CHANGING COURSE

A CLEAN ENERGY INVESTMENT PLAN FOR DOMINION VIRGINIA POWER

AUTHORED BY

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EXECUTIVE SUMMARY

The authors of this report were asked to evaluate the potential for additional energy efficiency[1] and renewable energy in Virginia, and to analyze the economic costs and benefits of a Clean Energy Investment Plan for Dominion Virginia Power ("Dominion" or "the Company") in comparison to the "Preferred Resource Plan" and other alternatives evaluated in the Company's 2012 Integrated Resource Plan ("IRP"). This Report presents the results of our analyses.

Our key findings, explained in more detail in the following pages, are:

- Dominion's current resource mix is heavily dependent on fossil–fired generation, with coal, natural gas, and oil–fired power plants providing nearly two–thirds of the energy from Dominion–owned facilities or that the Company purchases from non–utility generators or other utilities in the PJM energy market.
- Dominion's Preferred Resource Plan would encompass more of the same, adding more than 5,000 megawatts ("MW") of new or converted natural gas–fired capacity by 2027 while failing to retire any additional coal–fired units beyond those the Company currently plans to retire by 2015. As a result, as late as 2027, with the Preferred Resource Plan, coal and natural gas–fired facilities would continue to provide nearly 60 percent of the Company's energy mix.
- Dominion's Preferred Resource Plan is fraught with significant uncertainties and risks for ratepayers and the environment, and it fails to account for Virginia's substantial untapped potential for energy efficiency and renewable energy resources.
- Adoption of a Clean Energy Investment Plan, while only a first step in moving the Company towards a cleaner energy future, will provide by 2027 nearly 6,800 MW of energy efficiency and renewable resources and more than 18 million megawatt hours (MWh") of clean non–emitting energy each year, at a lower cost than building one or both of the new natural gas–fired combined cycle ("NGCC") power plants that Dominion plans to add by 2019.

The Clean Energy Investment Plan considered here is a moderately aggressive plan, just a first step in addressing the future welfare of Virginians. It is not an estimate of the maximum technological potential for clean energy, but rather was developed within the restrictive regulatory structure currently in place in Virginia. The steps taken in this plan are based on technologies already known, commercialized, and expected to be economically feasible within the time frame established. The Clean Energy Investment Plan considers a limited set of changes from Dominion's Preferred Resource Plan that are economically competitive; i.e. that would be as economic or more so than the Preferred Resource Plan based on current conditions and conservative projections of future trends. Changes in conditions such as much higher costs associated with greenhouse gas emissions might justify a much more aggressive move toward clean energy resources.

The Report's conclusion is that Virginia has substantial untapped potential for energy efficiency and renewable energy resources, particularly solar and offshore wind. Even a moderately aggressive Clean Energy Investment Plan would produce significant benefits for Dominion's ratepayers. However, instead of pursuing this new direction, Dominion has chosen a Preferred Resource Plan that continues its historic dependence on large central–station fossil–fired and nuclear generating units, thereby maintaining a resource strategy that is fraught with risks and uncertainties for ratepayers.

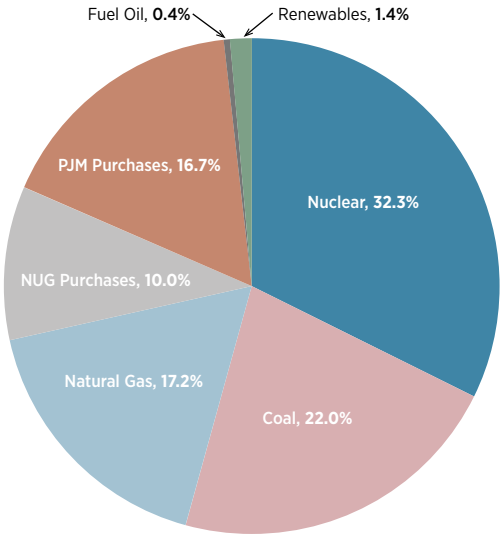
DOMINION'S EXISTING GENERATION RESOURCES

Dominion owns 102 generating units totaling 17,603 MW of capacity.[2] Approximately 12,000 MW, or nearly 70 percent, of this Company–owned capacity are fossil–fired plants that burn coal, natural gas, or oil.

Dominion also has 1,747 MW of capacity contracted from non–utility–generators ("NUGs") under contracts that will expire over the next eight years, with the last NUG contract expiring in 2021. Ninety six percent, or 1,684 MW, is from coal or natural gas–fired facilities.

Given all of the Company–owned fossil–fired capacity and NUG–contracted fossil–fired capacity, it is not surprising that Dominion's energy generation mix in recent years has been heavily dependent on coal, nuclear, and, increasingly, natural gas generation.

FIGURE ES–1: Dominion's 2012 Energy Mix.



However, even these figures understate the Company's dependence on fossil fuels. This is because, beyond Dominion–owned units and contracts with non–Company NUGs, the Company makes significant capacity and energy purchases from other generating units in the PJM energy market.[3]

In addition to its fossil–fired and nuclear capacity, Dominion's energy mix contains a modest 430 MW of renewable resources. These resources include the 83 MW wood–burning Pittsylvania Power Station, 29 MW of the Virginia City Hybrid Energy Center, and four hydro facilities.[4] But, as is illustrated in Figure ES–1, the energy from renewable resources has represented only a relatively small portion of Dominion's overall energy mix in recent years. Unfortunately, this is unlikely to change unless Dominion makes a significant turn towards a much cleaner energy future.

Finally, Dominion currently operates a small number of energy efficiency programs[5] that have been approved by the Virginia State Corporation Commission ("SCC"). The Virginia General Assembly has established a voluntary goal for utilities within the Commonwealth to reduce electricity consumption by 10 percent by 2022, using 2006 as a benchmark. This is a goal that the SCC has found to be "realistically accomplishable." However, Dominion's programs, and the additional efficiency programs that the Company is expected to propose in the fall of 2013, even if approved and delivered successfully, would bring total cumulative efficiency savings to 4.6 percent of 2006 consumption by 2022, far below the Commonwealth's 10 percent goal.

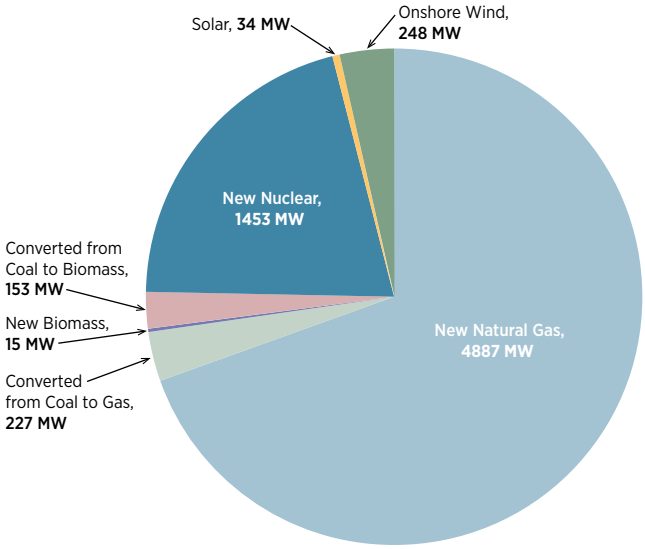
DOMINION'S PLANNED RESOURCES

In its 2012 IRP filing with the SCC, Dominion set forth what it termed its Preferred Resource Plan to: (a) meet projected future load and energy sales growth, (b) replace the capacity and energy it currently purchases under the expiring NUG contracts, and (c) reduce its capacity and energy purchases from the PJM energy market. If Dominion completes this plan over the next fifteen years, the Company will have:

1. Retired or converted to burn gas or biomass 380 MW of existing coal capacity by 2015 with no further coal retirements in any subsequent years.
2. Added 4,087 MW of new NGCC capacity and 800 MW of new gas–fired combustion turbine capacity.
3. Added 1,453 MW of new nuclear capacity.
4. Added 15 MW of municipal solid waste.
5. Added only 34 MW of solar capacity.
6. Added only 248 MW of land–based wind.
7. Added no offshore wind.

The new capacity that will be added between 2013 and 2027 in the Company's Preferred Resource Plan is shown, by fuel, in Figure ES–2, below.

FIGURE ES–2: New Supply Side Capacity to be Added under Dominion's Preferred Resource Plan by Fuel, 2013–2027.



Thus, Dominion's Preferred Resource Plan is essentially a roadmap for building more natural gas and nuclear capacity while adding extremely minor amounts of renewable solar and wind capacity. By pursuing this plan, the Company will become even more dependent on natural gas-fired capacity in 2027 than it was in 2012.

FIGURE ES–3: Dominion's Recent and Projected Generation from Company–Owned Natural Gas Units, 2008–2027.

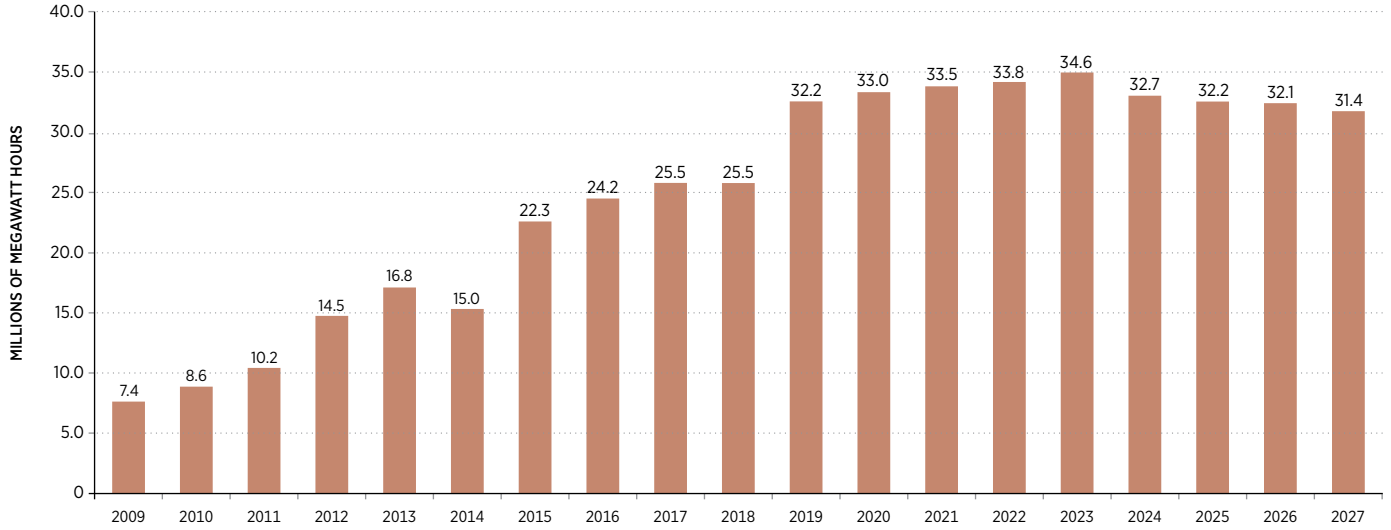
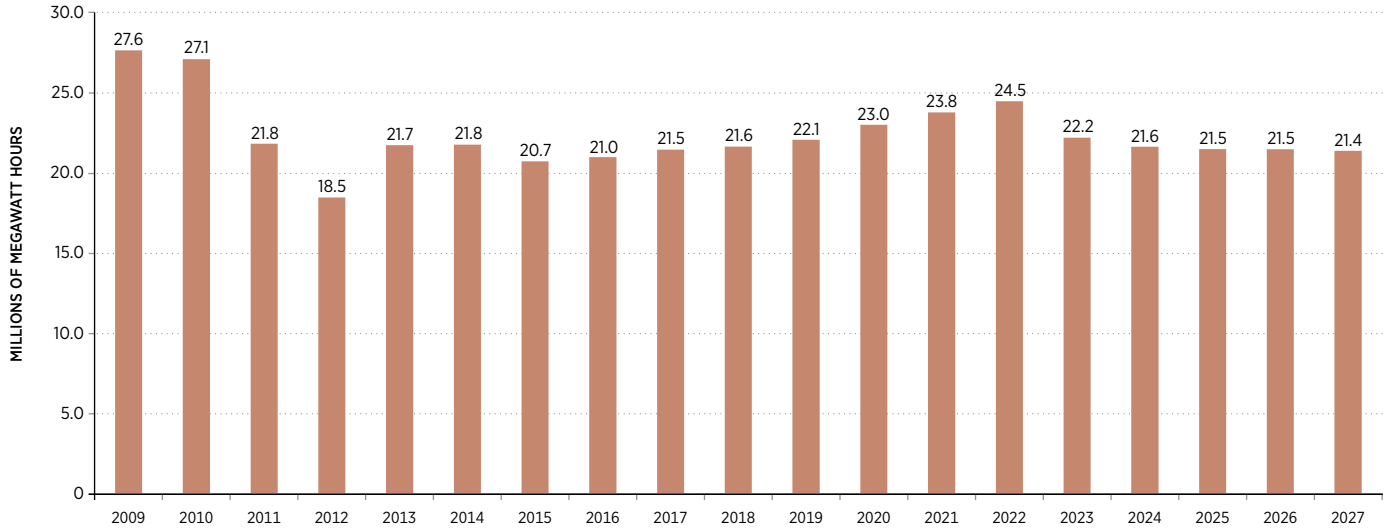


FIGURE ES–4: Dominion's Recent and Projected Generation from Company–owned Coal–Fired Units, 2008–2027.



Moreover, there is no evidence to suggest that Dominion will significantly reduce its current dependence on coal–fired capacity. In fact, the results of Dominion's resource planning analyses show that with its Preferred Resource Plan, the Company's projected generation from its coal-fired units will be about the same in 2027 as it is expected to be in 2013, despite the planned retirement and conversion of some of the Company's existing coal–fired units. This can be seen in Figure ES–4.

In contrast to this continued heavy reliance on fossil–fired generation, Dominion's use of energy from renewable resources would increase only modestly between 2012 and 2027, continuing to represent only 3 percent of the Company's energy mix as late as 2027. This is not surprising given that its Preferred Resource Plan only includes 153 MW of new biomass capacity (converted from coal burning), 15 MW of municipal solid waste capacity, 34 MW of nameplate solar capacity, and 248 MW of wind capacity. Clearly, Dominion foresees the same marginal role for renewable resources in 2027 as it had in 2012.

Moreover, while energy efficiency is a least–cost resource that serves as an important hedge against risky fossil–fuel capacity, Dominion failed to evaluate, let alone select, a plan that would achieve the Commonwealth's goal of reducing retail electric consumption by 10 percent from 2006 levels by 2022. Instead, the Company's Preferred Resource Plan projects achieving less than one–half of the 10 percent goal through 2027, adding only approximately 615 MW of demand–side management ("DSM") resources by 2017 and 206 MW of subsequent DSM resources between 2018 and 2027.

THE RISKS FROM DOMINION'S "BUSINESS-AS-USUAL" PREFERRED RESOURCE PLAN

The Company's Preferred Resource Plan is fraught with significant risks for the Company's ratepayers and the environment. These risks include:

- Uncertainty over natural gas prices. Dominion's Preferred Resource Plan includes the construction of more than 4000 MW of new gas-fired combined cycle generating capacity, which will make the Company's rates increasingly dependent on natural gas prices.
- Uncertainty over coal prices. Dominion's Preferred Resource Plan will also remain heavily committed to coal-fired generation for decades, which means the Company's rates will also depend, to a significant degree, on the delivered cost of coal.
- Uncertainty about future greenhouse gas regulations and prices. As a result of Dominion's continued heavy dependence on coal and natural gas, and its extremely limited investments in energy efficiency and non-carbon-emitting renewable resources, under the Preferred Resource Plan, the Company's annual carbon dioxide ("CO_2") emissions will increase by more than 50 percent between 2013 and 2027. These increasing emissions represent a significant economic risk for the Company's ratepayers in light of pending federal carbon regulations and the impacts of climate change.
- Risks associated with continuing to operate aging fossil-fired power plants in light of the large capital expenditures that may be necessary to bring those units into compliance with current and pending environmental regulations.
- Uncertainty whether Dominion's aging coal plants will experience declining operating performance and higher operating costs as a result of the aging of plant components and equipment.
- Uncertainty regarding the actual construction cost of Dominion's proposed North Anna 3 nuclear power plant.[6]
- Uncertainty regarding Dominion's energy forecasts. While Dominion's peak loads have been essentially flat between 2006 and 2012, the Company's Preferred Resource Plan is predicated on robust load growth continuing almost indefinitely. Lower peak loads and energy sales would reduce the need for, and the relative economics of, the new gas-fired and nuclear capacity included in the Preferred Resource Plan.

DOMINION'S ENERGY EFFICIENCY POTENTIAL

Energy efficiency has emerged as one of the most cost-effective approaches for a utility to meet growing energy demand, lower customer bills, and spur local job growth. What was once a developing idea is now a thriving industry in utility jurisdictions in nearly all 50 states. In 2010, energy efficiency programs saved customers in the U.S. and Canada over 124 million MWh of electricity and 1.3 billion therms of natural gas, which is equivalent to the electricity output of nearly 20 large power plants. Investing in energy efficiency at the achievable level should be a key component of Dominion's plans for meeting the energy needs of its customers over the coming years. Failing to adequately consider energy efficiency to meet demand growth misses an opportunity to utilize the "least cost" resource available to utilities, which provides maximum benefits to ratepayers.

While the amount that Dominion plans to save from energy efficiency programs through 2027 is far below what is achievable, Virginia has significant potential for cost-effective energy efficiency. The analysis in this Report reveals that, conservatively, the Company could reach and sustain energy efficiency savings of 1.3 percent of energy sales per year after a short period of ramping up from existing program levels. This 1.3 percent annual savings goal is consistent with what other utilities have achieved cost-effectively in recent years.

FIGURE ES-5: Achievable Annual Energy Efficiency Savings (MWh)

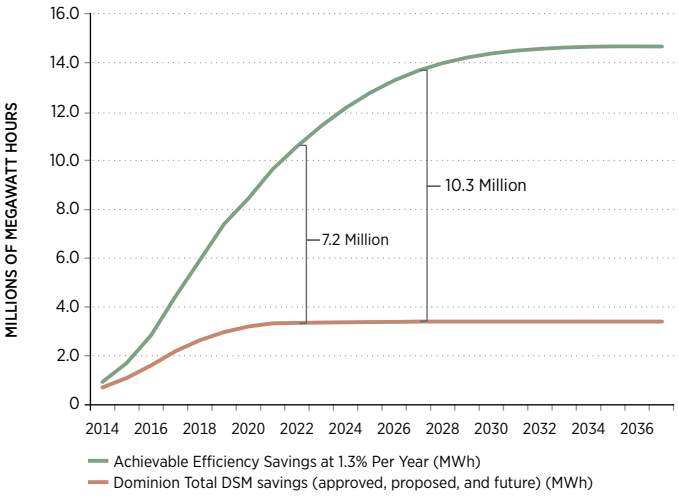
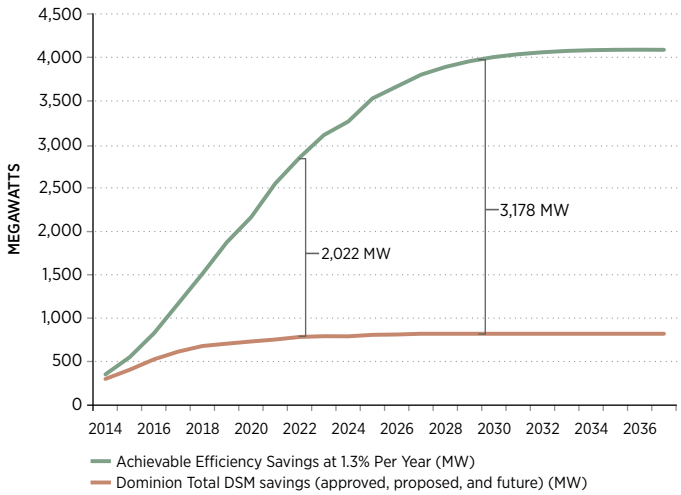


FIGURE ES–6: Achievable Annual Energy Efficiency Savings (MW)



An expanded energy efficiency portfolio would produce significantly more savings in both MWh of energy and MW of capacity than the limited efforts that the Company has included in its Preferred Resource Plan. The analysis in this Report estimates that the investments needed to save approximately 77 million MWh through 2027 would be far less than Dominion would spend on the power generated by the construction and operation of its two planned NGCC units.

DOMINION'S RENEWABLE RESOURCE POTENTIAL

The use of renewable resources has soared throughout the U.S. as the levelized costs for renewable technologies have plummeted. Although Dominion's Preferred Resource Plan adds very small amounts of renewable solar and wind capacity over the next 14 years, Virginia has significant resources of both solar and wind that could be developed for the benefit of Dominion's ratepayers and the Commonwealth as a whole.

SOLAR RESOURCES

The number of solar installations in the U.S. has surged in the past four years, climbing from a cumulative 817 MW of installed capacity in 2009 to 7,293 MW in 2012. This dramatic increase in the installation of new solar capacity has been driven, in large part, by plummeting prices for new solar systems. The median installed prices for residential and commercial photovoltaic systems fell by 11–14 percent from 2010 to 2011, and fell by an average of 5–7 percent annually between 1998 and 2011. The Solar Energy Industries Association has reported that nationally, solar installed prices fell another 14 percent between 2011 and 2012, with the average price of a solar panel declining by 60 percent since just the beginning of 2011.

Virginia's 2007 and 2010 Energy Plans note that the Commonwealth has the technical potential to generate 11,000 to 13,000 MW of solar PV. Thus, it is very disappointing that Virginia reported less than 5 MW of installed solar capacity as of 2011, all from customer–owned distributed generation. Even with the addition of Dominion's proposed 30 MW of Company–owned solar facilities, the amount of solar installed in Virginia will still be far less than Virginia's technical potential, and far less than the amount of solar PV installed as of the end of 2012 in North Carolina (259 MW), Maryland (120 MW), New Jersey (1,051 MW), or Pennsylvania (204 MW). Further, Dominion's Preferred Resource Plan would include only 34 MW of solar PV capacity as late as 2027.

The installation of a significant amount of solar capacity would have a number of substantial benefits for the state of Virginia, as the 2007 Virginia Energy Plan discussed:

> *These [solar PV] systems, integrated into the electric grid, could support local distribution systems during peak demand, provide reactive power control, support disaster recovery, provide a hedge against fuel–cost uncertainties, and provide other benefits. Solar electric is especially valuable in off–setting peak demand in summer, the time for solar energy generation.*

LAND–BASED WIND

There has been a surge in the addition of new domestic land–based wind capacity. In 2012, 13.2 gigawatts ("GW") of new wind capacity was commissioned in the United States, bringing total wind capacity in the nation to above 60 GW.

States near Virginia have added significant amounts of new land–based wind capacity in recent years, including 583 MW of capacity in West Virginia, 120 MW of capacity in Maryland, and 1,340 MW of capacity in Pennsylvania. However, despite acknowledging that Virginia has the potential for at least 800 MW of onshore wind, Dominion has no plans to add any wind capacity until 2022, and even then, the Preferred Resource Plan includes the addition of only 248 MW of wind by 2024. This lack of planned investment is surprising given the Company's acknowledgement that there has been a 30 percent decline in wind turbine prices in recent years and a 20 percent improvement in wind turbine perfor-

mance. Moreover, delaying development of new wind projects until 2022–2024 could mean forfeiting the benefits of the federal Wind Production Tax Credit, whose long-term prospects for renewal are uncertain.

