

# Evolving Electric Landscapes: A Comparative Analysis of Electricity Prices Across U.S. Sectors and States



**Group 12**

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# Introduction

- Electricity pricing analysis is crucial for understanding energy consumption patterns and their economic impacts.
- It provides insights into shifts towards sustainable energy sources and aids in forecasting future trends.
- Analyzing electricity prices helps identify potential cost savings and opportunities for enhancing energy efficiency.
- Such studies are essential for informing policy-making decisions related to energy regulation and sustainability initiatives.



# Dataset Overview

Year	State	Industry Sector Category	Residential	Commercial	Industrial	Transportation	Other	Total
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The dataset from [data.gov](#), intended for Exploratory Data Analysis (EDA) and dashboard creation using the Python library Dash, presents the following characteristics:

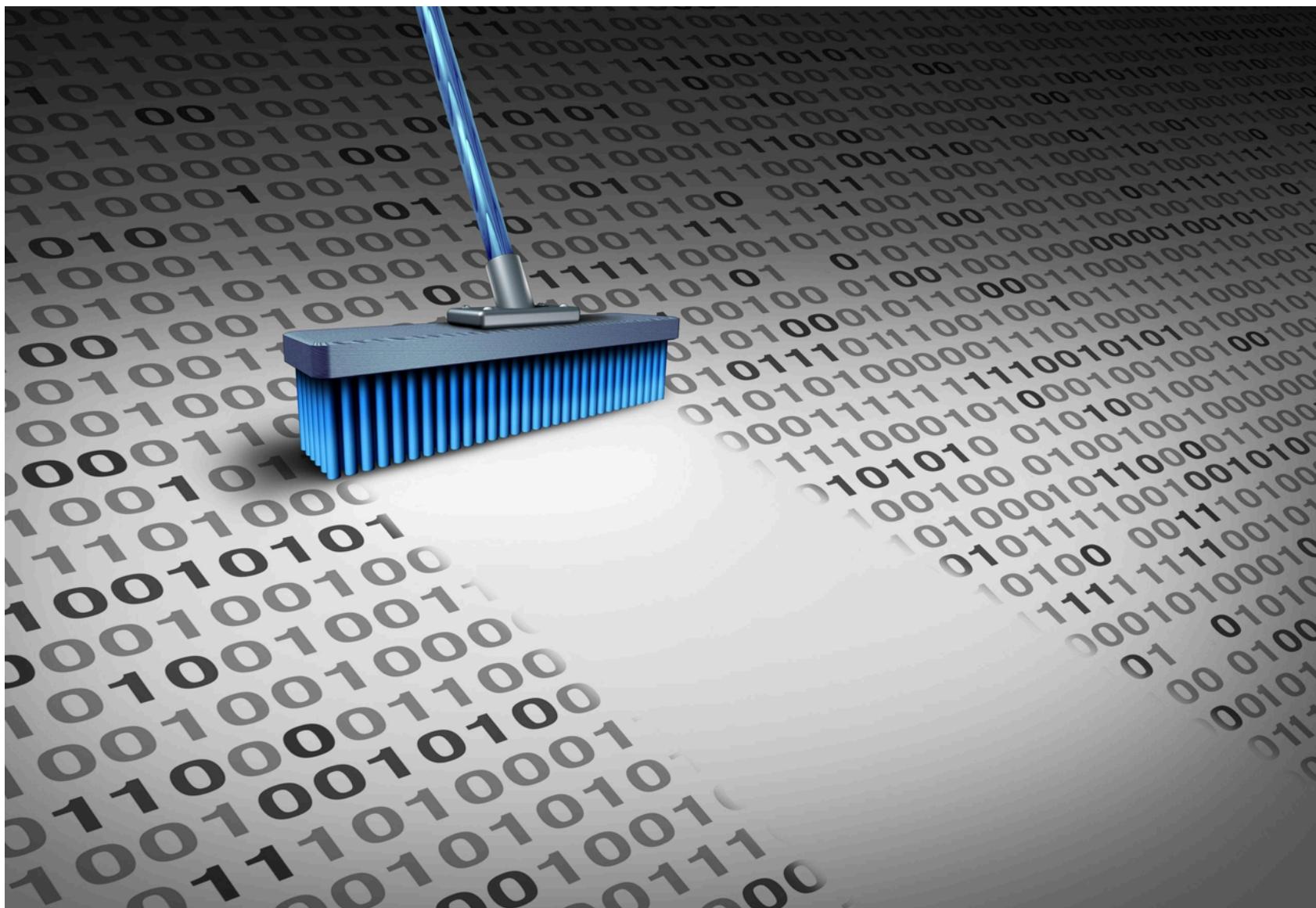
- Contains data on the average price of electricity across different industry sectors and states for different years.
- Features **9 columns**: Year, State, Industry Sector Category, Residential, Commercial, Industrial, Transportation, Other, and Total, indicating the context and price data per sector.
- Has **4,605 rows**, with non-null entries in most columns, though Transportation and Other have a significant number of missing values (1,607 and 2,998 non-null values, respectively).
- The Year column is of type integer, indicating the year of the data record, while prices (Residential, Commercial, Industrial, Transportation, Other, Total) are of type float, denoting the average price in cents per kilowatt-hour (¢/kwh). The State and Industry Sector Category columns are of type object, representing categorical data.

