Analysis of Virginia Residential Electricity Costs and the Impact of Data Centers

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Introduction

The Commonwealth of Virginia has entered a new era of electricity cost and consumption with the data center business. According to the Virginia Economic Development, Virginia has become the data center "capital of the world," changing the energy landscape for residents of the Commonwealth (2025). Data centers are large "specialized facilities that manage, process, and share large amounts of data," but "consume substantially more energy than other types of commercial or industrial operations," (Virginia Joint Legislative Audit and Review Commission, 2024). They are vital to the booming artificial intelligence (AI) and digital industries. Data centers require electricity to "power computing equipment inside…. [and] cooling equipment that prevents the computing equipment and building from overheating," (Virginia Joint Legislative Audit and Review Commission, 2024). Depending on the size of the building, a data center can use anywhere from 5 megawatts to 100 megawatts of electricity for operation (Virginia Joint Legislative Audit and Review Commission, 2024). The amount of space data centers occupy in Virginia has doubled since 2020 (Virginia Joint Legislative Audit and Review Commission, 2024). There is a growing public concern that data centers could possibly influence electric prices for Virginians. The purpose of this paper is to investigate the relationship between data center and electricity rates for residents across the Commonwealth of Virginia.

The rest of the paper proceeds as follows: Section 2 provides key background information, Section 3 states the hypotheses to be tested, Section 4 explains the data and variables used for analysis, Section 5 explains the methods, Section 6 explains the results, and Section 7 explains observations from the study.

Background Information

The data center industry has substantial impacts on Virginia's economy. Based on analysis of spending between Fiscal Years 2021 and 2023, "the data center industry provides approximately 74,000 jobs, $5.5 billion in labor income, and $9.1 billion in Virginia GDP overall to the state economy (Virginia Joint Legislative Audit and Review Commission, 2024). Proponents of data center development highlight the significant tax revenue that the industry provides local governments. For Prince William County, the data center industry "could add $54 million in revenue, with $19 million going toward schools and $21 million offsetting a real estate tax increase," (Paullin, 2024). For Southwest Virginia, the development of data centers could help financially distressed counties through increased local revenues (Virginia Joint Legislative Audit and Review Commission, 2024).

Virginia offers enticing tax incentives to data centers, with "exception from retail sales and use tax for qualifying computer equipment purchased by data centers," and "local business property tax rates on computer and related equipment…. have been reduced by a number of localities," (Virginia Economic Development Partnership, 2025). As of 2023, there were over 300 existing or proposed data centers across Virginia (Piedmont Environmental Council, 2023). Figure 1 shows the existing and proposed data centers distribution across Virginia, with a noticeable concentration in Northern Virginia. Northern Virginia is the "largest U.S. [data center] market," with the majority of data centers residing in the counties of Prince William, Fairfax, and Loudon (Yadav, 2024).