OFFSHORE WIND

Virginia also has significant offshore wind capacity potential in both the near-term and the long-term. The U.S. Department of Interior has estimated that in the near-term, 2,000 MW of offshore wind capacity could be installed in the Virginia Offshore Wind Energy Area that has been designated by the U.S. Bureau of Ocean Energy Management ("BOEM") as available for lease for commercial wind development. In the long-term, the 2010 Virginia Energy Plan estimated that the Commonwealth has the potential for 28,100 MW of installed offshore wind generating capacity.

By contrast with the U.S., which doesn't yet have any operating offshore wind capacity, Europe has 4,995 MW of installed offshore wind turbines, including the addition of 293 offshore wind turbines in 2012, representing 1,165 MW of new capacity. Another 14 projects that will increase Europe's offshore wind capacity by an additional 3,300 MW, are under construction.

The declining cost and improving performance trends for land-based wind technologies should improve the economics of offshore wind energy. Further, Dominion has acknowledged that the siting of wind turbines in the BOEM-designated Virginia Wind Energy Area will provide lower transmission costs. Yet Dominion's Preferred Resource Plan includes no investments in offshore wind over the 15-year planning period.

Land-based and offshore wind should have a significant role to play in Dominion's future resource mix due to its relative cost and its value as a hedge against future fossil fuel price increases and future CO_2 emissions costs. Moreover, as an electricity generation technology that does not emit any pollutants such as nitrogen oxide, aulfur dioxide, or small particulates, or create toxic or radioactive by-products, wind has substantially lower societal public health and environmental impacts and costs than fossil-fired and nuclear generation.

A CLEAN ENERGY INVESTMENT PLAN FOR DOMINION

A moderately aggressive, cost-effective Clean Energy Investment Plan would be a first, but significant step in moving Dominion in a new direction—away from such a heavy reliance on fossil-fired generation and toward substantial investments in clean and non-carbon-emitting energy efficiency and renewable resources. In this first step, the Clean Energy Investment Plan would use the following portfolio of resources to replace one or both of Dominion's planned large natural gas-fired units, reduce the generation at its existing fossil-fired units, and/or reduce its purchases of fossil-fired generation through the PJM energy market.

1. Energy efficiency spending and programs designed to achieve 1.3 percent annual savings.
2. The installation of 100 MW of distributed solar PV capacity in 2015, 150 MW in 2016, and 200 MW in each subsequent year for a total of 2,450 MW by 2027. Additional distributed solar PV capacity would continue to be installed after 2027.
3. The installation of 120 MW of land-based wind in 2019, 80 MW in 2020, 80 MW in 2021 and 80 MW in 2022, for a total of 360 MW.
4. The installation of 500 MW of offshore wind in 2022, 500 MW in 2026, 500 MW in 2029 and 500 MW in 2032. This would result in the 2,000 MW of capacity potential that the U.S. Department of Interior has identified for the Virginia Offshore Wind Energy Area.

TABLE ES-1: The Clean Energy Investment Plan Through 2027.

	RENEWABLE RESOURCES			DEMAND SIDE RESOURCES
Year	**Solar**	**Onshore Wind**	**Offshore Wind**	**Cumulative MW of Energy Efficiency Above That Planned by Dominion**
2014				52 MW
2015	100 MW			144 MW
2016	150 MW			299 MW
2017	200 MW			553 MW
2018	200 MW			831 MW
2019	200 MW	120 MW		1164 MW
2020	200 MW	80 MW		1428 MW
2021	200 MW	80 MW		1795 MW
2022	200 MW	80 MW	500 MW	2061 MW
2023	200 MW			2311 MW
2024	200 MW			2467 MW
2025	200 MW			2716 MW
2026	200 MW		500 MW	2849 MW
2027	200 MW			2977 MW

These goals are achievable based on domestic experience with the construction and operation of energy efficiency, solar PV, and land-based wind resources and the European track record with installing offshore wind capacity.

By 2027, the Clean Energy Investment Plan would provide nearly 6,800 MW of installed non-emitting clean capacity (3,750 MW firm) and nearly 18 million MWh of non-emitting clean energy each year. Moreover, these numbers would increase beyond 2027 as additional energy efficiency investments are made and as more distributed solar and offshore wind capacity is added.

Eventually, the Clean Energy Investment Plan would provide more than 23 million MWh of non-emitting clean energy each year by 2032 and more than 24 million MWh by 2037.

THE BENEFITS AND RISKS OF A CLEAN ENERGY INVESTMENT PLAN COMPARED TO DOMINION'S "BUSINESS-AS-USUAL" PREFERRED RESOURCE PLAN

Dominion currently plans to add two new large natural gas-fired units in the near-term as part of its Preferred Resource Plan — the Brunswick NGCC plant in 2016 and a second NGCC plant in 2019. This Report evaluates the costs and benefits of the Clean Energy Investment Plan in two scenarios. In the first scenario, the Clean Energy Investment Plan replaces both of Dominion's two planned NGCC plants. In the second scenario, we have assumed that either the Brunswick plant or the 2019 NGCC plant will be built, but not both. Consequently, in this second scenario, the Clean Energy Investment Plan would only replace one of Dominion's two planned NGCC plants, with the remaining clean energy available under that plan offsetting market purchases.

The Report reveals that the Clean Energy Investment Plan produces significant economic and risk reduction benefits, whether compared against one or both of Dominion's planned NGCC units.

COST: As shown in Tables ES-2 and ES-3, the Clean Energy Investment Plan would be less expensive for ratepayers through 2027 across a range of assumed natural gas, PJM energy market, and CO_2 prices than building and operating both of the Company's planned NGCC facilities.

TABLE ES-2: Economic Comparison with Both of Dominion's Planned NGCC Units – Lower Natural Gas and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
Millions of PV 2013 Dollars			
ICF CO_2	$6,454	$7,087	–$633
Synapse Low CO_2 Prices	$6,592	$7,488	–$895
Synapse Mid CO_2 Prices	$6,639	$7,758	–$1,119
Synapse High CO_2 Prices	$6,731	$8,226	–$1,496

TABLE ES-3: Economic Comparison with Both of Dominion's Planned NGCC Units — Higher Natural Gas Prices and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
Millions of PV 2013 Dollars			
ICF CO_2	$6,745	$7,807	–$1,061
Synapse Low CO_2 Prices	$6,884	$8,207	–$1,324
Synapse Mid CO_2 Prices	$6,930	$8,477	–$1,547
Synapse High CO_2 Prices	$7,022	$8,802	–$1,780

In addition, as shown in Tables ES-4 and ES-5, the Clean Energy Investment Plan would be less expensive for ratepayers across a range of assumed natural gas, PJM energy market, and CO_2 prices than building and operating one of the two NGCC units that Dominion plans to build and operate by 2019.

TABLE ES-4: Economic Comparison with One of Dominion's Two Planned NGCC Units – Lower Natural Gas and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF ONE OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
Millions of PV 2013 Dollars			
ICF CO_2	$3,488	$3,046	$441
Synapse Low CO_2 Prices	$3,299	$3,246	$53
Synapse Mid CO_2 Prices	$3,125	$3,380	–$255
Synapse High CO_2 Prices	$2,835	$3,614	–$779

TABLE ES-5: Economic Comparison with One of Dominion's Two Planned NGCC Units – Higher Natural Gas Prices and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF ONE OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
Millions of PV 2013 Dollars			
ICF CO_2	$3,267	$3,345	–$78
Synapse Low CO_2 Prices	$3,068	$3,544	–$477
Synapse Mid CO_2 Prices	$2,904	$3,679	–$775
Synapse High CO_2 Prices	$2,614	$3,769	–$1,155

Fuel Mix Diversity: After a ramping-up period, the Clean Energy Investment Plan would provide real fuel diversity and would provide significantly more energy and firm capacity each year than either or both of the NGCC units that Dominion is planning to add by 2019 as shown in Figures ES-7 and ES-8.

FIGURE ES-7: Annual Energy from the Clean Energy Investment Plan versus Dominion's Planned NGCC Units.

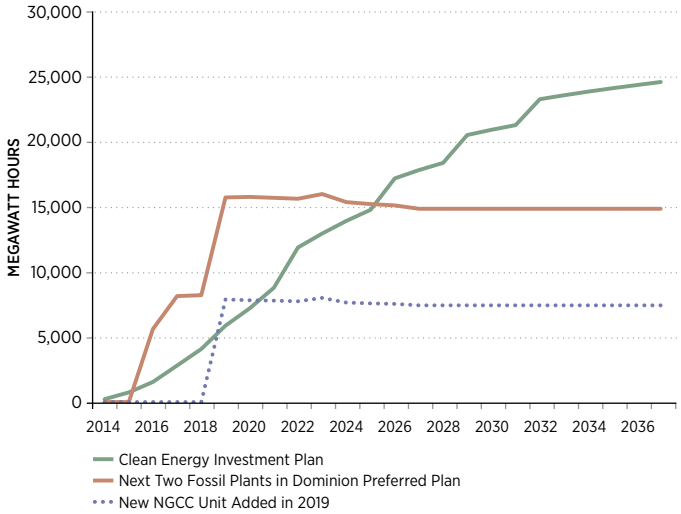
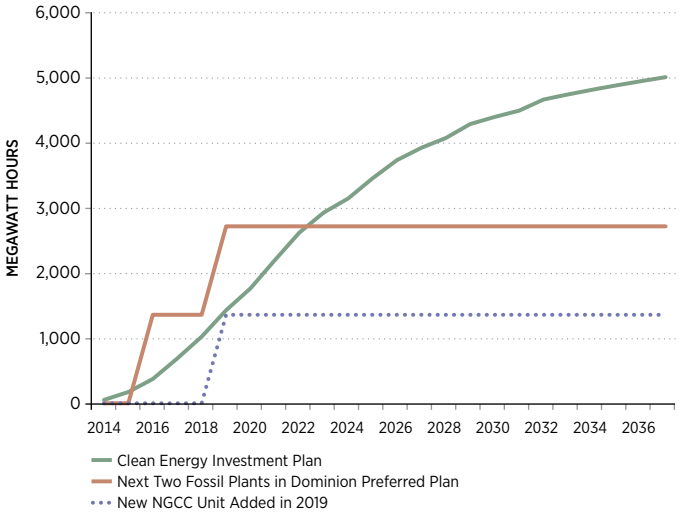


FIGURE ES-8: Firm Capacity from the Clean Energy Investment Plan versus Dominion's Planned NGCC Units.



Consequently, with the Clean Energy Investment Plan, Dominion would have a much more diverse energy fuel mix than its Preferred Resource Plan with either or both of the two new NGCC units.

TABLE ES-6: Dominion Fuel Mix in 2027—Dominion Preferred Plan with Both Planned NGCC Units vs. Clean Energy Investment Plan.[7]

	DOMINION PREFERRED RESOURCE PLAN	CLEAN ENERGY INVESTMENT PLAN REPLACING 2 NGCC UNITS + PJM PURCHASES	CLEAN ENERGY INVESTMENT PLAN REPLACING 1 NGCC UNIT + PJM PURCHASES
Nuclear	34%	34%	34%
Coal	18%	18%	18%
Natural Gas	27%	14%	20%
NUG Purchases	0%	0%	0%
PJM Purchases	14%	12%	5%
Fuel Oil	0%	0%	0%
Renewables	3%	10%	10%
DSM	3%	12%	12%
TOTAL	**100%**	**100%**	**100%**

Hedge against Fuel Price and PJM Energy Market Price Uncertainty and Volatility: Even during the ramping-up period between 2014 and 2027, the Clean Energy Investment Plan would produce a total of 120 million MWh of clean non-emitting energy. By 2037, the Clean Energy Investment Plan will have produced 344 million MWh of non-emitting energy. Thus, this plan would act as an effective hedge for Dominion's ratepayers against future increases in natural gas prices, coal prices, and PJM energy market prices.

Hedge against Future CO_2 Costs: When replacing both NGCC facilities, the Clean Energy Investment Plan would reduce the Company's total CO_2 emissions by approximately 31 million tons between 2014 and 2027 and by approximately 152 million tons between 2014 and 2037. When replacing one NGCC and offsetting 51 million MWh of PJM purchases or generation at the Company's existing fossil-fired power plants, the Clean Energy Investment Plan would reduce the Company's total CO_2 emissions by approximately 68 million tons between 2014 and 2027 and by approximately 218 million tons between 2014 and 2037. Consequently, the Clean Energy Investment Plan would be an effective hedge against future CO_2 costs.

Lower PJM Capacity Market Prices: Over time, a Clean Energy Investment Plan would have a positive impact on customers by lowering the market-clearing prices in the regional PJM capacity market.

Positive Benefits for the Electric Grid: Energy efficiency and distributed solar and, where possible, distributed wind resources can have a number of positive benefits for the electric grid:

- Avoided transmission improvements.
- Less grid congestion.
- Better security with less risk of a potentially significant attack on the already centralized U.S. electric grid.
- Fewer line losses.

Dominion and other utilities have argued against incorporating increased energy efficiency and renewable resources by noting that these resources are "intermittent" and therefore not "dispatchable." This argument is misleading because (a) not every increment of generating capacity on the grid has to be dispatchable and (b) both the Dominion system, and the larger PJM transmission grid to which it is connected, already have tens of thousands of MW of dispatchable capacity. The energy efficiency, distributed solar, and land–based and offshore wind resources included in the Clean Energy Investment Plan can provide both reliable energy and contribute to providing needed capacity for the PJM grid, a fact that is recognized and accepted by PJM.

Cleaner Air and Reductions in Climate Change Pollution: The addition of new natural gas–fired combined cycle capacity, and the Company's retirement and conversion of some existing coal–fired capacity, would lower Dominion's emissions of critical pollutants like SO_2, NO_x and mercury. However, replacement of the planned Brunswick and 2019 NGCC plants with the non–emitting energy efficiency and renewable resources in the Clean Energy Investment Plan would reduce Dominion's emissions even more and, over time, would allow the Company to significantly reduce its purchases of coal–fired energy generated at dirty power plants elsewhere in PJM. Further, as noted above, the Clean Energy Investment Plan would significantly reduce Dominion's CO_2 emissions, a greenhouse gas that contributes to climate change.

Enhanced Resource Plan Flexibility: Building a large power plant to meet customer demand is an all–or–nothing proposition. Once the plant is built (and even before completion), ratepayers are committed to paying its construction and operating costs. This is true whether or not the energy load the plant purports to serve materializes and regardless of the price of fuel or any environmental control or compliance costs that may come into effect in the future. The Clean Energy Investment Plan would add new capacity in much smaller increments, thereby providing Dominion with much greater flexibility to modify the resource plan in light of changed circumstances.

CONCLUSION

This Report reveals that even a moderately aggressive Clean Energy Investment Plan would produce significant benefits for Dominion's ratepayers. While the Company's Preferred Resource Plan presents a business–as–usual approach that continues the Company's dependence on large fossil–fired generating units, this is an approach that is fraught with substantial uncertainties and risks for ratepayers and the environment. Rather, the Clean Energy Investment Plan presents an economically viable option that will allow Dominion to move toward a truly diverse resource portfolio that manages and reduces or eliminates these risks.

PURPOSE AND SCOPE OF THE REPORT

The authors of this report were asked to evaluate the potential for additional energy efficiency[8] and renewable energy in Virginia, and to analyze the economic costs and benefits of a Clean Energy Investment Plan for Dominion Virginia Power ("Dominion" or "the Company") in comparison to the "Preferred Resource Plan" and other alternatives evaluated in the Company's 2012 Integrated Resource Plan ("IRP"). This report presents the results of our analyses.

The Clean Energy Investment Plan considered here is a moderately aggressive plan, just a first step in addressing the future welfare of Virginians. It is not an estimate of the maximum technological potential for clean energy, but rather was developed within the restrictive regulatory structure currently in place in Virginia. The steps taken in this plan are based on technologies already known, commercialized, and expected to be economically feasible within the time frame established. The Clean Energy Investment Plan considers a limited set of changes from Dominion's Preferred Resource Plan that are economically competitive; i.e., that would be as economic or more so than the Preferred Resource Plan based on current conditions and conservative projections of future trends.

CHANGING COURSE

INTRODUCTION

Virginia has substantial untapped potential for energy efficiency and renewable energy resources, particularly solar and offshore wind. Even a modest Clean Energy Investment Plan would produce significant benefits for Dominion's ratepayers.

However, instead of pursuing this new direction, Dominion has chosen a Preferred Resource Plan that continues its historic dependence on large central-station fossil-fired and nuclear generating units. Although this business-as-usual approach has produced significant profits for the Company, it is a resource strategy that is fraught with substantial uncertainties and risks for ratepayers and the environment. These include:

- **Uncertainty over natural gas prices.** Dominion's Preferred Resource Plan includes the construction of more than 4,000 megawatts ("MW") of new natural gas-fired combined cycle ("NGCC") generating capacity, which will make the Company's rates increasingly dependent on natural gas prices.
- **Uncertainty over coal prices.** Dominion's Preferred Resource Plan will also remain heavily committed to coal-fired generation for decades, which means the Company's rates will also depend, to a significant degree, on the delivered cost of coal.
- **Uncertainty about future greenhouse gas regulations and prices.** As a result of Dominion's continued heavy dependence on coal and natural gas, and its extremely limited investments in energy efficiency and non-carbon-emitting renewable resources, the Company's annual carbon dioxide ("CO_2") emissions will increase significantly, rather than decrease, for the foreseeable future. In fact, Dominion's own modeling analyses show that with the Preferred Resource Plan, its annual CO_2 emissions will increase by more than 50 percent between 2013 and 2027. These increasing emissions would represent a growing economic risk for the Company's ratepayers as well as contributing to global climate change.
- **Risks associated with continuing to operate aging fossil-fired power plants** in light of the large capital expenditures that may be necessary to bring those units into compliance with current and pending environmental regulations.
- **Uncertainty whether Dominion's aging coal plants will experience declining operating performance** and higher operating costs as a result of the aging of plant components and equipment.
- **Uncertainty regarding the actual construction cost** of Dominion's proposed North Anna 3 nuclear power plant.[9]
- **Uncertainty regarding Dominion's energy forecasts.** While Dominion's peak loads have been essentially flat between 2006 and 2012, the Company's Preferred Resource Plan is predicated on robust load growth continuing almost indefinitely. Lower peak loads and energy sales would reduce the need for, and the relative economics of, the new gas-fired and nuclear capacity included in the Preferred Resource Plan.

However, there is another direction that the Company could take. Dominion could make serious investments in energy efficiency and the development of renewable solar and wind resources instead of consigning these viable energy options to the extremely minor roles that they have historically played and that the Company's current resource plan foresees they will continue to play in the next 14 years, if not longer. This new direction would provide a number of significant benefits for ratepayers, the citizens of Virginia and the environment. A Clean Energy Investment Plan would:

- **Be less expensive for ratepayers in most scenarios** than building and operating one or both of the new natural gas-fired power plants that Dominion plans to add by 2019.
- **Provide real fuel diversity** that would offer an effective hedge against uncertainty and volatility in fossil fuel prices and the costs of purchasing power from plants owned by other companies.

- **Reduce Dominion's dependence on power produced at fossil-fired power plants in neighboring states.**
- **Significantly reduce the Company's carbon dioxide emissions,** which are a major cause of climate change and will be a financial risk when carbon is eventually regulated.
- **Result in cleaner air in Virginia and neighboring states.**
- **Provide positive benefits for the electric grid** including avoided need for transmission improvements, less grid congestion, better security and fewer line losses.
- **Provide more flexibility,** allowing Dominion to more easily revise its resource plans in light of changing circumstances.

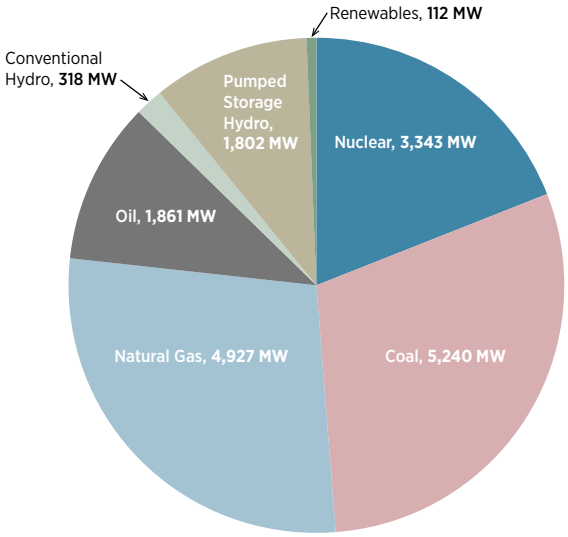
Changing Dominion's course will not be easy and will not be accomplished by a single act or decision, in a single year or even in a single decade. However, the change must start now as the Company's preferred route is not sustainable over the long-term and will lead to significant economic risk for its customers.

SECTION I — DOMINION'S EXISTING GENERATION RESOURCES

Dominion is the largest electric utility in the Commonwealth of Virginia, providing approximately two-thirds of the electricity consumed in the state. It has, on average, about 2.5 million customer accounts in Virginia and northeastern North Carolina, with approximately 95 percent of its sales in Virginia.

Dominion owns 102 generating units totaling 17,603 MW of capacity.[10] As shown in Figure 1 below, approximately 12,000 MW, or nearly 70 percent, of the company-owned capacity comes from fossil-fired plants that burn coal, natural gas, and oil.

FIGURE 1: Dominion's 2012 Installed Capacity.[11,12]



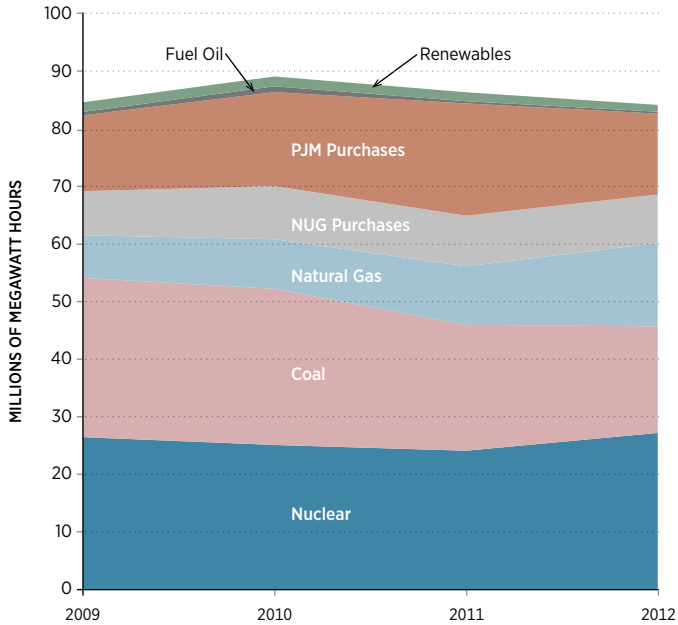
Dominion also has 1,747 MW of capacity contracted from non-utility-generators ("NUGs") under contracts that will expire over the next eight years, with the last NUG contract expiring in 2021. As can be seen from Table 1, below, 1,684 of these megawatts are from coal or natural gas-fired facilities.

