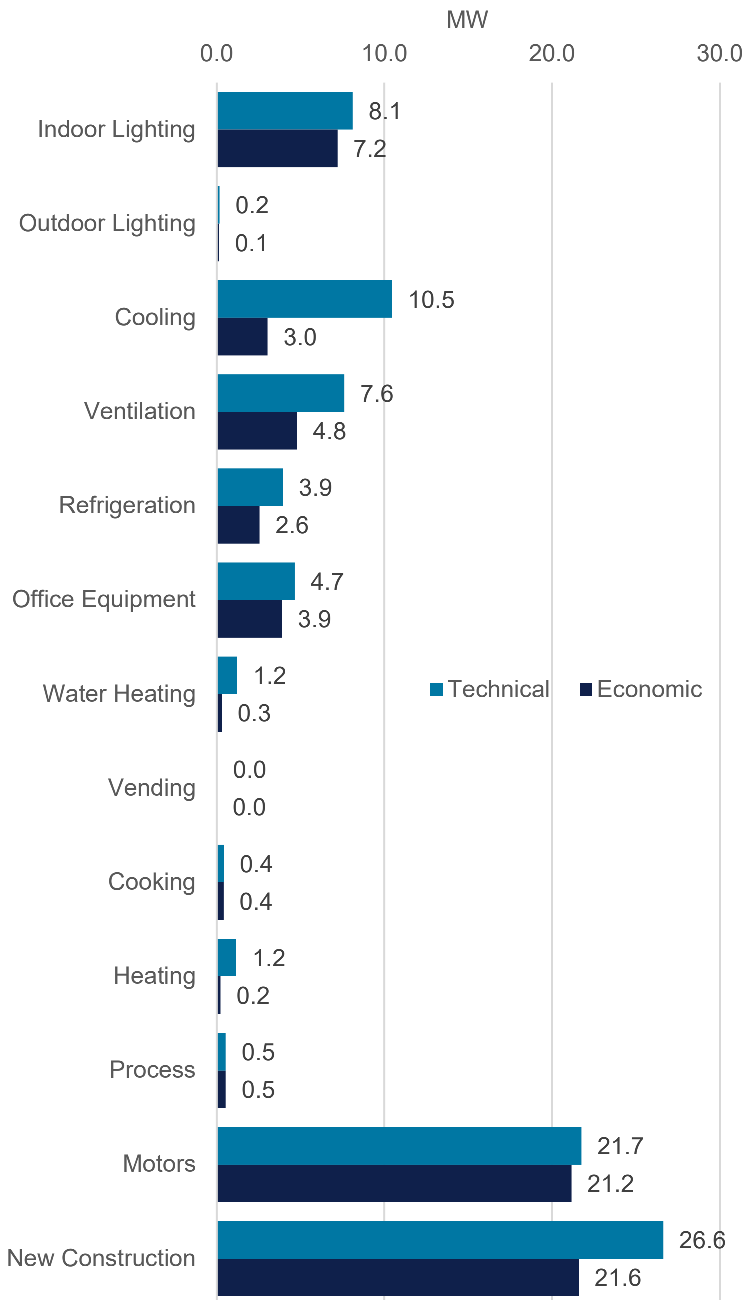


Figure 5-26. Demand Savings Potential by Non-Residential End Use, North Carolina

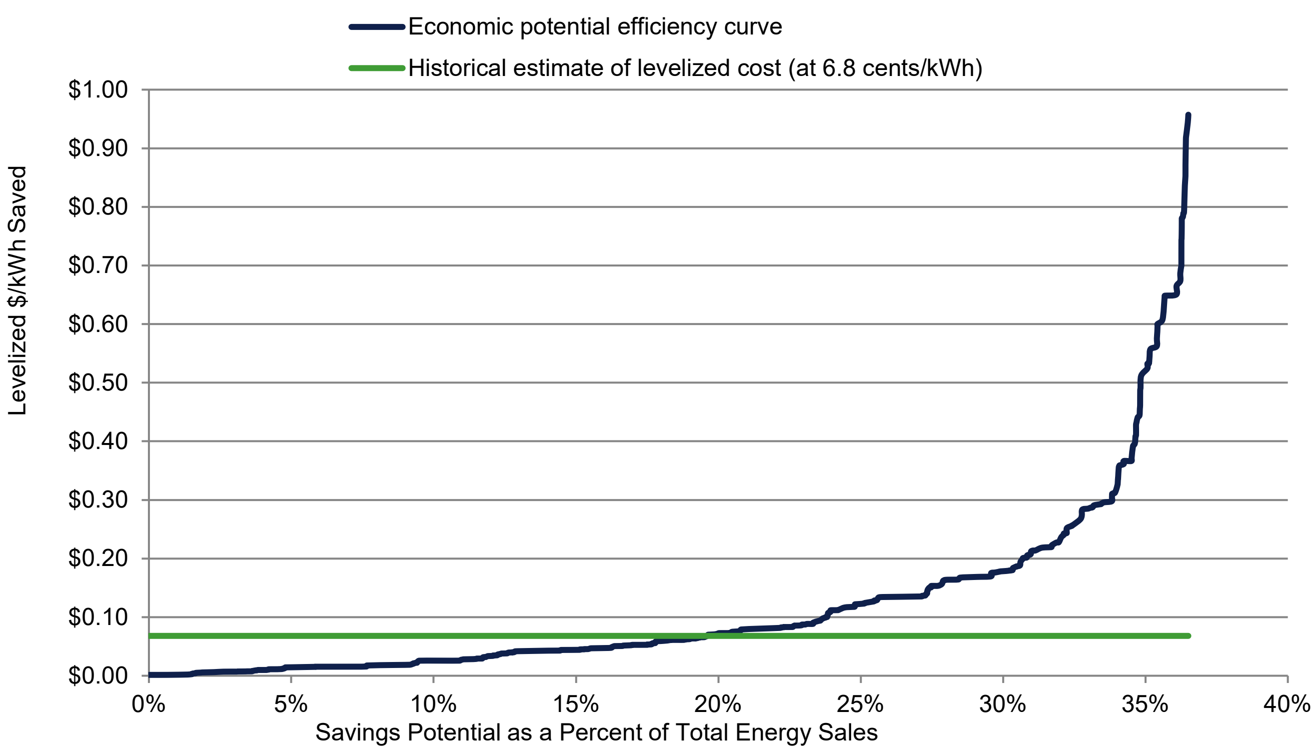


5.2.7 Energy Efficiency Supply Curves

A common way to illustrate the amount of energy savings per dollar spent is to construct an energy efficiency supply curve. A supply curve is typically depicted on two axes: one captures the cost per unit of saved energy (e.g., levelized $/kWh saved), and the other shows energy savings at each level of cost. Measures are sorted on a least-cost basis, and total savings are calculated incrementally with respect to measures that precede them. The costs of the measures are levelized over the life of the savings achieved. In this portion of the analysis, these costs are only referring to measure costs, and not the full cost of implementing these measures through a Dominion program.

Figure 5-27 presents the supply curves constructed for this study for electric energy efficiency, for Virginia and North Carolina combined. It represents the ordered set of efficiency measures in terms of their savings as a percentage of total energy sales.[19] The purpose of these curves is to show how much potential (as a percent of base consumption) can be realized (on the horizontal axis) compared to a scale of levelized costs (on the vertical axis), including measures that are not cost-effective. Historically, Dominion's levelized cost is estimated at approximately 6.8 cents per kWh and is shown on the chart in green. The economic potential of measures which can deliver savings at that levelized cost of energy represent approximately 19% of total energy sales.

Figure 5-27. Energy Savings Potential as a Percentage of Total Sales, Virginia* and North Carolina Combined



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

[19] For readability, this graph only presents measures with a savings potential of less than $1 per kWh.

5.2.9 Top 20 Saving Measures

Table 5-17 through Table 5-32 show the top 20 measures for energy and demand savings potential in the residential and non-residential sectors. For each section, the first table shows the top 20 measures as ranked by technical potential savings. The following table then shows the top 20 measures ranked by economic savings. All measures with a TRC less than one are not considered as part of the economic potential and thus were not carried over to the top 20 economic measures tables.

5.2.9.1 Residential

Table 5-17 through Table 5-20 show the top 20 measures by technical energy potential, economic energy potential, technical demand potential, and economic demand potential, respectively, for Dominion's residential sector in Virginia.

Table 5-17. Top 20 Measures Contributing to Residential Technical Energy Savings Potential, Virginia

Measure Name	Building Type	Technical GWh	Measure TRC	Economic GWh
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	962.3	2.9	962.3
Heat Pump Dryer	Single Family	915.9	0.4	0.0
2nd Refrigerator Recycling	Single Family	744.5	2.7	744.5
Motion/Occupancy Sensor	Single Family	403.7	0.3	0.0
Heat pump upgrade to (15 SEER, 8.2+ HSPF) (HP cooling Early Replacement)	Single Family	382.5	1.5	382.5
Heat Recovery Ventilators (HP heating early replacement)	Single Family	363.2	0.4	0.0
Air Source Heat Pump (resistance heating)	Single Family	329.9	3.2	329.9
Whole House Fans (HP cooling early replacement)	Single Family	282.5	0.5	0.0
Ground Source Heat Pump with Desuperheater (resistance heating)	Single Family	248.4	0.1	0.0
Whole House Fans (CAC early replacement)	Single Family	241.6	0.6	0.0
Heat Recovery Ventilators (resistance heating)	Single Family	195.2	0.3	0.0
Dimmer Switch	Single Family	184.8	0.1	0.0
Heat Recovery Ventilators (HP heating)	Single Family	183.1	0.5	0.0
Whole House Fans (HP cooling)	Single Family	169.5	0.7	0.0
15 SEER Split-System Air Conditioner w/ Quality Install - Early Replacement	Single Family	166.2	0.3	0.0
Plug Load Controls - Smart Power Strip (base Desktop PC)	Single Family	157.6	0.7	0.0
Heat pump upgrade to 16+ SEER/8.7+ HSPF (HP heating early replacement)	Single Family	155.8	0.5	0.0
Motion/Occupancy Sensor	Single Family	150.0	0.1	0.0
Solar Domestic Water Heating	Single Family	146.6	0.1	0.0
17 SEER (12.28 EER) Split-System Air Conditioner (CAC)	Single Family	145.5	0.3	0.0
ENERGY STAR CW CEE Tier 2 (MEF=2.0)	Single Family	143.8	0.3	0.0

Table 5-18. Top 20 Measures Contributing to Residential Economic Energy Savings Potential, Virginia

Measure Name	Building Type	Measure TRC	Economic GWh
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	2.9	962.3
2nd Refrigerator Recycling	Single Family	2.7	744.5
Heat pump upgrade to (15 SEER, 8.2+ HSPF) (HP cooling Early Replacement)	Single Family	1.5	382.5
Air Source Heat Pump (resistance heating)	Single Family	3.2	329.9
Proper Refrigerant Charging and Air Flow (CAC early replacement)	Single Family	1.0	123.4
Proper Refrigerant Charging and Air Flow (HP cooling)	Single Family	1.2	77.7
10% better than ENERGY STAR Dehumidifier ROB (35-45 pints/day)	Single Family	6.7	75.1
ENERGY STAR Desktop PC	Single Family	17.2	74.9
Proper Refrigerant Charging and Air Flow (CAC)	Single Family	1.1	71.2
DHW Tank Wrap	Single Family	1.2	68.3
ENERGY STAR Laptop PC	Single Family	7.3	64.8
LEDs (base CFL 6 hrs/day)	Single Family	2.3	56.9
LEDs (base Halogen (Specialty) 2.5 hrs/day)	Single Family	6.4	55.8
ECM Furnace Fan (variable speed motor) - Cooling	Multi-Family	2.6	54.1
Door Weatherization (CAC early replacement)	Single Family	1.3	39.1
ENERGY STAR LCD TV	Single Family	11.3	38.3
LEDs (base Halogen (Specialty) 6 hrs/day)	Single Family	9.9	36.9
LEDs (base Halogen 2.5 hrs/day)	Single Family	2.2	36.5
Air Source Heat Pump (resistance heating)	Multi-Family	3.3	34.7
Self-Install Weatherization (HP cooling Early Replacement)	Single Family	2.2	34.1
ENERGY STAR DVD Player	Single Family	2.9	32.8

Table 5-19. Top 20 Measures Contributing to Residential Technical Demand Savings Potential, Virginia

Measure Name	Building Type	Technical MW	Measure TRC	Economic MW
Heat Pump Dryer	Single Family	97.1	0.4	0.0
2nd Refrigerator Recycling	Single Family	82.4	2.7	82.4
Heat Recovery Ventilators (HP heating early replacement)	Single Family	44.3	0.4	0.0
Air Source Heat Pump (resistance heating)	Single Family	40.3	3.2	40.3
Motion/Occupancy Sensor	Single Family	37.4	0.3	0.0
Solar Domestic Water Heating	Single Family	31.3	0.1	0.0
Ground Source Heat Pump with Desuperheater (resistance heating)	Single Family	30.3	0.1	0.0
Heat Pump Water Heater - ENERGY STAR - Early Replacement	Single Family	29.9	0.3	0.0
ENERGY STAR CW CEE Tier 2 (MEF=2.0)	Single Family	27.7	0.3	0.0
Heat Recovery Ventilators (resistance heating)	Single Family	23.8	0.3	0.0
Heat Recovery Ventilators (HP heating)	Single Family	22.3	0.5	0.0
Heat pump upgrade to 16+ SEER/8.7+ HSPF (HP heating early replacement)	Single Family	19.0	0.5	0.0
Dimmer Switch	Single Family	17.1	0.1	0.0
DHW Tank Wrap	Single Family	14.6	1.2	14.6
Ground Source Heat Pump with Desuperheater (HP heating early replacement)	Single Family	14.5	0.0	0.0
Motion/Occupancy Sensor	Single Family	13.9	0.1	0.0
Heat Pump Water Heater - ENERGY STAR	Single Family	11.9	0.4	0.0
Smart Thermostat (HP heating early replacement)	Single Family	9.7	0.4	0.0
Refrigerator - Early Replacement (ENERGY STAR)	Single Family	8.2	0.2	0.0
Refrigerator (CEE Tier 2)	Single Family	7.9	0.3	0.0
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	7.4	2.9	7.4

In very cold weather, air-source heat pumps revert to electric resistance heating. In the past, that threshold was in the range of 25°F to 30°Fahrenheit. Heat pump technology has made strides in recent years in improving cold-weather performance, expanding the range of temperatures where air source heat pumps can save energy. Under a winter peak, it will be important for Dominion's program to focus on cold weather performance in addition to SEER and HSPF. The peak demand calculations for air source heat pumps and heat pump water heaters do not include any degradation in efficiency for winter peak, which may overstate the peak demand savings potential in severe winters, even assuming cold-climate heat pumps.

Table 5-20. Top 20 Measures Contributing to Residential Economic Demand Savings Potential, Virginia

Measure Name	Building Type	Measure TRC	Economic MW
2nd Refrigerator Recycling	Single Family	2.7	82.4
Air Source Heat Pump (resistance heating)	Single Family	3.2	40.3
DHW Tank Wrap	Single Family	1.2	14.6
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	2.9	7.4
LEDs (base CFL 6 hrs/day)	Single Family	2.3	5.3
LEDs (base Halogen (Specialty) 2.5 hrs/day)	Single Family	6.4	5.2
ENERGY STAR Desktop PC	Single Family	17.2	4.7
Air Source Heat Pump (resistance heating)	Multi-Family	3.3	4.2
ENERGY STAR Laptop PC	Single Family	7.3	4.0
Air Source Heat Pump (resistance heating)	Mobile Home	4.2	3.9
Self-Install Weatherization (HP heating early replacement)	Single Family	1.8	3.6
LEDs (base Halogen (Specialty) 6 hrs/day)	Single Family	9.9	3.4
LEDs (base Halogen 2.5 hrs/day)	Single Family	2.2	3.4
Pipe Wrap	Single Family	1.5	3.3
2nd Freezer Recycling	Single Family	2.2	2.6
Duct Insulation (HP heating early replacement)	Single Family	6.5	2.0
Self-Install Weatherization	Single Family	1.3	1.8
Self-Install Weatherization (HP heating)	Single Family	2.3	1.7
Hot water turndown 10 degrees	Single Family	2.8	1.3
LEDs (base Halogen (Specialty) 0.5 hrs/day)	Single Family	1.3	1.3
ENERGY STAR Laptop PC	Multi-Family	17.9	1.0

Table 5-21 through Table 5-24 show the top 20 residential measures by technical energy potential, economic energy potential, technical demand potential, and economic demand potential, respectively, for Dominion's North Carolina service territory. Many of the same measure appear on both North Carolina's and Virginia's lists (though in a different order), although savings potential is notably less in Dominion's smaller North Carolina service territory.

