Predicting Volatility in US Electricity Prices

Miles Franklin, David Harper,
Adam Goldstein, Himanshu Ghritalhre

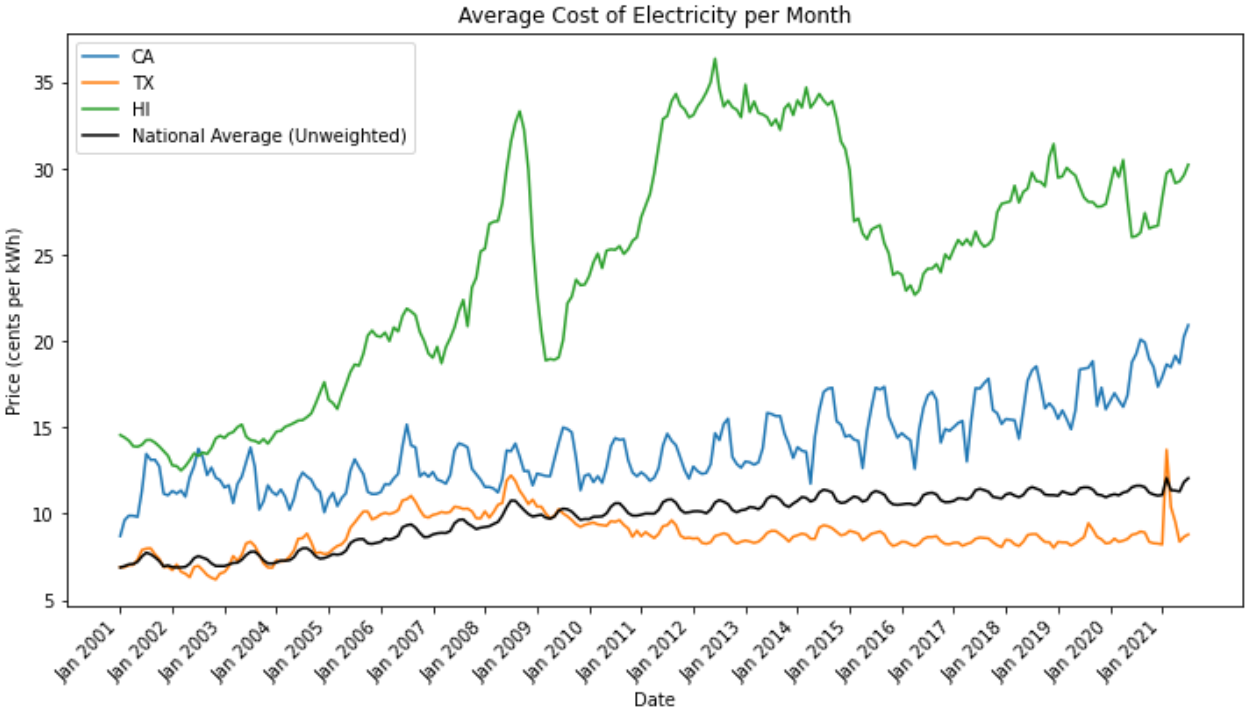
Project Overview

- **Target**
  - The goal of this project is to produce a model predicting the price volatility of electricity for a given year. We measure the volatility using the Coefficient of Variation, to normalize the data and facilitate state to state comparisons.

