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ISSUE BRIEF

MONEY UP IN SMOKE:
HOW DOMINION'S INVESTMENTS IN BIOMASS ELECTRICITY LOST BIG

Electricity from power plants that burn forest biomass is extraordinarily expensive compared to clean-energy alternatives, according to a new study commissioned by the Natural Resources Defense Council and conducted by researchers at the Georgia Institute of Technology. In *The Economics of Four Virginia Biomass Plants*,[1] the researchers calculated the cost of electricity from plants operated by utility giant Dominion Resources Inc., three of which were coal plants fully converted to burn biomass.[2] The study found that electricity from all four facilities costs significantly more than wind, solar, or energy efficiency programs.

Key findings include:

- Dominion's least expensive biomass electricity is approximately double the cost of the region's new onshore wind-generated electricity and energy-efficiency programs, and is close to double the cost of electricity from new utility-scale solar projects.
- It appears that Dominion did not fully evaluate the broad range of alternatives to coal-to-biomass conversions and missed opportunities for better investments in cleaner energy technologies that would have reduced costs for consumers in Virginia.

The U.S. Southeast is undergoing a significant energy transition marked by anticipated coal phase outs and falling renewables prices. As coal plants are slated to be retired, utilities, regulators, and policymakers should heed the lesson learned from Dominion's decisions in Virginia and reject costly coal-to-biomass conversions.

STUDY RATIONALE: COMPARING COSTS OF BIOMASS TO CLEAN ENERGY IN THE SOUTHEASTERN UNITED STATES

Dominion Resources, Inc. (Dominion) and its electric distribution company, Virginia Electric and Power Company, have contributed prominently to the recent expansion of biomass electricity generation in the U.S. Southeast, which has experienced a 20 percent increase in biomass generation between 2010 and 2015.[3] In 2013, Dominion converted three of its aging Virginia coal plants, located in Altavista, Hopewell, and Southampton, to burn woody biomass.[4] Each plant has a capacity of 71 megawatts (MW)—enough power to meet the needs of approximately 24,000 homes. Together, the three plants represent approximately 50 percent of all coal-to-biomass conversions in the region.[5] Dominion's 84 MW biomass plant in Pittsylvania, Virginia is one of the largest biomass power stations in the east.[6] Dominion can also co-fire as much as 117 MW of biomass at its Virginia City Hybrid Energy Center, which began commercial operations in 2012.[7] In total, Dominion has more than 350 MW of biomass capacity in Virginia, the majority of which has been installed since 2012.

Until now, Dominion's biomass investments have not been examined for their cost competitiveness compared to other non-coal energy choices in today's electricity markets. The Georgia Institute of Technology (GT) study calculated the cost of electricity from four of Dominion's facilities in Altavista, Hopewell, Southampton, and Pittsylvania, and compared these costs to energy efficiency programs and electricity generated by solar and onshore wind.

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BURNING FOREST BIOMASS TO GENERATE ELECTRICITY PRODUCES LASTING CARBON IMPACTS

Forest biomass is often described as a clean, renewable fuel and a green alternative to coal and other fossil fuels for producing electricity. But because wood is a much less efficient fuel, smokestack emissions from burning biomass are always greater than coal. And according to years of established science, net carbon emissions from most forms of forest biomass typically equal or exceed emissions from burning coal for decades or more.[8] That's because it can take from decades to centuries for forest regrowth to recapture enough carbon from the atmosphere just to reach the break-even point—the point at which burning the biomass is no worse for the climate than burning the fossil fuel.[9]

RESEARCH METHODS: HOW GT CALCULATED ELECTRICITY COSTS

Calculating Levelized Cost of Electricity

For each of the four Dominion plants, the researchers calculated the levelized cost of electricity (LCOE), an established cost-effectiveness metric representing the annualized net-present cost of all capital and operating expenses over the life of the investments.[10] The LCOE, measured in dollars per megawatt hour ($/MWh), allows utility planners and policymakers to evaluate costs comprehensively and to compare the economic competitiveness of different energy resources. The study also accounted for the economic benefits to Dominion of federal tax incentives and renewable energy certificates.[11]

Comparing Costs to Clean Energy Alternatives

The study compared the LCOE for each of the four Dominion biomass plants to the LCOE of new solar and wind facilities, based on data from the U.S. Energy Information Administration (EIA) and the financial advisory firm Lazard Asset Management. Both are well-established LCOE sources and their methodologies account for subsidies where applicable.[12] The EIA's estimates are generally considered to be conservative and are often criticized for overestimating the costs of renewable energy.[13] The GT researchers therefore used them to represent the higher end of costs for wind and solar energy. Lazard's analysis provides a range of estimates for each technology.