# Data Cleaning and Preprocessing

- Calculation of the 'Average Price' Column: A new column, Average Price, is calculated by taking the mean of the prices across different sectors (Residential, Commercial, Industrial, Transportation) for each row. This step can be seen as both preprocessing and feature engineering, as it creates a new piece of data from existing columns.

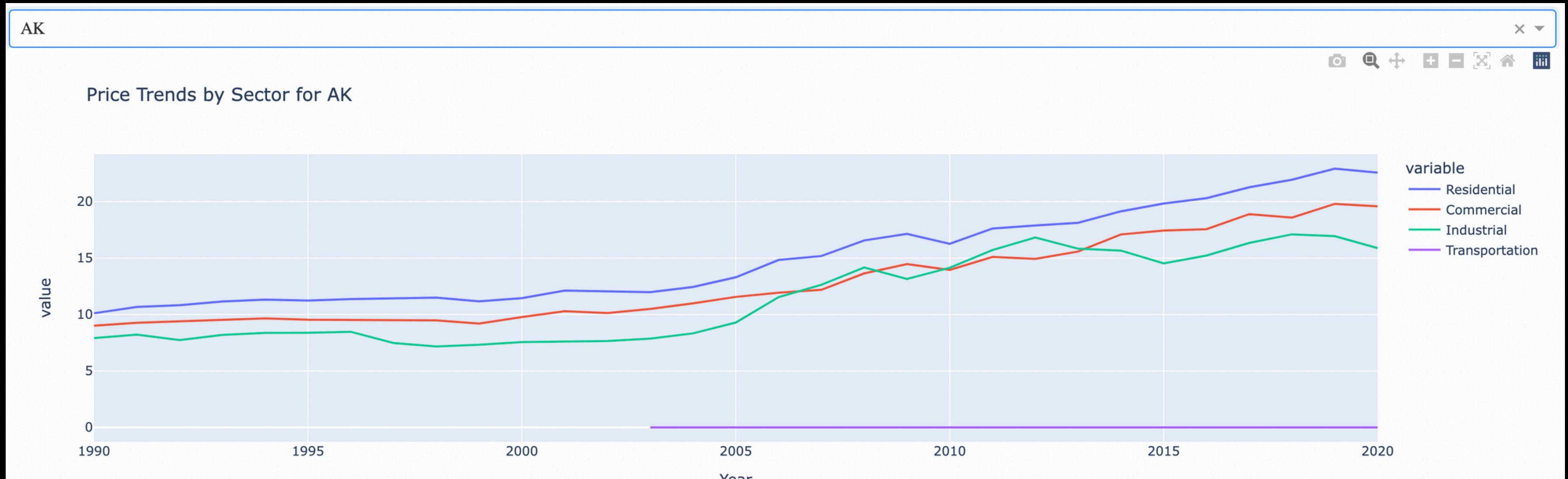
```
"dataset['Average Price'] = dataset[['Residential", "Commercial", "Industrial", "Transportation"]].mean(axis=1)"
```

- In the initial dataset overview, it was noted that certain columns, specifically Transportation and Other, had a significant number of missing values. However, missing values were not deemed impactful for the specific analysis and visualizations created.
- The operations mostly focuses on calculating averages and visualizing the data.



