# Long Term Hourly Electricity Forecasting Model and Peak Shift Analysis

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# Objective

- Develop a model to forecast long term hourly electricity demand.
- This model will allow us to investigate topics such as peak shift due to PV, DR integration, AAEE, TOU Rate Impacts, Ramp up Rates, Load Shapes, Monthly Demand etc…
- We have hourly EMS data from 2006 on for the three IOUs in California. Namely, PGE, SCE, and SDGE.
- Once we start getting AMI data, we will extend this model to do a more disaggregated forecast.
- Standardize data to PST

# Model Form

- The hourly model has the following form,
- $y_{t,p} = y^*_{t,p} * \bar{y}_i$
- Where, $y_t$ is the hourly demand for a particular hour.
- $y^*$ is the normalized hourly demand (normalized to the annual average consumption)
- $\bar{y}_t$ is the average consumption for a year, $p$ denotes the time of day, $p$ = 1,…,24 hours.
- $\log(y^*_{t,p}) = h_p(t) + f_p(WT_t) + f_p(AvgTemp_{24}) + f_p(LastMin_{24}) + f_p(DP_t) + f_p(CC) + f_p(Day1Temp) + f_p(Day2Temp) + f_p(Day3Temp) + e_t$
- $\bar{y}_t = f(Commercial\ Floor\ Space, Number\ of\ Households, Manufacturing\ Output, Income, Employment, Electricity\ Rates, \ldots, etc.\ (EUM\ and\ AEM))$

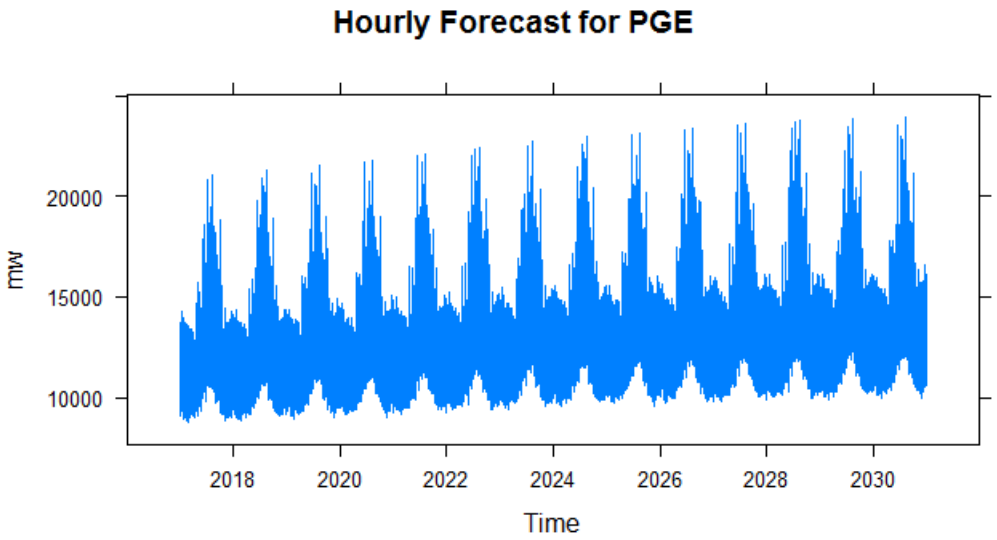
# For Forecasting

- Calculating the Forecast is a process.
- We have hourly weather data from 2000-2016, 17 Years
- We run 17 years of history, where each of 7 weeks start with different day.
- This gives us 119 scenario's that are used as input to our model.
- From the 119 scenario's with 8760 data, take the maximum ratio (y*) for each scenario and then take the median. We do the same for the second highest.
- So we build a ranked 8760 this way.
- This is our way of averaging.
- We calculate a normal year for each TAC using cooling degree days and heating degree days and comparing them with the 30 year average.
- We apply the ranked 8760 to the normal year for each TAC to calculate the 10 year forecast ratio.
- We apply the average consumption to this ratio to calculate the forecast.

