

Electricity Price Forecast

July 2019

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Electricity has a very dynamic market price since it is a commodity that is essential for daily life and non-storable where generation and demand must be continuously balanced. This in turn make it dependable of the weather conditions.

Data Sources:

- U.S. Energy Information Administration (EIA)
- National Oceanic and Atmospheric Administration NOAA

Problem Overview

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API Exploration, Data Acquisition Data Wrangling

U.S. Energy Information Administration (EIA)

Summary monthly data per state

U.S. Energy Information Administration (EIA)

Summary data from each station at a State
into a time range. Some States have
around 350 stations

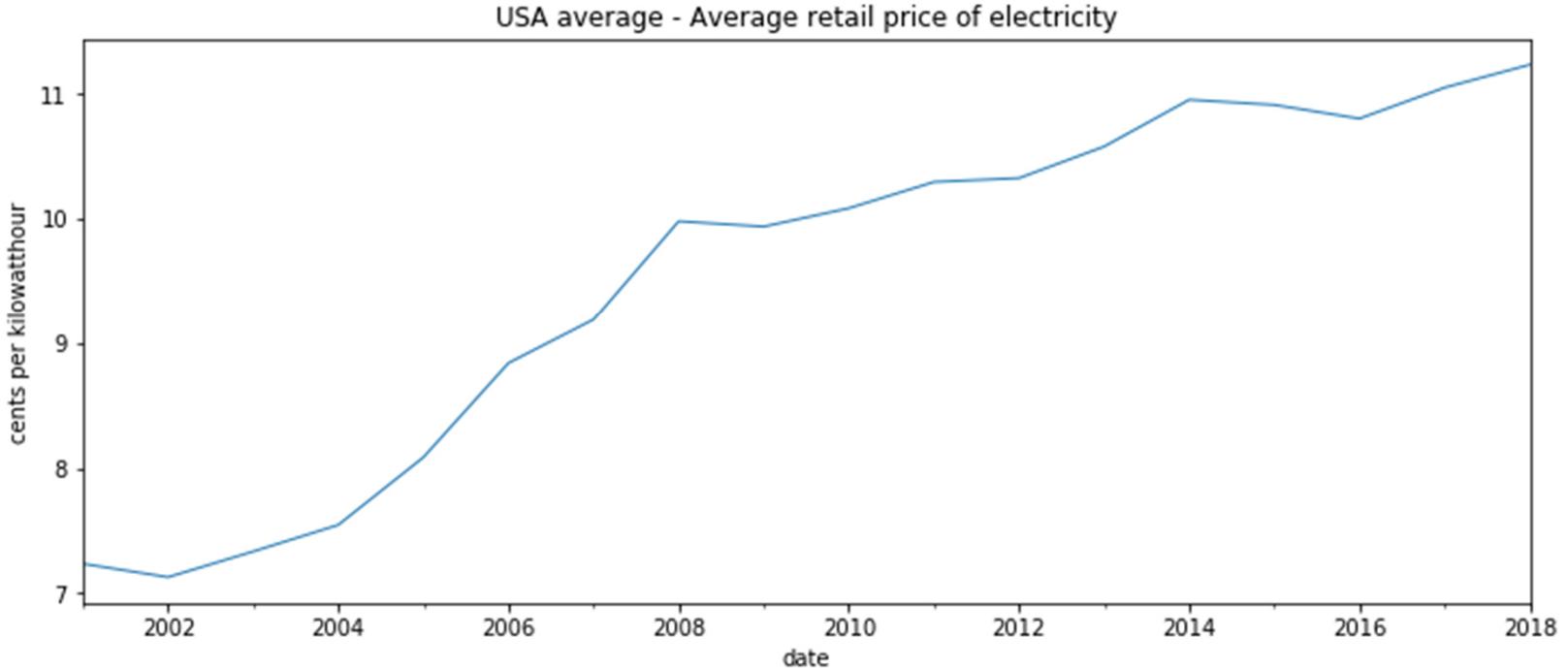
Data

- Average Retail Price of Electricity
- Net Generation
- Average Retail Price of Electricity
- Revenue from retail sales of electricity
- Number of Customer Accounts
- Date
- State

- Average Temperature
- Minimum Temperature
- Maximum Temperature
- Date
- ISO3166

Data Acquisition and Wrangling

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Retail price of Electricity grows over time.

Behavior of historical electricity prices

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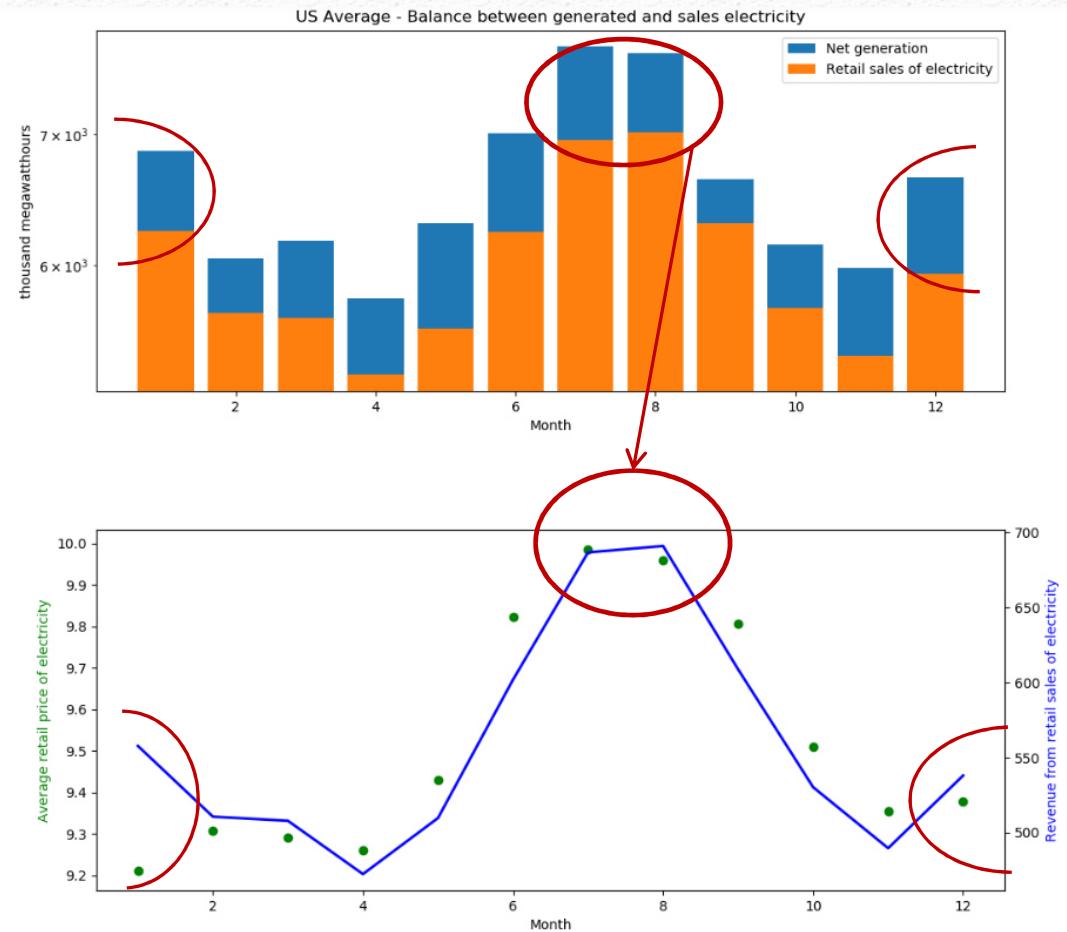