In addition, the GT researchers accounted for system integration costs, which reflect the costs of backup generation to supplement wind and solar power during periods of lower generation, as well as the costs to increase electrical system flexibility to adapt to supply and demand fluctuations.[14] These costs are typically $5/MWh or lower and are consistently less than $10/MWh. The researchers incorporated potential system-integration costs for solar and wind by adding a value of $5/MWh. They also generated a separate estimate using an upper limit of $10/MWh.[15]

Finally, the researchers compared the costs of producing electricity from Dominion's biomass plants with benchmarks for levelized costs of energy efficiency, relying on published research evaluating the cost-effectiveness of demand-side programs and energy-efficiency resources.

For more information on the data sources and methods, see the GT report found at www.cepl.gatech.edu/projects/Biomass.

SYSTEM INTEGRATION COSTS ARE WELL BELOW $10 PER MEGAWATT-HOUR

System integration costs are the costs of backup generation to supplement wind and solar facilities during periods of lower generation, as well as the costs associated with increasing the flexibility of the system to adapt to fluctuations in supply and demand. GT's summary of a substantial body of published research concludes that these integration costs are minimal in areas where the build-out of solar and wind is less than 10 percent of the total electric capacity, while at higher levels of build-out the costs are consistently less than $10/MWh.[16] In Virginia, the solar and wind build-out is well below 10 percent.[17]

KEY FINDINGS: EVEN WITH SUBSIDIES, ELECTRICITY FROM DOMINION'S BIOMASS PLANTS IS EXTRAORDINARILY EXPENSIVE

Biomass Costs: After factoring in the financial benefits of Renewable Energy Certificates (RECs) and federal subsidies,[18] the total levelized costs of Dominion's four biomass plants range from $84 per MWh to $133 per MWh.[19] The Altavista facility had the highest total LCOE at $133 per MWh, largely because of its higher biomass fuel costs. The other plants' total LCOEs are $84 per MWh and $85 per MWh. The total financial support from RECs and federal subsidies combined varies by plant, ranging from $9/MWh to $15/MWh. (See Table 1)

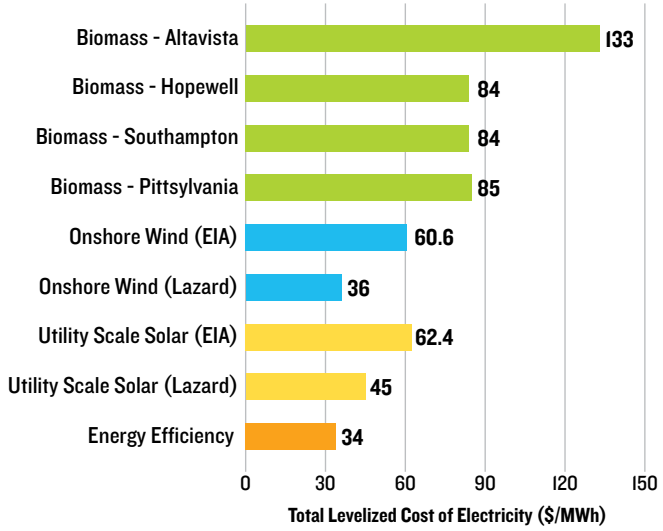
TABLE 1: TOTAL LEVELIZED COSTS OF DOMINION'S FOUR BIOMASS PLANTS

	Altavista	Hopewell	Southampton	Pittsylvania
LCOE ($/MWh)	147	98	99	94
Levelized federal tax credit ($/MWh)	(5)	(5)	(6)	0
Levelized RECs ($/MWh)	(9)	(9)	(9)	(9)
Total LCOE (with federal tax credit and RECs)	133	84	84	85

Notes: "Total" LCOE estimates are LCOE costs that account, where applicable, for federal subsidies, RECs, and/or system integration costs. Numbers in parentheses indicate revenues.

Solar and Wind Costs: Figure 1 shows how unfavorably the total levelized costs of electricity from Dominion's four biomass plants compare with onshore wind, solar, and energy efficiency. According to the EIA's analysis for the Virginia/North Carolina region, the levelized cost of onshore wind is $55.6/MWh and the levelized cost of solar is $57.4/MWh. When accounting for potential system integration costs, these costs are $60.6/MWh and $62.4/MWh for onshore wind and solar, respectively. Lazard's analysis demonstrated a median cost of $31/MWh for onshore wind and $40/MWh for solar. These costs rise to $36/MWh and $45/MWh, respectively, when adjusted for potential system integration costs.