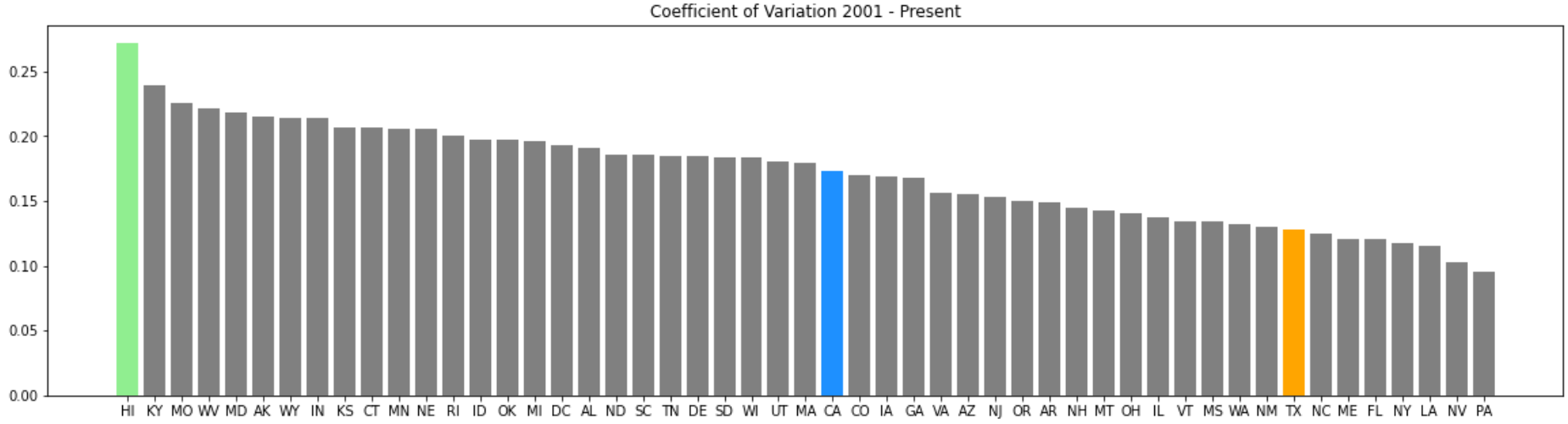
$$\text{Coefficient of Variation} = \frac{\text{Standard Deviation}}{\text{Mean}}$$

- **Features**
  - Distribution of fuel sources in a state (i.e. what percent of production is from coal, solar, etc.)
  - Whether or not the state is a net producer or consumer of electricity
    - Are the imports greater than the exports?
    - Is the state's consumption of electricity greater than its production of electricity?
  - What effect do weather patterns have on price stability?
    - Do these effects felt impact renewable sources just
  - Can activity in the Futures Contract Market help predict price action?

Understanding the Target Variable



Understanding the Target Variable Con’t



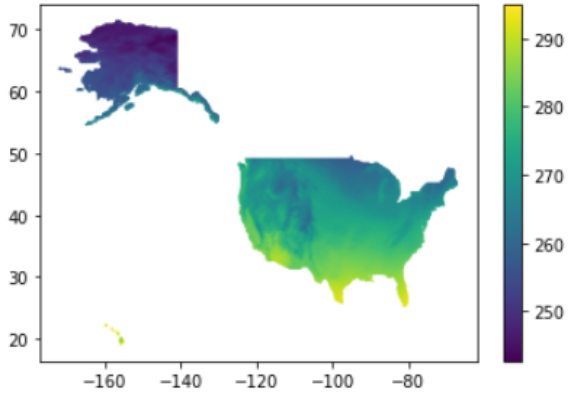
Futures Data

- Prices and Volume for Contracts
  - BZ - Brent Crude Oil
  - NG - Natural Gas
  - CL - Light Sweet Crude Oil
  - HO - Heating Oil
  - More will probably be added
- **Hypothesis:** In times of energy price volatility, people may be buying or selling more futures contracts to lock in their price before big moves

Weather Data

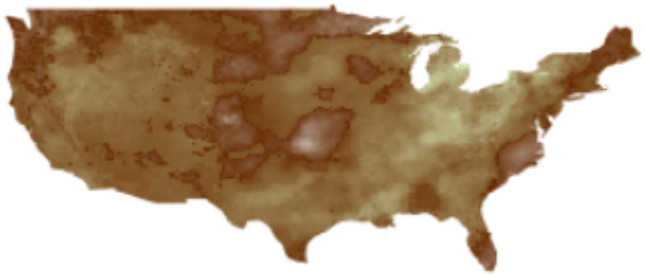
- Monthly Average Temperature at 6m above ground
  - All of the United States gridded at 60km X 60km
  - **Hypothesis:** Temperature impacts price volatility because during hot and cold spells, residents are using a higher than average amount of electricity
  - **Plan:** Define a metric that determines how far above average summer temperatures were for per year by state. Define another metric that measure how below average winter temperatures were.

