

Demand Side Analytics

Electricity Demand

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06/15/2021

Overview

Premise

- Infrastructure planning is based on electric peak demands
- How does seasonality change demand?
- Is demand tied to a time trend?
- What is the weather and electric demand relationship?
- Can we predict the electric demand?

Takeaways

- Electric Demand rises with temperature and dew point
- Summer and Winter spikes electric demand
- Weekdays and Working hours have higher demand
- Forecasts predict peak demands of ~1700 MW

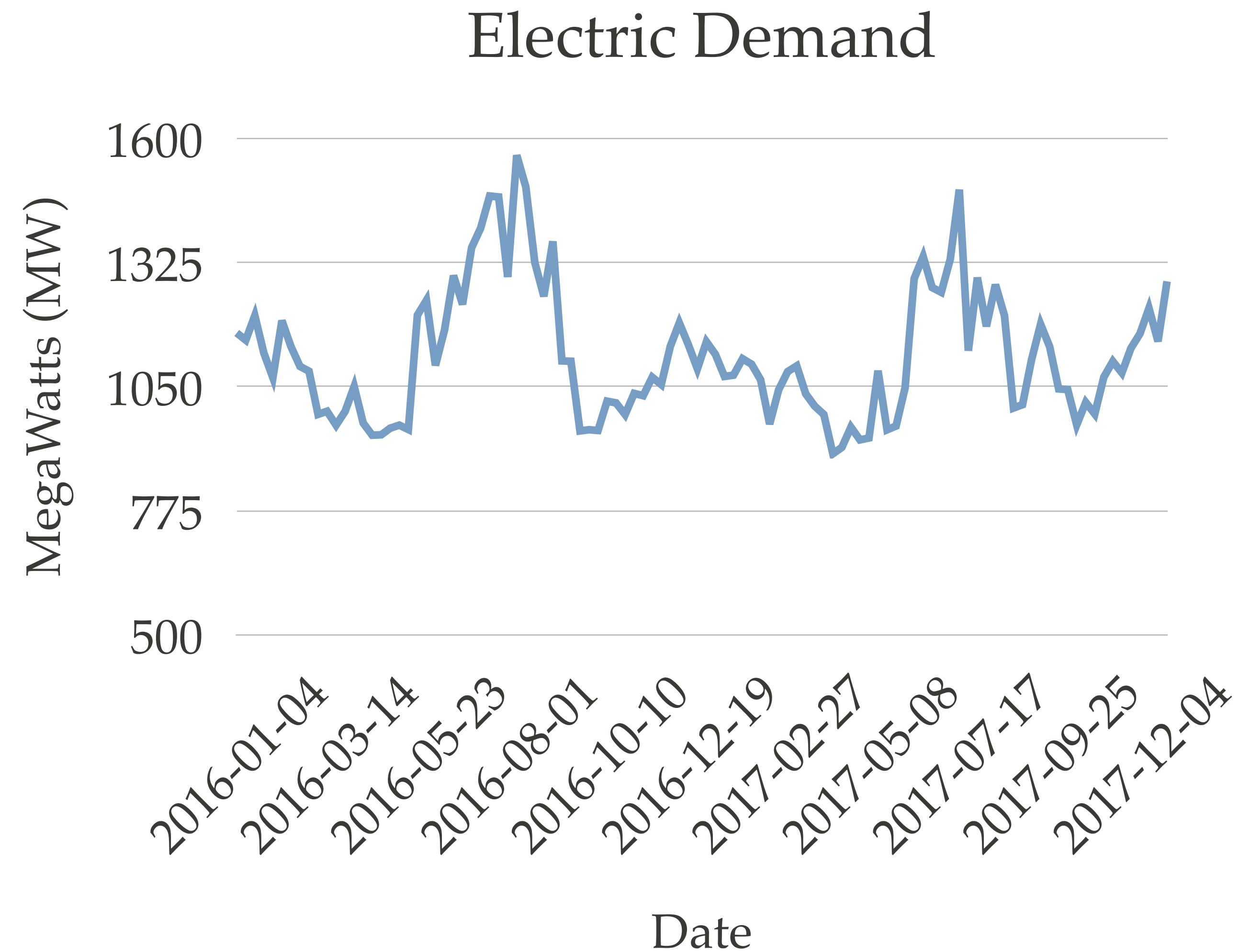
Data

- Weather data set:
 - Hourly Data from 01 / 2013 to 12 / 2017, ~80,000 Obs
 - Temperature, Dew point, Wind Direction*, Wind Speed**, and Sky Condition**
- Electric Demand data:
 - Hourly Data from 01 / 2016 to 12 / 2017, ~17,500 Obs
 - MegaWatts(MW)
- Data Clean
 - Data from 01 / 2016 to 12 / 2017
 - Temperature, Dew point, MW
 - Weekly running average is used
- Electric Demand*** is shown by Megawatts (MW)