Table 5-21. Top 20 Measures Contributing to Residential Technical Energy Savings Potential, North Carolina

Measure Name	Building Type	Technical GWh	Measure TRC	Economic GWh
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	51.9	3.4	51.9
Heat Recovery Ventilators (HP heating)	Single Family	50.6	0.6	0.0
Heat Pump Dryer	Single Family	42.4	0.4	0.0
2nd Refrigerator Recycling	Single Family	34.5	2.7	34.5
Whole House Fans (HP cooling)	Single Family	31.4	0.8	0.0
Motion/Occupancy Sensor	Single Family	18.7	0.3	0.0
Air Source Heat Pump (resistance heating)	Single Family	18.3	3.9	18.3
17 SEER (12.28 EER) Split-System Air Conditioner (CAC)	Single Family	17.5	0.4	0.0
Ground Source Heat Pump with Desuperheater (HP heating)	Single Family	15.8	0.0	0.0
Proper Refrigerant Charging and Air Flow (HP cooling)	Single Family	14.4	1.4	14.4
Ground Source Heat Pump with Desuperheater (resistance heating)	Single Family	13.8	0.1	0.0
Proper Sizing and Quality Install (CAC)	Single Family	13.0	0.6	0.0
Heat pump upgrade to (16+ SEER, 8.7+ HSPF) (HP cooling)	Single Family	13.0	0.6	0.0
Proper Sizing and Quality Install (HP cooling)	Single Family	13.0	0.4	0.0
Cool Roof (HP cooling)	Single Family	12.5	0.4	0.0
Smart Thermostat (HP heating)	Single Family	11.1	0.7	0.0
Heat Recovery Ventilators (resistance heating)	Single Family	10.8	0.3	0.0
Proper Refrigerant Charging and Air Flow (CAC)	Single Family	10.4	1.3	10.4
Solar Domestic Water Heating	Single Family	9.2	0.2	0.0
Dimmer Switch	Single Family	8.6	0.1	0.0
Smart Thermostat (HP cooling)	Single Family	8.4	0.9	0.0

Table 5-22. Top 20 Measures Contributing to Residential Economic Energy Savings Potential, North Carolina

Measure Name	Building Type	Measure TRC	Economic GWh
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	3.4	51.9
2nd Refrigerator Recycling	Single Family	2.7	34.5
Air Source Heat Pump (resistance heating)	Single Family	3.9	18.3
Proper Refrigerant Charging and Air Flow (HP cooling)	Single Family	1.4	14.4
Proper Refrigerant Charging and Air Flow (CAC)	Single Family	1.3	10.4
LEDs (base Halogen (Specialty) 2.5 hrs/day)	Single Family	6.4	5.8
LEDs (base CFL 6 hrs/day)	Single Family	2.3	4.8
Door Weatherization (HP cooling)	Single Family	1.5	4.5
LEDs (base Halogen (Specialty) 6 hrs/day)	Single Family	9.9	3.8
Self-Install Weatherization (HP heating)	Single Family	2.8	3.8
LEDs (base Halogen 2.5 hrs/day)	Single Family	2.7	3.5
10% better than ENERGY STAR Dehumidifier ROB (35-45 pints/day)	Single Family	6.7	3.5
ENERGY STAR Desktop PC	Single Family	17.2	3.5
ECM Furnace Fan (variable speed motor) - Cooling	Multi-Family	3.4	3.3
DHW Tank Wrap	Single Family	1.2	3.3
Door Weatherization (CAC)	Single Family	1.4	3.3
Self-Install Weatherization (HP cooling)	Single Family	3.1	3.1
ENERGY STAR Laptop PC	Single Family	7.3	3.0
Self-Install Weatherization (CAC)	Single Family	7.8	2.3
Duct Insulation (HP heating)	Single Family	9.9	2.1
Air Source Heat Pump (resistance heating)	Multi-Family	3.9	1.9

Table 5-23. Top 20 Measures Contributing to Residential Technical Demand Savings Potential, North Carolina

Measure Name	Building Type	Technical MW	Measure TRC	Economic MW
Heat Recovery Ventilators (HP heating)	Single Family	6.2	0.6	0.0
Heat Pump Dryer	Single Family	4.5	0.4	0.0
2nd Refrigerator Recycling	Single Family	3.8	2.7	3.8
Air Source Heat Pump (resistance heating)	Single Family	2.2	3.9	2.2
Solar Domestic Water Heating	Single Family	2.0	0.2	0.0
Ground Source Heat Pump with Desuperheater (HP heating)	Single Family	1.9	0.0	0.0
Motion/Occupancy Sensor	Single Family	1.7	0.3	0.0
Ground Source Heat Pump with Desuperheater (resistance heating)	Single Family	1.7	0.1	0.0
Smart Thermostat (HP heating)	Single Family	1.4	0.7	0.0
Heat Recovery Ventilators (resistance heating)	Single Family	1.3	0.3	0.0
ENERGY STAR CW CEE Tier 2 (MEF=2.0)	Single Family	1.3	0.3	0.0
Comprehensive Shell Air Sealing - Inf. Reduction (HP heating)	Single Family	1.0	0.3	0.0
Basement insulation R-13 (HP heating)	Single Family	0.9	0.4	0.0
Dimmer Switch	Single Family	0.8	0.1	0.0
Heat pump upgrade to 16+ SEER/8.7+ HSPF (HP heating)	Single Family	0.8	0.2	0.0
DHW Tank Wrap	Single Family	0.7	1.2	0.7
Heat Pump Water Heater - ENERGY STAR	Single Family	0.7	0.4	0.0
Motion/Occupancy Sensor	Single Family	0.6	0.1	0.0
LEDs (base Halogen (Specialty) 2.5 hrs/day)	Single Family	0.5	6.4	0.5
Self-Install Weatherization (HP heating)	Single Family	0.5	2.8	0.5
Ceiling R-11 to R-38 Insulation (HP heating)	Single Family	0.4	0.1	0.0

Table 5-24. Top 20 Measures Contributing to Residential Economic Demand Savings Potential, North Carolina

Measure Name	Building Type	Measure TRC	Economic MW
2nd Refrigerator Recycling	Single Family	2.7	3.8
Air Source Heat Pump (resistance heating)	Single Family	3.9	2.2
DHW Tank Wrap	Single Family	1.2	0.7
LEDs (base Halogen (Specialty) 2.5 hrs/day)	Single Family	6.4	0.5
Self-Install Weatherization (HP heating)	Single Family	2.8	0.5
LEDs (base CFL 6 hrs/day)	Single Family	2.3	0.4
ECM Furnace Fan (variable speed motor) - Cooling	Single Family	3.4	0.4
LEDs (base Halogen (Specialty) 6 hrs/day)	Single Family	9.9	0.4
LEDs (base Halogen 2.5 hrs/day)	Single Family	2.7	0.3
Duct Insulation (HP heating)	Single Family	9.9	0.3
Air Source Heat Pump (resistance heating)	Multi-Family	3.9	0.2
ENERGY STAR Desktop PC	Single Family	17.2	0.2
ENERGY STAR Laptop PC	Single Family	7.3	0.2
Air Source Heat Pump (resistance heating)	Mobile Home	4.2	0.2
Pipe Wrap	Single Family	1.5	0.2
LEDs (base Halogen (Specialty) 0.5 hrs/day)	Single Family	1.3	0.1
2nd Freezer Recycling	Single Family	2.2	0.1
Self-Install Weatherization	Single Family	1.6	0.1
Door Weatherization (HP heating)	Multi-Family	1.3	0.1
Hot water turndown 10 degrees	Single Family	2.8	0.1
LEDs (base Halogen 6 hrs/day)	Single Family	4.6	0.1

5.2.9.2 Non-Residential

Table 5-25 through Table 5-28 show the top 20 non-residential measures by technical energy potential, economic energy potential, technical demand potential, and economic demand potential, respectively, for Dominion's Virginia non-opt-out customers.

Even though these results assume a 33% opt-out rate among Dominions largest (greater than 1 MW demand) customers, a category that includes Dominion's large data center customers, ENERGY STAR servers and server power management enabling still rank among the top 20 measures for both technical and economic savings. This reflects the large numbers, and high energy consumption, of servers in other building types. Office buildings often contain server rooms, or at least network closets containing servers and other networking equipment, but servers are used in a wide range of building types. Point-of-sale terminals in retail, lodging, and restaurants may be supported by local servers in addition to centralized data processing. Hospitals and medical centers often also have sophisticated data networks. While energy management in dedicated data centers can be quite sophisticated, locally-sited server infrastructure may lag in the adoption of energy-efficient equipment and processes.

Table 5-25. Top 20 Measures Contributing to Non-Residential Technical Energy Savings Potential, Virginia*

Measure Name	Technical GWh	Measure TRC	Economic GWh
DX Packaged System, EER=13.4, 10 tons	795.1	1.9	786.5
Bi-Level LED Outdoor Lighting (Base Outdoor HID)	590.0	2.8	590.0
Variable Speed Drive Control, 5 HP	504.4	1.1	489.4
Server Power Management Enabling	497.0	36.3	497.0
ENERGY STAR server	476.0	48.7	476.0
Variable Speed Drive Control, 40 HP	346.0	5.4	338.8
LED screw-in replacement (base incandescent/halogen)	309.3	9.3	309.3
Variable Speed Drive Control, 15 HP	267.8	2.7	250.2
LED screw-in replacement (base Outdoor Incandescent)	234.3	5.3	234.3
Smart Thermostat - DX	201.2	0.2	0.0
High Efficiency Rooftop Heat Pump, heating	193.5	0.7	0.0
Smart Thermostat (Base Rooftop/packaged heating)	168.4	1.8	38.3
Duct Testing/Sealing - Chiller	160.6	4.3	83.6
Duct Testing/Sealing - DX	158.0	0.7	20.0
Air Handler Optimization, 40 HP	144.7	27.9	143.1
Refrigeration Coil Cleaning, walk-ins	142.1	3.6	140.1
Electronically Commutated Motors (ECM) on an Air Handler Unit	139.7	7.6	115.2
Demand Controlled Ventilation, 5 HP	136.2	0.2	0.0
Economizer - DX	130.1	0.3	0.0
PC Network Power Management Enabling	122.2	1.9	93.3
ROB 2L4' LED Tube (Base T12)	116.9	8.2	116.9

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Table 5-26. Top 20 Measures Contributing to Non-Residential Economic Energy Savings Potential, Virginia*

Measure Name	Measure TRC	Economic GWh
DX Packaged System, EER=13.4, 10 tons	1.9	786.5
Bi-Level LED Outdoor Lighting (Base Outdoor HID)	2.8	590.0
Server Power Management Enabling	36.3	497.0
Variable Speed Drive Control, 5 HP	1.1	489.4
ENERGY STAR server	48.7	476.0
Variable Speed Drive Control, 40 HP	5.4	338.8
LED screw-in replacement (base incandescent/halogen)	9.3	309.3
Variable Speed Drive Control, 15 HP	2.7	250.2
LED screw-in replacement (base Outdoor Incandescent)	5.3	234.3
Air Handler Optimization, 40 HP	27.9	143.1
Refrigeration Coil Cleaning, walk-ins	3.6	140.1
ROB 2L4' LED Tube (Base T12)	8.2	116.9
Electronically Commutated Motors (ECM) on an Air Handler Unit	7.6	115.2
High Bay Bi-Level Programmed LED Fixture	7.9	105.1
PC Network Power Management Enabling	1.9	93.3
Duct Testing/Sealing - Chiller	4.3	83.6
ROB 2L4' LED Tube (Base T8)	6.1	81.6
Demand Controlled Ventilation, 40 HP	1.5	68.9
ENERGY STAR or Better PC	2.3	68.5
RET Occ & Daylight Integral Sensor LED troffer (Base T12)	1.5	53.5

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Table 5-27. Top 20 Measures Contributing to Non-Residential Technical Demand Savings Potential, Virginia*

Measure Name	Technical MW	Measure TRC	Economic MW
ENERGY STAR server	105.8	48.7	105.8
DX Packaged System, EER=13.4, 10 tons	97.3	1.9	96.5
Server Power Management Enabling	88.5	36.3	88.5
Variable Speed Drive Control, 5 HP	63.7	1.1	61.6
LED screw-in replacement (base incandescent/halogen)	59.6	9.3	59.6
Variable Speed Drive Control, 40 HP	55.6	5.4	54.7
Duct Testing/Sealing - Chiller	37.1	4.3	25.0
Variable Speed Drive Control, 15 HP	34.0	2.7	31.2
Demand Controlled Ventilation, 5 HP	28.3	0.2	0.0
Demand Controlled Ventilation, 40 HP	28.2	1.5	23.7
Duct Testing/Sealing - DX	27.7	0.7	6.0
Air Handler Optimization, 40 HP	27.1	27.9	26.9
Economizer - DX	25.8	0.3	0.0
Smart Thermostat - DX	23.0	0.2	0.0
ROB 2L4' LED Tube (Base T12)	22.3	8.2	22.3
Electronically Commutated Motors (ECM) on an Air Handler Unit	17.8	7.6	14.9
ENERGY STAR or Better PC	16.3	2.3	12.0
Refrigeration Coil Cleaning, walk-ins	15.9	3.6	15.7
ROB 2L4' LED Tube (Base T8)	15.9	6.1	15.9
PC Network Power Management Enabling	15.7	1.9	12.1
Smart Thermostat (Base Rooftop/packaged heating)	15.6	1.8	9.0

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Table 5-28. Top 20 Measures Contributing to Non-Residential Economic Demand Savings Potential, Virginia*

Measure Name	Measure TRC	Economic MW
ENERGY STAR server	48.7	105.8
DX Packaged System, EER=13.4, 10 tons	1.9	96.5
Server Power Management Enabling	36.3	88.5
Variable Speed Drive Control, 5 HP	1.1	61.6
LED screw-in replacement (base incandescent/halogen)	9.3	59.6
Variable Speed Drive Control, 40 HP	5.4	54.7
Variable Speed Drive Control, 15 HP	2.7	31.2
Air Handler Optimization, 40 HP	27.9	26.9
Duct Testing/Sealing - Chiller	4.3	25.0
Demand Controlled Ventilation, 40 HP	1.5	23.7
ROB 2L4' LED Tube (Base T12)	8.2	22.3
ROB 2L4' LED Tube (Base T8)	6.1	15.9
Refrigeration Coil Cleaning, walk-ins	3.6	15.7
Electronically Commutated Motors (ECM) on an Air Handler Unit	7.6	14.9
High Bay Bi-Level Programmed LED Fixture	7.9	13.6
PC Network Power Management Enabling	1.9	12.1
ENERGY STAR or Better PC	2.3	12.0
Window Film (Standard) - DX	4.5	11.1
Centrifugal Chiller, 0.51 kW/ton, 500 tons	6.5	10.2
New Economizer - Chiller	2.6	9.7

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Table 5-29 through Table 5-32 show the top 20 measures by technical energy potential, economic energy potential, technical demand potential, and economic demand potential, respectively, for Dominion's North Carolina service territory.