# Data Visualizations

## Price Trends by Sector for each State



- Prices typically increase over time across all sectors, reflecting national economic conditions, inflation, and evolving energy markets.
- Each sector demonstrates unique pricing trends based on specific demand dynamics, regulatory impacts, and market conditions.
- Key inflection points in the trends often correlate with significant policy changes or economic events, affecting energy costs and consumption patterns differently across sectors.

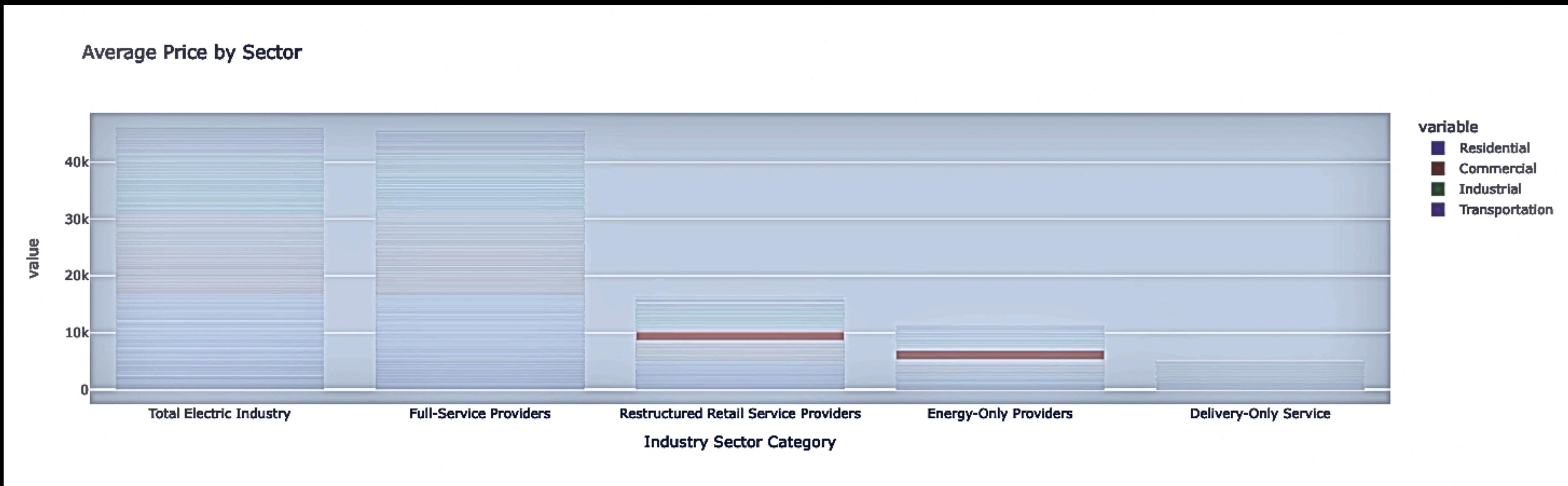
## Virginia (VA):

- Industrial Sector: Prices likely show modest increases, mirroring Virginia's stable energy mix and consistent industrial demand.
- Residential and Commercial Sectors: Both sectors might experience gradual price rises, influenced by Virginia's policies promoting renewable energy and efficiency, alongside growth in energy-intensive industries like data centers.

## Massachusetts (MA):

- Industrial Sector: Lesser growth in industrial electricity prices could reflect the state's shift from manufacturing to services, even as overall prices remain high due to supply constraints.
- Residential Sector: Significant policy-driven shifts toward clean energy in Massachusetts likely contribute to notable price increases, especially as the state addresses environmental goals and supply challenges.

# Price Trends by Sector



- Sectors experience varied price trends, with residential and commercial generally increasing, while industrial and transportation may vary due to different demand and efficiency factors.
- Sector-specific impacts arise from energy policies, with some sectors more affected by renewable incentives or carbon pricing than others.
- Economic conditions and technological advancements uniquely influence each sector, affecting prices through demand shifts and efficiency gains.

- **Residential Sector:**

Prices rise due to increased production and delivery costs, influenced by consumer demand and energy policy changes that focus on efficiency and renewables.

- **Commercial Sector:**

Commercial rates often align with residential trends but are additionally affected by economic cycles and shifts in energy efficiency initiatives within commercial infrastructures.

