Forecasting Future Energy Needs

Meet The Team

Adam Chua

Abhishek Sarepaka

Ally Nguyen

Noah Rivera

OBJECTIVE

Develop a comprehensive system to forecast future energy requirements by county, supporting SCE in infrastructure development and resource allocation. This project also aims to create customized energy-saving programs for areas with high energy usage.

Contents

KEY FACTORS ANALYSES

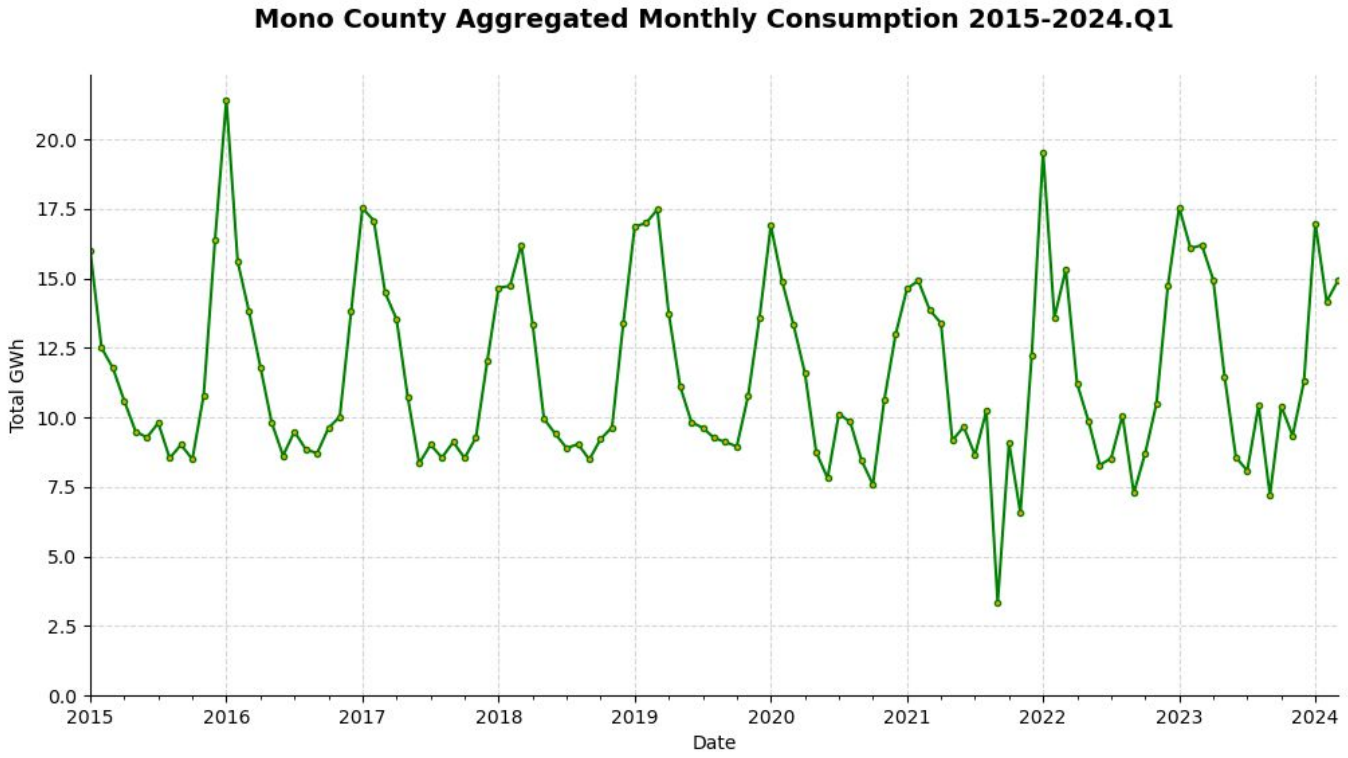
Historical Energy Consumption

Analysis of Energy trends in SCE territories

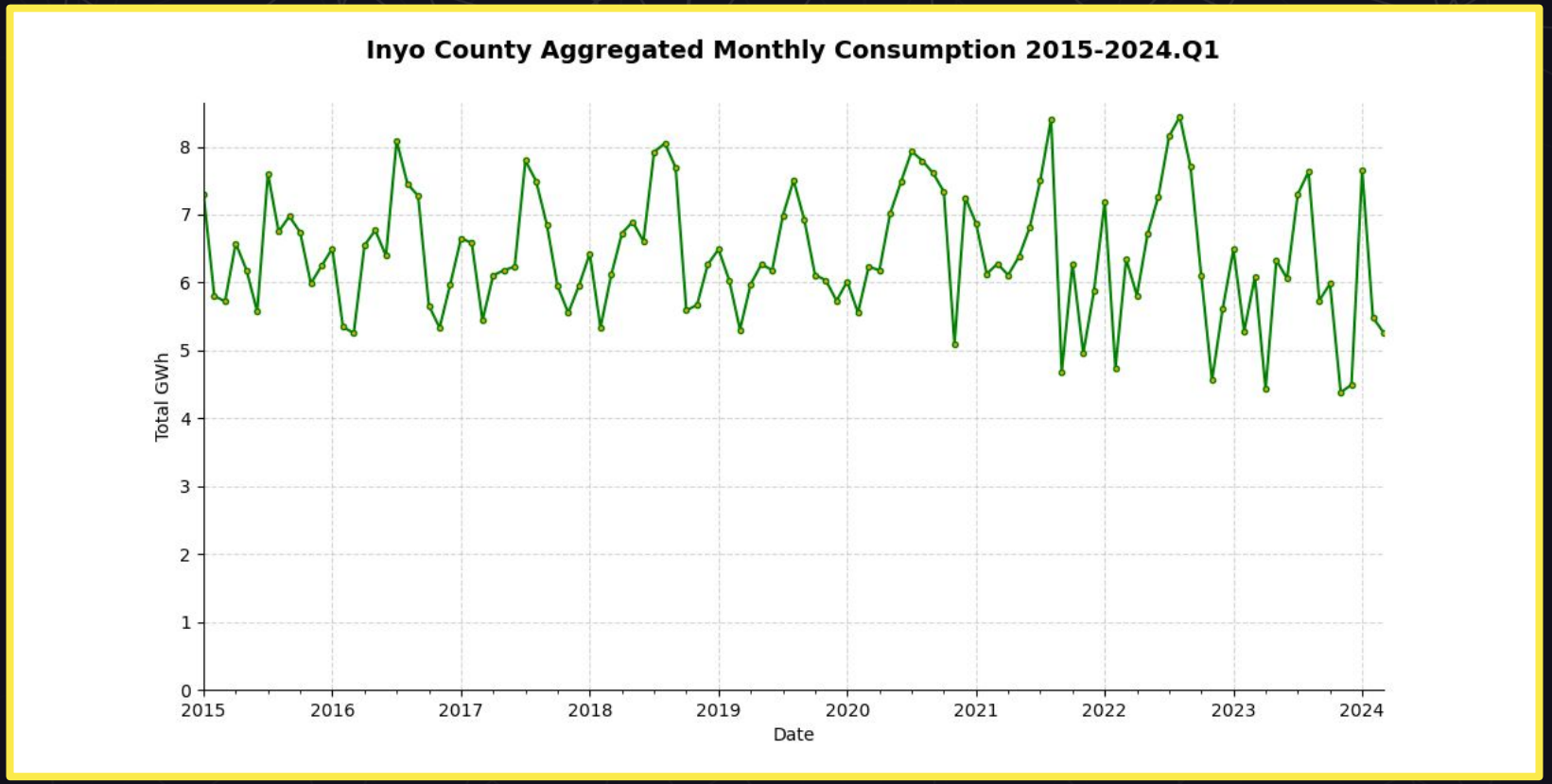
Let's Take A Look At The SCE territorial map:

Average Historical Energy Consumption (1990 - 2022)

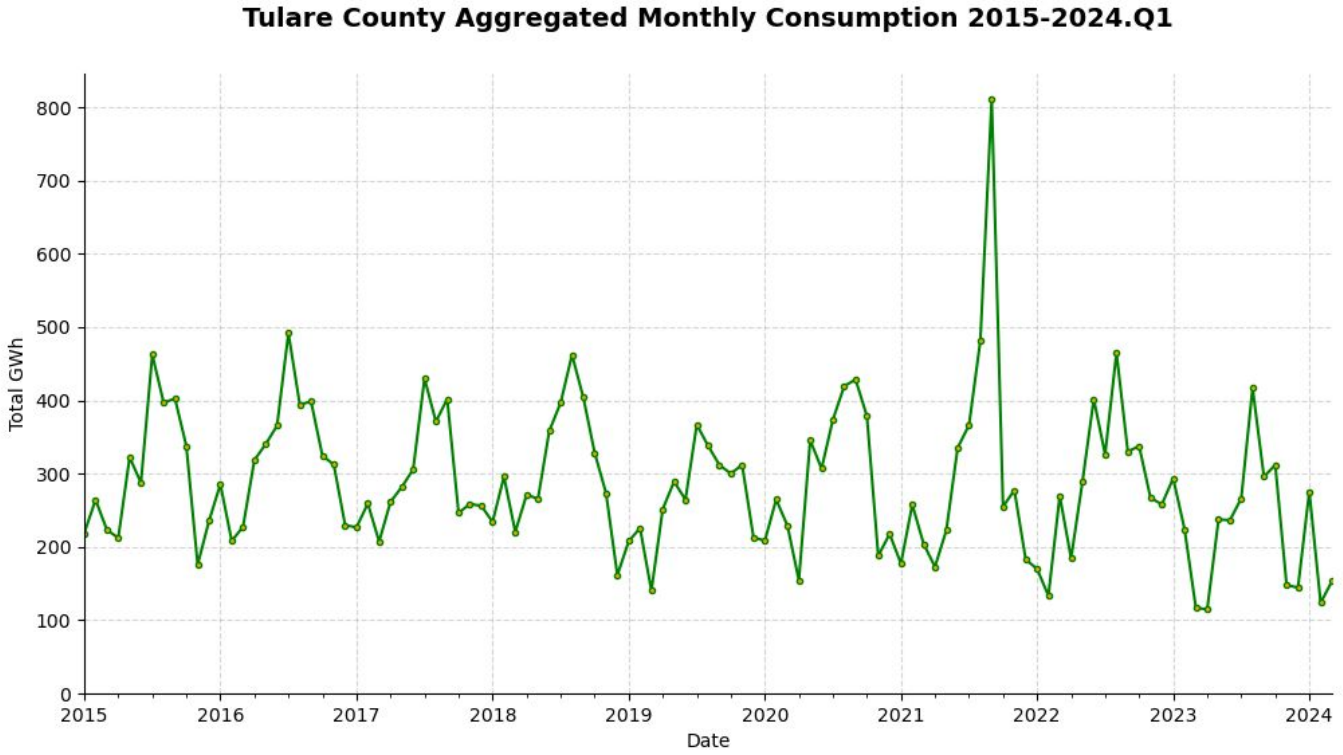
Breakdown of energy consumption by County:



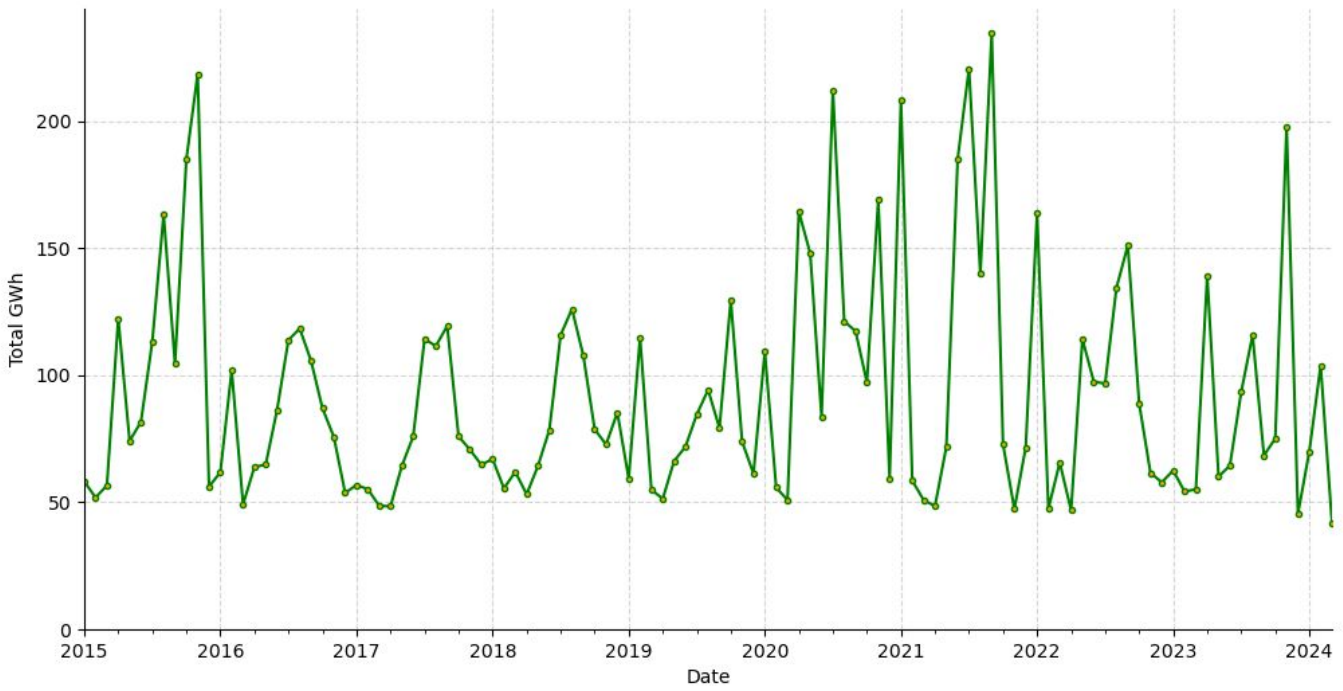
Maximum Energy Usage: 21 GWh
Minimum Energy Usage: 3 GWh



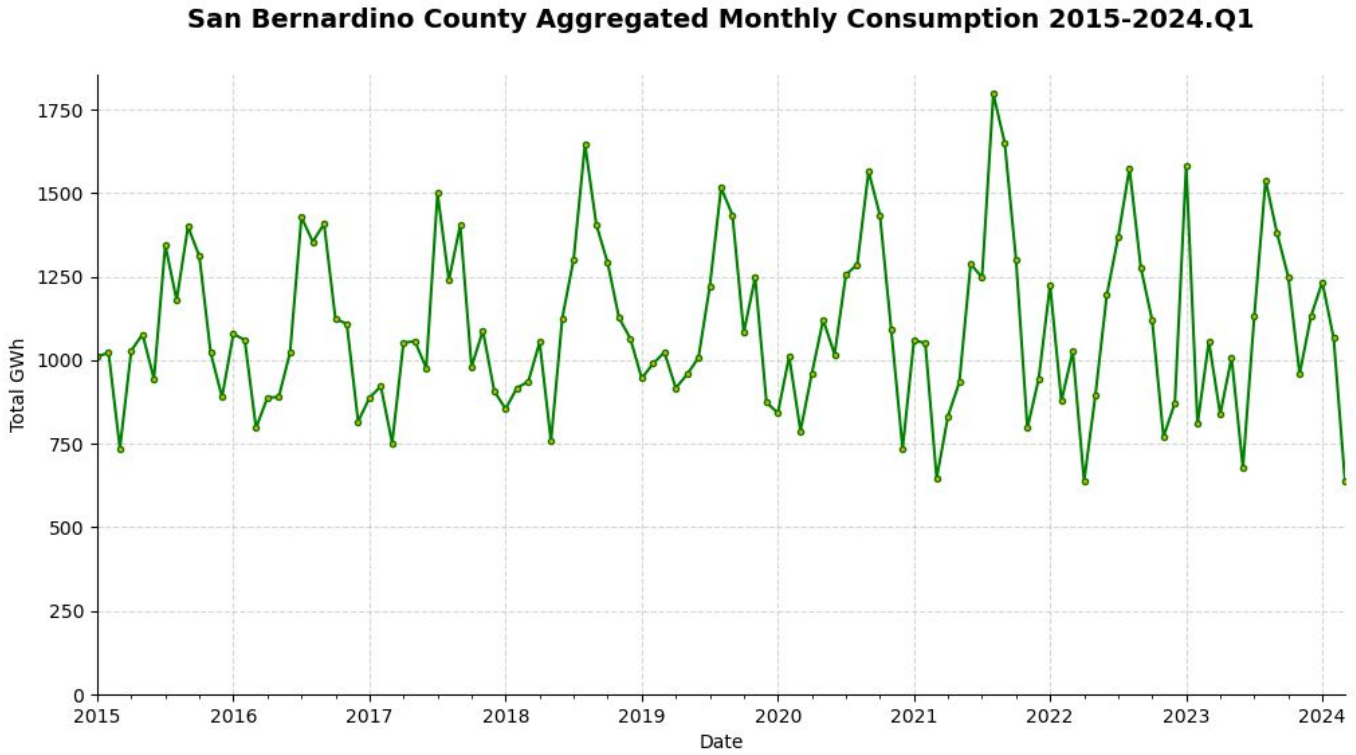
Maximum Energy Usage: 8.25 GWh
Minimum Energy Usage: 4.25 GWh



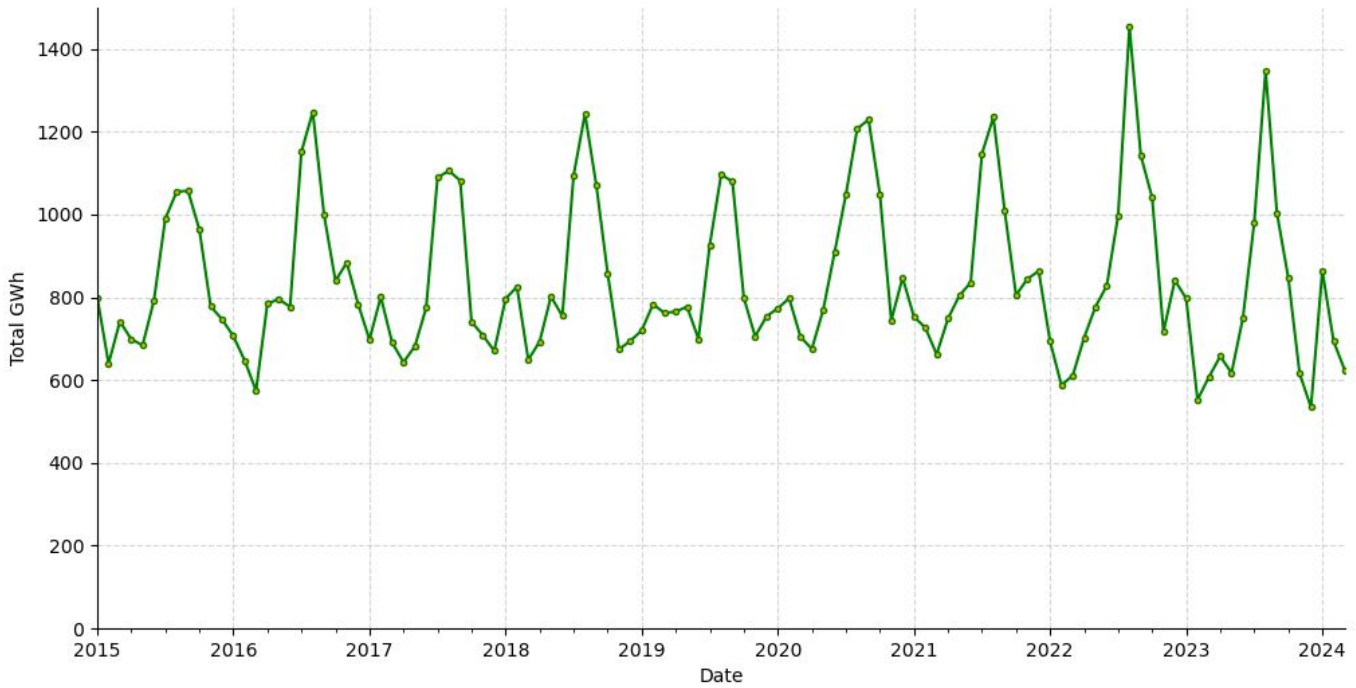
Maximum Energy Usage: 800.16 GWh
Minimum Energy Usage: 100.21 GWh



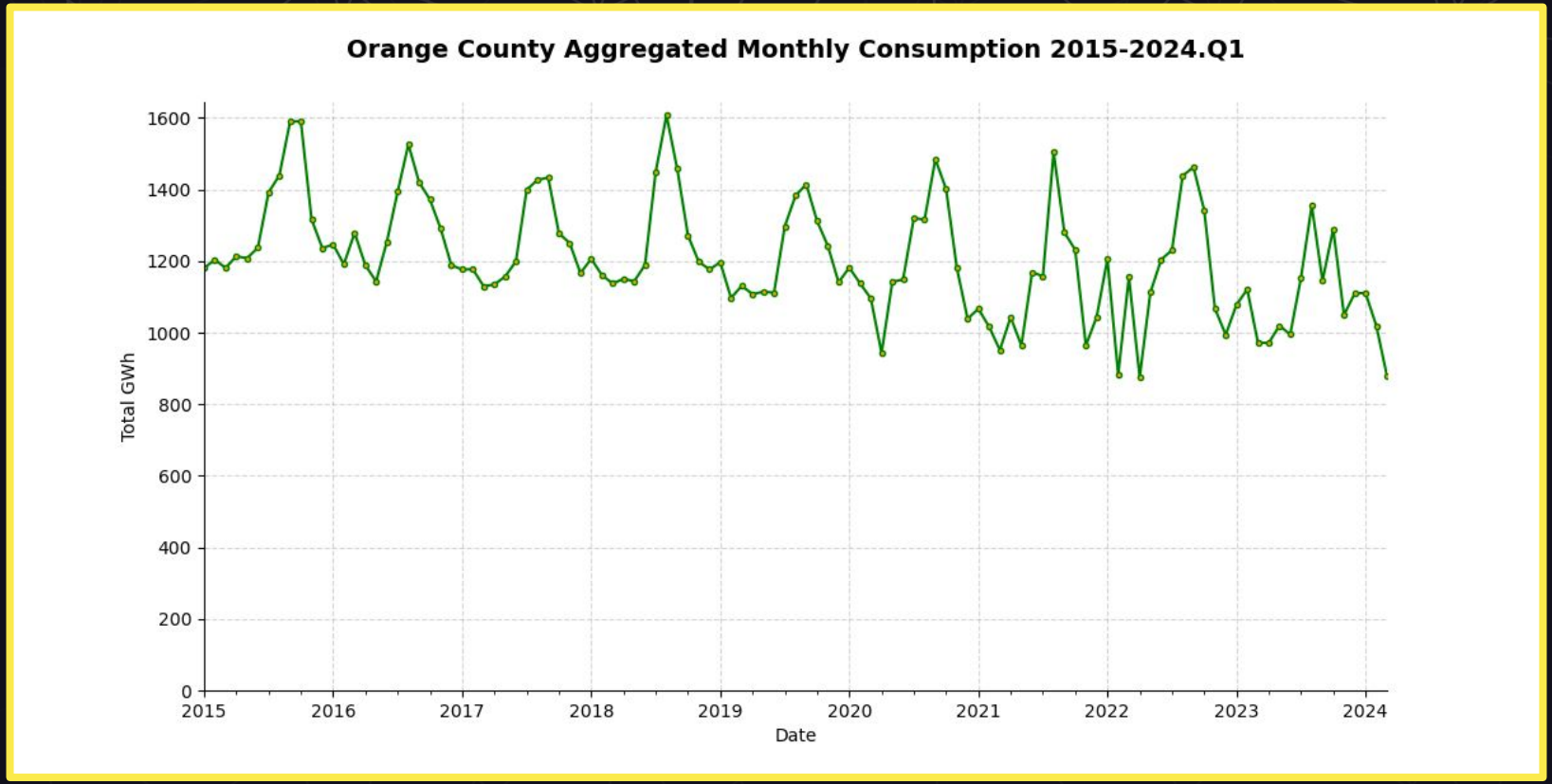
Maximum Energy Usage: 8.25 GWh
Minimum Energy Usage: 4.25 GWh



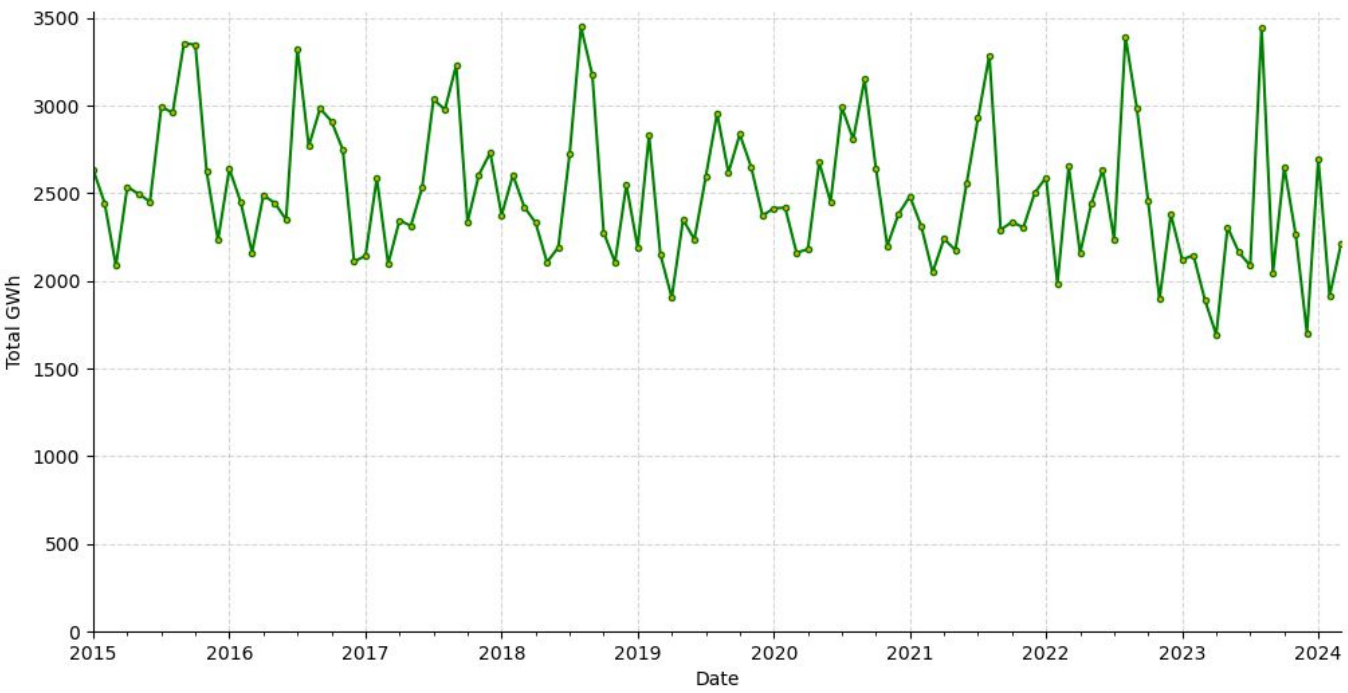
Maximum Energy Usage: 1750.40 GWh
Minimum Energy Usage: 500.5 GWh



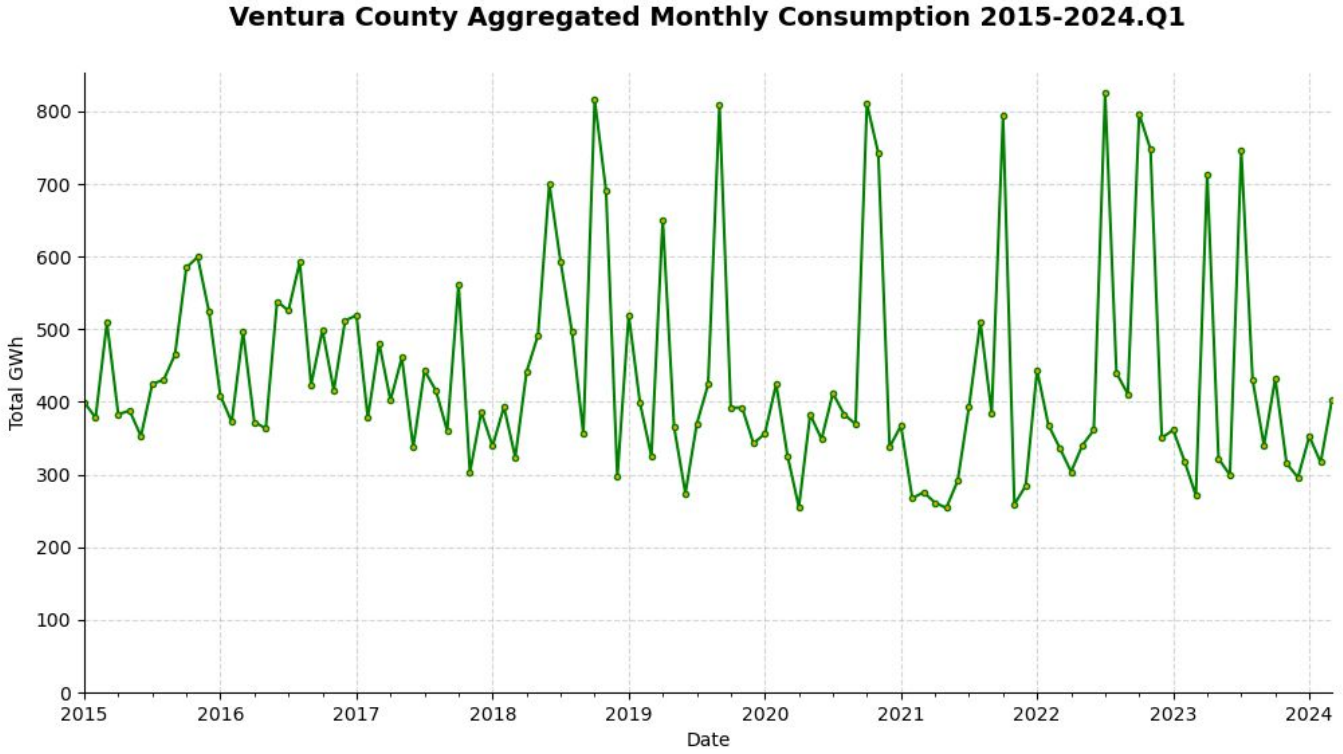
Maximum Energy Usage: 1400.4 GWh
Minimum Energy Usage: 400.75 GWh



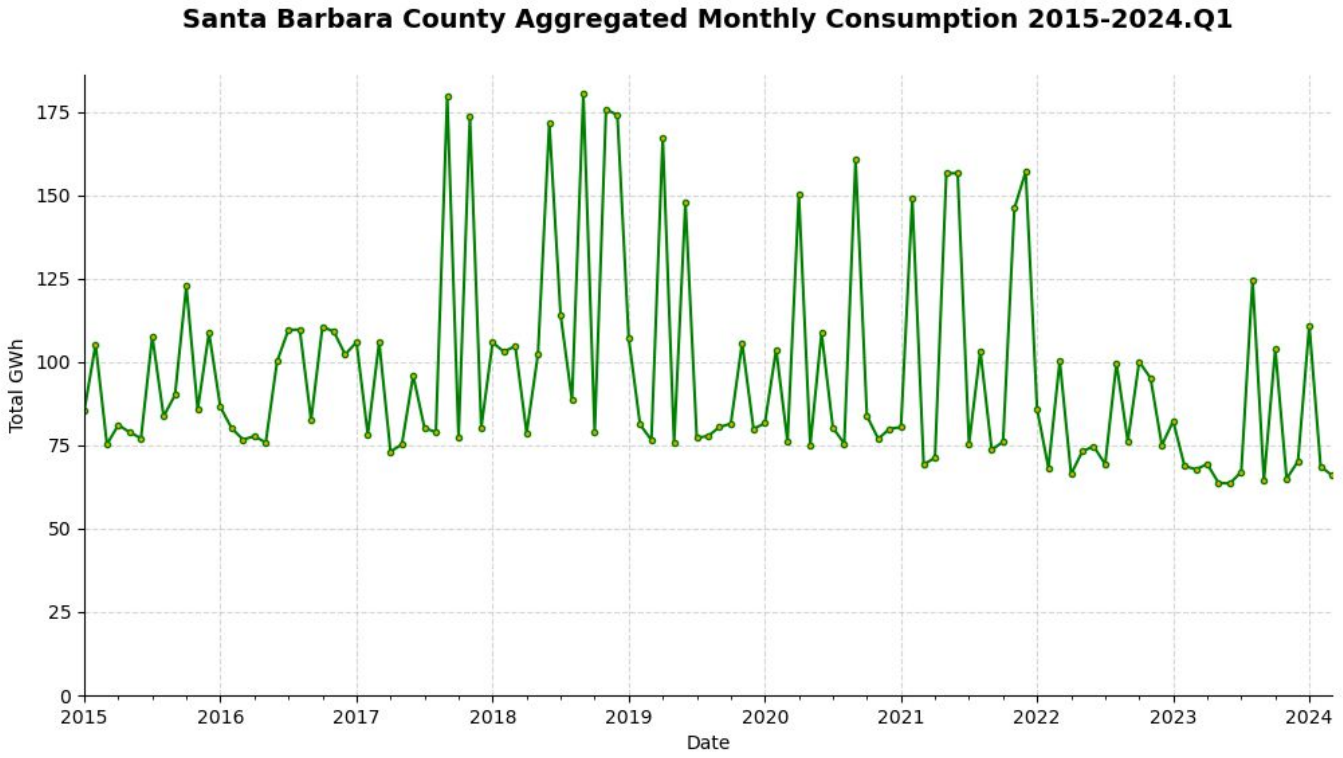
Maximum Energy Usage: 1600 GWh
Minimum Energy Usage: 800.25 GWh