Table 5-29. Top 20 Measures Contributing to Non-Residential Technical Energy Savings Potential, North Carolina

Measure Name	Technical GWh	Measure TRC	Economic GWh
Bi-Level LED Outdoor Lighting (Base Outdoor HID)	72.4	2.8	72.4
DX Packaged System, EER=13.4, 10 tons	39.3	1.9	25.2
Variable Speed Drive Control, 5 HP	20.9	1.3	19.4
LED screw-in replacement (base Outdoor Incandescent)	19.3	5.4	19.3
LED screw-in replacement (base incandescent/halogen)	16.3	9.3	16.3
Energy Star server	11.8	25.6	11.8
Variable Speed Drive Control, 15 HP	11.2	1.7	8.5
Refrigeration Coil Cleaning, walk-ins	10.8	3.5	10.7
Variable Speed Drive Control, 40 HP	10.4	2.2	8.9
Server Power Management Enabling	10.2	13.9	10.2
High Bay Bi-Level Programmed LED Fixture	9.2	7.7	9.2
ROB 2L4' LED Tube (Base T12)	9.0	7.9	9.0
Smart Thermostat - DX	8.3	0.2	0.0
Refrigeration Coil Cleaning, residential-type refrigerator	7.6	0.7	0.0
High Efficiency Rooftop Heat Pump, heating	7.4	0.7	2.1
Smart Thermostat (Base Rooftop/packaged heating)	7.2	1.1	0.8
Duct Testing/Sealing - DX	7.0	0.5	0.7
Electronically Commutated Motors (ECM) on an Air Handler Unit	5.8	5.0	4.7
Cool Roof - DX	5.7	0.4	1.0
ROB 2L4' LED Tube (Base T8)	5.6	5.2	5.6
Demand Controlled Ventilation, 5 HP	5.6	0.2	0.0

Table 5-30. Top 20 Measures Contributing to Non-Residential Economic Energy Savings Potential, North Carolina

Measure Name	Measure TRC	Economic GWh
Bi-Level LED Outdoor Lighting (Base Outdoor HID)	2.8	72.4
DX Packaged System, EER=13.4, 10 tons	1.9	25.2
Variable Speed Drive Control, 5 HP	1.3	19.4
LED screw-in replacement (base Outdoor Incandescent)	5.4	19.3
LED screw-in replacement (base incandescent/halogen)	9.3	16.3
Energy Star server	25.6	11.8
Refrigeration Coil Cleaning, walk-ins	3.5	10.7
Server Power Management Enabling	13.9	10.2
High Bay Bi-Level Programmed LED Fixture	7.7	9.2
ROB 2L4' LED Tube (Base T12)	7.9	9.0
Variable Speed Drive Control, 40 HP	2.2	8.9
Variable Speed Drive Control, 15 HP	1.7	8.5
ROB 2L4' LED Tube (Base T8)	5.2	5.6
Electronically Commutated Motors (ECM) on an Air Handler Unit	5.0	4.7
RET Occ & Daylight Integral Sensor LED troffer (Base T12)	1.4	3.9
Electronically commutated evaporator fan motor, walk-ins	13.7	3.2
High-efficiency fan motors, walk-ins	9.1	3.0
Freezer-Cooler Replacement Gaskets, walk-ins	7.7	2.9
PC Network Power Management Enabling	1.5	2.8
RET Occ & Daylight Integral Sensor LED troffer (Base T8)	1.1	2.5

Table 5-31. Top 20 Measures Contributing to Non-Residential Technical Demand Savings Potential, North Carolina

Measure Name	Technical MW	Measure TRC	Economic MW
DX Packaged System, EER=13.4, 10 tons	4.2	1.9	2.8
LED screw-in replacement (base incandescent/halogen)	3.2	9.3	3.2
Variable Speed Drive Control, 5 HP	2.6	1.3	2.4
Energy Star server	2.3	25.6	2.3
ROB 2L4' LED Tube (Base T12)	1.7	7.9	1.7
Server Power Management Enabling	1.5	13.9	1.5
Variable Speed Drive Control, 15 HP	1.5	1.7	0.9
Variable Speed Drive Control, 40 HP	1.3	2.2	1.2
High Bay Bi-Level Programmed LED Fixture	1.3	7.7	1.3
Refrigeration Coil Cleaning, walk-ins	1.2	3.5	1.2
Demand Controlled Ventilation, 5 HP	1.2	0.2	0.0
ROB 2L4' LED Tube (Base T8)	1.1	5.2	1.1
Duct Testing/Sealing - DX	1.1	0.5	0.0
Refrigeration Coil Cleaning, residential-type refrigerator	0.9	0.7	0.0
Duct Testing/Sealing - Chiller	0.8	0.4	0.0
Energy Star or Better PC	0.8	1.7	0.3
Electronically Commutated Motors (ECM) on an Air Handler Unit	0.8	5.0	0.6
PC Network Power Management Enabling	0.7	1.5	0.4
Smart Thermostat - DX	0.7	0.2	0.0
Cool Roof - DX	0.6	0.4	0.1
High Efficiency Rooftop Heat Pump, heating	0.5	0.7	0.1

Table 5-32. Top 20 Measures Contributing to Non-Residential Economic Demand Savings Potential, North Carolina

Measure Name	Measure TRC	Economic MW
LED screw-in replacement (base incandescent/halogen)	9.3	3.2
DX Packaged System, EER=13.4, 10 tons	1.9	2.8
Variable Speed Drive Control, 5 HP	1.3	2.4
Energy Star server	25.6	2.3
ROB 2L4' LED Tube (Base T12)	7.9	1.7
Server Power Management Enabling	13.9	1.5
High Bay Bi-Level Programmed LED Fixture	7.7	1.3
Refrigeration Coil Cleaning, walk-ins	3.5	1.2
Variable Speed Drive Control, 40 HP	2.2	1.2
ROB 2L4' LED Tube (Base T8)	5.2	1.1
Variable Speed Drive Control, 15 HP	1.7	0.9
Electronically Commutated Motors (ECM) on an Air Handler Unit	5.0	0.6
RET Occ & Daylight Integral Sensor LED troffer (Base T12)	1.4	0.5
PC Network Power Management Enabling	1.5	0.4
Air Handler Optimization, 40 HP	9.8	0.3
High-efficiency fan motors, walk-ins	9.1	0.3
Energy Star or Better PC	1.7	0.3
RET Occ & Daylight Integral Sensor LED troffer (Base T8)	1.1	0.3
LED screw-in replacement (base CFL)	1.1	0.3
LED Exit Sign	2.2	0.3

5.2.10 Trends in Technical and Economic Potential: Cross-Study Comparison

In this section, we compare the results of the current study to the 2017 and 2014 Dominion potential studies. The current study is based on residential and commercial saturation data collected in 2019 and 2020, while the 2017 study used residential saturation data collected in 2016, and the 2017 non-residential analysis and both 2014 analyses used data from 2013 surveys. Dominion's customer base has grown, and the mix of residential and commercial customers has shifted. Its avoided costs have changed, affecting which measures are cost effective under the TRC test. The market penetration of many measures increased. Dramatic changes occurred in the lighting market. In 2014 LEDs were still relatively expensive and not cost effective in many applications, and the lighting standards of the Energy Independence and Security Act (EISA) of 2007 had rolled out between 2012 and 2014. Now LEDs have substantial market penetration for most lamp types and had there not been regulatory intervention with respect to EISA's phase 2 lighting standards, most common screw-based incandescent lamps would have been off the market in 2020.

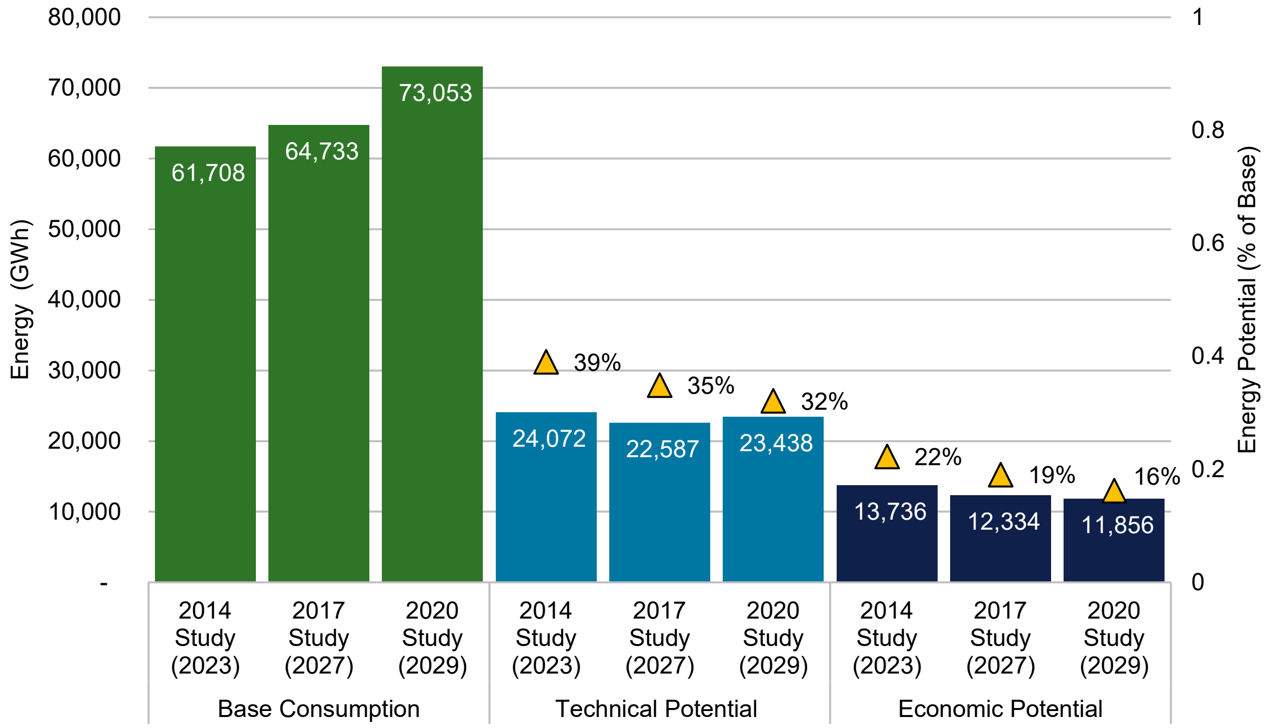
Dominion Energy's system peak has also shifted: Where previous studies assigned all avoided capacity costs to summer peak demand reductions, this study assigned avoided generation capacity costs to summer peak demand reductions, avoided transmission costs to winter peak demand reductions, and split distribution avoided costs evenly across summer and winter. These avoided costs are in line with how Dominion currently incurs costs for these three types of capacity. .

For each of the 10-year potential studies, we used base energy consumption at the end of the forecast period for savings comparisons: 2023 for the 2014 study, and 2027 for the 2017 study (the forecast started in 2018), and 2029 for the current study. We accounted for the accumulated effects of new construction over those 10 years in both potentials and base consumption. The difference in years accounts for a small portion of the change in the study results, as the number of customers, and corresponding base consumption, is expected to grow by 2029. The reader should keep this difference in mind during the discussion below.

Figure 5-28 compares the results of the 2014 and 2017 potential studies to the current study, focusing on Virginia only. All three studies exclude non-jurisdictional, federal, and actual opt-out customers, but the rules regarding opt-out eligibility have changed for the most recent study. In 2014 and 2017, all customers over 1 MW average demand were automatically exempt and customers over 500 kW demand were eligible to opt out. Under the new rules, no customers are automatically exempt, and the threshold for opt-out eligibility has increased to 1 MW. The comparisons below are based on actual opt-outs accepted in 2021, representing 33% of eligible consumption. Base energy consumption, technical potential, and economic potential are all shown (plotted on left axis). The yellow triangles indicate the percent of base energy consumption represented by the potential estimates (plotted on right axis).

Base electricity consumption increased by 5% from the 2014 to the 2017 study, then increased another 15% in the 2020 study. Factors influencing the change include both changes to raw sector consumption, the size of opt-out consumption excluded, and changes to the growth forecast (since base consumption is projected 10 years to the end of the forecast horizon and accounts for growth/decay in the building stock). Energy savings potential as a percent of base consumption, however, has declined across all three studies. We discuss the results in more detail below, explain these decreases.

Figure 5-28. Comparison of Technical and Economic Potential: 2020 Study vs 2017 Study and 2014 Study*



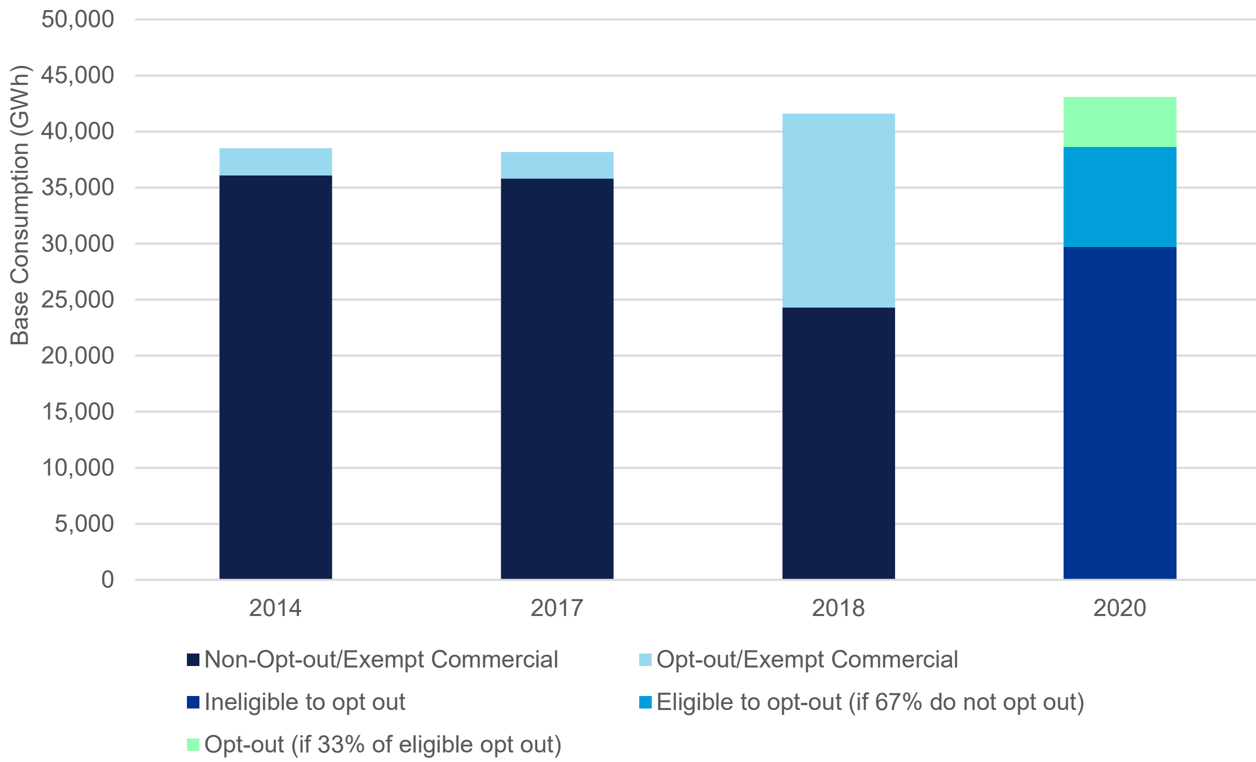
*2014 and 2017 study exclude opt-out customers (actual), non-jurisdictional and federal customers. The 2020 study excludes non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Comparisons of the non-residential sector between 2020 and the earlier studies are confounded by multiple factors.