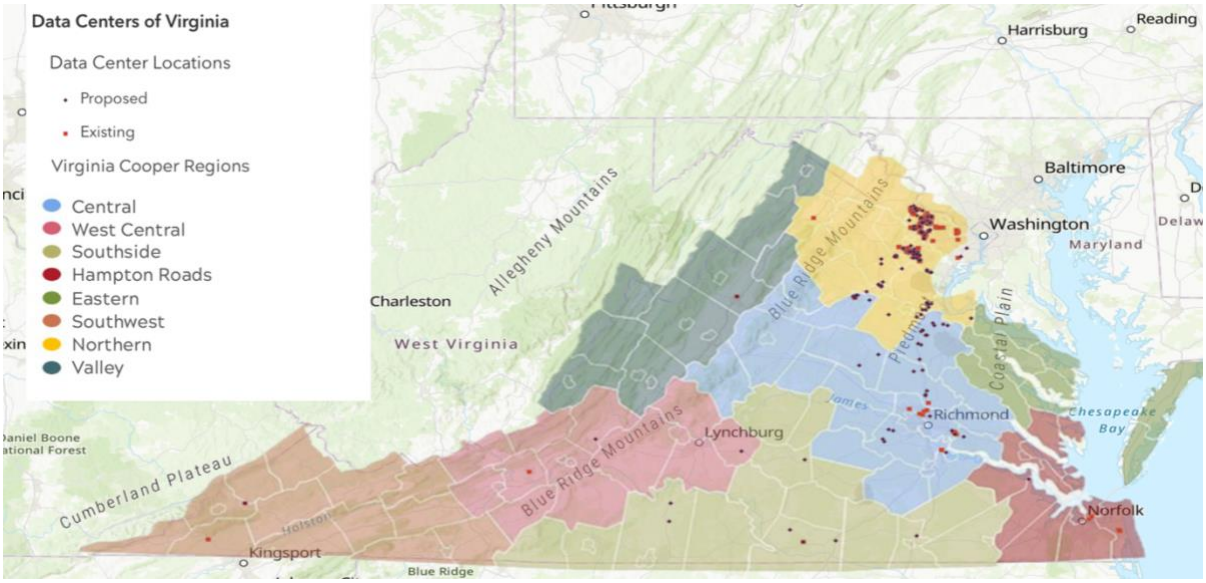

Figure 1: *Distribution of Data Centers across Virginia Regions.* Figure 1 depicts a map of Virginia overlayed with the regions and existing or proposed data center locations. **Source**: Data from Weldon Cooper Center and Piedmont Environmental Council

However, with rapid development of data centers in Virginia, there is increased focus on the demand for energy, and how that demand will affect the price of energy for residents. In 2023, data centers accounted for "approximately 4.4% of U.S. annual electricity consumption," and is projected to "double or triple by 2028, accounting for up to 12% of U.S. electricity use," (Offutt, M. and Ling, Z., 2025). Virginia's Joint Legislative Audit and Review Commission's analysis of the Commonwealth found "energy demand was essentially flat from 2006 to 2020," but "unconstrained demand for power in Virginia would double within the next 10 years, with the data center industry being the main driver," (2024).

Furthermore, energy and utilities "often must make expensive upgrades to power grids [to] handle increased energy demands from new data centers," with "smaller businesses and U.S. households often [shouldering] these costs," (Leppert, 2025). The citizens of Virginia are concerned that rising energy bill costs are connected to the prevalence of data centers in the

localities (Smith, 2025). These rising costs can add increased financial stress to households across the Commonwealth.

In Virginia, there is little to no state legislation to regulate data center growth, energy demand, or electric prices, leaving citizens vulnerable to rapid cost increases. In 2023, the average electrical rate for Virginia residents was approximately 14.3 cents per kilowatt hour, and in 2024 the average monthly electricity bill was $149 (U.S. Energy Information Administration, 2025). In September 2025, the average electrical rate for Virginia had risen to 16.6 cents per kilowatt hour, further raising citizens' monthly electric bill (U.S. Energy Information Administration Electric Power Monthly, 2025). In addition to the residential rate of electricity, the price of purchasing energy for all users (residential, commercial, industrial, and transportation) has increased. According to the U.S. Energy Information Administration State Energy Database System, Virginia's total average price for energy per Million British Thermal Units (MMBTU) increased 43% from 2020 to 2023 (EIA SEDS, 2023). This increase is shown in Figure 2.