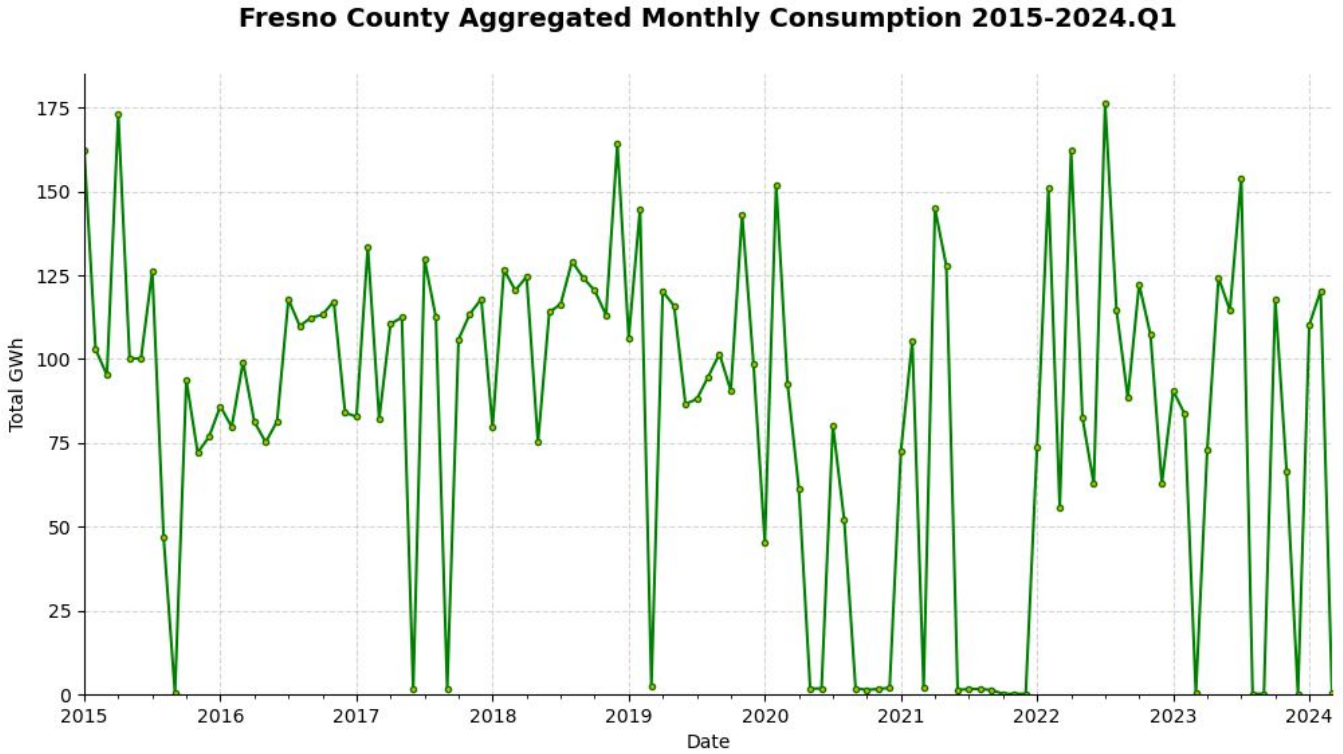
Maximum Energy Usage: 3425 GWh
Minimum Energy Usage: 1700 GWh



Maximum Energy Usage: 800.25 GWh
Minimum Energy Usage: 250 GWh

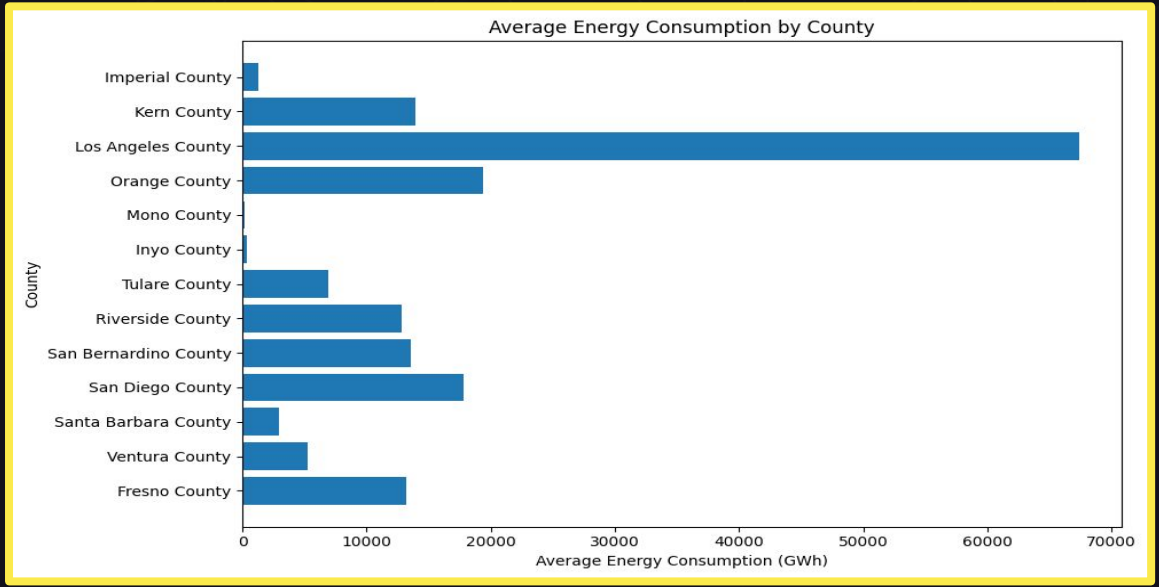


Maximum Energy Usage: 179 GWh
Minimum Energy Usage: 62 GWh



Maximum Energy Usage: 176 GWh
Minimum Energy Usage: 0 GWh

Comparative Analysis



- Los Angeles County has the highest energy consumption
- Mono and Inyo County has the lowest energy consumption

Why are some counties higher/lower than others?

Population Factors

Factors taken into consideration:

- Total Population vs. Energy Usage
- Population Growth Rate
- Migrational Patterns

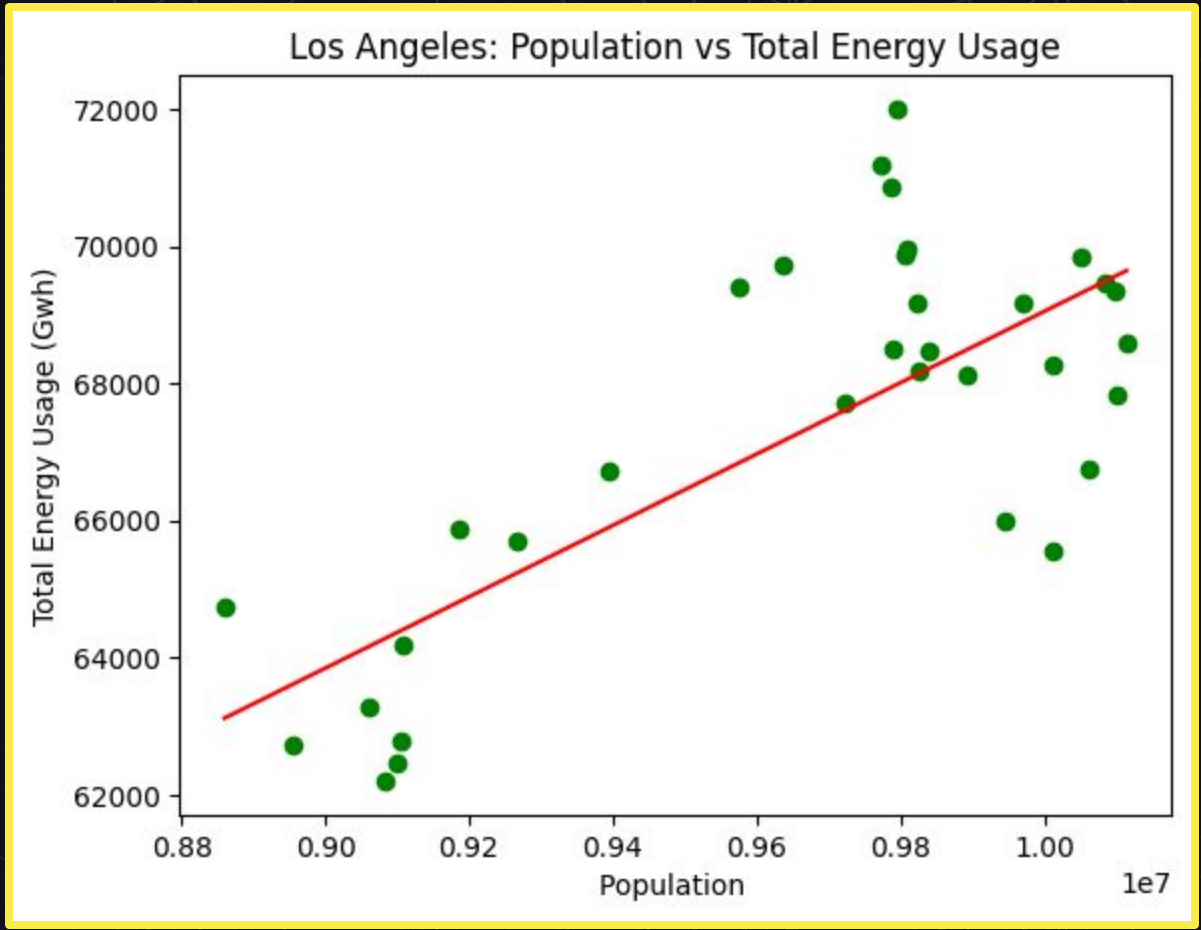
Population Study

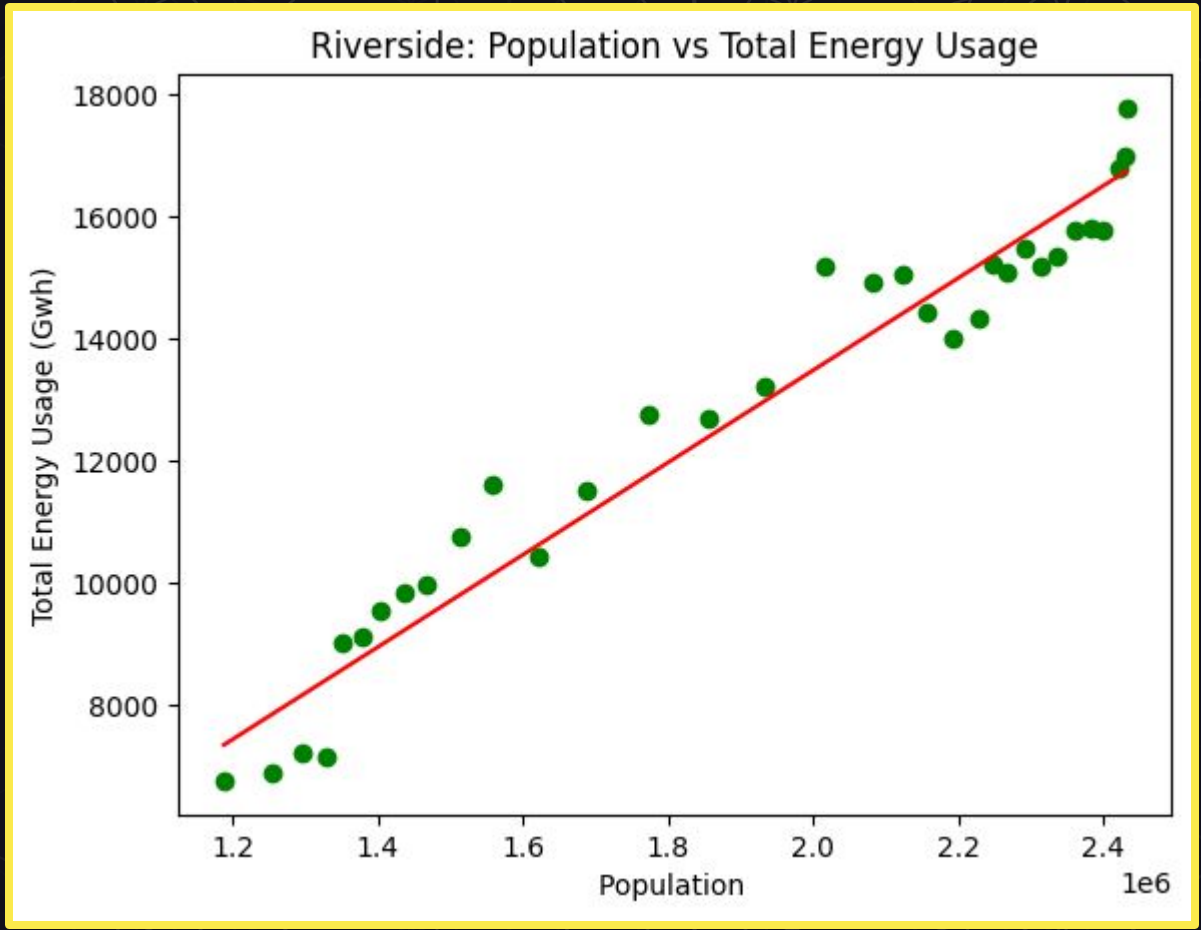
- Los Angeles County has the highest population
- Mono and Inyo County has the lowest population

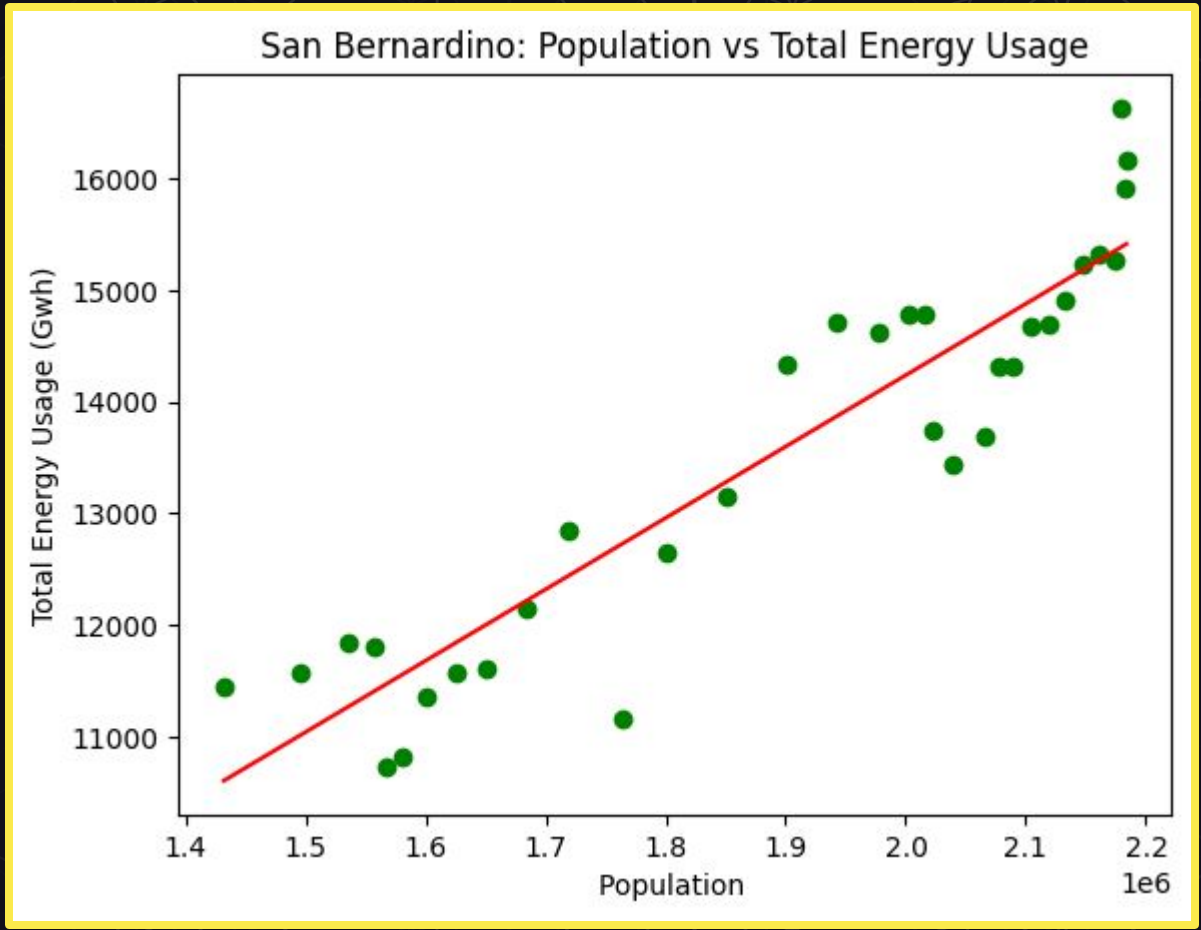
Linear Regression

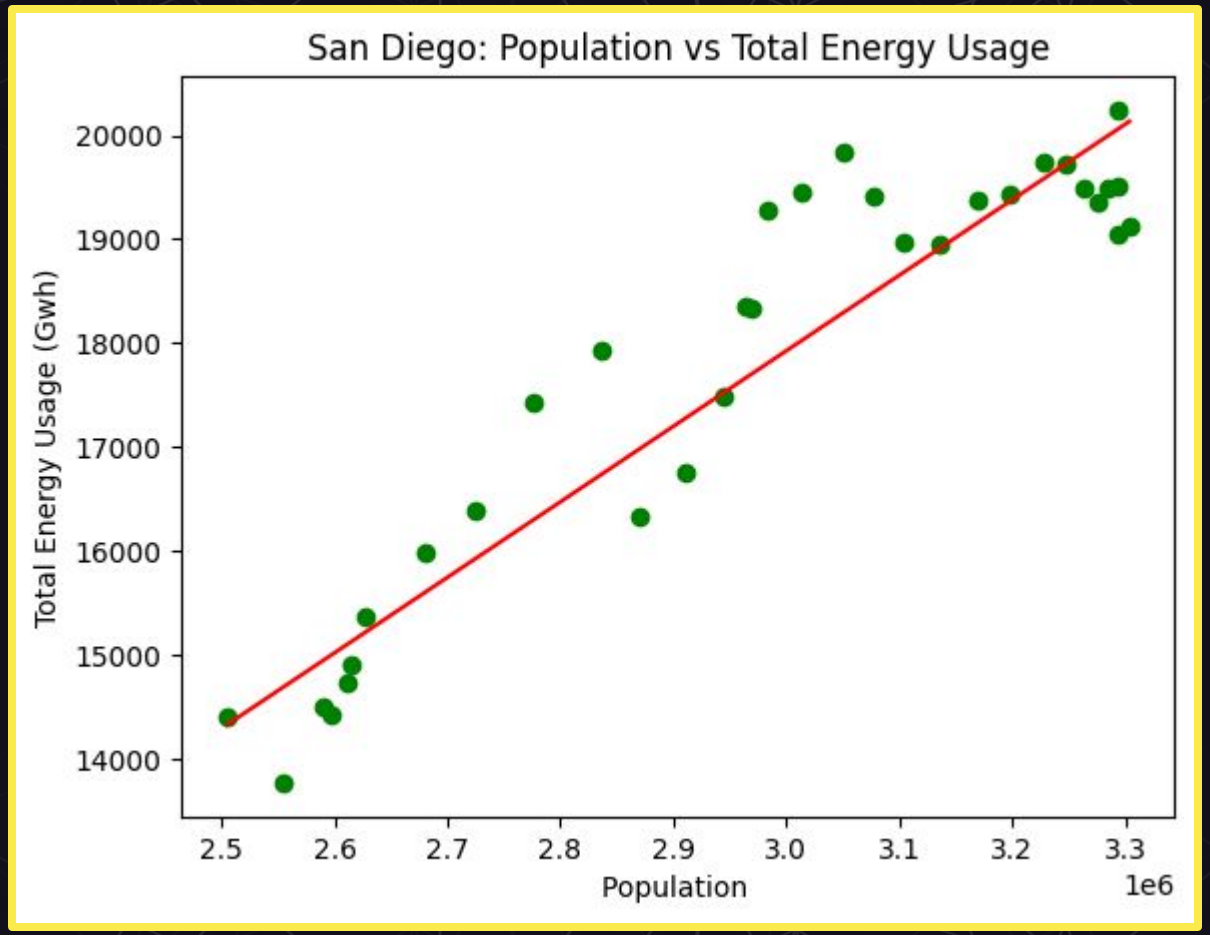
- statistical method used to model the relationship between a dependent variable and one or more independent variables by fitting a linear equation to the observed data points

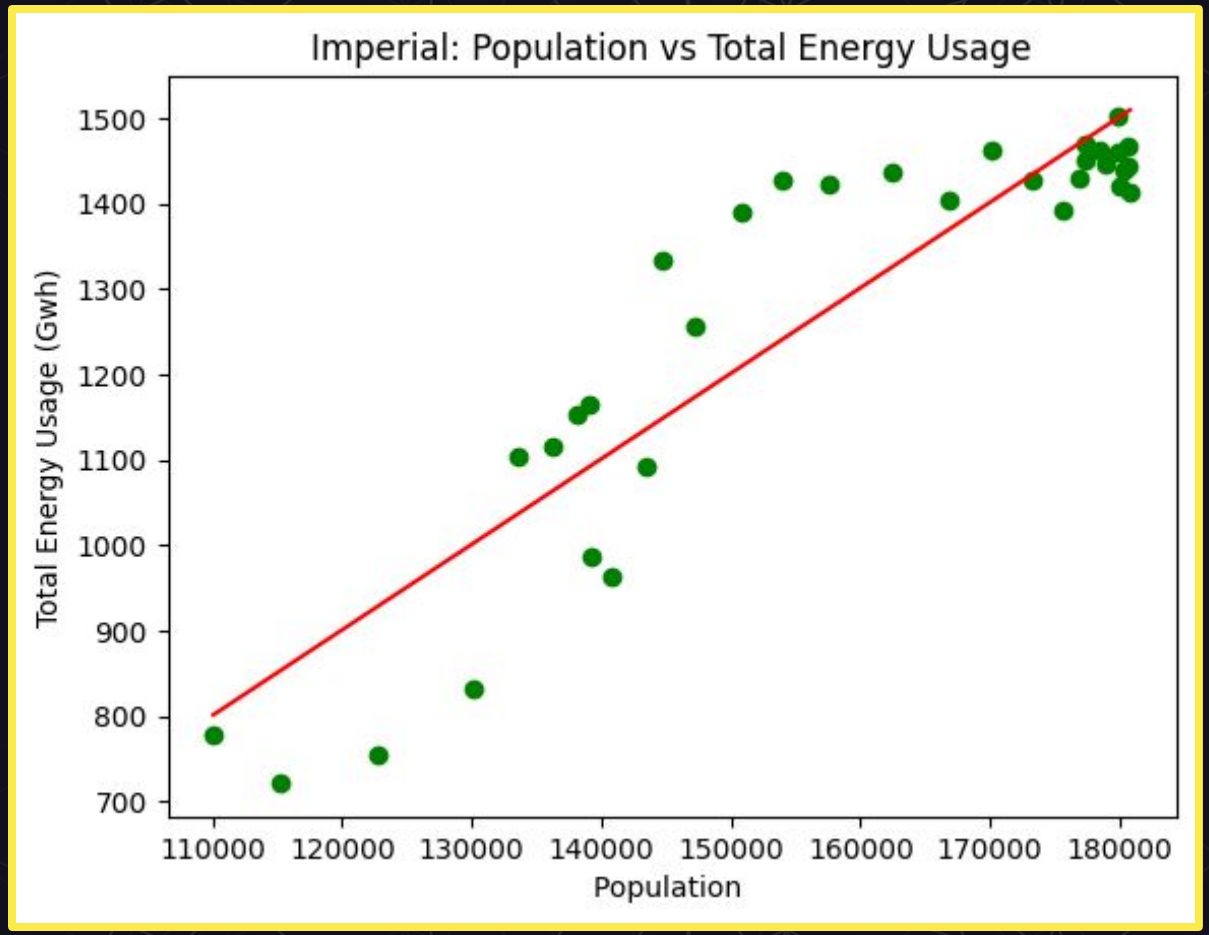
- commonly used for prediction and forecasting tasks

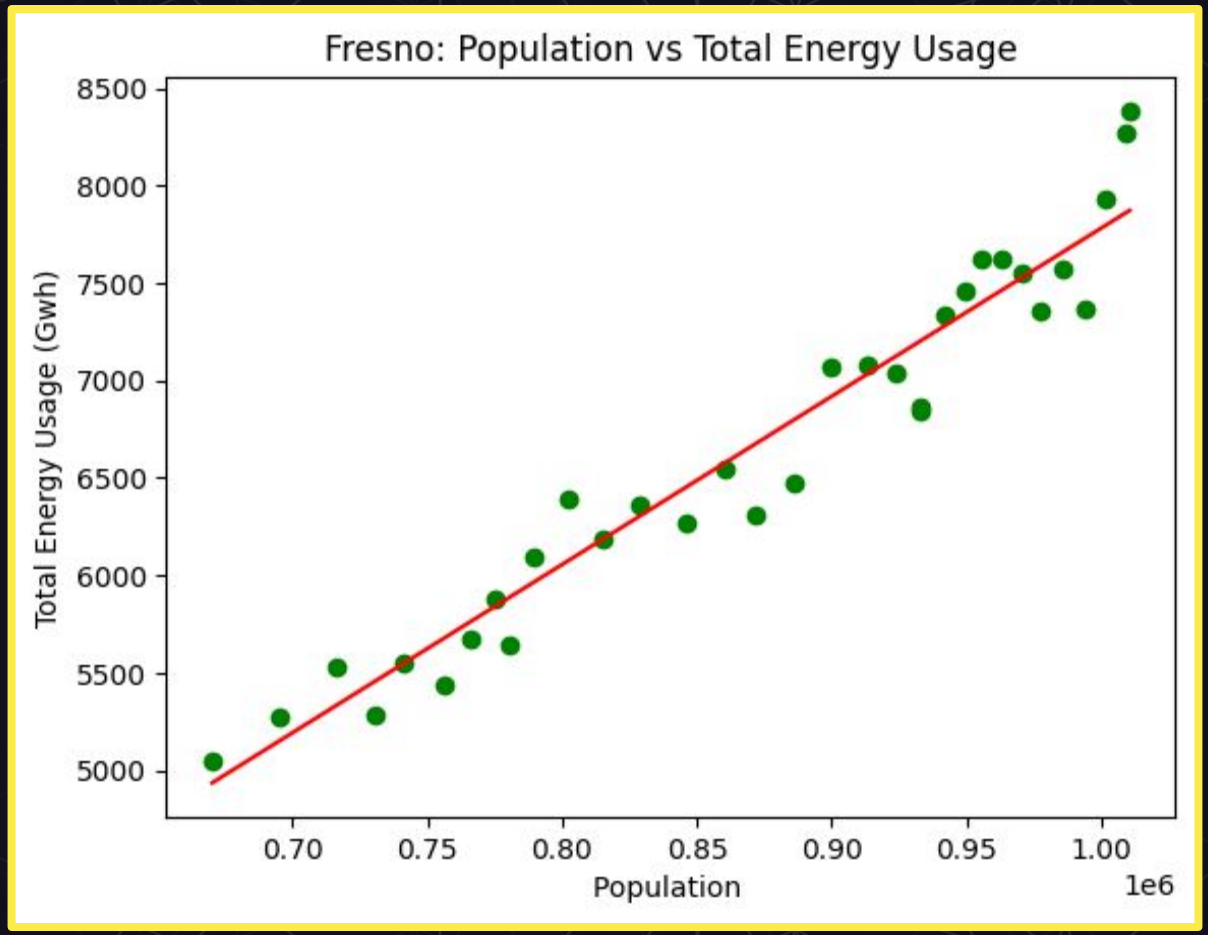

Los Angeles: Population vs Total Energy Usage
Total Energy Usage (Gwh)
72000
70000
68000
66000
64000
62000
0.88
0.90
0.92
0.94
0.96
0.98
1.00
Population
1e7

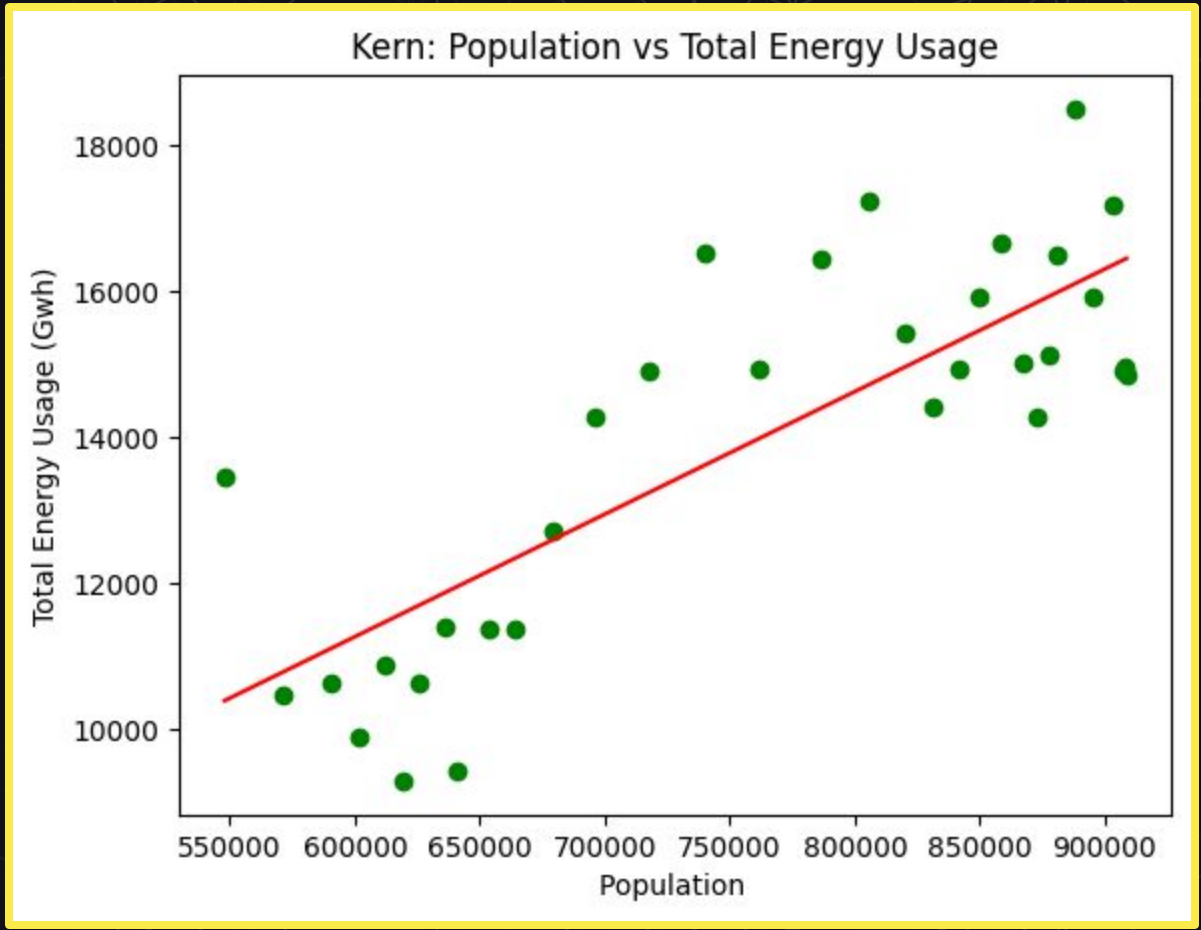

Riverside: Population vs Total Energy Usage
Total Energy Usage (Gwh)
18000
16000
14000
12000
10000
8000
1.2
1.4
1.6
1.8
2.0
2.2
2.4
Population
1e6

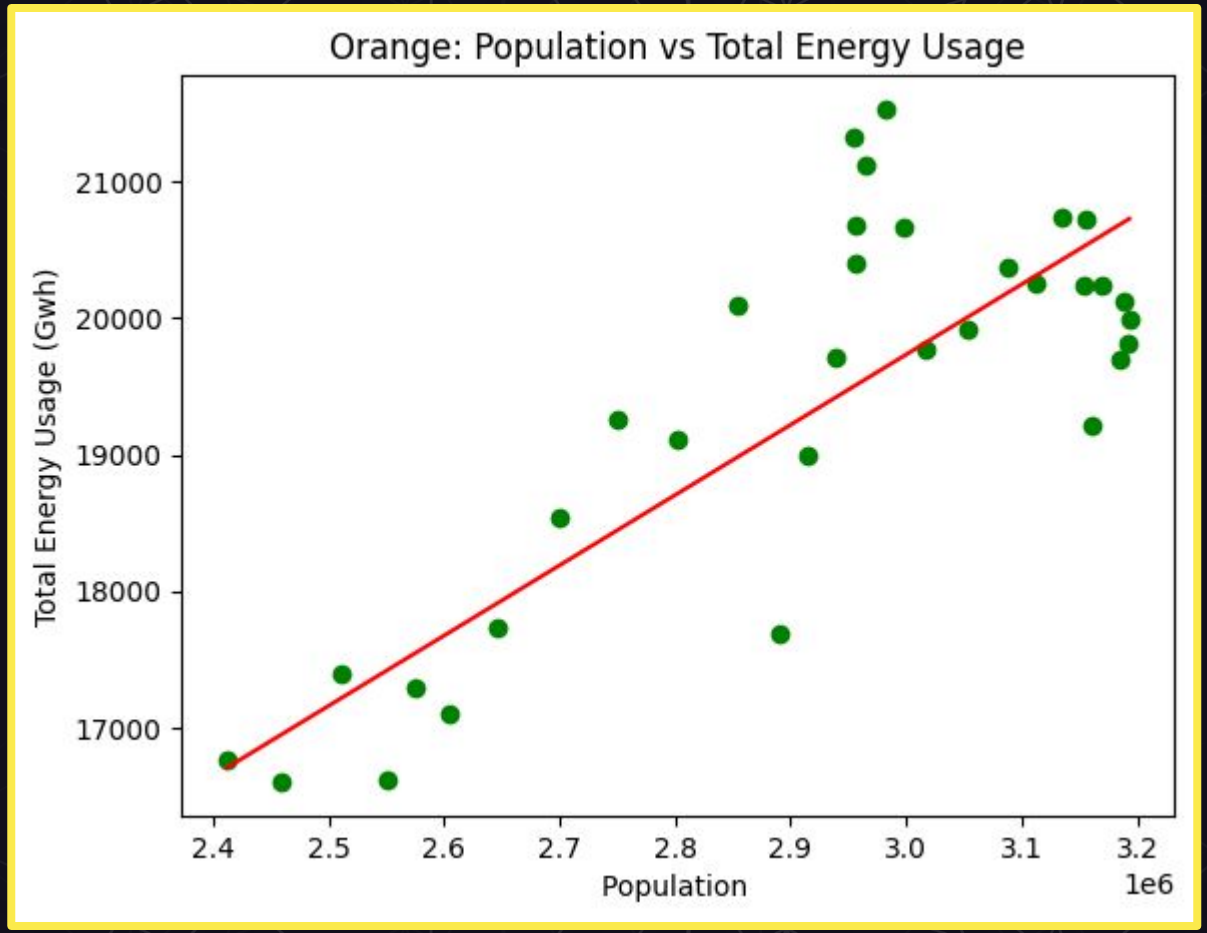

San Bernardino: Population vs Total Energy Usage
Total Energy Usage (Gwh)
16000
15000
14000
13000
12000
11000
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
Population
1e6