- **Inclusion of industrial customers.** The 2020 nonresidential base includes both commercial and industrial customer while the 2017 and 2014 studies included only the commercial sector.
- **Opt-out/exempt customers definition.** The legal definition of exempt and opt-out customers has changed multiple times over the past decade. Prior to 2018, customers with demand 10 MW and above were automatically exempt, while customers between 500 kW and 10 MW had the opportunity to opt out. In 2018, the law was changed to eliminate the opt out process and all customers with demand 500 kW or higher became automatically exempt. In 2020, with the passage of the Virginia Clean Economy Act, the law once again changed, stating that all customers over 1 MW have the opportunity to opt out (there is no longer an auto-exempt category).

Figure 5-29 shows the non-residential base consumption used for each of the studies, broken out by opt-out/exempt status.

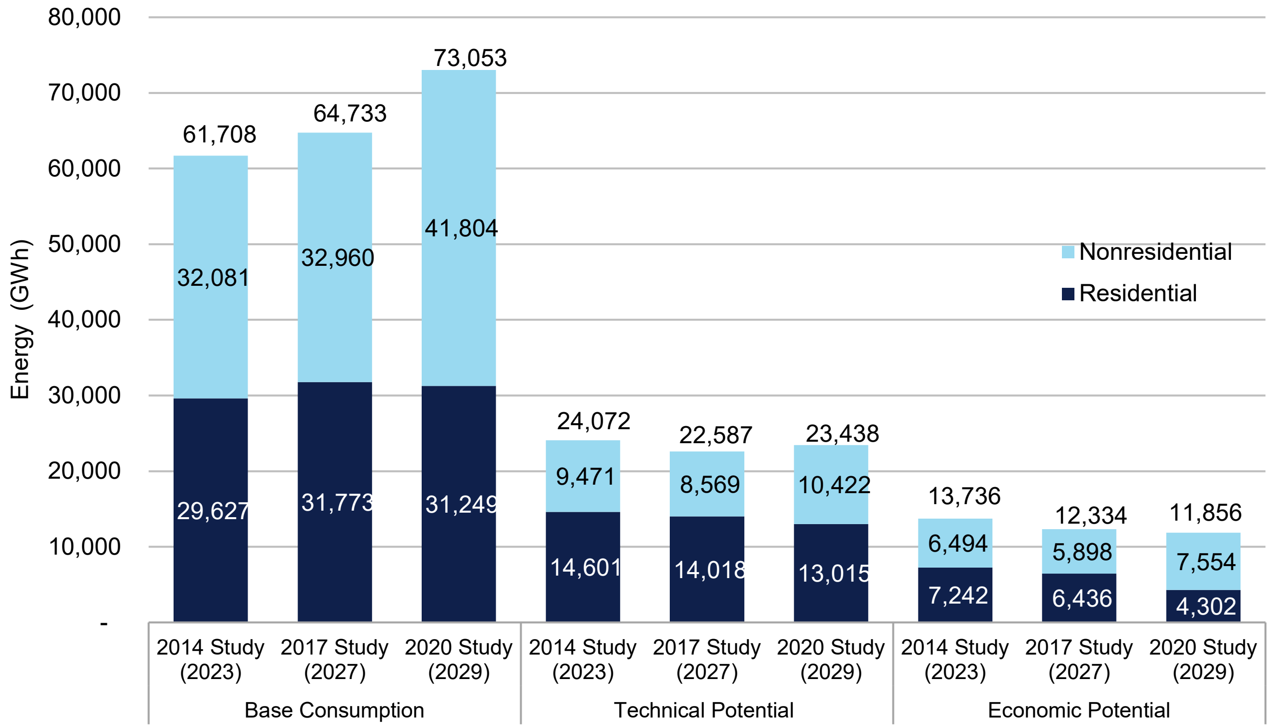
Figure 5-29. Non-residential Base Consumption by Opt-out/Exempt Status and Commercial/Industrial: 2020 Study vs 2017 Study and 2014 Study



*2014 and 2017 study exclude opt-out customers (actual), non-jurisdictional and federal customers. The 2020 study excludes non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-30 shows base consumption and technical and economic potential broken out by sector. Between the 2014 and 2017 studies, commercial technical potential declined 10%, followed by an increase of 22% from the 2017 to the 2020 study. Residential technical potential declined 4% from 2014 to 2017, followed by a decline of 7% between the 2017 and 2020 studies. In the commercial sector, the change in economic potential was similar: a 9% decline from 2014 to 2017 and a 28% increase from 2017 to 2020. In the residential sector, the declines were even steeper for economic than for technical, declining 11% from 2014 to 2017 and by 33% from 2017 to 2020.

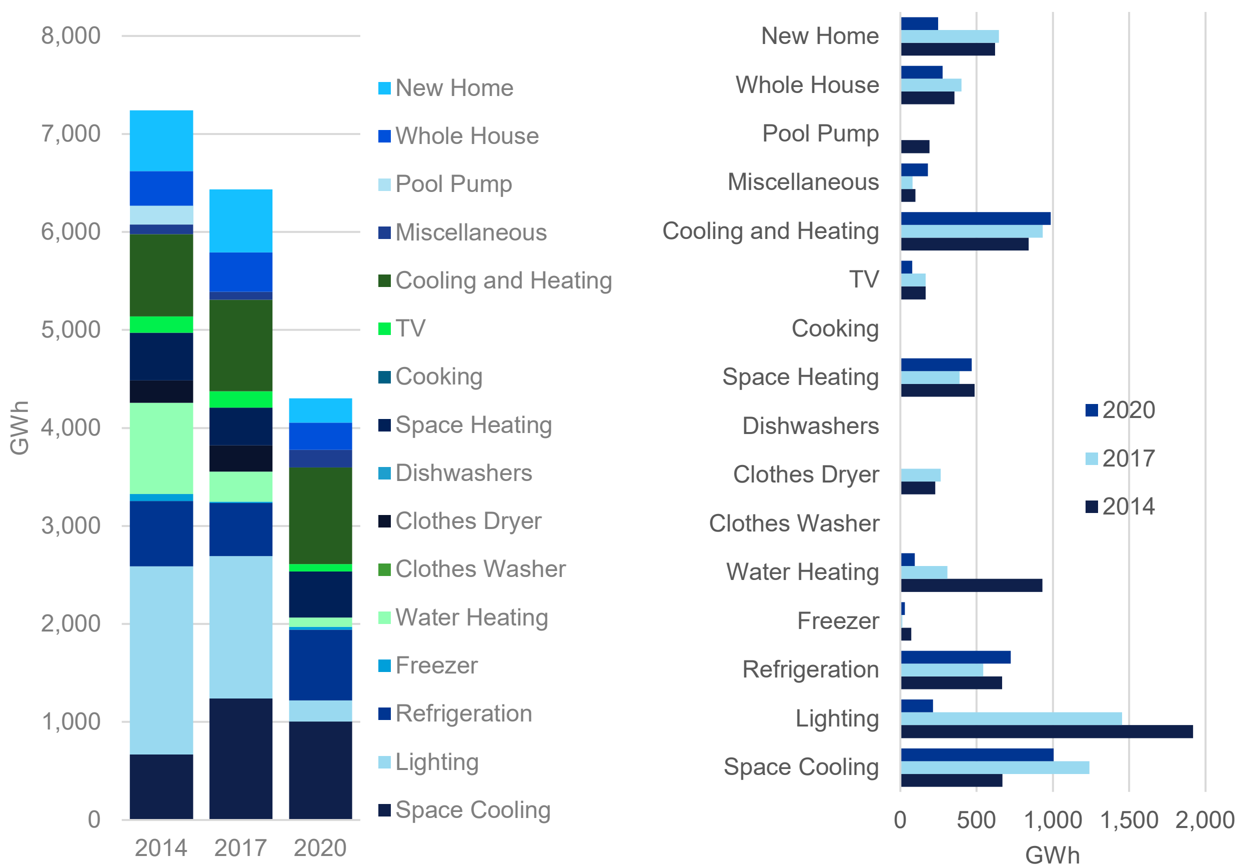
Figure 5-30. Comparison of Technical and Economic Potential by Sector: 2020 Study vs 2017 Study and 2014 Study



*2014 and 2017 study exclude opt-out customers (actual), non-jurisdictional and federal customers. The 2020 study excludes non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-31 shows the breakout of residential economic energy potential by end use across the 2014, 2017, and 2020 studies. Space cooling and lighting make up about 69% of the decline in potential between 2017 and 2020. The cost effectiveness of space cooling measures was adversely affected by when transmission avoided costs shifted from a summer system peak to a winter system peak and distribution avoided costs were balanced across the summer and winter peaks. Since cooling measures save energy predominantly during the summer, this shift reduced their overall capacity avoided cost benefits and their TRC. Lighting potential has been reduced as the lighting market has largely transformed from incandescent lamps being the dominant technology to LEDs being the dominant technology.

Figure 5-31. Comparison of Residential Economic Potential by End Use: 2020 Study vs 2017 Study and 2014 Study



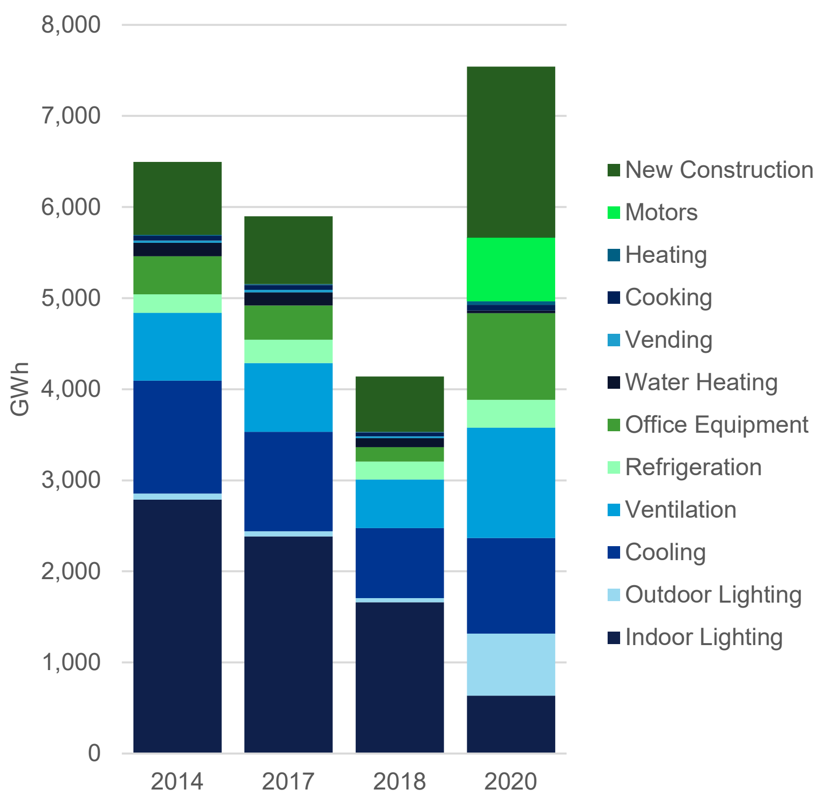
Note: The residential miscellaneous category includes air purifiers and home office equipment, and plug-load controls.

Figure 5-32 and Figure 5-33 show the end-use breakouts for the non-residential sector. There was a potential study update for non-residential in 2018 corresponding with the change in legislation regarding opt-out and exempt customers (eliminating the opt-out provision and making all customers over 500 kW demand exempt).

Indoor lighting and space cooling decreased sharply from the 2017 study to the 2020 study, due, as in the residential sector, to the LED transformation of the lighting market and the shift from a summer peak to a winter peak. An additional factor in the decline in commercial lighting was that the increase in LED lighting has reduced the number of cost-effective applications for lighting controls. Because we use a supply curve approach to model economic potential, we assume that the most cost-effective measure is installed first, followed by the reassessment of subsequent measures' cost-effectiveness. For most base lighting measures, the 2020 study found LED measures to be the most cost-effective. When we subsequently assessed lighting controls based on the presence of the LED, those control measures failed the TRC test. In 2017 and 2018, higher LED costs produced a different ordering, and many control measures passed the TRC test.

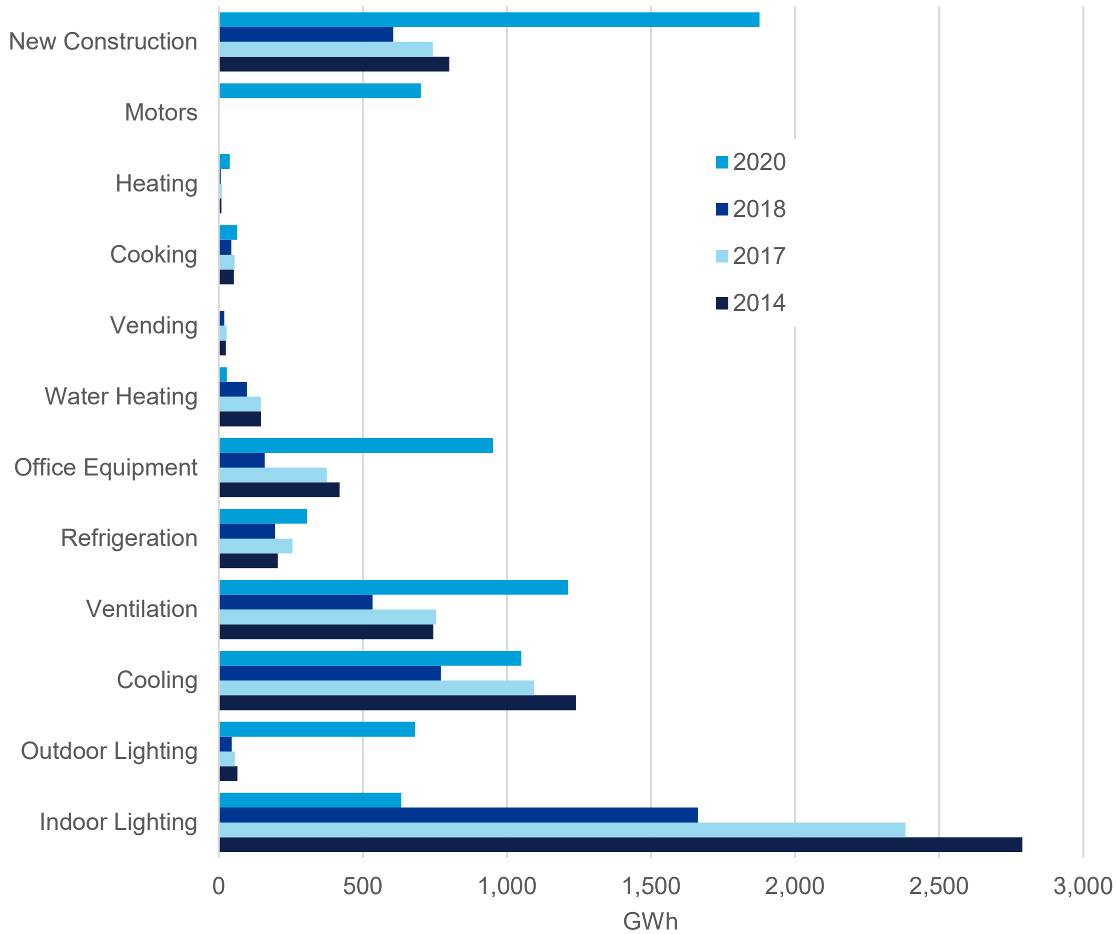
While indoor lighting potential declined, outdoor lighting potential increased dramatically. It benefited from the shift in transmission and distribution (T&D) costs to winter peak, since increased hours of darkness and an evening peak mean that outdoor lighting measures now save peak demand. Outdoor LED lighting measures also lagged indoor LEDs in reaching cost-effectiveness, and some measures tipped into cost-effectiveness between 2017 and 2020. Current LED saturations are lower in outdoor lighting than indoor, so the size of the remaining opportunity is larger. The increase in office equipment potential is due to the addition of ENERGY STAR servers to the model for 2020. New construction increased due to higher construction rates, including an increased rate of code-impacted major retrofits.