Months of higher temperature, higher prices

Electricity price & Temperature

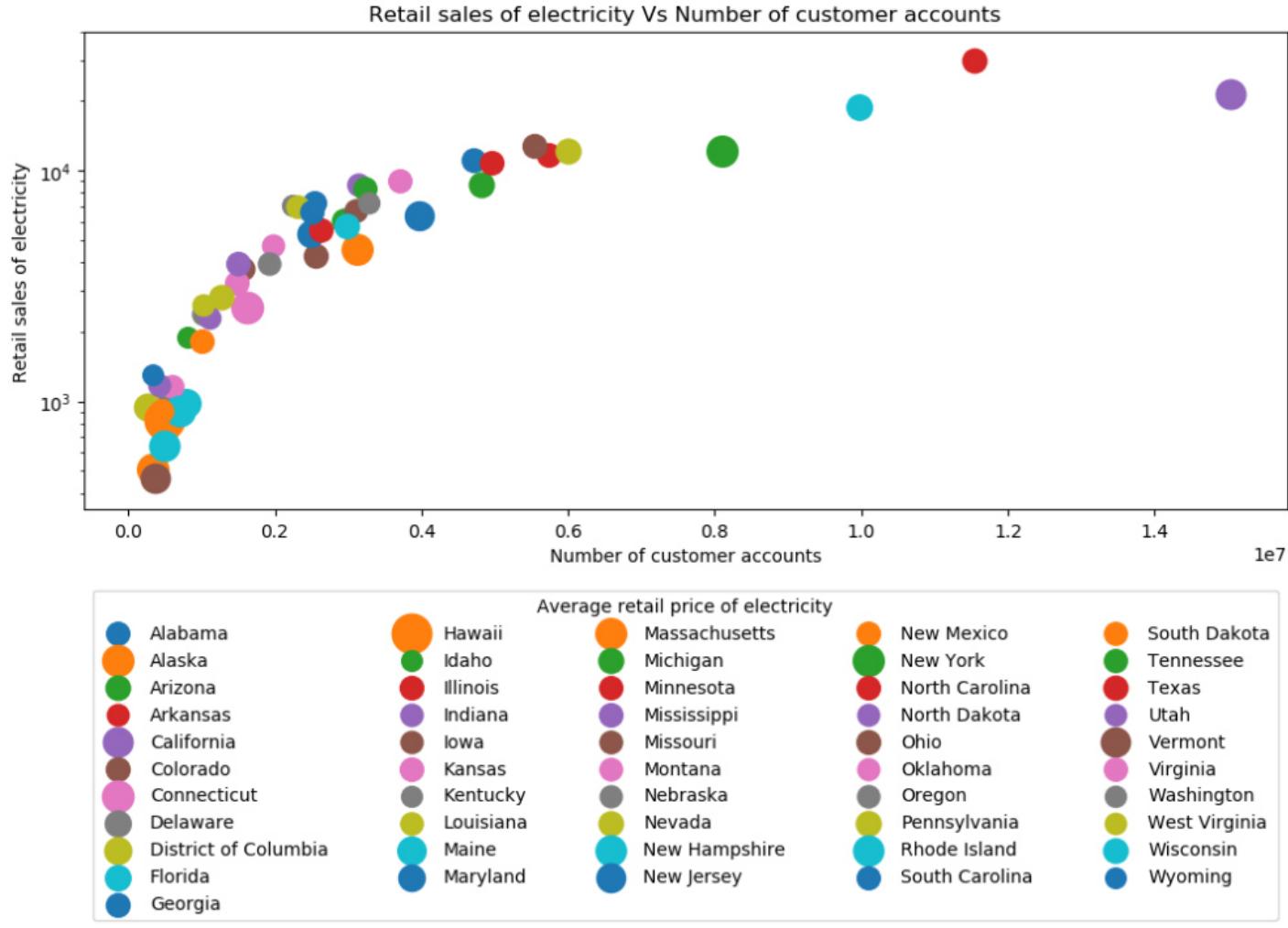
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- Higher sales, higher revenues.
- Consecutive months with similar temperatures/demands as Dec-Jan and July-Aug, the prices slightly decrease the second month but revenue stay or increase.