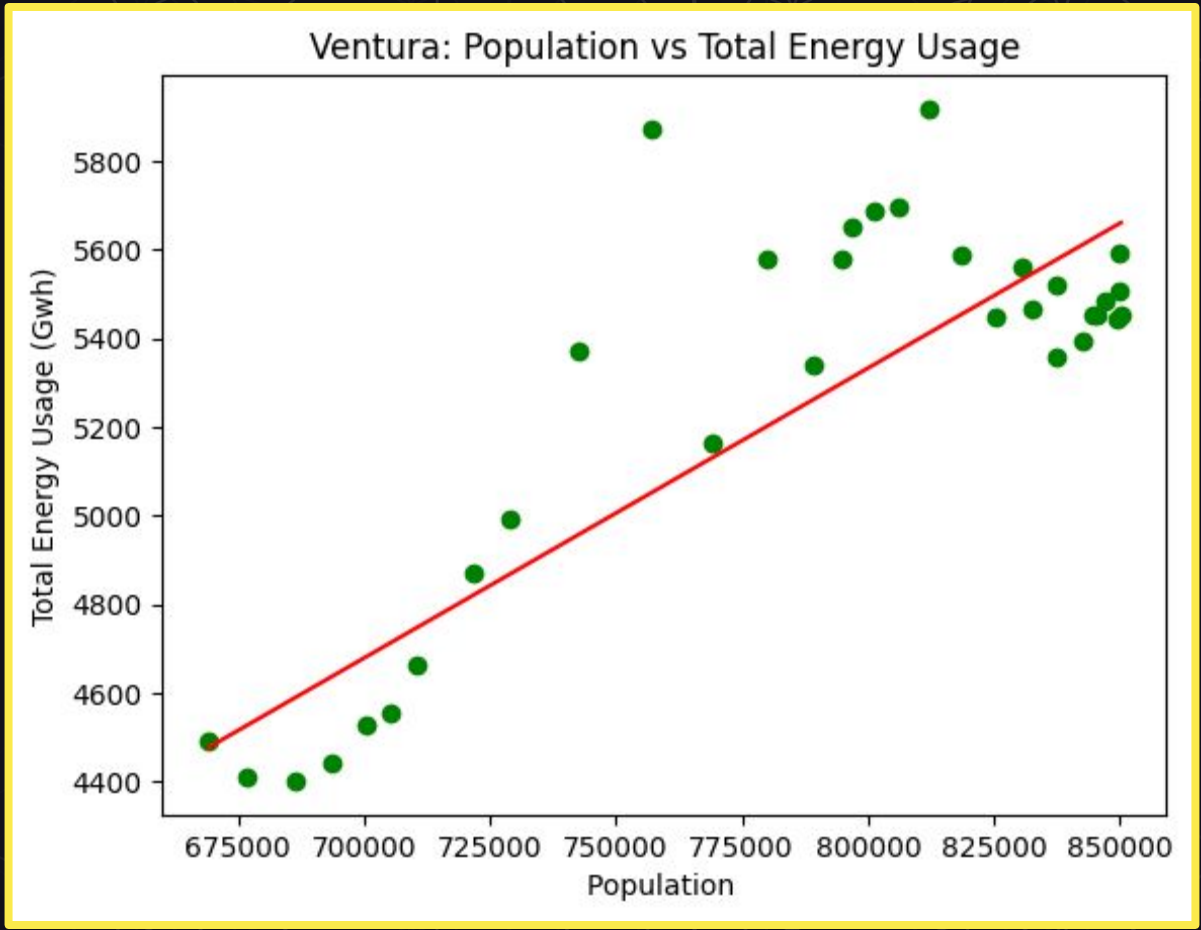

San Diego: Population vs Total Energy Usage
Total Energy Usage (Gwh)
20000
19000
18000
17000
16000
15000
14000
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
Population
1e6

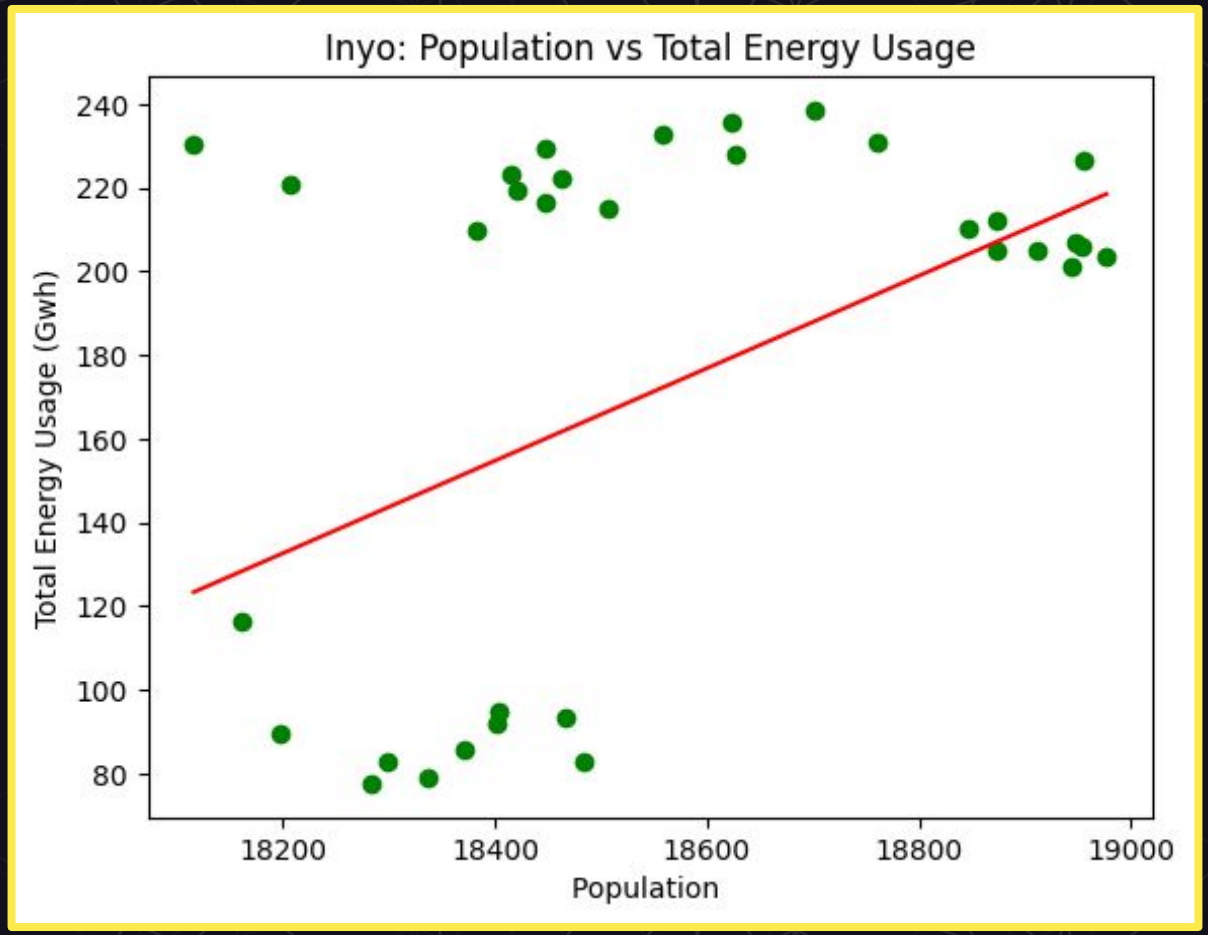

Imperial: Population vs Total Energy Usage
Total Energy Usage (Gwh)
1500
1400
1300
1200
1100
1000
900
800
700
110000
120000
130000
140000
150000
160000
170000
180000
Population

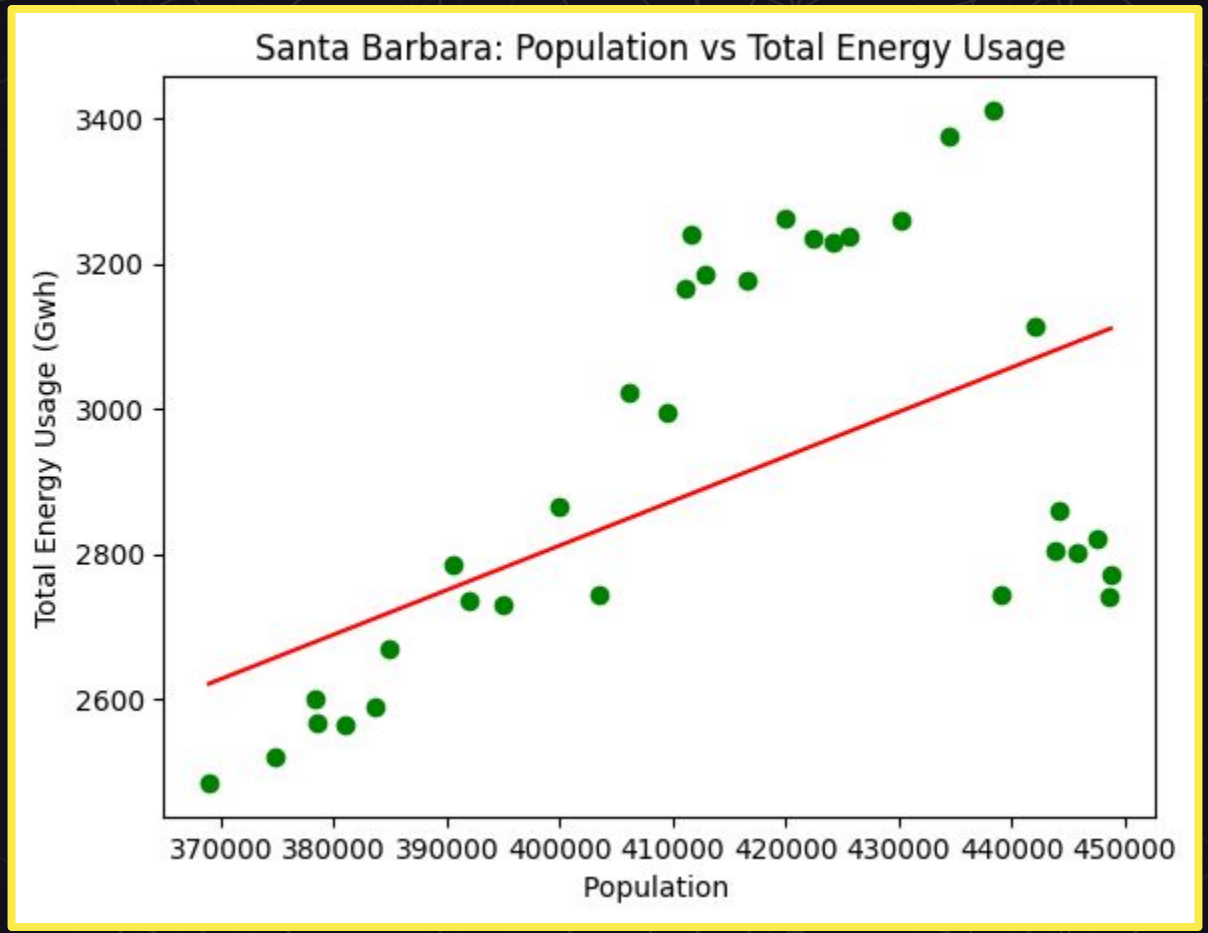

Fresno: Population vs Total Energy Usage
Total Energy Usage (Gwh)
8500
8000
7500
7000
6500
6000
5500
5000
0.70
0.75
0.80
0.85
0.90
0.95
1.00
Population
1e6

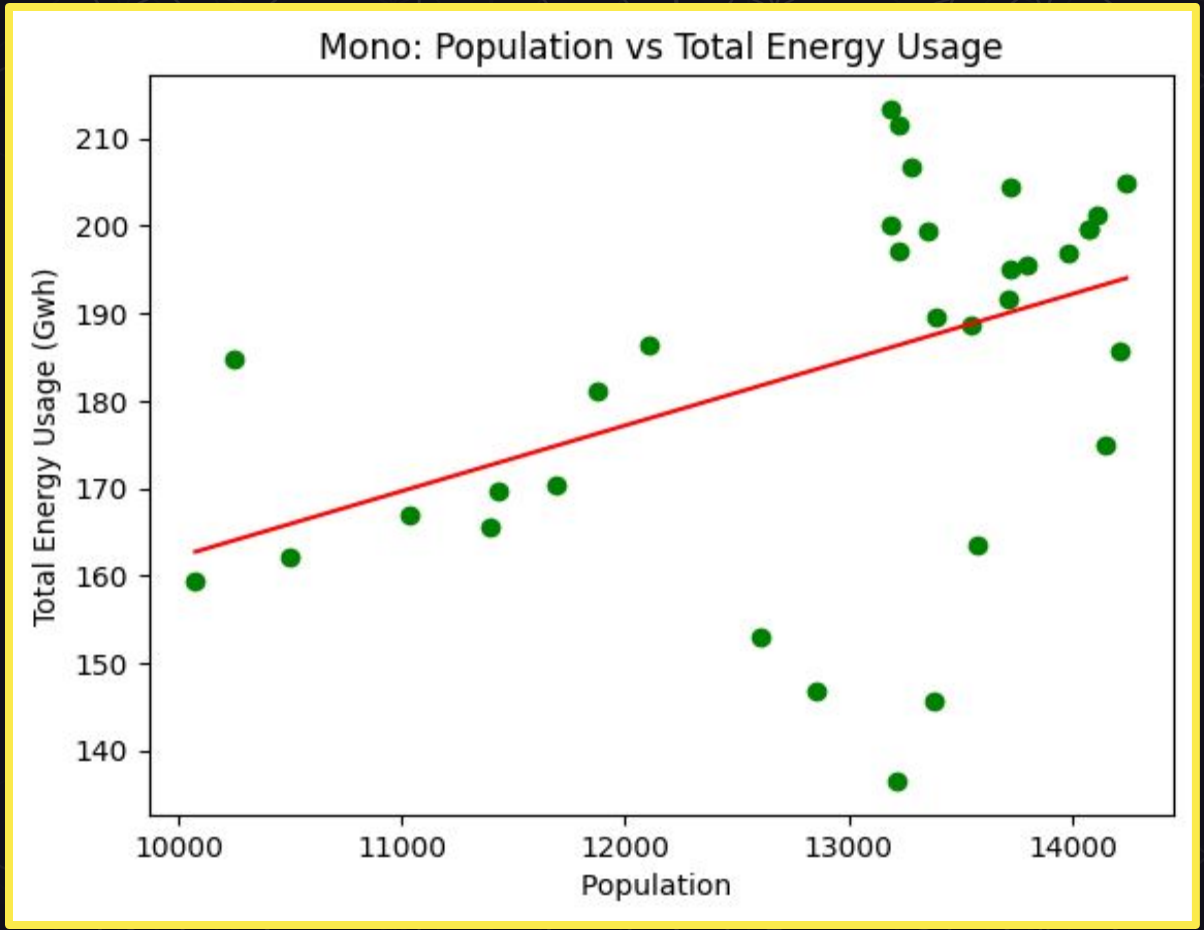

Kern: Population vs Total Energy Usage
Total Energy Usage (Gwh)
18000
16000
14000
12000
10000
550000
600000
650000
700000
750000
800000
850000
900000
Population

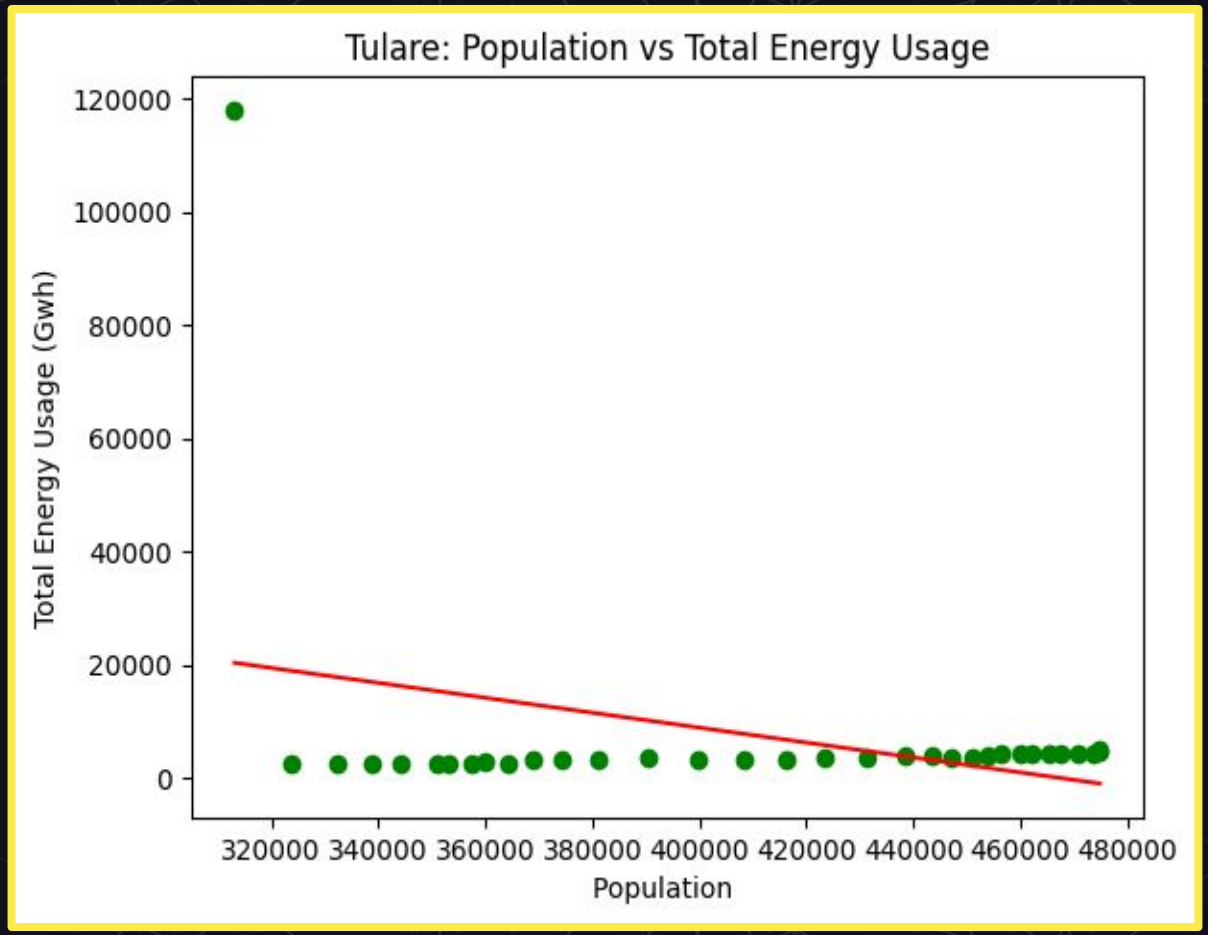

Orange: Population vs Total Energy Usage
Total Energy Usage (Gwh)
21000
20000
19000
18000
17000
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
Population
1e6


Ventura: Population vs Total Energy Usage
Total Energy Usage (Gwh)
5800
5600
5400
5200
5000
4800
4600
4400
675000
700000
725000
750000
775000
800000
825000
850000
Population

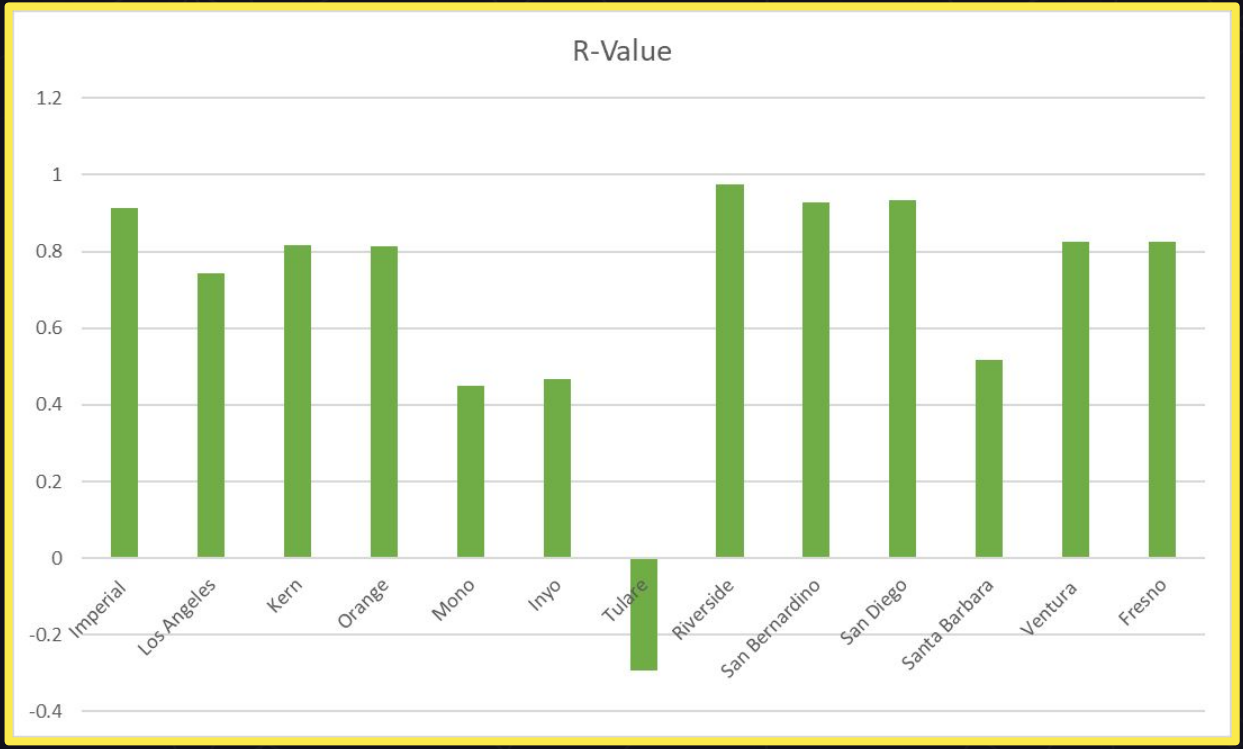

Inyo: Population vs Total Energy Usage
Total Energy Usage (Gwh)
240
220
200
180
160
140
120
100
80
18200
18400
18600
18800
19000
Population


Santa Barbara: Population vs Total Energy Usage
Total Energy Usage (Gwh)
3400
3200
3000
2800
2600
370000
380000
390000
400000
410000
420000
430000
440000
450000
Population


Mono: Population vs Total Energy Usage
Total Energy Usage (Gwh)
210
200
190
180
170
160
150
140
10000
11000
12000
13000
14000
Population

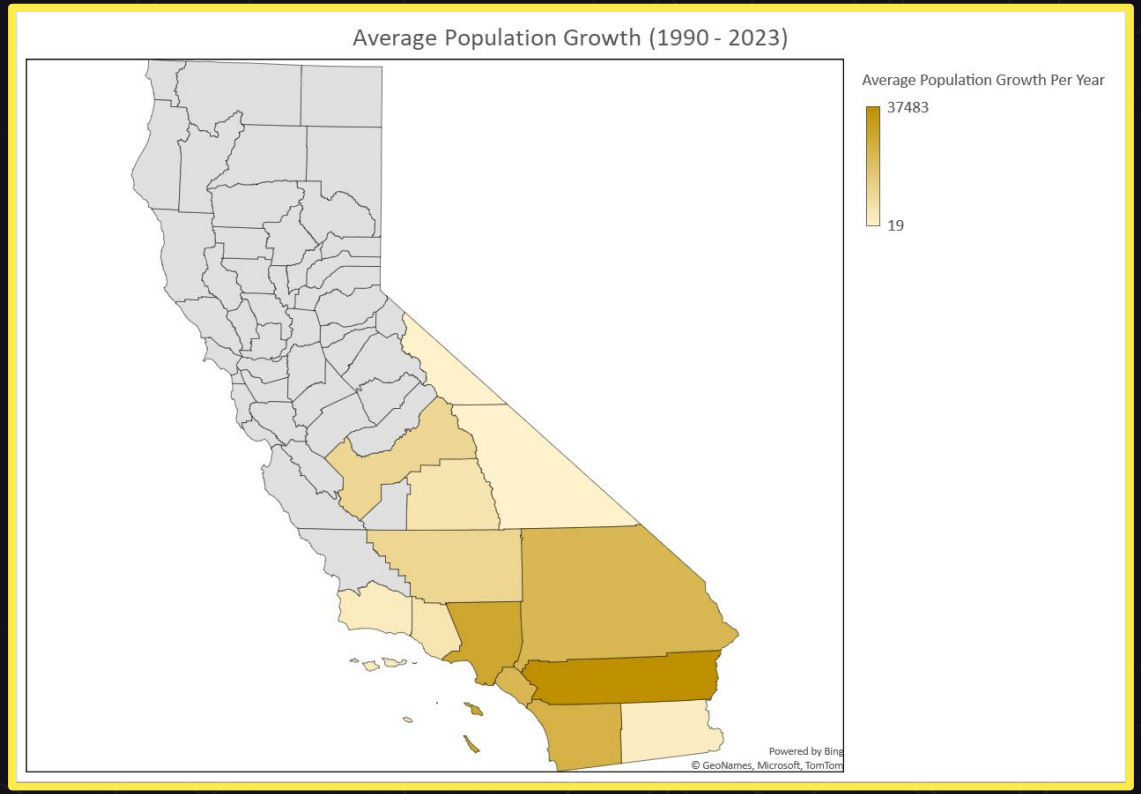

Tulare: Population vs Total Energy Usage
Total Energy Usage (Gwh)
120000
100000
80000
60000
40000
20000
0
320000
340000
360000
380000
400000
420000
440000
460000
480000
Population

R-Value for each Linear Regression Model per county:

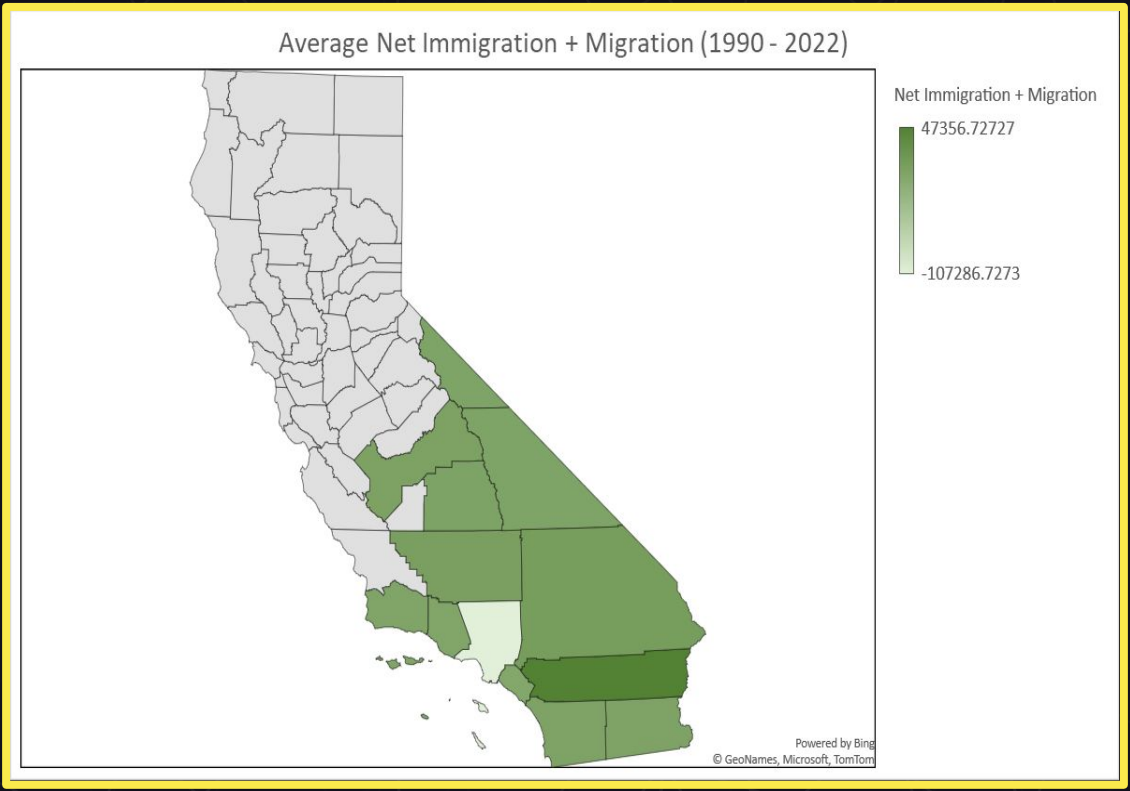


- Mono, Inyo, and Santa Barbara have low correlation rates
- Tulare has a negative correlation
- Rest have high correlation values

Population Growth



Migrational Patterns



Financial Trends

Research Analysis of Financial Trends

Energy Prices

Fluctuations in energy prices can affect economic activity and energy consumption patterns. High energy prices might incentivize energy efficiency and the shift towards alternative energy sources, while low prices could encourage higher consumption.

Key factors that affect energy prices include:

- Fuel Prices
- Power Plant Costs
- Transmission and distribution maintenance costs
- Weather conditions
- Price regulations

Technological Advances

Electric Vehicles

Modern EVs benefit significantly from advancements in lithium-ion battery technology, which have improved energy density, efficiency, and reduced charging times.

Nuclear Pumps

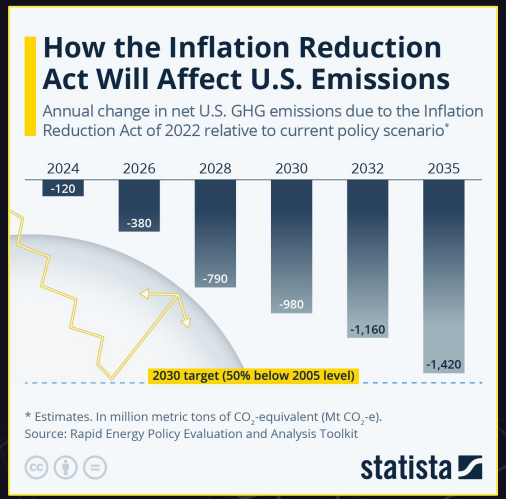
Advances in the design and materials used in nuclear pumps have increased their efficiency, reducing the energy required for operation and increasing the reliability of cooling systems in reactors.

Solar Panels

Modern solar panels have significantly higher efficiency rates due to advancements in photovoltaic (PV) cell technology. Developments in materials used have led to cheaper and more efficient solar cells that make solar panels more cost-effective and accessible.

Financing

In 2022, the United States introduced significant new funding through the Inflation Reduction Act (IRA), designed to greatly enhance energy efficiency measures that reduce energy costs.



This funding includes the $4.5 billion High-Efficiency Electric Home Rebate program, which offers up to $14,000 per household for improvements in heating, cooling, insulation, air sealing, and electrical systems, including lighting and appliances.

Marketing Effects

Market Adoption

The base factors for market adoption are:

- Willingness to adopt
- Awareness of efficient technologies

Derived from a regression analysis of technology adoptions from several studies on new technology market penetration.

Consumer Spending

Shown to affect sales of more energy efficient technologies.

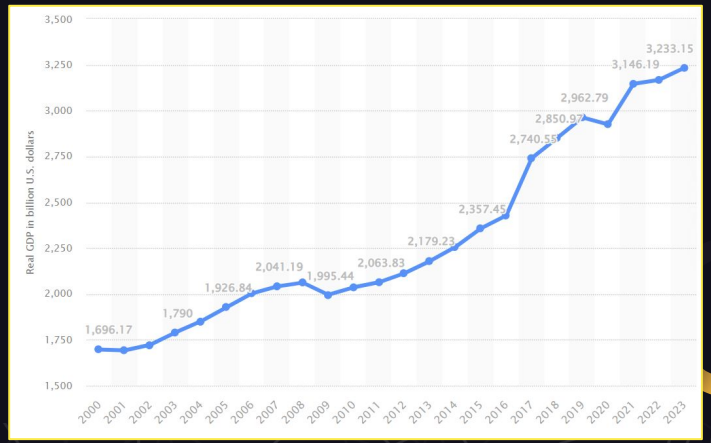
GDP

Globally, energy use and GDP are positively correlated, although energy intensity has declined over time and is usually lower in richer countries.