- **Possible Hurdles**: Heat waves or cold spells that impact a particular region may not get detected when calculating metrics for an entire state



Weather Data (contd)

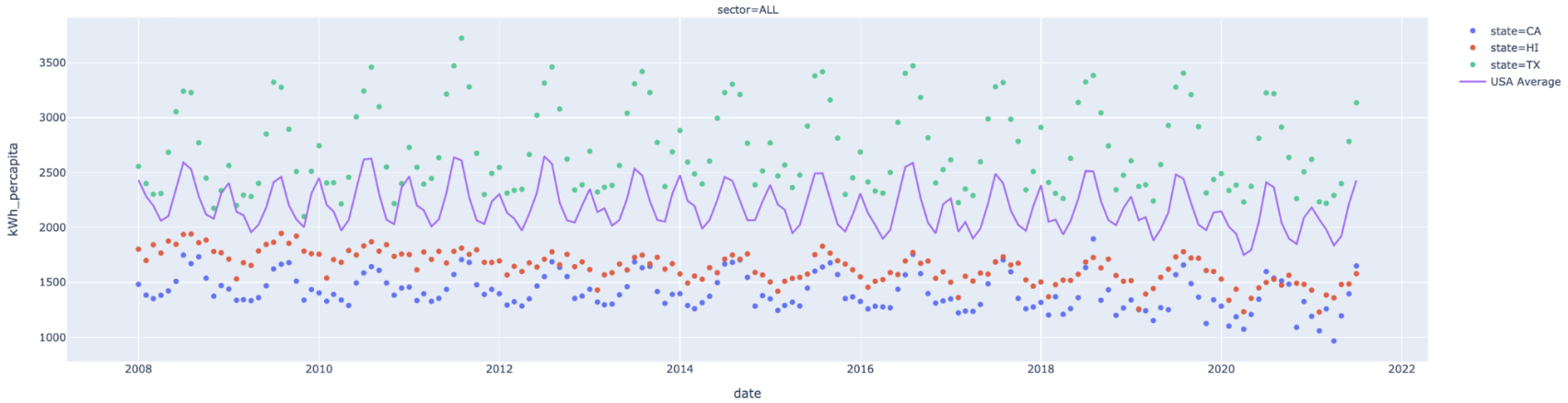
- Palmer Drought Severity Index
  - All of the Lower United States gridded at 60km X 60km
  - **Hypothesis:** Droughts impact price volatility in regions that rely on hydroelectric power.
  - **Plan:** Calculate how many standard deviations above average a state is in terms of their drought index for all years of interest



Monthly Energy Consumption

$$\text{kWh\_percapita} = \frac{\text{kWh}}{\text{electric\_accounts}}$$

Sectors include - Residential (RES), Commericial (COM), Transporation (TRA), Industrial (IND), and Other (OTH)



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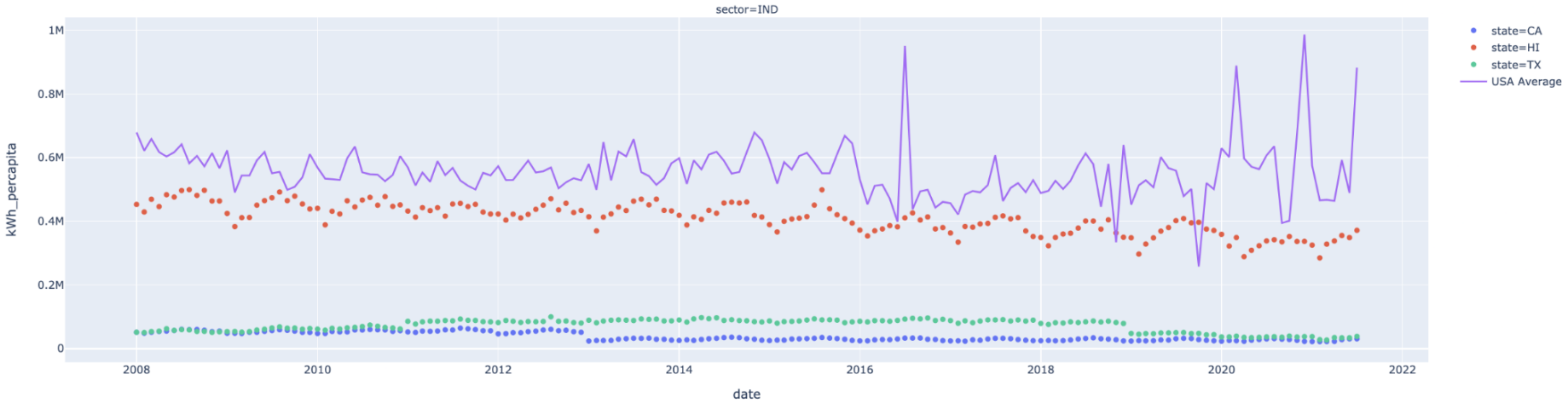

