Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

Missed Opportunities for Efficiency in Virginia

Prepared for Consumers Union

Authors:

Elizabeth A. Stanton, PhD

Rachel Wilson

Bryndis Woods

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www.aeclinic.org

Executive Summary

Dominion Energy Virginia (DEV or Dominion) is asking state utility regulators to approve billions of dollars in new spending to increase nuclear and natural gas capacity over the next 10 years in order meet its forecast for future energy demand. These costs would be passed on to consumers in the form of substantially higher utility bills. While Dominion has invested in energy efficiency—a cost-effective method to lower energy demand and reduce customer bills—it has done so at much lower levels than utilities in other states. In a recent study by the American Council for an Energy-Efficient Economy (ACEEE), Virginia ranked twenty-ninth among states for energy efficiency, suggesting substantial room for expanding energy efficiency efforts within the state. Lower demand also reduces the need for new power plants. Because new power plants are expensive and the cost of building them is borne by ratepayers, fewer new power plants means consumers could save even more. This report investigates the impact of various levels of energy efficiency on electric rates and bills of Dominion customers. We find that by investing in energy efficiency, Dominion customers would enjoy lower rates and bills while future energy demand would be met with fewer than half of the new power plants currently proposed by Dominion.

Dominion customer bills would decrease with greater energy efficiency savings, a missed opportunity compared to Dominion's current plans.

As compared to Dominion's planned energy efficiency ("Very Low Efficiency" in Table ES-1 below), more ambitious energy efficiency scenarios ("Low Efficiency" and "Medium Efficiency") reduce the average Dominion residential customer's annual electric bill by $41 to $92 in 2028. When Dominion residential customers' annual energy efficiency savings in 2028 are added together, savings total $102 to $229 million. Cumulatively, from 2018 through 2028, customer bill savings total $800 million to $1.7 billion.

Table ES-1. Average Virginia DEV residential electric bills

	Very Low Efficiency	Low Efficiency	Medium Efficiency
2028 Total Bills for all Residential Customers	$3,987 million	$3,885 million	$3,758 million
2028 Annual Bill for Average Residential Customer	$1,603	$1,562	$1,511

Bill savings from more energy efficiency outweigh the costs associated with them.

Utility costs—like those of building new capacity infrastructure, generation, transmission and distribution, or energy efficiency programs and their administration—are passed on to customers through their electric rates. The cost-benefit balance in the Low and Medium Efficiency scenarios is tipped in favor of increasing energy efficiency primarily through avoided capacity costs, as increasing energy efficiency lowers the need for new capacity additions. When combined with avoided transmission and distribution costs, the bill savings for residential customers outweigh the costs associated with energy efficiency programs.

Fewer power plants would be needed due to lower demand resulting from greater energy efficiency.

We created three energy efficiency scenarios to examine the impact of savings outlined by DEV in their Integrated Resource Plan (IRP), as well as two scenarios that explore energy efficiency levels above and beyond the current trajectory outlined by DEV. As shown below, greater energy efficiency reduces future electricity demand and reduces the need for additional capacity. In the Medium Efficiency scenario, enough energy is saved to eliminate the need for 2.4 GWs of new power plants. While this report assumes that new natural gas plants will serve marginal capacity (based on Dominion's IRP), it should be noted that new nuclear capacity would incur even higher costs.

Table ES-2. Very Low Efficiency, Low Efficiency, and Medium Efficiency scenarios

Scenario	Very Low Efficiency (VLE)	Low Efficiency (LE)	Medium Efficiency (ME)
Customer bills?	Most expensive	Second least expensive	Least expensive
Complies with 7.2 TWh EERS goal in what year?	2022	2020	2020
Complies with Virginia Renewable Portfolio Standard (RPS)?	Yes	Yes	Yes
New 1.0 GW natural gas power plants called for in 2028?	4.0	3.5	1.7

The differences in cost between higher energy efficiency scenarios and business-as-usual represent a missed benefit in terms of annual costs and changes to customer rates. If Dominion stays on its current path based on its IRP, in 2028, its residential customers will pay $102 million more on electricity than they would with Low Efficiency savings and $229 million more than with Medium Efficiency savings. It would benefit ratepayers, therefore, for DEV to increase energy efficiency to greater levels.

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I. Introduction

In 2007, the Virginia legislature passed SB 1416, which set a total state-wide energy efficiency goal 10.7 million megawatt-hours (MWh) annual savings by 2022.[1] SB 1416 noted that "it is in the public interest…to promote cost-effective conservation of energy through fair and effective demand side management, conservation, energy efficiency, and load management programs."[2] SB 1416 directs the State Corporation Commission (SCC) to evaluate whether the 10.7 million MWh goal by 2022 could be met cost-effectively; the Commission confirmed that it could in a 2008 report.[3] In 2015, Virginia Governor Terry McAuliffe accelerated the timeline of achieving the efficiency goal by two years, from 2022 to 2020, and formed an Executive Committee on Energy Efficiency to develop strategies to meet the goal. Together, SB 1416, the SCC report, and the Governor's Executive Committee on Energy Efficiency, form the basis of Virginia's energy efficiency resource standard (EERS)—a non-mandatory regulatory policy.

In April 2017, Virginia's 'Energy Efficiency Roadmap: Policy and Program Recommendations' was released.[4] The roadmap forecasts that Virginia will achieve just 36 percent of its annual 10.7 million MWh energy efficiency goal if actions are limited to projected policies and programs, leaving a statewide efficiency savings deficit of 6.9 million MWh annual savings in 2020. The Roadmap promotes steadily increasing energy savings targets on a long-term basis, beginning in 2018, to achieve wider-reaching energy efficiency programs in the residential and commercial sectors that achieve greater electricity savings.

In this report, the Applied Economics Clinic (AEC) investigates the impact of various levels of energy efficiency savings on electric rates of customers of the Dominion Energy subsidiary, Virginia Electric and Power Company (VEPCO), d/b/a Dominion Energy Virginia (DEV), in its Virginia service territory only (excluding their North Carolina territory, see Figure 1 below for reference). For clarity, we refer to the company as Dominion Energy Virginia (DEV) throughout the report. Virginia sales represented 95 percent of total DEV sales in 2016, with sales to North Carolina making up the remaining 5 percent. In 2016, DEV provided 68 percent of the

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[1] SB 1416 calls for 10 percent cumulative annual efficiency savings (savings including past years and current year measures) relative to 2006 electric sales; Virginia Acts of Assembly, SB 1416, Chapter 933, April 4, 2007, http://leg1.state.va.us/cgi-bin/legp504.exe?071+ful+CHAP0933.

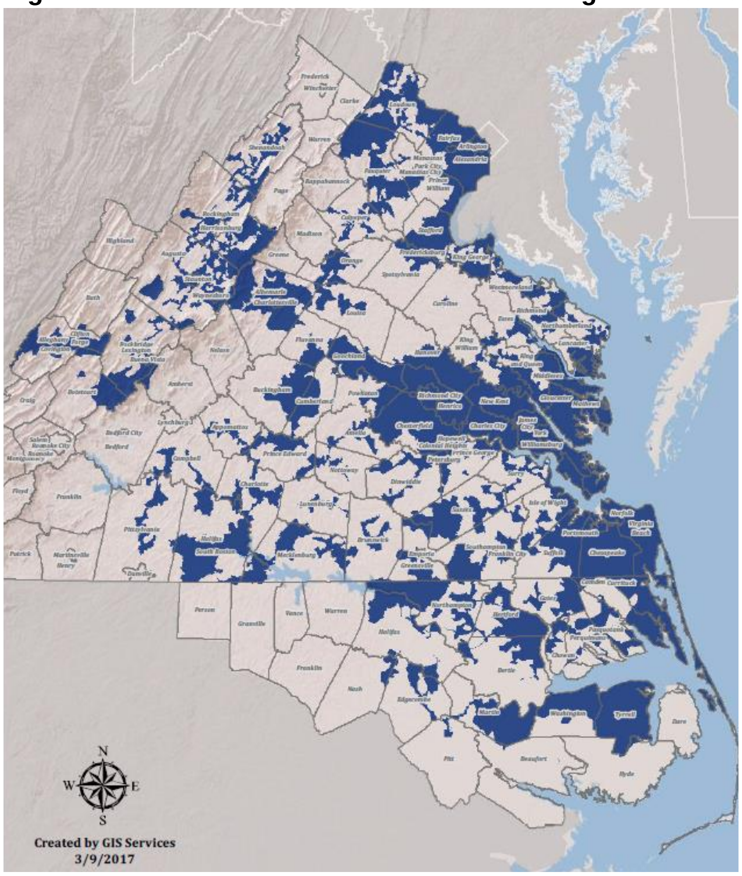
[2] Virginia Acts of Assembly, SB 1416, Chapter 933, April 4, 2007, http://leg1.state.va.us/cgi-bin/legp504.exe?071+ful+CHAP0933.

[3] Commonwealth of Virginia, State Corporation Commission, Report to the Commission on Electric Utility Regulation of the Virginia General Assembly and the Governor of the Commonwealth of Virginia, Case No. PUE-2007-00049, September 1, 2008, https://www.scc.virginia.gov/comm/reports/2008_ceur.pdf.

[4] Governor's Executive Committee, Virginia Energy Efficiency Roadmap: Policy and Program Recommendations, April 6, 2017, https://www.dmme.virginia.gov/de/LinkDocuments/GEC/4%20-%20Virginia%20Energy%20Efficiency%20Roadmap.pdf.