*Removed to incomplete data

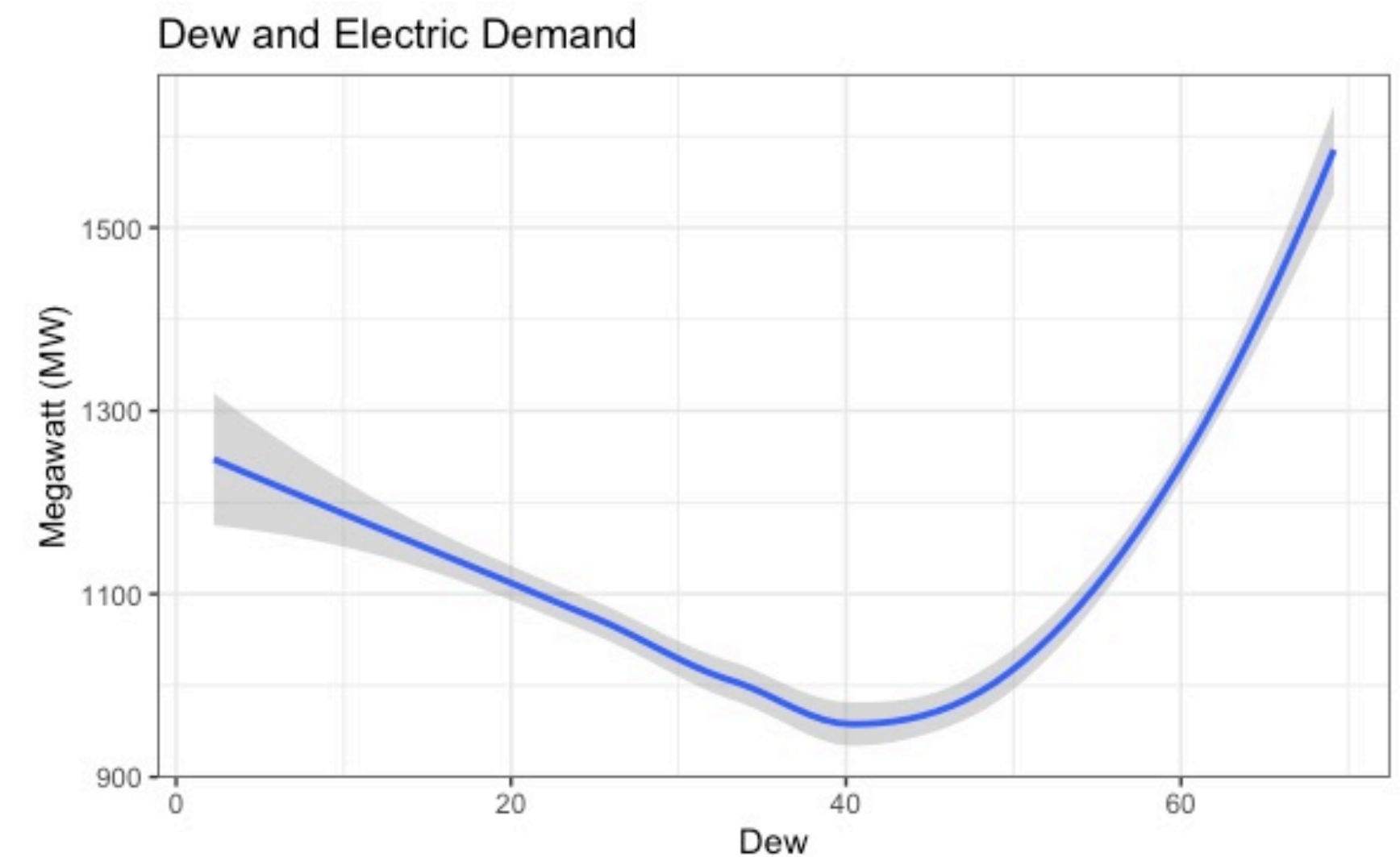