TABLE 1: Dominion 2012 Contracted NUG Capacity.[13]

FUEL	MW
Coal	742
Natural Gas	942
Municipal Solid Waste	63
TOTAL	**1,747**

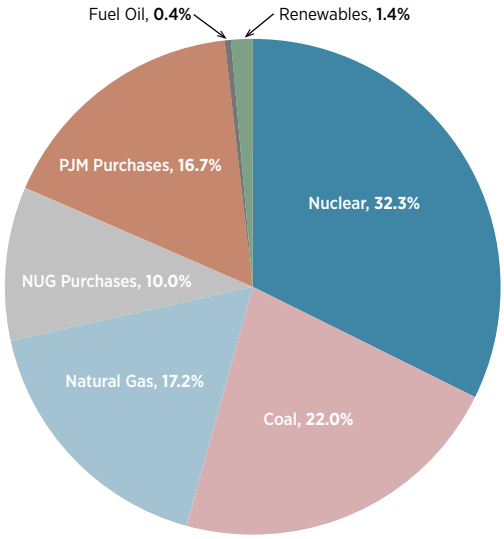
Given all of Dominion's owned nuclear and owned and NUG-contracted fossil-fired capacity, it is not surprising that the Company's energy generation mix in recent years has been very heavily dependent on nuclear, coal and, increasingly, natural gas.

FIGURE 2: Dominion Historic Energy Mix 2009-2012.



For example, as Figure 3 shows, the generation at the Company's gas-fired units provided approximately 17 percent of Dominion's energy mix in 2012, which reflected almost a doubling of gas-fired generation in only the three years since 2009. Although its contribution had shrunk since 2009, coal still represented 22 percent of Dominion's energy mix in 2012. Renewable resources, including hydro and biomass (but no wind or solar) represented only 1.4 percent of Dominion's energy mix.

FIGURE 3: Dominion's 2012 Energy Mix.



However, even Figures 1 through 3 and Table 1 understate the Company's dependence on fossil fuels. This is because, in addition to Dominion-owned units and contracts with non-company NUGs, the Company makes significant capacity and energy purchases from other generating units in PJM.[14]

Published data shows that coal and gas provided 95 percent of the marginal generation in PJM in 2011 and 89 percent of the marginal generation in 2012.[15] Also, Dominion has said that PJM power typically flows from the west, which traditionally has more coal capacity, to Dominion's PJM service territory ("Dom Zone") in the east, which is a net importer.[16] Given these factors, it is reasonable to expect that much, if not all, of the capacity and energy that Dominion has purchased from the PJM market has been fossil-fired.[17] Adding all of these energy sources — that is, generation from Dominion-owned gas, coal and oil-fired units, generation purchased from NUGs and generation purchased from PJM, it is clear that more than two-thirds of the energy sold by Dominion in 2012 was generated by the burning of the fossil fuels.

In addition to its fossil-fired and nuclear capacity, Dominion also has some 430 MW of renewable resources. These resources include the wood-burning Pittsylvania Power Station (83 MW), 29 MW of the Virginia City Hybrid Energy Center, and four hydro facilities.[18] But, as can be seen from Figures 2 and 3, the energy from renewable resources has represented only a relatively small portion of Dominion's overall energy mix in recent years. Unfortunately, this is unlikely to change unless Dominion makes a sharp turn towards a cleaner energy future.

Dominion currently operates a small number of energy efficiency programs[19] that have been approved by the Virginia State Corporation Commission ("SCC"). Five programs were approved as part of Dominion's application for a first phase of demand-side management ("DSM") programs, three of which ended.[20] The SCC recently extended two of the first phase DSM programs: the Low Income Program for two years and the Air Conditioner Cycling Program for three years.[21] Four additional programs were approved as part of Dominion's application for a second phase of DSM programs, and these programs are currently in operation in Virginia.[22] The approved programs (including programs previously approved but now ended) have resulted in cumulative energy savings of roughly 200,000 MWh and 25 MW of peak reduction through the end of 2012.[23] This represents just 0.3 percent of 2006 energy sales.

The Virginia General Assembly has established a voluntary goal for state utilities to reduce electricity consumption by 10 percent by 2022, using 2006 as a benchmark.[24] The SCC found that the 10 percent goal is "realistically accomplishable."[25] Dominion is expected to propose several additional efficiency programs in the fall of 2013. If approved and delivered successfully, these programs would bring total cumulative efficiency savings to 4.3 percent of 2006 consumption by 2022, far below the Commonwealth's 10 percent goal.[26]

SECTION II — DOMINION'S PLANNED RESOURCES

In its 2012 IRP filing with the SCC, Dominion set forth what it termed its Preferred Resource Plan: (a) to meet projected future load and energy sales growth, (b) to replace the capacity and energy it currently purchases under the expiring NUG contracts, and (c) to reduce its capacity and energy purchases from PJM. This Preferred Resource Plan is shown in Table 2.

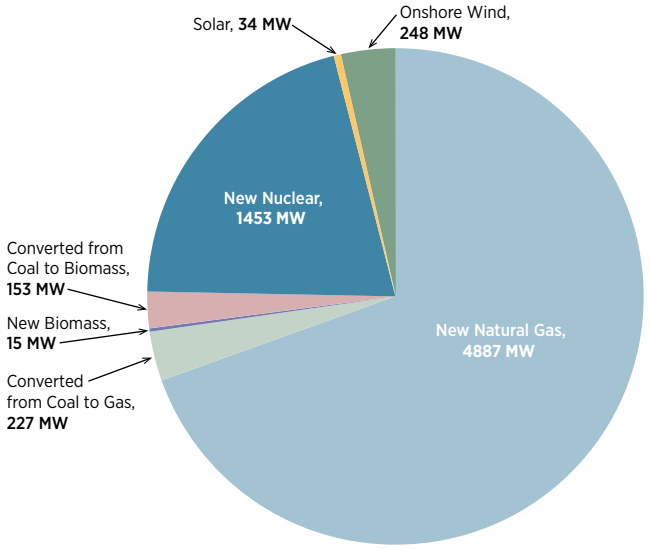
TABLE 2: Dominion Preferred Resource Plan, 2013–2027.					
	SUPPLY-SIDE RESOURCES				**DEMAND-SIDE RESOURCES**
Year	**New**	**Retrofit**	**Repower**	**Retire**	
2013	7 MW of firm power (24 MW nameplate) from company owned Community Solar Power Program		153 MW of capacity at the Altavista, Hopewell and Southampton Plants to burn biomass instead of coal		Approved, Extended and Future DSM Programs — 821 MW by 2027
2014	15 MW of Municipal Solid Waste		227 MW of the Bremo Power Plant to burn gas instead of coal		
2015	1,337 MW of natural gas-fired Warren County NGCC	786 MW Possum Point 5 with SNCR NO_x controls		918 MW of coal at Chesapeake Units 1–4 and Yorktown Units 1–2	
2016	1,375 MW of natural gas-fired Brunswick Project NGCC				
2017					
2018		818 MW Yorktown 3 with SNCR NO_x controls			
2019	1,375 MW unnamed natural gas-fired NGCC				
2020	4 MW of solar (10 MW nameplate)				
2021	400 MW of natural gas-fired combustion turbines				
2022	400 MW of natural gas-fired combustion turbines + 100 MW of wind				
2023	80 MW of wind				
2024	1,453 MW of North Anna 3 nuclear + 48 MW of wind				
2025					
2026					
2027					

If Dominion completes this plan, by 2027 the Company will have:

1. Retired or converted to burn gas or biomass 380 MW of existing coal capacity by 2015 with no further coal retirements in any subsequent years.
2. Added 4,087 MW of new natural gas–fired combined cycle capacity and 800 MW of new gas–fired combustion turbine capacity.
3. Added 1,453 MW of new nuclear capacity.
4. Added 15 MW of municipal solid waste.
5. Added only 34 MW of solar capacity.
6. Added only 248 MW of land–based wind.
7. Added no offshore wind.

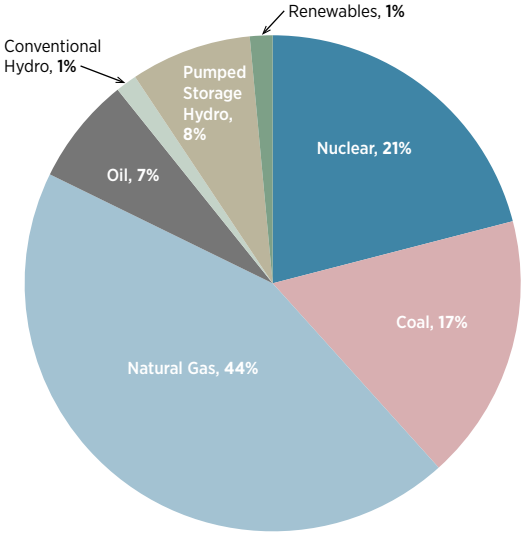
The new capacity that will be added between 2013 and 2027 in the Company's Preferred Resource Plan is shown, by fuel, in Figure 4, below.

FIGURE 4: New Supply Side Capacity to be Added under Dominion's Preferred Resource Plan by Fuel, 2013–2027.



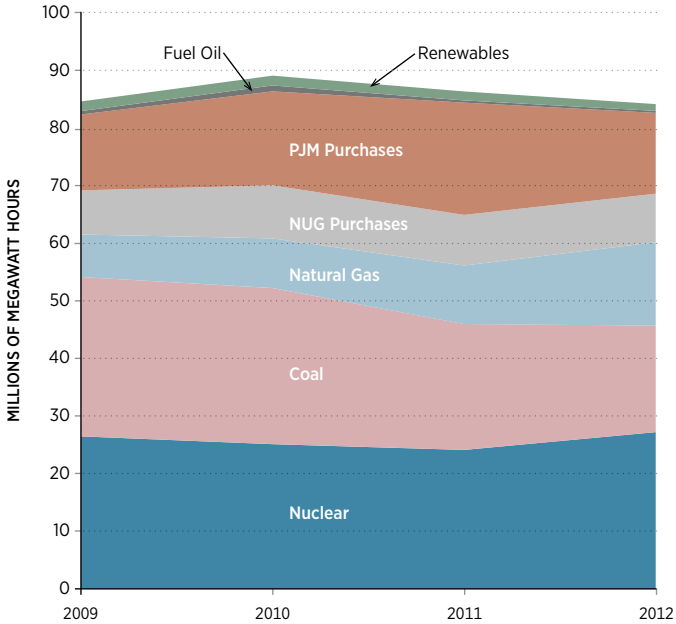
Thus, Dominion's Preferred Resource Plan is essentially a roadmap for building much more natural gas and nuclear capacity while adding extremely minor amounts of renewable solar and wind capacity. By pursuing this Plan, the Company will become even more dependent on natural gas–fired and nuclear capacity in 2027 than it was in 2012. And there is no evidence to suggest that it will significantly reduce its current dependence on coal–fired capacity.

FIGURE 5: Dominion's Projected 2027 Installed Capacity.[27, 28]



Given the planned large increase in Company–owned natural gas capacity, it is not surprising that generation from gas–fired units would play an increasing role in Dominion's energy mix during the years 2013 through 2027, as can be seen in Figure 6, below.

FIGURE 6: Dominion Projected 2013–2027 Energy Mix.



Dominion's increasing reliance on power produced at Company–owned natural gas–fired plants is even more clearly shown in Figure 7.

FIGURE 7: Dominion's Recent and Projected Generation from Company–owned Natural Gas Units, 2008–2027.

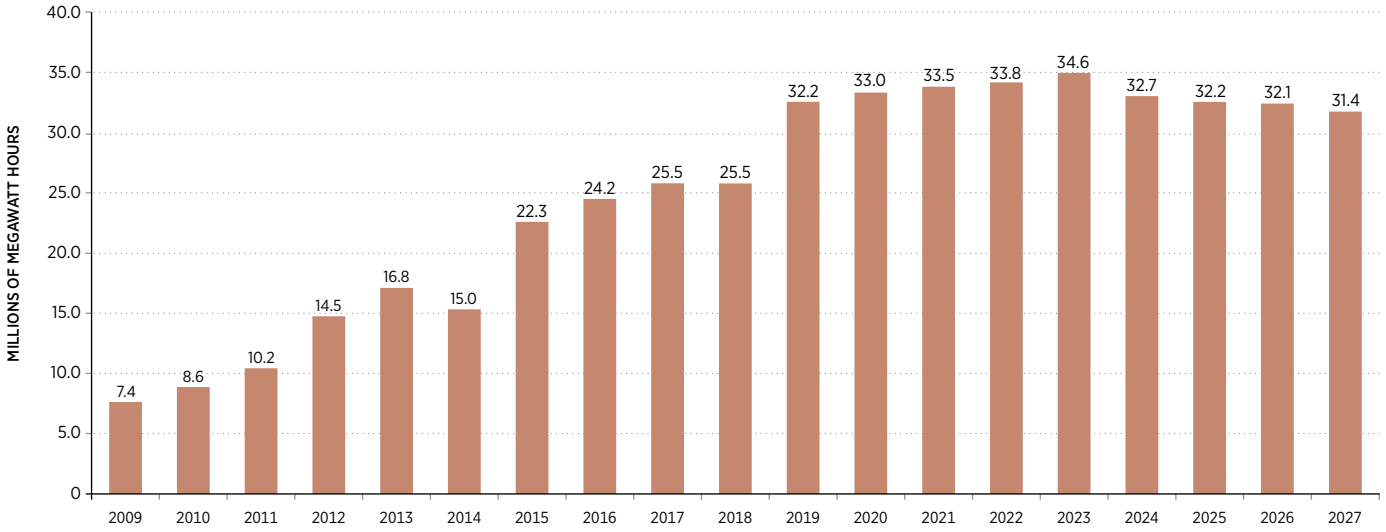
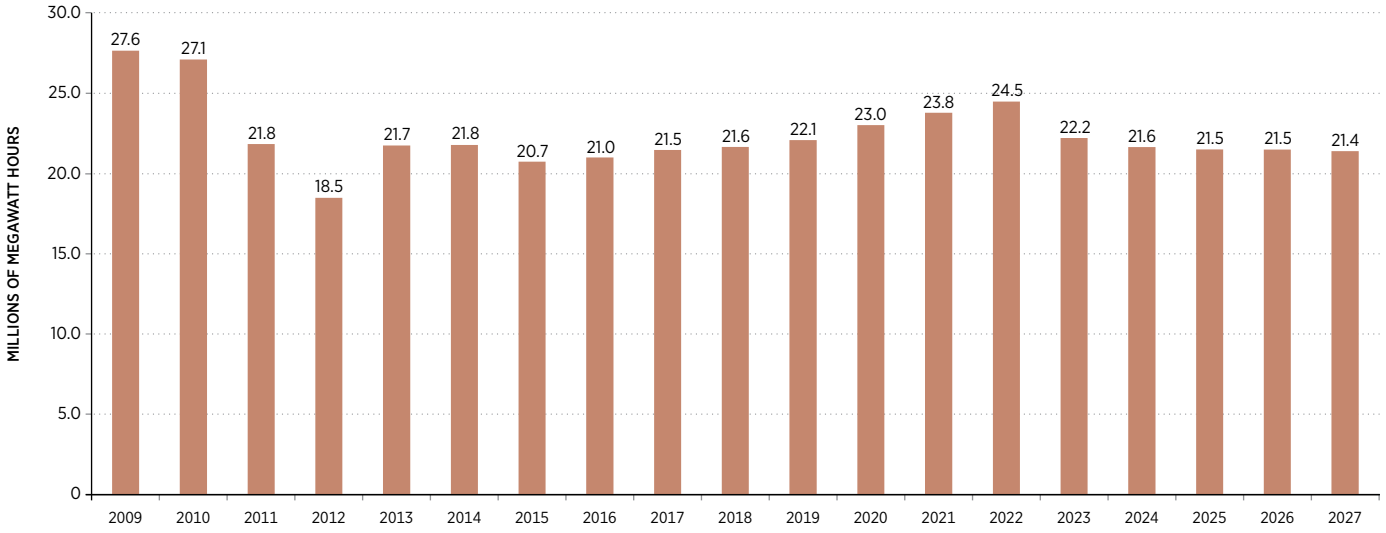


FIGURE 8: Dominion's Recent and Projected Generation from Company–owned Coal–Fired Units, 2008–2027.



Thus, under Dominion's Preferred Resource Plan, the Company's reliance on the generation from its own natural gas units will increase by 324 percent between 2012 and 2027. Dominion Chairman, President and CEO Thomas Farrell recently warned that overreliance on natural gas is "coming" and that "it is a mistake."[29] Unfortunately, his only solution for reducing reliance on natural gas and lowering carbon emissions is to build more nuclear units. As this report will show, a Clean Energy Investment Plan, with investments in energy efficiency and renewable energy resources, also will reduce the Company's reliance on natural gas and provide other significant benefits for the Company's ratepayers, including substantially lowering Dominion's annual carbon dioxide emissions.

Moreover, Dominion projects that its generation from coal–fired units will not decrease between 2012 and 2027 despite the retirement of 918 MW of existing coal-fired capacity in 2015 and the conversion of another 380 MW to burn natural gas or biomass.

But, at the same time that Dominion's reliance on natural gas will skyrocket and its reliance on coal will not decrease, its use of energy from renewable resources would increase only modestly between 2012 and 2027, continuing to represent only 3 percent of the Company's energy mix as late as 2027. This is not surprising given that its Preferred Resource Plan only includes 153 MW of new biomass capacity (converted from coal burning), 15 MW of municipal solid waste capacity, 34 MW of solar capacity, and 248 MW of wind capacity. Clearly, Dominion foresees the same exact marginal role for renewable resources in 2027 as it had in 2012.

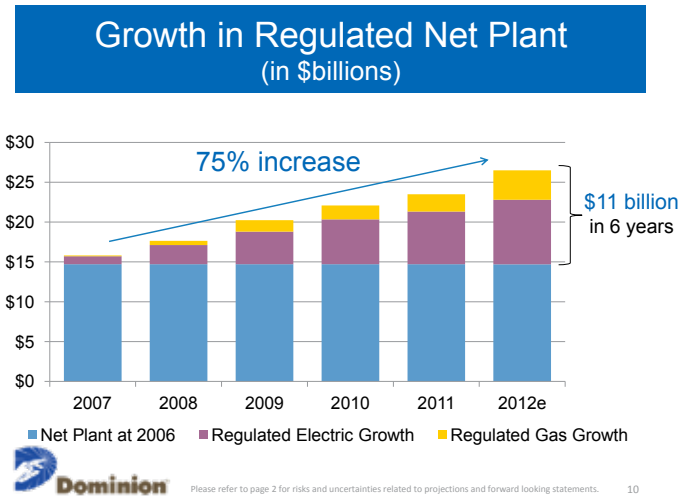
Moreover, while energy efficiency is a least–cost resource that serves as an important hedge against risky fossil–fuel capacity, Dominion failed to evaluate, let alone select, a plan that would achieve the

Commonwealth's goal of reducing retail electric consumption (in MWh) through demand-side resources by 10 percent from 2006 levels by 2022. Instead, the Company's Preferred Resource Plan projects achieving only modest energy savings through DSM programs through 2022. For example, the Plan includes adding only approximately 615 MW of DSM resources by 2017 and another 206 MW of subsequent DSM resources between 2018 and 2027. This means that the Company's Preferred Resource Plan, which covers the entirety of the goal period (i.e. through 2022 plus five additional years to 2027), would achieve savings of just 4.4 percent of 2006 consumption levels by 2027.

WHY DOMINION PREFERS THIS FOSSIL-BASED RESOURCE PLAN

The Company's profits are directly proportional to its rate base (net investment in plant and equipment). As Figure 9, below, shows, the Company is presenting its recent growth in the amount it has invested in new fossil-fueled generation as a benefit for investors.

FIGURE 9: Dominion September 2012 Presentation[30]



One of the conclusions of the same presentation was that Dominion's Regulated Infrastructure Investment Plan "continues to support further earnings growth."[31] In other words, the more that Dominion invests in expensive new fossil-fired and nuclear units, the higher the profit for the Company regardless of the risks to which its ratepayers are exposed by such a plan. And a resource plan that includes more than 4,500 MW of new gas-fired capacity and 1,453 MW of new nuclear capacity conservatively can be expected to add another $10 billion or more to Dominion's rate base by 2024.

SECTION III — THE RISKS FROM DOMINION'S "BUSINESS-AS-USUAL" RESOURCE PLAN

The Company's Preferred Resource Plan is fraught with significant risks for the Company's ratepayers and the environment. These risks include:

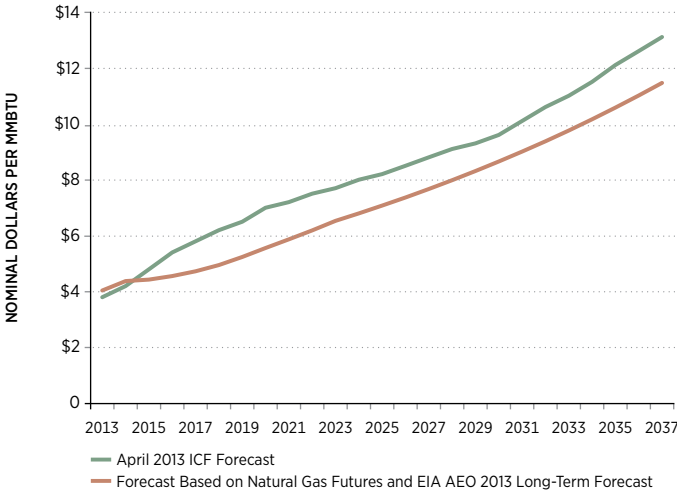
- Natural gas price uncertainty and volatility.
- Coal price uncertainty and volatility.
- Uncertainty in future PJM capacity and energy market prices.
- Uncertainty about future greenhouse gas regulations and prices.
- Uncertainty whether Dominion's aging coal plants will experience declining operating performance and higher operating costs as a result of the aging of plant components and equipment.
- Uncertainty regarding the actual construction cost of Dominion's proposed North Anna 3 nuclear power plant.[32]
- Uncertainty regarding Dominion's energy forecasts.

NATURAL GAS PRICE UNCERTAINTY

The more than 4,000 MW of NGCC generating capacity that Dominion is planning to build as part of its Preferred Resource Plan will make the Company increasingly dependent on natural gas, as shown in Figure 7, above. Consequently, the Company's rates, to an increasingly significant extent, will depend on future natural gas prices. The higher the natural gas price, the higher the Company's fuel rate will be. Moreover, higher natural gas prices would also increase the cost that the Company, and its ratepayers, will have to pay for energy purchased through the PJM energy market.

Natural gas prices have been low in recent years due to increased production from shale gas and the use of horizontal drilling technology. Many forecasts project that although natural gas prices will increase over time, they will continue to remain relatively low for the foreseeable future. However, some projections, including a recent forecast by Dominion's consultant, ICF, Inc., show substantially higher near-term natural gas prices, as can be seen in Figure 10:

FIGURE 10: Future Natural Gas Price Forecasts.