U.S. energy consumption per dollar of GDP declined nearly every year since 1949

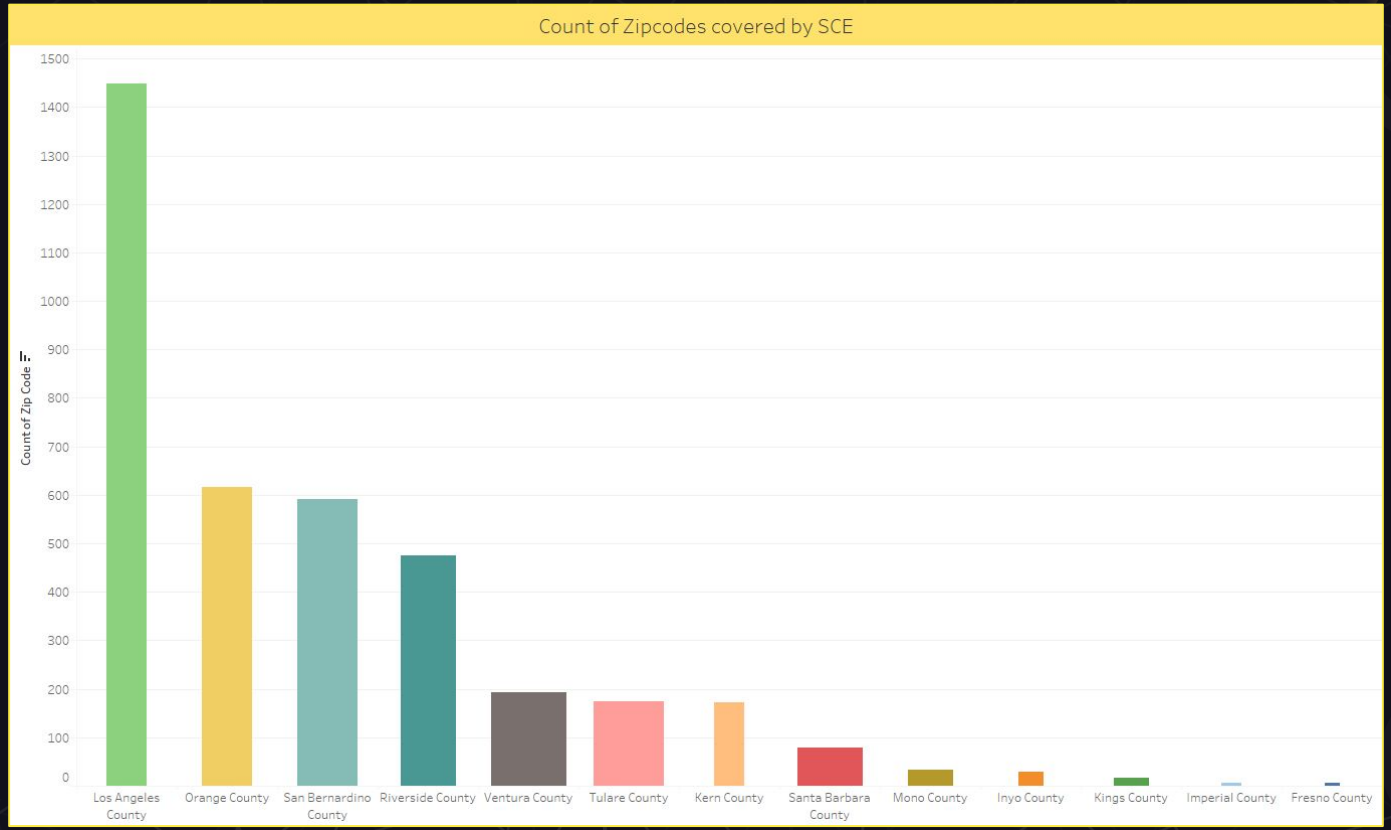
Along with per capita energy consumption, another measure of the intensity of energy consumption is how efficiently the economy uses energy to produce every dollar of gross domestic product (GDP). The amount of U.S. energy consumption per real 2012 dollar of GDP—the adjusted value to account for changes in the value of the U.S. dollar—declined in most years from 1949 through 2021. In 2022, energy use per dollar of GDP was 0.6% higher than in 2021. Although growth of U.S. energy consumption is closely tied to growth in GDP and other economic factors, it is partially offset by improvements in energy efficiency and other changes in the economy that result in lower energy use per unit of economic output. Many of the factors that contribute to lower per capita energy consumption also contribute to lower energy consumption per dollar of GDP.

Last updated: July 5, 2023, with data from the Monthly Energy Review, April 2023; data for 2022 are preliminary.

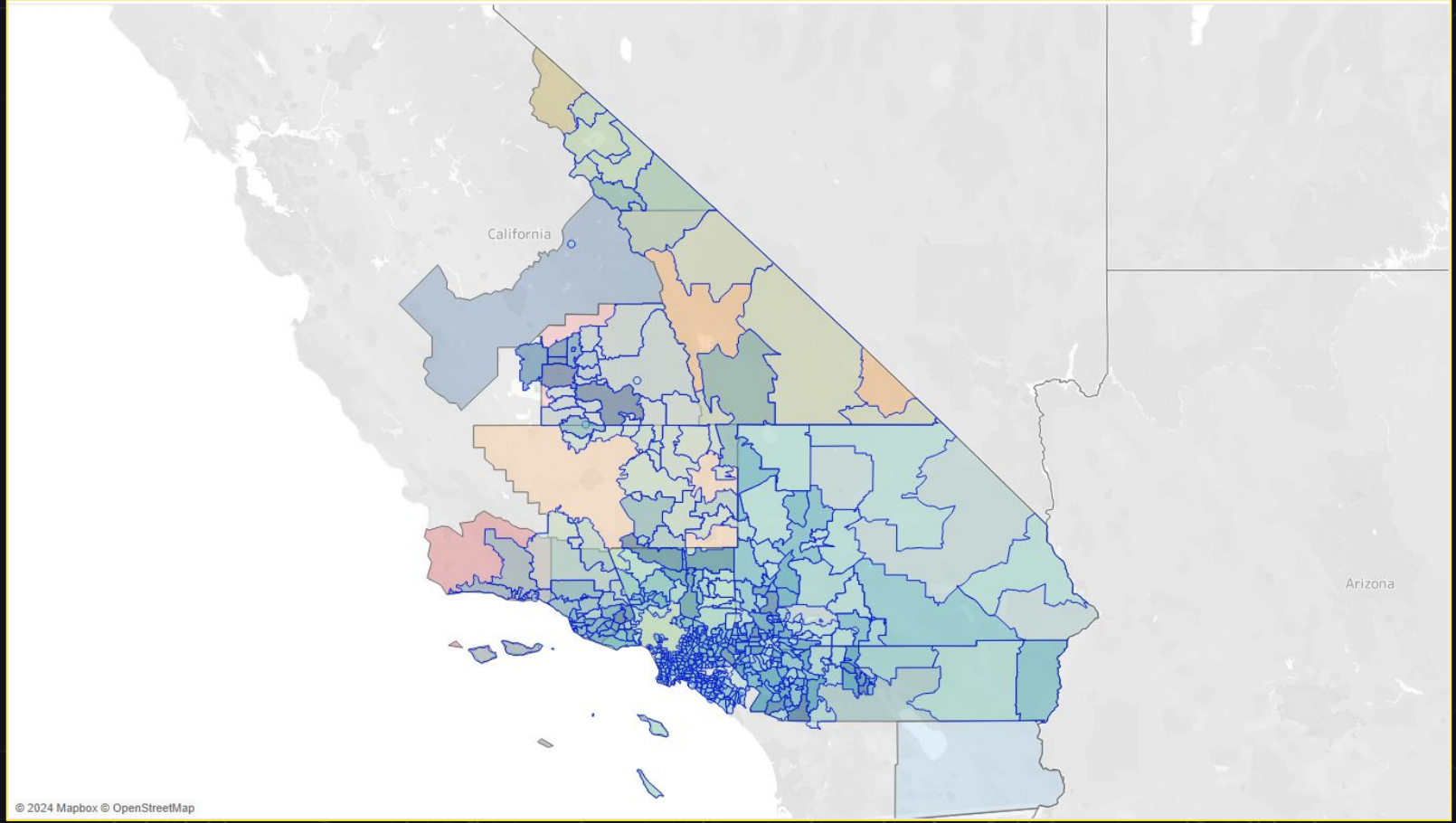


Energy Consumption to Income by County

How many zipcodes does SCE cover?

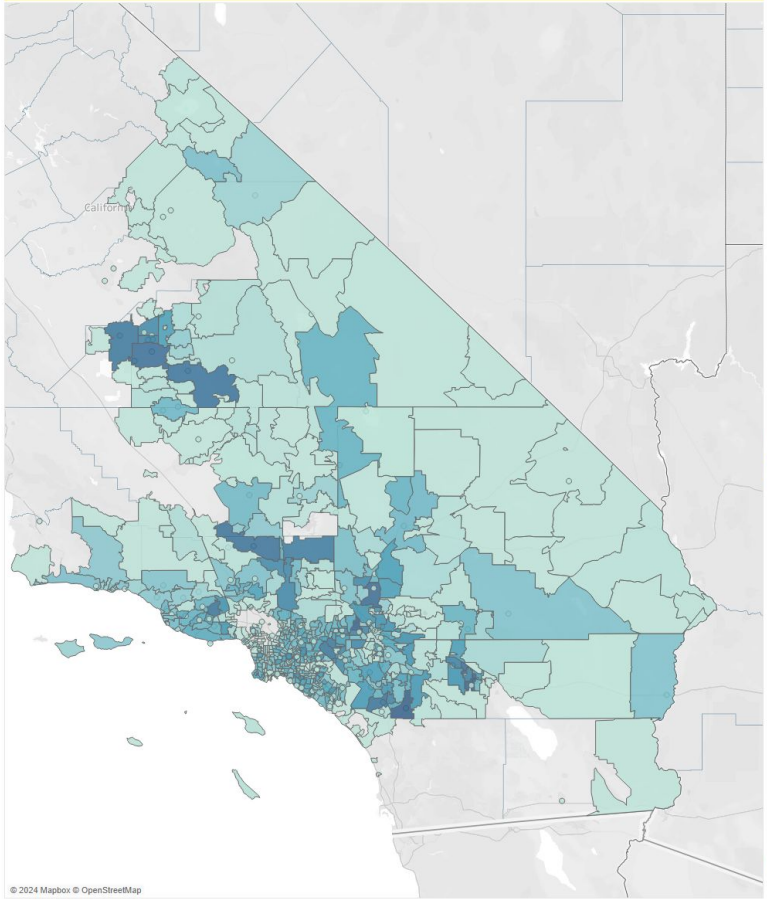


SCE Map Coverage (Residential Zoning Areas)



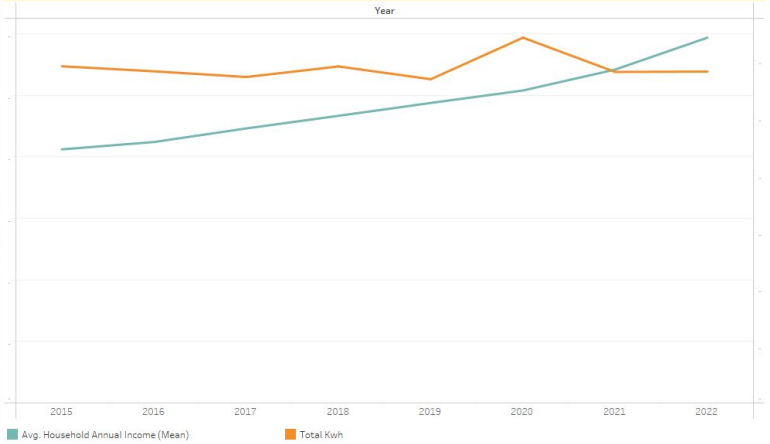
Southern California Edison Household Income to Electricity Usage

SCE KWh Total Usage By Year (All)

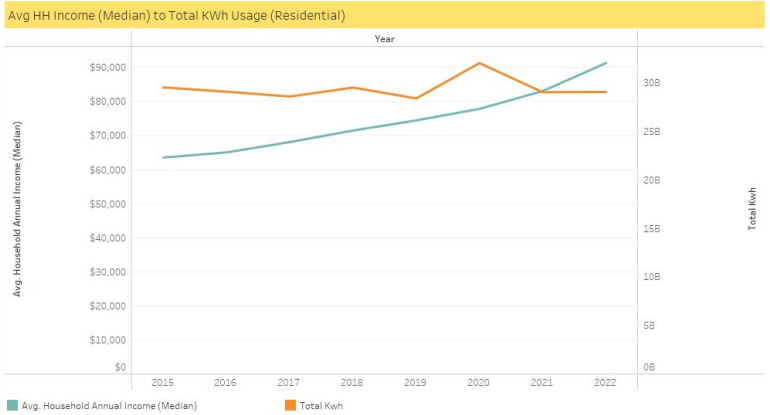


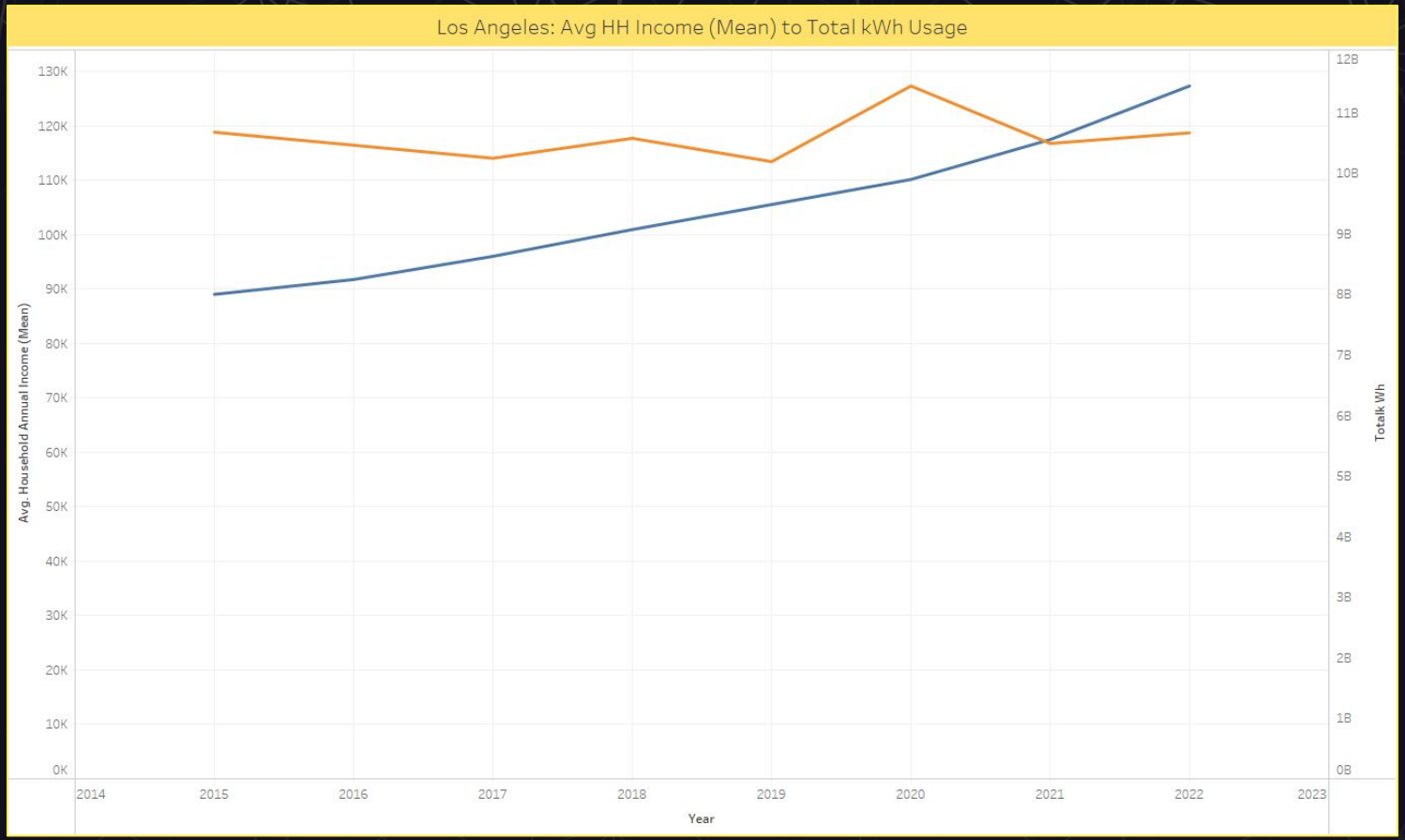
Year
All

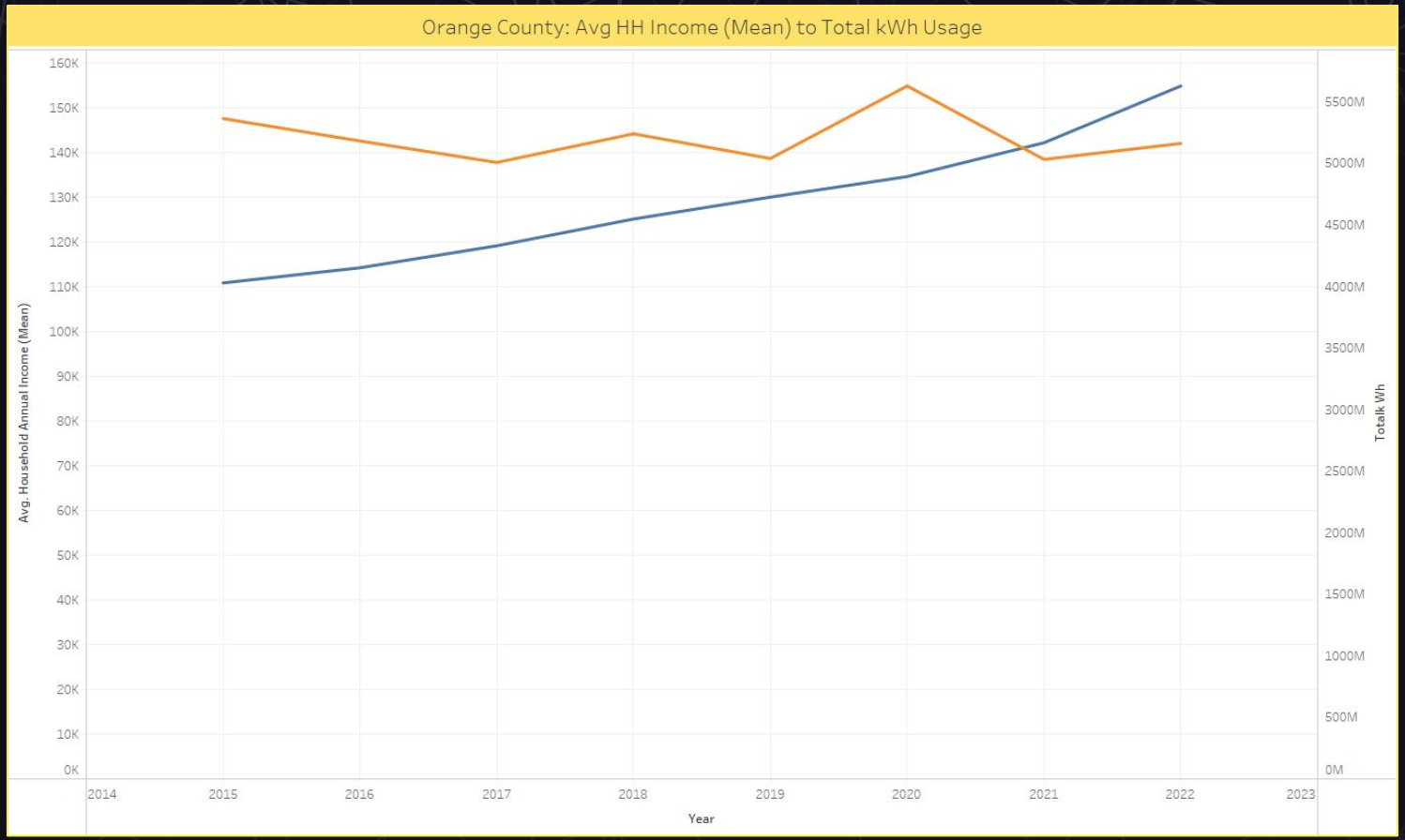
Avg HH Income (Mean) to Total KWh Usage (Residential)

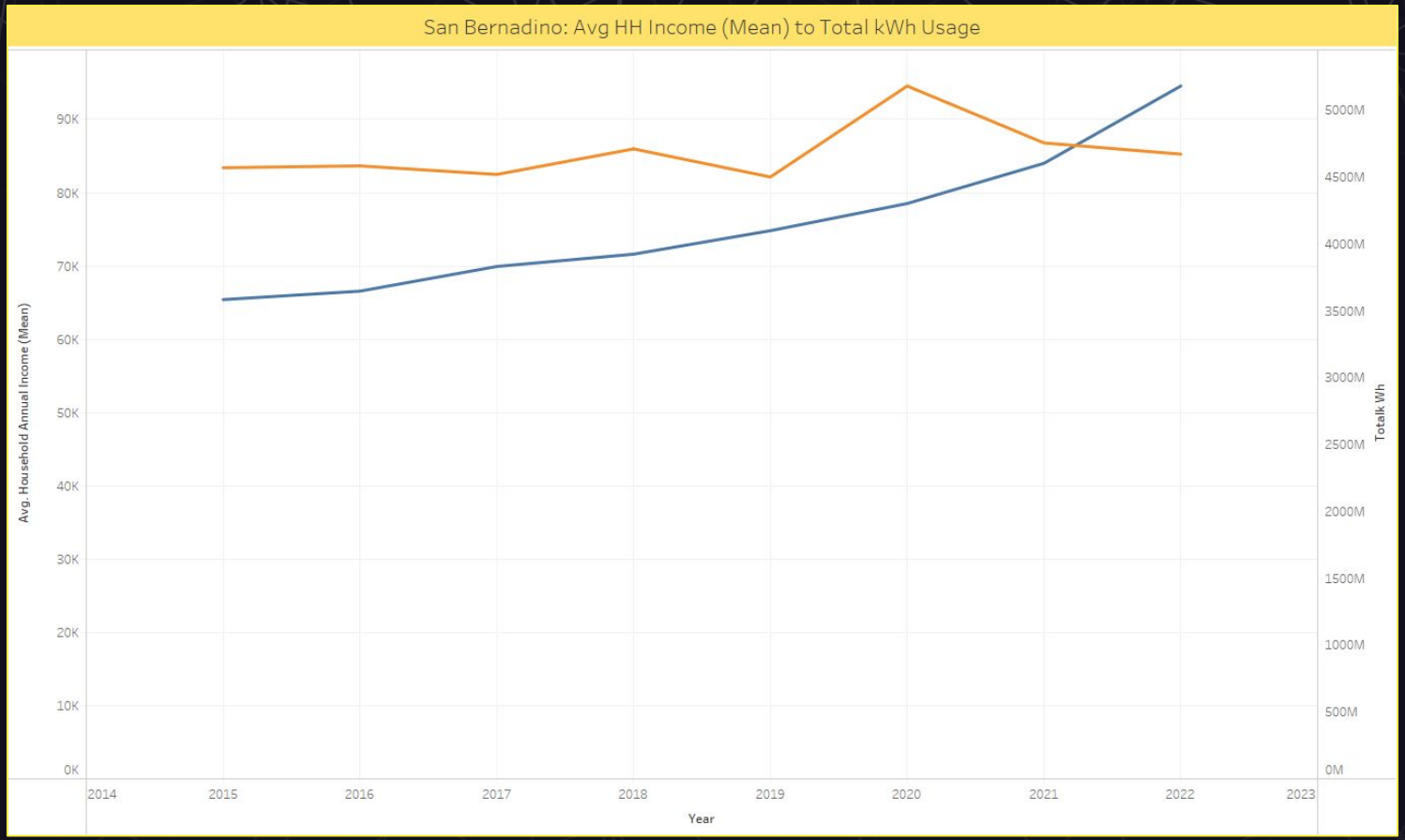


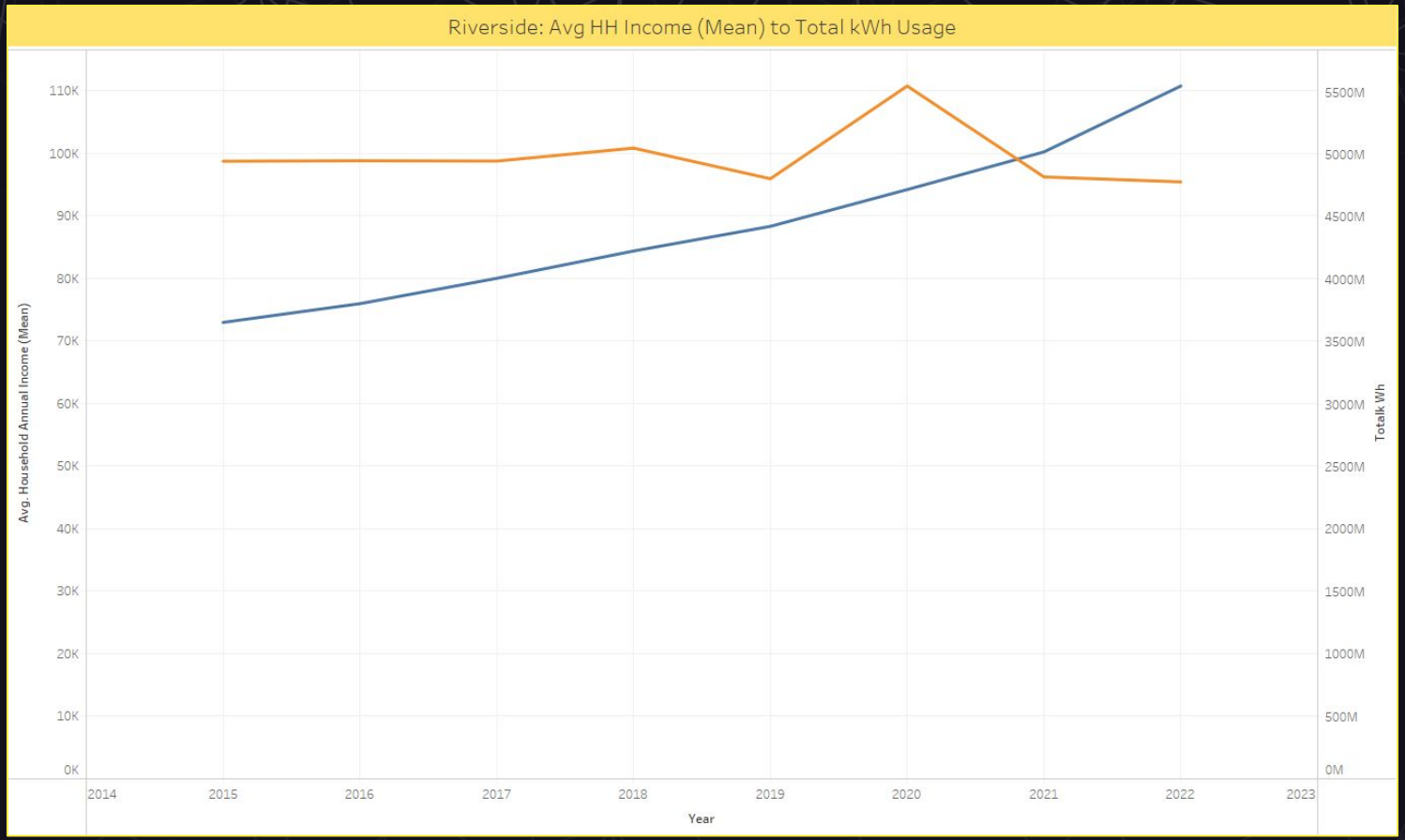
Avg HH Income (Median) to Total KWh Usage (Residential)

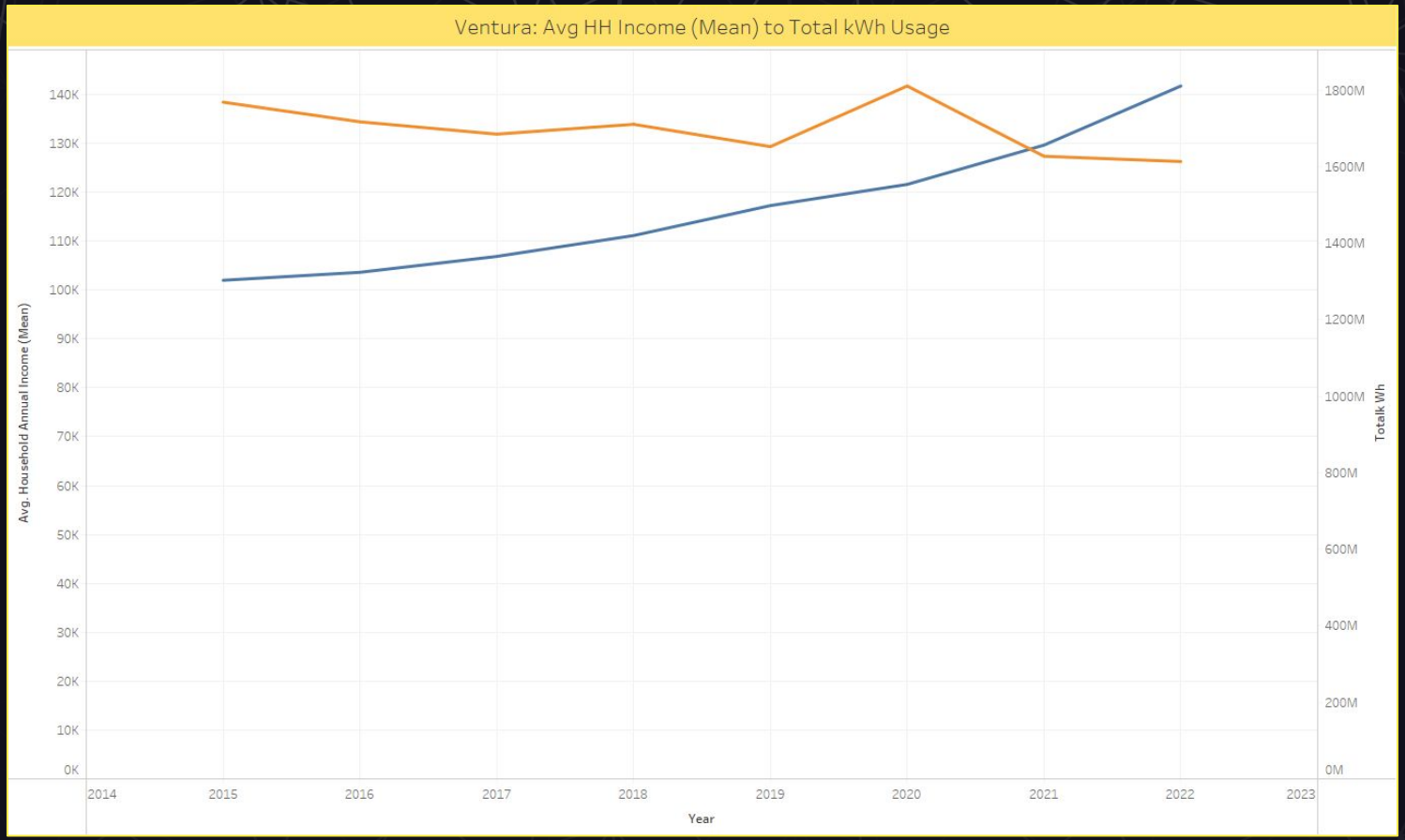


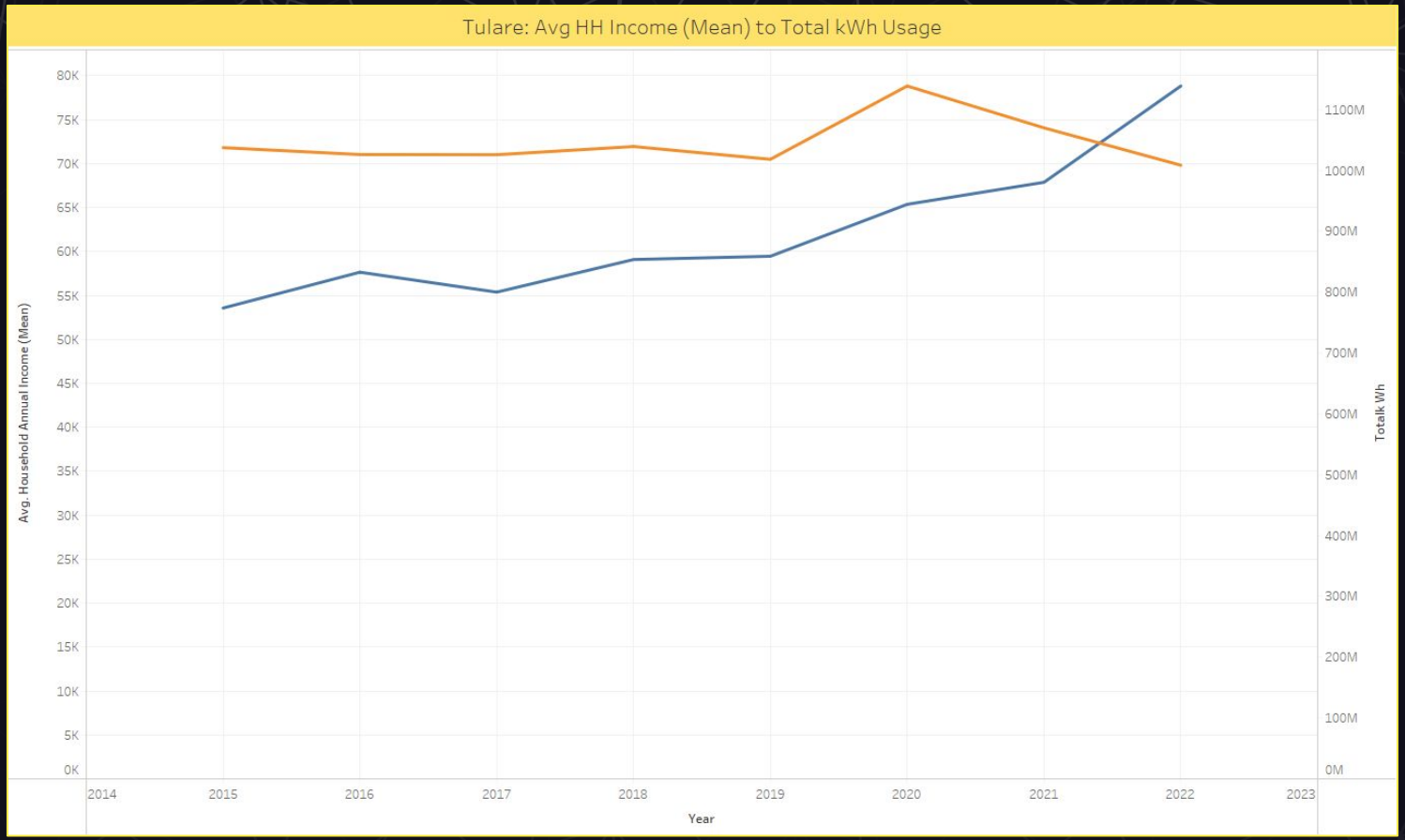

Los Angeles: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
130K
120K
110K
100K
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
12B
11B
10B
9B
8B
7B
6B
5B
4B
3B
2B
1B
0B
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