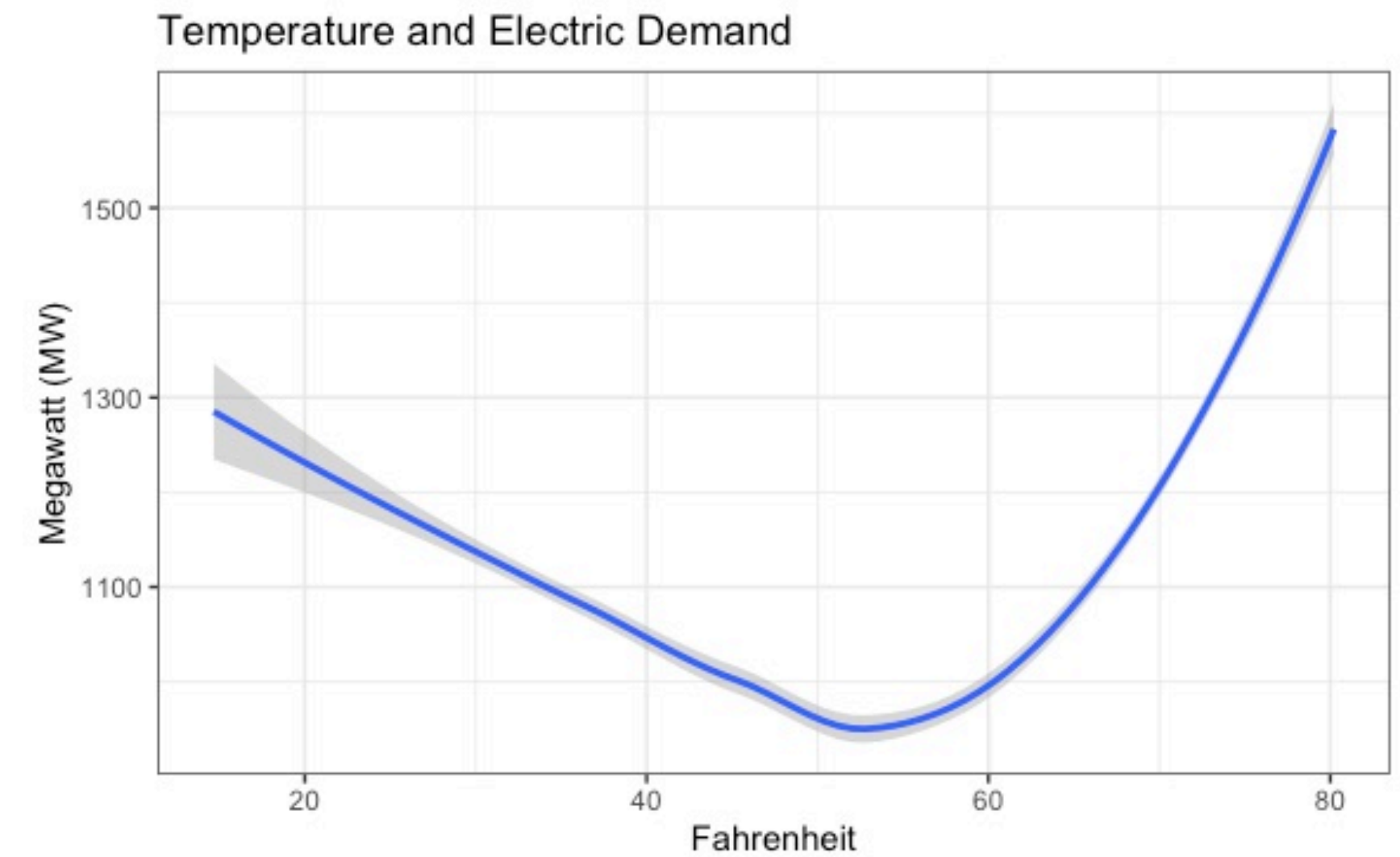