Commonwealth's electric sales across all sectors, and therefore, their share of the state's energy efficiency goal is 7.2 million MWh annual savings.[5]

Figure 1. Dominion electric service area in Virginia and North Carolina (in dark blue)



Source: *Reproduced from Dominion Energy. 2017. https://www.dominionenergy.com/library/domcom/pdfs/virginia-power/service-territory.pdf.*

We examined the impact of energy efficiency savings on customer electric rates under three scenarios:

- **Very Low Efficiency:** The Very Low Efficiency (VLE) scenario uses the planned (approved and proposed) energy efficiency savings presented in DEV's 2017 Integrated Resource Plan (IRP), as well as DEV's own forecast of peak and annual energy, and reaches its share of voluntary policy-prescribed annual efficiency savings, equal to 7.2

[5] Energy Information Administration (EIA) 861 2016.

million MWh, in 2022.[6]

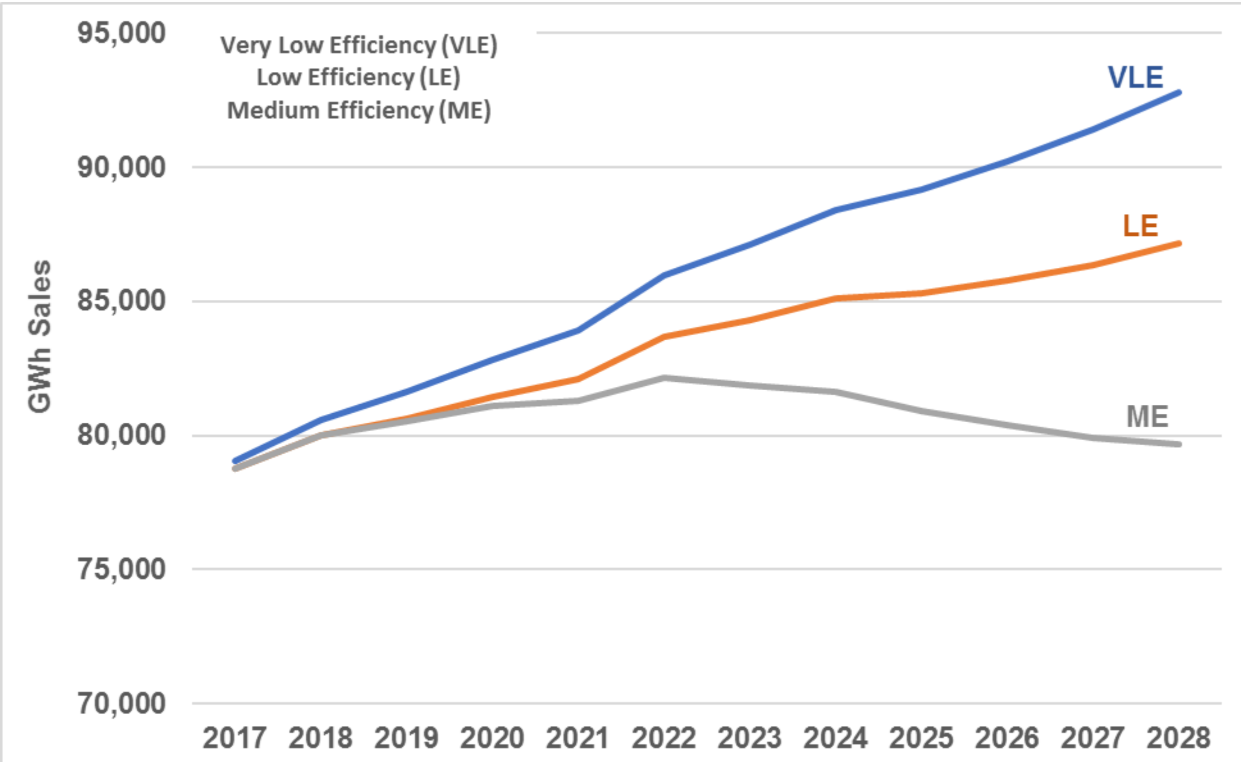
- **Low Efficiency:** The Low Efficiency (LE) scenario increases DEV's efficiency investments to achieve the 7.2 million MWh annual cumulative savings goal by 2020, after which point we assume that annual additions to energy efficiency savings (new measures) remain constant as a share of current year sales throughout the remainder of the period while total annual savings grow.

- **Medium Efficiency:** The Medium Efficiency (ME) scenario ramps up DEV's energy efficiency savings to match the U.S. utilities with the highest savings targets, using Eversource in Massachusetts as an example. We assume that DEV will reach 7.2 million MWh annual cumulative savings by 2020, after which point annual additions to energy efficiency savings (new measures) continue to rise until they reach 3 percent of sales in 2023 and then remain constant while total annual savings grow (see Figure 2 below for DEV's total sales in each of the three scenarios).

Baseline energy sales for all three scenarios come from the forecast in Dominion's 2017 IRP. Dominion's actual sales have not met DEV's projections in historical years, indicating overestimation in IRP forecasts.[7] Correcting for this overestimation in sales would lead to additional consumer savings through the avoidance of new generating capacity to meet forecasted demand (Figure 2).

[6] 7.2 million MWh savings equals 10 percent total annual efficiency savings relative to DEV 2006 sales. (10.7 million MWh is 10 percent of state-wide 2006 sales.) Annual total savings are typically called "cumulative" while savings from new measures (installed that year) are called annual incremental.
[7] Virginia Electric and Power Company's Report of its Integrated Resource Plan, Docket No. E-100, Sub 147, May 1, 2017, https://www.dominionenergy.com/library/domcom/pdfs/corporate/2017-irp.pdf.

Figure 2. Annual electricity sales in each DEV Virginia energy efficiency scenario

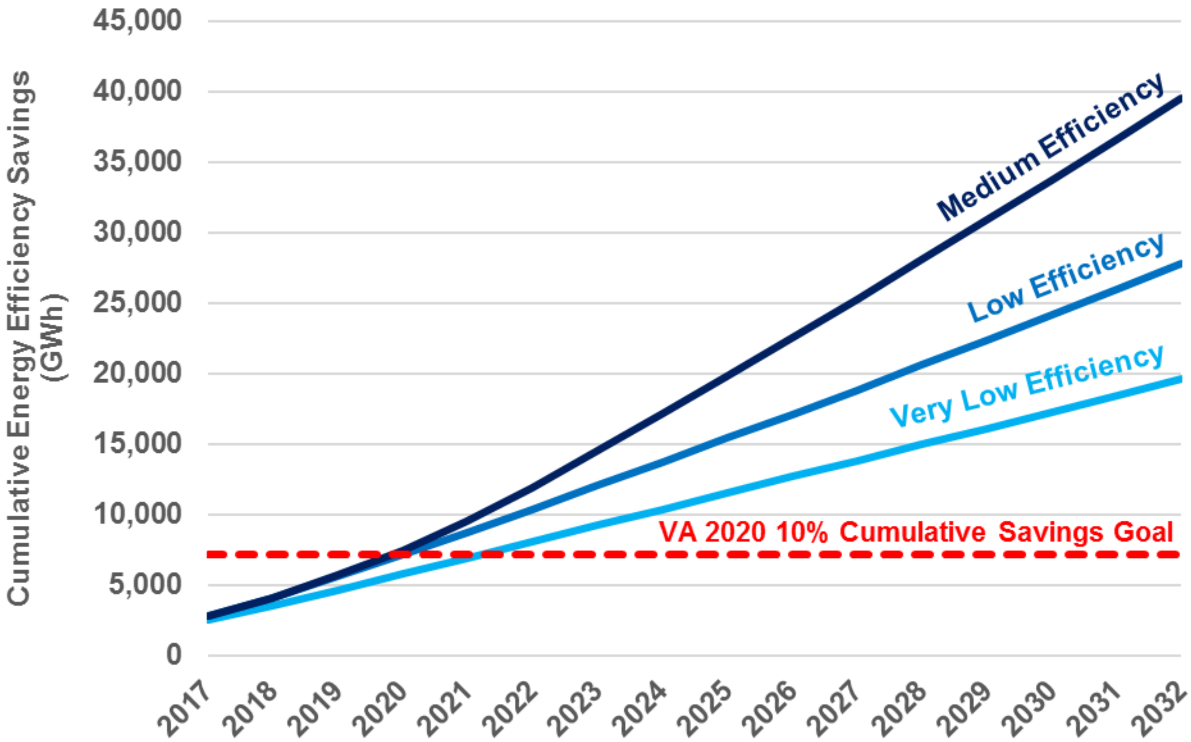


To examine the sensitivity of DEV's customer costs to variations in the level of energy efficiency savings (from IRP projected sales) we created a spreadsheet model of the three scenarios introduced above:

- **Very Low Efficiency:** 7.2 million MWh annual cumulative efficiency savings by 2022, achieving 1,197 GWh in total efficiency savings in 2028
- **Low Efficiency:** 7.2 million MWh annual cumulative efficiency savings by 2020 then slow growth in savings thereafter, achieving 1,813 GWh in total efficiency savings in 2028, and
- **Medium Efficiency:** 7.2 million MWh annual cumulative efficiency savings by 2020 then more ambitious growth in savings, achieving 2,840 GWh in total efficiency savings in 2028 (based on current efficiency savings rates of Eversource in Massachusetts).

The input assumptions for these scenarios differ only in the expected amount of energy efficiency (see Figure 3).