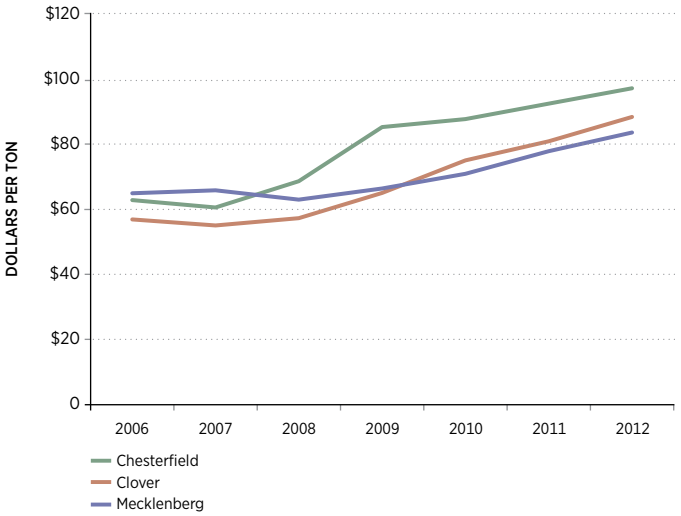
Moreover, it is not guaranteed that natural gas prices over the long term will not be higher even than ICF has recently forecast. In their resource planning analyses, many utilities consider a range of natural gas prices (including base, high, and low forecasts) in their recent forecast that is higher than the range we have included here.

COAL PRICE UNCERTAINTY

With its Preferred Resource Plan, Dominion will remain heavily committed to coal–fired generation for decades. This means the Company's rates will depend, to a significant degree, on the delivered cost of coal.

As shown in Figure 11, below, the delivered prices of the coal burned at the Company's coal–fired power plants have increased significantly in recent years.

FIGURE 11: Recent Delivered Coal Prices at Dominion Coal Plants.



The delivered cost of the coal burned at the Company's Chesterfield and Clover stations increased between 2006 and 2012 at an average annual rate of approximately 7.5 percent, or significantly higher than the overall rate of inflation.[33] The delivered cost of coal burned at the Mecklenburg Cogeneration facility rose at a lower, but not insignificant, 4.3 percent average annual rate.

Further, coal prices could be higher in the future than forecasted either due to increased demand, perhaps through increased exports, or as a result of rapidly rising production costs. As a recent article from SNL Financial noted, U.S. coal producers are scrambling in the face of skyrocketing production costs.[34] Although this report focused primarily on mines in Central Appalachia, mines in Northern Appalachia and other coal–producing areas are not immune to the depletion of less costly coal deposits and increasing production costs. At the same time, international coal market volatility could cause price spikes in domestic prices. For example, high coal prices were cited by Appalachian Power Company as one of the reasons for the 43 percent rate increase it requested from the West Virginia Public Service Commission in 2009.[35]

THE RISK OF EXPENSIVE CAPITAL OR O&M EXPENDITURES

A number of emerging factors could lead to higher capital expenditures and operating costs for the Company's coal–, oil– and natural gas–fired capacity.

First, the U.S. Environmental Protection Agency ("EPA") has finalized or is in the process of finalizing a series of public health and environmental safeguards. These include, but are not limited to, the Cross–State Air Pollution Rule, National Ambient Air Quality Standards for sulfur dioxide and ozone, the Mercury and Air Toxics Rule, a Cooling Water Intake Structures Rule under Section 316(b) of the Clean Water Act, updated Effluent Limitation Guidelines for coal ash and scrubber wastewater discharges, and a Coal Combustion Residuals Rule under the Resource Conservation and Recovery Act. Because of the severe human health and environmental impacts linked to coal–fired power plant pollution, these regulations will disproportionately affect coal more than any other fuel source.

Second, new or more stringent environmental regulations in the future could lead to higher capital expenditures and operating costs.

Finally, the aging of power plant structures, components and equipment could also lead to expensive capital expenditures, higher annual O&M costs and/or degraded operating performance. For example, the four remaining units at Dominion's Chesterfield coal–fired plant are currently 61, 53, 49, and 44 years old. It is reasonable to expect that these units will experience equipment degradation as they continue to age, creating a need for significant investments in equipment repairs or replacements, and increasing the annual operating cost of these units over time.

This risk is likely to become even more substantial as the units age beyond 60 years. In fact, no coal unit of 100 MW or larger has operated for more than 65 years and only a few smaller units have operated longer. Therefore, there is great uncertainty as these plants age about: (a) what the effective and economic operating lives of coal–fired units will be, (b) what additional capital investments will be required, (c) what their operating performance will be (in terms of generation, planned and forced outage rates, availability, and equivalent forced outage rates), and (d) what their operating costs will be.

UNCERTAINTY ABOUT FUTURE GREENHOUSE GAS REGULATIONS AND COSTS

Carbon dioxide is the main greenhouse gas contributing to climate change. As a result of Dominion's continued heavy dependence on coal and natural gas and its extremely limited investments in energy efficiency and non–carbon–emitting renewable resources, the Company's annual CO_2 emissions will continue to increase, rather than decrease, for the foreseeable future. This is shown in Figure 12, below.

Consequently, unless the Company changes direction and undertakes a serious plan to reduce its reliance on fossil fuels, Dominion's annual CO_2 emissions will increase by more than 50 percent between 2013 and 2037.

Moreover, Figure 12 only includes the CO_2 emissions from Company–owned generating units. It does not include any CO_2 emissions attributable to the fossil–fired generation that the Company is projected to purchase from PJM. Therefore, the economic risk that future CO_2 regulation and prices pose to Dominion's ratepayers is significantly higher than Figure 12 suggests.

Even though there is uncertainty regarding the timing, design, stringency, and cost of any federal greenhouse gas regulatory regime, it is generally agreed that CO_2 emissions from fossil–fired power plants will be very expensive for utility companies and their ratepayers at some time in the not–too–distant future. For this reason, an increasing number of utilities, including Dominion, consider future CO_2 prices in their IRP analyses. For example, Figure 13, shows the recent forecasts of future CO_2 prices by Synapse Energy Economics and by ICF International, a consultant to Dominion on gas and coal commodity and CO_2 prices.[36] Dominion's 2012 IRP modeled a base case scenario where carbon regulations will be implemented starting in 2023 and a no carbon cost scenario where future carbon legislation is removed from the forecast and therefore no carbon costs would be incurred over the planning period. However, this analysis improperly accounted for the risks associated with future carbon regulations as it did not consider a wide range of potential CO_2 prices that could be significantly higher and begin earlier than the single price trajectory that the Company did include. The Obama Administration's recently announced Climate Action Plan makes it more likely that substantial action on reducing CO_2 emissions from new and existing generating units will be taken before the 2023 starting date assumed by Dominion in its 2012 IRP and that CO_2 prices will be higher than Dominion has assumed.

FIGURE 12: Dominion's Projected Annual CO_2 Emissions 2012–2037.

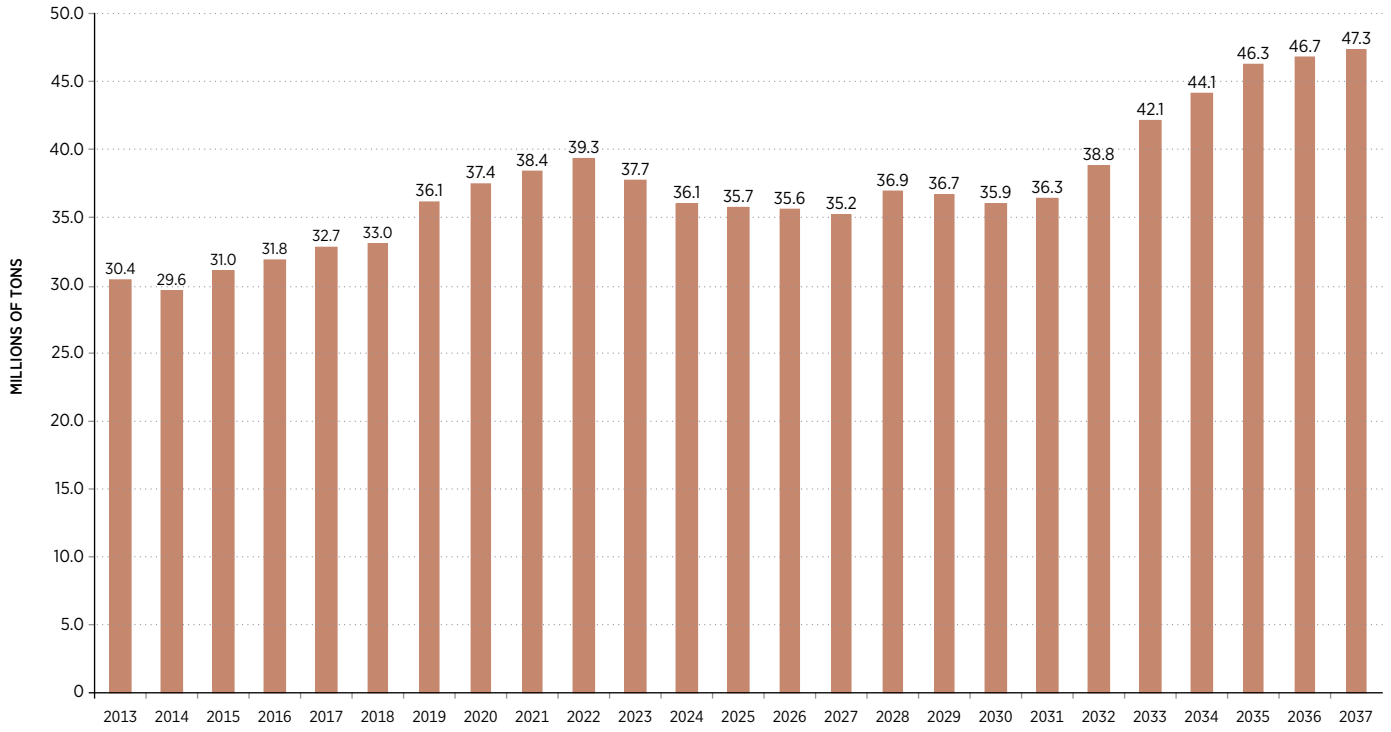


FIGURE 13: Recent CO_2 Price Forecasts — Synapse Energy Economics and ICF, International.

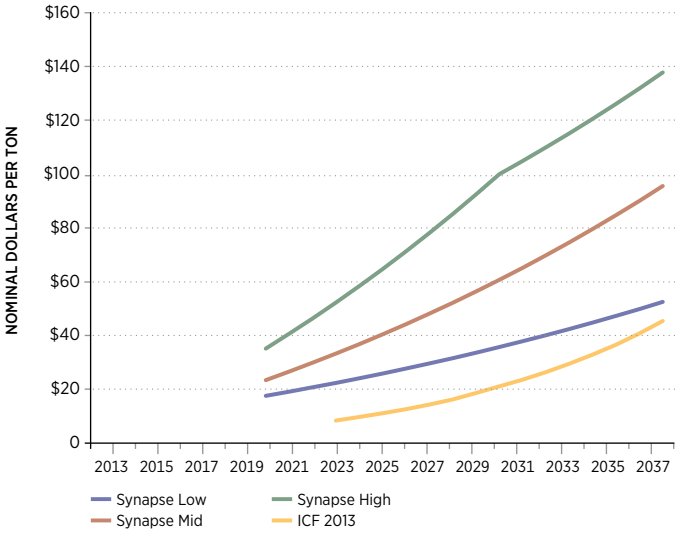
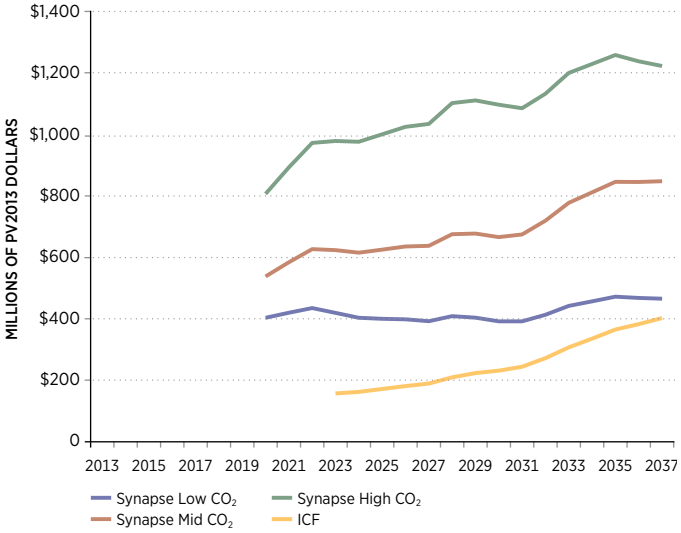


Figure 14, below, then shows the potential annual costs of Dominion's CO_2 emissions based on the projected emissions in Figure 12 and the Synapse and ICF price forecasts in Figure 13.

FIGURE 14: The Potential Annual Costs of Dominion's CO_2 Emissions, 2012–2037 at the Recent Price Forecasts from Synapse Energy Economics and ICF International.



Thus, between 2020 and 2037, the CO_2 emissions from Dominion's natural gas and coal–fired power plants could cost ratepayers between $3.8 billion and $19.4 billion, in Present Value 2013 dollars (that is, $14.4 billion and $63.3 billion, in nominal dollars). Moreover, as noted above, these figures do not include any CO_2 emissions costs associated with Dominion's purchases of fossil–fired power from PJM even though it is reasonable to expect that the market clearing prices of power in PJM will be higher due to the cost of purchasing CO_2 emission allowances. Consequently, the CO_2 cost risk to Dominion's ratepayers from the Company's continued heavy reliance on fossil fuels is even greater than suggested by Figure 14.

Although it is possible that Dominion could obtain some free or low cost CO_2 emission allowances for some period of time, there still is an opportunity cost associated with using those allowances. Therefore, it is appropriate to price all emissions when examining the impact of CO_2 regulations. Given the increasing public concern about climate change, especially in the wake of natural disasters such as Hurricane Sandy, it is not credible to think that there will be no carbon costs at any time between 2013 and 2037.

DOMINION'S UNCERTAIN NEED FOR POWER

Dominion has attributed its need for new generating capacity in its Preferred Resource Plan to its belief that the Company's load growth over the next fifteen years will be similar to the robust load growth that it experienced in the fifteen years between 1997 and 2011.[37] For example, Dominion presented testimony to the SCC that cited the past Dom Zone load growth and its current projection that the weather–normalized peak load for the Dom Zone will increase at a 1.7 percent average annual growth rate over the next 15 years as support for the Company's proposed Brunswick County combined–cycle project.[38] The testimony filed by the Company was technically correct when it said that the Dom Zone actual peak loads have grown by some 5,716 MW over the last 15 years (1997 to 2011). However, all of that growth occurred between 1997 and 2006. In fact, as shown in Figure 15.a., below, although there have been some minor ups and downs, the Dom Zone peak loads have been essentially flat between 2006 and 2012. The same is true for the Dom Zone energy sales — after robust growth in the years prior to 2006, energy sales have been flat since 2006 with some minor ups and downs that may have been due to variations in annual weather. This can be seen in Figure 15.b.

FIGURE 15.A.: Recent Dom Zone Peak Loads, 1997–2012.

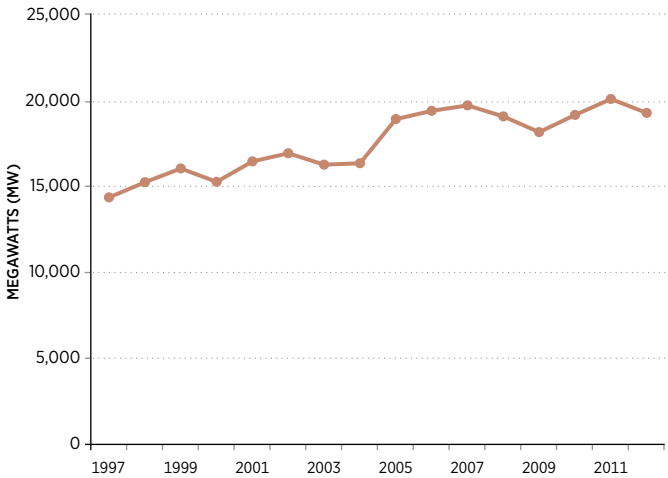
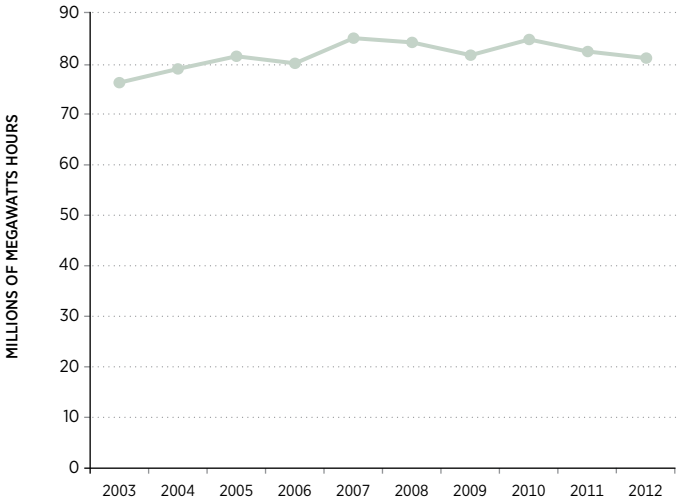


FIGURE 15.B.: Recent Dominion Virginia Power Energy Sales, 2003–2012.



Therefore, contrary to what Dominion has suggested, there has not been any growth in peak loads or energy sales since 2005/2006:

- The Dom Zone peak load was just slightly lower in 2012 than it had been in 2006.
- Dominion's energy sales in 2012 were lower than its sales had been in 2005.

Despite the leveling off of its peak loads and energy sales, Dominion failed to make any significant changes in its projected long-term peak load and energy sales growth rates, which ranged between 1.5 percent and 2.16 percent in the Company's 2006–2012 IRP filings. Instead, Dominion has kept the same expectation of relatively robust future growth each year (by not appreciably reducing its long-term growth rate) and merely delayed the start of that robust growth by another year. This is shown in Figures 16.a. and 16.b., below:

FIGURE 16.A.: Dominion IRP Dom Zone Peak Load Forecasts 2006–2012.

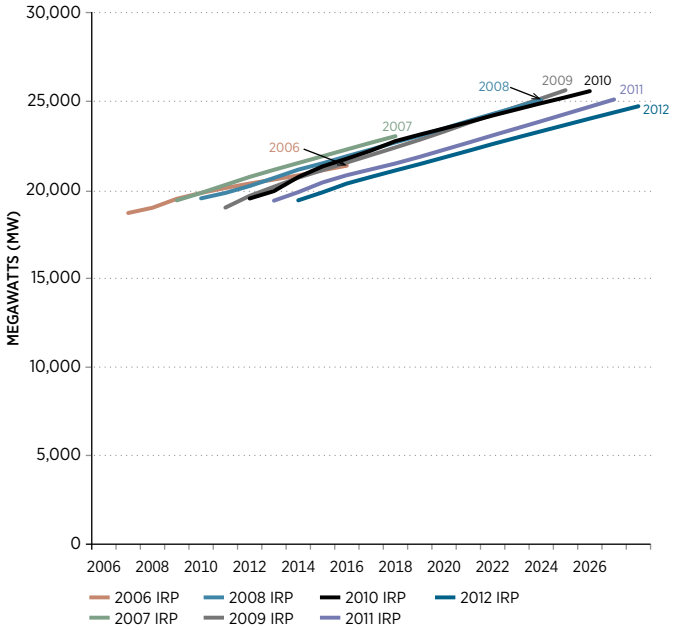
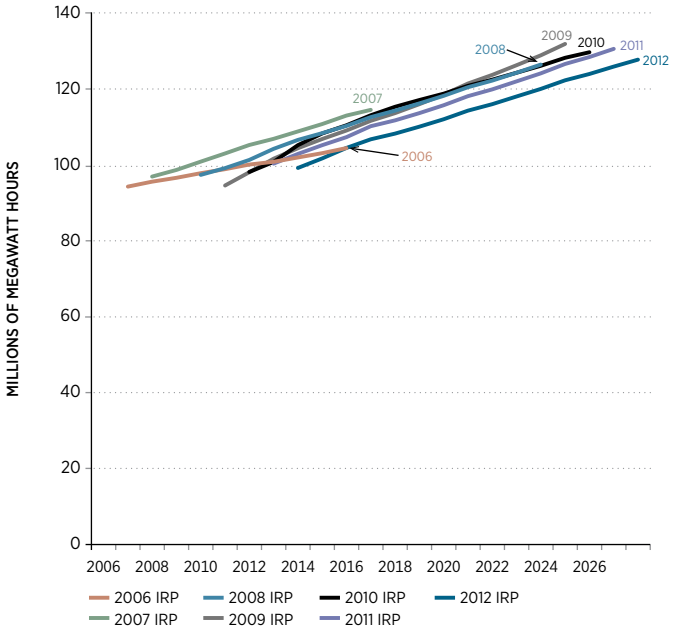


FIGURE 16.B.: Dominion's Dom Zone Energy Sales Forecasts, 2006–2012.



The Company's persistent belief that its past robust growth would suddenly reappear (despite the evidence of relatively flat load and energy sales growth) has led it to over-forecast its recent peak loads and energy sales. For example:

- Dominion's 2006–2010 IRPs over-forecasted the actual 2011 weather-normalized Dom Zone peak load by between 300 MW and 1,500 MW and the 2012 weather-normalized Dom Zone peak load by between 600 MW and 1,800 MW.
- Dominion's 2006–2011 IRPs over-forecasted the actual Dom Zone 2012 energy sales by some 3 to 6 percent.

Although the economic downturn in recent years has undoubtedly been a major factor behind the relatively flat peak loads and energy sales Dominion and the Dom Zone have experienced, it is likely not the only causal factor. In fact, a number of utilities and analysts have concluded that fundamental changes in energy consumption are likely to reduce utility load growth in the long-term, even after the economy has recovered from the Great Recession. For example, as early as November 2008, Jim Rogers, the Chairman and CEO of Duke Energy, concluded that reduced consumption reflected more than the ongoing economic recession, noting that "[s]omething fundamental is going on here."[39]

Other utility executives have concluded that demand growth, which had been dampened during the Great Recession, is not likely to bounce back to earlier levels because of fundamental changes in how the nation consumes power.[40] For example, AEP Chief Financial Officer and Executive Vice President Brian Tierney told the

September 2012 Bank of America/Merrill Lynch Power and Gas Leaders Conference:

> *On the industrial side, a lot of our customers have already made changes to their demand consumption and are being as energy efficient as possible, but we are starting to see some of those trends work their way into the commercial side of the business and even into people's homes. It is not just behavioral modification, we think there are some structural changes.*[41]

Xcel Energy's Chairman, President and CEO Benjamin Fowke III agreed, adding,

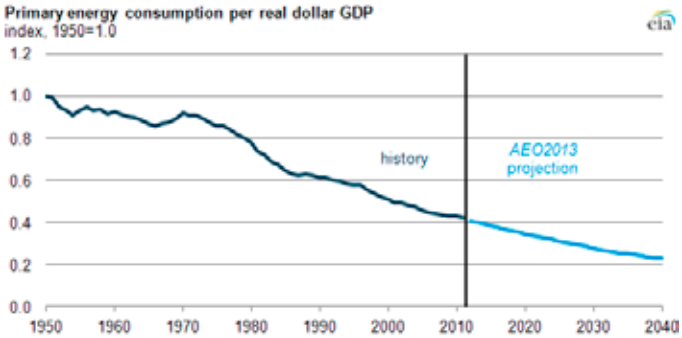
> *"I think it is our demand–side management efforts: we think that cuts into about 70 basis points of sales growth. I do think we are seeing something more fundamental on the residential side. I think that has to do with the efficiency of appliances."*[42]

Data published by the U.S. Energy Information Administration of the Department of Energy ("EIA") shows that there has been a long term declining trend in energy intensity, which the EIA anticipates will continue in the future:

> *In the United States, energy intensity has been declining steadily since the early 1970s and continues to decline in EIA's long–term projection. A country's energy intensity is usually defined as energy consumption per unit of gross domestic product (GDP). Greater efficiency and structural changes in the economy have reduced energy intensity.*[43]

This trend can be seen in Figure 17, below, which is taken from the U.S. EIA website.