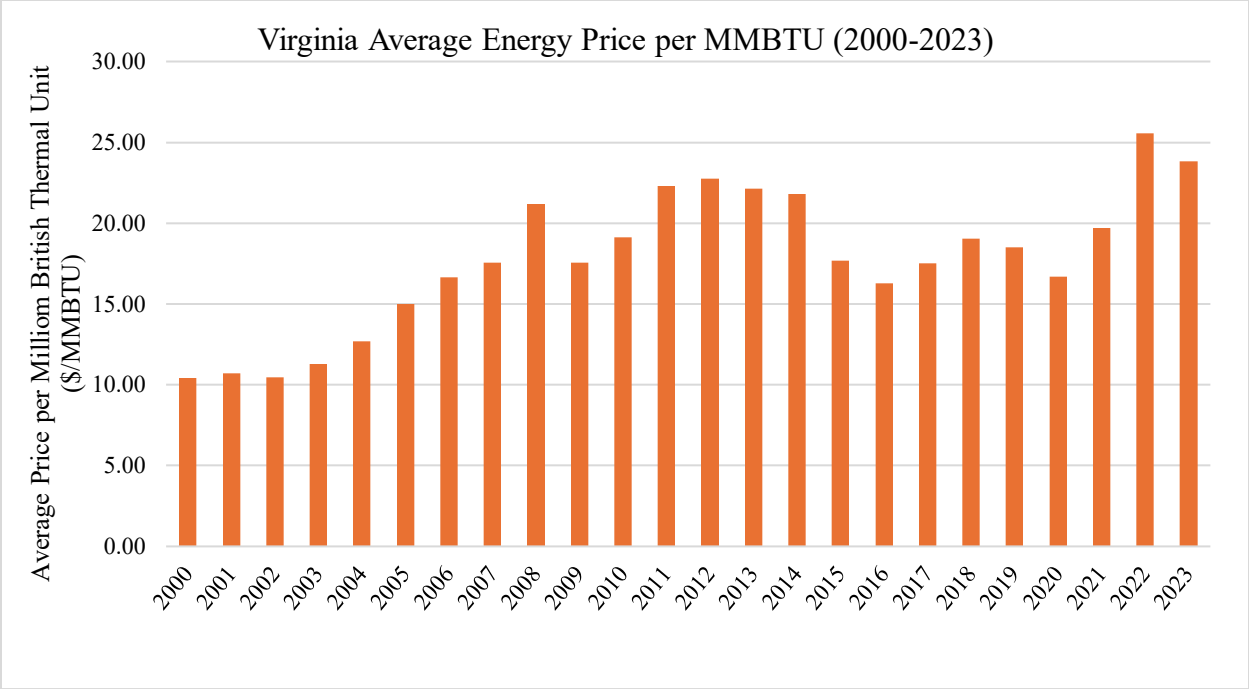

Figure 2: *Average Cost of Energy Per MMBTU* ***Source:*** *Data from the U.S. Energy Information Administration State Energy Database System (SEDS)*

The State Corporation Commission (SCC) of Virginia monitors utility rates and ensures that energy customers are separated by sector (residential, commercial, industrial, and transportation) fairly and paying the appropriate rate (Virginia Joint Legislative Audit and Review Commission, 2024). According to the Virginia Joint Legislative Audit and Review Commission, data centers are paying for their costs, with different rates from residential customers (2024). However, generation and transmission costs (costs associated with energy infrastructure) are passed on to customers, meaning as this infrastructure is built to meet the demands of data centers, non-data center customers will be disproportionally affected, (Virginia Joint Legislative Audit and Review Commission, 2024). A study done by Carnie Mellon University on the costs of data centers concluded that, “Central and Northern Virginia face projected 2030 electricity cost increases” exceeding their model by 25%, (Blackhurst, et.al., 2025). Dominion Energy, a key electric provider in the Northern and Central regions of Virginia,

requested the State Corporation Commission to approve “base rate increases of $822 million in 2026 and $345 million for 2027,” (State Corporation Commission, 2025). While this specific proposal was rejected, the SCC approved new prices that will increase residential monthly electric bills by more than $11 starting in 2026 (State Corporation Commission, 2025). These rate increases are concerning to Virginia’s citizens, who will bear the brunt of these cost increases.

Hypotheses

This report analyzes the correlation between the cost of electricity for residents in Virginia and the distribution of data centers across Virginia Cooper Regions. The key hypothesis I test is listed as follows:

H1: There is a relationship between the cost of electricity in 2024 and the location of data centers in Virginia.

N1: There is not a relationship between the cost of energy in 2024, specifically electricity, and the location of data centers in Virginia.

Additionally, the next hypothesis examines correlations between the residential use and the distribution of data centers in Virginia.

H2: There is a relationship between residential electricity use and total number of data centers in Virginia.

N2: There is not a relationship between residential electricity use and total number of data centers in Virginia.

Finally, the relationship between the 2020 and 2024 residential electric rates are examined.

H3: There is a statistically significant change in residential electrical rates from 2020 to 2024.

N3: There is not a statistically significant change in residential electrical rates from 2020 to 2024.

Data

Multiple data sources are used for this analysis. First, the University of Virginia Weldon Cooper Center for Public Administration Cooper Regions of Virginia is used for the lists of Virginia counties and their corresponding region. There is a total of 133 counties and cities observed. The list of proposed and existing data centers of Virginia is obtained from the Piedmont Environmental Council's ArcPro GIS map metadata. There are 328 total observations for existing and proposed data centers. The breakdown of existing and proposed data centers across the Cooper regions of Virginia are shown in Table 1.