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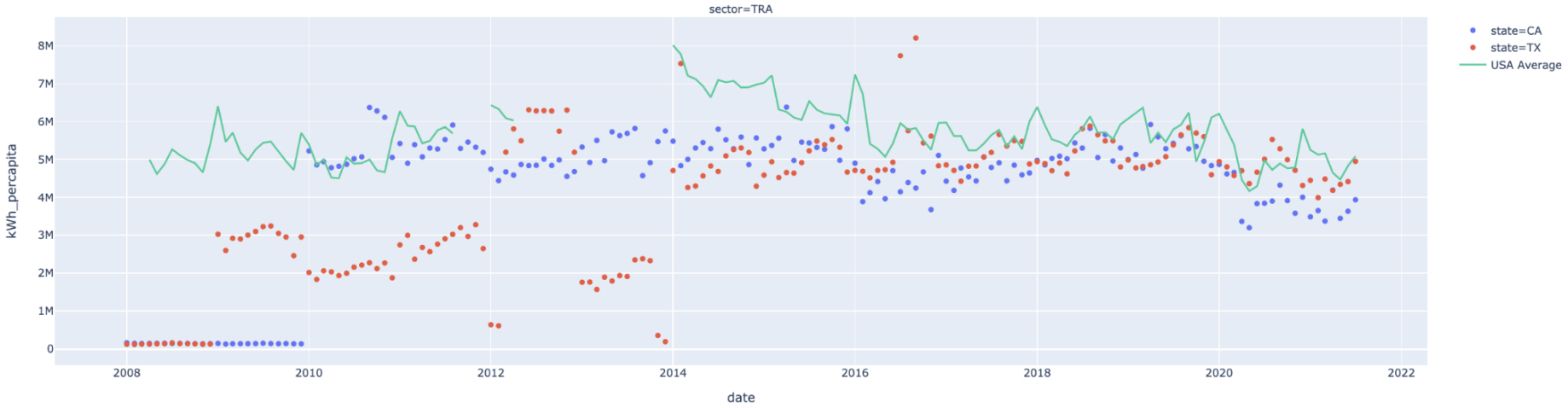