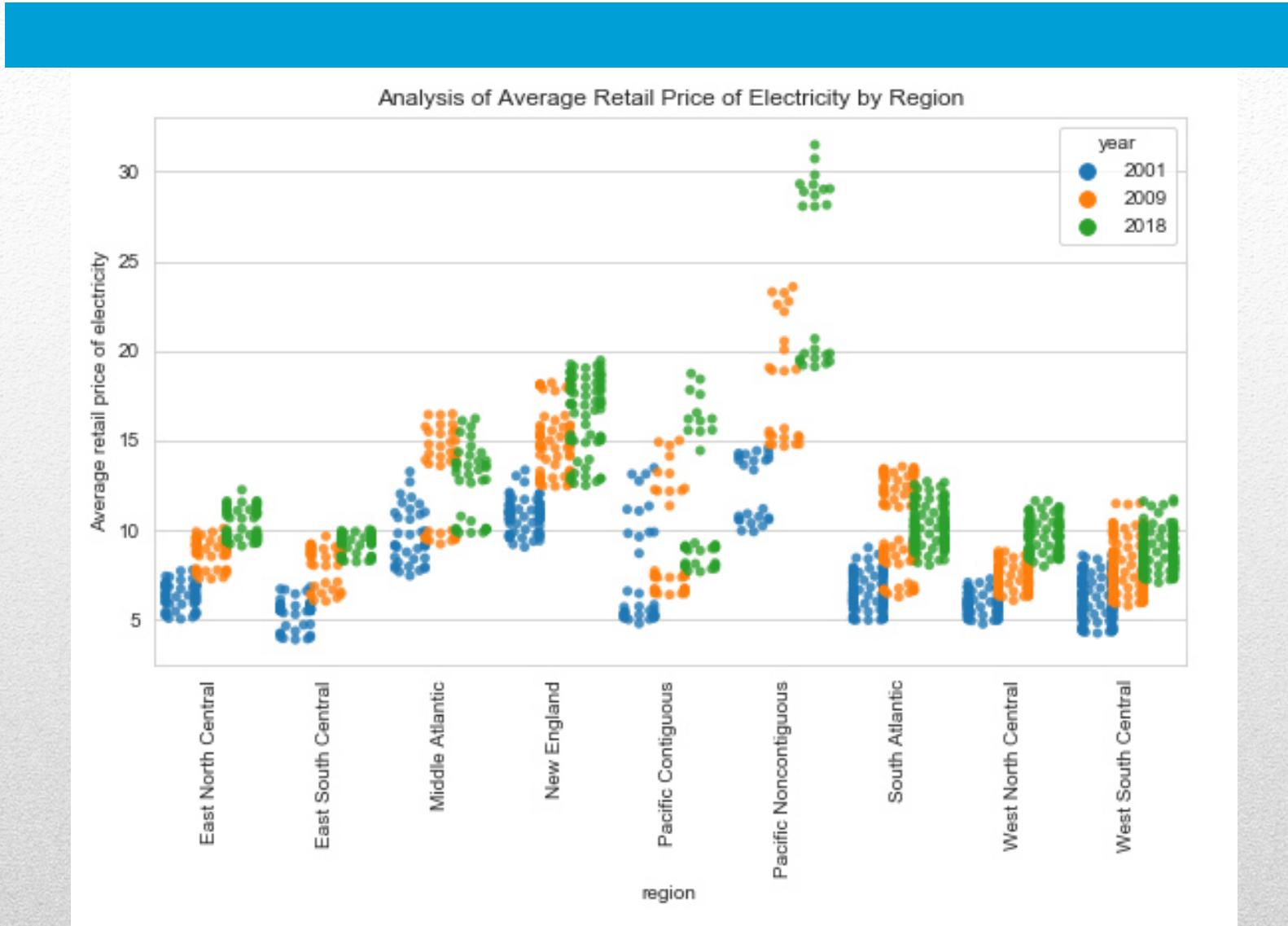
Price, Revenue, Demand

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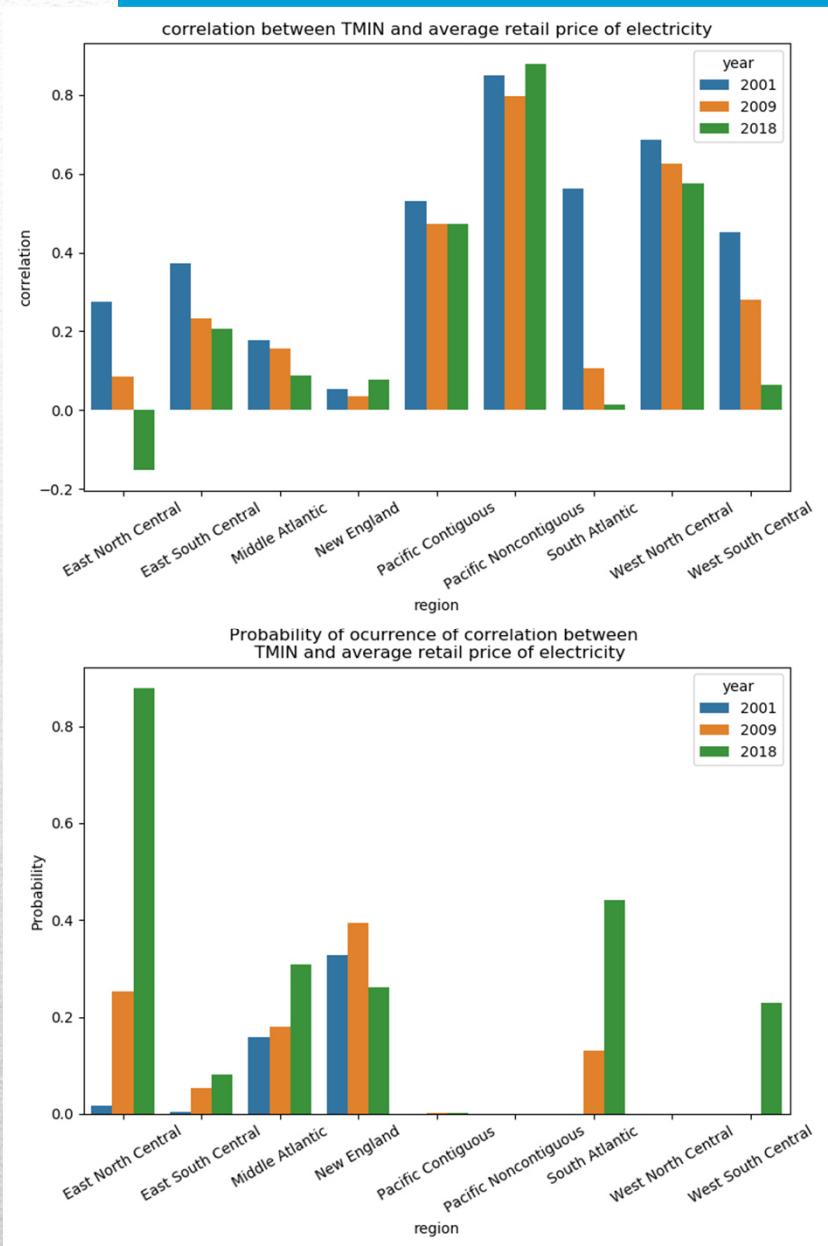
Number of customer Accounts

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Exploratory Data Analysis

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Low correlation between TMIN and Retail Price is something that is likely to happen but high correlation does not seem to be very likely

Exploratory Data Analysis

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The Data is Time Series and non-stationary:

Trend

- Grows over time
- Inflation or other macro-economic factors

Seasonality

- Periodic change of the price
- Correlation with temperature and/or other features

Time-series univariable models:

- Moving Average
- Facebook profet
- ARIMA

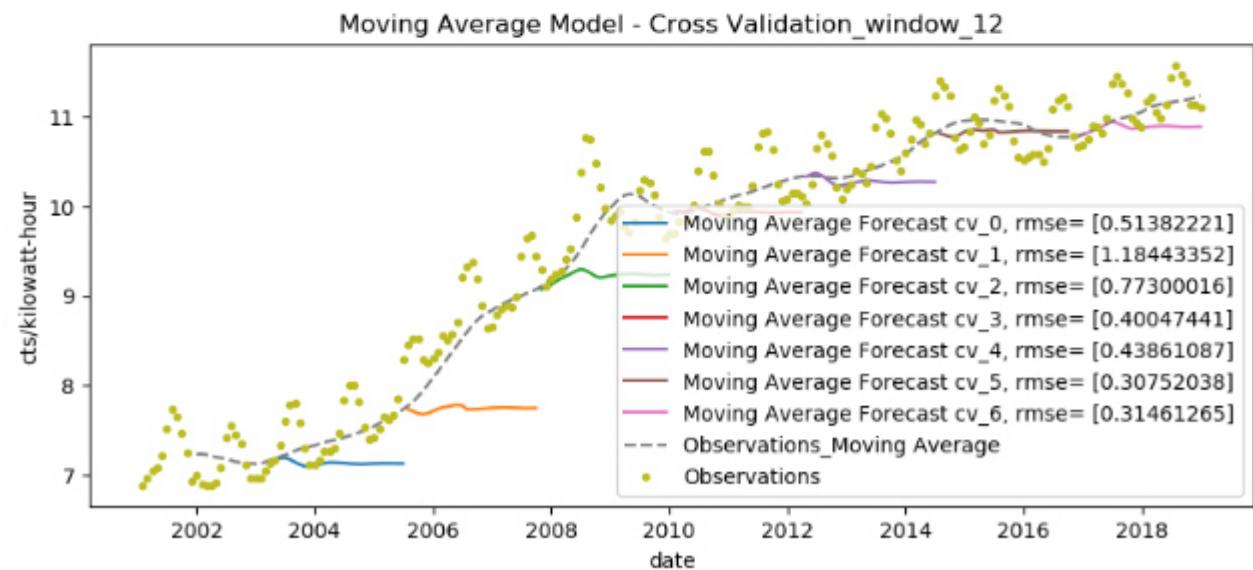
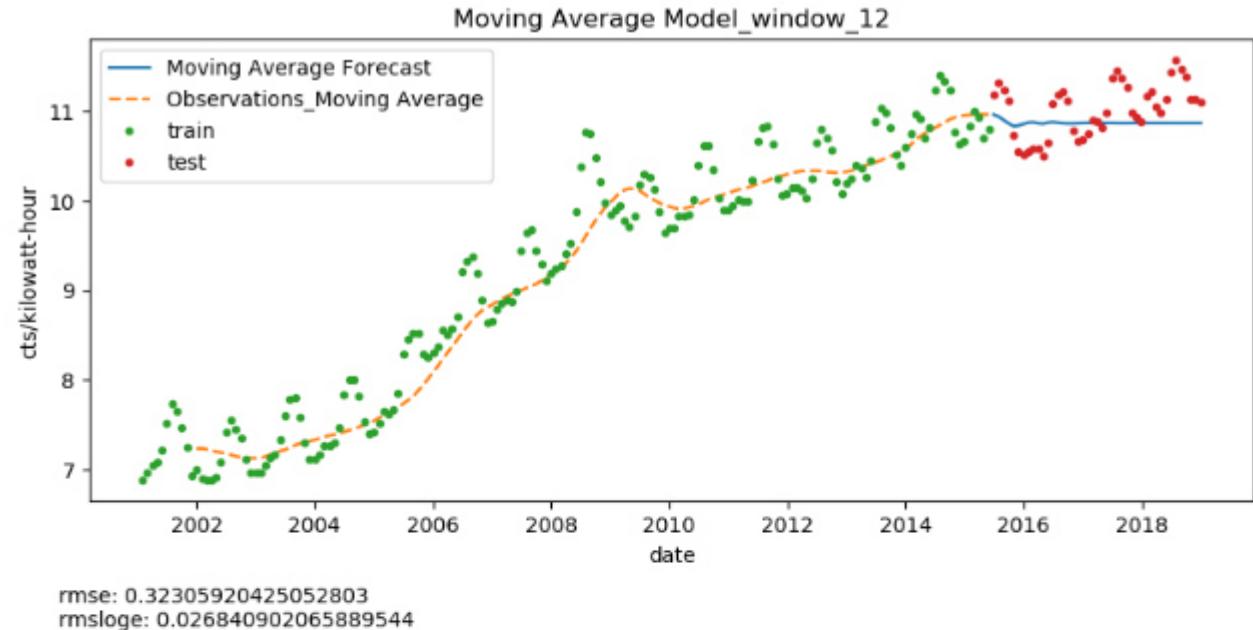
Multi-variable models:

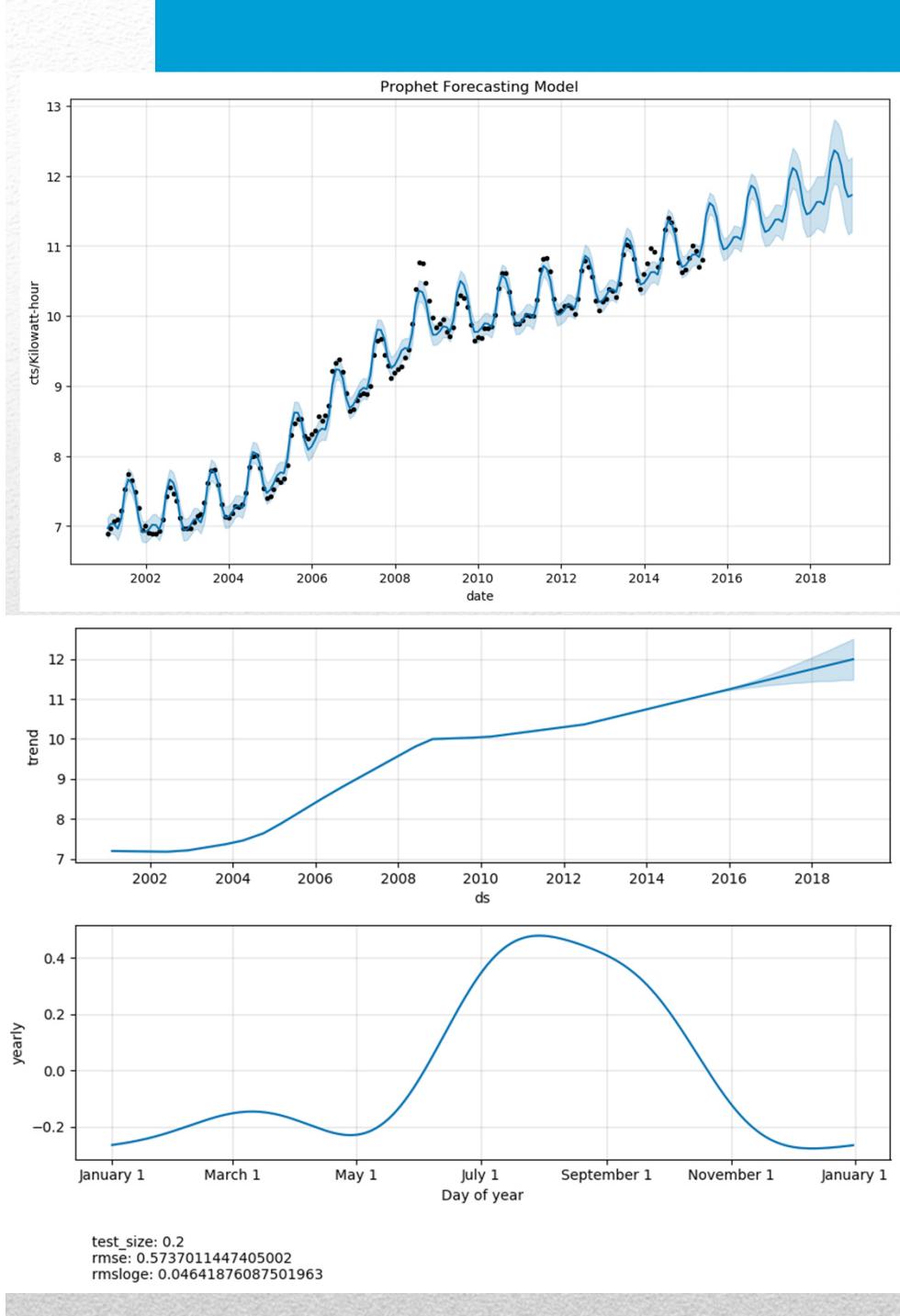
- Moving Average + Linear Regression (Combined model)
 - Moving Average + Lasso (Combined model)
 - Moving Average + Ridge (Combined model)
 - Moving Average + ElasticNet (Combined model)
- Long Short-Term Memory (LSTM) (Unsupervised model)

Models under consideration

Moving Average

- Smooth out short-term fluctuations and highlight longer-term trends or cycles.
- A decent option for trend forecast but not for price fluctuations in short term.





$$Y = X_i(1) \text{ Trend} + X_i(2) \text{ Seasonality}$$

Trend: linear regression with changing points as hyperparameter.