- **Industrial Sector:**

Industrial electricity pricing shows relative stability, reflecting the sector's energy consumption volume, efficiency improvements, and potential for negotiated energy agreements.

- **Transportation Sector:**

Transportation energy prices exhibit variability, driven by market specifics, regulatory developments in emissions, and the integration of electric vehicle infrastructure

# Average Price - Statewide

The chart is a horizontal bar graph which represents the comparison of average prices across various states. The bars are color-coded according to a gradient scale that indicates the average price, with different colors representing different price ranges. The x-axis represents the average price, while the y-axis lists the states

## **Washington (WA):**

- This state has the highest average price among the states shown close to or above 400.

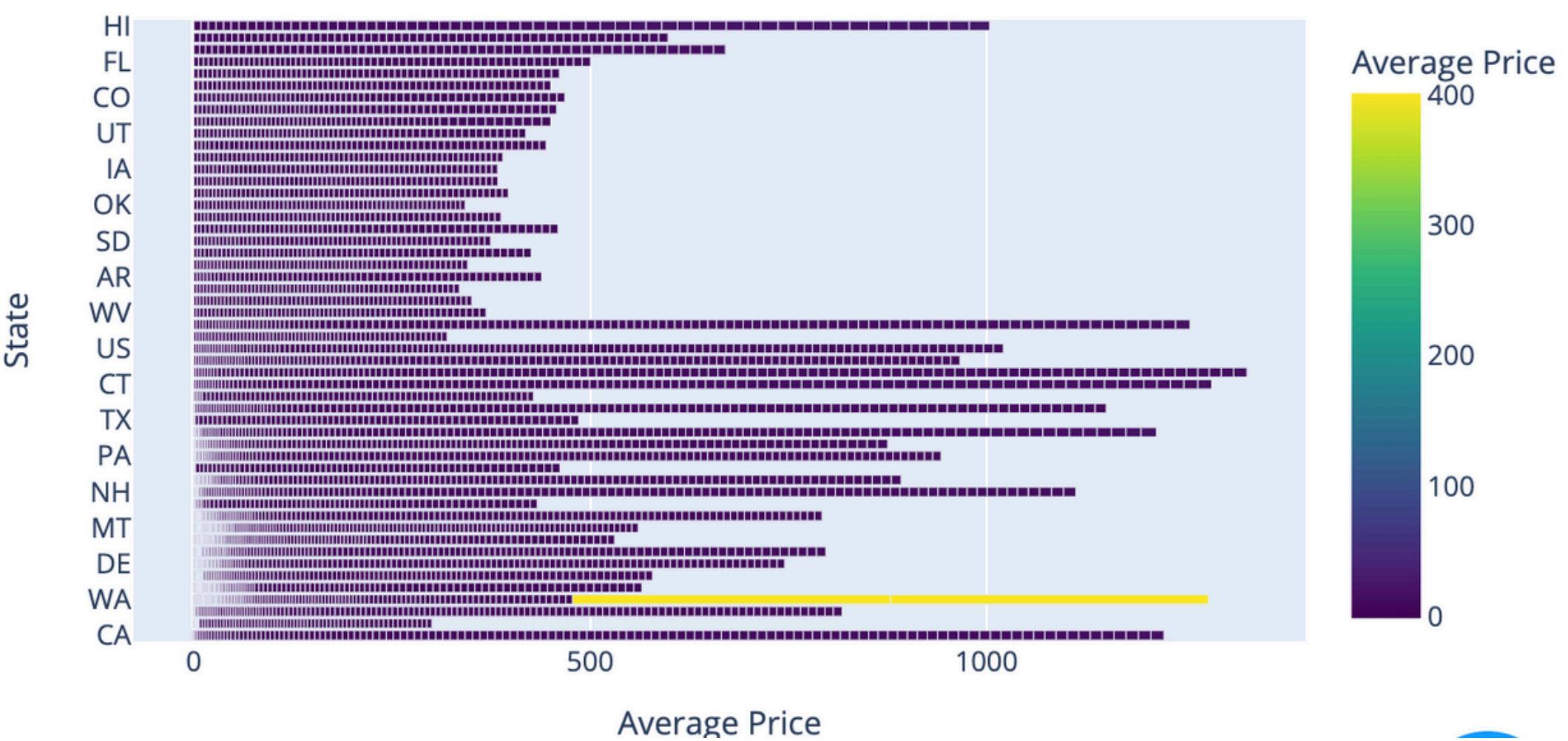
## **California (CA):**

- The bar for CA is significantly shorter than HI which might indicate an average price closer to 100-200.

