# Electrifying Expansion:

## An Analysis of Electric Vehicle Adoption and Energy Costs in the United States

Group B - IST 687 Spring 2023

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# Business Questions

1. Which states have the highest numbers of new electric vehicle registrations?

2. Which states have the most affordable electricity rates?
    a. How have rates changed over the last 5+ years?

# EV Registration Dataset

- Below are the HTML websites where our data originated:
  - https://afdc.energy.gov/vehicle-registration?year=2021
  - https://afdc.energy.gov/vehicle-registration?year=2020
  - https://afdc.energy.gov/vehicle-registration?year=2019
  - https://afdc.energy.gov/vehicle-registration?year=2018
- We performed the following operations on each webpage to put the tables into a dataframe:
  - Created a variable and read in the url
    - webpage <- read_html(url)
  - Extracted the table from the webpage
    - table_html <- webpage %>%  html_nodes("table") %>%  .[[1]]
  - Put the table into a dataframe
    - table_df <- table_html %>%  html_table(fill = TRUE)

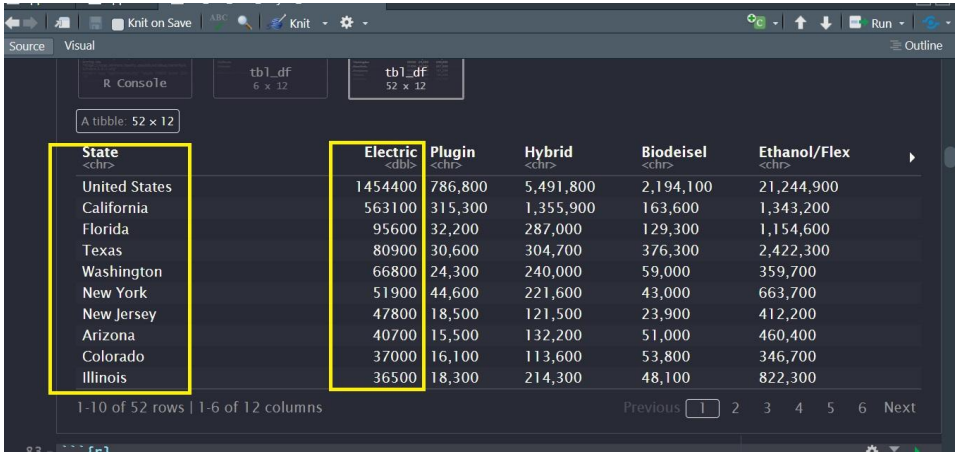
# EV Registration Dataset cont...

Now that the tables are in dataframes, we need to clean the data

- Remove the original headers by removing the first row
  - table_df <- table_df[-1, ]
- The row 1 we are left contains symbols that R Studio recognizes as code operators so we need to rename the columns
  - (i.e. colnames(table_df)[2] <- "Electric")
- The column we are concerned about shows numbers with commas as characters that need to be converted to numeric and have commas removed
  - table_df$Electric <- as.numeric(gsub(",", "", table_df$Electric))