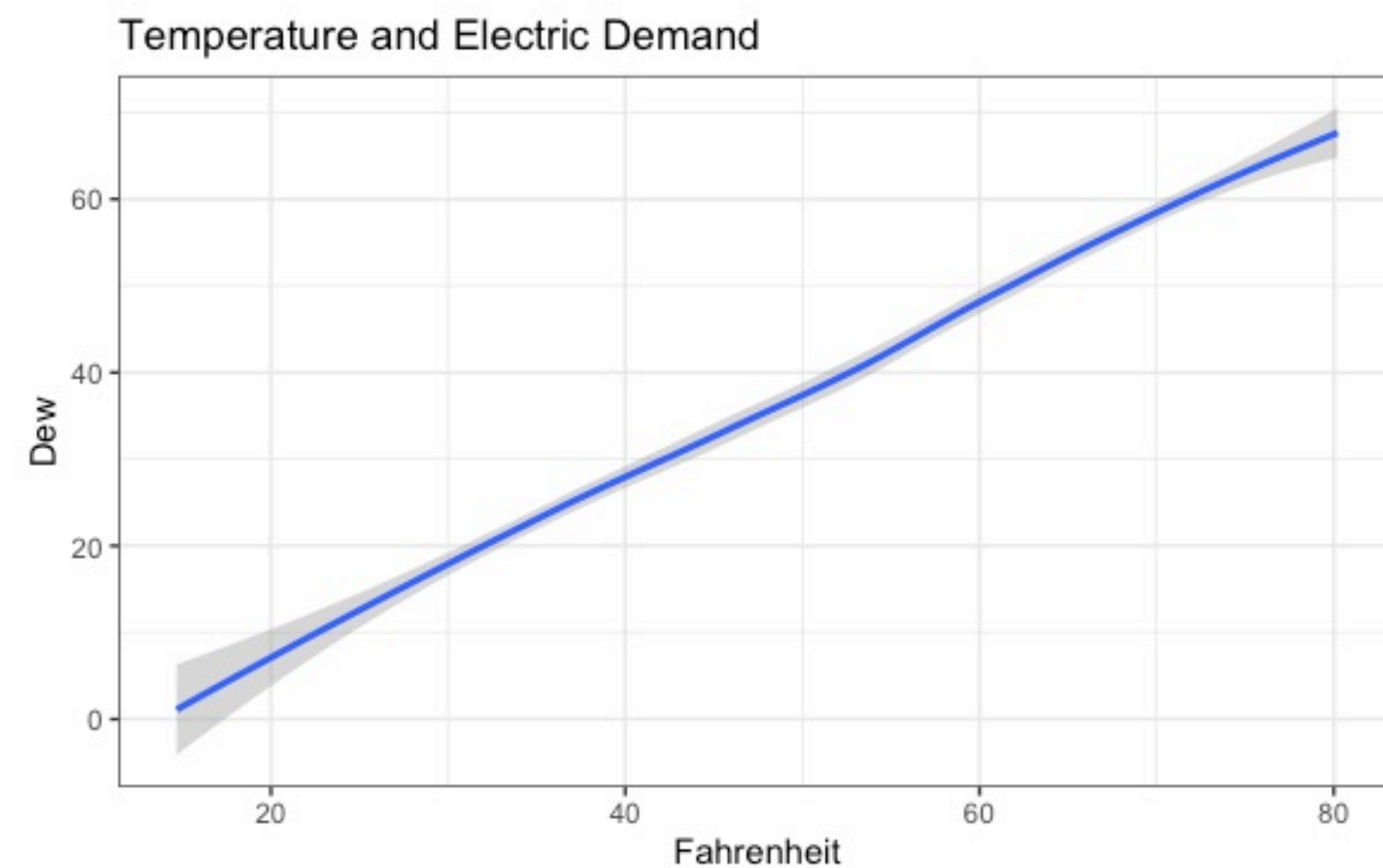
**No correlation