Hyperparameter: Default 'autoscale'

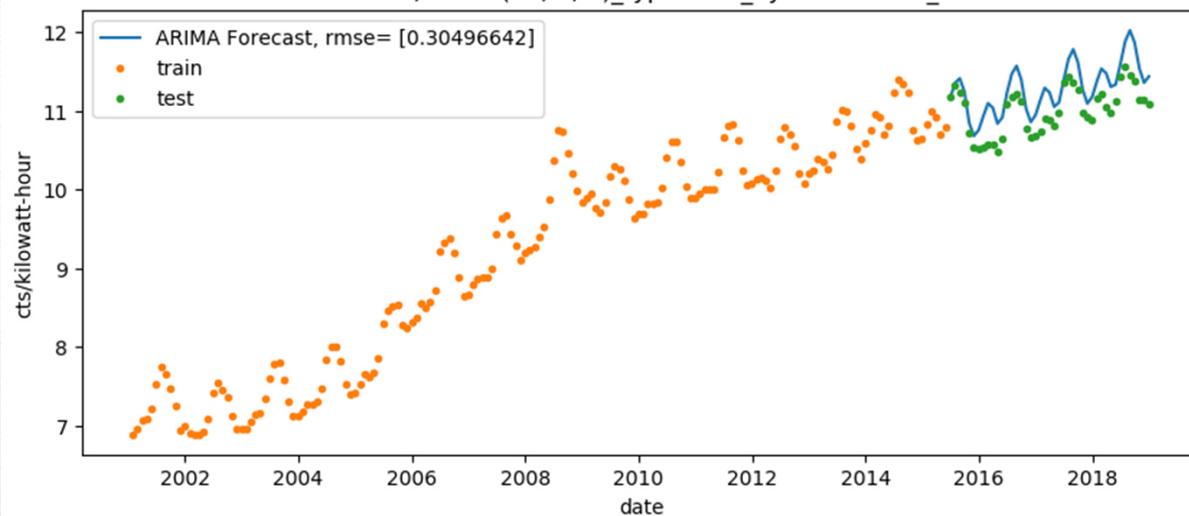
Seasonalities: partial Fourier sum.

Hyperparameter: fourier_order=5 selected by inspection

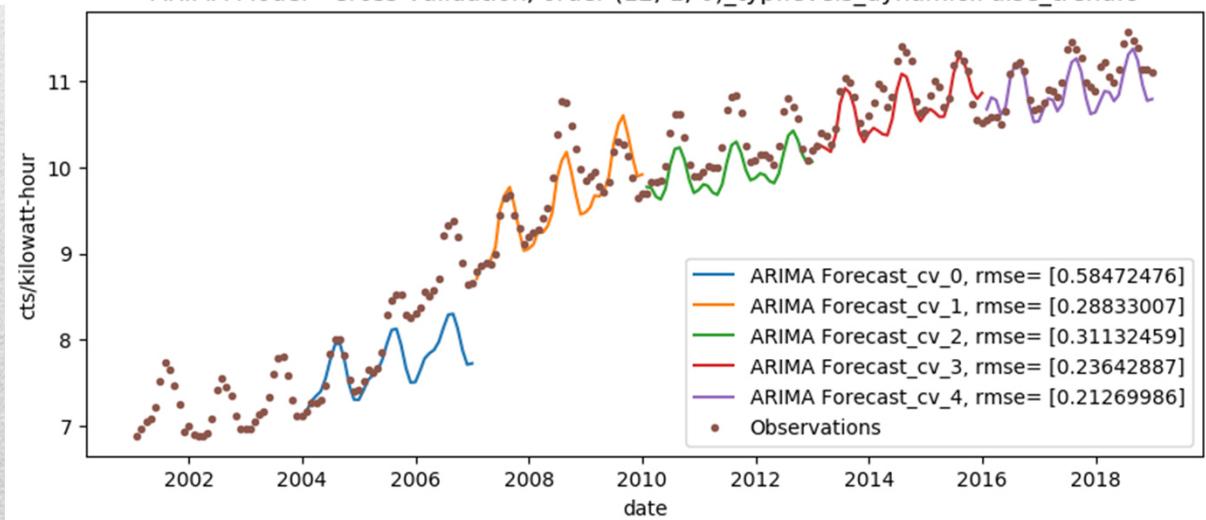
Facebook-Prophet

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ARIMA Model, order (12, 1, 0)_typ:levels_dynamic:False_trend:c

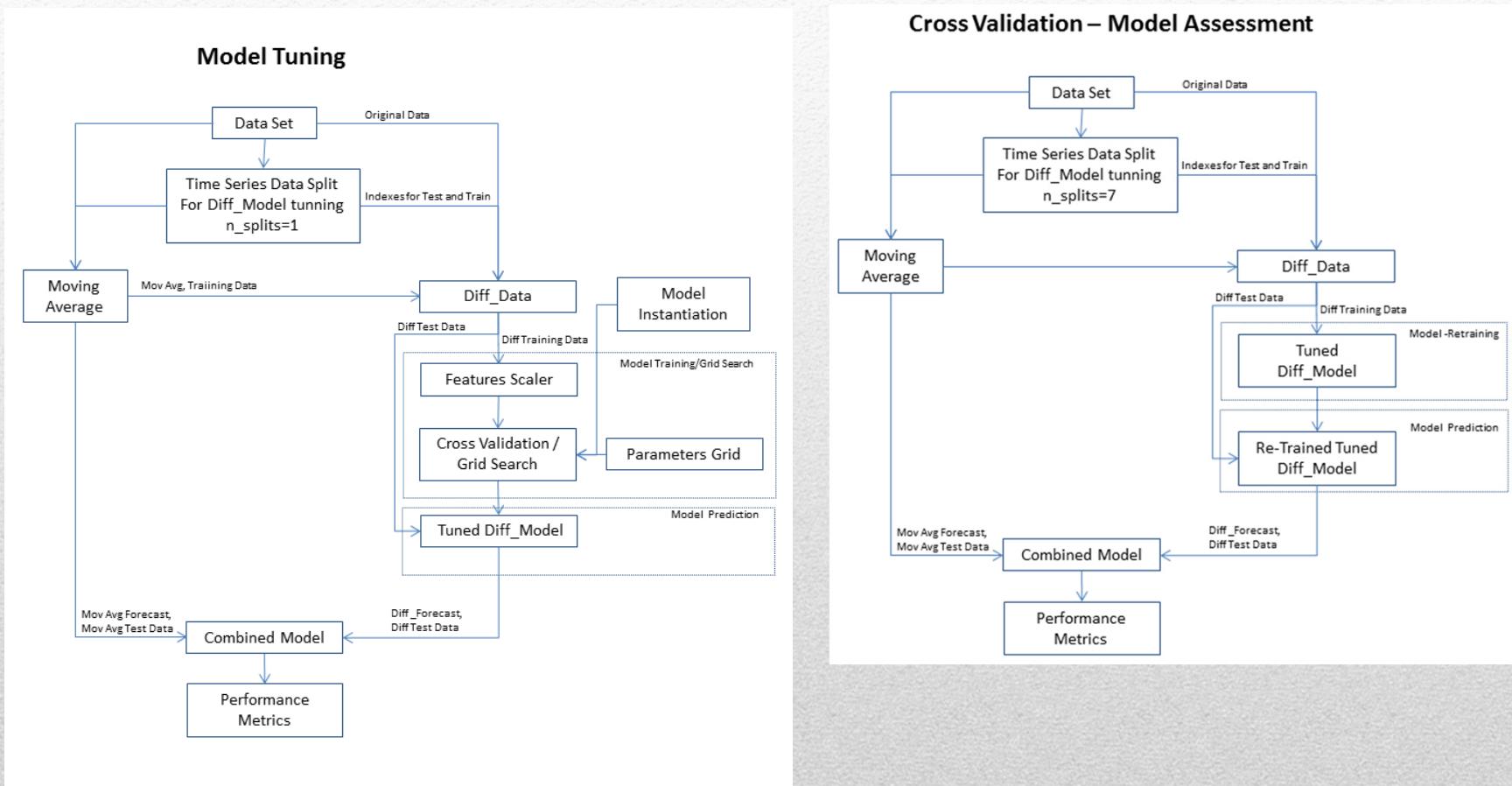


ARIMA Model - Cross Validation, order (12, 1, 0)_typ:levels_dynamic:False_trend:c



ARIMA

- Moving average (Mov Avg) is used in this case to estimate the trend .
- The difference of the outcome/response Y and the Mov Avg is called “differentiated outcome/response variable diff_Y” which is then considered an atemporal data set.