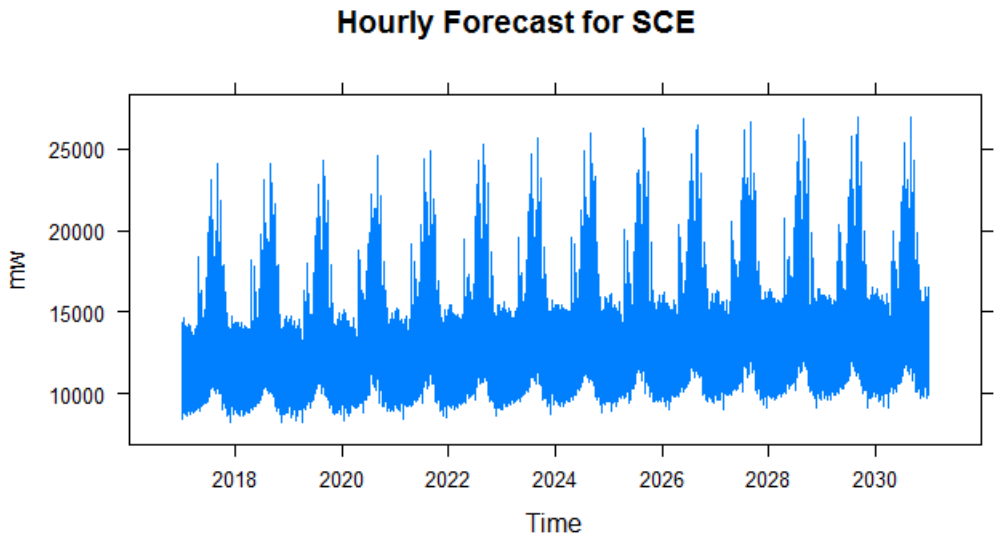
# Goodness of Fit

| TAC | Hour (0-23) PST | R2 | MAPE |
|---|---|---|---|
| PGE | 4 | 0.819 | 2.76 |
| | 12 | 0.95 | |
| | 17 | 0.961 | |
| | | | |
| SCE | 4 | 0.872 | 3.37 |
| | 12 | 0.951 | |
| | 17 | 0.952 | |
| | | | |
| SDGE | 4 | 0.813 | 4.01 |
| | 12 | 0.928 | |
| | 17 | 0.9 | |

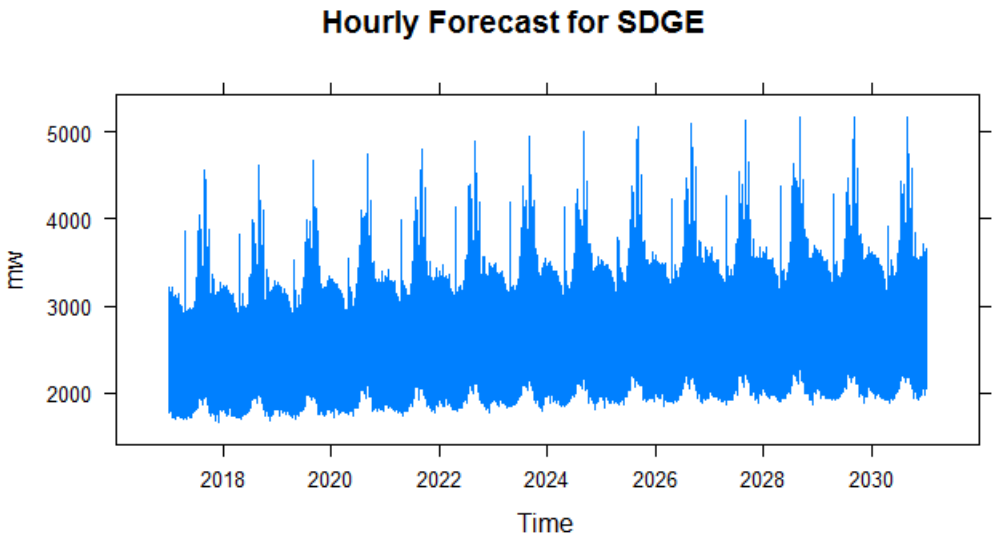
# Forecast Results PGE



# Forecasted Results SCE



# Forecast Results SDGE



# TAC Peak Factors

| Peak Factors for PGE | Factor | CED 2017P |
|---|---|---|
| 1in5 | 1.07239 | 1.045 |
| 1in10 | 1.098178 | 1.066 |
| 1in20 | 1.126519 | 1.081 |

| Peak Factors for SCE | Factor | CED 2017P |
|---|---|---|
| 1in5 | 1.073356 | 1.057 |
| 1in10 | 1.095867 | 1.099 |
| 1in20 | 1.106615 | 1.11 |

| Peak Factors for SDGE | Factor | CED 2017P |
|---|---|---|
| 1in5 | 1.061166 | 1.047 |
| 1in10 | 1.124467 | 1.093 |
| 1in20 | 1.158097 | 1.118 |

# Peak Shift Analysis

| | | |
|---|---|---|
| PGE | Last Historical Year Peak Hour 16 (0-23) PST | |
| | One hour shift in 2018 | |
| | One hour shift in 2027 | |

| | | |
|---|---|---|
| SCE | Last Historical Year Peak Hour 14 (0-23) PST | |
| | One hour shift in 2017 | |
| | One hour shift in 2018 | |

| | | |
|---|---|---|
| SDGE | Last Historical Year Peak Hour 16 (0-23) PST | |
| | One hour shift in 2021 | |
| | One hour shift in 2022 | |

# Questions or Concerns