## **Texas (TX):**

- The bar for TX is of the average size indicating an average price closer to 200-300.

State-wise Average Price Comparison



# Residential vs Commercial

The chart is the scatter plot comparing, 'Residential' and 'Commercial', with data points color-coded by state.

## **Colorado(CO):**

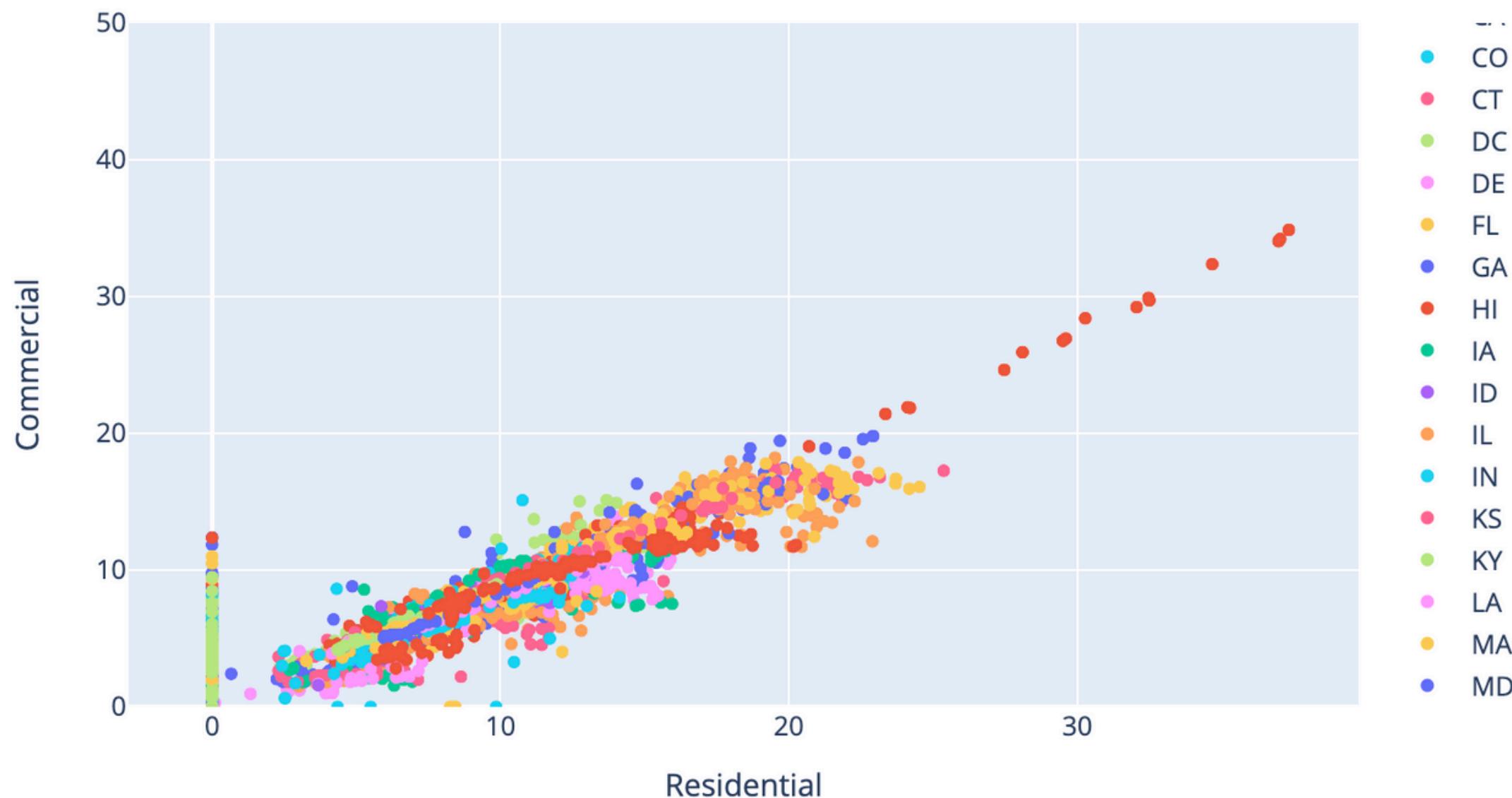
- Data points labeled in the color associated with Colorado show a relationship where, as the 'Residential' prices increase, the 'Commercial' prices also increase. This indicates a positive correlation between residential and commercial prices within Colorado.