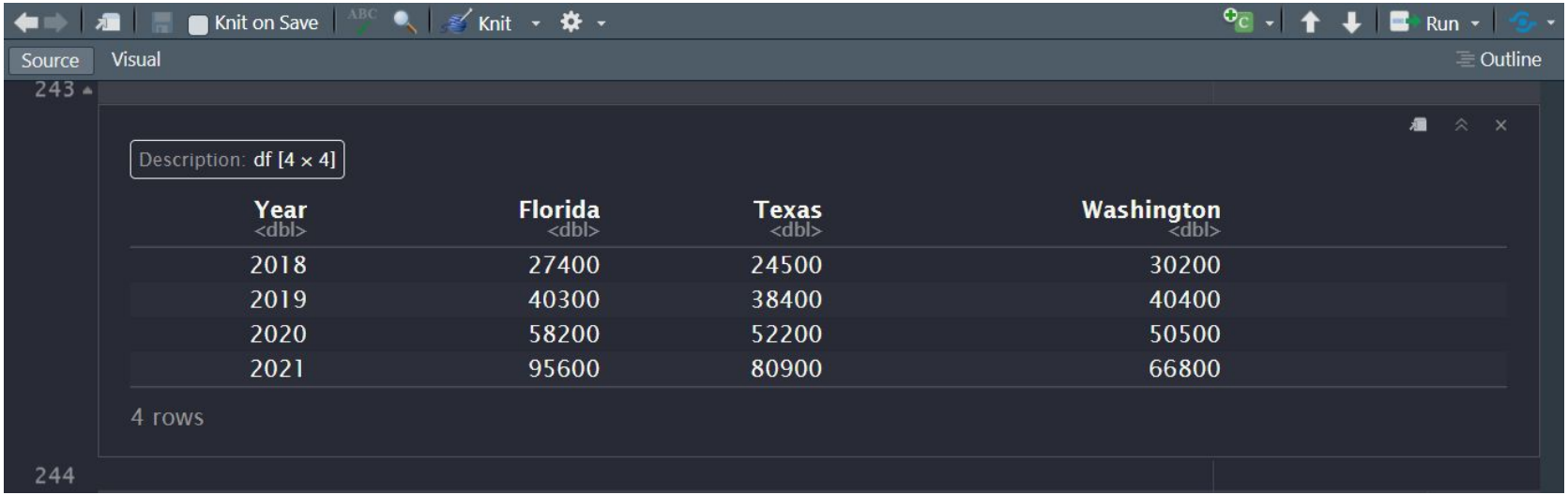
# EV Registration Dataset cont...

We now have a cleaned dataset we can use to perform descriptive statistics and create plots:




| State <chr> | Electric <dbl> | Plugin <chr> | Hybrid <chr> | Biodeisel <chr> | Ethanol/Flex <chr> |
|---|---|---|---|---|---|
| United States | 1454400 | 786,800 | 5,491,800 | 2,194,100 | 21,244,900 |
| California | 563100 | 315,300 | 1,355,900 | 163,600 | 1,343,200 |
| Florida | 95600 | 32,200 | 287,000 | 129,300 | 1,154,600 |