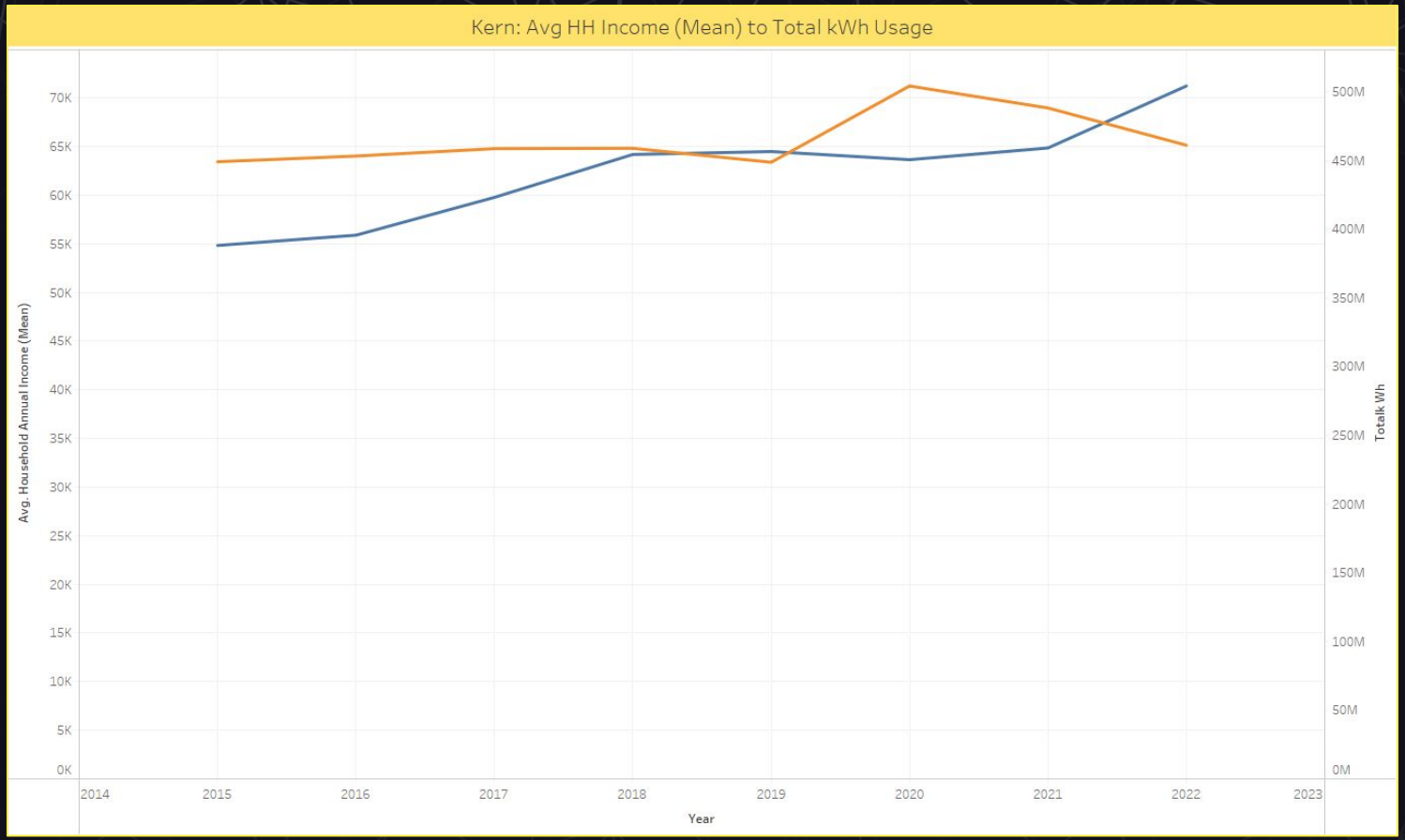

Orange County: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
160K
150K
140K
130K
120K
110K
100K
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
5500M
5000M
4500M
4000M
3500M
3000M
2500M
2000M
1500M
1000M
500M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

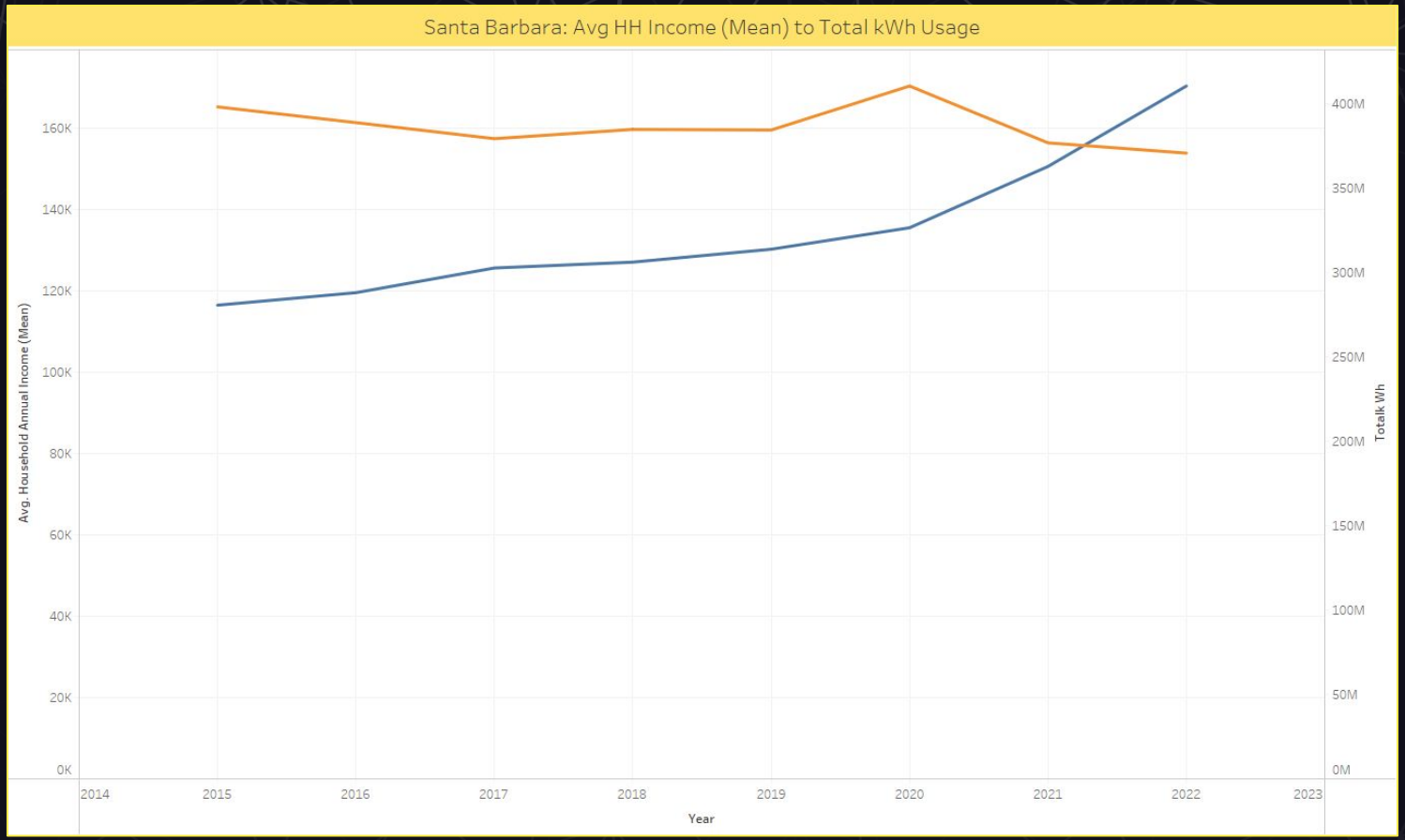

San Bernadino: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
5000M
4500M
4000M
3500M
3000M
2500M
2000M
1500M
1000M
500M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year


Riverside: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
110K
100K
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
5500M
5000M
4500M
4000M
3500M
3000M
2500M
2000M
1500M
1000M
500M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

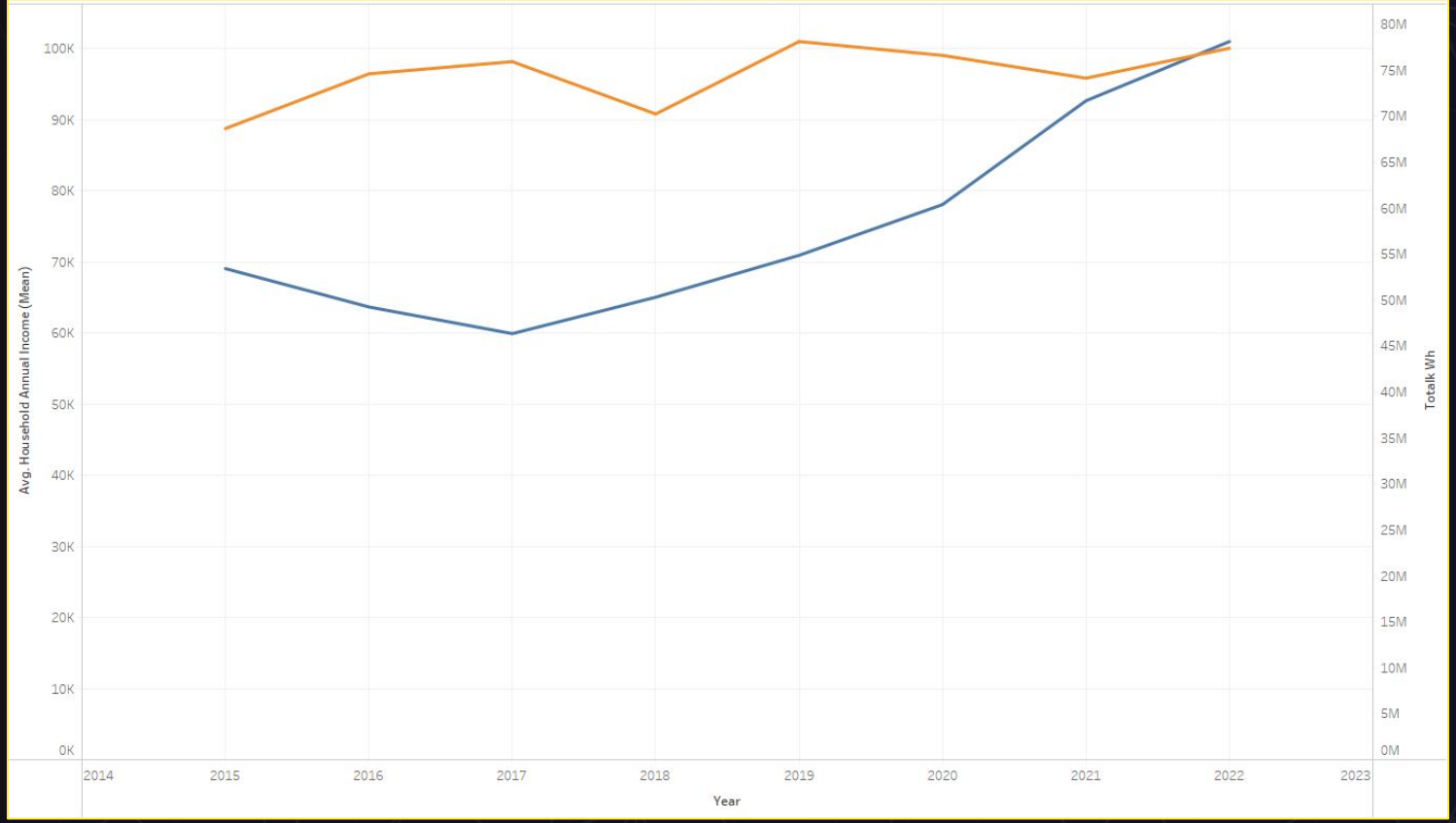

Ventura: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
140K
130K
120K
110K
100K
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
1800M
1600M
1400M
1200M
1000M
800M
600M
400M
200M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

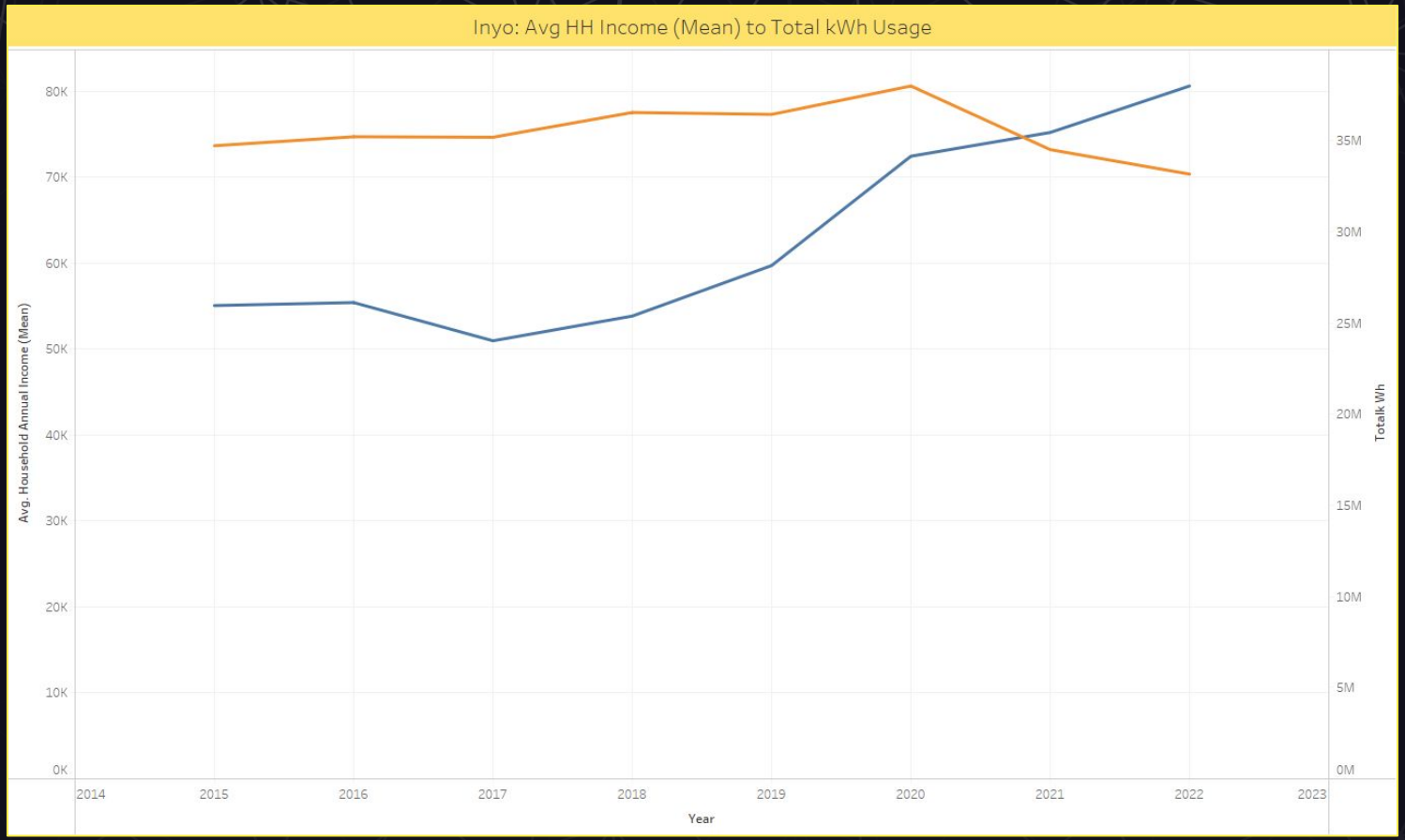

Tulare: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
80K
75K
70K
65K
60K
55K
50K
45K
40K
35K
30K
25K
20K
15K
10K
5K
0K
Totalk Wh
1100M
1000M
900M
800M
700M
600M
500M
400M
300M
200M
100M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

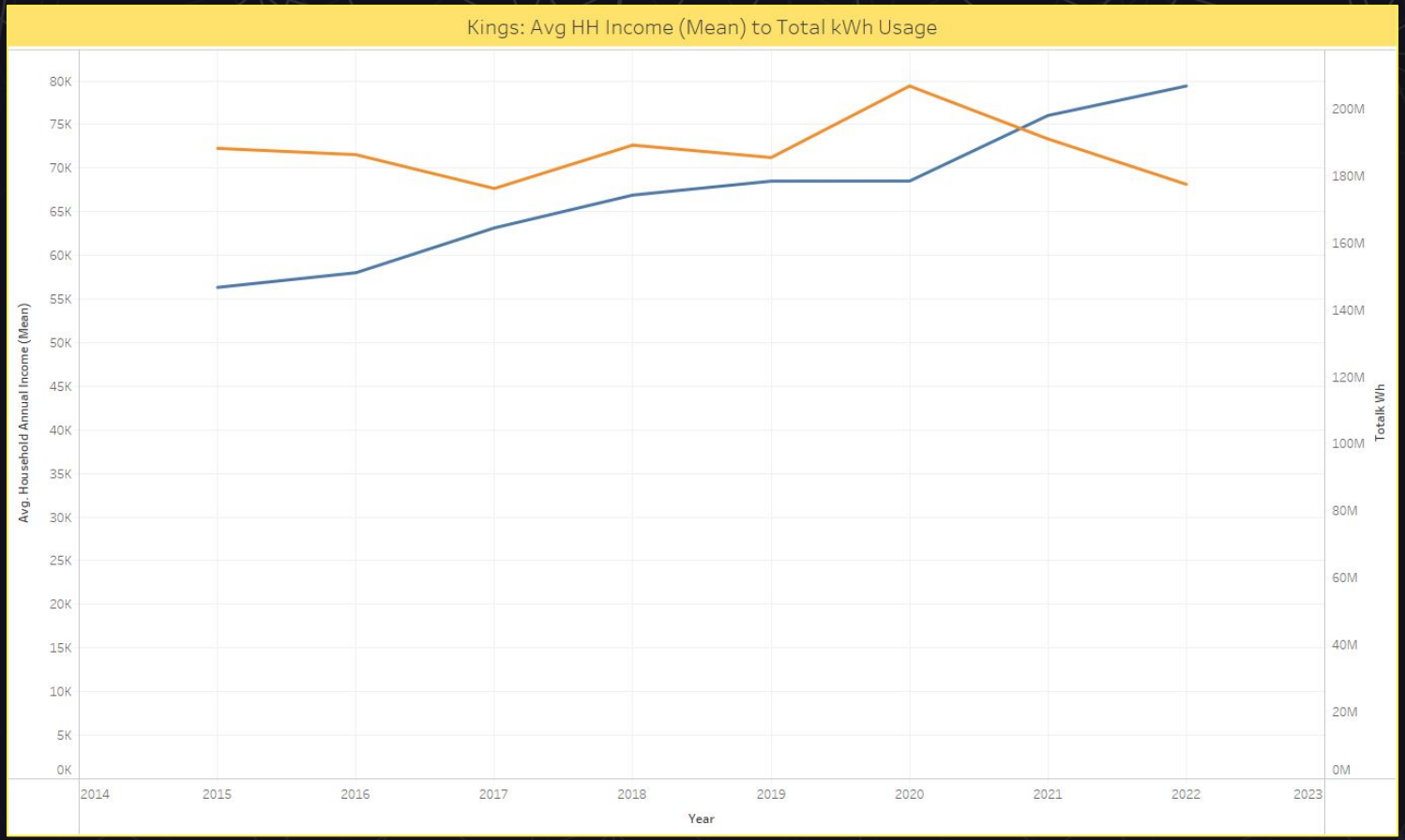

Kern: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
70K
65K
60K
55K
50K
45K
40K
35K
30K
25K
20K
15K
10K
5K
0K
Totalk Wh
500M
450M
400M
350M
300M
250M
200M
150M
100M
50M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

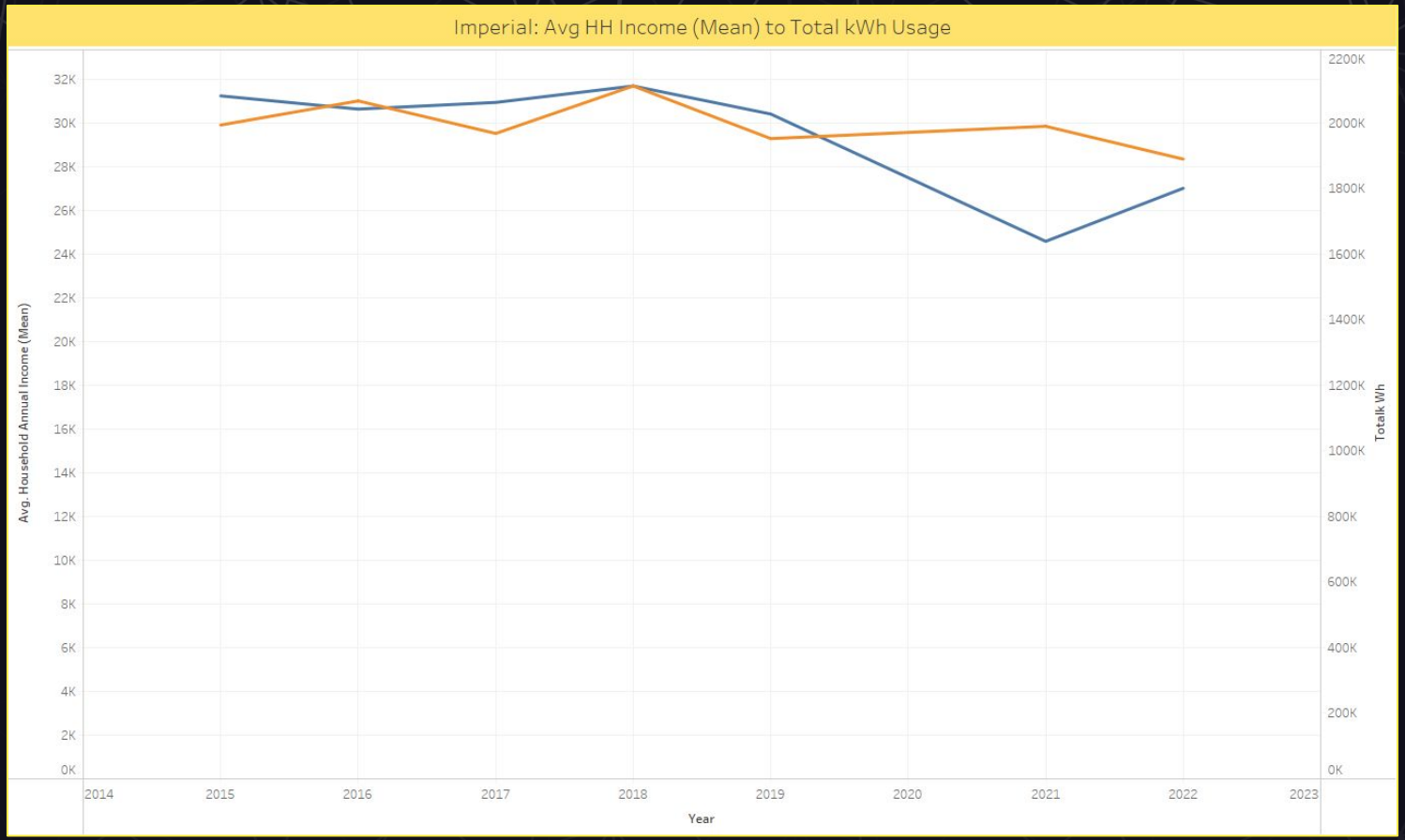

Santa Barbara: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
160K
140K
120K
100K
80K
60K
40K
20K
0K
Totalk Wh
400M
350M
300M
250M
200M
150M
100M
50M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

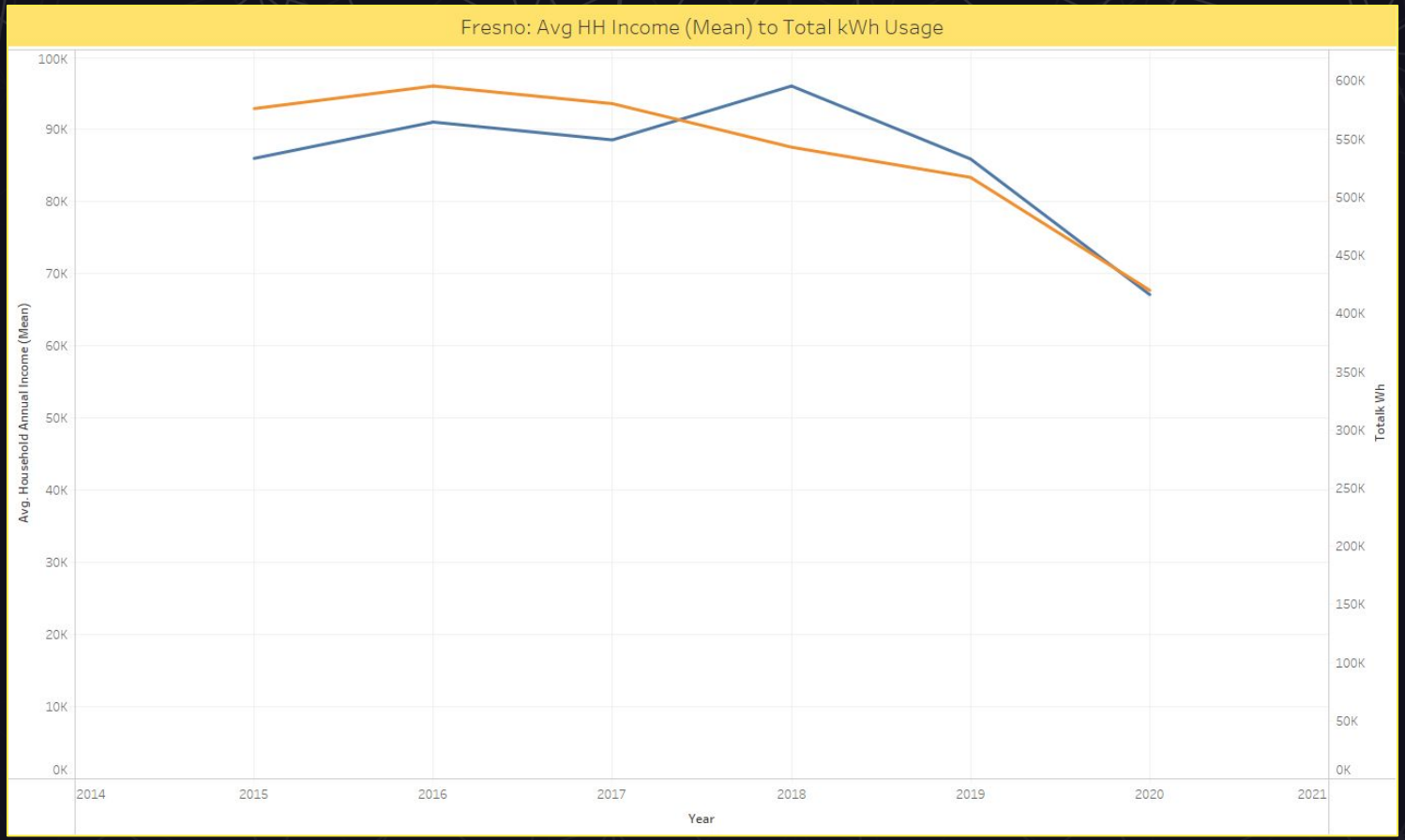
Mono: Avg HH Income (Mean) to Total kWh Usage




Inyo: Avg HH Income (Mean) to Total kWh Usage
80K
70K
60K
50K
40K
30K
20K
10K
0K
Avg. Household Annual Income (Mean)
35M
30M
25M
20M
15M
10M
5M
0M
Totalk Wh
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year


Kings: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
80K
75K
70K
65K
60K
55K
50K
45K
40K
35K
30K
25K
20K
15K
10K
5K
0K
Totalk Wh
200M
180M
160M
140M
120M
100M
80M
60M
40M
20M
0M
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year


Imperial: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
32K
30K
28K
26K
24K
22K
20K
18K
16K
14K
12K
10K
8K
6K
4K
2K
0K
Totalk Wh
2200K
2000K
1800K
1600K
1400K
1200K
1000K
800K
600K
400K
200K
0K
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year


Fresno: Avg HH Income (Mean) to Total kWh Usage
Avg. Household Annual Income (Mean)
100K
90K
80K
70K
60K
50K
40K
30K
20K
10K
0K
Totalk Wh
600K
550K
500K
450K
400K
350K
300K
250K
200K
150K
100K
50K
0K
2014
2015
2016
2017
2018
2019
2020
2021
Year

Political & External Factors

Affecting Energy Consumption

Political Ideology & Energy Efficiency

Democrat-Leaning

Tend to prioritize social and environmental concerns that may lead to higher eco-energy efficiency

Republican-Leaning

Often prioritize economic factors

Ideological differences in support for investments in energy efficiency, depend on a myriad of factors that affect the current economical and environmental states

California’s Energy Policies & Initiatives

Senate Bill 100

Goal of achieving 100% carbon-free energy by 2045, and updates the state’s Renewables Portfolio Standard to ensure that by 2030 at least 60% of California’s electricity is renewable

Inflation Reduction Act

Increased investments in state and local governments to invest in energy efficiency and grid resilience

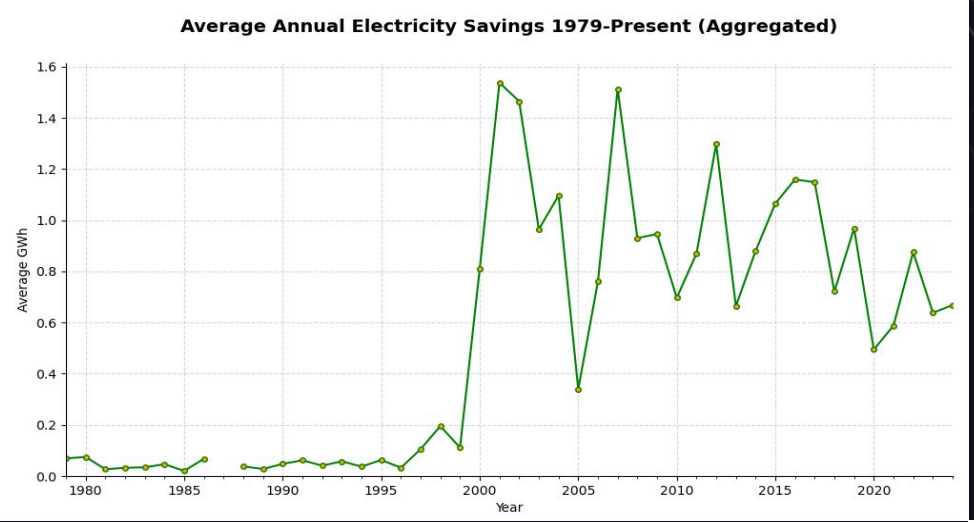
California’s Energy Policies & Initiatives

Energy Systems Infrastructure Planning

California is transitioning its electricity system to rely increasingly on clean energy sources like solar, wind, and geothermal power as the core part of this

California Energy Commission

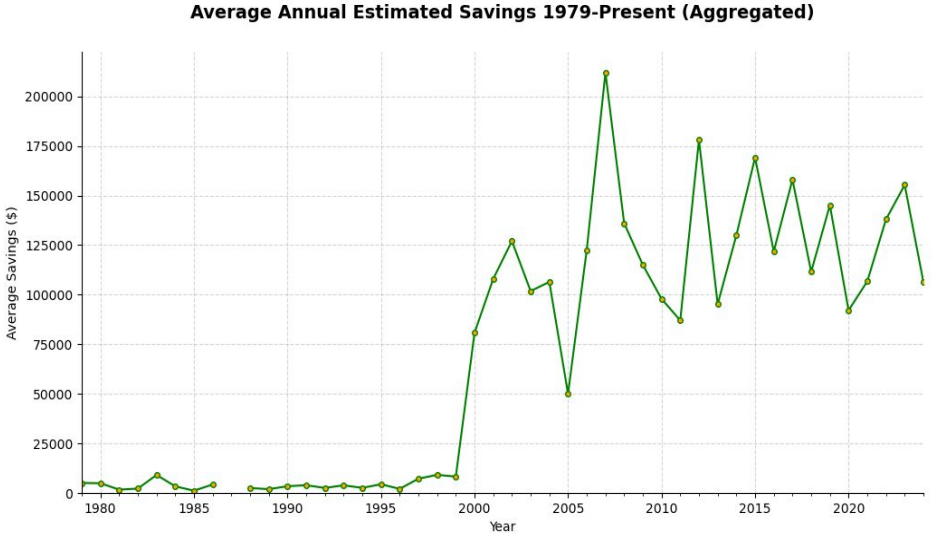
Implemented energy efficiency standards for buildings and appliances and offers incentives and rebates for energy-efficient upgrades



Energy Conservation Assistance Act

Average Energy Savings (kWh)	Total Energy Savings (kWh)
470,169	434,906,781

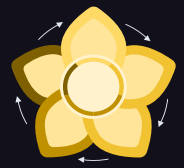
Average Estimated Savings ($)	Total Estimated Savings ($)
$53,429.47	$49,368,827.08



Impact of Clean Energy Transition

Expected to increase electricity consumption but is accompanied by efforts to strengthen the power grid and promote energy efficiency

Investments in renewable energy technologies, such as solar and wind power, are projected to reduce energy costs over time



EV Policies aim to reduce greenhouse emissions from transportation and alleviate strain on the electricity grid

As more people replace their gas-powered vehicles with EV's, electricity usage is expected to increase

Significant Legislation and Programs

SB 100

SB 1020

Inflation Reduction Act

DOE Title 17 Clean Energy Financing Program

Renewables Portfolio Standard

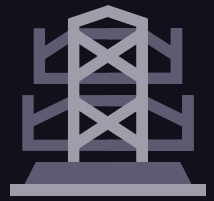
California’s Energy Grid Advancements

Complement Renewable Energy

Today’s fleet of storage resources can capture enough electricity to power up to 5 million California homes.