Figure 3. Annual cumulative energy savings in each DEV energy efficiency scenario



To balance sales with generation while maintaining DEV's obligation to be available to meet customers' needs during times of peak electric demand,[8] we adjust additions of new natural gas power plants in future years.[9] In Dominion's IRP, natural gas power plants are the new resource investments that are driven by consumer demand and marginal capacity needs; the other additions in the IRP are renewables that have a role in meeting Virginia's voluntary Renewable Energy Portfolio Goal.[10] However, it should be noted that new nuclear capacity would result in even higher costs and lower greenhouse gas emissions than those modeled in the scenarios.[11]

[8] Dominion's coincident capacity reserve requirement of 12.5 percent.
[9] With the exception of the IRP scenario. We do not adjust future natural gas additions in the IRP scenario. This results in an excess capacity position in some years, as acknowledged in DEV's IRP report.
[10] For more details on Virginia's Voluntary Renewable Energy Portfolio Goal refer to Section III.
[11] The third nuclear reactor Dominion is planning to build in Virginia is estimated to cost in the range of $19 billion. See "US NRC approves new nuclear unit for Dominion's North Anna plant in Virginia," May 31, 2017, Platts S&P Global, accessed at https://www.platts.com/latest-news/electric-power/washington/us-nrc-

For simplicity, we assume that, for DEV's existing and planned generating units, each generation type's rate of operation (capacity factor) follows the Dominion IRP and that DEV will sell excess generation (or buy deficit generation) from the greater PJM region.[12] The only changes to capacity were made to natural gas additions in future years in the Low Efficiency and Medium Efficiency scenarios. While dispatch rates could change as energy efficiency increases, not only does assuming they remain stable allow us to single out the effects of energy efficiency, but DEV is free to—and has a financial incentive to—sell their excess generation within PJM. All three scenarios meet Virginia's renewable energy goal.[13] The methodology and input assumptions used in this report are described below in Section III.

Our analysis found the lowest residential bills with the greatest energy efficiency savings (the Medium Efficiency scenario) and the highest customer bills with the smallest savings (the Very Low Efficiency scenario). The difference in costs between these two scenarios represents a missed opportunity for DEV's customers.

The structure of this report is as follows: Section II presents our findings and Section III presents the methodology and assumptions utilized in our analysis.

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approves-new-nuclear-unit-for-dominions-21892141.

[12] The simple dispatch model created for this analysis was designed to capture DEV-owned plant operations only, to answer the question about the amount of future generating capacity in Virginia that could be avoided (and the cost savings to consumers) through additional energy efficiency in the state. DEV owns capacity sufficient to meet its peak demand in its own service territory plus its required reserve margin; however, DEV's generating units operate within the larger PJM region, and thus the dispatch of DEV's existing units is affected by supply and demand throughout all of PJM. PJM's 2018 forecast of anticipated demand predicted that electricity demand will continue to decline over the next several years and that peak summer demand in 2018 will require 1,843 fewer MWs of power than in 2017 (PJM Resource Adequacy Planning Department, PJM Load Forecast Report, January 2018, https://www.eenews.net/assets/2018/01/02/document_ew_02.pdf.). Increasing the amount of energy efficiency in Virginia can affect the dispatch of units outside of the state. Similarly, demand in other parts of the region could keep DEV's plants dispatching at historic levels even with increased energy efficiency in Virginia. This is the basis for the assumption in the report that the capacity factors for each unit type are held constant, and that DEV sells/buys excess/deficit generation into/from the market.

[13] For more details on Virginia's Voluntary Renewable Energy Portfolio Goal refer to Section III.

II. Findings

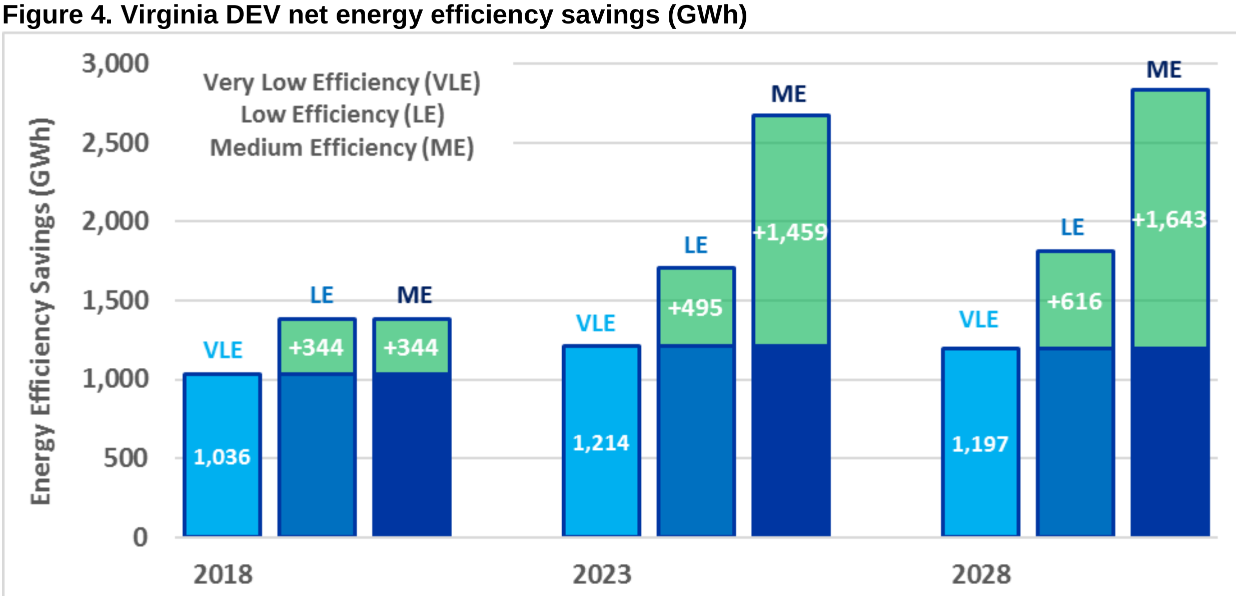
Energy efficiency savings reduce the need for investment in new generating capacity and the expense of generating electricity using fossil fuels like natural gas and coal. The result is lower costs for consumers and a reduction in greenhouse gas emissions and other pollutants.

Generation and Capacity

The figures that follow present results both in terms of their absolute amounts and the difference (called "delta") between the Very Low Efficiency (VLE) scenario and the Low Efficiency (LE) and Medium Efficiency (ME) scenarios.[14] This style of data presentation is standard practice in the energy analysis field and serves to focus our findings on changes that are expected to occur if efficiency savings are raised above the current trajectory identified in DEV's IRP. Additional savings are balanced by fewer new additions of natural gas power plants. Where this balancing process is imperfect or is constrained by DEV's obligation to ensure power is delivered at times of peak use, excess generation is assumed to be sold to other utilities.

Both the Low Efficiency scenario and Medium Efficiency scenario have more gigawatt-hour (GWh) energy efficiency savings than the Very Low Efficiency scenario (see Figure 4). Peak energy megawatt (MW) savings follow the pattern of annual energy savings in GWh (see Figure 5).

Figure 4. Virginia DEV net energy efficiency savings (GWh)

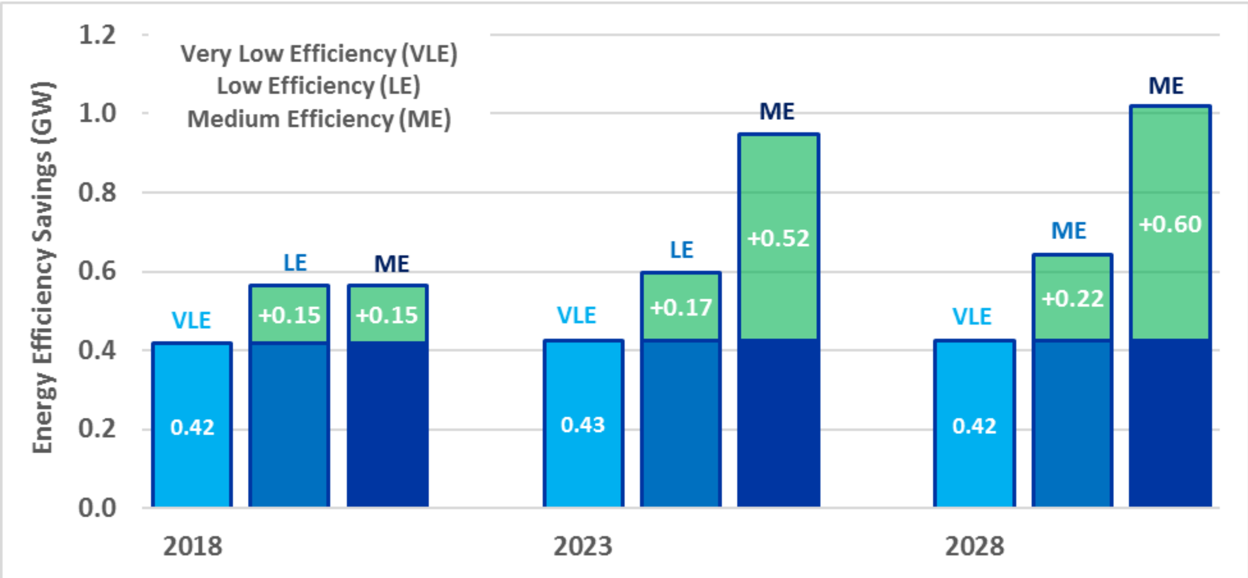


Note: *The total height of each column (including the green portion) is the value for that scenario in that year.*

[14] Absolute data can be found in Table 2 in the Appendix to this document.