| Texas | 80900 | 30,600 | 304,700 | 376,300 | 2,422,300 |
| Washington | 66800 | 24,300 | 240,000 | 59,000 | 359,700 |
| New York | 51900 | 44,600 | 221,600 | 43,000 | 663,700 |
| New Jersey | 47800 | 18,500 | 121,500 | 23,900 | 412,200 |
| Arizona | 40700 | 15,500 | 132,200 | 51,000 | 460,400 |
| Colorado | 37000 | 16,100 | 113,600 | 53,800 | 346,700 |
| Illinois | 36500 | 18,300 | 214,300 | 48,100 | 822,300 |

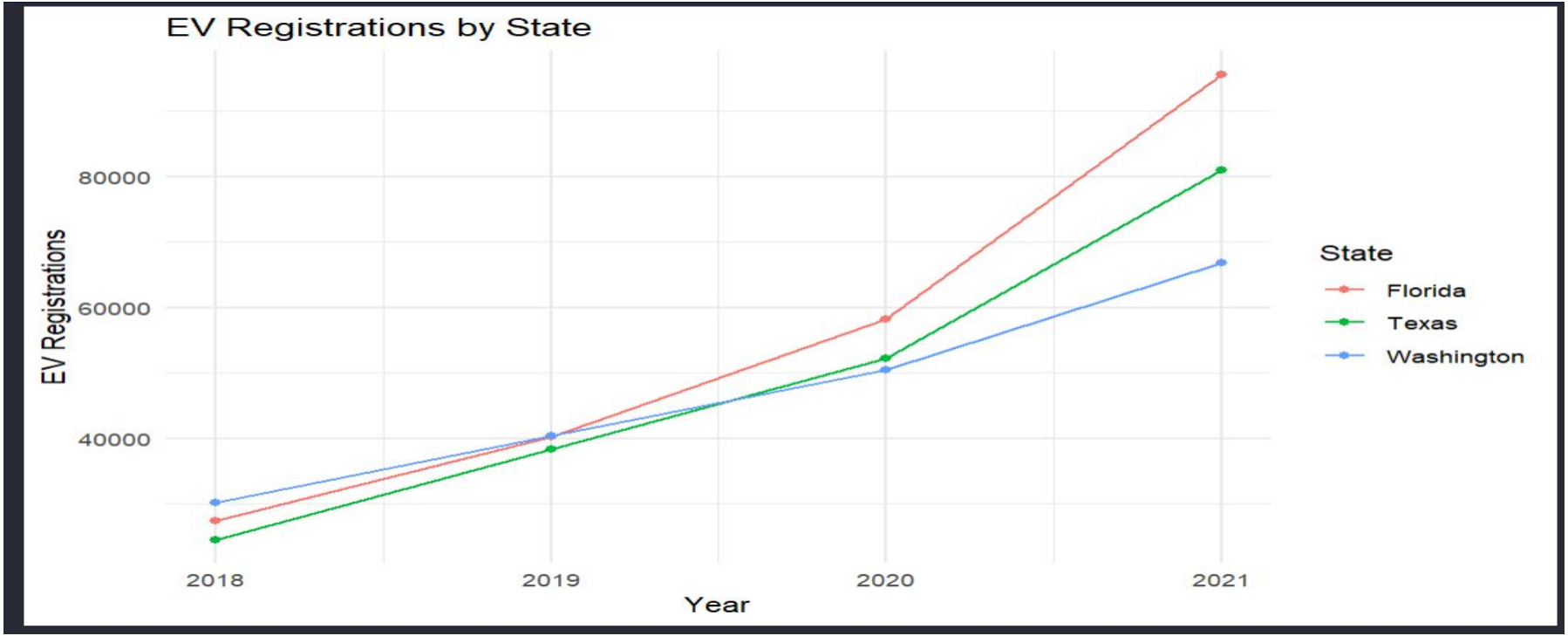
# EV Registration Growth/Which States had the Greatest Totals