FIGURE 17: U.S. Energy Intensity[44]



Consequently, companies around the nation are reducing their expectations for future load and energy sales growth. For example, in August 2012, the consulting firm Wood Mackenzie released a report entitled *A Lost Decade of Demand Growth*, which cited an expected reduction in U.S. power demand growth from the 2 percent per annum rate achieved over the last two decades to slightly over 1 percent. The report also described how radical changes in demand growth projections, along with other uncertainties, are transforming the future of the power industry. According to Wood Mackenzie's press release:

> *"Meanwhile, the major driver really underpinning much of this new state of the market is a significant shift in electricity demand growth expectations."*
>
> * * * *
>
> *"The crystal ball seems to have not served us well in predicting the Great Recession or its severe impacts on energy demand," notes Ghosh. "Given the recessionary impacts on gross domestic product, industrial activity, real estate and unemployment, all coupled with a possible behavioral drag in energy demand, demand growth expectations have been reduced to much lower levels."*
>
> *Another source of pressure on demand growth is energy efficiency. Wood Mackenzie notes that since 2008, multiple states and federal policies have been introduced, motivating investment in energy efficiency programs, and further accentuating the loss of future demand growth.*
>
> *In aggregate, more than a decade of future demand growth has been lost as a result of economic forces and energy efficiency initiatives. Demand levels that were previously forecast to be reached by 2019 are now not expected until 2030, according to Wood Mackenzie."*[45]

In April 2012, another industry consulting firm, Itron, published the results of a survey of 77 utilities regarding their load forecasts.[46] Across the respondents, forecasted growth is expected to be close to 1 percent through the 2021 time horizon, which is much lower than historical growth. Future growth is expected to be due primarily to customer growth, as residential and commercial electric intensities are projected to be flat or declining during the forecast horizon. The survey also revealed a tendency to overestimate growth in recent years.[47]

Duke's Jim Rogers recently cited the Wood Mackenzie report and noted, "we are not going to reach [forecasted] 2019 [load] levels until 2030" despite an economic rebound since 2008. In past decades, for every 1 percent growth in gross domestic product, there was as much as 5 percent growth in demand for electricity. But those days are gone." He also said that "We are on the way to seeing a decoupling of the growth of demand for electricity with the growth in GDP. That will have a profound implication for how we think about our business."[48]

The Company's Preferred Resource Plan that includes the Brunswick Project and a second NGCC unit in 2019 is predicated on robust load growth continuing almost indefinitely. Lower peak loads and energy sales would reduce the need for and the relative economics of

the new gas-fired capacity included in that Preferred Resource Plan.

For example, Figures 18.a. and 18.b. below, compare Dominion's 2012 IRP Dom Zone forecasts with what its annual peak loads and energy sales will be if they only grow at an average one percent annual rate between 2013 and 2027.

FIGURE 18.A.: Projected Dom Zone Peak Loads — Dominion's 2012 IRP vs. One Percent Average Annual Growth.

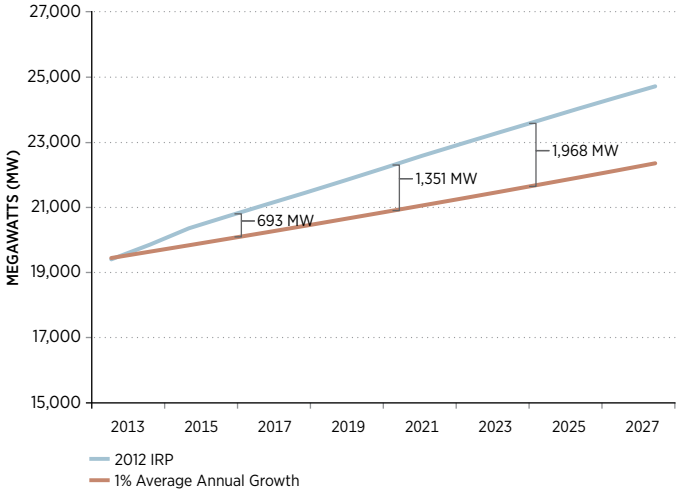
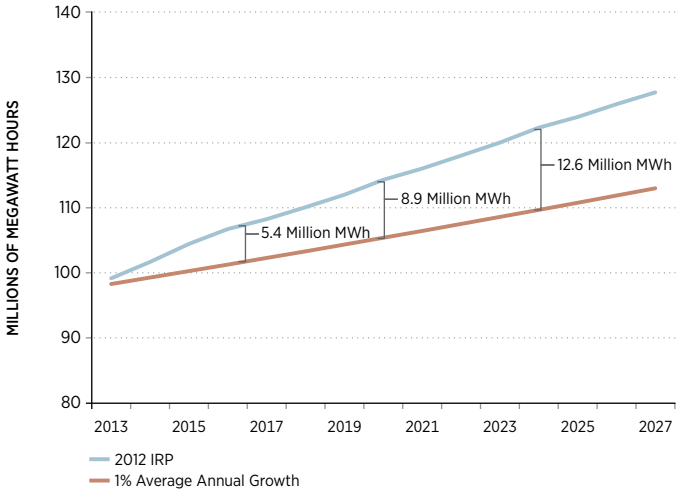


FIGURE 18.B.: Projected Dom Zone Energy Sales — Dominion's 2012 IRP vs. One Percent Average Annual Growth.



Thus, if the Dom Zone achieves only 1 percent average annual growth in its summer peak loads and its energy sales:

- By 2016, its peak load will be 693 MW below its 2012 IRP forecast and annual Dom Zone energy sales will be 5.4 million MWh lower.
- By 2020, its peak load will be 1,351 MW below its 2012 IRP forecast and annual Dom Zone energy sales will be 8.9 million MWh lower — a reduction almost equal to the power the Company expects to generate at the Brunswick Project or from the second NGCC unit it is planning to bring online in 2019.
- By 2024, its peak load will be 1,968 MW below its 2012 IRP forecast and annual Dom Zone energy sales will be 12.6 million MWh lower — a reduction greater than the capacity and energy that Dominion expects to generate at Brunswick or the 2019 NGCC plant *and* significant capacity and energy purchases from PJM.

Recognizing that circumstances may have changed, and that the future may not precisely replicate the past, could eliminate Dominion's need for at least one of the two new fossil-fired NGCC units it is planning to bring online in 2016 and 2019.

It is important to emphasize that Figures 18.a. and 18.b. provide illustrative examples of what the Company's future peak loads and energy sales could be if the Dom Zone experiences a 1 percent average annual growth rate for each. As shown above, such a 1 percent average annual growth rate would be significantly higher than the actual annual growth rate experienced by the Company and the Dom Zone in the seven-year period between 2006-2012.

SECTION IV — DOMINION'S ENERGY EFFICIENCY POTENTIAL

Energy efficiency has emerged as one of the most cost-effective approaches to meeting growing energy demand, lowering customer bills, and spurring local job growth. What was once a developing idea is now a thriving industry in utility jurisdictions in nearly all 50 states. In 2010, energy efficiency programs saved customers in the U.S. and Canada over 124 million MWh of electricity and 1.3 billion therms of natural gas, which is equivalent to the electricity output of nearly 20 large power plants.[49] Investing in energy efficiency at the achievable level should be a key component of Dominion's plans for meeting the energy needs of its customers over the coming years. Failing to adequately consider energy efficiency to meet demand growth misses an opportunity to utilize the least cost resource available to utilities and provide maximum benefits to ratepayers.

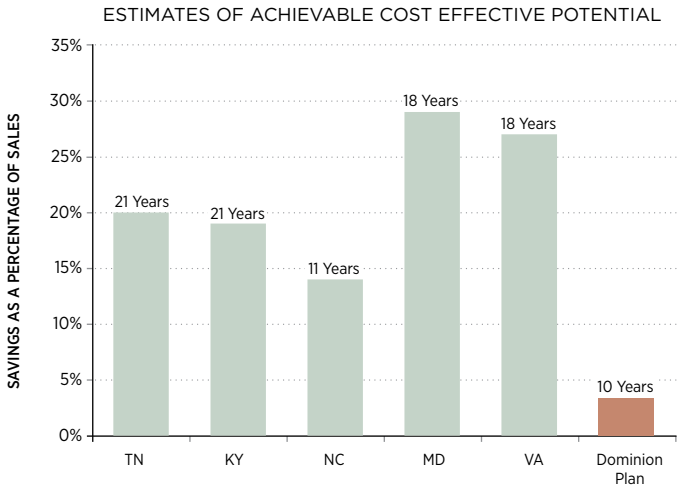
THERE IS SIGNIFICANT POTENTIAL IN VIRGINIA FOR ENERGY EFFICIENCY

In comparison with other jurisdictions, existing plans for efficiency in Virginia are low. According to its 2012 IRP, Dominion plans to save a total of 3.4 percent of its sales forecast through efficiency after ten years of efficiency program implementation. This is far below what is achievable, on the order of several million MWh and hundreds of MW.

Several estimates of achievable efficiency potential from Virginia and other nearby jurisdictions reveal that

far more efficiency is available than the level assumed by the Company. The figure below presents estimates of achievable efficiency in Virginia, Tennessee, Kentucky, North Carolina, and Maryland. Even the study with the lowest estimate, a projected 14 percent savings over 11 years in North Carolina, is more than four times Dominion's 3.4 percent over a similar timeframe. Moreover, there is evidence that potential studies are often conservative. These studies are more likely to underestimate rather than overestimate potential savings for reasons such as limiting measure and program lists or customer incentive payments, ignoring technology advancement, and difficulty quantifying some of the benefits of energy efficiency.

FIGURE 19: Energy Efficiency Potential Study Estimates.[50]



In addition to estimated potential, actual impacts of energy efficiency programs administered in other states demonstrate that higher levels of savings are achievable. Dozens of investor–owned utilities, municipal utilities, and third party program administrators throughout the country have achieved efficiency savings at least twice or three times the levels assumed by the Company. Table 3, below, shows utilities in the U.S. with annual sales exceeding one million MWh that acquired annual efficiency savings in excess of 1 percent of sales, a level twice that of the Company's highest annual savings rate.

At the state level, the 2012 ACEEE Energy Efficiency Scorecard indicates that nine states achieved savings of over 1 percent of annual retail electricity sales.[51] These states, which include Minnesota, Massachusetts, Nevada, and Hawaii, vary greatly in terms of their climates and economies. The top performing states, Vermont and California, achieved 2.3 percent and 1.8 percent of sales respectively. Furthermore, successful efficiency program designs can be found in many states and are delivered by dozens of utilities, not just those listed above. Together, they provide a wealth of potential examples from which the Company can draw inspiration and guidance in pursing higher levels of efficiency in Virginia. Details on exemplary and best practice programs have been published by ACEEE, Pacific Gas & Electric, EPA, and others.[52] The success of these diverse states and utilities suggests that there is far more achievable energy efficiency potential in Virginia than is currently being achieved or proposed.

Moreover, policymakers in a wide range of jurisdictions have confirmed commitments to targets equal to or greater than 1 percent per year, indicating a general consensus regarding the feasibility of such targets. A summary prepared by ACEEE in September 2012 shows that 24 states have enacted long–term (3+ years) binding energy targets. Of the 20 states with EERS polices in place for over two years, only 4 were achieving less than 90 percent of their goals, while 13 were achieving at least 100 percent of their goals and 3 were achieving between 90 and 100 percent.[53]

Although the effects of energy efficiency are often described and measured in terms of reduction in energy usage (i.e., kWh savings), the impact of efficiency on peak demand or capacity (i.e., kW reduction) is also important for long–term resource planning. Programs in various regions and states have demonstrated that significant demand savings are achievable from investment in energy efficiency. Perhaps most notable are California's efforts to cut peak demand during the state's electricity crisis of 2000–2001.[54] Efficiency and conservation–related programs reduced peak demand in California by an estimated 3,668 MW in 2001. Elsewhere, the Northwest Power and Conservation Council, a group charged with developing and maintaining a regional power plan for the Pacific Northwest, projected in their 2010 IRP that the region could meet 85 percent of its load growth over the next 20 years with energy efficiency.[55]

In summary, several factors clearly suggest that Virginia is not on track to acquiring its achievable energy efficiency savings potential. Dominion's current plans achieve less than half of the 10 percent goal that Dominion and the SCC found realistically achievable. Meanwhile, lawmakers in a range of jurisdictions have made commitments to higher savings levels than Dominion has pursued, studies indicate substantially greater energy savings of at least 1 percent per year over periods ranging from 10 to 20 years, and actual experience in multiple states and by many individual utilities and program administrators confirms that this is possible.

Using all of the above information and the authors' experience planning and implementing efficiency programs, we developed an alternative estimate of achievable efficiency savings in Virginia from 2013 through 2027 as a percentage of forecast loads. We assume

TABLE 3: Mid to Large-Sized Utilities with EE Savings > 1% of Sales in 2011.

UTILITY NAME	OWNERSHIP	STATE	ENERGY EFFICIENCY	TOTAL SALES	EFFICIENCY AS A PERCENTAGE OF SALES
Cleveland Electric Illum Co	Investor Owned	OH	483,678	18,916,146	2.6%
Massachusetts Electric Co	Investor Owned	MA	365,100	21,332,015	1.7%
Southern California Edison Co	Investor Owned	CA	1,391,899	84,267,390	1.7%
United Illuminating Co	Investor Owned	CT	86,107	5,576,374	1.5%
PUD No 1 of Clark County-(WA)	Political Subdivision	WA	67,529	4,466,548	1.5%
Ohio Edison Co	Investor Owned	OH	371,017	24,656,347	1.5%
Los Angeles Department of Water & Power	Municipal	CA	345,517	23,152,407	1.5%
Puget Sound Energy Inc	Investor Owned	WA	348,925	23,504,616	1.5%
Western Massachusetts Elec Co	Investor Owned	MA	54,149	3,694,563	1.5%
Salt River Project	Political Subdivision	AZ	388,820	26,714,442	1.5%
PPL Electric Utilities Corp	Investor Owned	PA	522,675	36,941,727	1.4%
Arizona Public Service Co	Investor Owned	AZ	397,201	28,210,326	1.4%
Duquesne Light Co	Investor Owned	PA	193,717	14,027,155	1.4%
San Diego Gas & Electric Co	Investor Owned	CA	269,224	19,514,579	1.4%
Tucson Electric Power Co	Investor Owned	AZ	127,512	9,332,109	1.4%
Rochester Public Utilities	Municipal	MN	16,370	1,241,205	1.3%
Connecticut Light & Power Co	Investor Owned	CT	290,844	22,315,268	1.3%
City of Tacoma-(WA)	Municipal	WA	62,159	4,829,955	1.3%
The Toledo Edison Co	Investor Owned	OH	131,633	10,436,973	1.3%
Duke Energy Indiana Inc	Investor Owned	IN	349,896	27,810,378	1.3%
The Narragansett Electric Co	Investor Owned	RI	96,008	7,668,087	1.3%
PUD No 2 of Grant County	Political Subdivision	WA	49,922	4,022,551	1.2%
Interstate Power and Light Co	Investor Owned	IA	187,458	15,339,960	1.2%
Northern States Power Co-Minnesota	Investor Owned	MN	431,804	35,905,077	1.2%
City of Pasadena-(CA)	Municipal	CA	13,578	1,140,269	1.2%
Idaho Power Co	Investor Owned	ID	163,247	13,734,430	1.2%
Snohomish County PUD No 1	Political Subdivision	WA	81,122	6,881,746	1.2%
Pacific Gas & Electric Co	Investor Owned	CA	1,082,225	92,759,304	1.2%
Dayton Power & Light Co	Investor Owned	OH	162,278	14,021,742	1.2%
City of Seattle-(WA)	Municipal	WA	107,729	9,600,232	1.1%
Nevada Power Co	Investor Owned	NV	234,090	21,038,333	1.1%
City of Eugene-(OR)	Municipal	OR	26,491	2,410,101	1.1%
Tennessee Valley Authority	Federal	TN	333,563	30,412,353	1.1%
City of Burbank Water and Power	Municipal	CA	12,245	1,118,708	1.1%
City of Roseville-(CA)	Municipal	CA	12,838	1,173,389	1.1%
City of Glendale	Municipal	CA	11,763	1,085,030	1.1%
City of Fort Collins-(CO)	Municipal	CO	15,265	1,446,604	1.1%
Madison Gas & Electric Co	Investor Owned	WI	35,349	3,357,554	1.1%
Ohio Power Co	Investor Owned	OH	501,984	48,427,671	1.0%
City of Riverside-(CA)	Municipal	CA	20,989	2,047,277	1.0%
West Penn Power Company	Investor Owned	PA	202,574	20,104,093	1.0%
Detroit Edison Co	Investor Owned	MI	481,000	48,205,462	1.0%
Duke Energy Ohio Inc	Investor Owned	OH	200,992	20,238,171	1.0%
Public Service Co of Colorado	Investor Owned	CO	279,108	28,485,784	1.0%
Long Island Power Authority	State	NY	197,402	20,248,464	1.0%
PECO Energy Co	Investor Owned	PA	383,591	39,369,235	1.0%

Source: EIA Form 861 Data, 2011

that savings can reach and sustain 1.3 percent of energy sales per year after a short period over which savings increase from existing levels to this higher level.

Figures 20 and 21, below, compare our estimated annual energy efficiency savings (in both MWh and MW) with the savings from Dominion's more limited efforts.

FIGURE 20: Achievable Annual Energy Efficiency Savings (MWh)

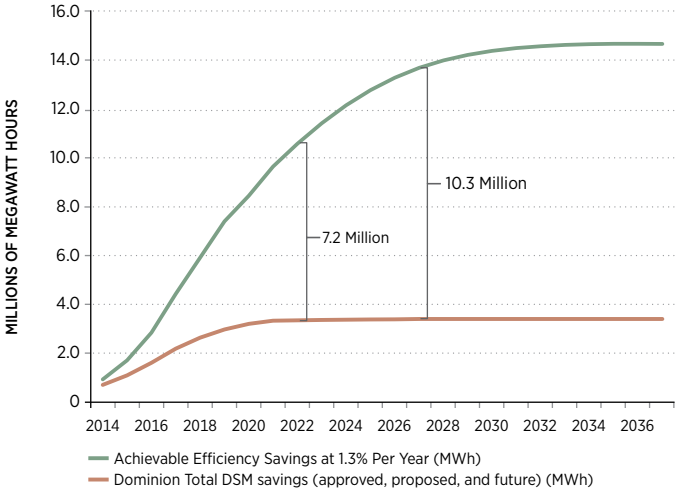
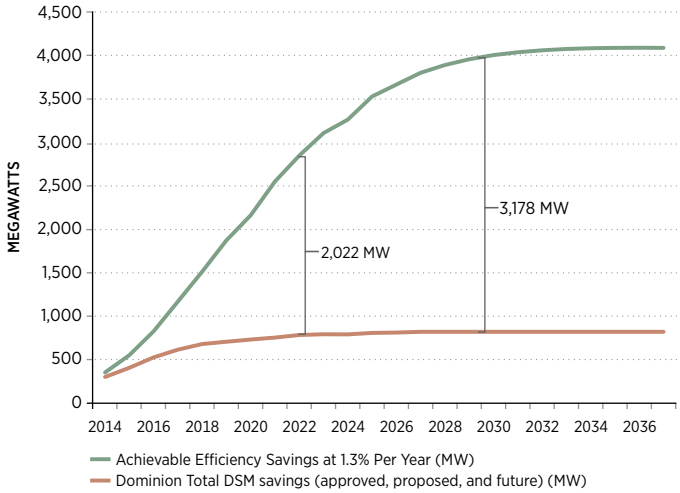


FIGURE 21: Achievable Annual Energy Efficiency Savings (MW)



It is important to note that this estimate is conservative. As previously stated, potential studies are more likely to underestimate rather than overestimate the true potential. Additionally, in developing the savings estimate, we assumed a period of four years to "ramp up" to 1.3 percent annual savings, recognizing the need for the proper infrastructure and processes to be in place before maximum savings are possible. Although Dominion actually has been implementing efficiency programs for over a year, as a conservative assumption, we count the four-year period from 2012, the first year both Phase I and Phase II of Dominion-delivered efficiency programs were in operation.

Achieving a higher level of energy savings requires a greater investment in efficiency programs. To estimate the possible cost of higher levels of efficiency investment, we looked at several sources for efficiency costs, including estimated costs from potential studies, actual costs from leading efficiency programs, and an assessment of cost-effectiveness. For example, 2010 program data reported in the ACEEE 2012 Scorecard, an annual publication that assesses empirical data of actual state energy efficiency program performance, shows that many of the 13 top-performing states in energy efficiency are achieving savings at costs between $0.20 and $0.40 per first-year kWh, while at the same time reaching greater depth of savings than the Company's proposed portfolio. In nearby jurisdictions, Maryland and Pennsylvania utilities spent an average of $0.23 per first-year kWh in 2010 and 2011. Data also indicate that efficiency savings are not getting more expensive over time,[56] or as savings depth increases.[57]

Using these and other data, we developed a projected average first-year cost of $0.239/kWh (in 2013 dollars) for the alternative efficiency estimate presented earlier. This indicates an incremental efficiency investment (above what Dominion can be expected to spend) of approximately $3.2 billion, in nominal dollars, for the years 2013 through 2027. These incremental expanded efficiency investments (above what Dominion can be expected to spend) would save approximately 77 million MWh through 2027 while saving an additional 65 million MWh through 2037, even if there were no further spending on energy efficiency programs after 2027.

EQUITY ISSUES

Some would argue that distributional equity is a concern with efficiency programs. Although all ratepayers must pay to fund the costs of efficiency programs, only participants in these programs receive the direct benefit of bill savings. Other ratepayers will see rate increases, at least in the short term, as a result of the reduction in total sales volume. While taking an action that raises some customers' energy bills should not be undertaken lightly and requires careful consideration of distributional effects, it is important to point out that it is misleading to only consider these effects as they might result from efficiency. For a utility (or public utility commission) determining how to meet load requirements, the choice is not between doing efficiency (or renewables or other alternatives) and doing nothing. Rather, the choice is between building additional expensive fossil-fired or nuclear generation resources or investing in resources with lower total costs for Virginia's ratepayers. While it is true that energy efficiency programs will slightly raise both rates and bills for some customers who choose not to participate in the programs, building a new power plant will result in rate increases for *all* of Dominion's customers, none of whom will have a choice

as to their participation in this investment. Additionally, greater investment in efficiency allows more customers to participate in efficiency programs, minimizing the number of non–participants who may see bill increases.

Moreover, customers who choose not to reduce consumption (whether through program participation or without utility assistance) also benefit from system–wide efficiency investments, particularly those that reduce the demand for energy during the periods of highest total use. On hot summer days and cold winter mornings, high energy demand drives up electricity market prices. If utilities can help some of their customers use less energy during these times, their total costs are reduced and these savings can lower rates for customers regardless of efficiency program participation.