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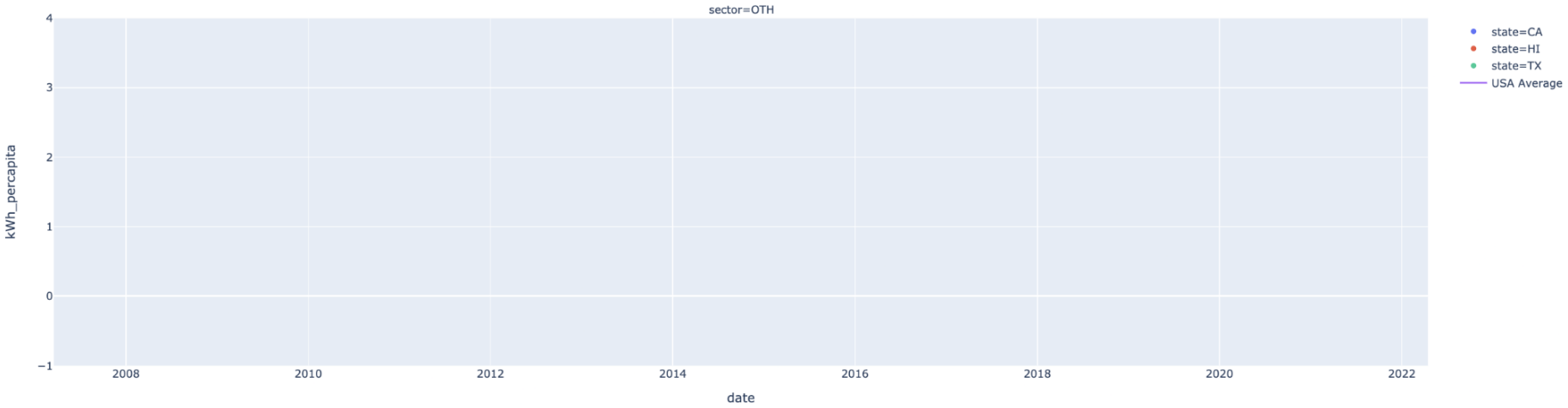
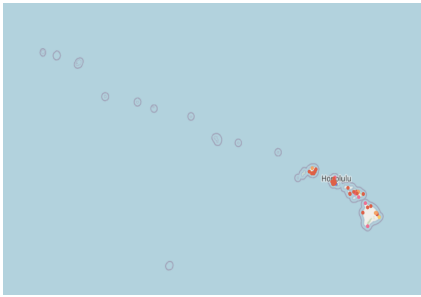
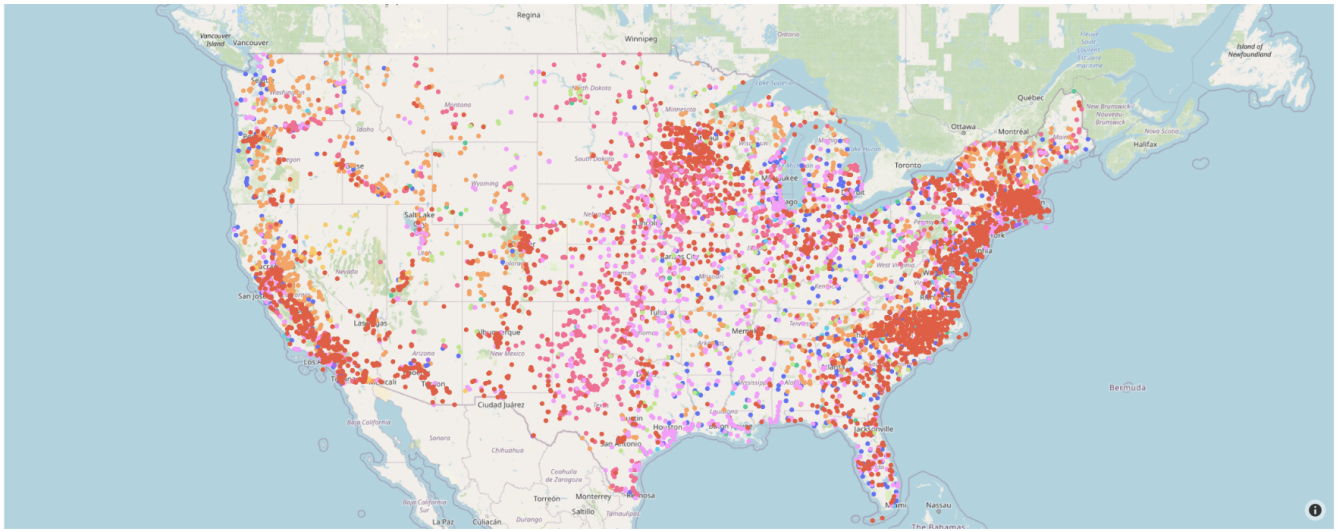


Plant Data




Regina
Winnipeg
Vancouver
Vancouver Island
Ottawa
Montréal
Québec
Toronto
Halifax
Island of Newfoundland
Bermuda
Nassau
The Bahamas
Ciudad Juárez
Monterrey
Torreón
Saltillo
La Paz
Culiacán
PrimSource=biomass
PrimSource=petroleum
PrimSource=other
PrimSource=batteries
PrimSource=hydroelectric
PrimSource=nuclear
PrimSource=wind
PrimSource=coal
PrimSource=natural gas
PrimSource=geothermal
PrimSource=pumped storage
PrimSource=solar

Similar Projects

- **Forecasting Electricity Price Time Series Data in Python using a VAR Model**
- http://dannychua.github.io/Electricity-Price-Predictor/
- http://www.energyonline.com/reports/files/lcg_volatility.pdf

Next Steps

- Additional data
  - Look into transportation sector (TRA) for why there are gaps in the monthly consumption data
  - Per Capita Calculation - Add United States population to compare with electric accounts
  - Emissions allowance market
- Modeling
  - Combine data sources into one table of features to begin modeling
  - Start with regression models and simplify into classification models if needed
  - Evaluate what features are the strongest for our model