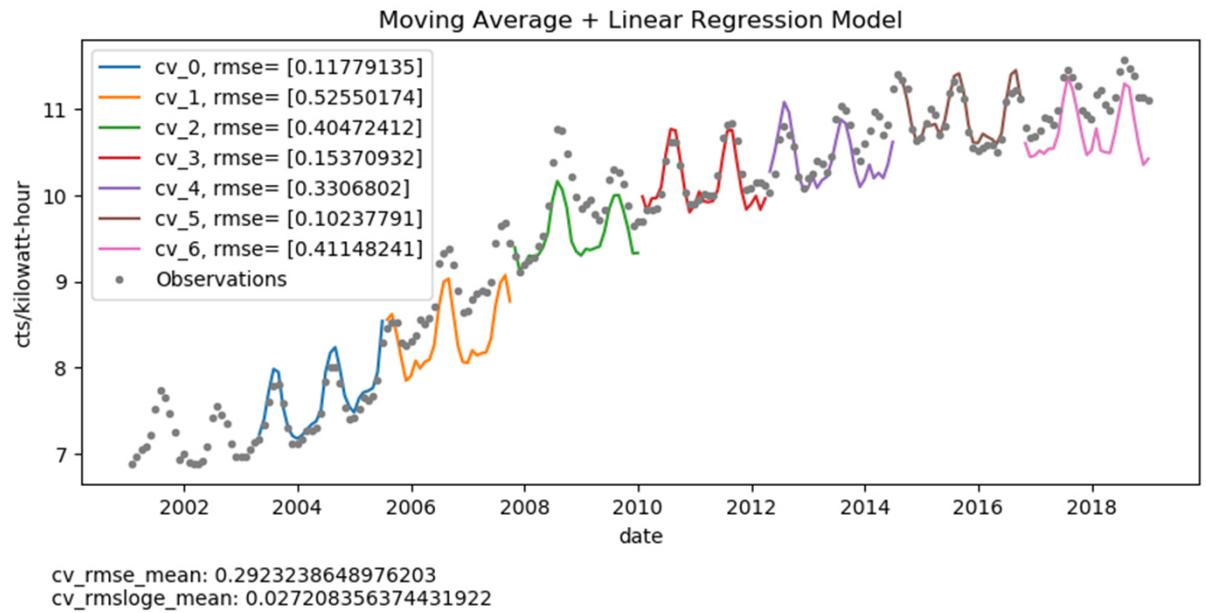
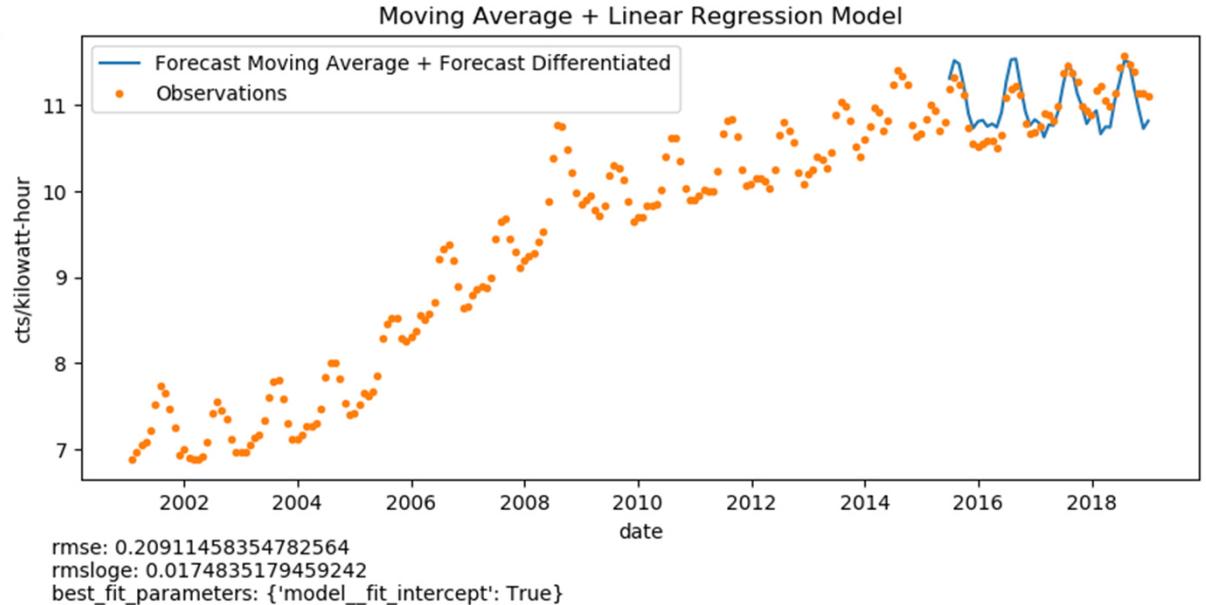
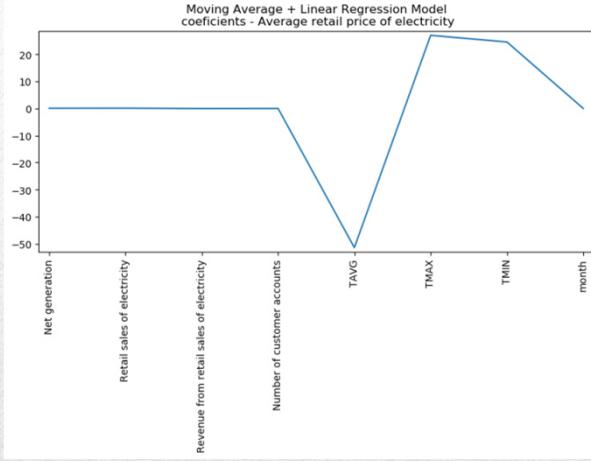