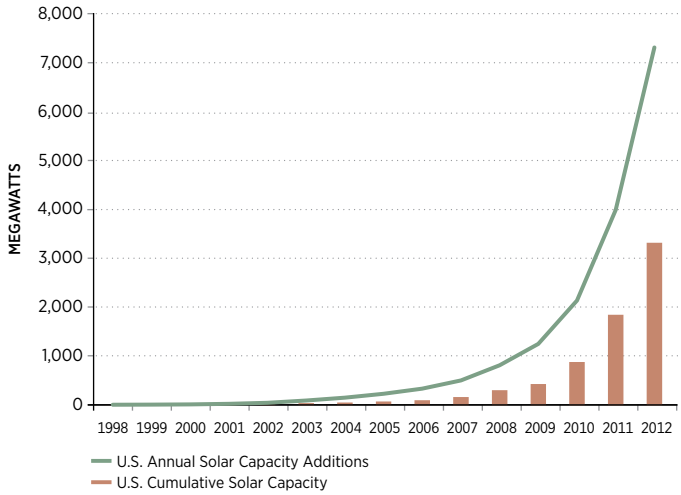
SECTION V — DOMINION'S RENEWABLE RESOURCE POTENTIAL

The use of renewable resources has soared throughout the U.S. as the levelized costs for renewable technologies have plummeted.[58] Although Dominion's Preferred Resource Plan adds only very small amounts of renewable solar and wind capacity over the next 14 years, the Commonwealth has significant solar and wind resources that could be developed for the benefit of Dominion's ratepayers and the state as a whole.

SOLAR POTENTIAL

The number of solar installations in the U.S. has surged in the past four years, climbing from a cumulative 817 MW of installed capacity in 2009 to 7,293 MW in 2012. In fact, 2012 was the most active year, with some 3,313 MW of new solar capacity installed around the nation, an increase of 76 percent from 2011.

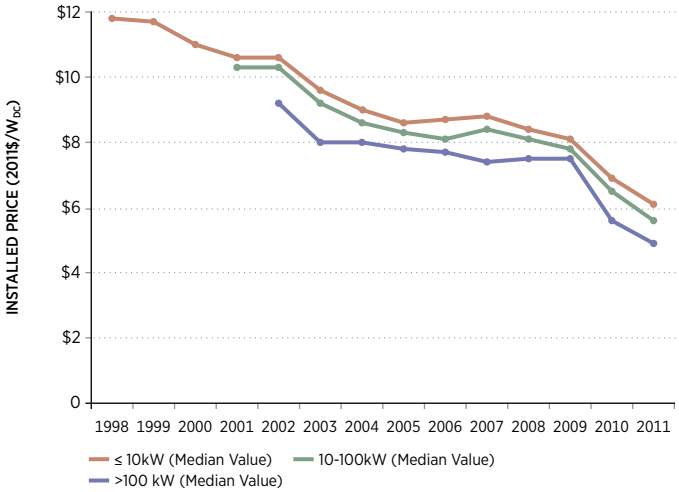
FIGURE 22: Annual and Cumulative U.S. Solar Capacity Installations, 1998–2012.[59]



The solar industry expects the surge in solar photovoltaic ("PV") installation will continue through at least 2016, forecasting: (1) 4.3 GW of solar PV capacity will be installed in 2013, (2) a 28 percent annual growth rate for solar PV for 2013–2016, and (3) there will be a resurgence in the installation of distributed solar PV systems.[60]

This dramatic increase in the installation of new solar capacity has been driven, in large part, by plummeting prices for new solar systems. The median installed prices for residential and commercial PV systems fell by 11–14 percent from 2010 to 2011, and fell by an average of 5–7 percent annually between 1998 and 2011.[61]

FIGURE 23: Median Installed Prices for Residential and Commercial Solar PV Systems, 1998–2011.



The Solar Energy Industries Association has reported that nationally, solar installed prices fell another 14 percent between 2011 and 2012, with the average price of a solar panel declining by 60 percent since just the beginning of 2011.

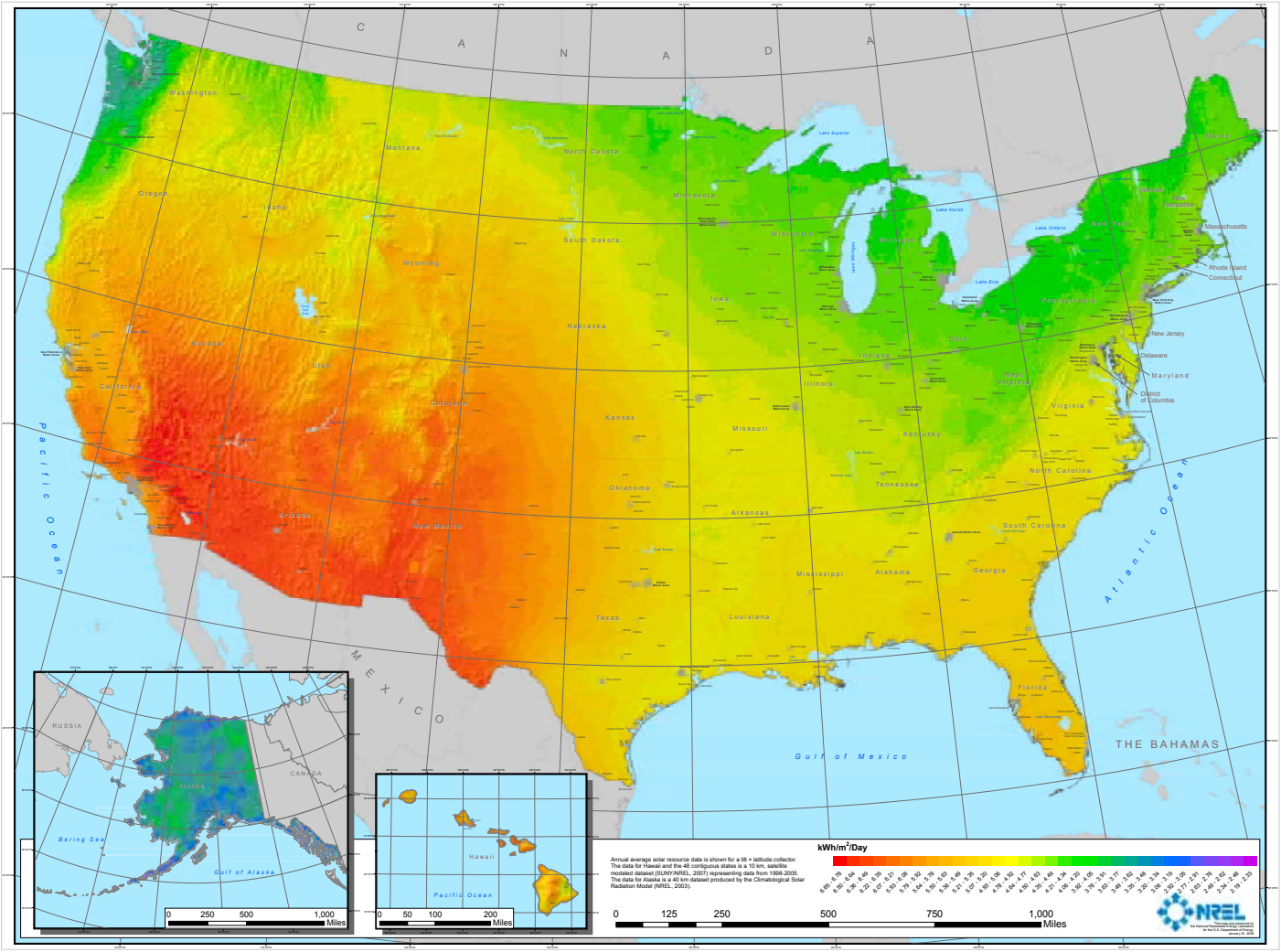
As depicted in Table 4, below, North Carolina, Maryland and New Jersey, have installed significant amounts of new solar PV capacity in recent years.

TABLE 4: Solar PV Installation (in MW) in North Carolina, Maryland and New Jersey 2010–2012.

	2010	2011	2012	CUMULATIVE AS OF END OF 2012
	(MW)	(MW)	(MW)	(MW)
North Carolina	31	55	132	259
Maryland	8	22	74	120
New Jersey	132	313	415	1,051

Virginia has ample solar intensity to support photovoltaic and thermal uses at levels at least as high as those found in these neighboring jurisdictions. Figure 24 shows that Virginia shares an equal or greater potential for solar resources than North Carolina, Maryland, and New Jersey.

FIGURE 24: U.S. Solar Resource Map



The Virginia 2007 and 2010 State Energy Plans agree that the state has the technical potential for more than 10,000 MW of solar PV.[62] Thus, it is very disappointing that Dominion currently has no Company–owned solar resources. Even with Dominion's proposed 30 MW of new solar capacity, which the SCC approved in 2012, the amount of solar installed in Virginia will still be far less than in North Carolina, Maryland, New Jersey, or Pennsylvania which had 196 MW of solar as of the end of 2012. There is no logical reason why Virginia cannot achieve the same, or even higher, annual solar installation rates than any of these other states through greater investments in utility–owned solar and through greater incentives and improved regulatory structures that would promote customer–owned distributed solar.

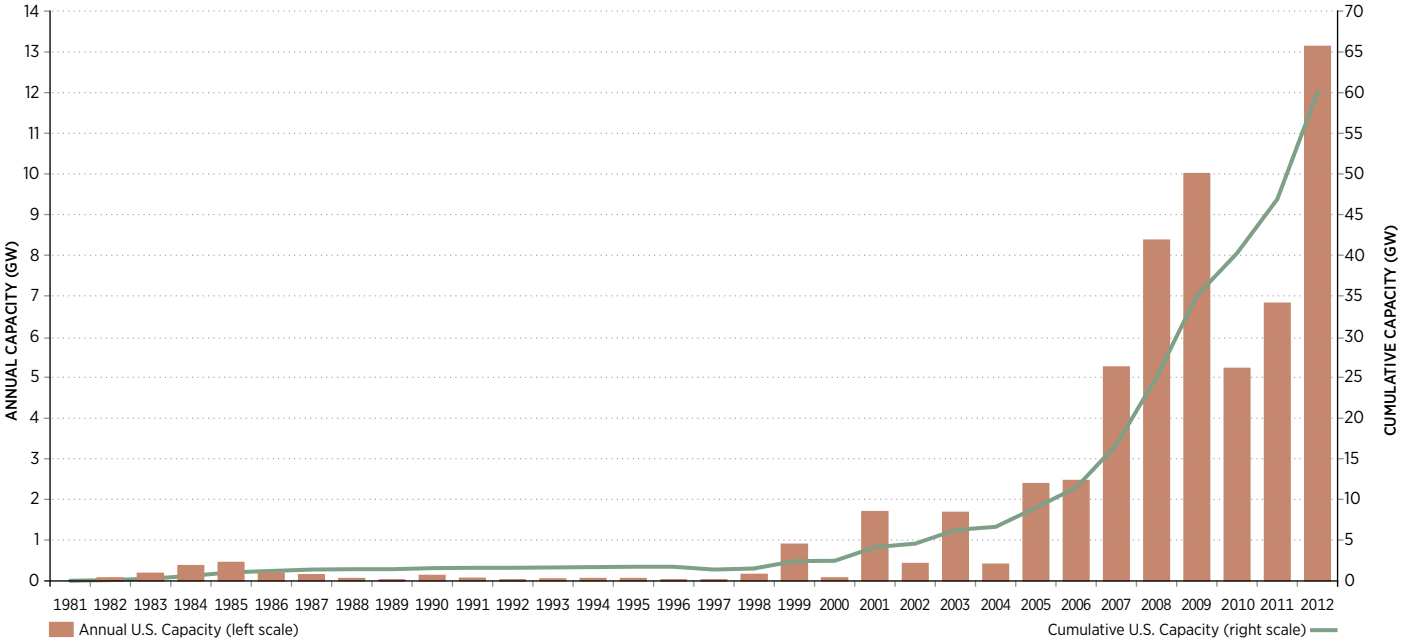
Dominion appears to have restricted the amount of new solar PV capacity based on the fact that the technology is intermittent and on its relative levelized cost of energy compared to other resources that the Company considered in its IRP analysis.[63] However, it is unclear whether the Company has considered the significant cost reductions in installed solar systems that have been achieved in recent years. Nor does the Company's analysis consider the potential value of solar in reducing Dominion's peak demands or as a hedge against future fossil price increases and future CO_2 emissions costs.

In fact, the installation of a significant amount of solar capacity would have a number of substantial benefits for the state of Virginia, as the 2007 Virginia Energy Plan discussed:

> *These [solar PV] systems, integrated into the electric grid, could support local distribution systems during peak demand, provide reactive power control, support disaster recovery, provide a hedge against fuel–cost uncertainties, and provide other benefits. Solar electric is especially valuable in off–setting peak demand in summer, the time for solar energy generation.*[64]

Moreover, as an electricity generation technology that does not emit any pollutants such as NO_x, SO_2, or small particulates, or create toxic or radioactive by–products, solar has substantially lower societal public health and environmental impacts and costs than fossil–fired and nuclear generation. Unfortunately, Dominion's assessment of distributed solar ignored all of these potential

FIGURE 25: Annual and Cumulative Growth in U.S. Wind Power Capacity



benefits, and in doing so, undervalued the role that solar resources could play as part of Dominion's generation mix going forward.

LAND-BASED WIND

There has been a surge in the addition of new domestic wind capacity. 2012 was a record year for wind development in the U.S. with 13.2 GW of new capacity commissioned. This brought the total wind capacity in the nation to above 60 GW, as shown in the above figure from the recent Lawrence Berkeley National Laboratory ("LBNL") report, *Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices.*

States near Virginia have added significant amounts of new land-based wind capacity in recent years. West Virginia has a total of 583 MW of installed wind capacity, Maryland has 120 MW, and Pennsylvania has 1,340 MW. However, despite acknowledging that Virginia has the potential for at least 800 MW of land-based wind, Dominion has no plans to add any wind capacity until 2022. Even then, the Company plans to only add a total of 248 MW of wind by 2024.[65] This lack of development is surprising given the Company's acknowledgement that there has been a 30 percent decline in wind turbine prices in recent years and a 20 percent improvement in wind turbine performance.[66] Moreover, delaying development of new wind projects until 2022–2024 could mean forfeiting the benefits of the wind Production Tax Credit, whose long-term prospects for renewal beyond 2014 are uncertain.

LBNL's *2011 Wind Technologies Market Report* provides strong evidence that supports Dominion's observation that wind turbine prices have declined in recent years:

> ***With increased competition among manufacturers, wind turbine prices continued to decline in 2011.*** *After hitting a low of roughly $700/kW through 2008, average wind turbine prices increased by approximately $800/kW (>100%) through 2008, rising to an average of more than $1,500/kW. Wind turbine prices have since dropped significantly, despite continued technological advancements that have yielded increases in hub heights and especially rotor diameters. A number of turbine transactions announced in 2011 had pricing in the $1,150–$1,350/kW range and price quotes for recent transactions are reportedly in the range of $900–$1,280/kW, depending on the technology. These price reductions, coupled with improved turbine technology and more-favorable terms for turbine purchasers, should, over time, exert downward pressure on total project costs and wind power prices.*[67] *(Emphasis in original)*

LBNL has noted that reported installed wind project costs had turned the corner in 2011, down almost $100/kW, or approximately 4 percent, from the reported average costs in 2009 and 2010.[68] As a result, LBNL notes that[69] the "Steep reductions in wind turbine prices [that have been] negotiated over the last two years, with some evidence of a simultaneous reduction in balance of plant costs … are expected to lead to sizable near-term [installed project] capital cost reductions."[70]

At the same time that prices have been declining, turbine operating performance has been improving, with LBNL reporting that, "Turbine design advancement [has led to an] enormous increase in capacity factors,"[71] noting further that:

> *Sizable historical/continued increases in hub heights and rotor swept area (in proportion to nameplate capacity), [have led] to improvements in capacity factors within individual wind resource classes, especially in lower–wind–speed sites.*

These two factors, that is, reduced wind turbine prices leading to lower installed project costs and improved capacity factors, have led LBNL to conclude that the levelized cost of wind energy projects being planned in 2012 was at an "all–time low."[72]

As it did with solar PV, Dominion limited the amount of land–based wind included in its IRP analysis based on the fact that wind is an intermittent resource and based on its relative cost. Even accepting, for the sake of argument, Dominion's observation that building wind projects along the ridges of the Appalachian Mountains would be more expensive due to location and smaller project sizes (lack of economies of scale),[73] wind should still play a significant role in Dominion's future resource mix due to its relative cost and its value as a hedge against future fossil fuel price increases and future CO_2 emissions costs. Moreover, as an electricity generation technology that does not emit any pollutants such as CO_2, NO_x, SO_2, or particulate matter, or create toxic or radioactive by–products, wind has substantially lower societal public health and environmental impacts and costs than fossil fuel–fired and nuclear generation. Unfortunately, Dominion's assessment of wind failed to fully analyze and quantify these potential benefits.

OFFSHORE WIND

Virginia has significant offshore wind capacity potential in both the near–term and the long-term. The U.S. Department of the Interior has estimated that in the near term, up to 2,000 MW of offshore wind capacity could be installed in the Virginia Wind Energy Area that has been designated by the Bureau of Ocean Energy Management ("BOEM") as available for lease for commercial wind development. Other estimates of the BOEM offshore Wind Energy Areas ("WEA") off New Jersey, Delaware, Maryland and Virginia show a combined 16,800 – 17,100 MW of potential installed capacity in the near term.[74]

In the long term, the 2010 Virginia State Energy Plan estimated that there is the potential for 28,100 MW of installed offshore wind capacity off Virginia's coast.[75] The National Renewable Energy Laboratory ("NREL") has projected 65 GW as the technical potential for Virginia offshore wind capacity.[76]

Although the U.S. has no installed offshore wind generating capacity, the federal government has recently taken a number of aggressive actions to develop new offshore wind resources.

- In November 2010, the Secretary of the Interior announced a "Smart from the Start" initiative for developing Atlantic Outer Continental Shelf ("OCS") offshore wind resources through a smarter permitting process that is efficient, thorough, and unburdened by unnecessary red tape.
- In February 2011, the government released a National Offshore Wind Strategy to guide the nation's effort to achieve 54 GW of deployed offshore wind capacity by 2030, with 10 GW of capacity deployed by 2020. To achieve these goals, the Offshore Wind Strategy reported the cost and timeline for deploying offshore wind energy must both be reduced.
- A Virginia Proposed Sale Notice was published in the Federal Register on December 3, 2012. BOEM has received eight nominations of interest from parties, including from Dominion, wishing to obtain a commercial lease for wind energy projects.

BOEM has decided to move forward with the leasing process for the Virginia WEAs on a non–competitive basis, leasing the entire tract rather than segments.[77] A commercial lease could be in place for the Virginia WEA by the end of this year or early in 2014.

Even though the U.S. doesn't have any operating offshore wind capacity, Europe has 4,995 MW of installed offshore wind turbines, including the addition in 2012 of 293 offshore wind turbines representing 1,165 MW of new capacity.[78] Another 14 projects that would increase Europe's offshore wind capacity by an additional 3,300 MW are under construction. China also has begun to install offshore wind.

The declining cost and improving performance trends for land–based wind technologies also should improve the economics of offshore wind energy. For example, studies by the National Renewable Energy Laboratory of the U.S. Department of Energy and by respected consulting firms like Navigant Consulting and The Brattle Group have identified both the factors which lead to uncertainties in estimating the future costs of offshore wind facilities and the factors which lead them to conclude those costs will decline substantially over time due to technical improvements and an industry learning curve.[79] Thus, it is reasonable to expect that the levelized cost of energy from offshore wind projects will decline over time—by perhaps as much as 20 percent by 2022 and 30 percent by 2030.

In addition, Dominion has acknowledged that the siting of offshore wind facilities in the BOEM Virginia Offshore Wind Energy Area will provide lower transmission costs:

..., the Virginia General Assembly passed legislation in 2010 that created the Virginia Offshore Wind Development Authority ("VOWDA") to help facilitate offshore wind energy development.... As required by the 2010 legislation, the Company completed a transmission study to determine possible offshore wind interconnection points to the onshore transmission grid. The Company released the results of the study in December 2010, which found that Virginia has an advantage compared to many states because it has the capability to interconnect large scale wind generation facilities with the existing grid in Virginia Beach, Virginia. The study revealed the up to 4,500 MW (nameplate) of offshore wind generation can be connected with minimal on-shore transmission upgrades. The Company completed a second study in 2012 evaluating offshore transmission options to potentially support multiple projects. The study found that for every 500-700 MW (nameplate) of offshore wind capacity constructed, one service platform is appropriate with two lines to shore. This transmission solution limits the potential for stranded transmission investment and emphasizes the potential cost savings that may be achieved through a phased build-out with a potential for standardization of offshore transmission infrastructure.[80]

In fact, Dominion has expressed an interest in studying the wind potential in the Virginia WEA. In December 2012, the Department of Energy) announced that it would fund seven offshore wind technology demonstration projects, including a Dominion-sponsored project to develop two 6 MW turbines 22 miles off the coast of Virginia adjacent to the Virginia WEA.[81] Dominion will receive $4 million in federal matching funds to undertake initial engineering, design, and permitting for the demonstration turbines. DOE will select up to three of the projects that will receive up to an additional $47 million over four years to move forward with the final design, permitting, and ultimate construction of demonstration projects.

Despite the Company's expressed interest in pursuing the development of Virginia's WEA, Dominion's Preferred Resource Plan failed to include investments in offshore wind. The Company stated that the selection of what it has called a "Fuel Diversity" plan as the Preferred Resource Plan in its 2012 IRP "includes a balanced mix of baseload, intermediate, and peaking units as well as a diverse fuel mixture including fossil, nuclear, and renewable resources that will mitigate fuel price volatility."[82] Yet the failure to include any real diversity from renewable resources, such significant energy efficiency, solar, land-based and offshore wind, undermines this analysis.

Moreover, Dominion's assessment of the economics of a "Renewable" Plan in its 2012 was heavily biased by the following:

- The "Renewable" Plan did not include any additional low-cost energy efficiency resources and only included a relatively minor 30 MW of solar.
- The "Renewable" Plan included all of the new natural gas-fired capacity in its Base Plan — that is, the Warren, Brunswick and 2019 combined cycle units and new combustion turbine capacity in 2023 and 2024. This was on top of the new offshore wind.
- The "Renewable" Plan only reflected scenarios with low or no CO_2 prices.

Despite these biases, the "Renewable" Plan considered by Dominion averaged less than 3 percent more expensive than the "Fuel Diversity" Plan that the Company has selected as its Preferred Resource Plan.[83] This is not a significant price to pay for the ability of the additional wind power to act as a hedge to mitigate the risks of higher future natural gas and carbon-related costs. However, the Clean Energy Investment Plan, outlined below, shows that clean energy investments can meet the Commonwealth's needs at a lower cost than Dominion's Preferred Plan in most scenarios.

SECTION VI – A CLEAN ENERGY INVESTMENT PLAN FOR DOMINION

A moderately aggressive, cost-effective Clean Energy Investment Plan would be a first, but significant, step in moving Dominion in a new direction — away from such a heavy reliance on fossil-fired generation and toward substantial investments in clean, non-carbon-emitting energy efficiency and renewable resources. In this first step, the Clean Energy Investment Plan would use the following portfolio of resources to replace one or both of Dominion's planned large fossil-fired units, reduce the generation at its existing fossil-fired units, and/or reduce its purchases of fossil-fired generation through the PJM energy market.