***Electricity is a utility , quantity represents demand



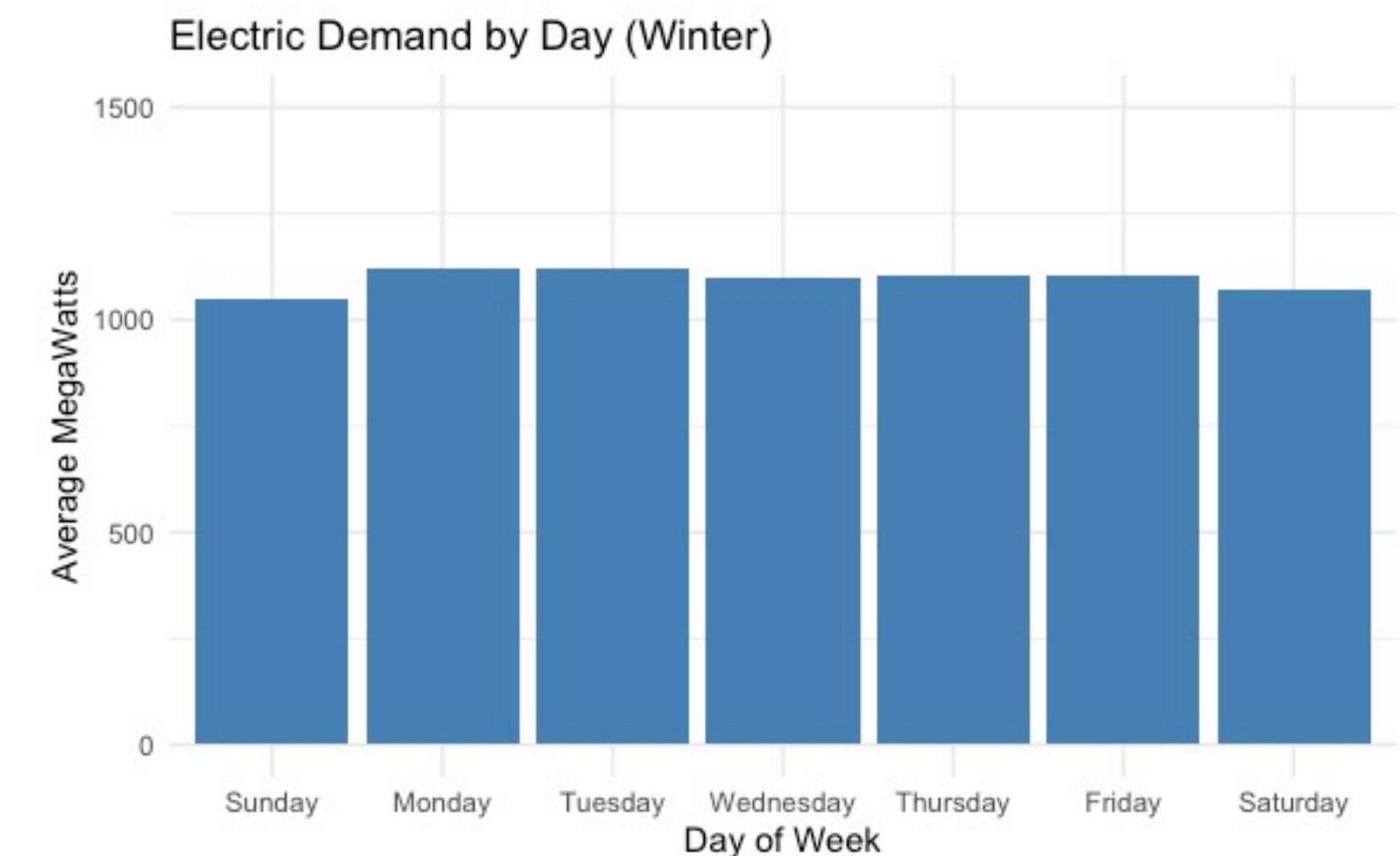