## **Florida (FL):**

- Florida's points may be similar in trend to Colorado, suggesting that in Florida, as residential prices increase, so do commercial prices. However, the distribution and density of the points could give more insights into how strong this relationship is and shows that there are outliers

## **Kansas (KS):**

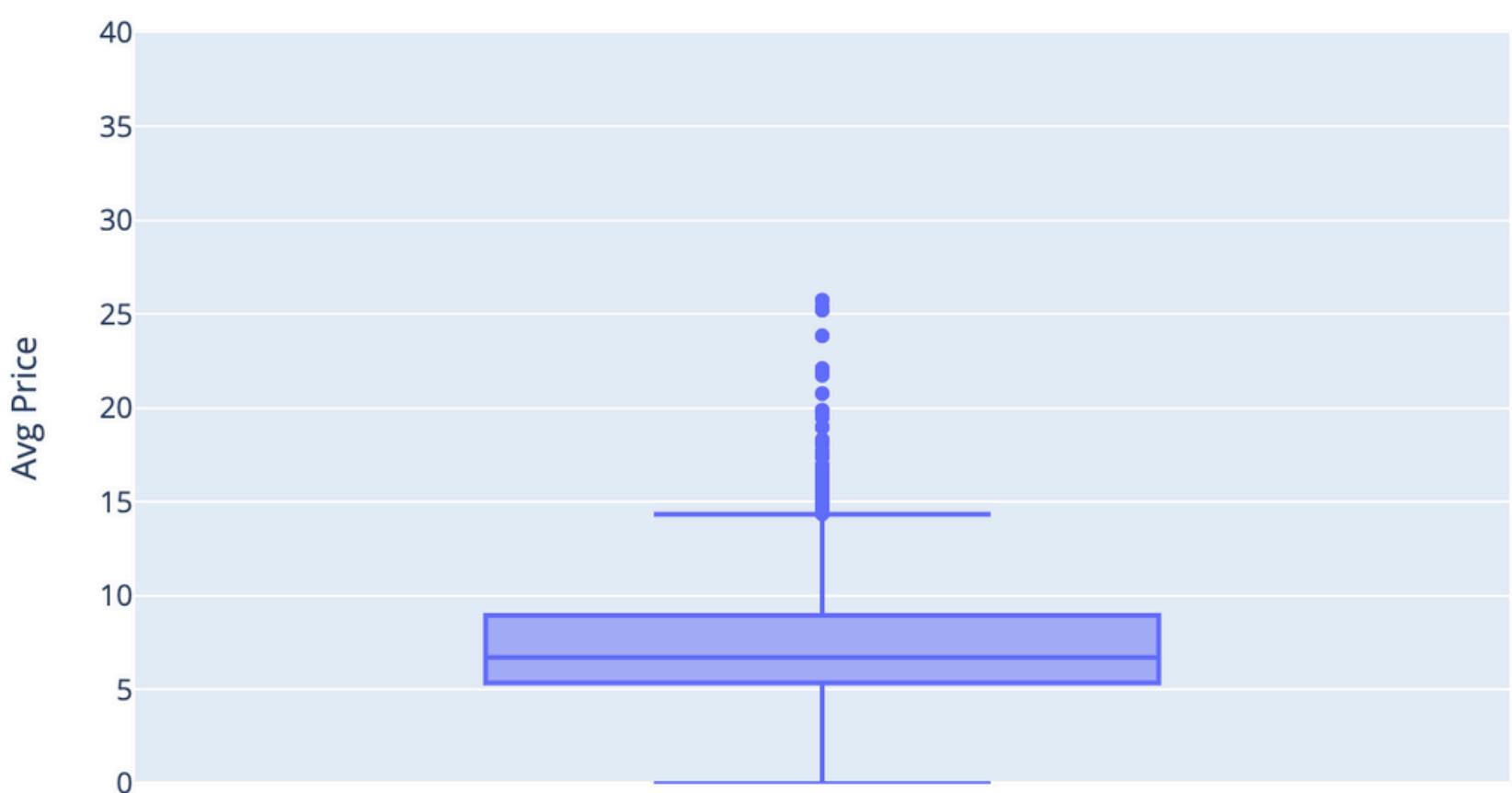
The points for Kansas show a spread along the plot similar to the other states.