Figure 5-32. Non-residential Economic Potential Broken Down by End Use: 2020 Study vs 2017 Study, 2018 Study and 2014 Study



*2014 and 2017 study exclude opt-out customers (actual), non-jurisdictional and federal customers. The 2020 study excludes non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-33. Comparison of Non-residential Economic Potential by End Use: 2020 Study vs 2017 Study, 2018 Study and 2014 Study



*2014 and 2017 study exclude opt-out customers (actual), non-jurisdictional and federal customers. The 2020 study excludes non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

We have cited Dominion's low avoided costs in explaining its low energy-efficiency potential compared to other utilities. Avoided cost trends are also a key factor in explaining the trends in Dominion's potential over time, since lower avoided costs reduce the benefits of energy efficiency and can tip the TRC of some measures from passing to failing. Figure 5-34 and Figure 5-35 show the energy avoided costs used for the 2014, 2017, and 2020 studies for peak time-of-use period and off-peak time-of-use, respectively. Energy avoided costs decreased across the three studies. While the drop from 2014 to 2017 is the most dramatic, especially in later years of the forecast, the changes from 2017 to 2020 is large (20% for on-peak in 2020). Costs shown are in nominal dollars; if the avoided costs used in the 2014 and 2017 study were adjusted for inflation the gaps would be even wider.

Figure 5-34. Energy Avoided Costs, Peak Period: 2020 Study vs 2017 Study and 2014 Study (Nominal $)

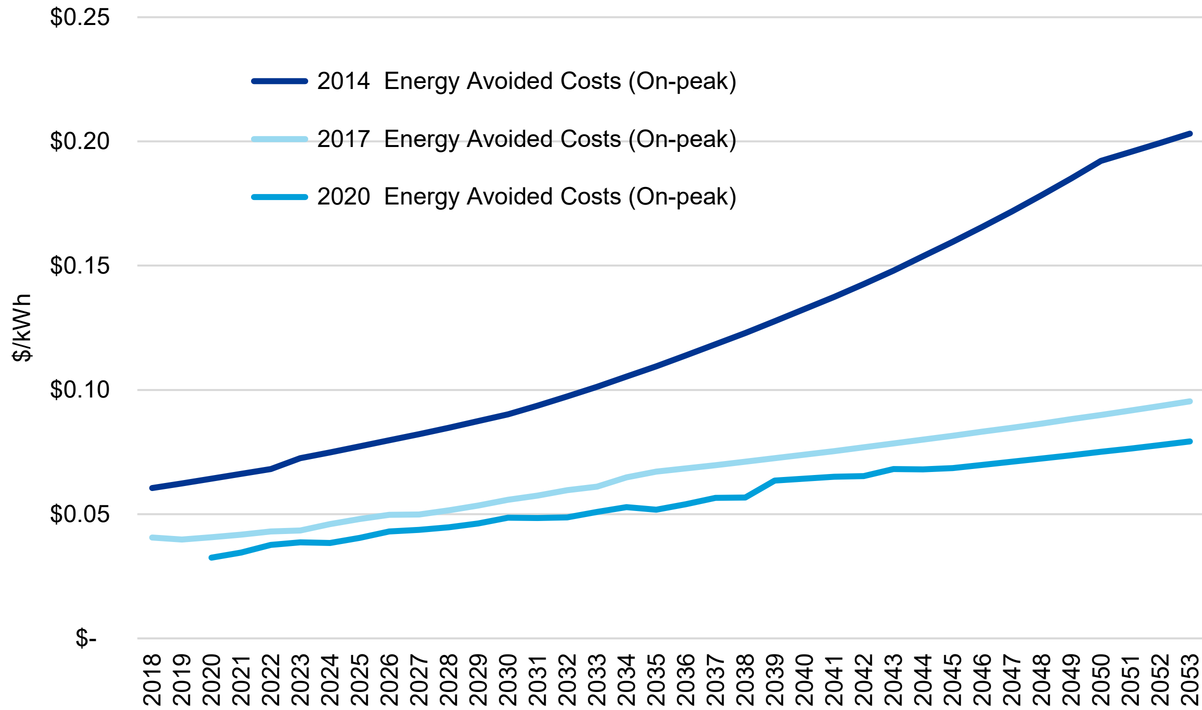


Figure 5-35. Energy Avoided Costs, Off-Peak Period: 2020 Study vs 2017 Study and 2014 Study (Nominal $)

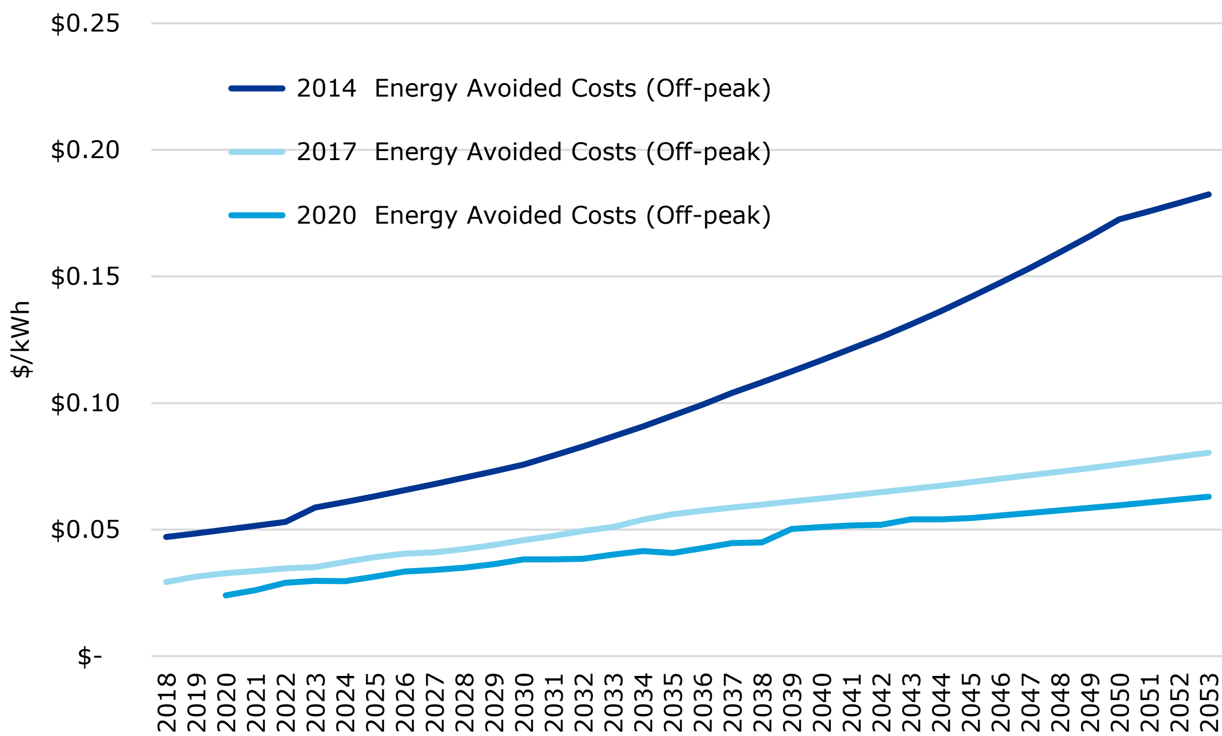


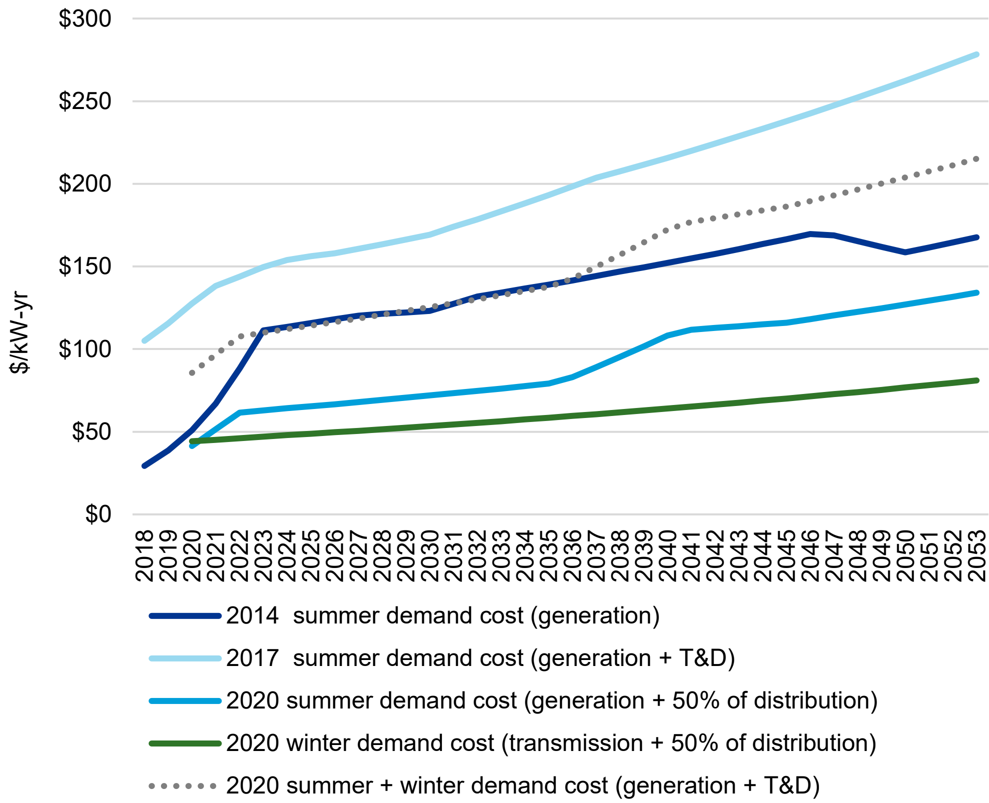
Figure 5-36 shows capacity avoided costs used for the three studies. The picture here is more complicated due to differing treatment of generation capacity avoided costs, transmission capacity avoided costs, and distribution capacity avoided costs. While Dominion continues to pay for generation capacity based on its contributed to summer peak within the Pennsylvania, New Jersey, and Maryland (PJM) Interconnection power pool, it pays PJM for transmission costs based on the PJM Dominion zone peak load, which is forecast to peak in the winter over the time frame of this potential study. Whereas in the two previous studies, all generation capacity and transmission and distribution (T&D) benefits accrued to summer demand reduction, this study assigned generation capacity avoided cost benefits to summer, transmission avoided costs to winter, and split distribution avoided costs evenly across summer and winter.

Comparisons are further complicated by the omission of T&D capacity avoided costs from 2014 study (an omission that was not recognized until we compared the results of the 2017 study to those of the 2014 study for the 2017 report). The increase in capacity avoided costs from 2014 to 2017 reflects the addition of T&D avoided costs in addition to changes in capacity costs of generation. The omission of T&D in 2014, however, makes the 2014 avoided cost directly comparable to the 2020 summer avoided cost, as both reflect only the avoided cost of generation. And that cost had dropped substantially from 2014 to 2020.

To put the 2020 values on the same footing as the 2017 avoided capacity costs (which include both generation capacity and T&D), the chart includes a line adding the 2020 generation capacity costs (summer) and T&D avoided costs (winter). This puts the costs on the same scale for comparison, and again, the 2020 avoided costs are substantially lower than those used in the 2017 study. This comparison is only illustrative, however, since the seasonality of savings will impact the avoided cost savings in aggregate.

But for the 2020 study, the capacity avoided, including T&D capacity costs, is back to the levels used in the 2014 study (even though the 2020 costs include T&D capacity and the 2014 costs do not).

Figure 5-36. Capacity Avoided Costs: 2020 Study vs 2017 Study and 2014 Study (Nominal $)



5.3 Achievable (Program) Potential Results

This section provides a high-level summary of the achievable potential analysis, based on the results of the technical and economic potential analyses. This achievable analysis excludes opt-out and non-jurisdictional customers and uses the current 33% opt-out rate among eligible customers

In contrast to the technical and economic potential estimates that are based on measure-level costs and savings, the achievable analysis bundles measures into defined programs with specified marketing budgets, administrative budgets, and incentive levels. The program budgets are used in the TRC and other cost-effectiveness tests at the program and portfolio level (measure-level TRCs calculated when calculating technical and economic potential excluded program costs). Rates of adoption over time take into account market and other factors that affect the adoption of efficiency measures. As further described in Section 4 and Appendix A of this report, our method of estimating measure adoption takes into account market barriers and program incentives and reflects actual consumer and business implicit discount rates. The discount rate assumptions can be found in Appendix C of the report, while annual budget assumptions can be found in Appendix I of the report.

In this analysis, achievable potential refers to the amount of savings that would occur in response to one or more specific program interventions. Gross or total market savings shown in this section includes net savings and savings attributable to program free-riders – those customers who would have installed the measure in the absence of the program. Net or program savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.

The achievable analysis began by calibrating model parameters based on current program budgets and savings.[20] This process anchors the model's parameters that represent customers' receptiveness to programs and response to specific incentives to concrete program data, and provides a solid foundation for projection changes to measure adoption in response to program changes. The model parameters adjusted in this process represent such things as the cost to reach a customer through program marketing, what the maximum annual uptake is for each measure, and how accepting or resistant the market is to a particular measure (market barriers). DNV set the input marketing and administrative budgets to match Dominion's current programs, then calibrated these model parameters until the energy savings and incentive expenditures output by the model also aligned with current programs. The resulting calibrations closely represent recent Dominion's program experience.

After the calibration was complete, all cost-effective measures from the technical and economic analysis were added to the model, using existing measures as a guideline for setting measure-specific parameters for the new measures. Administrative and marketing budgets were increased to account for the additional measures.

Because achievable potential depends on the type and degree of intervention applied, we developed potential estimates under alternative funding scenarios: Base, 50% incentives and 75% incentives.[21] We estimated program energy and peak demand savings under each scenario for the 2020-2029 period.

- Base (calibration scenario): Assumes that programs follow the current planned trajectory of budgets and incentives, including the rollout of DSM VIII program, with budgets increasing with inflation.
- 50% incentives: Assumes customer incentives are set at 50% of incremental costs.
- 75% incentives: Assumes customer incentives are offered at 75% of incremental costs

Table 5-33 shows the results of the achievable analysis as compared to base consumption, technical potential, and economic potential, for Dominion's Virginia and North Carolina service territories combined.[22]

As a percentage of base consumption, the Dominion results are lower than results seen in other jurisdictions, largely due to Dominion's low avoided costs and rates. Low avoided costs result in fewer measures passing the cost effectiveness screening, while low rates reduce the customer's benefits from adopting a measure, resulting in lower measure penetrations.

Table 5-33. Ten-Year Cumulative Potential – GWh, Virginia* and North Carolina Combined

Sector	2029 Base Energy Consumption (GWH)	Ten Year Cumulative Potential - GWh				
		Technical Potential	Economic Potential	Base (Program)	50% Achievable (Program)	75% Achievable (Program)
Residential	33,001	13,707	4,515	1,367	1,616	2,341
Savings % of Base	N/A	42%	14%	4.1%	4.9%	7.1%
Non-residential, non-opt-out	44,893	11,175	8,141	514	989	1,285
Savings % of Base	N/A	25%	18%	1.1%	2.2%	2.9%
Total	77,894	24,882	12,656	1,881	2,605	3,626
Savings % of Base	N/A	32%	16%	2.4%	3.3%	4.7%

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

20 The calibration stage only includes measures that can be mapped to Dominion programs. All cost-effective measures are included in the funding scenario analyses.