Moving Average + Other regressors

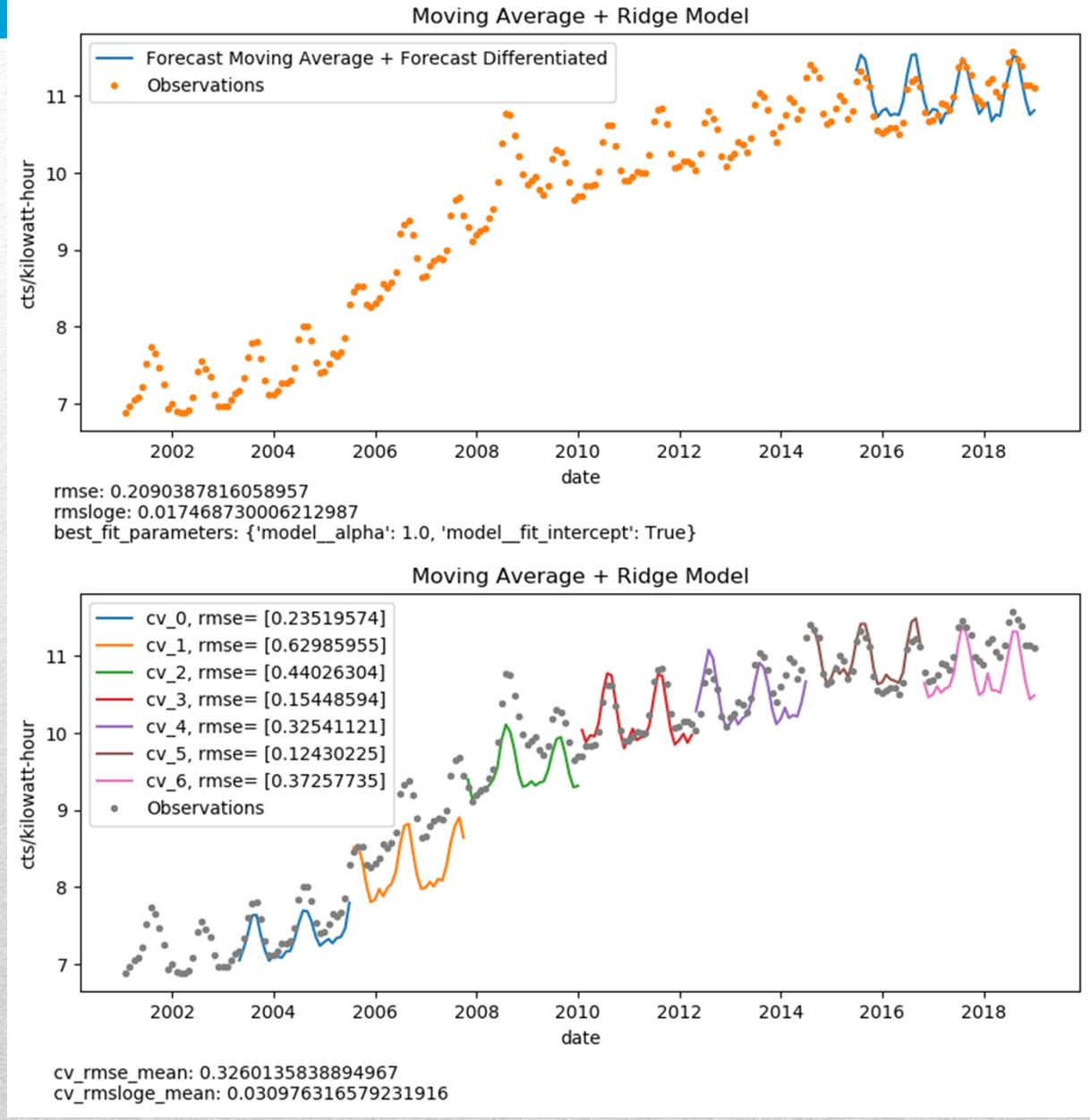
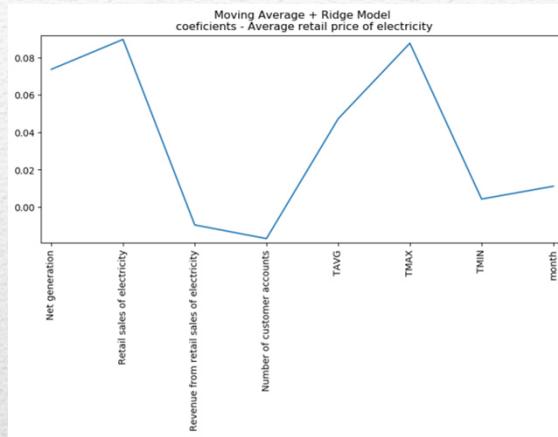
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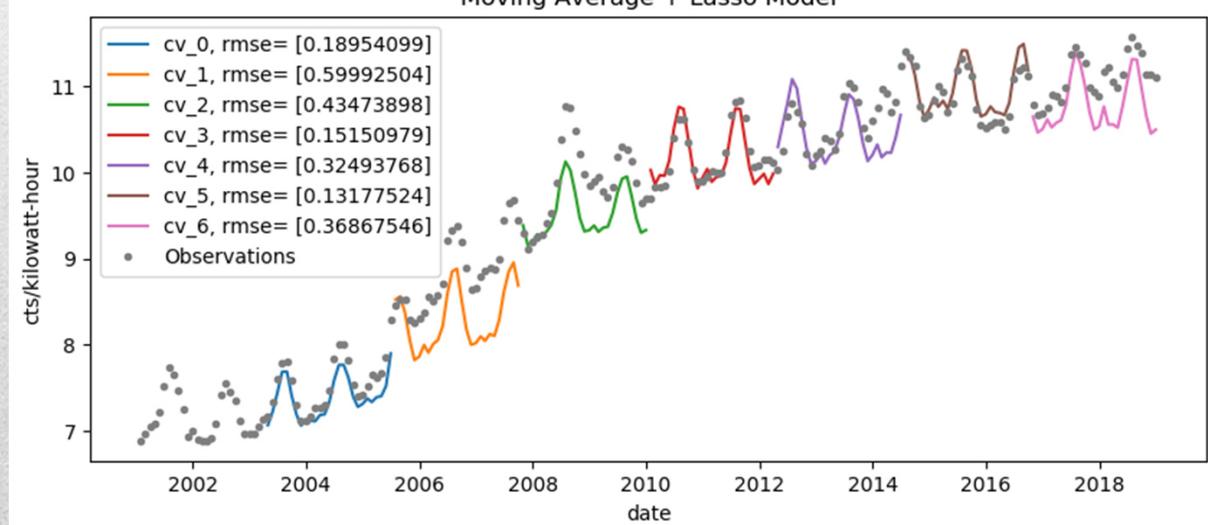
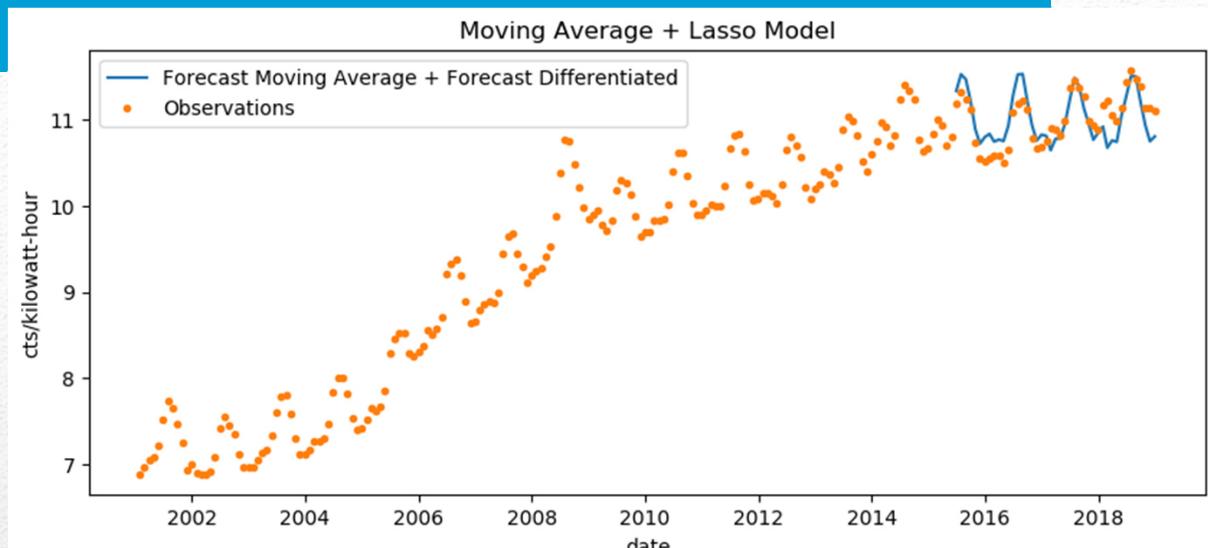
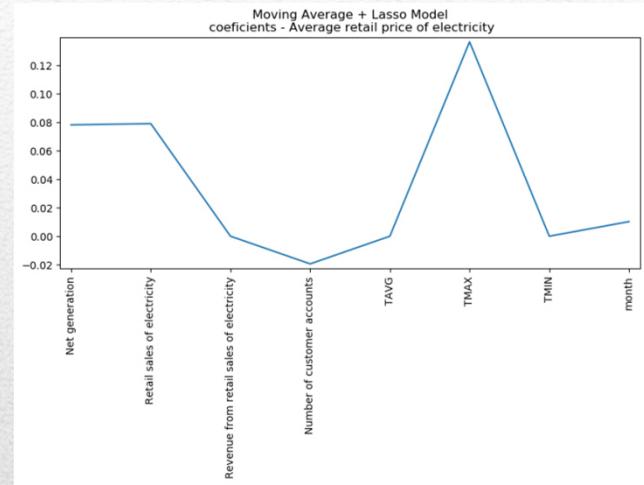
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Mov Avg + Linear Regression