# Distribution of Avg Electricity Prices

The graph presents a box plot distribution of electricity prices for the Residential, Commercial, Industrial, and Transportation sectors

- **Price Range Variation:** The Residential and Commercial sectors likely have a wider price range, as indicated by longer box plot 'whiskers', which suggest greater variability in prices across states.
- **Median Prices:** The median price (indicated by the line in the middle of the box) could show that Residential prices are generally higher than Industrial, with Commercial and Transportation sectors potentially falling in between.
- **Outliers:** Any points above or below the 'whiskers' represent outliers. If present in the Residential or Commercial sectors, this would indicate that some states have exceptionally high or low electricity prices compared to the national average.
- **Sector Comparison:** By comparing the box plots of each sector side by side, one can identify which sector has the most consistent pricing across states (a shorter box) and which has the most variation (a longer box or wider 'whiskers').
- **Quartile Distribution:** The spread of the box—representing the interquartile range—shows where the bulk of the state prices lie. A taller box in the Commercial sector, for example, would suggest a more significant disparity between the lower and upper quartiles, indicating that there's less uniformity in pricing across states within that sector.



# Price Variation in all Sectors

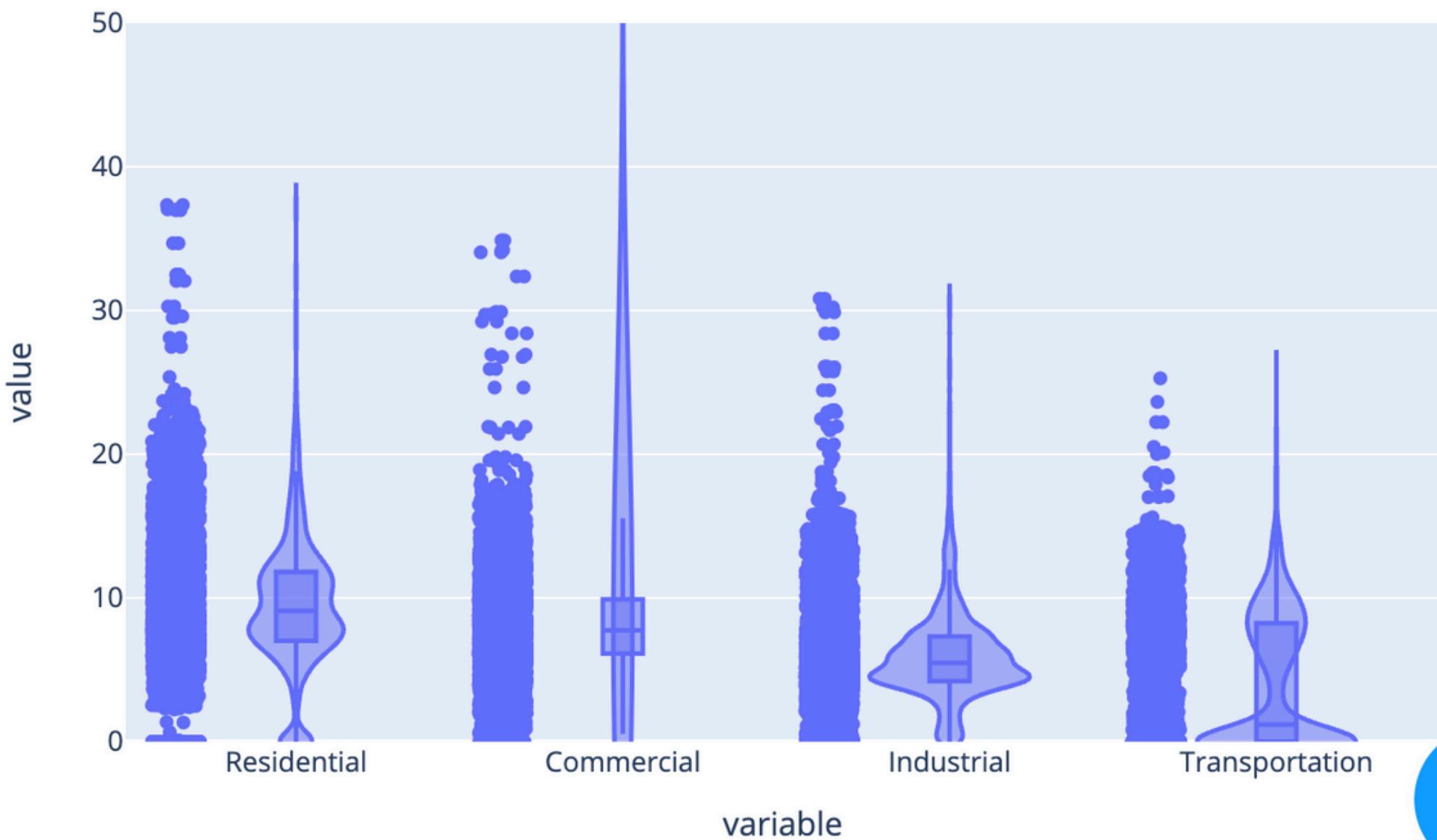
- **Variation Across States:** Significant differences in electricity prices exist between states, with some, like Wyoming and Washington, showing lower prices and California displaying higher prices.
- **Service Provider Comparison:** Full-Service Providers generally have higher prices compared to Energy-Only and Delivery-Only services, evident from the heatmap's color intensity.
- **Restructured Retail Service Providers:** Prices vary widely across states for these providers, with some states like Washington having comparable prices to other service types, while others like California exhibit higher prices.
- **Total Electric Industry:** This category provides an average view of pricing across all service providers, balancing the extremes seen in individual categories.
- **Inter-State Comparisons:** Quick comparison reveals states like California consistently have higher prices across service categories, while others like Wyoming have lower prices.
- **General State Trends:** States like Utah and Tennessee show consistent pricing across service types, while California exhibits high variability, possibly due to diverse pricing strategies or regulatory influences.