The green sections show the delta or change from the Very Low Efficiency scenario value, and the labels in the green sections are the amounts of these deltas. A table with all results in absolute terms (the total heights of the columns) is presented in an Appendix to this report.

Figure 5. Virginia DEV net energy efficiency savings at peak (GW)



While the figures throughout this report show differences between scenarios in 2018, it should be noted that our historical data end in 2016. This means that both 2017 and 2018 data are projections, based on forecasts made by Dominion in 2015 and 2016. Energy sector data typically do not become available until one to two years after the fact: for example, actual 2017 data may not be available until 2018 or even 2019.

In its IRP, DEV forecasts 0.4 GW, 2.0 GW, and 4.0 GW cumulative (total over time) natural gas capacity additions in 2018, 2023, and 2028, respectively (see Table 1). The Low Efficiency and Medium Efficiency scenarios require fewer additions of new natural gas power plants. Fewer capacity additions result in a benefit for customers because the costs of new infrastructure are passed on to ratepayers, and expanded energy efficiency programs are less expensive for consumers than new DEV power plants.

Table 1. Natural gas capacity additions in Very Low Efficiency (VLE), Low Efficiency (LE) and Medium Efficiency (ME) scenarios (GW)

	2018	2023	2028
Very Low Efficiency	0.4	2.0	4.0
Low Efficiency	0.0	2.0	3.5
Medium Efficiency	0.0	1.7	1.7

Figure 6 reports the difference in natural gas capacity additions, respectively, between the Low Efficiency and Medium Efficiency scenarios and the Very Low Efficiency scenario. Figure 7 shows the change in natural gas generation in GWh between the Very Low Efficiency scenario and the other two scenarios. Figure 6 and Figure 7 can be compared to 2016 actual values of 7.5 GW and 27,700 GWh of natural gas capacity and generation.

Figure 6. Virginia DEV net natural gas capacity resources (GW)

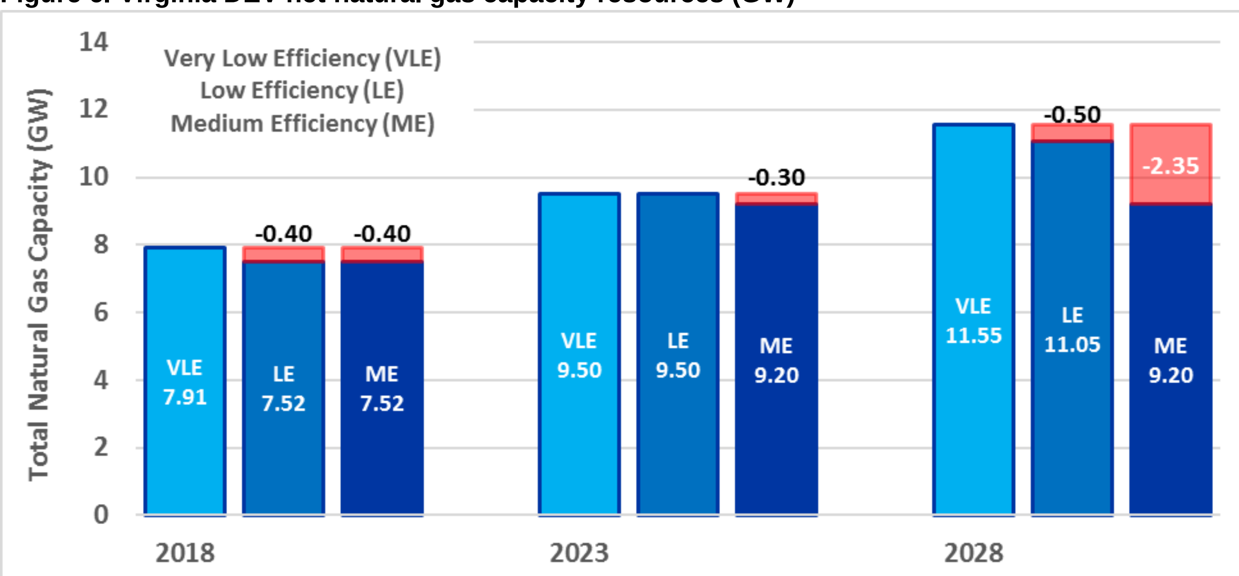
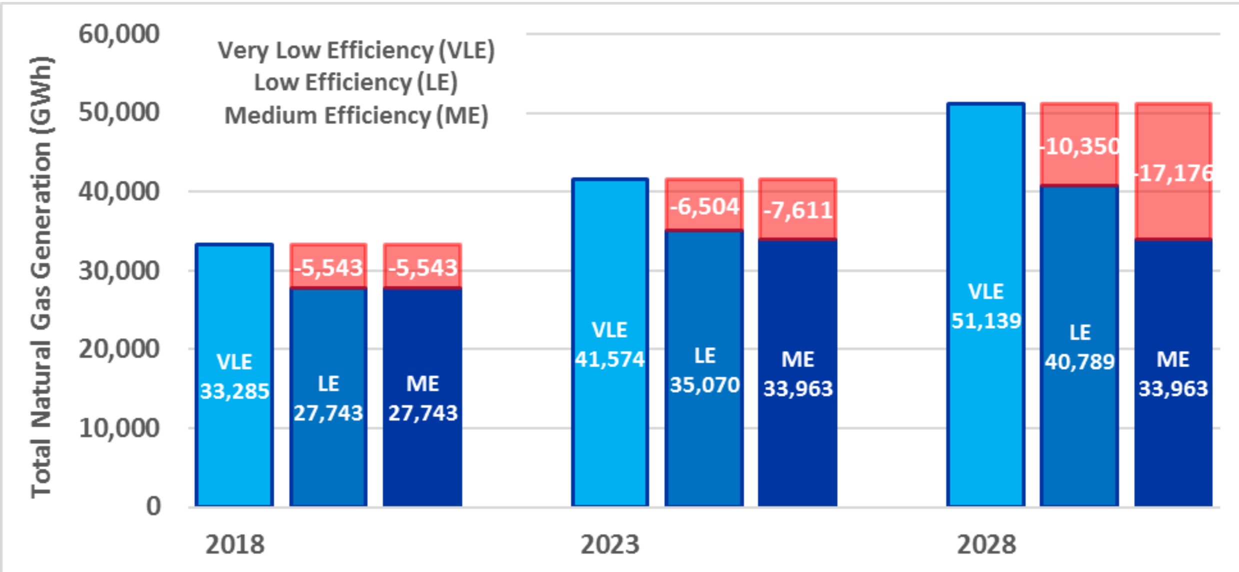


Figure 7. Virginia DEV net natural gas generation (GWh)

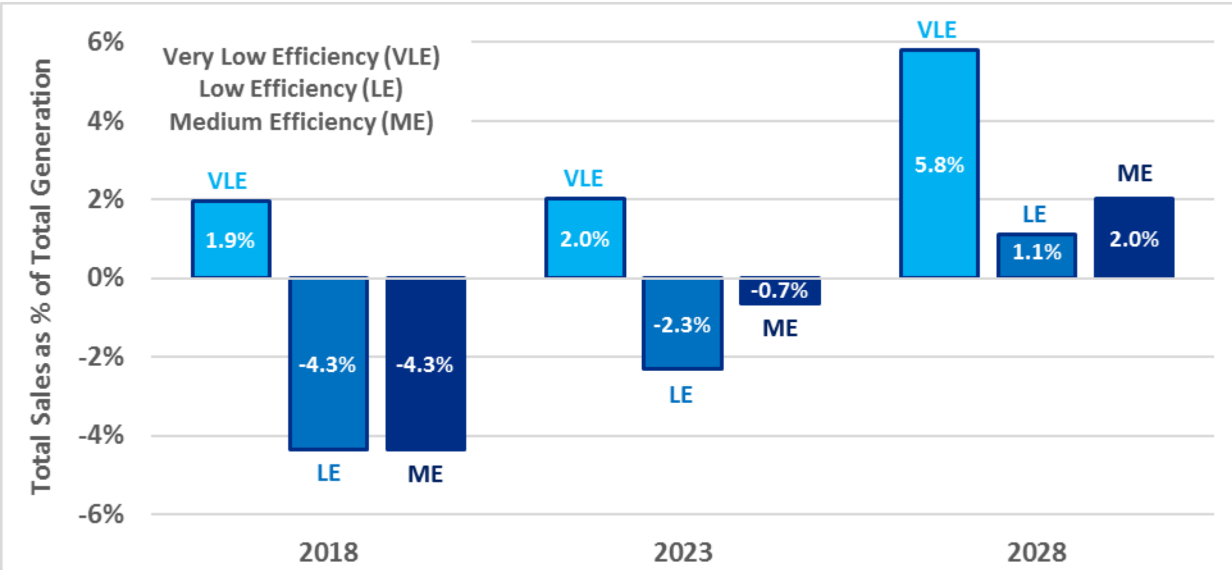


We assumed, for simplicity, that regardless of investments in efficiency or new capacity, the average hours of operation per year by generation type (capacity factor) would follow the Dominion IRP. Instead of decreasing generation in response to excess capacity we assume that DEV increases its sales to other utilities (off-system sales), as it does currently when it has excess capacity. Figure 8 shows DEV's off-system total sales as a percentage of total generation.[15] As shown in Figure 8, annual off-system sales or purchases between 2018 and 2028 are 6 percent or less of total generation. High off-system sales in the Very Low Efficiency scenario occur even though DEV is projecting much higher customer sales than expected by the Energy Information Administration (EIA): DEV's IRP capacity additions appear to greatly exceed its expected demand for electricity. Indeed, reserve capacity in the Very Low Efficiency scenario is 16.3 percent in 2018, as compared to the required minimum value of 12.5 percent.