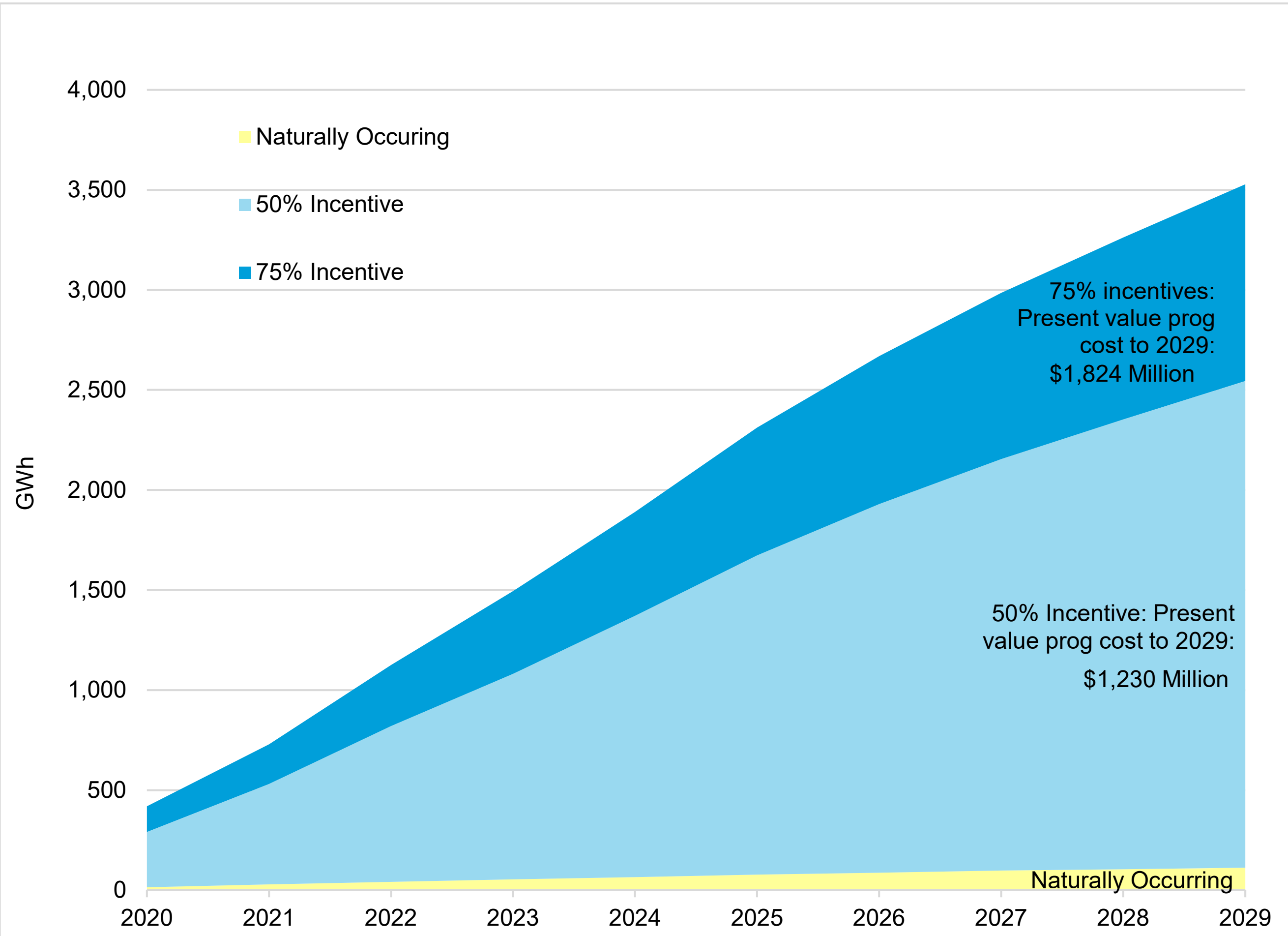
21 These scenarios reflect the percentage of incremental measure cost that is assumed to be paid in customer incentives.

22 Base consumption and all potentials exclude opt-out and exempt customers within Dominion's applicable service territory. While technical and economic potentials include savings for non-jurisdictional customers, they were excluded from achievable potential.

5.3.1 Achievable (Program) Potential – Overall Results

Figure 5-37 shows our estimates of achievable potential savings over time for Virginia. As shown in this figure, by 2029 cumulative net[23] energy savings are projected to be between 2,433 GWh under the 50% scenario and 3,417 GWh under the 75% incentive scenario. In each scenario, savings increase over time. The figure includes the cumulative program cost over the 10-year forecast (the sum of inflation-adjusted costs over 10 years, including marketing, administrative, and incentive costs) associated with each scenario.

Figure 5-37. Achievable Electric Energy Savings: All Evaluated Sectors, Virginia*

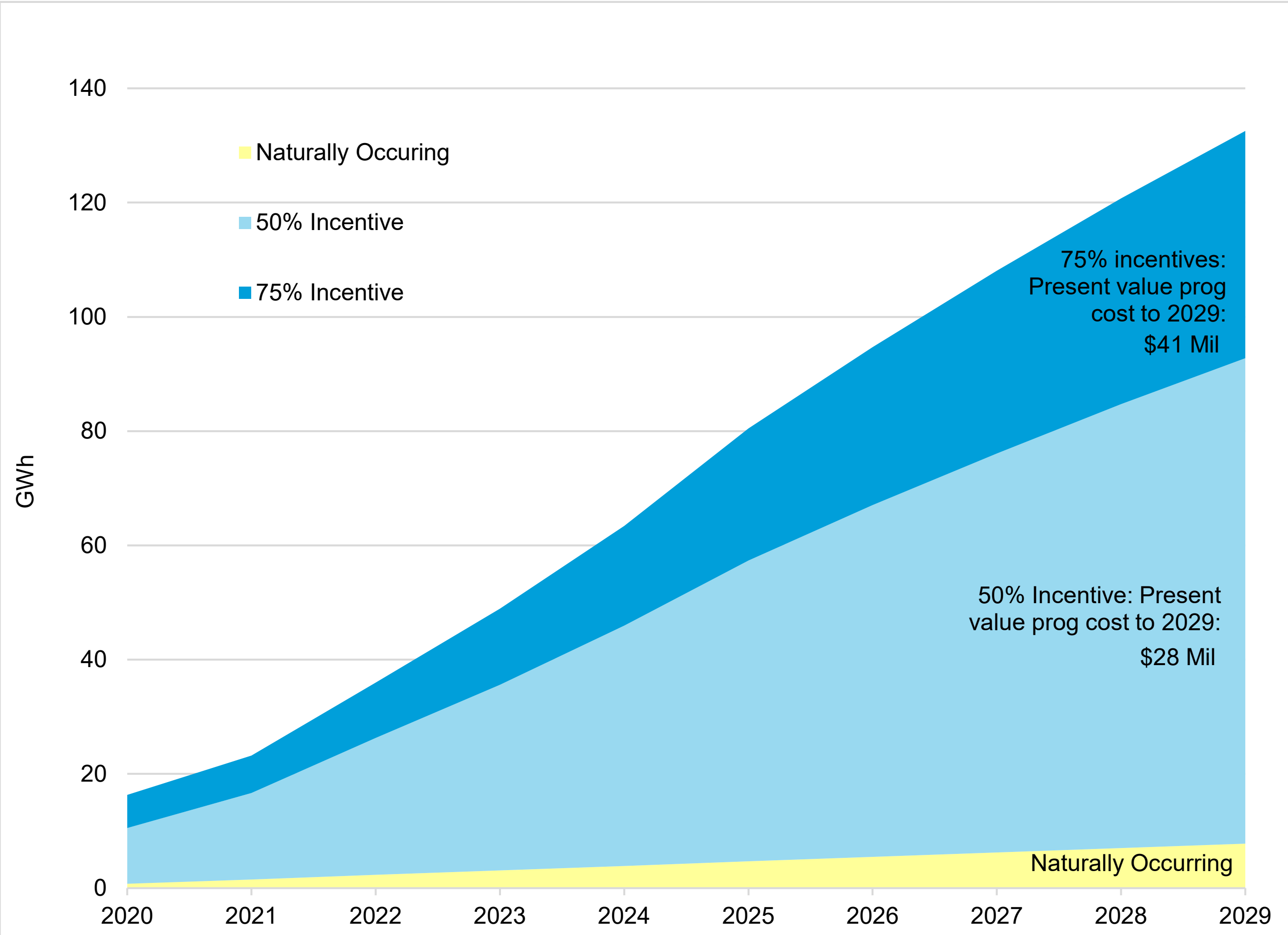


*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-38 shows the analogous chart for North Carolina. As shown, cumulative net energy savings are projected to reach 85 GWh under the 50% scenario (93 GWh gross savings), up to 125 GWh under the 75% scenario (133 GWh gross savings).

[23] Throughout this section, *net* refers to savings beyond those estimated to be naturally occurring; that is, from customer adoptions that would occur in the absence of any programs or standards.

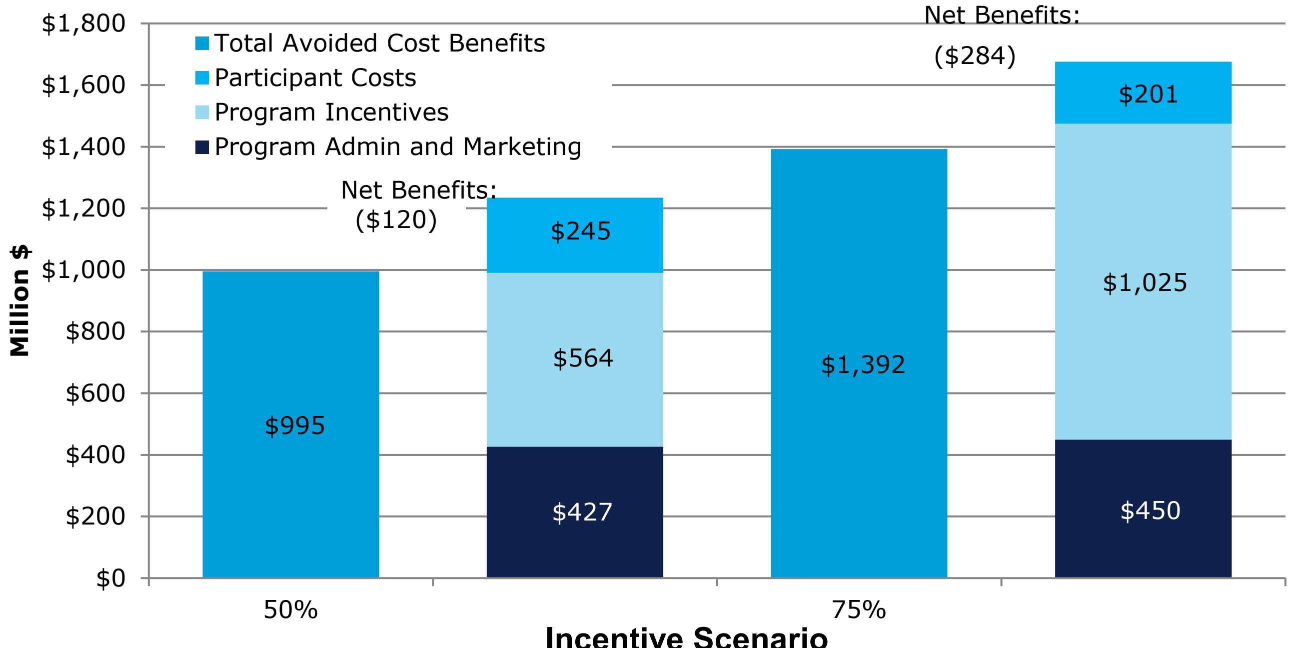
Figure 5-38. Achievable Electric Energy Savings: All Evaluated Sectors, North Carolina



As incentive levels increase between program scenarios, the costs to administer and market the program also increase from additional programmatic activity. Increased incentives also affect participant costs as the incremental cost participants must pay per measure has decreased as a result of the higher incentives. It is also important to note that although the level of naturally occurring savings does not change between scenarios, program free riders receive the same incentives payments as program participants.

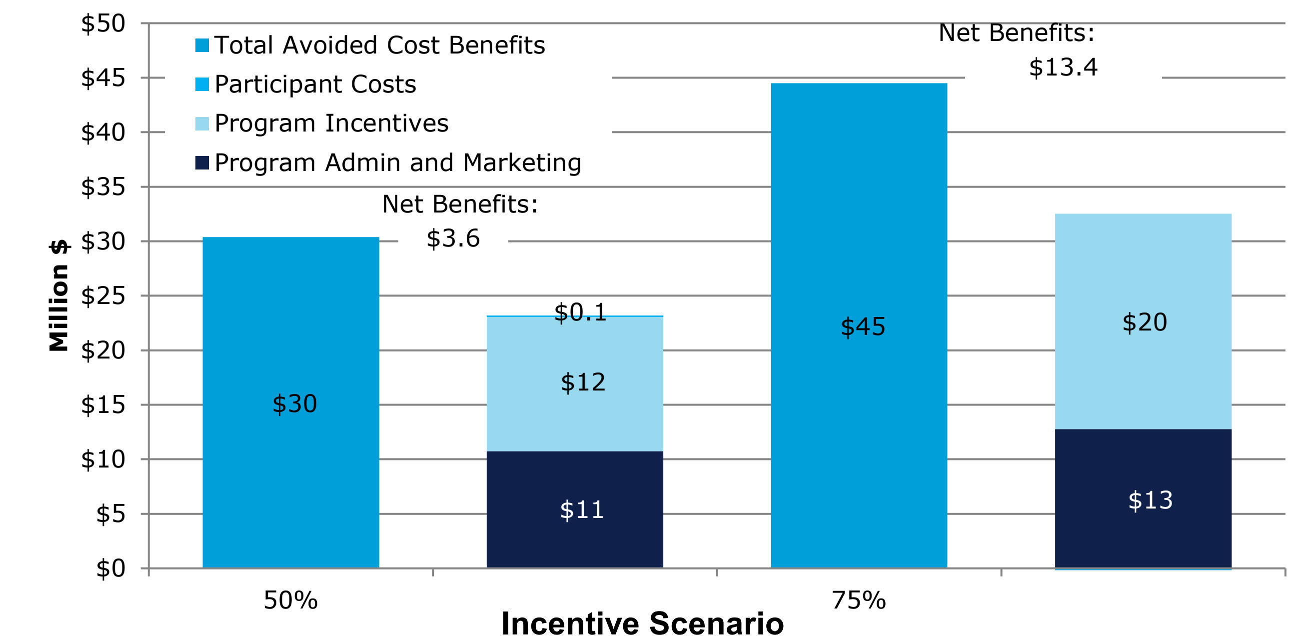
Figure 5-39 depicts the estimated costs and benefits under each funding scenario from 2020 to 2029 for Virginia, while Figure 5-40 depicts the analogous values for North Carolina. In Virginia, total costs (incentives, administrative and marketing costs, and net participant costs) exceed the net avoided cost benefits for both program scenarios. In the 50% scenario costs exceed benefits by $120 million and the gap grows to $284 million in the 75% incentive scenario. In North Carolina, net benefits are $3.6 million in the 50% scenario and $13.4 million in the 75% scenario. We discuss the reasons for the Virginia programs lack of cost effectiveness later in this section.

Figure 5-39. Benefits and Costs of Energy Efficiency Savings—Virginia,* 2020-2029† (Million $)



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.
†PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%

Figure 5-40. Benefits and Costs of Energy Efficiency Savings—North Carolina, 2020-2029* (Million $)



*PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%

Additional key results of the efficiency scenario forecasts from 2020 to 2029 are summarized in Table 5-34, for Virginia, and in Table 5-35 for North Carolina.