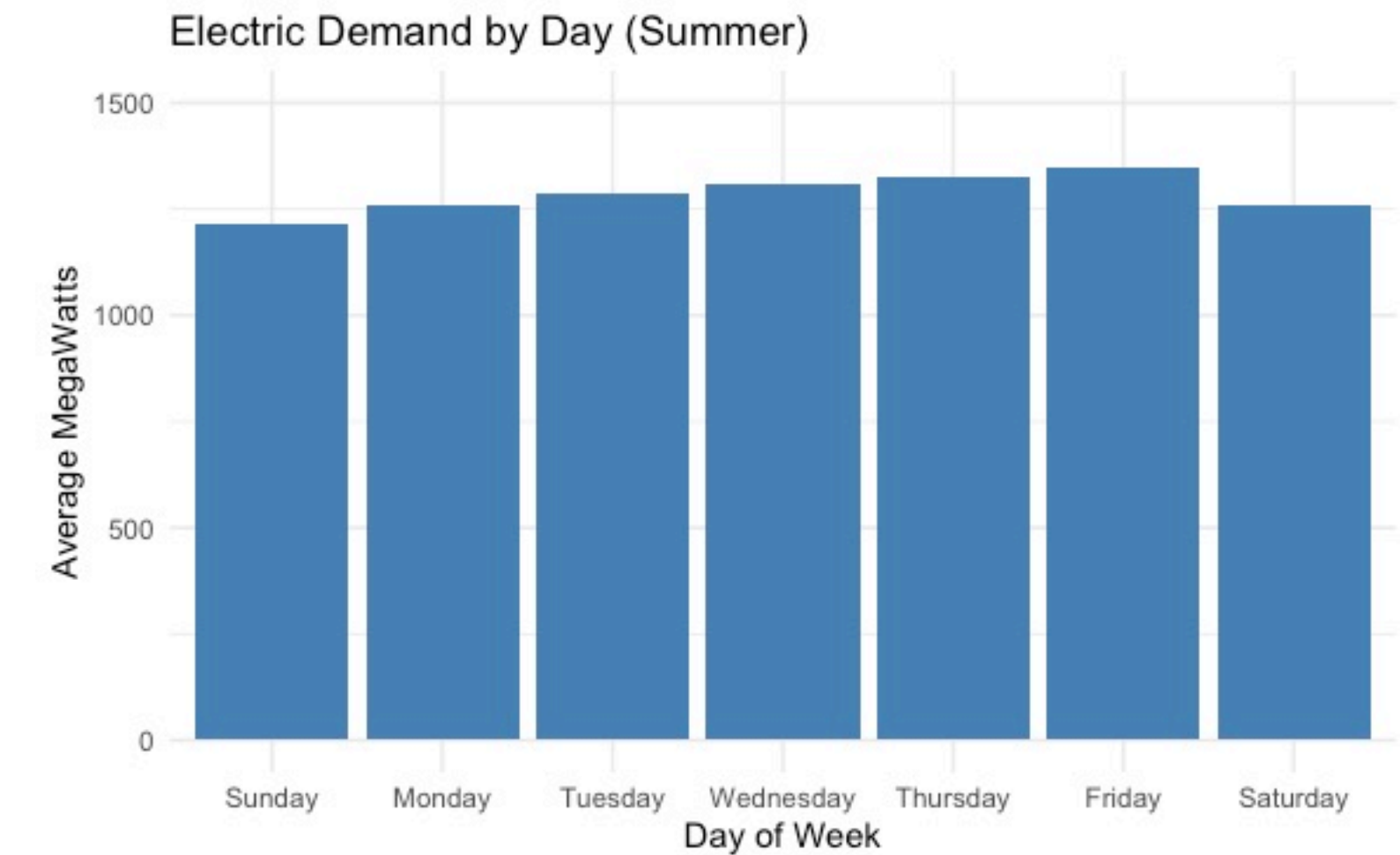
Weather and Electric Demand