| Year <dbl> | Florida <dbl> | Texas <dbl> | Washington <dbl> |
|---|---|---|---|
| 2018 | 27400 | 24500 | 30200 |
| 2019 | 40300 | 38400 | 40400 |
| 2020 | 58200 | 52200 | 50500 |
| 2021 | 95600 | 80900 | 66800 |

4 rows

# EV Registration Growth/Which States had the Greatest Totals



# Electric Utility Rates Datasets

The datasets used are annual reports of investor-owned utility companies which contain their rates by zip code.

Variables we focused on:

- utility_name
- state
- comm_rate

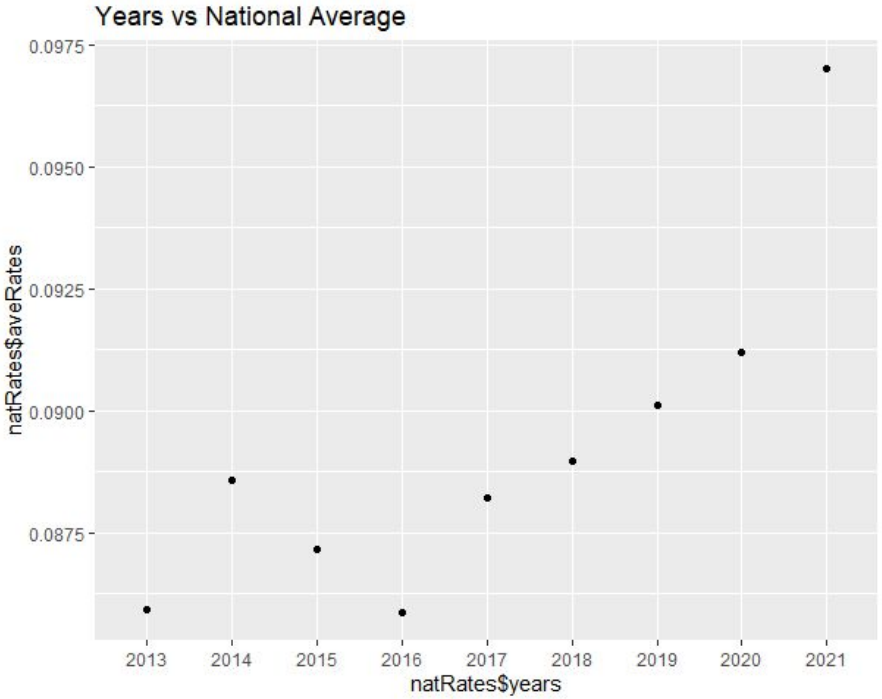
Data was pulled from the Open Energy Data Initiative

| | zip | eiaid | utility_name | state | service_type | ownership | comm_rate | ind_rate | res_rate |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 35218 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 2 | 35219 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 3 | 35214 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 4 | 35215 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 5 | 35216 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 6 | 35210 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 7 | 35211 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |
| 8 | 35212 | 195 | Alabama Power Co | AL | Bundled | Investor Owned | 0.1066873 | 0.05977189 | 0.1159894 |