Table 5-34. Summary of Achievable Potential Results—Virginia,* 2020-2029†

Result - Programs	Program Scenario:	
	50 percent Incentives	75 percent Incentives
Total Market Energy Savings - GWh (year 10 annual)	3,068	4,052
Total Market Peak Demand Savings - MW (year 10 annual)	292	367
Program Energy Savings - GWh (year 10 annual)	2,433	3,417
Program Peak Demand Savings - MW (year 10 annual)	192	268
Program Costs - Real, $ Million		
Administration (10-year total)	$338	$388
Marketing (10-year total)	$194	$169
Incentives (10-year total)	$698	$1,268
Total Program Costs (10-year total)	$1,230	$1,824
Present Value Avoided Costs (PV 10-year cost)	$995	$1,392
Present Value Annual Program Costs (Adm/Mkt) (PV 10-year cost)	$427	$450
Present Value Net Measure Costs (PV 10-year cost)	$808	$1,226
Net Benefits (Present Value 10-year cost)	($240)	($284)
TRC Ratio	0.81	0.83

*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.
†PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%

Table 5-35. Summary of Achievable Potential Results—North Carolina, 2020-2029*

Result - Programs	Program Scenario:	
	50 percent Incentives	75 percent Incentives
Total Market Energy Savings - GWh (year 10 annual)	143	182
Total Market Peak Demand Savings - MW (year 10 annual)	13	17
Program Energy Savings - GWh (year 10 annual)	85	125
Program Peak Demand Savings - MW (year 10 annual)	6	11
Program Costs - Real, $ Million		
Administration (10-year total)	$9	$10
Marketing (10-year total)	$4	$5
Incentives (10-year total)	$15	$25
Total Program Costs (10-year total)	$28	$41
Present Value Avoided Costs (PV 10-year cost)	$30	$45
Present Value Annual Program Costs (Adm/Mkt) (PV 10-year cost)	$11	$13
Present Value Net Measure Costs (PV 10-year cost)	$12	$18
Net Benefits (Present Value 10-year cost)	$7	$13
TRC Ratio	1.31	1.43

* PV (present value) of benefits and costs is calculated over the measure life for 2020-2029 program years, customer discount rate = 7.83%, utility discount rate = 6.83%, inflation rate = 1.93%; GWh and MW savings are cumulative through 2029.

The threshold for cost-effectiveness is a TRC of one, meaning that the avoided cost benefits and participant benefits exceed the measure and program costs. Measures are included in the achievable analysis based on measure economics alone, without the added hurdle of program marketing and administrative costs. With the addition of those costs, North Carolina's modelled portfolio is cost effective in both scenarios, with TRCs ranging from 1.31 to 1.43. Virginia's modelled portfolio falls significantly below the TRC threshold when all costs are included in the analysis.

The Dominion zone within PJM is now winter peaking, but Dominion Energy has historically had a summer peak, and continues to pay for generation capacity based on its contribution to PJM's summer peak. However, it now pays for transmission based on PJM's Dominion zone winter peak. The avoided costs used in this analysis reflect this split, and put a lower value on summer peak reductions and a greater value on winter peak reductions compared to the two previous DNV potential studies.

To calibrate the model, DNV grouped measures and assigned budgets to match Dominion's current programs—programs that were developed and initiated when facing a summer peak. As a result, DNV included measures in the analysis that are as of 2020 were offered in programs but are not cost effective under the modeled avoided cost structure.

This had little impact on the non-residential analysis, but for residential, it meant that our business-as-usual analysis (in which we modelled continuing current programs) contained a large number of such measures. The net savings from the cost-effective measures were not enough to offset the net costs of these measures, and with the added layer of administrative and marketing expenditures, the portfolio was not cost effective.

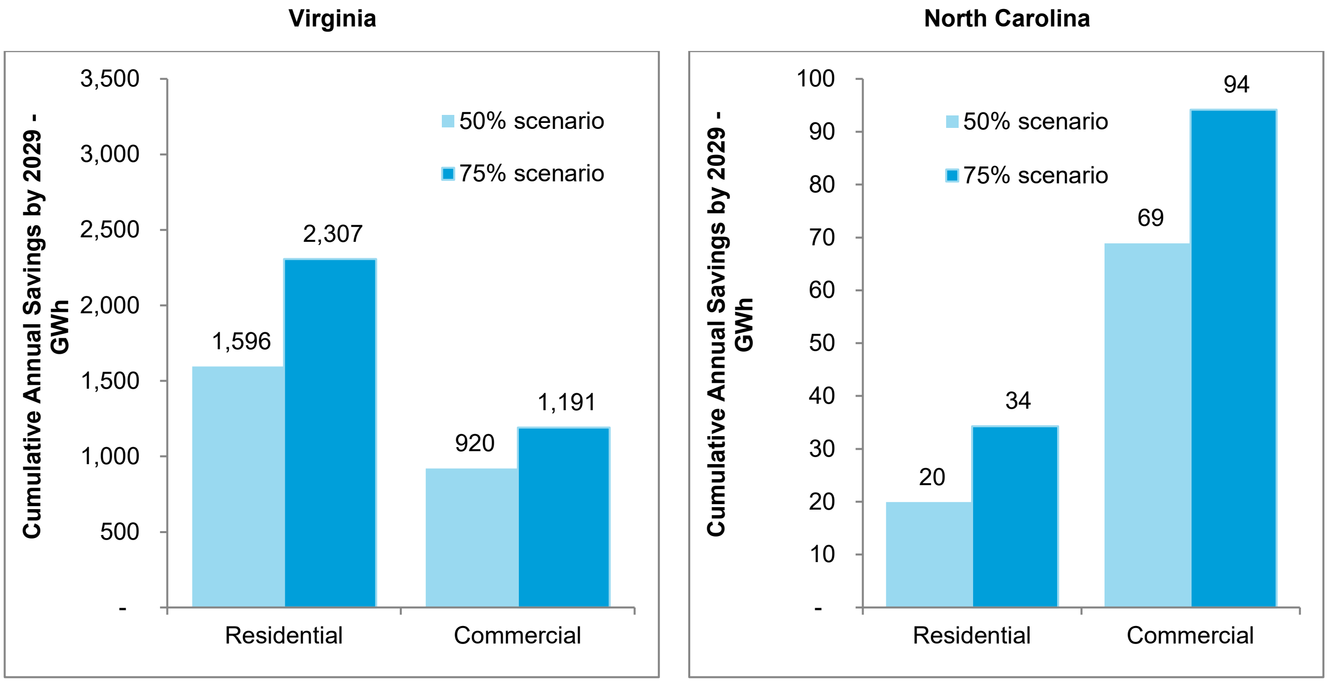
It is also important to understand what the TRCs reported in Table 5-34 and Table 5-35 represent. They are averages over the 10-year forecast. Retrofit programs tend to become less cost effective over time as measures saturate the market, so a program that is cost effective in the early years of the forecast may still have an average 10-year TRC that is below one. In our model, we did not terminate programs or measures as their cost effectiveness dropped but modelled them as running through the full 10-year forecast.

5.3.2 Breakdown of Achievable Potential by Sector

Cumulative net achievable potential estimates by sector for the period of 2020-2029 are presented in Figure 5-41 and Figure 5-42 for Virginia and North Carolina. These figures compare the residential and non-residential sector results for each funding scenario.

Under the program assumptions developed for this study, achievable energy under the 50% and 75% scenarios are highest for the residential sector in Virginia, and for the non-residential sector in North Carolina.[24] Achievable peak demand savings is more balanced across the two sectors in Virginia, but skew toward non-residential for North Carolina.

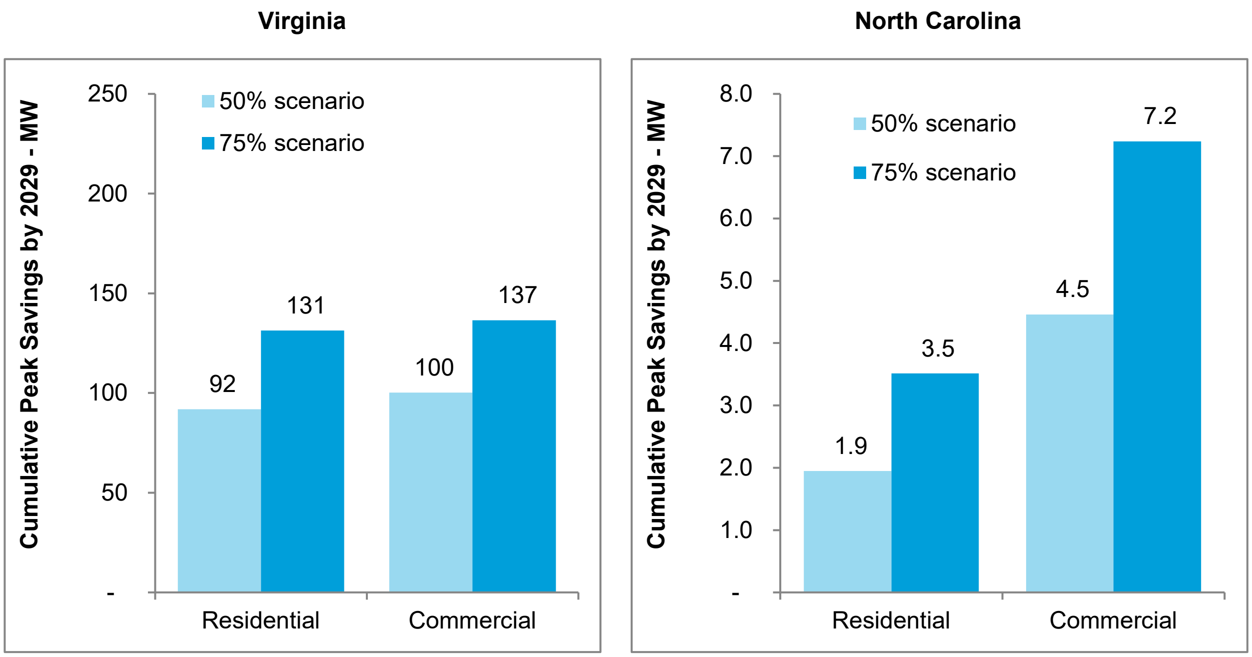
Figure 5-41. 2029 Net Achievable Energy Savings by Sector



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

[24] The estimates of peak demand savings are from the installation of energy efficiency measures and do not include demand savings from demand response technologies such as direct load control or dynamic pricing.

Figure 5-42. 2029 Net Achievable Peak-Demand Savings by Sector



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-43 shows cumulative net achievable program savings for the total residential sector by program scenario, for Virginia. By 2029, net energy savings range from 1,513 GWh under the 50% scenario, to 2,226 GWh under the 75% incentive scenario. In North Carolina (Figure 5-44), net energy savings ranges from 16 GWh under the 50% scenario to 31 GWh under the 75% scenario.