We do not assume any additional retirements (other than those in DEV's IRP), and we only curtail natural gas investments.

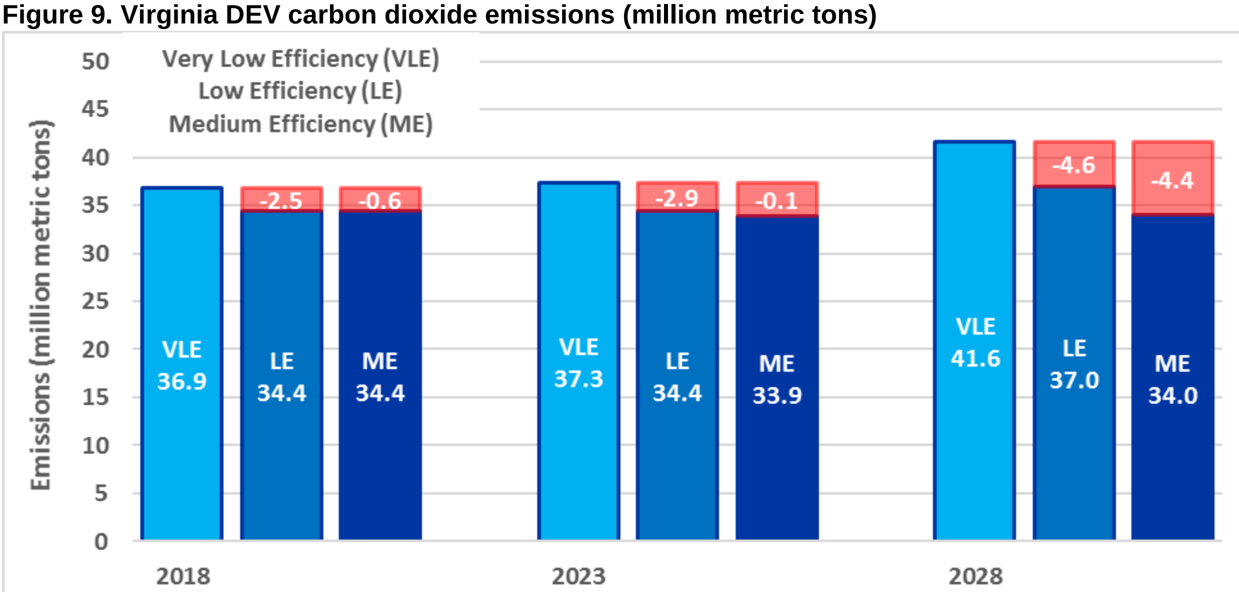
[15] On-system sales represent sales to customers to meet demand, while off-system sales occur once customer demand has been fulfilled, and represent sales to other utilities.

Figure 8. Virginia DEV net off-system sales as share of total generation (GWh)



Greater energy efficiency savings combined with constraints on how many new natural gas plants can be avoided (due to the need for reserves to fulfill peak demand) result in surplus generation for DEV. Less natural gas generation results in lower greenhouse gas emissions. If DEV were to reduce generation rather than sell excess within the PJM region, emissions declines would be even greater. While Figure 9 shows the change in carbon dioxide emissions from all of DEV's generation, including the emissions of DEV's off-system sales, an inventory of emissions could also be made based on DEV's sales to its own customers (on-system sales).

Figure 9. Virginia DEV carbon dioxide emissions (million metric tons)



Note: *Emissions shown here are for all DEV generation, including emissions associated with net off-system sales.*

Rates and Bills

Energy efficiency measures carry administrative and program costs that are passed on to customers through their electric rates.[16] These same efficiency measures also lower system-wide electricity costs in many ways, including reducing operations and maintenance costs (such as fuel) at existing power plants, deferring or avoiding the need for new generation assets, deferring or avoiding the need for new transmission and distribution assets, and more. The net effect of additional efficiency savings on rates can be either positive or negative depending on the components captured. Any increase in rates resulting from the need to recover costs associated with energy efficiency programs is generally offset by avoided costs of generation, transmission, and distribution. In some states, electric utilities may request recovery of lost revenues due to decreased sales, which can lead to a net increase in rates.[17] However, this has not been the case in Virginia thus far.[18]

Our analysis of residential electric rates in Virginia found that average customer energy usage, energy costs, and bills decrease with greater energy efficiency savings (Figure 10 and Figure 11).

[16] In DEV's most recent DSM docket before the VA State Corporation Commission (SCC), Case No PUE-2016-00111, testimony from Jeffrey Loiter of Optimal Energy concludes that DEV could achieve additional energy efficiency savings by increasing the participation rates in its approved programs. Loiter calculates that if DEV "had reached at least the planned level of participation for each program (but still over-achieved in the Residential Home Energy Check-up and Non-Residential Duct Testing and Sealing Program), total savings through 2015…would be between 50 and 75% greater than the actual results." Loiter also targets central air conditioning (CAC) and heat pump savings as the most prominent area of energy efficiency potential that DEV is not capturing. He suggests that it pursue conversions from baseboard heat to ductless heat pumps, an integrated approach to maintenance and upgrades of existing CAC and heat pump systems (including ductwork), and building shell improvements for heat pump customers as part of a broader, more aggressive energy efficiency strategy. Testimony available at: http://www.scc.virginia.gov/docketsearch/DOCS/3d4%2501!.PDF

[17] Woolf, T., Malone, E. and C. Neme. 2014. Regulatory Policies to Support Energy Efficiency in Virginia. Prepared for the Virginia Energy Efficiency Council. Page 14. Available at: http://www.synapse-energy.com/sites/default/files/Regulatory%20Policies%20to%20Support%20Energy%20Efficiency%20in%20Virginia%2014-110.pdf

[18] In Virginia, utilities may request recovery of lost revenues from the State Corporation Commission (SCC). Dominion has seldom requested and has never been granted lost revenue recovery and we have not included lost revenues as a rate component in this analysis.

Figure 10. Average Virginia DEV residential customer annual energy use, 2017-2032

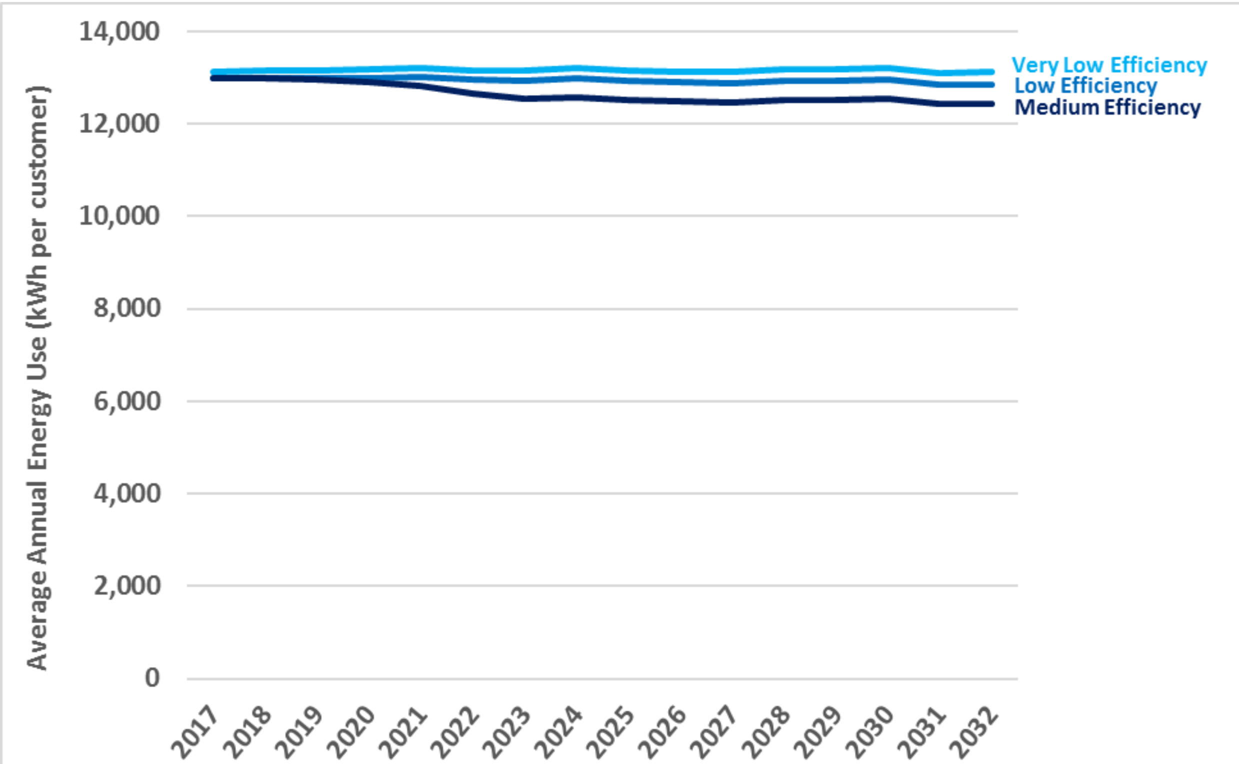
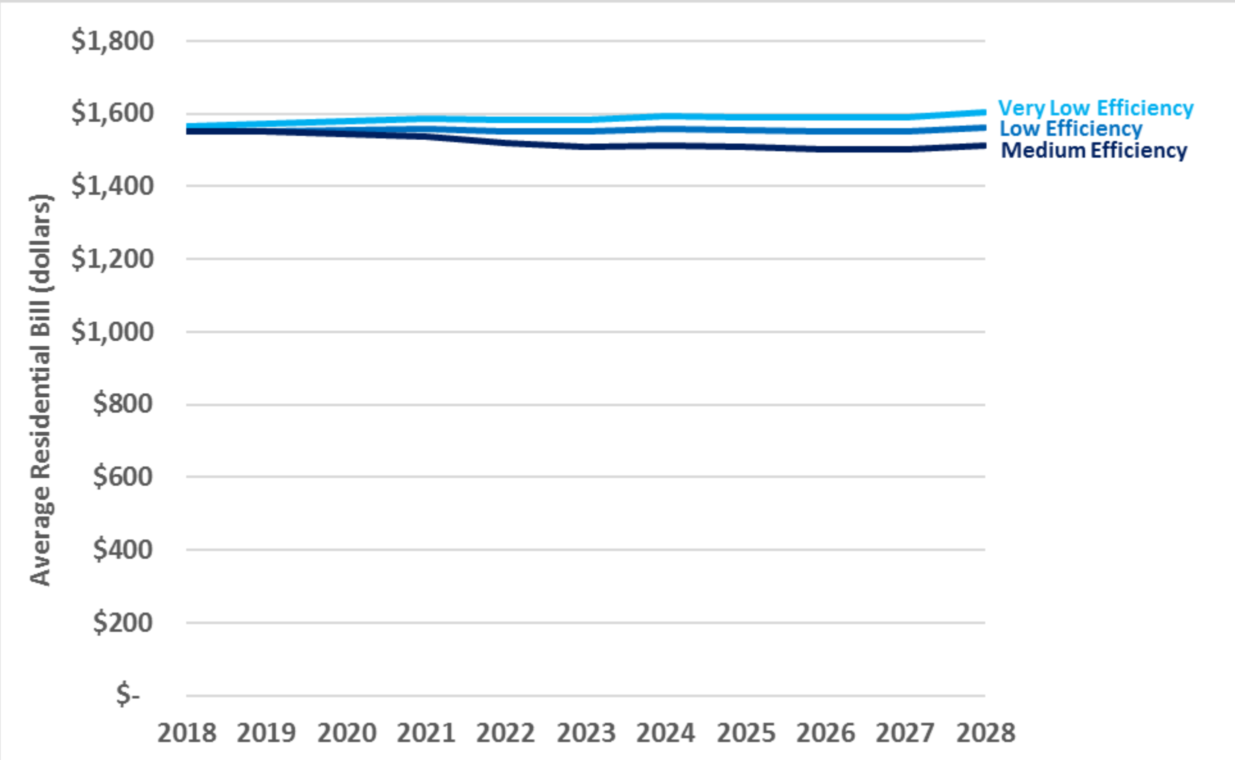