Showing 1 to 8 of 37,830 entries, 9 total columns

# Average Rate Change/ Is There a Trend?

- A positive linear relationship is apparent between the national average rate and years.
- There is a big jump between the years 2020 and 2021

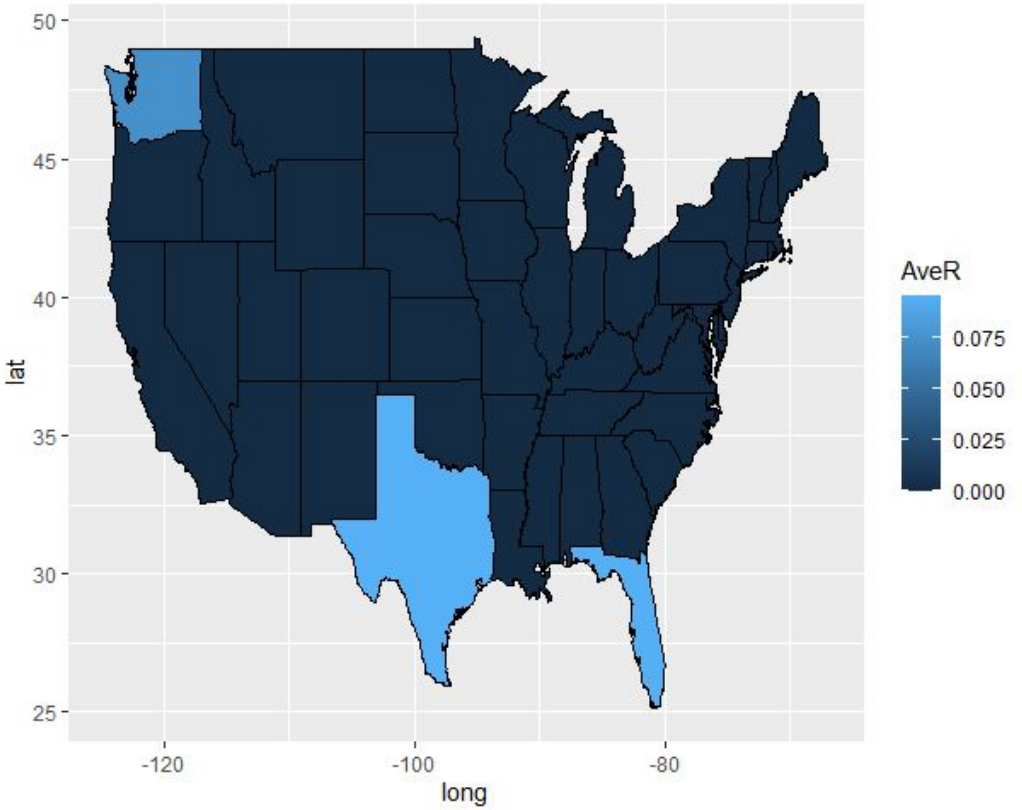


# Rates of our Target States

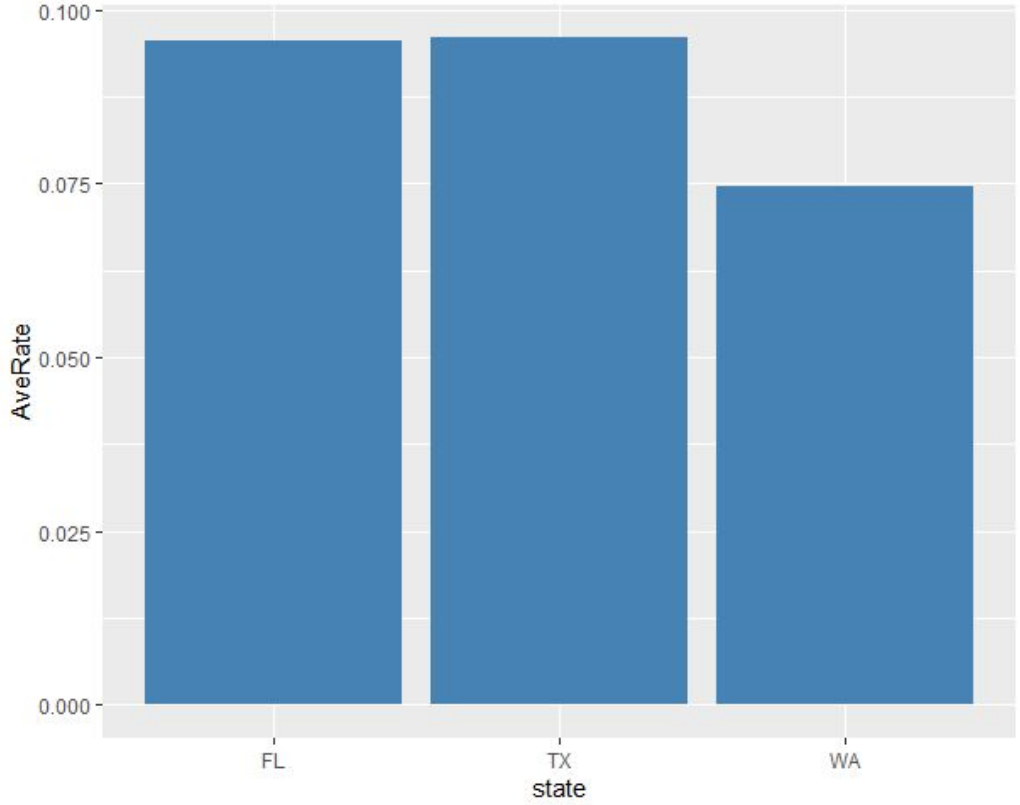
| | state | AveRate |
|---|---|---|
| | <chr> | <dbl> |
| 1 | FL | 0.0955 |
| 2 | TX | 0.0959 |
| 3 | WA | 0.0747 |

>

- The rates follow the same ranking as the EV totals for each of these states.
- FL and TX are very close.