Battery Storage Infrastructure

Investments have been made to accompany the energy grid, with planned expansions by 2026



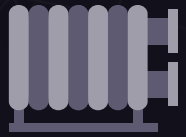
Load Flexibility

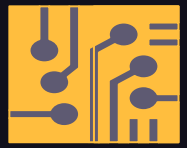
Practice of adjusting energy usage to match the supply of electricity.

Decarbonization Challenges & Opportunities

Natural Gas to Electric Heating

Could substantially reduce emissions in California's building sector but will increase electricity consumption





Technological Advancements

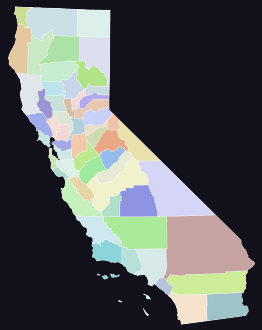
Energy-efficient structural design and power stability for critical facilities are emerging trends in California.

Water Heating

Energy-intensive element, comprising fully 1/4 of total residential energy use, improving water-heating efficiency could significantly decrease California’s overall energy usage

Future Energy Strategies & Goals

California aims for carbon neutrality by 2045, necessitating bold actions and policy initiatives that lead to a 100% clean grid and build more renewable sources to reduce pollution, mitigate climate change impacts, and stabilize energy costs



Load flexibility, energy storage, and additional renewable resources are essential for meeting electricity demand, especially as solar power generation fluctuates

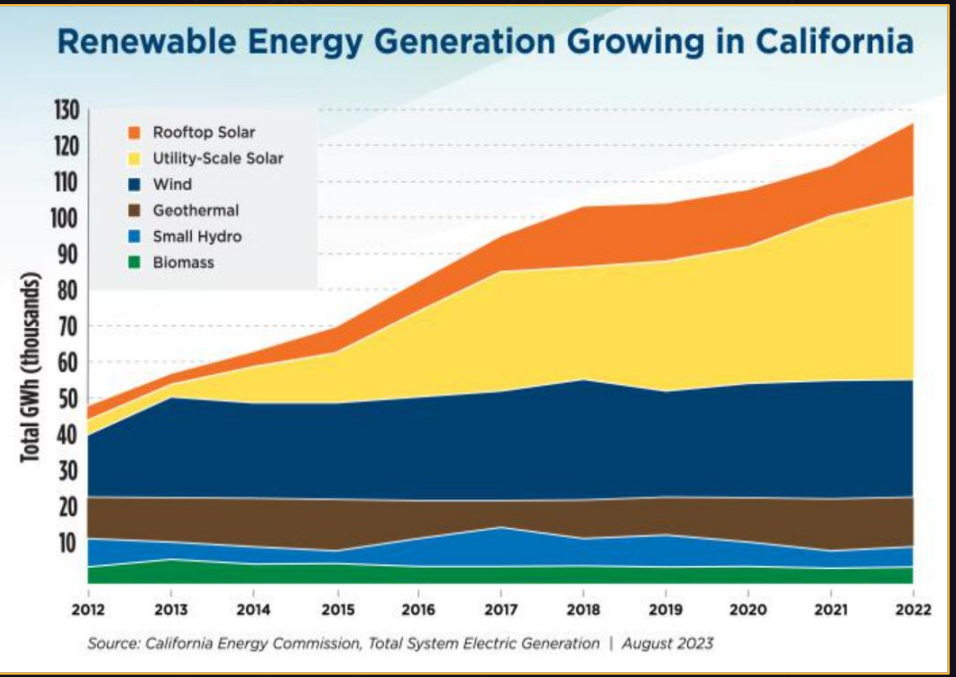
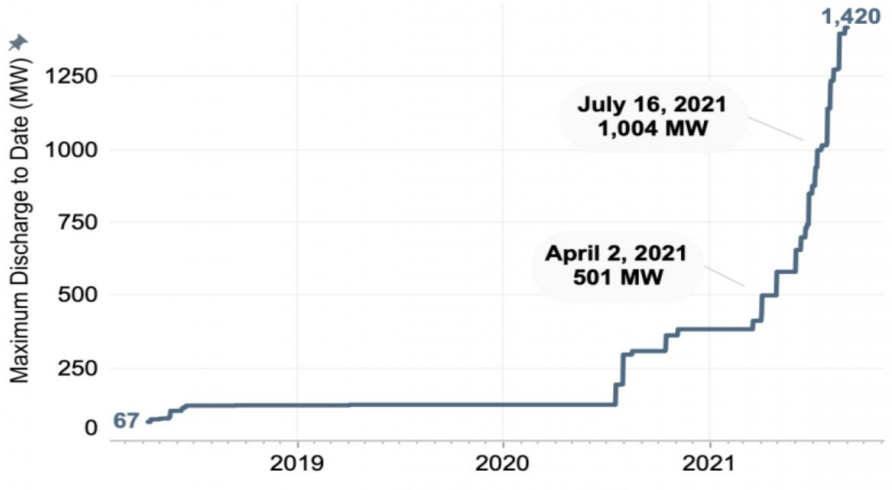


Figure 1. Maximum 5-minute battery output to date. Maximum output doubled from 500 to 1,000 MW over just three and a half months and continues to grow.

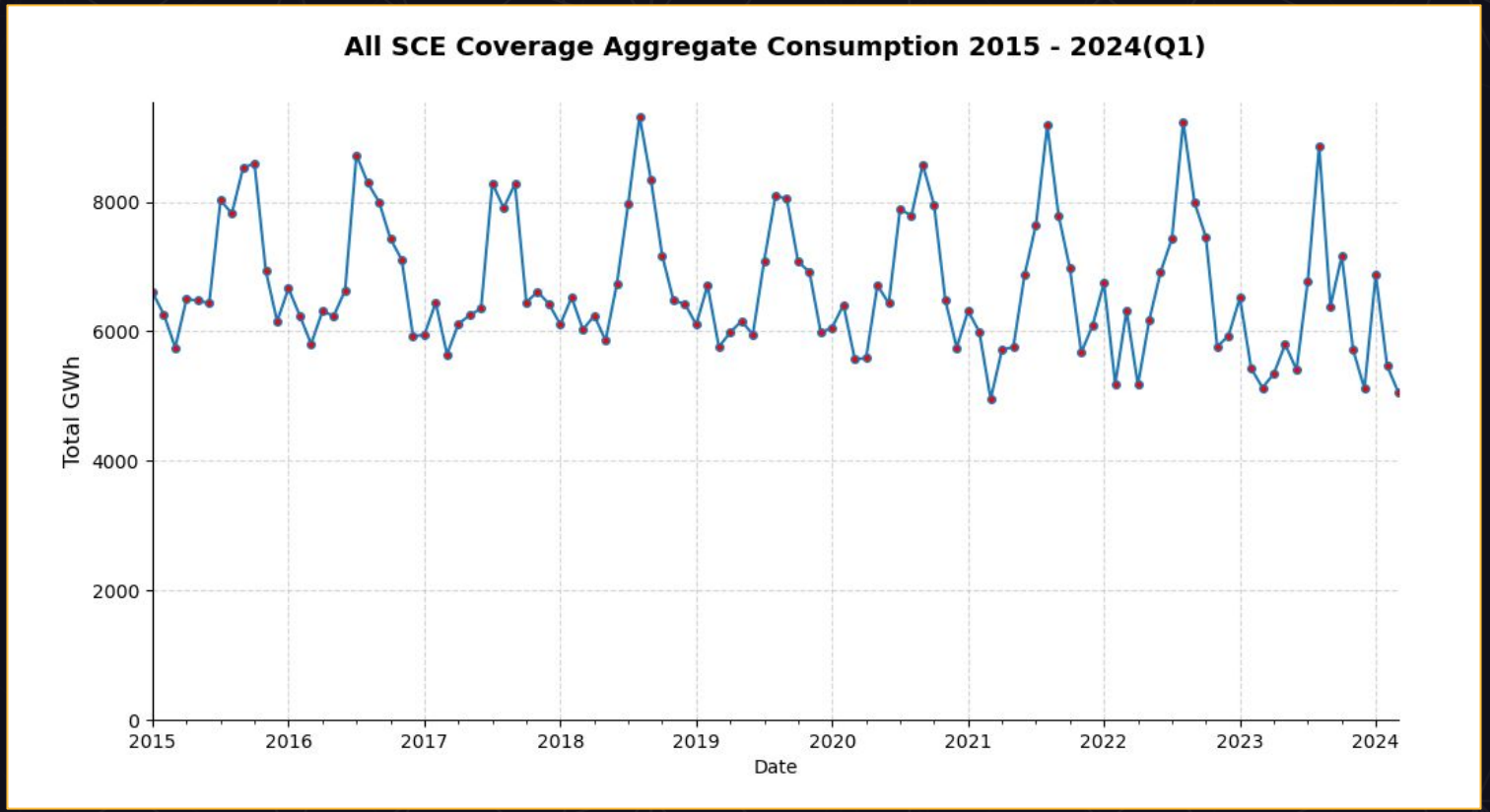


Source: California Energy Commission (CEC) analysis of California Independent System Operator (ISO) data

Forecasting Models

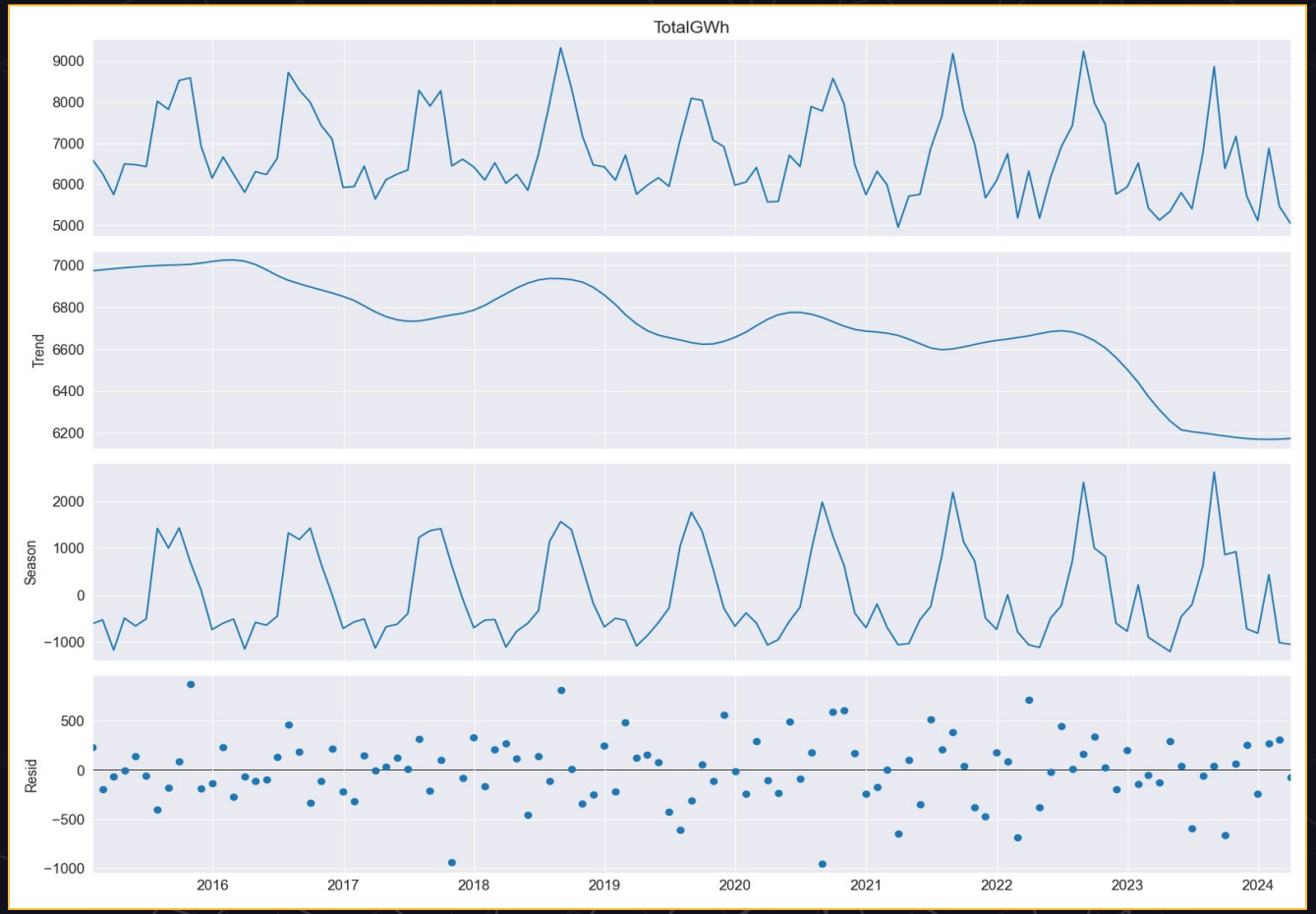
Technologies Used

Let's Take A Look At The Past...



Data Source: SCE Quarterly Energy Data Reports

Time-Decomposition



SARIMAX

Seasonal Autoregressive Integrated Moving Average with Exogenous Regressors

- ★ A statistical model designed to capture and forecast the underlying patterns, trends and seasonality in time-series data.
- ★ A powerful time series forecasting technique that extends the traditional ARIMA model to account for **seasonality and external factors.**

Components

Seasonal (S)	*Periodic patterns in data (weekly, monthly, annually, e.g.)*
Autoregressive (AR)	*Represents relationship between current and previous values in the data*
Integrated (I)	*Differencing to make data stationary by removing trends and seasonality*
Moving Average (MA)	*Accounts for dependency of current value on past error terms, used to calculate trend*
Exogenous Regressors (X)	*Allows inclusion of external factors that may affect data*

SARIMAX Parameters

p

Autoregressive Order

d

Differencing Order

q

Moving Average Order

P

Seasonal
Autoregressive Order

D

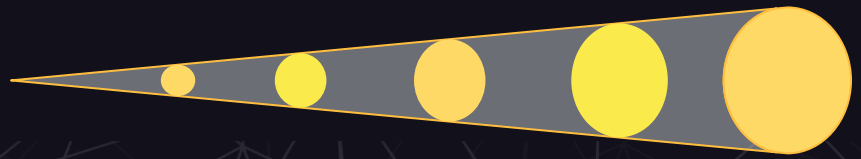
Seasonal
Differencing Order

Q

Seasonal
Moving Average
Order

s/m

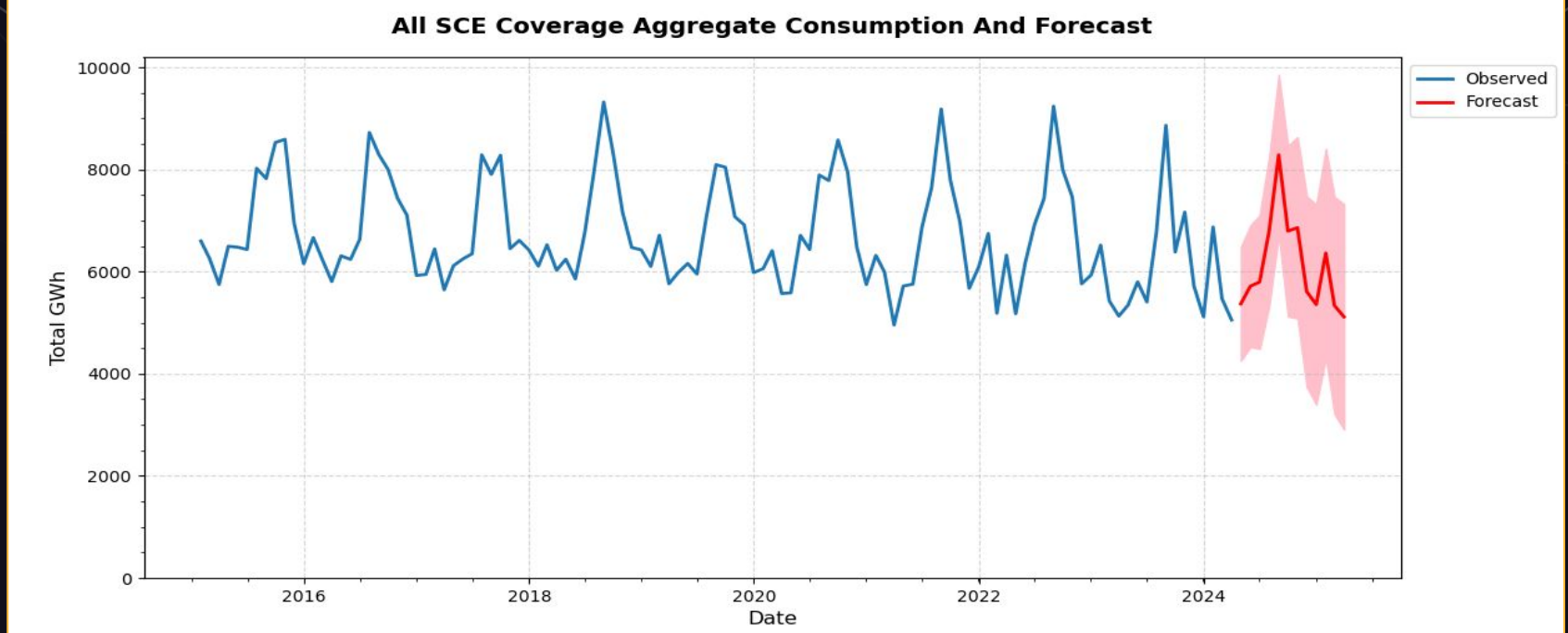
Seasonal Period



AutoArima To Find Optimal Model Parameters

```
Performing stepwise search to minimize aic
 ARIMA(0,1,2)(0,0,1)[12] intercept   : AIC=inf, Time=0.29 sec
 ARIMA(0,1,0)(0,0,0)[12] intercept   : AIC=1818.138, Time=0.01 sec
 ARIMA(1,1,0)(1,0,0)[12] intercept   : AIC=1755.811, Time=0.14 sec
 ARIMA(0,1,1)(0,0,1)[12] intercept   : AIC=1783.109, Time=0.16 sec
 ARIMA(0,1,0)(0,0,0)[12]             : AIC=1816.168, Time=0.01 sec
 ARIMA(1,1,0)(0,0,0)[12] intercept   : AIC=1818.627, Time=0.02 sec
 ARIMA(1,1,0)(2,0,0)[12] intercept   : AIC=1754.755, Time=0.33 sec
 ARIMA(1,1,0)(2,0,1)[12] intercept   : AIC=1758.579, Time=0.90 sec
 ARIMA(1,1,0)(1,0,1)[12] intercept   : AIC=1752.300, Time=0.29 sec
 ARIMA(1,1,0)(0,0,1)[12] intercept   : AIC=1783.855, Time=0.12 sec
 ARIMA(1,1,0)(1,0,2)[12] intercept   : AIC=1752.562, Time=0.82 sec
 ARIMA(1,1,0)(0,0,2)[12] intercept   : AIC=1772.004, Time=0.32 sec
 ARIMA(1,1,0)(2,0,2)[12] intercept   : AIC=1756.537, Time=0.99 sec
```

```
Best model:  ARIMA(2,1,0)(1,0,1)[12]
Total fit time: 19.666 seconds
                                SARIMAX Results
==========================================================================================
Dep. Variable:                                 y   No. Observations:                  111
Model:             SARIMAX(2, 1, 0)x(1, 0, [1], 12)   Log Likelihood                -866.718
Date:                              Mon, 22 Apr 2024   AIC                           1743.435
Time:                                      23:35:21   BIC                           1756.937
Sample:                                  01-31-2015   HQIC                          1748.912
                                       - 03-31-2024
Covariance Type:                               opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.6216      0.081     -7.656      0.000      -0.781      -0.462
ar.L2         -0.2782      0.079     -3.521      0.000      -0.433      -0.123
ar.S.L12       0.9345      0.042     22.244      0.000       0.852       1.017
ma.S.L12      -0.4895      0.142     -3.438      0.001      -0.769      -0.210
sigma2      3.234e+05   4.85e+04      6.667      0.000    2.28e+05    4.18e+05
==============================================================================
```



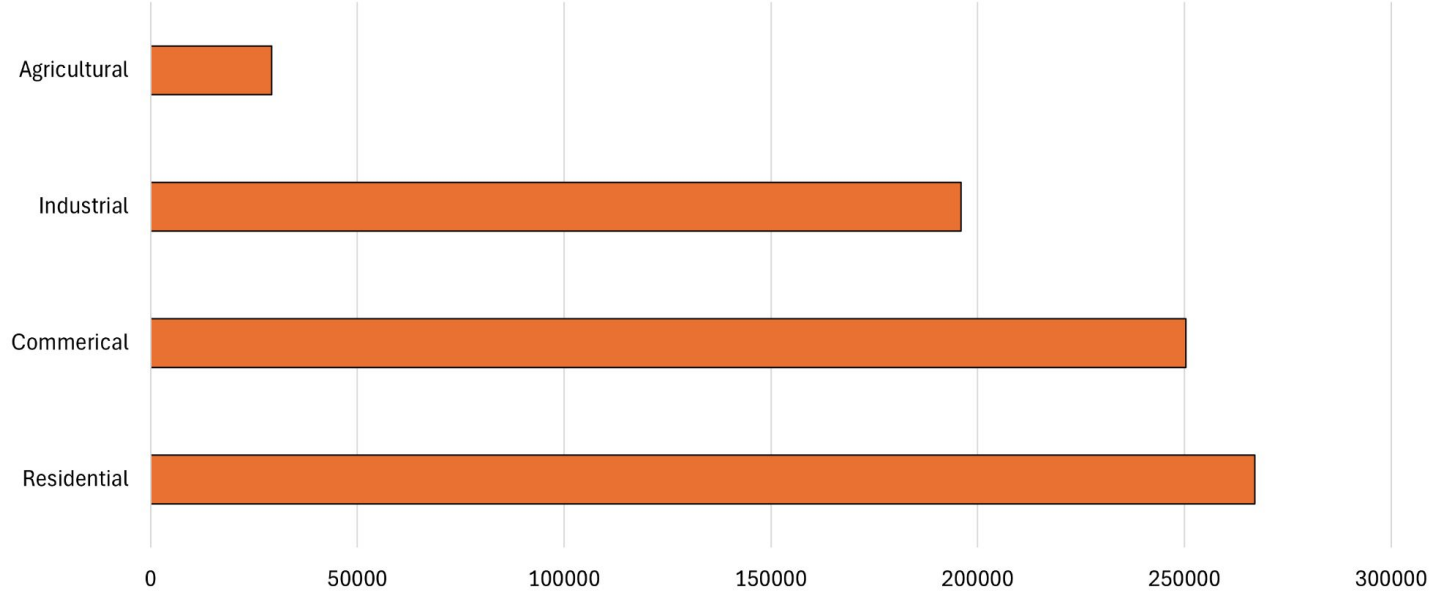
Date	Observed (GWh)
30-Apr-23	5345.507
31-May-23	5800.381
30-Jun-23	5406.098
31-Jul-23	6777.656
31-Aug-23	8865.066
30-Sep-23	6383.990
31-Oct-23	7166.511
30-Nov-23	5714.850
31-Dec-23	5115.264
31-Jan-24	6874.243
29-Feb-24	5469.842
31-Mar-24	5054.461

Date	Forecasted (GWh)
30-Apr-24	5370.162
31-May-24	5715.001
30-Jun-24	5796.459
31-Jul-24	6793.667
31-Aug-24	8287.066
30-Sep-24	6794.765
31-Oct-24	6860.351
30-Nov-24	5609.573
31-Dec-24	5355.777
31-Jan-25	6364.541
28-Feb-25	5336.996
31-Mar-25	5115.173

Total Observations
117702
MAE
238.36
RMSE
303.75

Total Observed	73,973.87
Total Forecasted	73,399.53
Difference	**- 0.78 %**

All SCE Coverage Consumption By Customer Class



	Residential	Commerical	Industrial	Agricultural
All SCE Coverage	267070.961	250393.818	196015.033	29338.236

Total GWh

County Forecasts

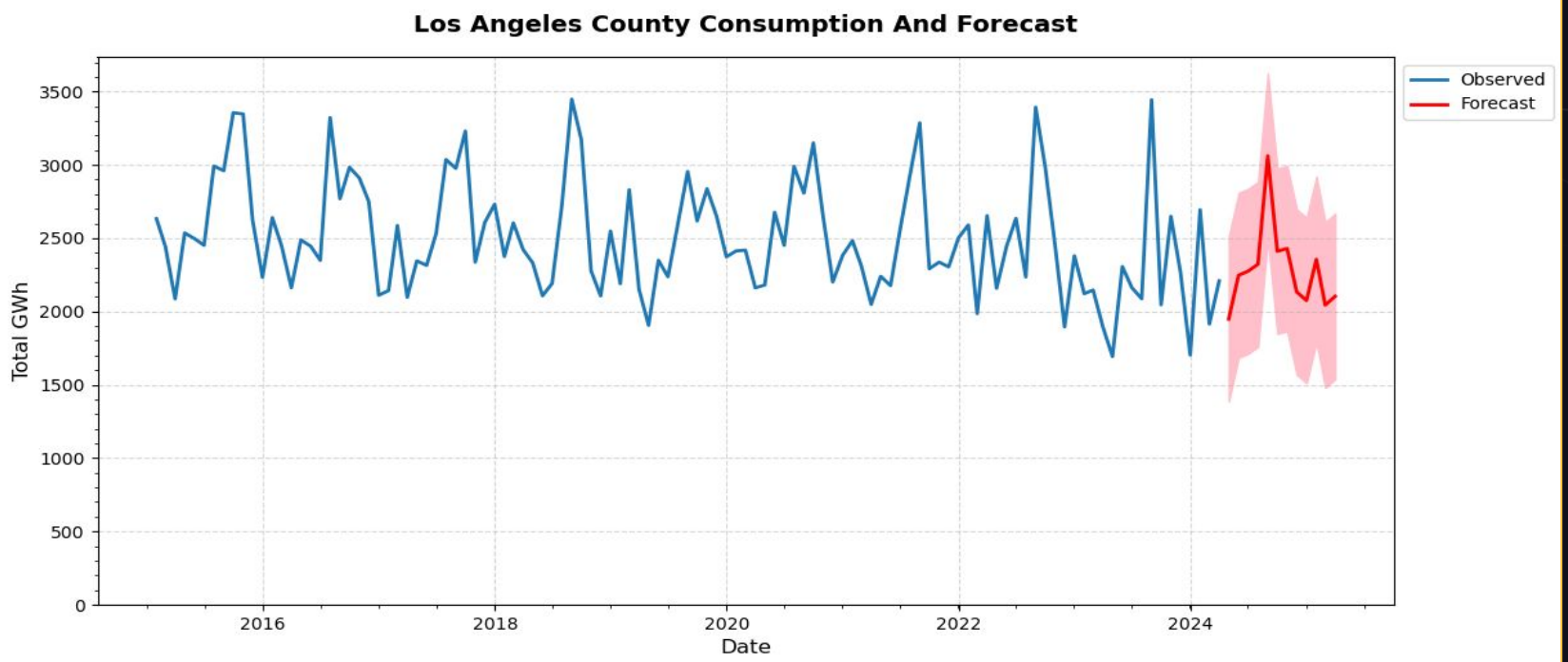
- Predicted Consumptions with Error Values
- Projected Percentage Change Based On Forecasted Period

Zip Codes → **Counties**

Mapped + Grouped to their associated Counties

Data Source: California ZIP Codes List, Map, and Demographics (unitedstateszipcodes.org)

Counties With A Projected Usage ***Increase***

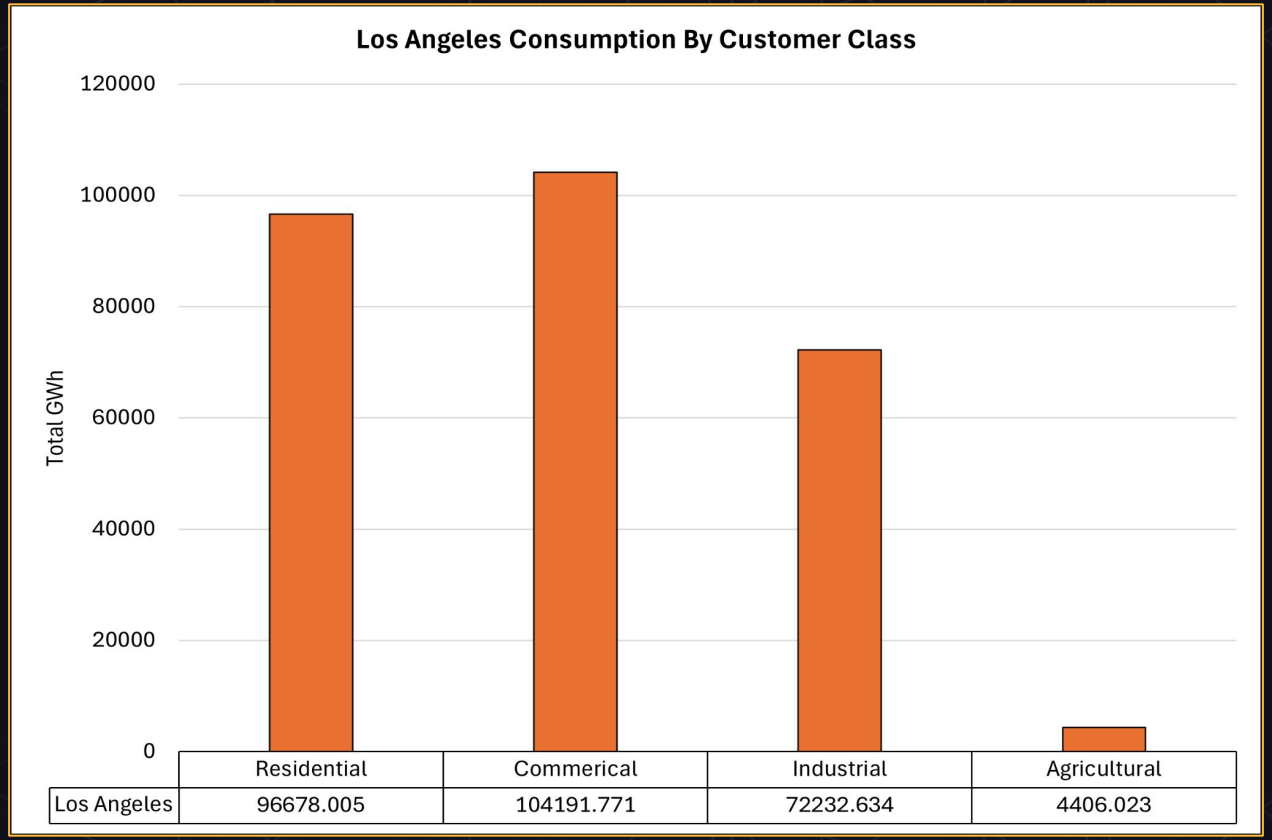


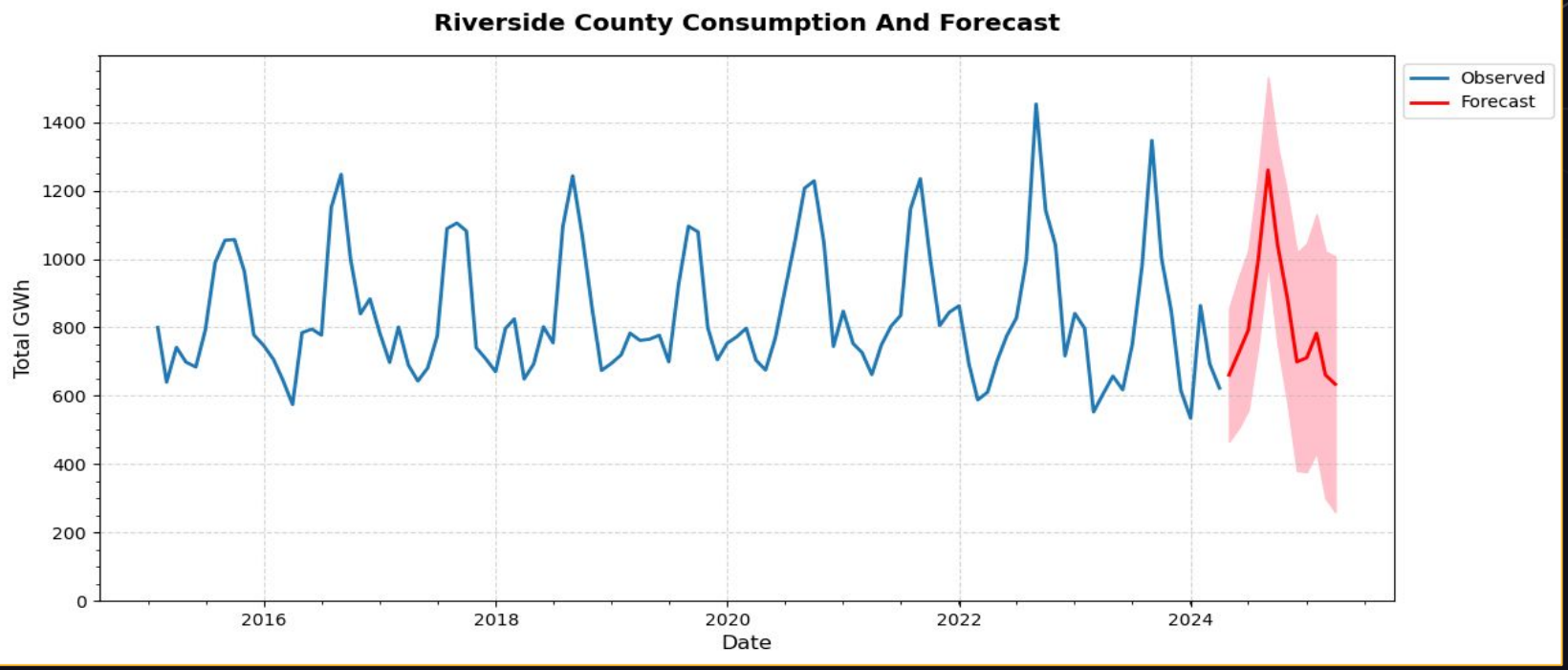
Date	Observed (GWh)
30-Apr-23	1692.609
31-May-23	2306.070
30-Jun-23	2162.239
31-Jul-23	2086.327
31-Aug-23	3444.264
30-Sep-23	2045.026
31-Oct-23	2648.331
30-Nov-23	2267.631
31-Dec-23	1702.490
31-Jan-24	2693.731
29-Feb-24	1913.847
31-Mar-24	2208.602