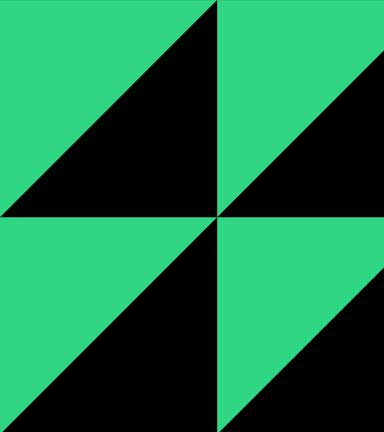


# Sector Price Distribution

The graph presents a violin plot with an integrated box plot, displays the distribution of electricity prices within the Residential, Commercial, Industrial, and Transportation sectors

- **Price Distribution Shape:** Width of violin plot indicates frequency of states at different price points, wider sections suggesting more states with prices around that
- Residential: Prices are varied, with a wide distribution indicating a range of prices where a lot of states fall into, suggesting diversity in residential property values.
- Commercial: Prices are tightly grouped around the median, showing that most states have commercial property values that are similar. There's less diversity in commercial prices compared to residential ones.
- Industrial: Like residential, there's a broad range of industrial property prices across states, but the values are more centered around the median than in residential, indicating less extreme price variations.
- Transportation: There's a smaller frequency range of prices, with a notable concentration around the median. This suggests that transportation-related prices are quite consistent across different states.
- **Outliers and Extremes:** Points outside main width of violin plot represent outlier states with exceptionally high or low prices, important for identifying extremes.
- **Box Plot Quartiles:** Box plot shows interquartile range, with larger box suggesting greater price dispersion within quartile range, such as in the Transportation sector.





# Conclusion

- **Dashboard Setup with Dash:** Setting up a Dash application, which includes:
  1. A main title ("Electricity Price Dashboard").
  2. A dropdown menu for selecting states, populated with unique state values from the dataset.
  3. Multiple Graph components displaying the created visualizations, including the bar chart, state comparison charts, and the violin plot.
  4. An interactive callback function that updates one of the charts based on the state selected from the dropdown menu.
- **Interactive Dashboard Launch:** The application is configured to run on a specified port, making it accessible for user interaction.

**THANK YOU**