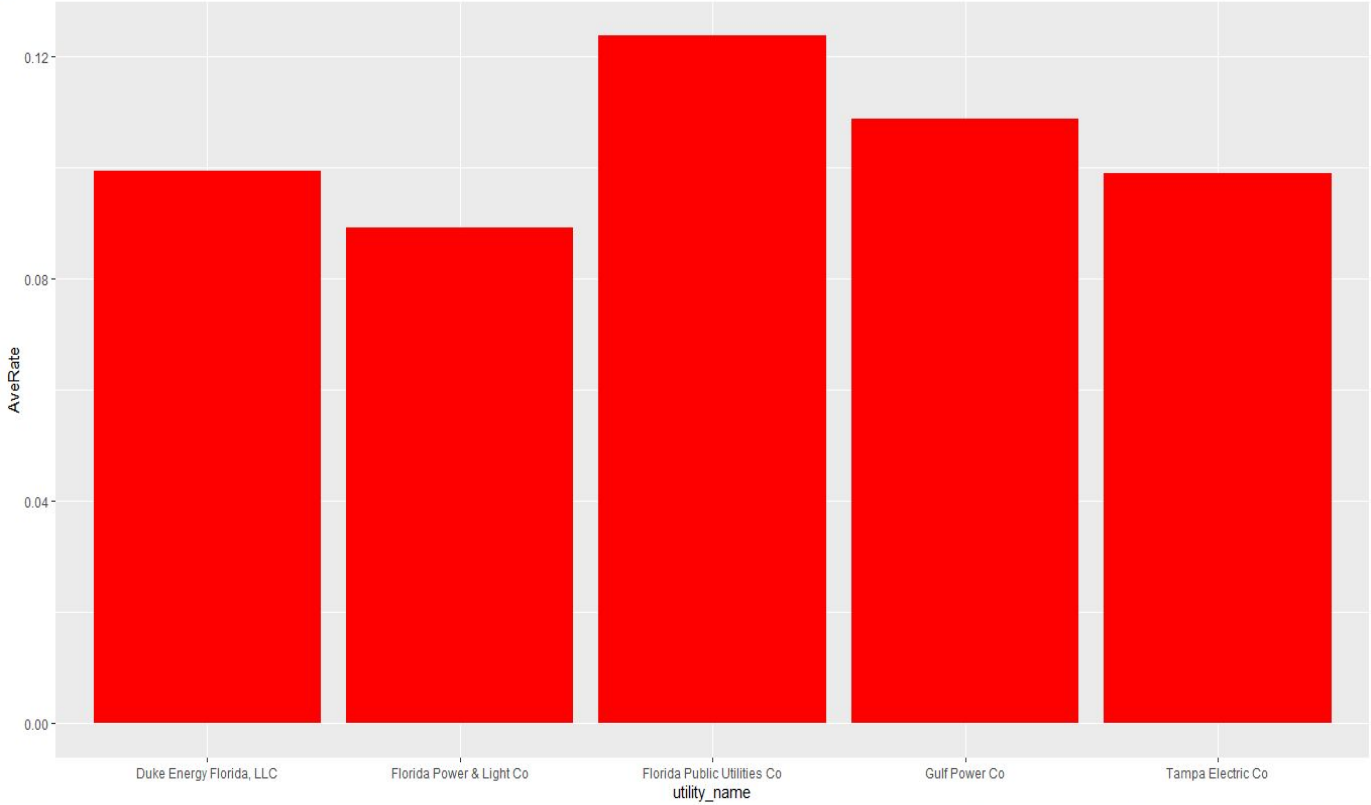


# Data on Target States continued...



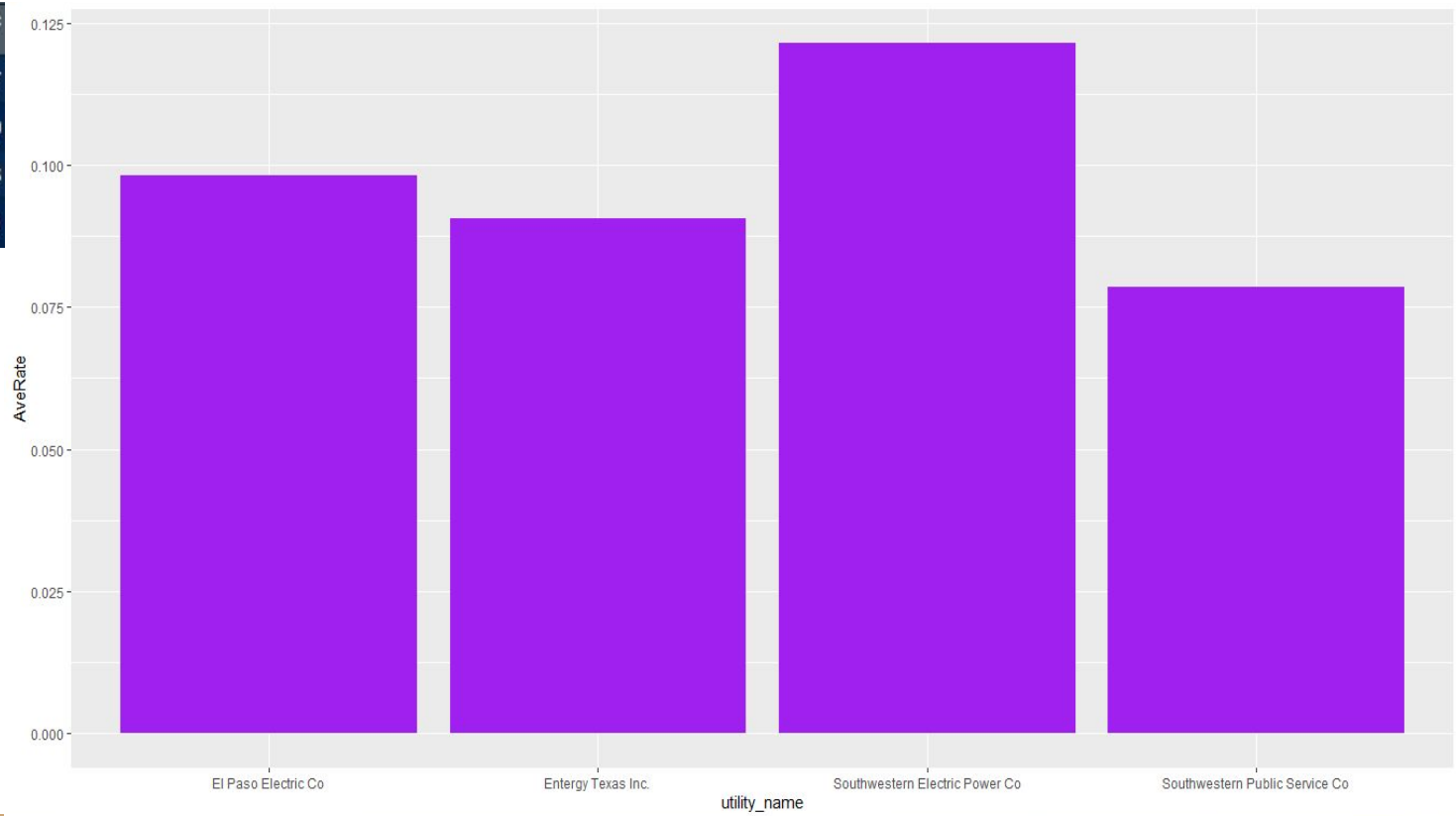
# Florida Rates Broken Down

| | utility_name | AveRate |
|---|---|---|
| 1 | Duke Energy Florida, LLC | 0.09942953 |
| 2 | Florida Power & Light Co | 0.08920694 |
| 3 | Florida Public Utilities Co | 0.12370978 |
| 4 | Gulf Power Co | 0.10880191 |