Cooper Center Region	*Existing Data Centers*	*Proposed Data Centers*
Northern	119	154
Central	12	19
Hampton Roads	4	2
Valley	2	1
Southwest	2	2
Southside	1	7
West Central	1	2
Eastern	0	0

Table 1:*Virginia Cooper Regions and Total Data Centers.* Table 1 displays the existing and proposed data centers across the Virginia regions. **Source**: Data from Weldon Cooper Center and Piedmont Environmental Council

Virginia electricity rates for each Virginia County in 2024, as well as the number of Power Plants and Utility Providers per county, is obtained from the company Find Energy. Residential electrical rates in 2020 from the National Renewable Energy Laboratory SLOPE (State and Local Planning for Energy) Database. The unit for both 2020 and 2024 residential electricity rate is cents per kilowatt hour. The 2024 electricity usage per Virginia county was

obtained from OpenEI, a subsidiary of the National Renewable Energy Laboratory. The unit for electricity usage is kilowatt hours

Dependent Variables

*Residential Electricity Rate***:** The 2024 and 2020 electric rates in cents per kilowatt hours for residents in each Virginia county. This is the average rate that citizens would pay for electricity each month throughout the year. The mean for the 2020 residential rate is .1192346 cents per kilowatt hour with a standard deviation of 0.0075517. The mean for the 2024 residential electric rate is 0.1503632 cents per kilowatt hour with a standard deviation of .0131136.

2024 Residential Electricity Use: The electricity usage from residents in kilowatt hours was obtained for each county in Virginia for 2024. The mean for the 2024 residential electric use is 315,000,000 kilowatt hours with a standard deviation of 558,000,000 kilowatt hours.

Independent Variables

Data Center Distribution: The total number of data centers, both existing and proposed, for every county was distributed into the Virginia Cooper Regions. The mean for total data centers in Cooper Regions is 2.458 in and the standard deviation is 12.808.

Number of Power Plants: This is the total number of power plants located in each county. A power plant produces electricity for localities or industries within that locality. The mean for the number of power plants per county is 0.6315 and the standard deviation is 1.0764.

Number of Electricity Providers: This is the total number of electricity providers available to residents in each county. For example, Prince William County Virginia has 2 electricity

providers: Northern Virginia Electric Cooperative and Dominion Energy. The mean for electric providers is 2.233 providers per county and the standard deviation is 1.0863.

Descriptive statistics are shown in Table 2. County, City, and Cooper Regions are ordinal variables. The number of data centers, power plants, and electric providers are count variables., Residential electric rates and use are continuous variables.

Variable	*Observations*	*Mean*	*Std. dev*	*Min*	*Max*
2020 Residential Rate	133	.1192346	.0075517	.0987	.1391
2024 Residential Rate	133	.1503632	.0131136	.111	.1847
2024 Residential Use	133	3.15e+08	5.58e+08	1.49e+07	4.89e+09
Electric Providers	133	2.233083	1.086328	1	6
Power Plants	133	.6315789	1.076426	0	7
Total Data Centers	133	2.458647	12.80833	0	113

Table 2: Descriptive Statistics. Table 2 displays the means, standard deviations, minimum value and maximum values for the variables. **Source**: Data from Find Energy, Open EI, and National Renewable Energy Laboratory SLOPE **Residential Rates are cents/kWh*

Methods

The relationship between residential electric rates and distribution of data centers was examined using the multiple linear regression equation listed as follows:

2024 Residential Electric Rate $= \boldsymbol{\alpha} + \boldsymbol{\beta_1}\ (\boldsymbol{Data\ Centers}) + \boldsymbol{\beta_2}(\boldsymbol{Electric\ Providers}) + \boldsymbol{\beta_3}\ (\boldsymbol{Residential\ Electric\ Use}) + \boldsymbol{\beta_4}(\boldsymbol{Power\ Plants})$

Y represents the outcome variable of *2024 residential electric rates*. The constant is represented by α. The distribution of data centers in Virginia Cooper Regions is represented by $\beta_1\ (x)$. The control variables are the number of power plants, electric providers, and residential electric use are represented by $\beta_2(x) - \beta_4(x)$.

For the second regression analysis, the relationship between residential electric use and distribution of data centers was examined using the linear regression equation listed as follows:

2024 Residential Electric Use $= \boldsymbol{\alpha} + \boldsymbol{\beta_1}\ (\boldsymbol{Data\ Centers}) + \boldsymbol{\beta_2}(\boldsymbol{Electric\ Providers}) + \boldsymbol{\beta_3}(\boldsymbol{Residential\ Electric\ Rate}) + \boldsymbol{\beta_4}(\boldsymbol{Power\ Plants})$

Y represents the outcome variable of *2024 residential electric usage*. The constant is represented by α. The distribution of data centers in Virginia Cooper Regions is represented by $\beta_1(x)$. The control variables are the number of power plants, electric providers, and residential electric rate are represented by $\beta_2(x) - \beta_4(x)$. For each regression analysis, Cooper Region 4, the Northern Virginia, region was used as the omitted variable.