- We see a tight correlation between electric demand, Temperature and Dew
- Low temperatures require heating and high temperatures require cool ie peaks of electric demand
- Temperature and Dew are positively correlated



Electric Demand and Day

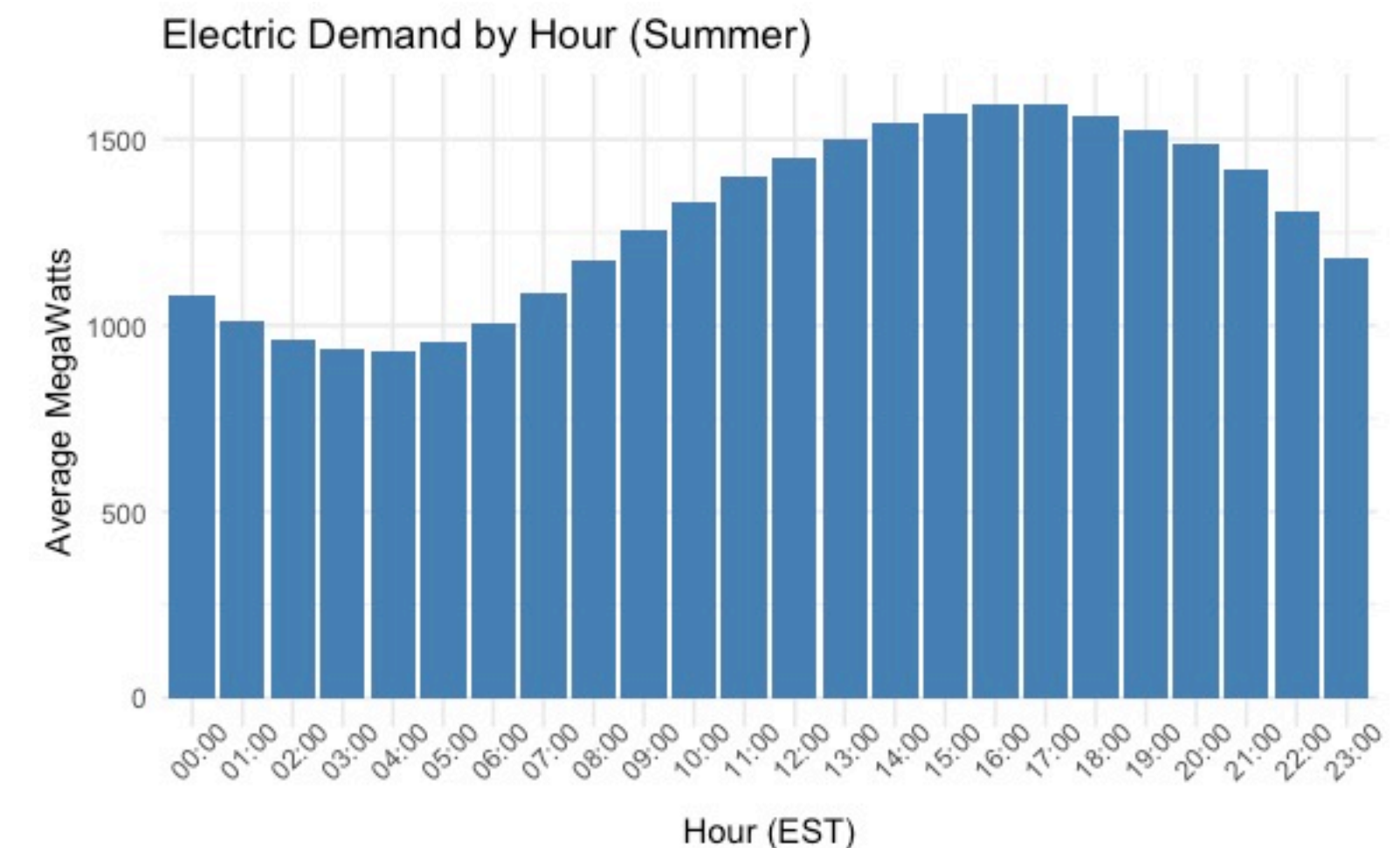
- Electric Demand rises by ~100 MW on weekdays
- Trend holds year round
- Summer months (hotter) have a higher demand than winter months (colder)



Electric Demand and Time

- Waking Hours* had a increase in demand, ~60% of day
- Summer Electric Demand rises by ~500 MW during waking hours*
- Winter Electric Demand rises by ~300 MW during waking hours*
- Summer months (hotter) have a higher demand than winter months (colder)

*8am-10pm



Demand Sensitivity

- Temperature ~ Electricity Price elasticity* is inelastic (.015)
- Dew ~ Electricity Price elasticity* is inelastic (.019)
- Summers have significantly** higher electric demand by day than winters
- Summers have significantly*** higher electric demand by hours than winters

*Elasticity calculated using quadratic fit and average values

**Through Z-Test at .05 level

***Through F-Test at .05 level

Model Walk

- Simple Time Series Regression
 - Variables limited* to Temperature and Dew
- Training Data from 2016-2017
- Test Data from 2016-2017
- Forecast Data from 2013-2016