FIGURE 1: TOTAL LCOE OF BIOMASS, ONSHORE WIND, SOLAR, AND ENERGY EFFICIENCY



Notes: "Total" LCOE estimates are LCOE costs that account, where applicable, for federal subsidies, RECs, and/or system integration costs.

Dominion's least expensive biomass energy is approximately $22/MWh costlier than the EIA's conservative estimates for clean energy alternatives, representing a 35 percent cost premium.[20] Using Lazard's median estimates, the cheapest electricity from Dominion's biomass plants is more than twice as costly as electricity from onshore wind and almost twice as costly as electricity from solar.

Energy Efficiency Program Costs: The GT study references the results of a large body of research evaluating the cost effectiveness of demand-side programs and concludes that energy efficiency is far cheaper than energy from Dominion's four biomass plants.[21] One regional benchmark[22] demonstrates 51 million MWh of energy savings at a levelized cost of $34/MWh—less than half the cost of producing electricity from Dominion's biomass conversions (Figure 1).[23]

These LCOE findings are confirmed by GT's separate compilation of 2016 data from the region's wholesale electricity markets,[24] which suggests that electricity from Dominion's four Virginia biomass plants is more expensive than 88 percent of electricity generation from other sources, including solar, wind, hydroelectric, and natural gas.[25]

Electricity from Dominion's four Virginia biomass plants is more expensive than 88 percent of electricity generation from other sources in the region, including solar, wind, hydroelectric, and natural gas.

A BAD INVESTMENT THAT STATES AND UTILITIES SHOULD NOT REPEAT

According to the GT study, it appears that Dominion did not sufficiently evaluate alternative investments to coal-to-biomass conversions, which would have cost Virginians less:

> *A review of publicly available information led us to conclude that Dominion's planning process did not fully evaluate a broad range of alternatives to coal plant conversions to biomass. . . . By narrowly delimiting their assessment to either conversions to biomass or continued coal plant operations, Dominion failed to reveal that more cost-effective options were available.*

Moreover, Dominion relied on federal subsidies and state RECs to justify its investments in biomass. Even with this public support, the electricity produced from Dominion's coal-to-biomass conversions is costlier than many available alternatives.[26]

This lesson is key in the southeastern United States, a region undergoing a significant energy transition marked by anticipated coal phase-outs and falling renewables prices. Several major investor-owned utilities in the region are undertaking long-term planning and investment decisions over the next few years that will lock in energy choices for decades. As coal plants are slated to retire, it is critical that utilities, regulators, and policymakers heed the lessons learned from Dominion's coal-to-biomass conversions in Virginia and channel investment into more cost-effective alternatives. Any utility decision to further expand biomass use for electricity in the region threatens to undermine carbon reductions under state initiatives to address climate change, and poses a risk to investors and consumers.

BIOMASS IS NOT A COMPETITIVE SOURCE OF ELECTRICITY IN THE SOUTHEASTERN UNITED STATES

In May 2018 as this issue brief went to press, Dominion announced its intention to retire its wood-burning biomass power plant located in Pittsylvania, Virginia. The company also plans to cut back its operations at its other three biomass plants, Altavista, Hopewell, and Southampton, which were also analyzed in the Georgia Institute of Technology study. This decision underscores how wind, solar, and energy efficiency are far less costly than biomass, making Dominion's wood-burning plants uncompetitive in today's electricity markets.

ENDNOTES

1 Herein referred to as the GT study.

2 Marilyn A. Brown, Alice Favero, Valerie Thomas, and Aline Banboukian, *The Economics of Four Virginia Biomass Plants*, Georgia Institute of Technology, April 2018, www.cepl.gatech.edu/projects/Biomass.

3 Fred Mayes, *Southern States Lead Growth in Biomass Electricity Generation*, U.S. Energy Information Administration, May 25, 2016.

4 Dominion Energy, *Biomass Fuel*, www.dominionenergy.com/about-us/making-energy/renewables/biomass (accessed May 2, 2018).

5 GT study, Appendix A.

6 S&P Market Intelligence, *Pittsylvania Power Station Power Plant Profile* (subscription required).

7 Dominion Energy, *Virginia City Hybrid Energy Center*, www.dominionenergy.com/about-us/making-energy/coal-oil/virginia-city-hybrid-energy-center (accessed May 2, 2018).