Results

Energy Rate

The first regression analysis completed examined whether 2024 residential electric rate is affected by the distribution of data centers in Virginia Cooper regions. The regression analysis results are shown in Table 3. The estimated effect of the distribution of data centers on electric rates is quite small. In addition to the estimated effect being nearly zero, it is not statistically significant. The p-value between the Virginia residential electric rates and the total number of data centers, is more than 0.05, holding all else constant. This means that the null hypothesis fails to be rejected in favor of the alternative that there is an association between the distribution of data centers and residential electric rates for 2024**.**

Source	SS	df	MS	Number of obs	=	133
				F(10, 122)	=	8.34
Model	.009219052	10	.000921905	Prob > F	=	0.0000
Residual	.013480678	122	.000110497	R-squared	=	0.4061
				Adj R-squared	=	0.3575
Total	.022699729	132	.000171968	Root MSE	=	.01051

twentyfourres~te	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
cooperregion1	.0032292	.003492	0.92	0.357	-.0036835	.010142
cooperregion2	.0010894	.0044577	0.24	0.807	-.0077351	.0099139
cooperregion3	-.0015203	.0039173	-0.39	0.699	-.0092749	.0062344
cooperregion5	.0064501	.0038309	1.68	0.095	-.0011337	.0140338
cooperregion6	.0165323	.0038662	4.28	0.000	.0088787	.0241859
cooperregion7	.0015179	.0037429	0.41	0.686	-.0058916	.0089274
cooperregion8	.0218196	.0039279	5.56	0.000	.0140439	.0295953
totaldatacenters	-.0000228	.000078	-0.29	0.771	-.0001773	.0001317
totalproviders	.0009718	.0009907	0.98	0.329	-.0009893	.0029329
totalpowerplants	-.000526	.0009053	-0.58	0.562	-.002318	.0012661
_cons	.1423914	.0033112	43.00	0.000	.1358366	.1489462

Table 3:*2024 Electric Rate Regression Analysis Results.* **Legend:** Regression analysis of the 2024 Residential Electric Rate and Total Number of Data Centers, Cooper Regions, Number of Electric Providers, Number of Power Plants, and 2024 Residential Electric Use. The p-value is less than 0.05. There is a statistically significant difference in rates.

When examining the electric rates between Virginia region, relationships between regions are evaluated. When comparing Southwest (Cooper Region 6) to Northern (Cooper Region 4, appearing as "Cons"), the p-value is less than 0.05, meaning it is statically significant. Southwest has an electric rate that is 0.01653 cents more than Northern Virginia, holding all else constant. West Central (Cooper Region 8) has an electric rate that is 0.021819 cents more compared to Northern Virginia, holding all else constant. These relationships are statistically significant, which means that there is a difference in residential electric rates between these regions, holding all else constant. Statistically speaking, no other regions were different than Northern Virginia. There was not a statistically significant relationship between power plants, providers, regions, and data centers. Approximately, 36% of variation can be explained by the regions, power plants, providers, and data centers.

Energy Use

The next regression analysis completed examines whether the 2024 residential electric use is affected by the distribution of data centers in Virginia Cooper regions. The regression analysis results are shown in Table 4.

Source	SS	df	MS	Number of obs	=	133
				F(11, 121)	=	5.44
Model	1.3617e+19	11	1.2379e+18	Prob > F	=	0.0000
Residual	2.7552e+19	121	2.2770e+17	R-squared	=	0.3308
				Adj R-squared	=	0.2699
Total	4.1169e+19	132	3.1189e+17	Root MSE	=	4.8e+08

twentyfourresidentialuse	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
cooperregion1	-1.01e+08	1.59e+08	-0.63	0.527	-4.16e+08	2.14e+08
cooperregion2	-3.48e+08	2.02e+08	-1.72	0.088	-7.48e+08	5.30e+07
cooperregion3	1.10e+08	1.78e+08	0.62	0.538	-2.42e+08	4.62e+08
cooperregion5	-3.16e+08	1.76e+08	-1.79	0.075	-6.64e+08	3.26e+07
cooperregion6	-2.57e+08	1.88e+08	-1.37	0.175	-6.30e+08	1.16e+08
cooperregion7	-2.73e+08	1.70e+08	-1.60	0.111	-6.09e+08	6.40e+07
cooperregion8	-1.51e+08	2.00e+08	-0.76	0.451	-5.46e+08	2.44e+08
totalpowerplants	5.07e+07	4.12e+07	1.23	0.221	-3.08e+07	1.32e+08
totalproviders	-1.88e+07	4.51e+07	-0.42	0.678	-1.08e+08	7.06e+07
totaldatacenters	1.94e+07	3544157	5.48	0.000	1.24e+07	2.64e+07
twentyfourresidentialrate	-3.35e+08	4.11e+09	-0.08	0.935	-8.47e+09	7.80e+09
_cons	4.86e+08	6.04e+08	0.80	0.423	-7.11e+08	1.68e+09