Figure 11 shows average annual customer bills in the three scenarios. Customer bills increase over time with Very Low Efficiency forecasted levels of electric sales and energy efficiency. Bills are lower in the Low Efficiency scenario and lower still in the Medium Efficiency scenario. Compared to the Very Low Efficiency scenario in 2028, the average DEV residential customer's annual bill is $41 less expensive under the Low Efficiency scenario; and $92 less expensive under the Medium Efficiency scenario. Cumulatively, from 2018 through 2028, Dominion customer bill savings total $800 million to $1.7 billion.

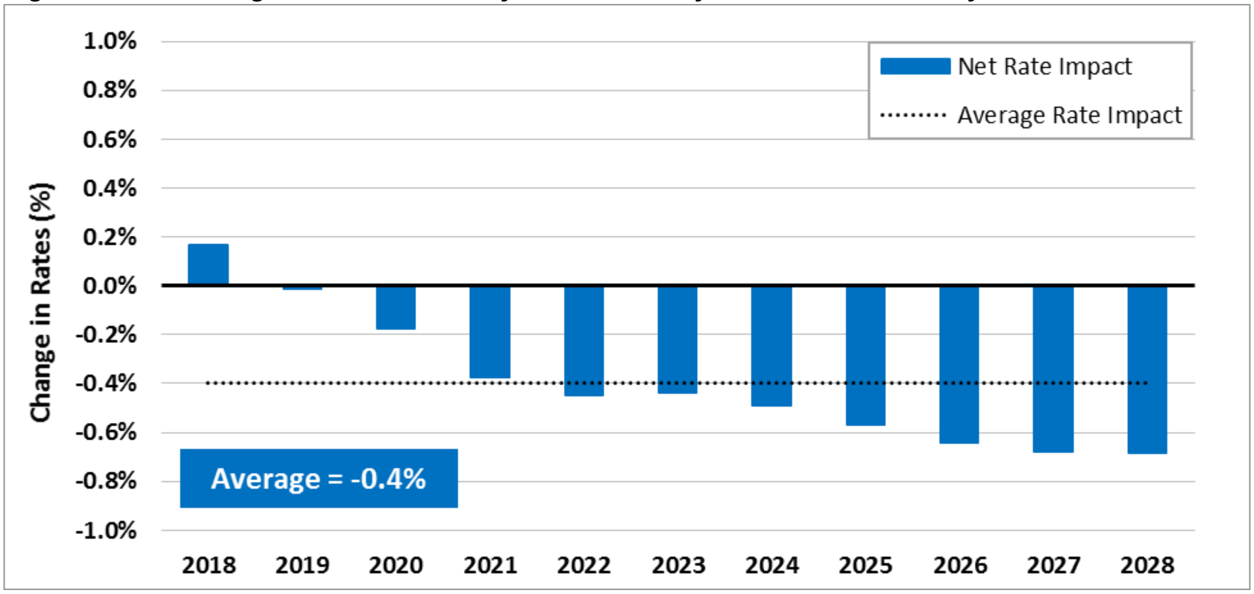
Figure 11. Average annual Virginia DEV residential electric bills



The most aggressive efficiency case considered delivers a 5.74 percent average reduction in consumer electricity bills in 2028. The next most aggressive efficiency case cuts bills by 1.96 percent. Most of these savings result from lower energy use, while a smaller portion is driven by changes in customer rates.

Utility charges to consumers resulting from increased energy efficiency are outweighed by the savings associated with the avoided capacity, transmission, and distribution. When efficiency savings are increased from the Very Low Efficiency scenario to the Low Efficiency scenario, customers see a small rate increase (but not a higher bill) in the first year of the analysis period as energy efficiency program costs are raised. In the second year and beyond, the avoided costs of capacity, transmission, and distribution outweigh the costs of energy efficiency and lead to a decline in residential rates, with an average rate impact over the ten-year period of -0.4 percent, and -0.7 percent in 2028 (Figure 12).

Figure 12. Net change in rates from Very Low Efficiency in the Low Efficiency scenario



When efficiency savings are increased from the Very Low Efficiency scenario to the Medium Efficiency scenario, customers see a slightly smaller decline in rates over the analysis period, with an average impact on residential rates over the period of -0.3 percent, and -0.8 percent in 2028 (Figure 13).

Figure 13. Net change in rates from Very Low Efficiency in the Medium Efficiency scenario