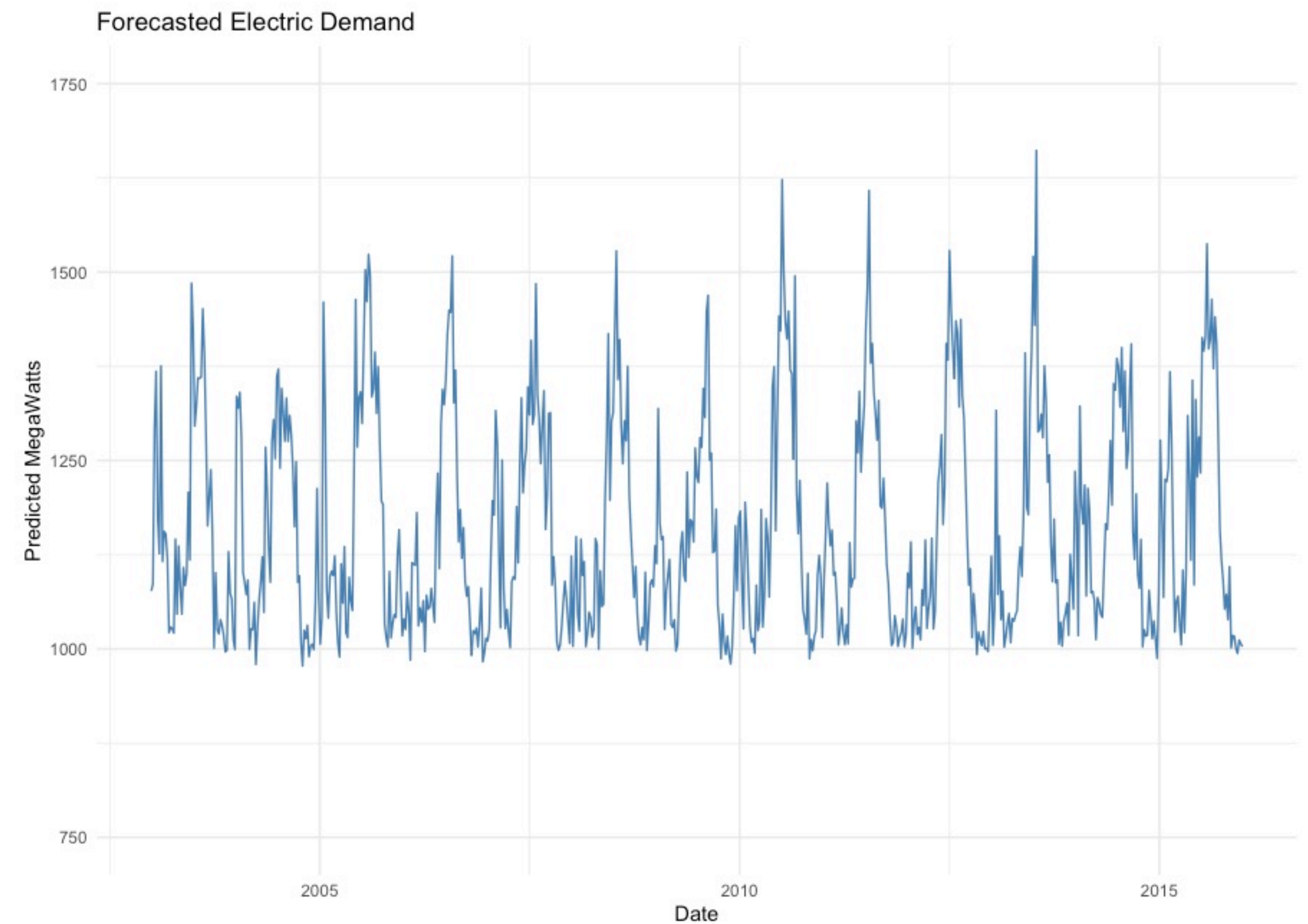
Model:

$$\begin{aligned} \text{Forecast_MW} = & \\ & 1731 + (-28.76 \times \text{Temperature}) + (.3321 \times \text{Temperature}^2) + \\ & (-6.328 \times \text{Dew}) + (.06838 \times \text{Dew}^2) \end{aligned}$$

*Due to correlation and model fitting

Forecast

- The seasonality trend over time as expected
- Lower bound of ~1000 MW and an upper bound of ~1700 MW
- R^2 of .57 and RSME of 3.73



Closing thoughts

Takeaways

- Electric Demand has weather, seasonality, weekly and hourly trends
- Electric Demand is inelastic
- Summers have higher demand than winters
- Forecasts predict peak demands of ~1700 MW

Question?