1. Energy efficiency spending and programs designed to achieve 1.3 percent annual savings, as shown in Figures 20 and 21, above.
2. The installation of 100 MW of distributed solar PV capacity each year beginning in 2015, 150 MW in 2016 and 200 MW in each subsequent year for a total 2,450 MW by 2027 or approximately 25 percent of the potential identified by Dominion. Additional distributed solar PV capacity would continue to be installed after 2027.
3. The installation of 120 MW of land-based wind in 2019, 80 MW in 2020, 80 MW in 2021, and 80 MW in 2022, for a total of 360 MW, or less than one-

half of the land-based wind potential identified by Dominion.

4. The installation of 500 MW of offshore wind in 2022, 500 MW in 2026, 500 MW in 2029, and 500 MW in 2032. This would be the 2,000 MW of capacity potential that the U.S. Department of Interior has cited for the Virginia Offshore Wind Energy Area.

This Clean Energy Investment Plan is shown in Table 5, below:

TABLE 5: The Clean Energy Investment Plan Through 2027.

	RENEWABLE RESOURCES			DEMAND SIDE RESOURCES
Year	**Solar**	**Onshore Wind**	**Offshore Wind**	**Cumulative MW of Energy Efficiency Above That Planned by Dominion**
2014				52 MW
2015	100 MW			144 MW
2016	150 MW			299 MW
2017	200 MW			553 MW
2018	200 MW			831 MW
2019	200 MW	120 MW		1164 MW
2020	200 MW	80 MW		1428 MW
2021	200 MW	80 MW		1795 MW
2022	200 MW	80 MW	500 MW	2061 MW
2023	200 MW			2311 MW
2024	200 MW			2467 MW
2025	200 MW			2716 MW
2026	200 MW		500 MW	2849 MW
2027	200 MW			2977 MW

These goals are achievable based on the domestic U.S. experience with solar PV and land-based wind resources and the European track record with installing offshore wind capacity.

Figure 26 shows, on a cumulative basis, the MWs of installed energy efficiency, distributed solar, land-based wind, and offshore wind through 2027 under the Clean Energy Investment Plan. Figure 27 then presents, again on a cumulative basis, the firm MWs of capacity that would be provided by the Clean Energy Investment Plan. The conversion from the installed MW to firm MW figures reflects the intermittent nature of solar and wind capacity.

FIGURE 26: Clean Energy Investment Plan Cumulative Installed MW of Capacity, 2014–2027.

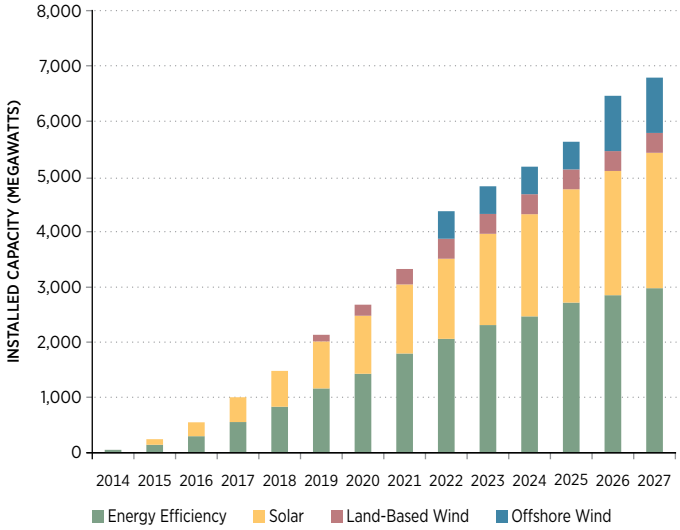


FIGURE 27: Clean Energy Investment Plan Cumulative Firm MW of Capacity, 2014–2027.

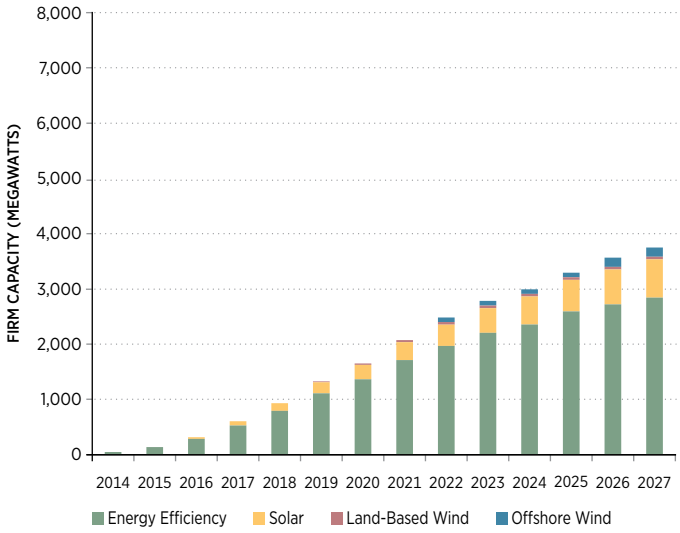
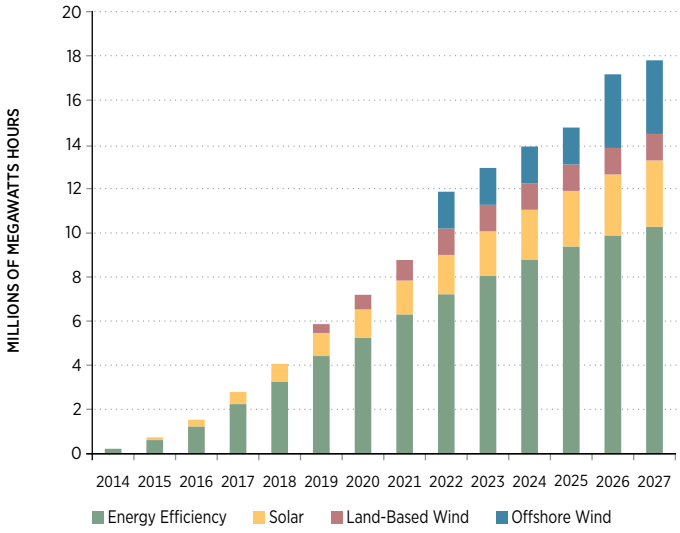


Figure 28, below, shows the annual supply-side and demand-side MWh of energy that would be provided by the Clean Energy Investment Plan.

FIGURE 28: Clean Energy Investment Plan Annual MWh of Energy, 2014–2027.



Thus, by 2027 the Clean Energy Investment Plan would provide nearly 6,800 MW of installed non–emitting clean capacity (3750 MW firm) and nearly 18 million MWh of non–emitting clean energy each year. And these numbers would increase beyond 2027 as additional energy efficiency investments are made and as more distributed solar and offshore wind capacity is added. Eventually the Clean Energy Investment Plan would provide more than 23 million MWh of non–emitting clean energy each year by 2032 and more than 24 million MWh by 2037.

Dominion currently plans to add two new large fossil–fired units in the near term as part of its Preferred Resource Plan — the Brunswick NGCC plant in 2016 and a second NGCC plant in 2019. We have evaluated the costs and benefits of the Clean Energy Investment Plan in two scenarios. In the first scenario, we compare the Clean Energy Investment Plan to both of Dominion's planned new fossil fired units — Brunswick and the 2019 NGCC plant. In this scenario neither of Dominion's two planned NGCC plants would be built. In the second scenario, we have assumed that either the Brunswick plant or the 2019 NGCC plant will be built but not both. Consequently, in this second scenario, the Clean Energy Investment Plan would only replace one of Dominion's two planned NGCC plants. As is shown in the following discussion, the Clean Energy Investment Plan produces significant economic and risk reduction benefits whether compared against one or both of Dominion's planned new fossil units.

SCENARIO 1: THE BENEFITS AND RISKS OF A CLEAN ENERGY INVESTMENT PLAN COMPARED TO BOTH NGCCS IN DOMINION'S PREFERRED RESOURCE PLAN

By replacing both of Dominion's two planned fossil–fired NGCC plants and moving the Company in a new and cleaner direction, the Clean Energy Investment Plan would produce a significant number of economic benefits for Dominion's ratepayers.

Cost: We have compared the total costs (fixed and operating) of the Clean Energy Investment Plan to the total costs (fixed and operating) of Dominion's two planned fossil units — Brunswick and the 2019 NGCC plant. Our analyses show that the Clean Energy Investment Plan would produce an equivalent amount of power as the Brunswick and 2019 NGCC plants with a lower total cost through 2027. These results are shown in Tables 6 and 7, below, for scenarios with lower and higher natural gas and PJM energy market prices and over a wide range of possible CO_2 prices.

TABLE 6: Economic Comparison with Lower Natural Gas and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
	Millions of PV 2013 Dollars		
ICF CO_2 Prices	$6,454	$7,087	–$633
Synapse Low CO_2 Prices	$6,592	$7,488	–$895
Synapse Mid CO_2 Prices	$6,639	$7,758	–$1,119
Synapse High CO_2 Prices	$6,731	$8,226	–$1,496

TABLE 7: Economic Comparison with Higher Natural Gas Prices and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
	Millions of PV 2013 Dollars		
ICF CO_2 Prices	$6,745	$7,807	–$1,061
Synapse Low CO_2 Prices	$6,884	$8,207	–$1,324
Synapse Mid CO_2 Prices	$6,930	$8,477	–$1,547
Synapse High CO_2 Prices	$7,022	$8,802	–$1,780

Our analyses show that the Clean Energy Investment Plan would be an even more economic option than shown in Tables 6 and 7 if natural gas prices, PJM energy prices, and CO_2 prices actually turn out to be higher than have been assumed in these analyses.

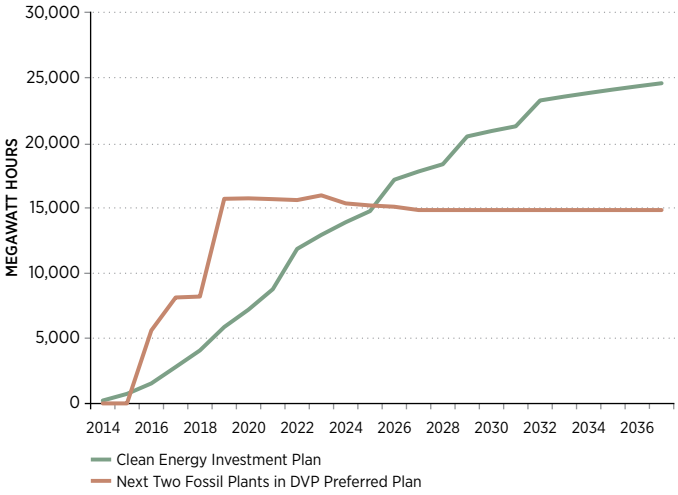
The results presented in Tables 6 and 7 are based on the following key input assumptions:

- Dominion's public annual plant costs for the Brunswick Project.
- The ICF, International, and Synapse Energy Economics 2012 forecasts of CO_2 prices shown in Figure 13.
- The natural gas prices shown in Figure 10. The lower natural gas price forecast was developed by using current NYMEX natural gas futures prices through 2023 and then escalated these prices at a 4.1 percent annual rate in subsequent years.
- First–year energy efficiency costs of $239 per MWh (23.9 cents per kWh) in 2013 dollars.
- A levelized cost of $150 per MWh (15 cents per kWh) for solar PV capacity installed in 2015.[84]
- A levelized cost of $100 per MWh (10 cents per kWh) for land–based wind capacity installed in 2019.[85]
- A levelized cost of $228 per MWh (28 cents per kWh) for offshore wind capacity installed in 2022.[86]

- PJM Market Prices — Current futures energy prices for the PJM Western Hub through 2019 were adjusted to reflect the historic differentials between that Hub and the Dom Zone. After 2019, the PJM energy prices were escalated at the same 4.1 percent long-term annual rate as natural gas prices. PJM energy market prices also were adjusted to reflect the application of a CO_2 price beginning either in 2020 (under the Synapse forecasts) or 2023 (under the ICF forecast).
- PJM Capacity Prices — The actual results of the PJM capacity auctions through the 2015/16 and 2016/17 Delivery Years were used and then were escalated at a 3–4 percent annual rate beginning in 2017.

Fuel Mix Diversity: Between 2014 and 2027, the Clean Energy Investment Plan would replace the 161 million MWh of generation that Dominion estimates (rather than projects) will be projected by the Brunswick Project and 2019 NGCC plants with 120 million MWh of clean energy from energy efficiency and renewable resources. The remaining 41 million MWh of projected generation from the Brunswick and 2019 NGCC units would be replaced by purchases from PJM. As shown in Figure 29, below, after 2025, the Clean Energy Investment Plan would provide enough energy to enable Dominion to displace the planned generation from the Brunswick and 2019 NGCC units, while at the same time reducing either its purchases from PJM or the generation at its existing coal- or gas-fired units.

FIGURE 29: Annual Energy from the Clean Energy Investment Plan versus Dominion's Two Planned NGCC Units.[87]



By 2037, the Clean Energy Investment Plan would have produced 344 million MWh of non-emitting energy, enough to displace both of Dominion's planned NGCC plants and approximately 35 million of additional generation at the Company's existing fossil-fired units and/or purchases from other fossil-fired units in PJM.

While Dominion's Preferred Resource Plan is their "Fuel Diversity" plan, which was designed to address "uncertainty surrounding load growth, environmental regulations, fuel costs, construction costs, unit retirement and renewable energy requirements,"[88] by 2027, the Clean Energy Investment Plan would have a much more diverse energy mix than Dominion's Preferred Resource Plan, as can be seen in Table 8, below:

TABLE 8: Dominion Fuel Mix in 2027 — Dominion Preferred Plan with Both Planned NGCC Units vs. Clean Energy Investment Plan.[89]

	DOMINION'S PREFERRED RESOURCE PLAN	CLEAN ENERGY INVESTMENT PLAN REPLACING 2 NGCC UNITS + PJM PURCHASES
Nuclear	34%	34%
Coal	18%	18%
Natural Gas	27%	14%
NUG Purchases	0%	0%
PJM Purchases	14%	12%
Fuel Oil	0%	0%
Renewables	3%	10%
DSM	3%	12%
TOTAL	**100%**	**100%**

Thus, under Scenario 1 of the Clean Energy Investment Plan, the Company would depend on natural gas for only 14 percent of its energy generation as compared to 27 percent, or almost double, under the Company's Preferred Resource Plan. Conversely, the Company would increase DSM resources from 3 percent under the Preferred Resource Plan to 12 percent under the Clean Energy Investment Plan and would increase renewable resources from 3 percent under the Preferred Resource Plan to 10 percent under the Clean Energy Investment Plan.

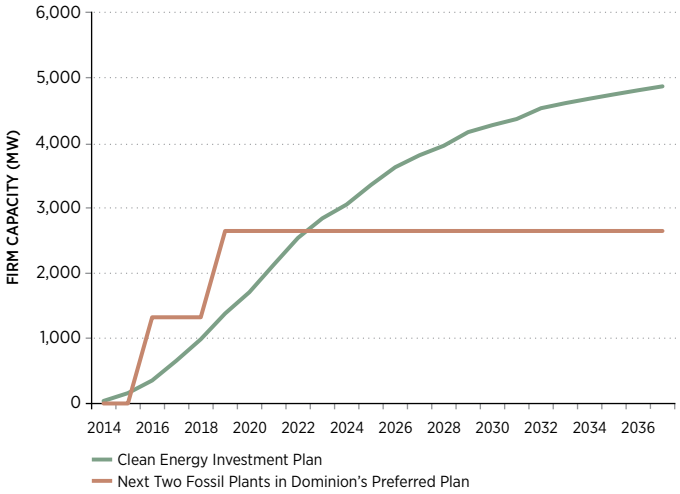
Hedge against Fuel Price Uncertainty and Volatility: Because Scenario 1 of the Clean Energy Investment Plan would replace 120 million MWh of natural gas-fired generation through 2027 with energy efficiency and solar and wind resources, none of which have any fuel costs, it would act as an effective hedge for Dominion's ratepayers against future gas and coal price increases. The benefit of the Clean Energy Investment Plan as a hedge against natural gas and coal price uncertainty and volatility would be even greater after 2027 when the Clean Energy Investment Plan would provide even more MWh from energy efficiency and new solar and wind resources.

Hedge against Future CO_2 Costs: By replacing 120 million of the 161 million MWh of gas-fired generation projected for the Brunswick and 2019 NGCC units with energy efficiency and renewable resources that do not emit any CO_2, the Clean Energy Investment Plan would reduce the Company's total CO_2 emissions between 2014 and 2027 by approximately 31 million tons and by approximately 152 million tons between 2014 and 2037. This would save ratepayers between $150 million and $210 million, in Present Value 2013 dollars by 2027. By

2037, it would save ratepayers between $1.0 and $4.4 billion, in present value 2013 dollars.

Lower PJM Capacity and Energy Market Prices: In Dominion's recent filing for approval of a certificate of public convenience and necessity to construct and operate the Brunswick Project, the Company noted that the energy from the new power plant will have a positive impact on its own and other customers in the region by lowering the market–clearing price of power, thus reducing the cost of purchased power over a large area and many customers.[90] A Clean Energy Investment Plan can have a similar effect through the development of energy efficiency and renewable resources. Unfortunately, because of the need to ramp–up energy efficiency and renewable resources, the Clean Energy Investment Plan is likely to have less of an impact on PJM energy and capacity prices in the near–term than the Company's Preferred Resource Plan. But the Clean Energy Investment Plan can be expected to have a much more significant impact on both PJM capacity and energy prices after about 2025 when the total MW of firm capacity and MWh of energy produced by the Clean Energy Investment Plan will exceed the MW and MWh that Dominion projects for its two planned NGCC units. This is shown in Figure 29, and Figure 30, below:

FIGURE 30: Firm Capacity from the Clean Energy Investment Plan versus Dominion's Two Planned NGCC Units.



Positive Benefits for the Electric grid: Energy efficiency and distributed solar and, where possible, distributed wind resources can have a number of positive benefits for the electric grid:

- Avoided transmission improvements
- Less grid congestion
- Better security with less of a risk of a potentially significant attack on the already centralized U.S. electric grid
- Fewer line losses

Dominion and other utilities have argued against incorporating increased energy efficiency and renewable resources by noting that these resources are "intermittent" and therefore not "dispatchable." This argument is misleading because (1) not every increment of generating capacity on the grid has to be dispatchable and (2) both the Dominion system, and the larger PJM transmission grid to which it is connected, already have tens of thousands of MW of dispatchable capacity. The distributed solar and the land–based and offshore wind resources included in the Clean Energy Investment Plan can both (1) provide reliable energy and (2) contribute to providing needed capacity for the PJM grid, a fact that is recognized and accepted by PJM.

Cleaner Air and Reductions in Climate Change Pollution: The addition of new natural gas–fired combined cycle capacity, and the Company's retirement and conversion of some existing coal–fired capacity would lower Dominion's emissions of critical pollutants like SO_2, NO_x and mercury. However, replacement of the planned Brunswick and 2019 NGCC plants with the non–emitting energy efficiency and renewable resources in the Clean Energy Investment Plan would reduce Dominion's emissions even more, and over time would allow the Company to significantly reduce its purchase of coal–fired energy generated at dirty power plants elsewhere in PJM.

Enhanced Resource Plan Flexibility: Building a large power plant to meet customer demand is an all–or–nothing proposition. Once the plant is built (or even before completion) the Company's ratepayers are committed to pay for its construction cost, and eventually its operating costs. This is true whether or not the load the plant purports to serve materializes, and regardless of the price of fuel or any environmental control or compliance costs that may come into effect in the future. The Clean Energy Investment Plan would add new capacity in much smaller increments, thereby providing much greater flexibility to change the resource plan in light of changed circumstances.

Dominion's experience with the deregulated Brayton Point coal plant in Massachusetts offers a cautionary tale regarding the potential for significantly changed circumstances.[91] Dominion agreed in the middle of the last decade to install cooling towers and to upgrade the scrubber system at Brayton Point to address environmental concerns. This project was completed in 2012 at a total cost of approximately $1 billion. However, by that time the demand for the power from the plant had almost disappeared and energy and capacity market prices had been greatly reduced. As a result, Dominion Resources is currently in the process of selling the plant

for less than $300 million. An investment that looked like a good idea back in 2005 has turned into an economic loss for the Company's shareholders. The Clean Energy Investment Plan would allow Dominion the flexibility to change direction if future circumstances do not turn out as currently expected. Committing several billion dollars to build two new natural gas–fired combined cycle plants would not provide that same flexibility.

SCENARIO 2: THE BENEFITS AND RISKS OF A CLEAN ENERGY INVESTMENT PLAN COMPARED TO ONE OF DOMINION'S TWO PLANNED NGCC UNITS

The Clean Energy Investment Plan would be a good idea even if either the Brunswick NGCC unit or Dominion's planned 2019 NGCC plant is built, as it would produce significant economic benefits for Dominion's ratepayers.

Cost: Across a range of assumed natural gas prices, PJM energy market prices and CO_2 prices, the Clean Energy Investment Plan would produce much more power through 2027 at a total price that would be lower than the cost of building and operating either of the two NGCC plants that Dominion currently plans to add in 2016 and 2019, as shown in Tables 9 and 10, below:[92]

TABLE 9: Economic Comparison with Lower Natural Gas and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF ONE OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
	Millions of PV 2013 Dollars		
ICF CO_2	$3,488	$3,046	$441
Synapse Low CO_2 Prices	$3,299	$3,246	$53
Synapse Mid CO_2 Prices	$3,125	$3,380	–$255
Synapse High CO_2 Prices	$2,835	$3,614	–$779

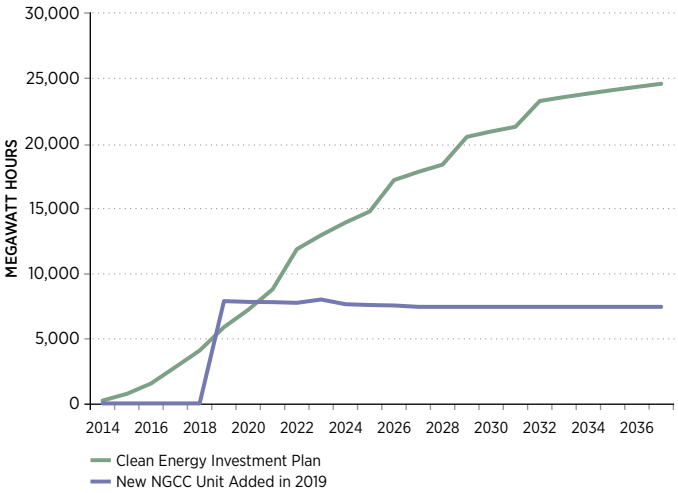
TABLE 10: Economic Comparison with Higher Natural Gas and PJM Energy Prices.

	TOTAL COST OF THE CLEAN ENERGY INVESTMENT PLAN	TOTAL COST OF ONE OF THE TWO PLANNED NGCC UNITS IN DOMINION'S PREFERRED RESOURCE PLAN	RELATIVE COST OF THE CLEAN ENERGY INVESTMENT PLAN
	Millions of PV 2013 Dollars		
ICF CO_2	$3,267	$3,345	–$78
Synapse Low CO_2 Prices	$3,068	$3,544	–$477
Synapse Mid CO_2 Prices	$2,904	$3,679	–$775
Synapse High CO_2 Prices	$2,614	$3,769	–$1,155

Thus, the only scenario in which building and operating either of Dominion's planned NGCCs would clearly be a lower–cost option would be the one with low natural gas and PJM energy market prices and the lowest CO_2 prices.