Mov Avg + Ridge



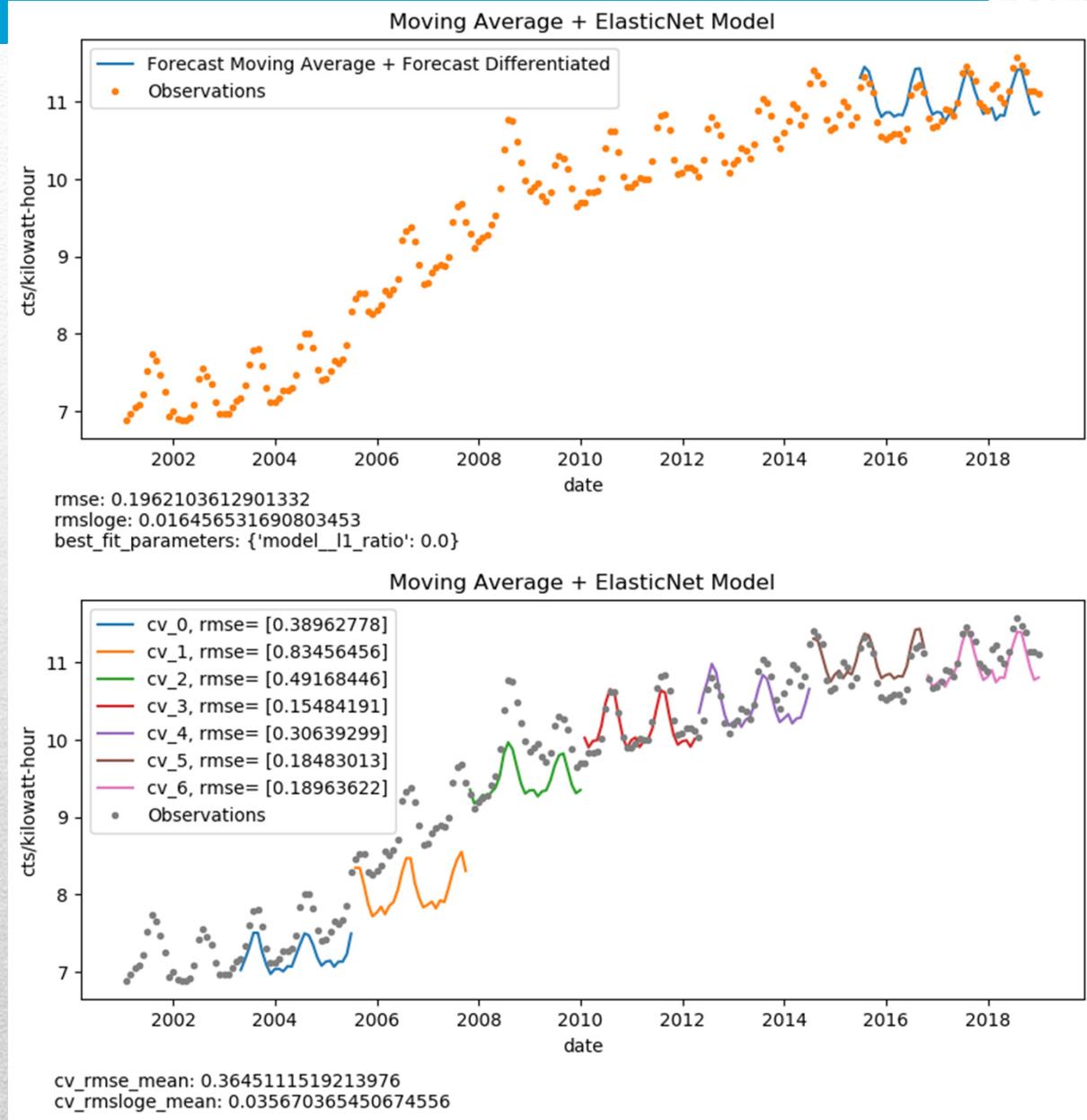
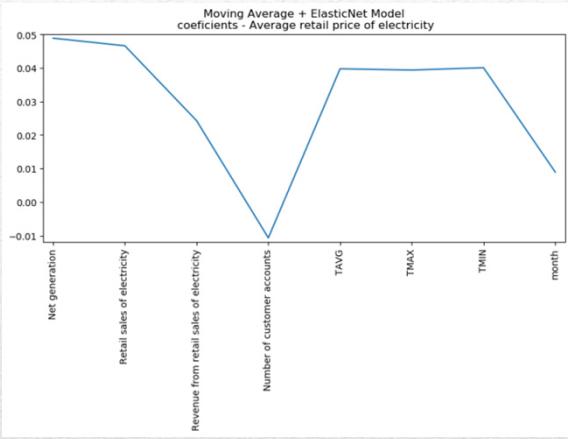


Mov Avg + Lasso

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Mov Avg + ElasticiNet



	<code>cv_rmse_mean</code>	<code>cv_rmsloge_mean</code>	<code>rmse</code>	<code>rmsloge</code>
Moving Average	0.5618	0.0547	0.3231	0.0268
fbprophet	0.3647	-	0.5737	0.0464
Mov_Avg+Linear Regression	0.2923	0.0272	0.2091	0.0175
Mov_Avg+Lasso	0.3144	0.0297	0.2081	0.0174
Mov_Avg+Ridge	0.3260	0.0310	0.2090	0.0175
Mov_Avg+ElasticNet	0.3645	0.0357	0.1962	0.0165
ARIMA	0.3267	0.0308	0.3050	0.0250

Model Selection Metrics

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- Time Series models as fbprophet and ARIMA are good options to forecast prices based on historical trends and seasonality.
- Combined models Mov_Avg + other regressors performance is comparable to fbprophet and ARIMA model in the electricity price case.
- Time series models as fbprophet and ARIMA use as only feature the date-time information while the combined models use other features to forecast the differentiated (seasonality) part.
- The best model to use would depend on the purpose of the forecast and the available information.
- It is recommended to re-trained the selected model with new data in order to capture changes on patterns of behavior.

Conclusions

- The current analysis was based on US average temperature. Nevertheless, individual models per US region has to be tuned in order to be able to forecast Electricity price at any state of USA.

Next Steps

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