Date	Forecasted (GWh)
30-Apr-24	1947.918
31-May-24	2246.633
30-Jun-24	2274.569
31-Jul-24	2321.465
31-Aug-24	3061.117
30-Sep-24	2410.706
31-Oct-24	2428.892
30-Nov-24	2133.120
31-Dec-24	2074.585
31-Jan-25	2355.096
28-Feb-25	2042.961
31-Mar-25	2103.129

Total Observations
42304
MAE
225.86
RMSE
252.38

Total Observed	27,171.17
Total Forecasted	27,400.190
Difference	**0.84** %


Los Angeles Consumption By Customer Class
120000
100000
80000
60000
40000
20000
0
Total GWh
Residential
Commerical
Industrial
Agricultural
Los Angeles
96678.005
104191.771
72232.634
4406.023

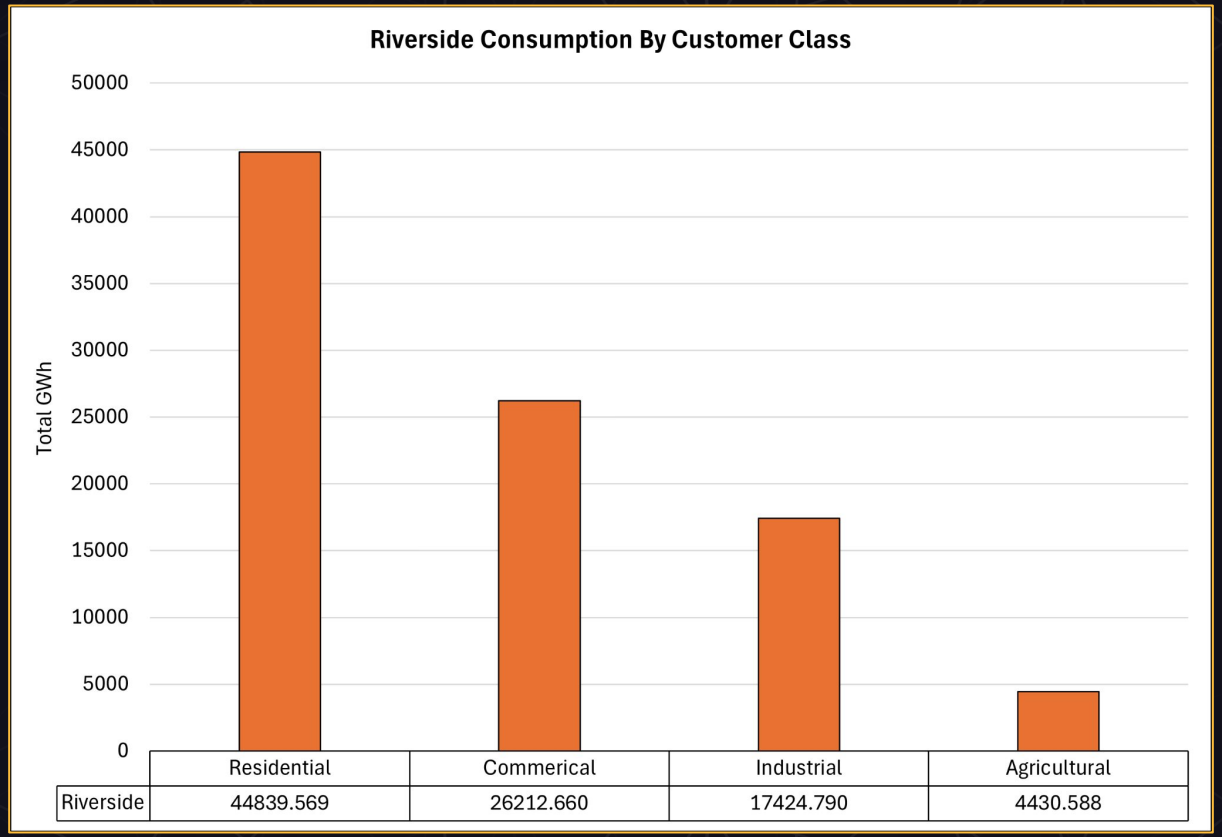


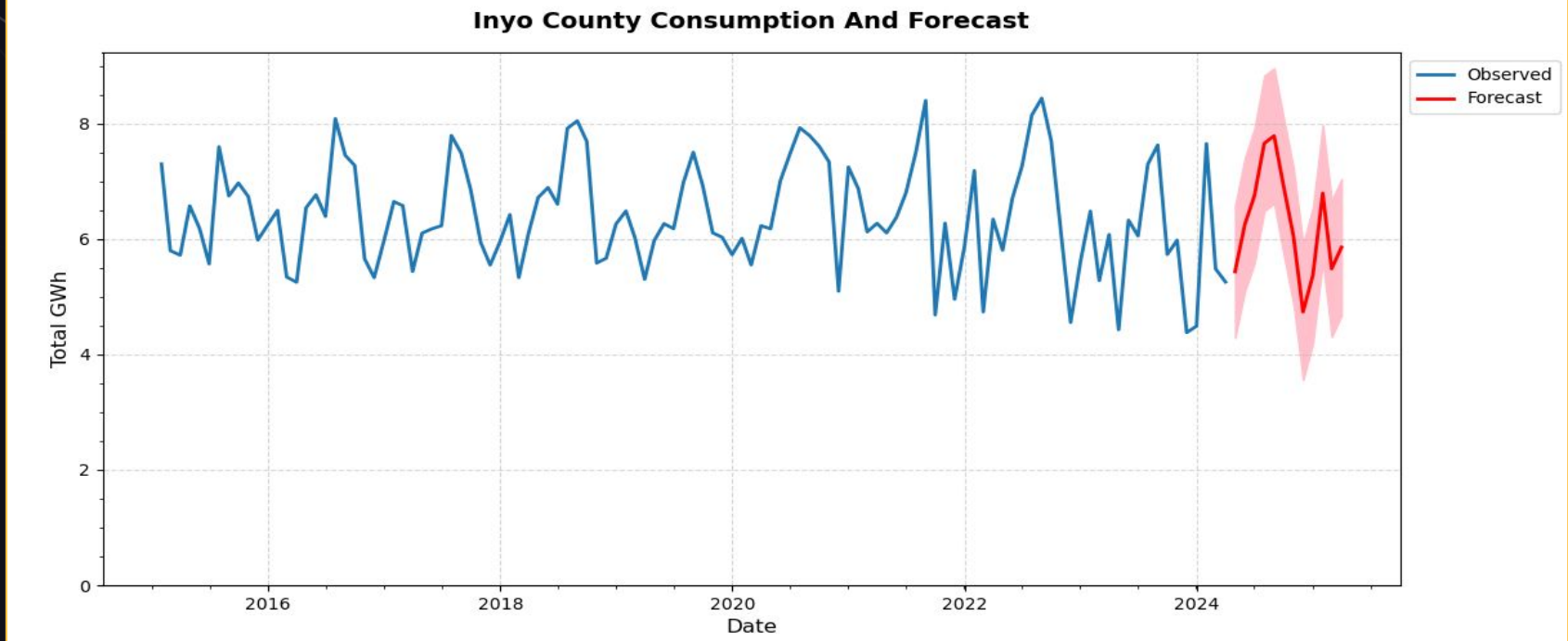
Date	Observed (GWh)
30-Apr-23	657.350
31-May-23	617.293
30-Jun-23	749.840
31-Jul-23	981.096
31-Aug-23	1347.202
30-Sep-23	1003.618
31-Oct-23	847.386
30-Nov-23	615.917
31-Dec-23	534.174
31-Jan-24	863.932
29-Feb-24	693.535
31-Mar-24	622.249

Date	Forecasted (GWh)
30-Apr-24	660.496
31-May-24	726.809
30-Jun-24	792.701
31-Jul-24	996.113
31-Aug-24	1260.693
30-Sep-24	1042.313
31-Oct-24	884.943
30-Nov-24	699.270
31-Dec-24	711.086
31-Jan-25	782.804
28-Feb-25	660.950
31-Mar-25	633.533

Total Observations
15369
MAE
59.88
RMSE
76.63

Total Observed	9,533.59
Total Forecasted	9,851.71
Difference	**3.34 %**


Riverside Consumption By Customer Class
Total GWh
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Residential
Commerical
Industrial
Agricultural
Riverside
44839.569
26212.660
17424.790
4430.588

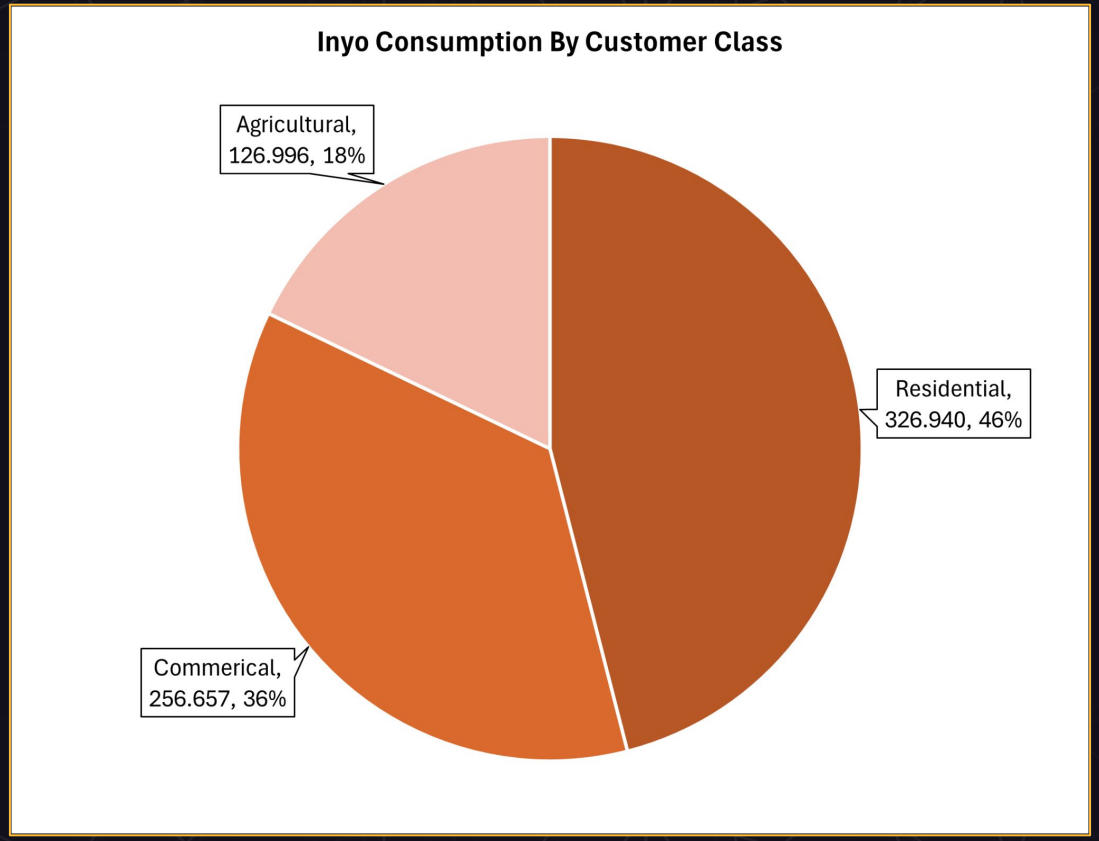


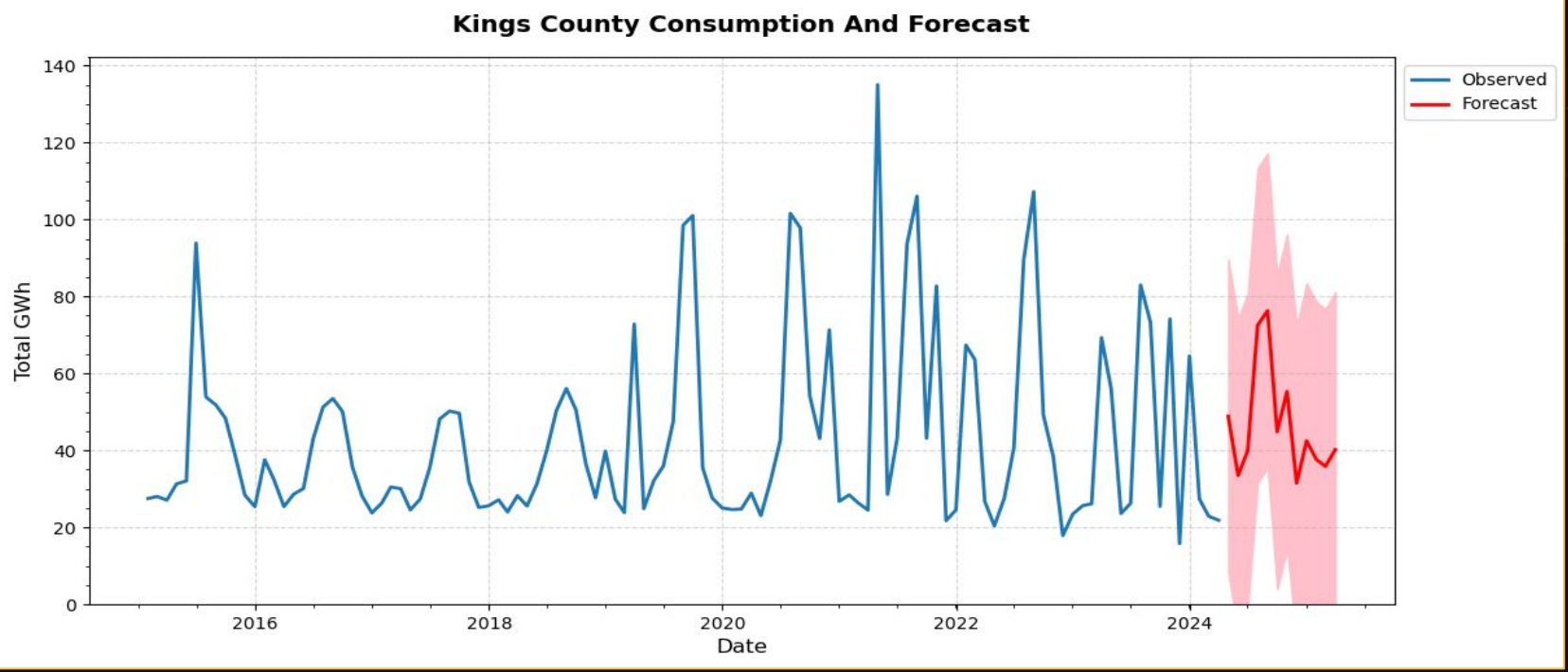
Date	Observed (GWh)
30-Apr-23	4.431
31-May-23	6.329
30-Jun-23	6.056
31-Jul-23	7.302
31-Aug-23	7.631
30-Sep-23	5.735
31-Oct-23	5.981
30-Nov-23	4.380
31-Dec-23	4.493
31-Jan-24	7.655
29-Feb-24	5.485
31-Mar-24	5.258

Date	Forecasted (GWh)
30-Apr-24	5.436
31-May-24	6.256
30-Jun-24	6.751
31-Jul-24	7.661
31-Aug-24	7.791
30-Sep-24	6.915
31-Oct-24	6.049
30-Nov-24	4.739
31-Dec-24	5.376
31-Jan-25	6.797
28-Feb-25	5.486
31-Mar-25	5.861

Total Observations
703
MAE
0.52
RMSE
0.65

Total Observed	70.74
Total Forecasted	75.12
Difference	**6.19 %**


Inyo Consumption By Customer Class
Agricultural, 126.996, 18%
Residential, 326.940, 46%
Commerical, 256.657, 36%

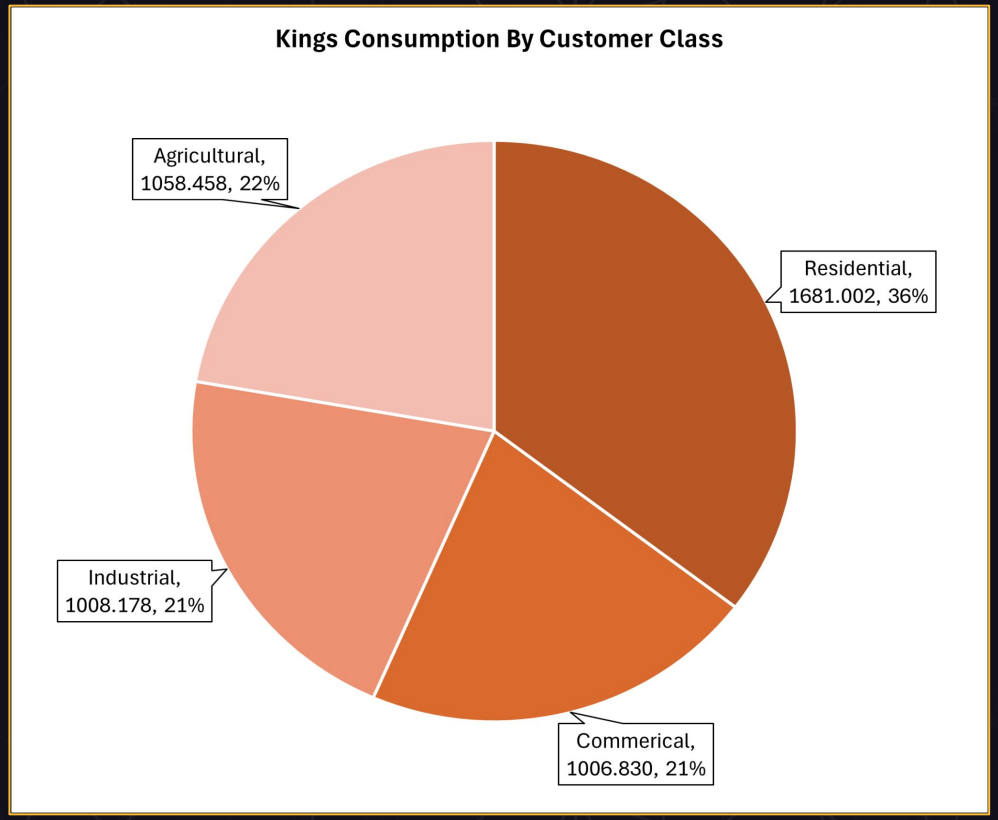


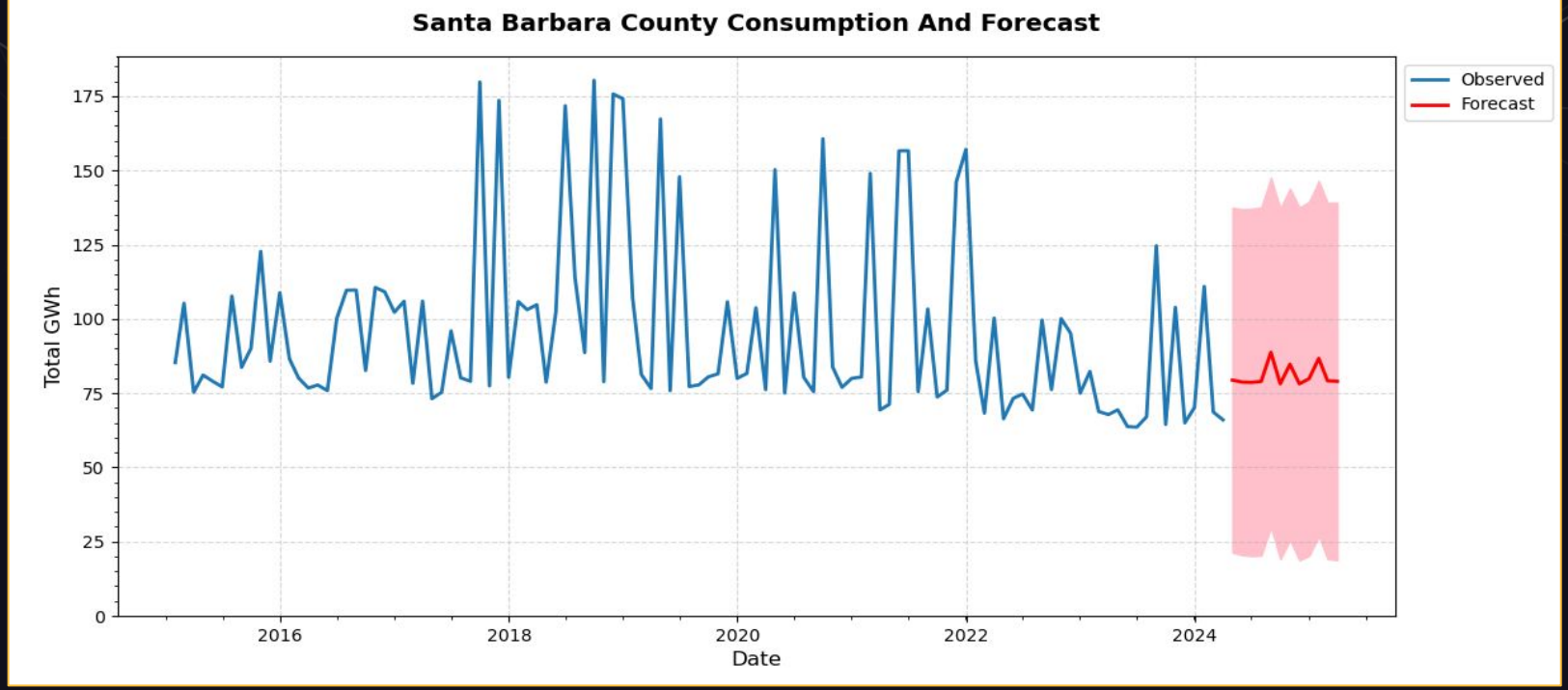
Date	Observed (GWh)
30-Apr-23	56.041
31-May-23	23.589
30-Jun-23	26.259
31-Jul-23	82.971
31-Aug-23	73.295
30-Sep-23	25.444
31-Oct-23	74.138
30-Nov-23	15.763
31-Dec-23	64.531
31-Jan-24	27.329
29-Feb-24	22.863
31-Mar-24	21.844

Date	Forecasted (GWh)
30-Apr-24	48.853
31-May-24	33.455
30-Jun-24	39.901
31-Jul-24	72.503
31-Aug-24	76.280
30-Sep-24	44.829
31-Oct-24	55.279
30-Nov-24	31.462
31-Dec-24	42.470
31-Jan-25	37.573
28-Feb-25	35.840
31-Mar-25	40.193

Total Observations
587
MAE
13.48
RMSE
14.52

Total Observed	514.07
Total Forecasted	558.64
Difference	**8.67** %


Kings Consumption By Customer Class
Agricultural, 1058.458, 22%
Residential, 1681.002, 36%
Industrial, 1008.178, 21%
Commerical, 1006.830, 21%



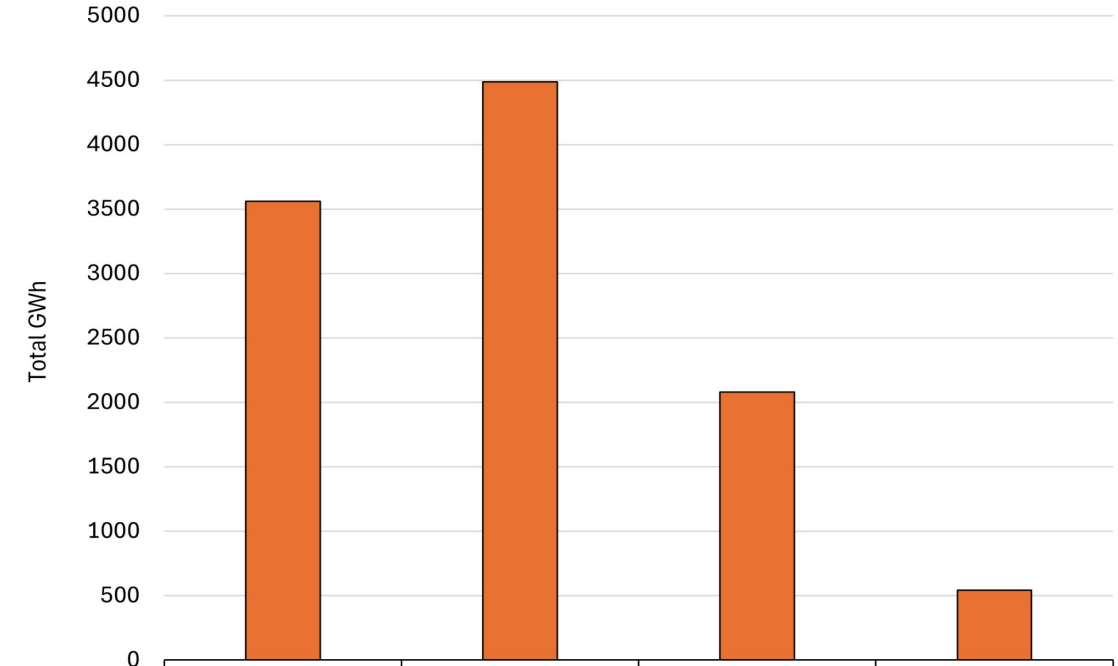
Date	Observed (GWh)
30-Apr-23	69.371
31-May-23	63.730
30-Jun-23	63.556
31-Jul-23	67.047
31-Aug-23	124.621
30-Sep-23	64.478
31-Oct-23	103.894
30-Nov-23	64.981
31-Dec-23	70.192
31-Jan-24	110.952
29-Feb-24	68.640
31-Mar-24	66.001

Date	Forecasted (GWh)
30-Apr-24	79.389
31-May-24	78.718
30-Jun-24	78.610
31-Jul-24	78.945
31-Aug-24	88.747
30-Sep-24	78.128
31-Oct-24	84.713
30-Nov-24	78.132
31-Dec-24	79.849
31-Jan-25	86.694
28-Feb-25	79.139
31-Mar-25	78.976

Total Observations
2494
MAE
15.93
RMSE
17.48

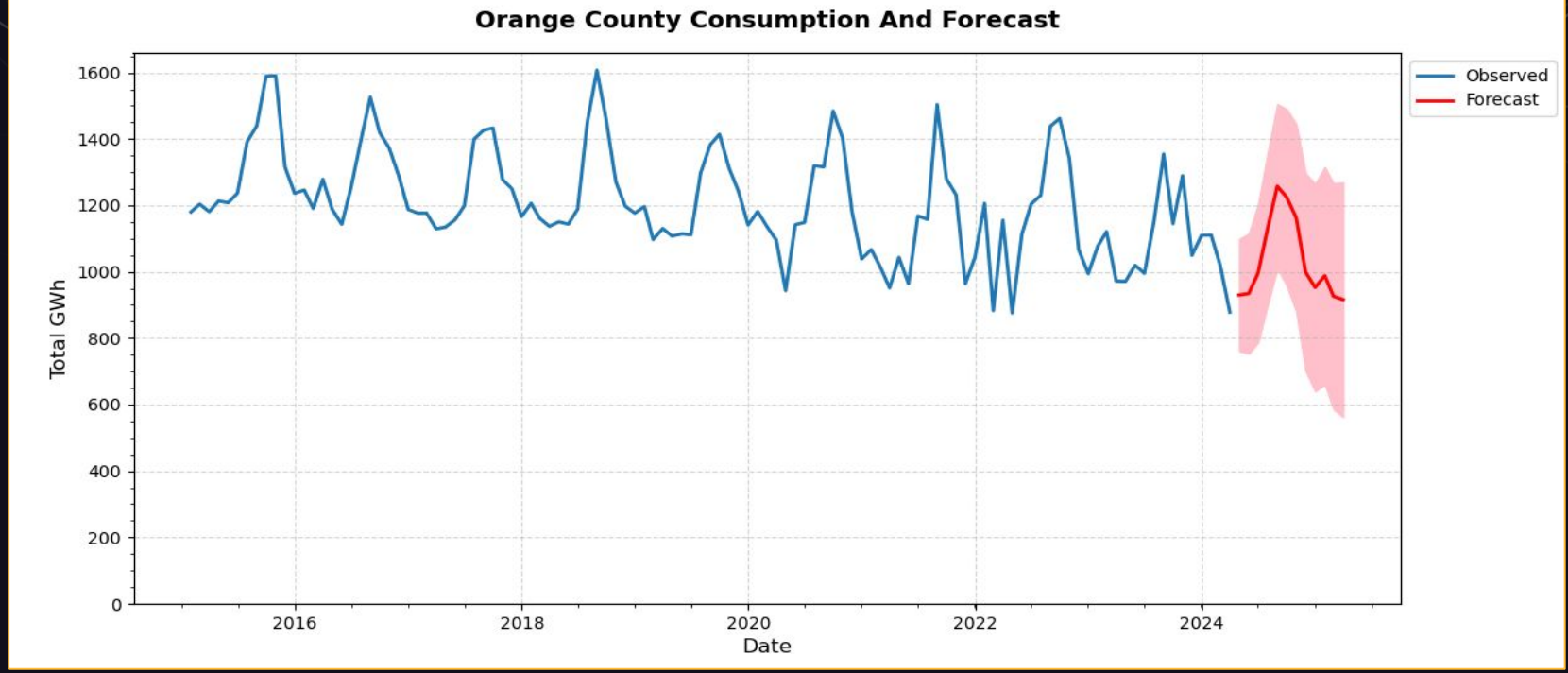
Total Observed	937.46
Total Forecasted	970.04
Difference	**3.47 %**

Santa Barbara Consumption By Customer Class



	Residential	Commerical	Industrial	Agricultural
Santa Barbara	3561.123	4488.228	2081.719	541.572