Table 4: *Residential Electric Use Regression Analysis Results.* **Legend:** Regression analysis of the 2024 Residential Electric Use and Total Number of Data Centers, Cooper Regions, Number of Electric Providers, Number of Power Plants, and 2024 Residential Electric Use. The p-value is less than 0.05. There is a statistically significant difference in use for Cooper Regions and total data centers.

The average residential electric use in 2024 increased by 19,400,000 kilowatt hours or 19,470 megawatt hours for each data center added per region. This is a large increase. On average, a single Virginia home uses approximately “13 megawatt hours per year” according to the Solar Energy Industries Association (n.d.). The relationship between residential electric use in 2024 and the total number of data centers distributed across Virginia Cooper regions is statistically significant as the p-value is less than 0.05. The null hypothesis is rejected in favor of the alternative that there is a relationship between residential electric use in 2024 and distribution

of total data centers, holding all else constant. However, there is not a statistically significant relationship between 2024 residential use and the number of power plants and electric providers available for residents across Virginia Cooper regions. Approximately, 27% of variation can be explained by the regions, power plants, providers, data centers, and the residential electric rate.

Observations

The goal of this research and analysis was to see if there was a relationship present between the distribution of data centers on residential electric rates and use. From my visualization in Figure 2, there is a clear increase in the price of energy per MMBTU, and subsequently electric rates for Virginia Residents. The next observation is that a statistically significant relationship exists between residential electric use and distribution of data centers in across Virginia Cooper Regions. The regression analysis shows residential electric use in 2024 is positively influenced by the distribution of data centers. This observation is supported by the background information in Section 2. The conclusion cannot be made that data centers are primary reason for this increase in residential use as there may be other influences not applied in the regression equation, but there is a clear relationship present.

Another observation is the lack of relationship between 2024 residential electric rates and distribution of data centers. No Virginia Cooper Regions have electric rates that were impacted by the distribution of data centers in a statistically significant way that can be seen from this analysis. The conclusion cannot be made that there is not an impact on residential electric rates by the presence of data centers, but if there is, it is not a significant one from this finding. This result is slightly surprising as it does not fully align with the background information present. One possibility for this inconsistency is that the data available and accessible is recent and limited. The data center industry has recently increased in Northern

Virginia, so it possible that not enough time has passed for an effect on residential electric rates to be meaningfully observed. A future study with a decade of data on residential electric rates and data centers may produce different results.

Study limitations

The limitations to the study were accessibility and availability of data. There are limited sites with complete information on data centers, such as owners, energy consumption, or construction and completion date. Websites that may have this complete information have a paywall or require project information be sent to the company. Furthermore, complete information on residential electric rates and use across Virginia counties was limited and difficult to find for years besides 2020 and 2024. This availability of data limited the scope of the study only to the years 2020 and 2024, rather than a more detailed analysis with the years 2019, 2021, 2022, and 2023.

Policy Recommendations and Future Study

From these observations, policy recommendations can be made. The first recommendation is a new classification for data centers for both rate and use effective immediately. While the State Corporation Commission for Virginia recently created a new rate class for data centers, it will not be effective until 2027 (State Corporation Commission, 2025). Another policy recommendation is legislation from Virginia's lawmakers that requires data centers to generate their own electricity. This proposed legislation would also provide regulation of the data center industry in Virginia, would alleviate some pressure from residential users and the overall electrical grid in Virginia.

For future studies, more variables and years of data should be included. A key addition for future studies would be the consideration of multiple years of data for each Virginia county and city. This would allow for a more accurate analysis that would provide further insight on the relationship between Virginia residential electric rates, residential electric use, and distribution of data centers. More variables, such as weather, county population, additional consumer sectors (commercial, industrial, transportation), and type of energy consumed by sector should also be used in a regression analysis. A further research question would evaluate the relationship between data centers in Virginia Cooper Regions, electric rates, and electric consumption for all consumers across Virginia over the course of 20 years.

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