Figure 5-43. 2029 Achievable Energy Savings: Residential Sector, Virginia

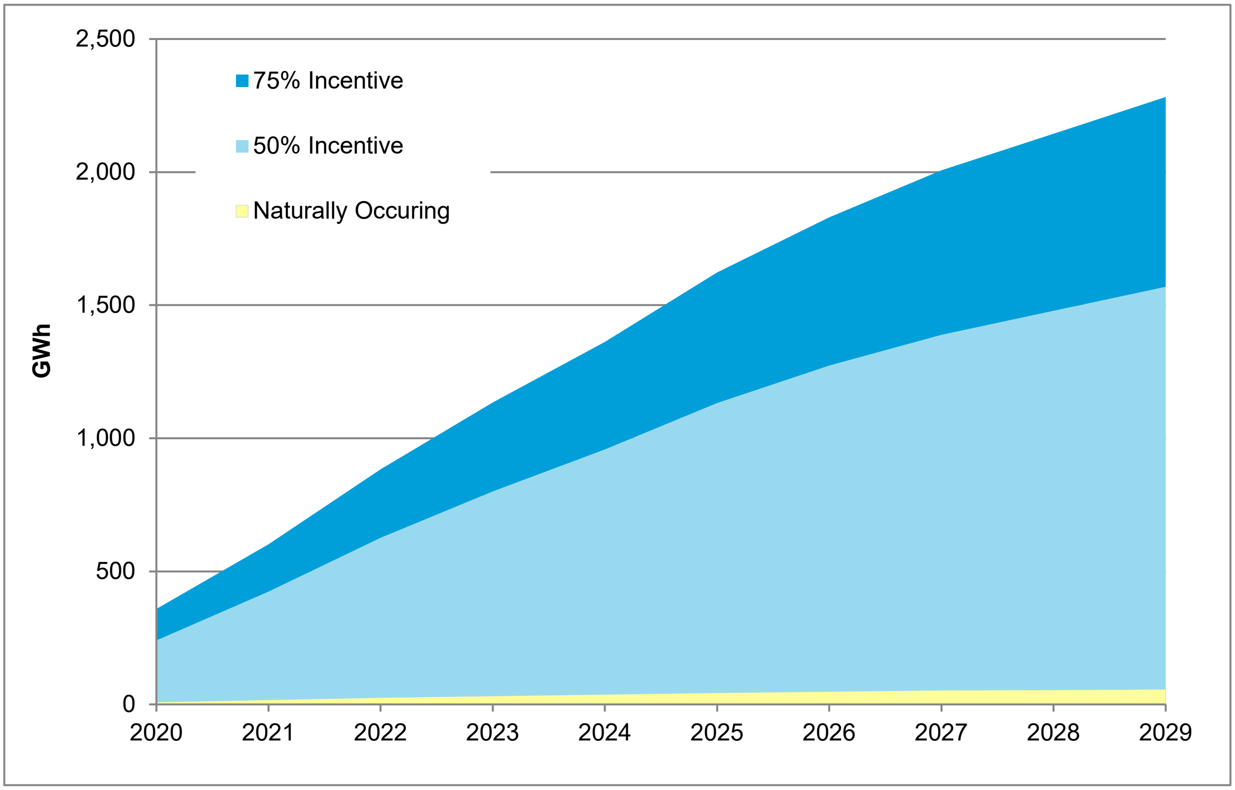


Figure 5-44. 2029 Achievable Energy Savings: Residential Sector, North Carolina

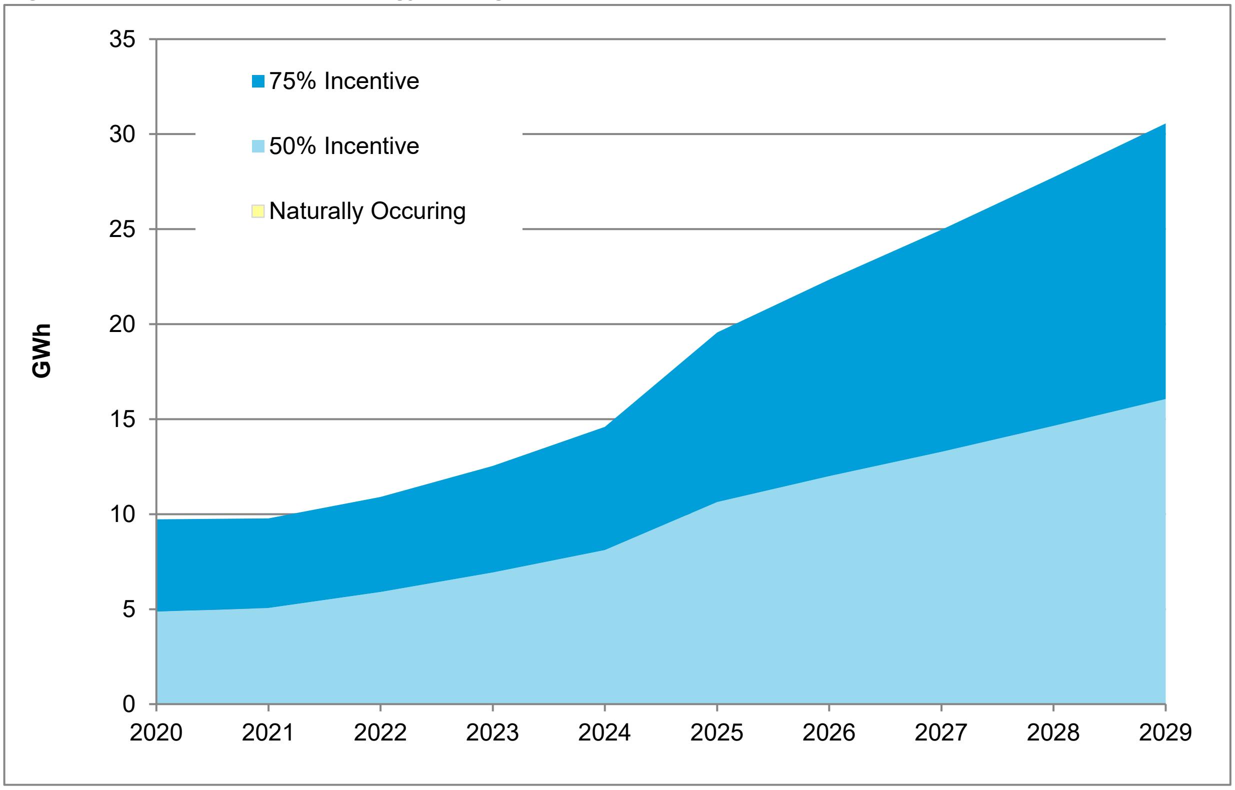
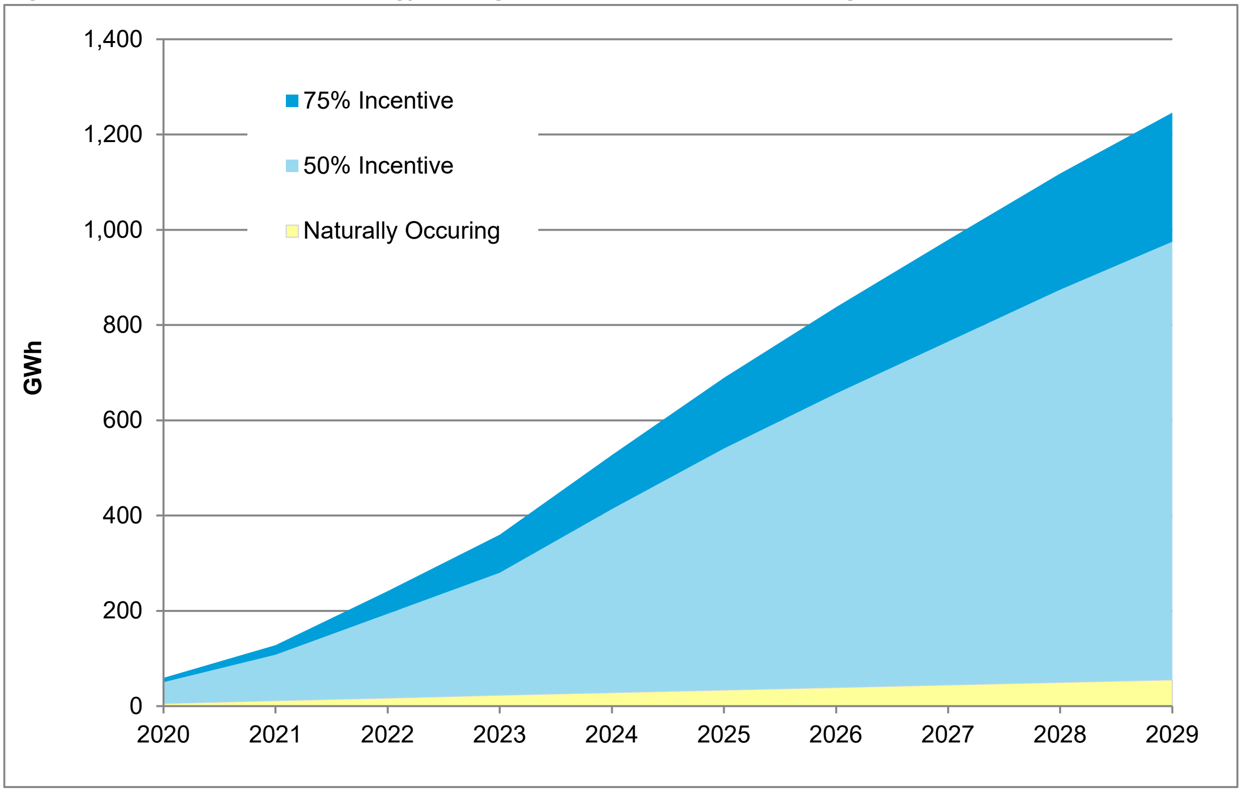


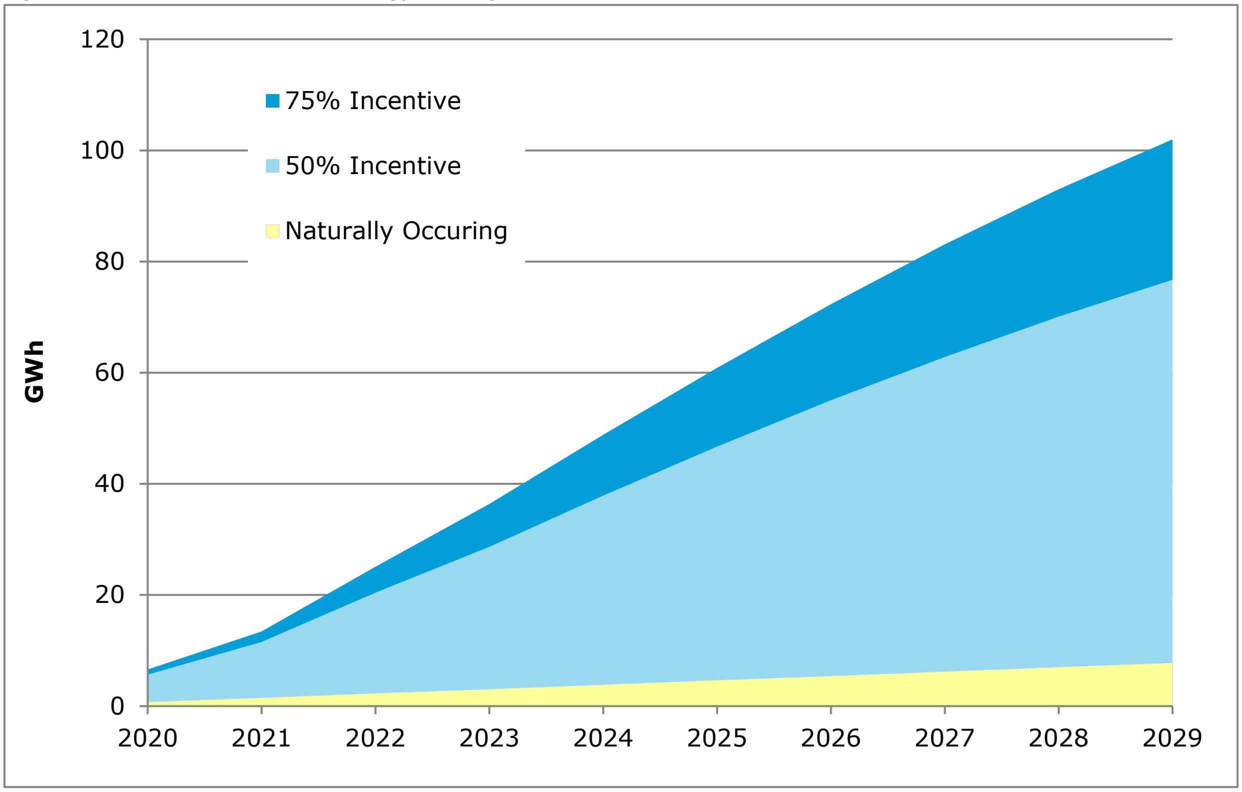
Figure 5-45 shows cumulative net achievable program savings by non-residential program scenario for Virginia. By 2029, net energy savings in Virginia are projected to reach 920 GWh under the 50% scenario, and 1,191 GWh under the 75% incentive scenario. Savings in North Carolina are projected to reach 69 GWh for the 50% scenario and 94 GWh for the 75% scenario, as shown in Figure 5-46.

Figure 5-45. 2029 Achievable Energy Savings: Non-Residential Sector, Virginia



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

Figure 5-46. 2029 Achievable Energy Savings: Non-Residential Sector, North Carolina

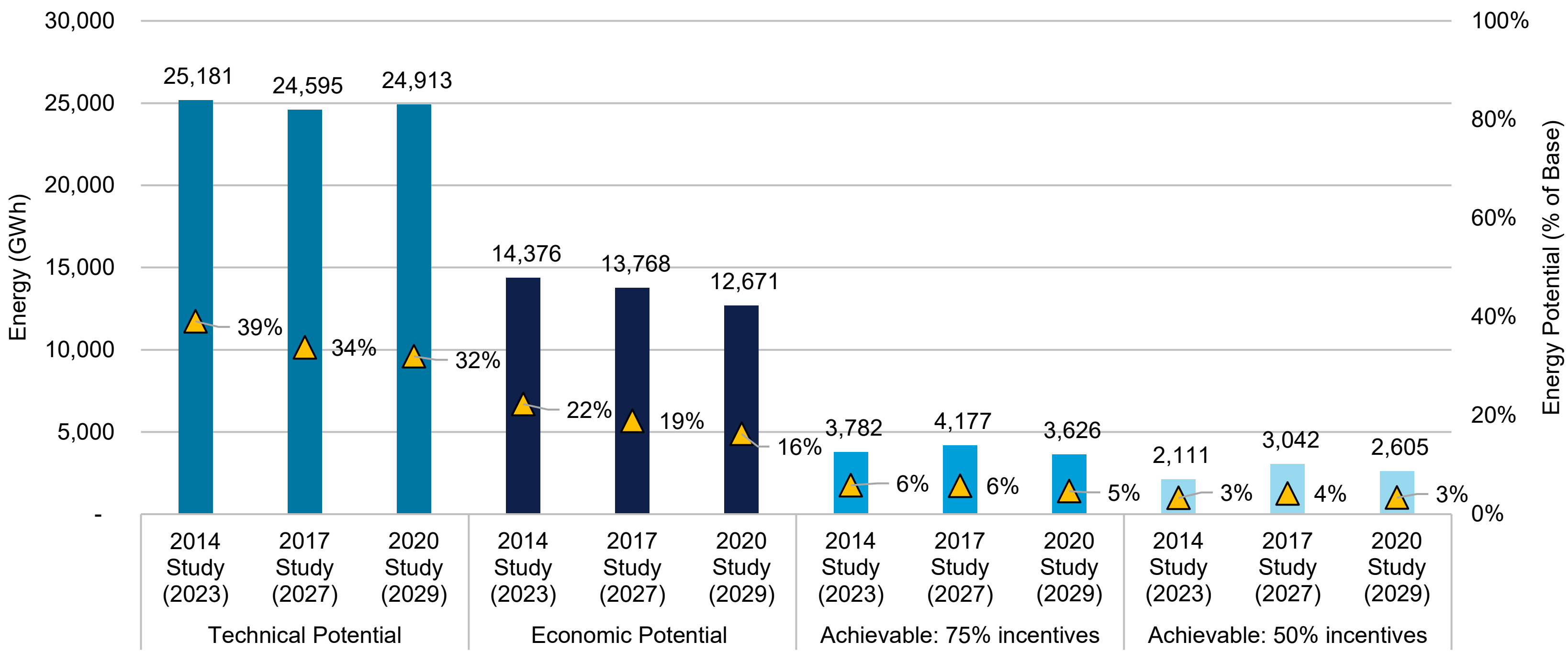


5.3.3 Cross-study Comparison of Achievable Results

In this section, we compare the results of the current study to prior Dominion Potential study results, and other studies completed outside of Dominion by DNV. Figure 5-47 compares the results of the 2014 and 2017 potential studies to the current study, including technical potential, economic potential, and achievable potential for the 75% and 50% scenarios (plotted on left axis). The yellow triangles indicate the percent of base energy consumption represented by the potential estimates (plotted on right axis). Achievable potentials for the two incentive scenarios declined in absolute terms and on a percentage basis from the 2017 study to the 2020 study. For example, achievable potential dropped from 4,177 (5.7%) for the 75% scenario in the 2017 study to 3,626 GWh (4.7%) under the 2020 study. A similar drop was observed for the 50% achievable scenario, from 3,042 GWh (4.2%) in 2017 to 2,605 GWh (3.3%) in 2020.

The discussion in section 5.2.9 explaining the decrease in technical and economic potential applies here as well.

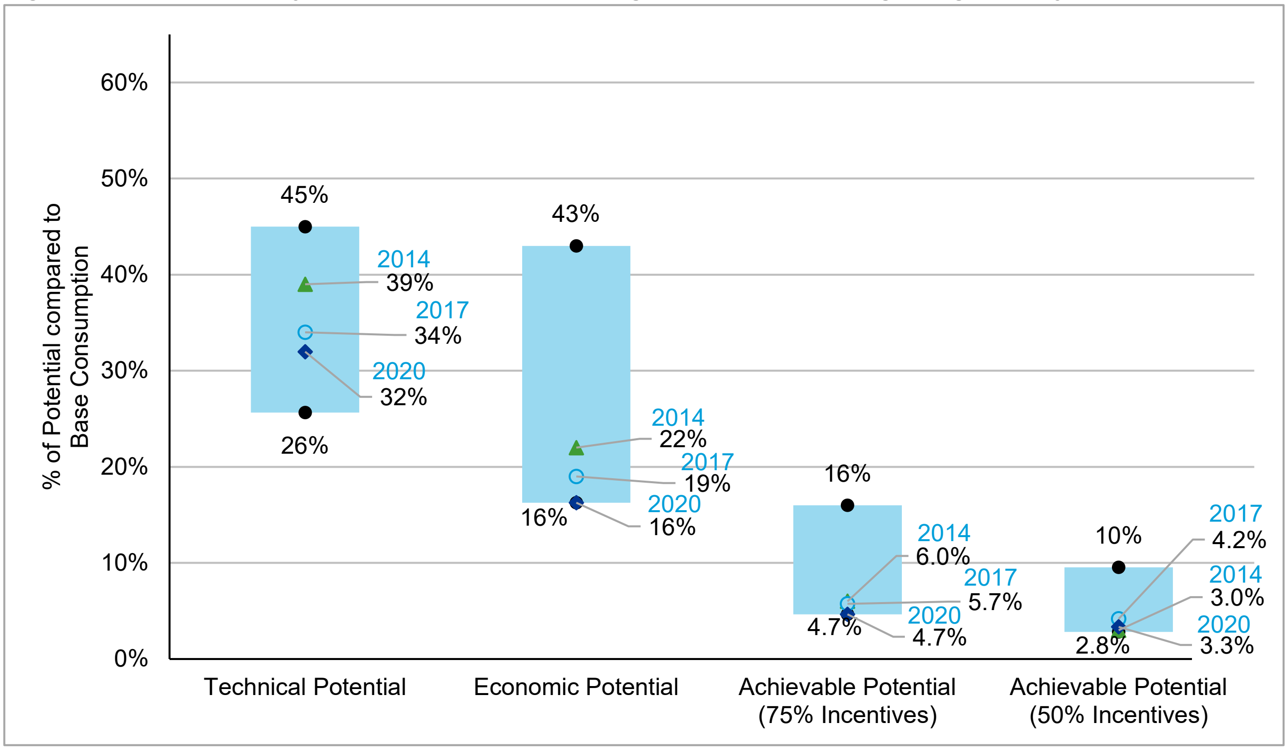
Figure 5-47. Comparison of Technical, Economic, and Achievable Potential: 2020, 2017, and 2014 Studies, Virginia Only



*2014 and 2017 studies exclude non-jurisdictional and actual opt-out/exempt customers. 2020 study excludes non-jurisdictional and 33% of opt-out-eligible customers.

Figure 5-48 compares the results of the Dominion 2014 potential study and the current study to historical ranges of potential savings from other DNV studies. The blue bars indicate the range of potential from other DNV studies for technical, economic, 75% and 50% achievable scenarios. Dominion's technical potential is in the mid-range when compared to other studies. However, the economic and achievable potential is on the lower end of the spectrum, largely due to Dominion's low avoided costs and rates. As discussed above, low avoided costs result in fewer measures passing the cost effectiveness screening, while low rates reduce the customer's benefits from adopting a measure, resulting in lower measure penetrations.

Figure 5-48. Current Study Compared to Historical Ranges of Potential Savings, Virginia Only



*Excludes Virginia non-jurisdictional and federal customers and uses the current 33% opt-out rate among eligible customers.

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