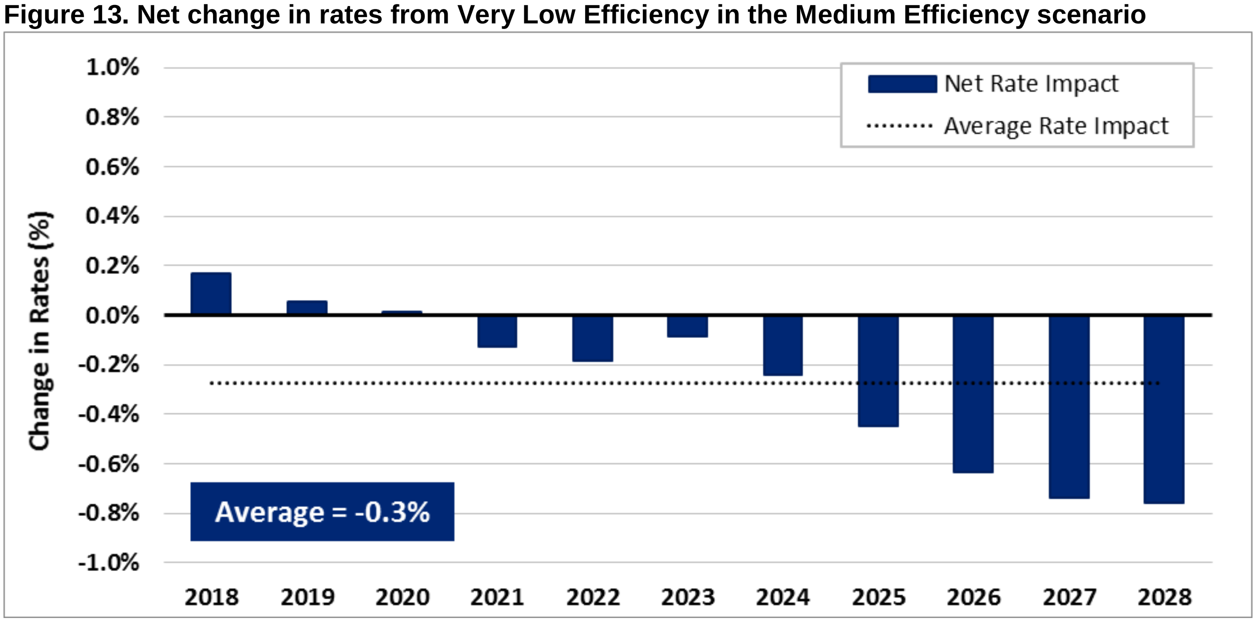
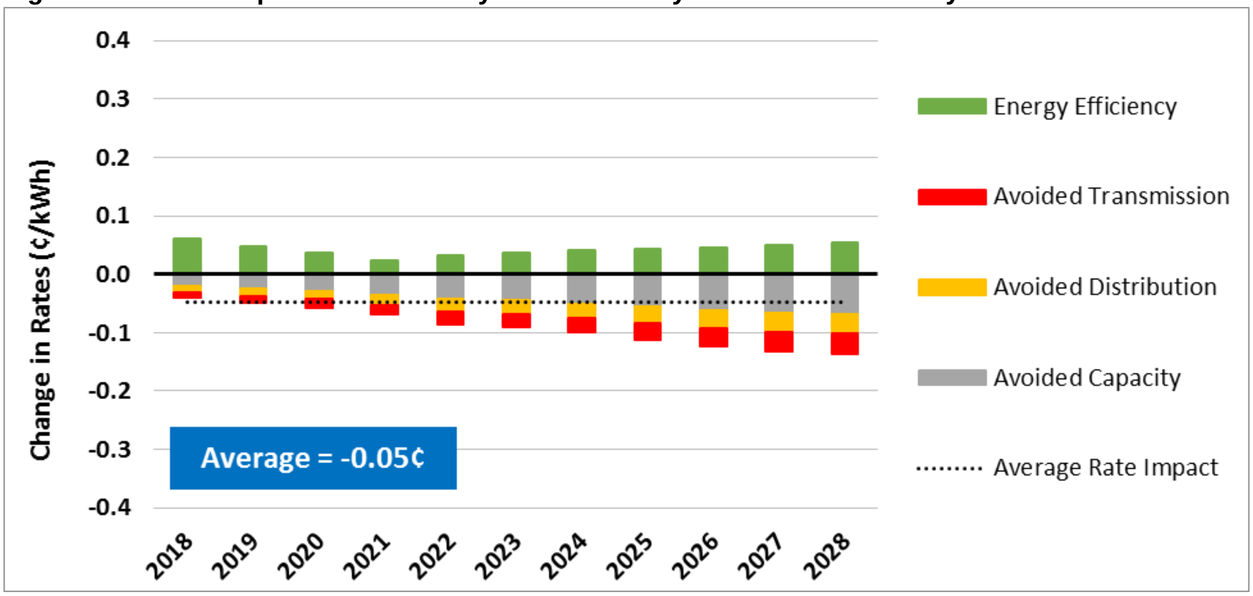


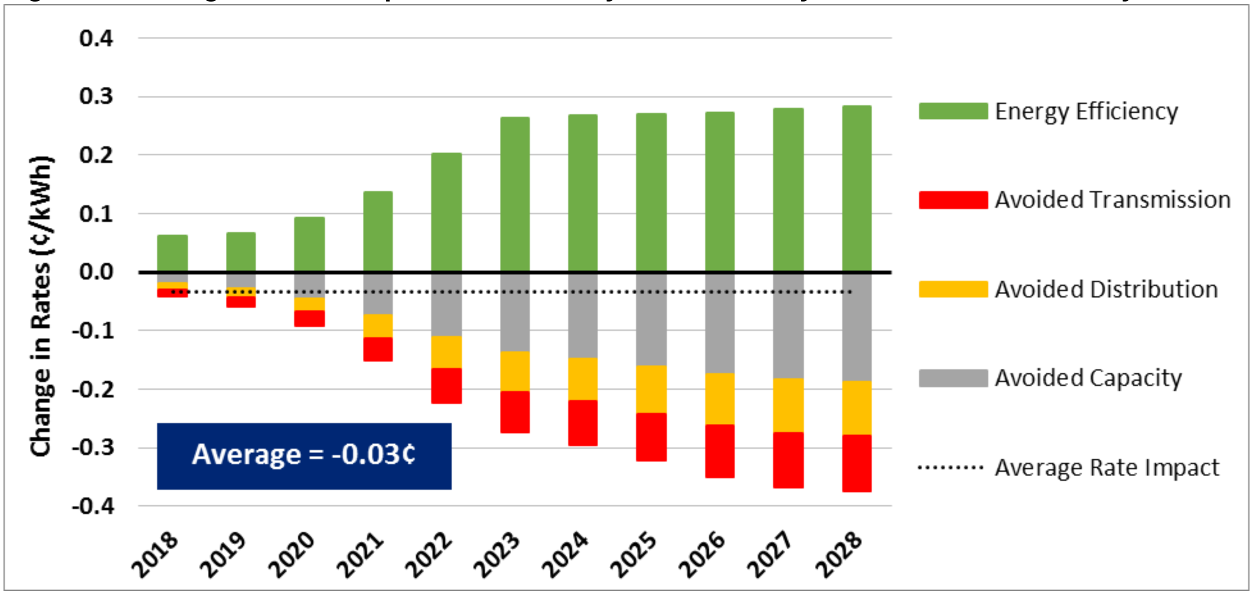
Figure 14 and Figure 15 show changes in customer rates by individual rate component. Avoided capacity costs grow most dramatically over the analysis period, and when combined with the cost associated with avoided transmission and distribution, the savings to residential customers outweigh the costs associated with energy efficiency charges and lost transmission/distribution revenues that are recovered by DEV. An increase in energy efficiency that allows achievement of Virginia's EERS goal in 2020 would result in an average residential bill cost savings of 0.05 cents/kWh between 2018 and 2028, and 0.08 cents/kWh in 2028 (see Figure 14).

Figure 14. Rate components from Very Low Efficiency to the Low Efficiency scenario



An increase in energy efficiency to the level of a utility like Eversource in Massachusetts (as in the Medium Efficiency scenario) would result in an average residential bill cost savings of 0.03 cents/kWh between 2018 and 2028, and 0.09 cents/kWh in 2028 (see Figure 15).

Figure 15. Change in rate components from Very Low Efficiency to the Medium Efficiency scenario

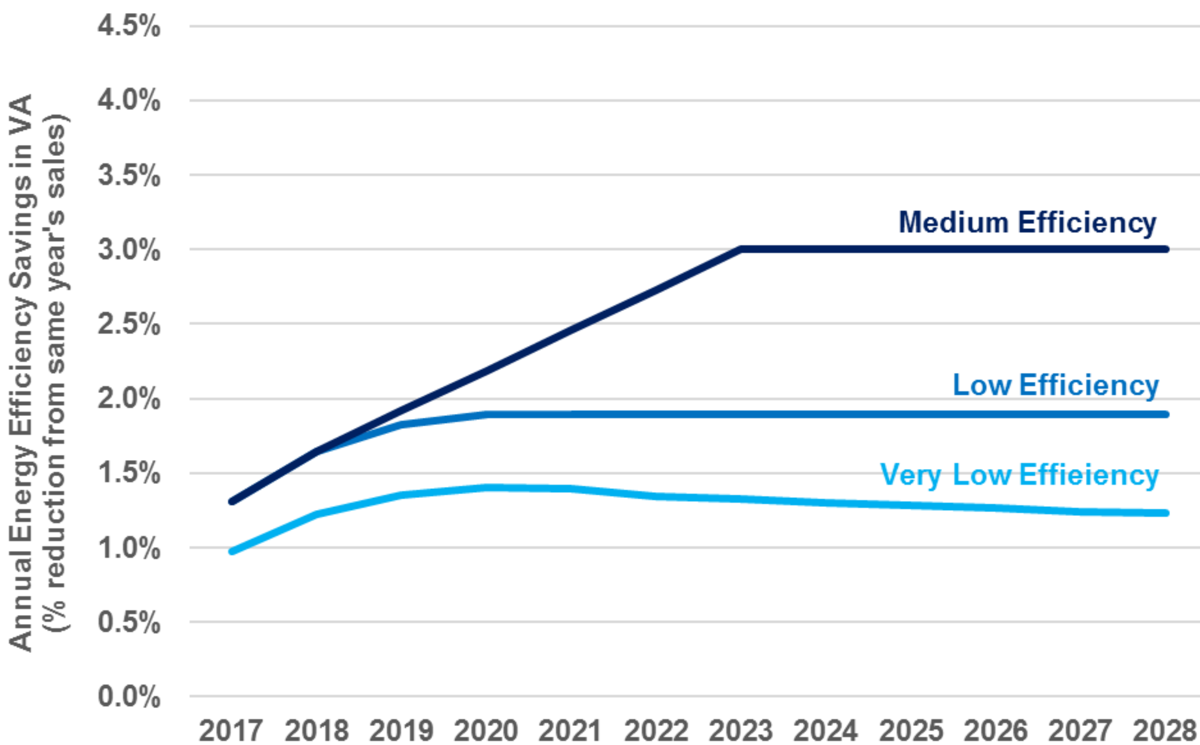


III. Methodology and Assumptions

We used a simple spreadsheet methodology to construct three scenarios of capacity, generation, and emissions by resource type, as well as costs and rates across all resource types, from 2018 to 2028 using different sets of assumptions regarding future energy efficiency savings: Very Low Efficiency, Low Efficiency and Medium Efficiency (see Figure 16 below).