| 5 | Tampa Electric Co | 0.09904431 |



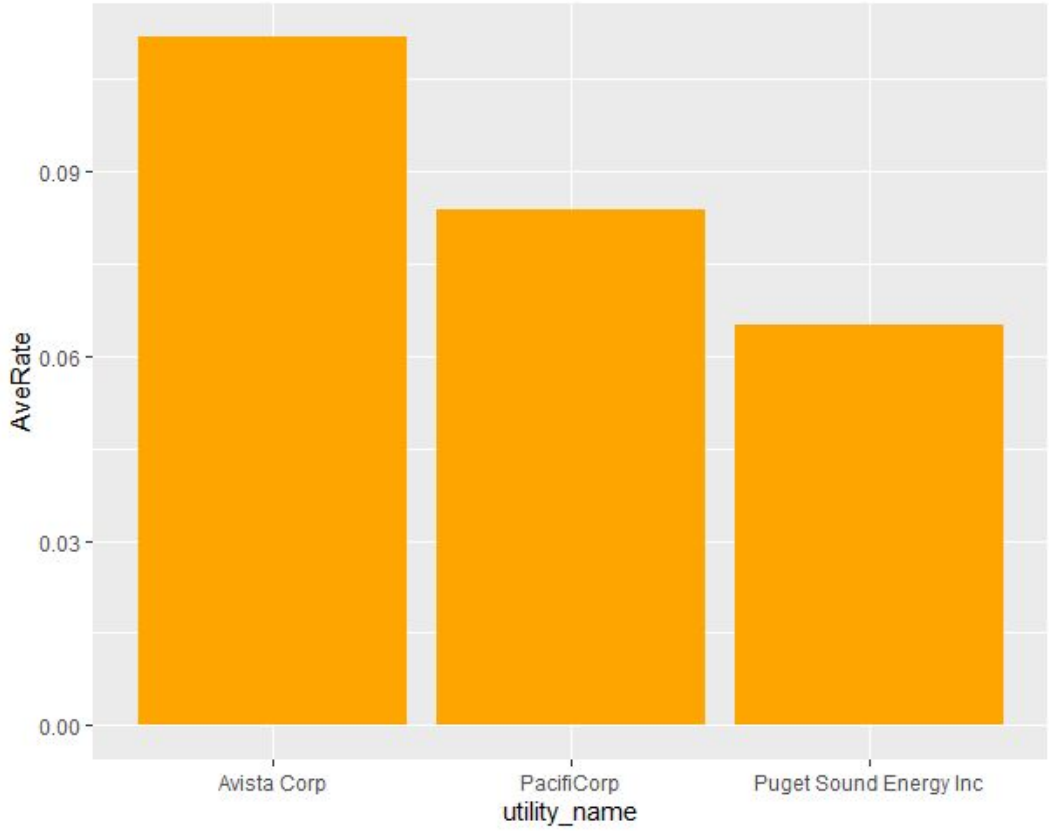
# Texas Rates Broken Down

| | utility_name | AveRate |
|---|---|---|
| 1 | El Paso Electric Co | 0.09819167 |
| 2 | Entergy Texas Inc. | 0.09047900 |
| 3 | Southwestern Electric Power Co | 0.12133228 |
| 4 | Southwestern Public Service Co | 0.07845001 |