Fuel Mix Diversity: Between 2013 and 2027, the 120 million MWh of clean energy that would be produced by the Clean Energy Investment Plan would replace all of the 69 million MWh that Dominion projects would be generated by a new NGCC unit and an additional 51 million MWh of PJM purchases or generation at the Company's existing fossil–fired power plants. This can be seen in Figure 31, below:

FIGURE 31: Energy from the Clean Energy Investment Plan versus One of Dominion's Two Planned NGCC Units.



Consequently, by 2027, even if either the proposed Brunswick or the planned 2019 NGCC unit is built, Dominion would have a much more diverse energy mix with the Clean Energy Investment Plan than it would have under its Preferred Resource Plan, as can be seen in Table 11, below:

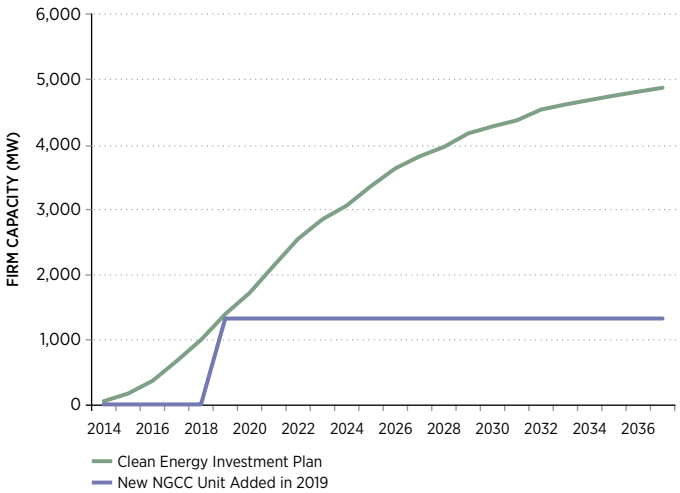
TABLE 11: Dominion Fuel Mix in 2027.

	DOMINION'S PREFERRED RESOURCE PLAN	CLEAN ENERGY INVESTMENT PLAN REPLACING 1 NGCC UNIT + PJM PURCHASES
Nuclear	34%	34%
Coal	18%	18%
Natural Gas	27%	20%
NUG Purchases	0%	0%
PJM Purchases	14%	5%
Fuel Oil	0%	0%
Renewables	3%	10%
DSM	3%	12%
TOTAL	**100%**	**100%**

Consequently, under Scenario 2, Dominion would depend on natural gas for only 20 percent of its generation with the Clean Energy Investment Plan. Importantly, the Company would only rely on PJM energy purchases for 5 percent of its energy requirements, far below the projected 14 percent reliance under Dominion's Preferred Resource Plan.

Hedge against Fuel Price and PJM Energy Market Price Uncertainty and Volatility: In Scenario 2, through 2027 the Clean Energy Investment Plan would replace 69 million MWh of natural gas–fired generation and 51 million MWh of purchased generation from a mix of coal–fired and natural gas–fired facilities with energy efficiency and solar and wind resources, none of which have any fuel costs. This would provide an effective hedge for Dominion's ratepayers against future natural gas, coal price, and PJM energy market price uncertainty and volatility. This hedge would become even more effective in the years after 2027 as the Clean Energy Investment Plan will produce even more MWh in those years from clean and renewable energy that will be available to displace energy from either Dominion's own coal–fired or gas–fired units or purchased from PJM. At the same time, the additional capacity produced by the Clean Energy Investment Plan, shown in Figure 32, below, would lower the clearing prices in the PJM capacity auctions.

FIGURE 32: Firm Capacity from the Clean Energy Investment Plan versus One of Dominion's Two Planned NGCC Units.



Hedge against Future CO_2 Prices: In Scenario 2, the Clean Energy Investment Plan would reduce the Company's total CO_2 emissions between 2014 and 2027 by approximately 68 million tons and its CO_2 emissions between 2014 and 2037 by approximately 218 million tons. These figures reflect reductions in the CO_2 emissions attributable to the energy that Dominion purchases through the PJM energy market as well as to the Company's internal generation. This would save ratepayers between $223 million and $1.6 billion, in Present Value 2013 dollars by 2027. By 2037, it would save ratepayers between $1.3 and $5.9 billion, in present value 2013 dollars.

Electric Grid Benefits: The energy efficiency and distributed generation in the Clean Energy Investment Plan have the very same benefits in this scenario as in Scenario 1.

Cleaner Air, Reductions in Climate Change Pollutants, and Resource Plan Flexibility: As discussed with respect to Scenario 1, above, the Clean Energy Investment Plan would provide cleaner air and increased resource plan flexibility even if the Brunswick plant is built.

SECTION VII — CONCLUSION

The key findings of this Report are that:

- Dominion's current resource mix is heavily dependent on fossil–fired generation, with coal, natural gas, and oil–fired power plants providing nearly two–thirds of the energy from Dominion–owned facilities or that the Company purchases from non–utility generators or other utilities in the PJM.
- Dominion's Preferred Resource Plan would encompass more of the same, adding more than 5,000 MW of new or converted natural gas–fired capacity by 2027, while not retiring any additional coal–fired units beyond those the Company currently plans to retire by 2015. As a result, as late as 2027, with the Preferred Resource Plan, coal and natural gas–fired facilities would continue to provide nearly 60 percent of the energy from Dominion–owned facilities or that the Company purchases.
- Dominion's Preferred Resource Plan is fraught with substantial uncertainties and risks for ratepayers and the environment, and it fails to account for Virginia's substantial untapped potential for energy efficiency and renewable energy resources.
- Adoption of a Clean Energy Investment Plan, while only a first step in moving the Company towards a cleaner energy future, will provide by 2027 nearly 6,800 MW of energy efficiency and renewable resources and more than 18 million MWhs clean non–emitting energy each year, at a lower cost than building one or both of the new natural gas–fired combined cycle power plants that Dominion plans to add by 2019.

The Clean Energy Investment Plan considered here is a moderately aggressive plan, just a first step in addressing the future welfare of Virginians. It is not an estimate of the maximum technological potential for clean energy, but rather was developed within the restrictive regulatory structure currently in place in Virginia. The steps taken in this plan are based on technologies already known, commercialized, and expected to be economically feasible within the time frame established. The Clean Energy Investment Plan considers a limited set of changes from Dominion's Preferred Resource Plan that are economically competitive; i.e., that would be as economic or more so than the Preferred Resource Plan based on current conditions and conservative projec-

tions of future trends. Changes in conditions such as much higher costs associated with greenhouse gas emissions might justify a much more aggressive move toward clean energy resources.

The Report's overall conclusion is that Virginia has substantial untapped potential for energy efficiency and renewable energy resources, particularly solar and off-shore wind. Even a moderately aggressive Clean Energy Investment Plan would produce significant benefits for Dominion's ratepayers. A Clean Energy Investment Plan would:

- Be less expensive for ratepayers in most scenarios than building and operating one or both of the new fossil–fired power plants that Dominion plans to add by 2019.
- Provide real fuel diversity that would provide an effective hedge against uncertainty and volatility in fossil fuel prices and the costs of purchasing power from plants owned by other companies.
- Reduce Dominion's dependence on power produced at fossil–fired power plants in neighboring states.
- Significantly reduce the Company's carbon dioxide emissions, which are a major cause of climate change and will be a financial risk when carbon is eventually regulated.
- Result in cleaner air in Virginia and neighboring states.
- Provide positive benefits for the electric grid including avoided need for transmission improvements, less grid congestion, better security and fewer line losses.
- Provide more flexibility, allowing Dominion to more easily revise its resource plans in light of changing circumstances.

Changing Dominion's direction will not be easy and will not be accomplished by a single act or decision, in a single year or even in a single decade. However, the change must start now as the Company's preferred route is not sustainable over the long–term and will lead to significant economic risk for its customers.

ENDNOTES

1 Energy efficiency refers to any action taken to reduce the energy required to provide the same or greater level of service or comfort, for example by installing a more efficient air conditioning unit that results in lower energy consumption to maintain the same temperature in a home. In contrast, choosing lower levels of service or comfort, such as by raising the thermostat set–point during the cooling season, is more appropriately termed 'conservation.'

2 Capacity refers to the amount of power that a generating plant produces at any moment. It is calculated in terms of Kilowatts ("KW") or Megawatts ("MW"). Energy is the amount of power that a plant produces over time. It is calculated in terms of Kilowatt Hours ("KWh") or Megawatt Hours ("MWh").

3 PJM is the Independent System Operator ("ISO") that operates and oversees the wholesale power markets in the Mid–Atlantic states and portions of the Midwest.

4 The remainder of the 585 MW of the Virginia City Hybrid Energy Center are coal–burning.

5 Energy efficiency programs are efforts intended to change energy customers' purchasing decisions and behaviors to reduce energy consumption while still maintaining the desired level of service and comfort. Several market barriers exist that prevent energy users from selecting high–efficiency equipment even when the total cost to own and operate the higher–efficiency version is lower than for standard equipment. Efficiency programs, whether directed by utilities, states, or third–parties, are designed to overcome these barriers and therefore increase economic welfare for customers, utilities, and society as a whole. This may involve providing financial incentives to lower the cost of efficiency alternatives, providing information to assist customers with purchasing decisions, training designers and contractors to select and promote efficiency equipment, and other activities.

6 Although there is a significant risk that the proposed North Anna 3 nuclear plant will be much more expensive to build than Dominion now estimates, an assessment of the risk from that project is beyond the scope of this Report.

7 Based on energy generation (in MWh).

8 Energy efficiency refers to any action taken to reduce the energy required to provide the same or greater level of service or comfort, for example by installing a more efficient air conditioning unit that results in lower energy consumption to maintain the same temperature in a home. In contrast, choosing lower levels of service or comfort, such as by raising the thermostat set–point during the cooling season, is more appropriately termed 'conservation.'

9 Although there is a significant risk that the proposed North Anna 3 nuclear plant will be much more expensive to build than Dominion now estimates, an assessment of the risk from that project is beyond the scope of this report.

10 Capacity refers to the amount of power that a generating plant produces at any moment. It is calculated in terms of Kilowatts ("KW") or Megawatts ("MW"). Energy is the amount of power that a plant produces over time. It is calculated in terms of Kilowatt Hours ("KWh") or Megawatt Hours ("MWh").

11 Source: Table 3F on page AP–27 of Dominion's 2012 IRP.

12 MW figures represent net dependable installed capability during peak season.

13 Source: Table 3B on page AP–14 of Dominion's 2012 IRP.

14 PJM is the Independent System Operator ("ISO") that operates and oversees the wholesale power markets in the mid–Atlantic states and portions of the Midwest.

15 *2011 State of the Market Report for PJM, at page 31, and 2012 State of the Market Report for PJM*, at page 62.

16 Dominion Virginia Power's response to Environmental Respondent's Interrogatory 1–8 in Virginia State Corporation Commission Case No. PUE–2012–00128.

17 It also is reasonable to expect that although the mix between coal and gas in PJM will change over time, as older coal units are retired and new combined cycle gas–fired units are added, future purchases from PJM also will continue to be, to a very large extent, from fossil–fired units.

18 The remainder of the 585 MW of the Virginia City Hybrid Energy Center are coal–burning.

19 Energy efficiency programs are efforts intended to change energy customers' purchasing decisions and behaviors to reduce energy consumption while still maintaining the desired level of service and comfort. Several market barriers exist that prevent energy users from selecting high–efficiency equipment even when the total cost to own and operate the higher–efficiency version is lower than for standard equipment. Efficiency programs, whether directed by utilities, states, or third–parties, are designed to overcome these barriers and therefore increase economic welfare for customers, utilities, and society as a whole. This may involve providing financial incentives to lower the cost of efficiency alternatives, providing information to assist customers with purchasing decisions, training designers and contractors to select and promote efficiency equipment, and other activities.

20 Order Approving Demand–Side Management Programs, Virginia State Corporation Commission, Case No. PUE–2009–00081 (entered Mar. 24, 2010).

21 Order, Virginia State Corporation Commission, Case No. PUE–2012–00100 (entered Apr. 19, 2013) (extending two programs that were approved in Case No. PUE–2009–00081).

22 Order, Virginia State Corporation Commission, Case No. PUE–2011–00093 (entered Apr. 30, 2012).

23 Evaluation, Measurement and Verification Report for Dominion Virginia Power, Case No. PUE–2011–00092, Prepared by KEMA, Inc. (filed Apr. 1, 2013).

24 Enactment Clause 3, Chapter 888, Va. Acts of Assembly (2007).

25 Va. State Corp. Commission, *Report: Study to Determine Achievable and Cost–effective Demand–side management Portfolios Administered by Generating Electric Utilities in the Commonwealth*, at 10 (Nov. 15, 2009).

26 Based on data provided in Dominion's 2012 IRP.

27 Source: Table 3F on page AP–27 of Dominion's 2012 IRP.

28 MW figures represent net dependable installed capability during peak season.

29 *Dominion CEO: Overreliance on natural gas is coming*, SNL Financial, March 25, 2013.

30 Dominion presentation at the September 2012 Bank of America/Merrill Lynch Power & Gas Leaders Conference, Slide 24.

31 Id.

32 Although there is a significant risk that the proposed North Anna 3 nuclear plant will be much more expensive to build than Dominion now estimates, an assessment of the risk from that project is beyond the scope of this report.

33 The delivered coal costs at the Company's Chesapeake and Yorktown coal-fired units increased at more than 8.5 percent per year between 2006 and 2012. However, these units have not been included in Figure 11 due to their pending retirement.

34 *US coal producers scrambling in face of skyrocketing production costs*, SNL Financial, April 10, 2013.

35 Case No. 09-0177-E-GI.

36 See the *2012 Carbon Dioxide Price Forecast*, October 2012, Available at www.synapse-energy.com. Although the CO_2 prices that ICF has prepared for Dominion are confidential, a public set of ICF CO_2 price forecasts was recently filed by Monongahela Power in the Public Rebuttal Testimony of Judah L. Rose in Public Service Commission of West Virginia Case No. 12-1571-E-PC, at Exhibit A-4.

37 Dominion Virginia Power is located in the Dominion Zone ("Dom Zone") of PJM. PJM is the Regional Transmission Operator that coordinates and oversees the sale and movement of wholesale electricity in all or parts of thirteen states (including Virginia) and the District of Columbia. Dominion represents approximately 88 percent of the load and energy sales in the Dom Zone.

38 Direct Testimony of Glenn A. Kelly, at page 3, line 15, to page 4, line 3.

39 *Surprise Drop in Power Delivers Jolt to Utilities*, The Wall Street Journal, November 21, 2008.

40 *Utility executives agree 'fundamental changes' dampen future demand growth*, SNL Financial, September 21, 2012.

41 Id.

42 Id.

43 Available at http://www.eia.gov/todayinenergy/detail.cfm?id=10191.

44 Id.

45 Available at http://www.woodmacresearch.com/cgi-bin/wmprod/portal/corp/corpPressDetail.jsp?oid=10742820.

46 Itron, *2012 Forecasting Benchmark Survey*, October 22, 2012.

47 *See id*.

48 *Duke's Rogers call for utility, regulatory business model 'rethink'*, SNL Financial, January 30, 2013.

49 Wallace, Patrick, and Hilary J. Foster. "State of the Efficiency Program Industry: Budgets, Expenditures, and Impacts 2011. CEE, 2012. http://www.cee1.org/files/2011%20CEE%20Annual%20Industry%20Report.pdf

50 Global Energy Partners. "Tennessee Valley Authority Potential Study." Report No. 1360. December 21, 2011; Neubauer, Max and R. Neal Elliot. "Technical Assistance Program; Energy Efficiency Cost Effective Resource Assessment for Kentucky." Prepared by ACEEE for Oak Ridge National Laboratory and the US Department of Energy. March 8, 2012; GDS Associates. "A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina." December, 2006; ACEEE. "Energy Efficiency: The First Fuel for a Clean Energy Future." ACEEE Report No. E082. February, 2008; ACEEE. "Energizing Virginia: Efficiency First." ACEEE Report No. E085. September, 2008.

51 The most recent year for which audited data are available is 2010.

52 See, for example, Nowak, S. et al, *Leaders of the Pack: ACEEE's Third national Review of Exemplary Energy Efficiency Programs.* ACEEE Report U132. June 2013; *The National Action Plan for Energy Efficiency*, http://www.epa.gov/cleanenergy/documents/suca/napee_report.pdf.

53 State Energy Efficiency Resource Standards Policy Brief. http://aceee.org//files/pdf/policy-brief/state-eers-summary-0912.pdf. Accessed 1 march 2013.

54 York, D., Kushler, M., and Witte, P. "Examining the Peak Demand Impacts of Energy Efficiency: A Review of Program Experience and Industry Practice." ACEEE Report Number U072. February 2007.

55 Northwest Power and Conservation Council, "Sixth Northwest Conservation and Electric Power Plan," February 2010. http://www.nwcouncil.org/media/6284/SixthPowerPlan.pdf

56 Direct Testimony of Timothy Woolf before the Minnesota Office of Administrative Hearings, OAH No. 12-2500-17037-2, Exhibit JI-5-E.

57 Takahashi, K. and D. Nichols. "The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date." Proceedings of 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

58 *Sustainable Energy in America: 2013 Factbook*, Bloomberg New Energy Finance, January 2013, at page 3.

59 Sources: *Tracking the Sun V*, Lawrence Berkeley National Laboratory, November 2012, and the *U.S. Solar Market Insight Report, 2012 Year in Review, Executive Summary*, the Solar Energy Industries Association and GTM Research.

60 *U.S. Solar Market Insight Report, 2012 Year in Review, Executive Summary*, at page 3.

61 *Tracking the Sun V*, at page 10.

62 For example, the 2010 Virginia State Energy Plan estimated that there was the potential for between 11,000 MW and 13,000 MW of new installed solar PV capacity in the state. At page 6-2.

63 For example, see page 74 of Dominion's 2012 IRP Resource Plan.

64 *The 2007 Virginia Energy Plan*, at page 54.

65 The Virginia 2010 State Energy Plan concludes that there is the potential for 1,793 MW of new installed land-based wind capacity in the state. At page 6-2.

66 *Analysis of the Past, Present & Future Prospects for Land-Based Wind Energy in Virginia*, a June 21, 2012 presentation at the 2012 Virginia Statewide Wind Energy Symposium by Salud Goodin of the Dominion Business Development Group.

67 At page vi.

68 Id.

69 Id.

70 *Recent Development in the Levelized Cost of Energy from U.S. Wind Power Projects*, Lawrence Berkeley National Laboratory, February 2012,

71 Id.

72 *Recent Developments in the Levelized Cost of Energy from U.S. Wind Power Projects*, Wiser, Lantz, and Bollinger from the Lawrence Berkeley National Laboratory and Hand from the National Renewable Energy Laboratory, February 2012, at page 41.

73 See *Analysis of the Past, Present & Future Prospects for Land-Based Wind Energy in Virginia*, a June 21, 2012 presentation at the 2012 Virginia Statewide Wind Energy Symposium by Salud Goodin of the Dominion Business Development Group.

74 *History and Updated Results for Offshore Wind*, October 2012, George Hagerman, VCERC Director of Research.

75 At page 6-2.

76 *Assessment of Offshore Wind Energy Resources for the United States*, National Renewable Energy Laboratory, Technical Report NREL/TP-500-45889, June 2010, at page 91.

77 *Notice of Determination of No Competitive Interest (DNCI) for a Proposed Outer Continental Shelf (OCS) Research Lease Offshore Virginia*, 78 Fed. Reg. 16,529 (Mar. 15, 2013).

78 SNL Financial, January 27, 2013.

79 For example, see *2010 Cost of Wind Energy Review*, NREL, April 2012; *Offshore Wind Market and Economic Analysis: Annual Market Assessment*, Navigant Consulting prepared for the U.S. Department of Energy, November 2012; and *A Learning Investment-based Analysis of the Economic Potential for Offshore Wind: The case of the United States*, The Brattle Group, February 2013.

80 Dominion 2012 IRP, at page 78.

81 Dominion News Release, *Dominion Virginia Power Welcomes First-Round Selection For Offshore Wind Turbine Demonstration Facility* (Dec. 12, 2012), available at http://dom.mediaroom.com/2012-12-12-Dominion-Virginia-Power-Welcomes-First-Round-Selection-For-Offshore-Wind-Turbine-Demonstration-Facility.

82 Dominion 2012 IRP, at page 103.

83 Dominion 2012 IRP, at page 103.

84 This price is consistent with the levelized solar PV prices in NREL's *An Economic Analysis of Photovoltaics versus Traditional Energy Sources: We Are We Now and Where Might We Be in the Near Future*, June 2011; with the declining trends in solar panel costs and installation costs documented in LBNL's *Tracking the Sun IV* and *Tracking the Sun V*; and other sources such as the 2012 report by the North Carolina Sustainable Energy Association on solar PV levelized and installation costs.

85 This price is higher than the recent PPA prices signed for the years 2013-2037, as reported in the LBNL report *Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices*, LBNL-6103E, March 2013, and the calculated range of Lazard's 2012 levelized cost of energy for wind projects. This reflects the Company's claim that wind projects in the ridge lines of the Appalachian Mountains would be more expensive due to location and small sites meaning no economies of scale. The $100 per MWh wind price also includes a wind integration cost.

86 This price is consistent with recent analyses of the future cost of offshore wind by NREL, the Brattle Group and Navigant Consulting: *2010 Cost Wind Energy Review*, NREL April 2012; *2011 Cost of Wind Energy Review*, NREL, March 2013; *A Learning Investment-based Analysis of the Economic Potential for Offshore Wind: The Case of the United States*, The Brattle Group, February 2013; and *Offshore Wind Market and Economic Analysis: Annual Market Assessment*, Navigant Consulting for the U.S. Department of Energy, November 2012. This price also is approximately 25 to 40 percent higher than the levelized costs of energy for offshore wind in three recent analyses: *History and Updated Results for Offshore Wind, Presented at the MTS/IEEE Oceans '12 Conference* in October 2012, George Hagerman, Virginia Coastal Energy Research Consortium; Lazard 2012 *Levelized Cost of Energy Analysis — Version 6.0*; and *Mid-Atlantic Wind — Overcoming the Challenges*, Princeton Energy Resources International, June 2012, sponsored by the U.S. Department of Energy and the Maryland Department of Natural Resources. The additional 25-40 increment allows for construction cost uncertainty and for a wind integration cost.

87 It is reasonable to expect that Dominion would be able to make any needed energy and capacity purchases from PJM through 2025 even with the projected levels of coal plant retirements. For example, see Ensuring a Clean, Modern Electric Generating Fleet While Maintaining Electric System Reliability, the Analysis Group and M.J. Bradley & Associates, August 2010, June 2011, and November 2011 and the February 2013 Direct Testimony of Michael M. Schnitzer on Behalf of the Electric Power Supply Association and the PJM Power Providers Group in Virginia State Corporation Commission Case No. PUE-2012-00128.

88 Dominion 2012 IRP, at page 109.

89 Based on energy generation (in MWh).

90 Brunswick Combined Cycle Unit Application, Section I, paragraph 11 (page 7).

91 Dominion Resource is the parent company of Dominion Virginia Power.

92 The assumptions used in the analysis of the economic costs of Scenario 2 are the same as those used in the evaluation of Scenario 1, above, except that the alternative is only one of Dominion's two planned NGCC plants.

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