8 Andrea Colnes, et al., *Biomass Supply and Carbon Accounting for Southeastern Forests*, The Biomass Energy Resource Center, Forest Guild, and Spatial Informatics Group, February 2012, https://www.biomasscenter.org/images/stories/SE_Carbon_Study_FINAL_2-6-12.pdf. M. Harmon, *Impacts of Thinning on Carbon Stores in the PNW: A Plot Level Analysis*, Oregon State University, May 2011. S. Mitchell, M. Harmon, and K. O'Connell, "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production," GCB Bioenergy 4, no. 6 (November 2012): 818-827. A. Repo, et al., "Sustainability of Forest Bioenergy in Europe: Land-use-related Carbon Dioxide Emissions of Forest Harvest Residues," GCB Bioenergy, March 2014. A. L. Stephenson and D. MacKay, *Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK*, U.K. Department of Energy and Climate Change, July 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf. M. TerMikaelian, et al., "Carbon Debt Repayment or Carbon Sequestration Parity? Lessons from a Forest Bioenergy Case Study in Ontario, Canada," GCB Bioenergy, May 2014. T. Walker, et al., *Biomass Sustainability and Carbon Policy Study*, Manomet Center for Conservation Sciences, June 2010, www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-full-hirez.pdf.

9 John D Sterman, et al., "Does Replacing Coal with Wood Lower CO_2 Emissions? Dynamic Lifecycle Analysis of Wood Bioenergy," Environmental Research Letters, January 2018, www.iopscience.iop.org/article/10.1088/1748-9326/aaa512/meta.

10 This includes capital costs, fixed operations, maintenance costs, fuel costs, and non-fuel variable costs.

11 The GT study accounted for federal production tax credits for the three conversion plants, assuming a value of $12/MWh for 10 years starting in 2013, derived from U.S. Internal Revenue Service sources. The authors assumed production tax credits to be unavailable for the Pittsylvania plant since Dominion purchased it 10 years after its construction. RECs are issued state renewable portfolio standards when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource. The GT study uses a current value of $14.83/MWh based on Dominion's public disclosures in its Integrated Resource Planning proceedings, which produces a levelized REC value over the lifetime of the plants of $9/MWh in their calculations.

12 U.S. Energy Information Administration, *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017*, January 5, 2017. Lazard Asset Management, *Levelized Cost of Energy*, Version 10.0 (2016), https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf. The U.S. Energy Information Administration provides LCOE estimates for new generating plants entering service in 2022, which include regional estimates for the Virginia/North Carolina region. Lazard provides LCOE estimates based on recently completed power plants in the U.S. Both are well documented and transparent in their assumptions and account for federal subsidies, where applicable.

13 Michael J. Coren, "The US government keeps spectacularly underestimating solar energy installation," Quartz, October 19, 2017, www.qz.com/1103874/the-us-government-underestimated-solar-energy-installation-in-the-us-by-4813-along-with-renewable-wind-and-solar-generation. Alan Neuhauser, "Wasted Energy," U.S. News & World Report, May 28, 2015, www.usnews.com/news/articles/2015/05/28/wasted-energy-the-pitfalls-of-the-eias-policy-neutral-approach. Steve Clemmer, "EIA Analysis Shows the EPA's Clean Power Plan Is Affordable, Renewable Energy Makes a Key Contribution," Union of Concerned Scientists, June 3, 2015, https://blog.ucsusa.org/steve-clemmer/eia-analysis-shows-clean-power-plan-is-affordable-renewable-energy-is-key-754.

14 GT study, 11.

15 According to the study, these costs are consistently less than $10/MWh.

16 GT study, 11.

17 U.S. Energy Information Administration, *Electric Power Monthly with Data for* February 2018, April 2018, Table 6.2.A and Table 6.2.B, www.eia.gov/electricity/monthly. As of the end of 2017, Virginia had 0 MW of wind and 369 MW of utility-scale solar. The state had a total of 27,651 MW of power capacity online at the end of 2017. This means that 1.33% of the state's power capacity comes from wind and solar.

18 GT study, Table 4: The economic benefits from federal subsidies and RECs amounted to approximately $15/MWh for the coal-to-biomass conversion plants.

19 GT study, Table 4.

20 Even under the most conservative "upper limit" system integration assumptions of $10/MWh, Dominion's lowest biomass costs still exceed the cost of wind and solar by approximately $18 per MWh (25 percent higher).

21 GT study, 13. Marilyn Brown and Yu Wang, *Green Savings: How Policies and Markets Drive Energy Efficiency*, (Santa Barbara, California: Praeger Press, 2015).

22 The EmPOWER Maryland Energy Efficiency Act, passed by the Maryland General Assembly in In 2008, sets targets for electric energy and demand reductions.

23 GT study, 13.

24 Specifically, the study generated a surrogate PJM supply curve for 2016 based on the variable operations and maintenance costs of power plants located in the PJM service territory. According to the authors, "this supply curve serves as a rough proxy of the market competitiveness of Dominion's four Virginia biomass plants relative to other plants in the region."

25 GT study, 9.

26 GT study, 15.