# Washington Rates Broken Down

| | utility_name | AveRate |
|---|---|---|
| 1 | Avista Corp | 0.11169114 |
| 2 | PacifiCorp | 0.08377217 |
| 3 | Puget Sound Energy Inc | 0.06504221 |



# What We've Determined

Our investigation revealed that the costs in Florida and Texas were strikingly comparable, at 0.0955¢/kWh and 0.0959¢/kWh, respectively, while the cost in Washington State was approximately 22% lower, at 0.0747¢/kWh. Considering the minimal variation in energy costs, we proceeded to examine new electric vehicle (EV) registrations as a proxy for demand, to determine whether any state demonstrated strong enough demand that could counterbalance potential energy cost savings.

Our findings indicated that for every one EV registered in Florida, there were 0.77 registrations in Texas and 0.44 in Washington. These figures suggest that both Florida and Texas were more favorable than Washington from a demand perspective. Furthermore, the savings of 0.02¢/kWh for Washington were insufficient to warrant relocation of operations to a state with less than half the demand for EVs compared to Florida.

# Additional data...

| Year | Florida | Forecast(Florida) | Lower Confidence Bound(Florida) | Upper Confidence Bound(Florida) |
|---|---|---|---|---|
| 2018 | 27400 | | | |
| 2019 | 40300 | | | |
| 2020 | 58200 | | | |
| 2021 | 95600 | 95600 | 95600.00 | 95600.00 |
| 2022 | | 114178.204 | 97885.53 | 130470.88 |
| 2023 | | 136900.9676 | 120102.91 | 153699.03 |
| 2024 | | 159623.7312 | 142331.19 | 176916.27 |
| 2025 | | 182346.4948 | 164569.45 | 200123.54 |
| 2026 | | 205069.2584 | 186816.88 | 223321.63 |
| 2027 | | 227792.022 | 209072.78 | 246511.27 |
| 2028 | | 250514.7856 | 231336.50 | 269693.07 |

# Additional data...

| Year | Washington | Forecast(Washington) | Lower Confidence Bound(Washington) | Upper Confidence Bound(Washington) |
|---|---|---|---|---|
| 2018 | 30200 | | | |
| 2019 | 40400 | | | |
| 2020 | 50500 | | | |
| 2021 | 66800 | 66800 | 66800.00 | 66800.00 |
| 2022 | | 77726.24545 | 73546.55 | 81905.94 |
| 2023 | | 89843.88054 | 85534.53 | 94153.23 |
| 2024 | | 101961.5156 | 97525.31 | 106397.72 |
| 2025 | | 114079.1507 | 109518.65 | 118639.65 |
| 2026 | | 126196.7858 | 121514.35 | 130879.22 |
| 2027 | | 138314.4209 | 133512.21 | 143116.63 |
| 2028 | | 150432.056 | 145512.08 | 155352.03 |

# Additional data...

| Year | Texas | Forecast(Texas) | Lower Confidence Bound(Texas) | Upper Confidence Bound(Texas) |
|---|---|---|---|---|
| 2018 | 24500 | | | |
| 2019 | 38400 | | | |
| 2020 | 52200 | | | |
| 2021 | 80900 | 80900 | 80900.00 | 80900.00 |
| 2022 | | 96634.94696 | 86512.77 | 106757.13 |
| 2023 | | 115243.5663 | 104807.40 | 125679.73 |
| 2024 | | 133852.1856 | 123108.81 | 144595.56 |
| 2025 | | 152460.8049 | 141416.42 | 163505.19 |
| 2026 | | 171069.4242 | 159729.73 | 182409.11 |
| 2027 | | 189678.0435 | 178048.30 | 201307.79 |
| 2028 | | 208286.6629 | 196371.73 | 220201.60 |