We constructed the Very Low Efficiency scenario using information exclusively from Dominion's 2017 IRP, making no adjustments. The Very Low Efficiency scenario results in excess capacity, which is acknowledged in DEV's IRP document. The Low Efficiency scenario and Medium Efficiency scenarios differ from the Very Low Efficiency scenario in their amount of energy efficiency. In the Low Efficiency and Medium Efficiency scenarios, to balance sales with generation while maintaining Dominion's coincident capacity reserve requirement of 12.5 percent, we adjust natural gas capacity additions in 2018, 2023 and 2028. The input assumptions for our Low Efficiency and Medium Efficiency scenarios adjust DEV's summer peak energy use projections in proportion to the Dominion IRP forecasted sales growth. Figure 16 presents the energy efficiency savings, as a percent of annual sales, modeled in the Very Low Efficiency, Low Efficiency, and Medium Efficiency energy efficiency scenarios through 2028.

Figure 16. Annual incremental energy efficiency savings in each DEV energy efficiency scenario



All three scenarios meet Virginia's voluntary Renewable Energy Portfolio Goal. In 2007, Virginia enacted a voluntary renewable goal for investor-owned electric utilities (IOUs) to provide 15 percent of electric energy sales from renewable sources annually by 2025 (from a 2007 baseline). While Virginia's renewable goal is not compulsory, it does require IOUs to report on their efforts to meet the goal.[19] Under the renewable goal, IOUs are not required to account for each MWh of energy with a Renewable Energy Credit (REC), nor are MWh savings required to occur in Virginia, as is common in other state's Renewable Portfolio Standard (RPS) programs.[20] State Senator Donald McEachin (D) introduced legislation in 2016 to amend the goal to become mandatory, but the legislation was not been passed.[21]

DEV's residential electric rates are made up of five different charge components: a fixed customer charge of $7, and charges for energy efficiency, generation, transmission, and distribution on a cents/kWh basis. The fixed customer charge remains constant over the three scenarios analyzed in this report. The change in charges between scenarios was determined by dividing annual program cost to ratepayers by annual efficiency savings. We determined annual program cost by multiplying DEV's cost of saved energy in $/MWh (calculated as total program costs divided by total energy savings) with the annual saved energy values calculated for the Low Efficiency and Medium Efficiency scenarios.

To estimate changes to residential electric rates under the Low Efficiency and Medium Efficiency scenarios, we calculated the impact that the increased energy and demand savings would have on the individual components that make up residential rates, obtained from DEV's current rate schedule.[22] Total costs to residential consumers of generation, transmission, and distribution were calculated under each of the scenarios based on the volume of sales in that scenario. Avoided costs were calculated as a function of efficiency savings. Individual charges for generation, transmission, and distribution (taking account of avoided costs due to efficiency) were then calculated for all three scenarios: Very Low Efficiency, Low Efficiency and Medium Efficiency.

Costs and Benefits Not Covered in This Report

This analysis focused on the impacts of energy efficiency on consumer bills, utility rates, the need for new generating capacity, and emissions. Costs and benefits associated with energy efficiency improvements not covered by this report include the cost of energy efficiency improvements not

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[19] DSIRE, Virginia Voluntary Renewable Energy Portfolio Goal, Updated February 8, 2015, http://programs.dsireusa.org/system/program/detail/2528.

[20] Chesapeake Climate Action Network, Virginia's Renewable Portfolio Standard: Utilities Receive Millions in Bonuses for Business as Usual?, October, 2012, http://chesapeakeclimate.org/wp/wp-content/uploads/2012/10/RPS-Backgrounder-10-2012.pdf.

[21] Virginia's Legislative Information System, SB 761, January 22, 2016, https://lis.virginia.gov/cgi-bin/legp604.exe?161+ful+SB761+pdf.

[22] Virginia Electric and Power Company, Rate Schedule, Revised October 1, 2017, https://www.dominionenergy.com/.

covered by utilities and the added consumer benefits that arise from efficiency measures, such as improved home safety and comfort, water conservation, and the societal health and economic benefits of reducing criteria and greenhouse gas pollutants from power plants.

Inputs

What follows is a list of the inputs used in our spreadsheet analysis and their sources:

Capacity

- Data for historical years 2005 and 2010 come from EIA 860 data and include all values for "Dominion Virginia Power" in 2005 and "Virginia Electric and Power Co" in 2010 (including both VA and NC).

- Data for historical and future years 2014-2028 come from Dominion's 2017 IRP, Appendix 3F, pp.185.

    - Dominion's IRP does not distinguish between types of renewables in future years. All historical renewable capacity through 2016 comes from biomass. To distinguish between types of renewables (biomass, wind and solar) included in Dominion's future resource portfolio, we did the following:

        - Assume that the 2016 biomass capacity (236 MW) continues unchanged into the future.

        - To determine future wind and solar capacity, sum the 2017 solar and 2021 wind additions, as listed in the IRP (for 2018 and 2023, respectively).

        - To determine the remaining future solar and wind capacity figures (solar for 2023 and 2028 and wind for 2028), take the total renewable capacity for 2023 and 2028 as listed in the IRP Appendix 3F and subtract the figures for biomass, solar and wind as relevant.

        - This ensures that our total renewable capacity figures for biomass, wind and solar in 2018, 2023 and 2028 match the total renewable capacity figures listed in the IRP Appendix 3F.

- Data for "DSM Peak Reduction" come from Dominion's 2017 IRP, Appendix 3N, pp.200 adjusted to rise in direct proportion to annual energy efficiency projections by scenario.

- Natural gas capacity is the balancing factor in our modeling. For each scenario, we reduce capacity additions in each future year in 100 MW blocks until the last level that maintains an adequate peak coincident reserve requirement, as defined in Dominion's 2017 IRP, Section

4.2, Figure 4.2.2.1, pp.67.

Capacity factors

- Solar and wind capacity factors come from Dominion's 2017 IRP, Appendix 3D, pp.182.
- All other capacity factors are calculated from Dominion's 2017 IRP historical generation and capacity levels.

Generation

- Data for years 2005 and 2010 come from EIA Form 923 data and include all values for "Dominion Virginia Power" in 2005 and "Virginia Electric and Power Co" in 2010 (including both VA and NC).
- Data for years 2014-2016 come from Dominion's 2017 IRP, Appendix 3G, pp.186 (following the same exception for renewables described above regarding capacity).
- "Pumped Hydro Storage" includes both "Hydro Pumped Storage" (line i) and "Less Pumping Energy" (line n) from the IRP Appendix 3G, pp. 186.
- Generation is calculated for each year and scenario as capacity multiplied by 8,760 hours multiplied by capacity factor.

Energy and peak

- Historical "Annual (reconstituted) sales" data come from EIA Form 861 data for all "Virginia Electric and Power Co" (including both VA and NC).
- Forecasted sales data is obtained from Dominion's 2017 IRP, Appendix 2B, pp. 158.
- Data for "Utility Summer Peak Load (adjusted)" come from the "Summer Peak, Adjusted Load" values from Dominion's 2017 IRP, Appendix 2H, pp.164.
- For the forecasted "Utility Summer Peak Load (adjusted)" figures, multiply the 2016 figure by the ratio of growth in sales and growth in peak from 2016-2018 defined in Dominion's 2017 IRP;
- Repeat the same process between 2018-2023 and 2023-2028.
- Data for coincident peak reserve requirement come from Dominion's 2017 IRP, Section 4.2, Figure 4.2.2.1, pp.67.

Emissions Rate

- Emissions rates are technology-specific and are calculated based on EIA Form 923 data for Virginia. We use the 2015 emissions rates throughout the future period modeled.

Emissions

- Emissions are the product of emissions rates multiplied by generation.

Expected Retirements and Additions

- Expected retirements and additions are obtained from EIA Form 860 data and from Dominion's 2017 IRP, Section 3.1, Figure 3.1.5.1, pp.41.

Electric Rates

- Sales data come from Dominion's 2017 IRP, Appendix 2B, pp. 158.

- Customer counts come from Dominion's 2017 IRP, Appendix 2E, pp. 161.

- Annual energy savings and lifetime energy savings data come from Dominion's 2017 IRP, Appendix 5E, pp. 235.

- Annual demand savings data come from Dominion's 2017 IRP, Appendix 3O, pp. 201.

- Rate information comes from the Virginia Electric and Power Company Filed Tariff, Revised 10-01-17.

- Dominion's cost of saved energy, in $/MWh is calculated by dividing reported costs of energy efficiency by reported savings.[23]

- Avoided costs are estimated at $30/MWh for energy, $50/kW for capacity, and $25/kW for transmission and distribution.

[23] Dominion's 2016 electric sales, as reported in its 2017 IRP, are multiplied by its customer conservation charge to arrive at the total cost of its energy efficiency programs. This cost is then divided by reported efficiency savings to arrive at the cost of saved energy.

Appendix

Table 2. Findings by scenario

	Very Low Efficiency			Low Efficiency			Medium Efficiency		
	2018	2023	2028	2018	2023	2028	2018	2023	2028
Total Demand Side Management (DSM) (GWh)	1,036	1,214	1,197	1,380	1,709	1,813	1,380	2,673	2,840
Total DSM (GW)	0.42	0.43	0.42	0.56	0.60	0.64	0.56	0.95	1.02
Total Natural Gas Combined Cycle (NGCC) capacity (GW)	7.91	9.50	11.55	7.52	9.50	11.05	7.52	9.20	9.20
Total NGCC generation (GWh)	33,285	41,574	51,139	27,743	35,070	40,789	27,743	33,963	33,963
Total off-system sales (GWh)	1,601	1,810	5,700	-9	1,902	5,358	-9	3,265	6,003
Emissions (million metric tons)	36.85	37.31	41.59	36.26	37.71	40.24	36.26	37.22	37.22