Counties With A Projected Usage ***Decrease***

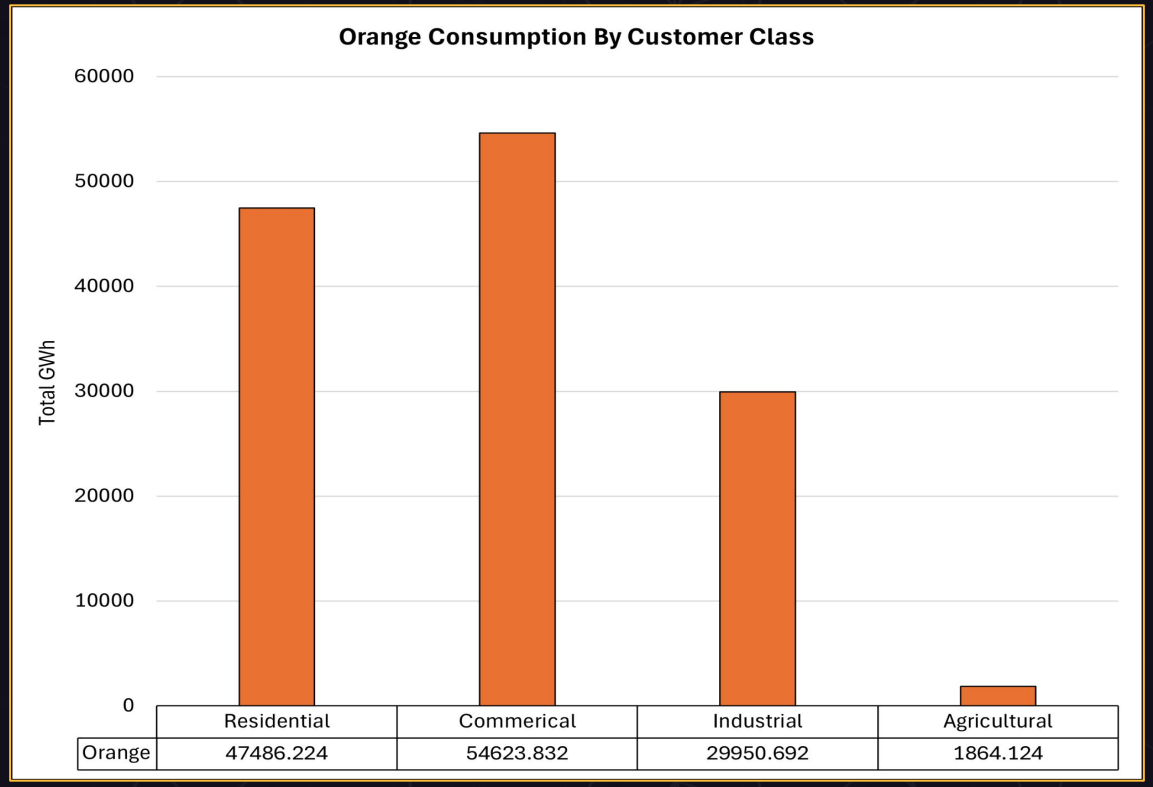


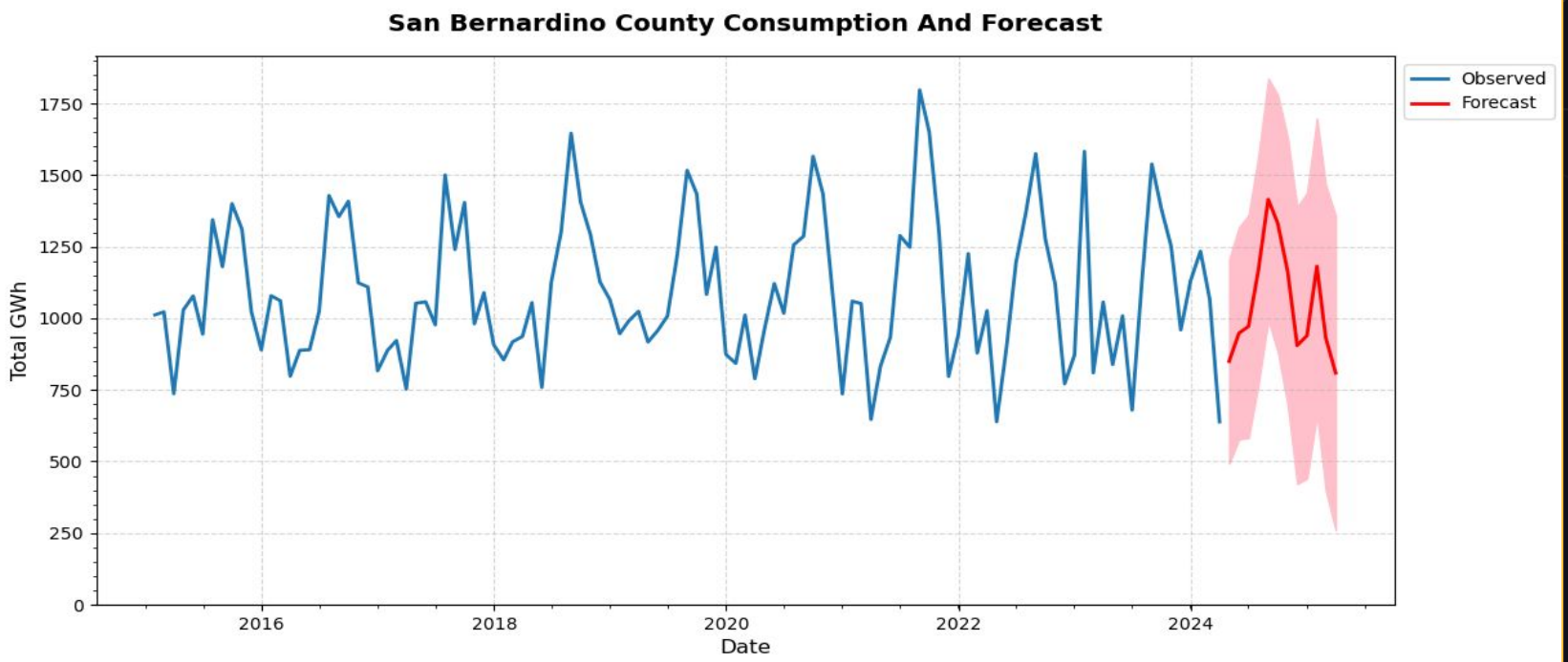
Date	Observed (GWh)
30-Apr-23	971.132
31-May-23	1019.520
30-Jun-23	995.141
31-Jul-23	1153.507
31-Aug-23	1355.042
30-Sep-23	1144.992
31-Oct-23	1289.703
30-Nov-23	1049.532
31-Dec-23	1109.989
31-Jan-24	1110.921
29-Feb-24	1019.566
31-Mar-24	878.710

Date	Forecasted (GWh)
30-Apr-24	930.060
31-May-24	934.348
30-Jun-24	995.831
31-Jul-24	1131.029
31-Aug-24	1257.999
30-Sep-24	1224.933
31-Oct-24	1162.580
30-Nov-24	999.351
31-Dec-24	952.767
31-Jan-25	988.364
28-Feb-25	926.176
31-Mar-25	916.079

Total Observations
18731
MAE
76.19
RMSE
88.41

Total Observed	13,097.75
Total Forecasted	12,419.52
Difference	**- 5.18 %**


Orange Consumption By Customer Class
Total GWh
60000
50000
40000
30000
20000
10000
0
Residential
Commerical
Industrial
Agricultural
Orange
47486.224
54623.832
29950.692
1864.124



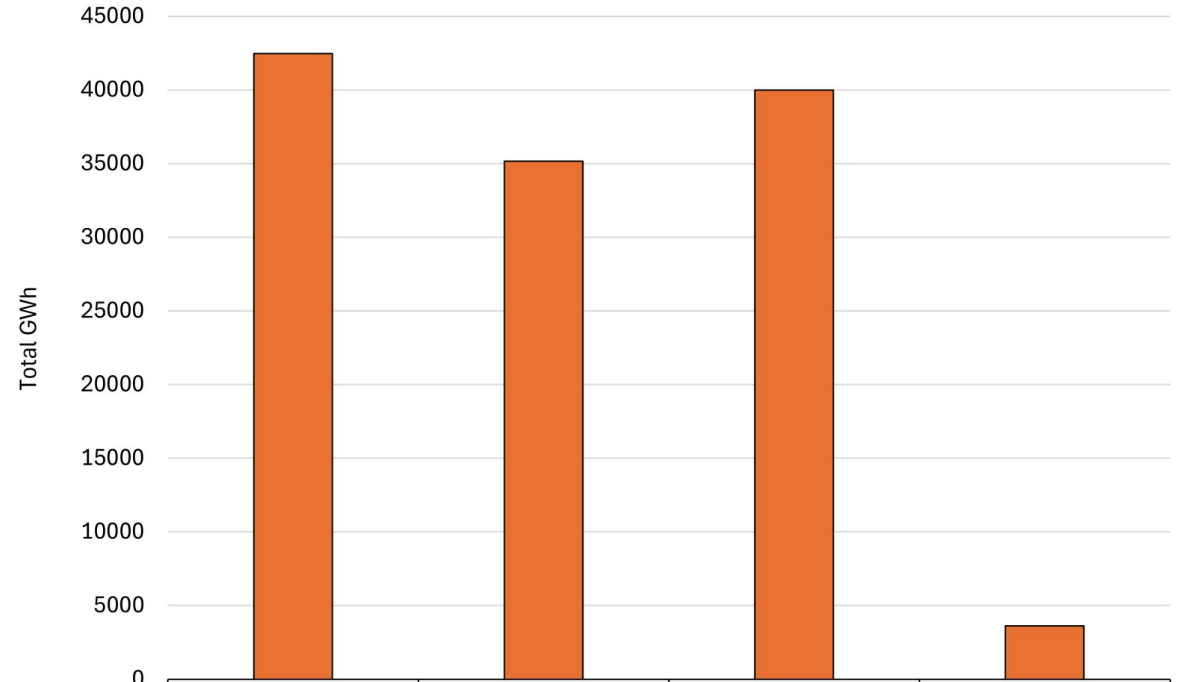
Date	Observed (GWh)
30-Apr-23	838.765
31-May-23	1008.538
30-Jun-23	679.274
31-Jul-23	1130.950
31-Aug-23	1538.715
30-Sep-23	1382.333
31-Oct-23	1249.857
30-Nov-23	959.405
31-Dec-23	1131.718
31-Jan-24	1234.221
29-Feb-24	1066.673
31-Mar-24	638.373

Date	Forecasted (GWh)
30-Apr-24	849.674
31-May-24	948.019
30-Jun-24	971.764
31-Jul-24	1167.896
31-Aug-24	1415.371
30-Sep-24	1331.546
31-Oct-24	1164.612
30-Nov-24	905.018
31-Dec-24	939.546
31-Jan-25	1181.763
28-Feb-25	931.404
31-Mar-25	808.863

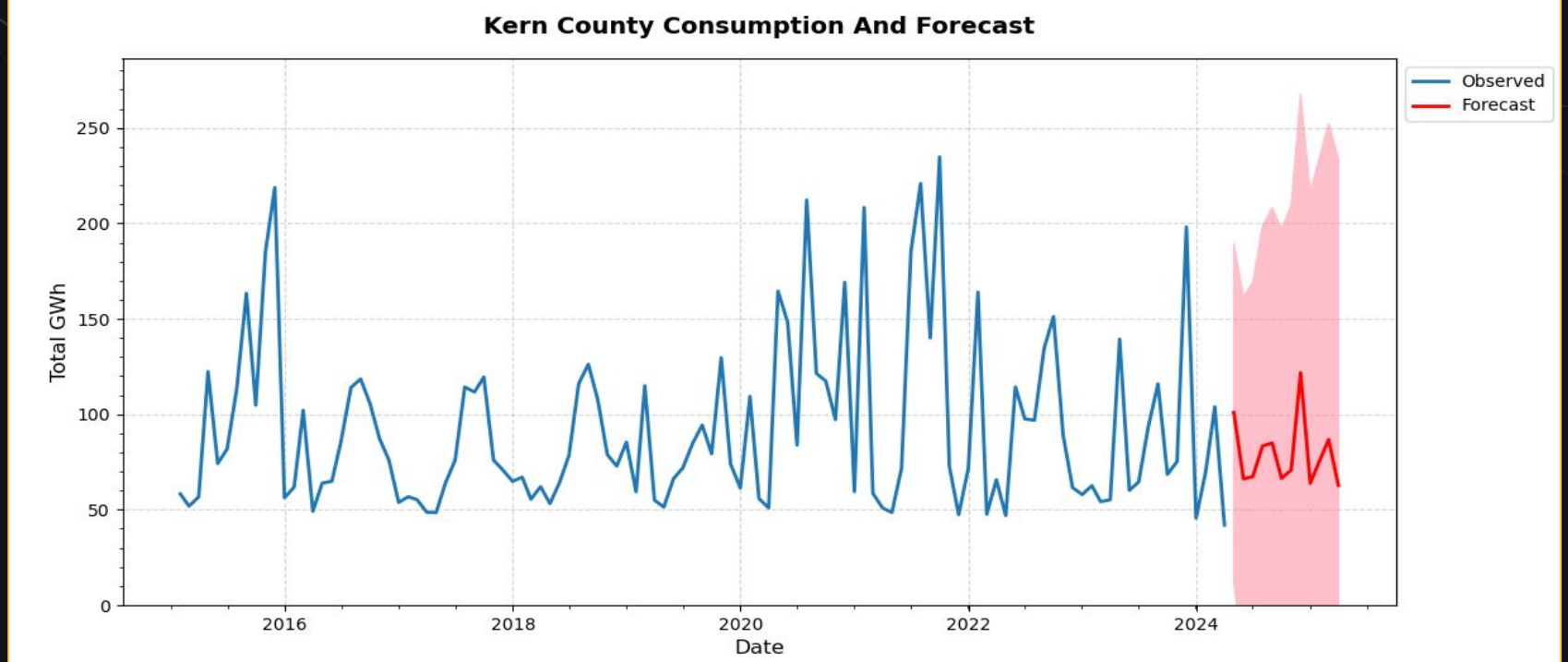
Total Observations
18069
MAE
105.42
RMSE
130.95

Total Observed	12,858.82
Total Forecasted	12,615.48
Difference	**- 1.89 %**

San Berdardino Consumption By Customer Class



	Residential	Commerical	Industrial	Agricultural
San Berdardino	42474.197	35158.772	39998.672	3625.635



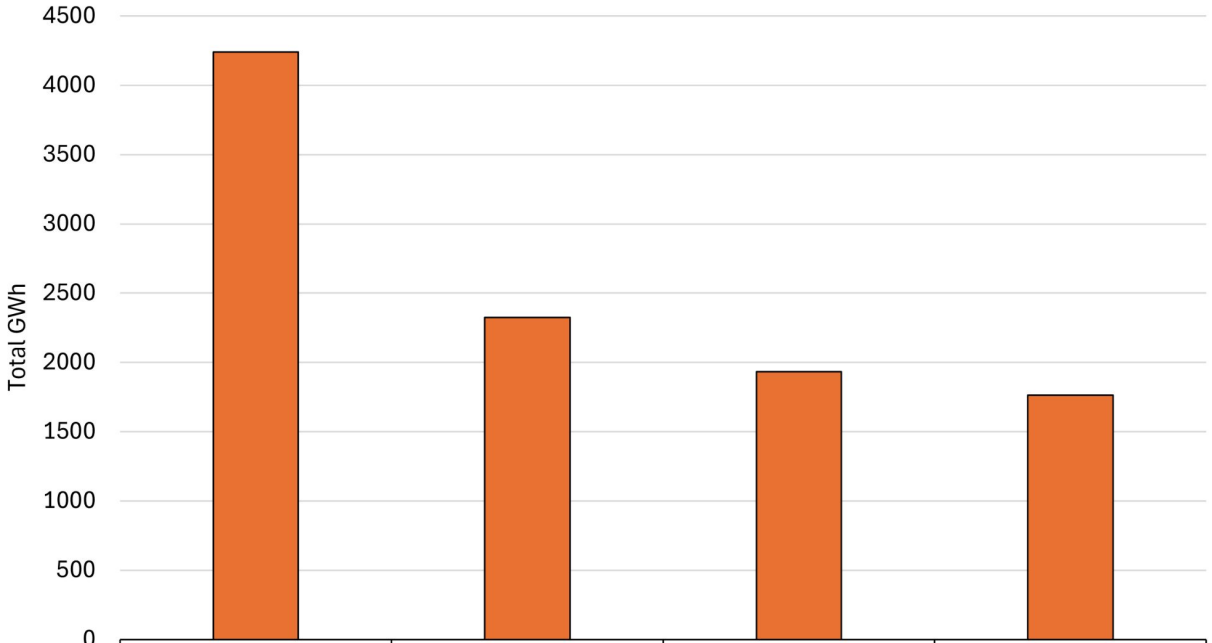
Date	Observed (GWh)
30-Apr-23	139.345
31-May-23	60.149
30-Jun-23	64.516
31-Jul-23	93.569
31-Aug-23	115.908
30-Sep-23	68.494
31-Oct-23	75.167
30-Nov-23	198.119
31-Dec-23	45.562
31-Jan-24	70.029
29-Feb-24	103.897
31-Mar-24	41.919

Date	Forecasted (GWh)
30-Apr-24	100.937
31-May-24	66.101
30-Jun-24	67.326
31-Jul-24	83.380
31-Aug-24	84.944
30-Sep-24	66.433
31-Oct-24	70.800
30-Nov-24	121.707
31-Dec-24	63.794
31-Jan-25	76.064
28-Feb-25	86.752
31-Mar-25	62.793

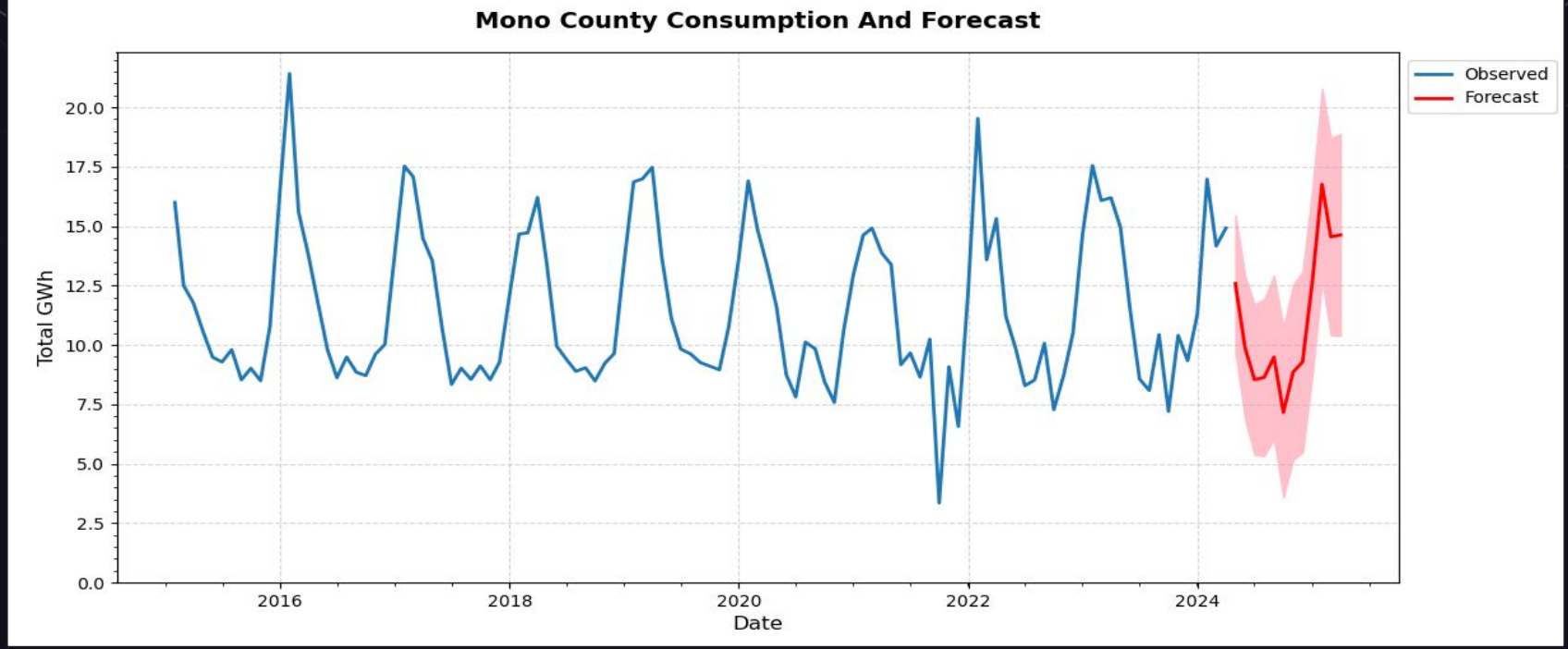
Total Observations
4581
MAE
19.45
RMSE
28.2

Total Observed	1,076.68
Total Forecasted	951.03
Difference (%)	**- 11.67**

Kern Consumption By Customer Class



	Residential	Commerical	Industrial	Agricultural
Kern	4239.782	2323.241	1934.912	1763.781

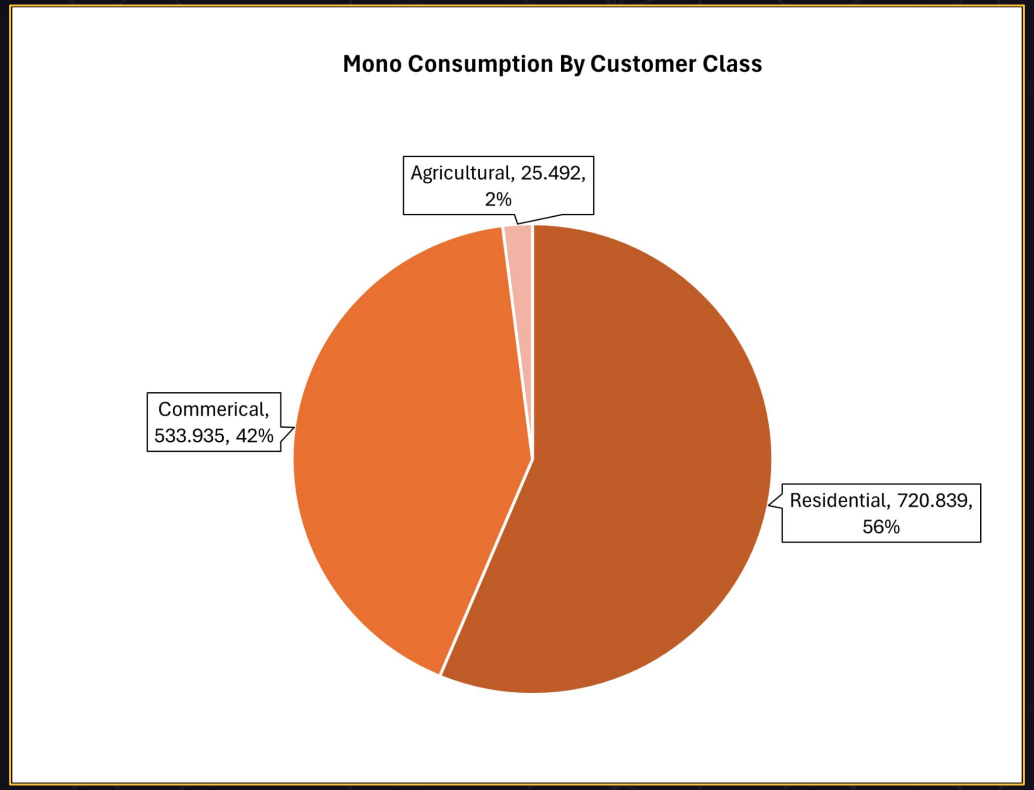


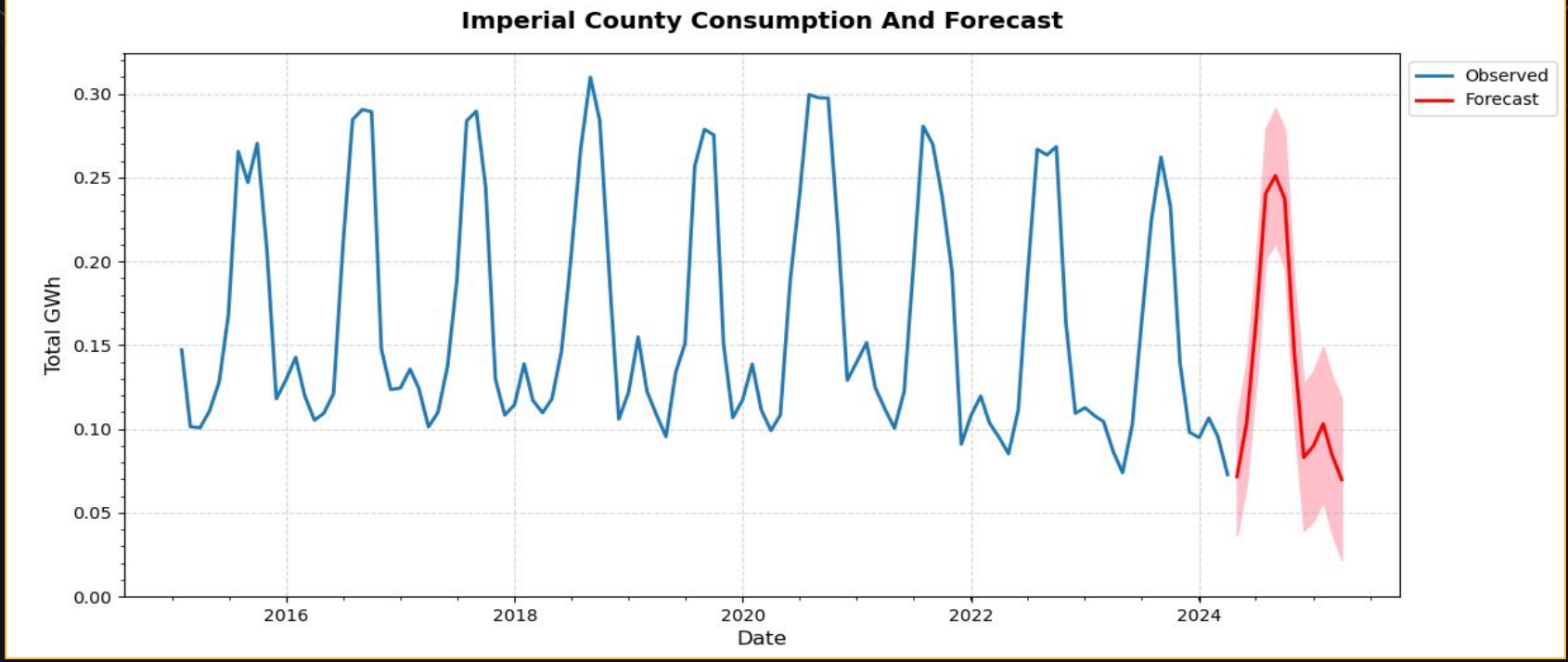
Date	Observed (GWh)
30-Apr-23	14.950
31-May-23	11.466
30-Jun-23	8.563
31-Jul-23	8.082
31-Aug-23	10.428
30-Sep-23	7.204
31-Oct-23	10.400
30-Nov-23	9.337
31-Dec-23	11.287
31-Jan-24	16.977
29-Feb-24	14.162
31-Mar-24	14.917

Date	Forecasted (GWh)
30-Apr-24	12.580
31-May-24	9.869
30-Jun-24	8.534
31-Jul-24	8.635
31-Aug-24	9.483
30-Sep-24	7.157
31-Oct-24	8.856
30-Nov-24	9.281
31-Dec-24	12.642
31-Jan-25	16.756
28-Feb-25	14.548
31-Mar-25	14.628

Total Observations
1051
MAE
0.78
RMSE
1.07

Total Observed	137.77
Total Forecasted	132.97
Difference	**- 3.49 %**


Mono Consumption By Customer Class
Agricultural, 25.492, 2%
Commerical, 533.935, 42%
Residential, 720.839, 56%

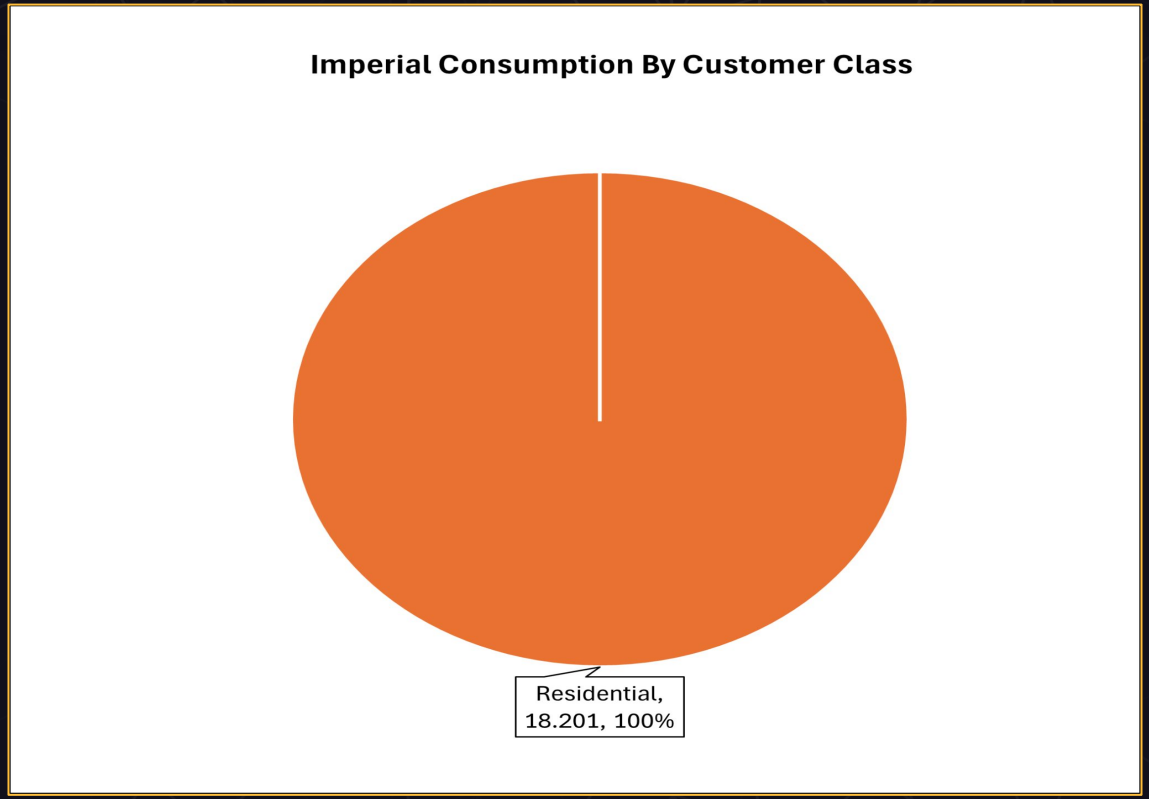


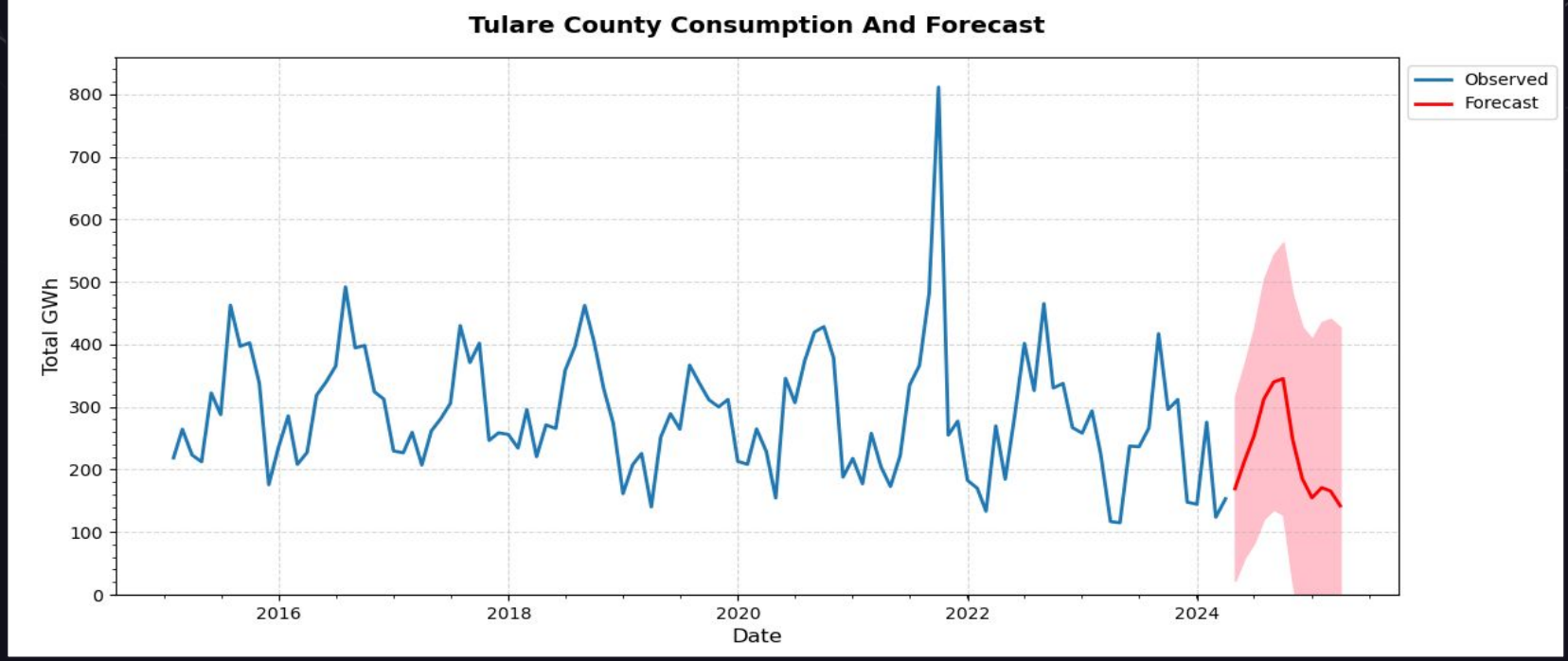
Date	Observed (GWh)
30-Apr-23	0.074
31-May-23	0.102
30-Jun-23	0.164
31-Jul-23	0.224
31-Aug-23	0.262
30-Sep-23	0.233
31-Oct-23	0.139
30-Nov-23	0.098
31-Dec-23	0.095
31-Jan-24	0.106
29-Feb-24	0.095
31-Mar-24	0.073

Date	Forecasted (GWh)
30-Apr-24	0.071
31-May-24	0.104
30-Jun-24	0.164
31-Jul-24	0.240
31-Aug-24	0.251
30-Sep-24	0.237
31-Oct-24	0.145
30-Nov-24	0.083
31-Dec-24	0.090
31-Jan-25	0.103
28-Feb-25	0.085
31-Mar-25	0.070

Total Observations
111
MAE
0.006
RMSE
0.008

Total Observed	1.67
Total Forecasted	1.64
Difference	**- 1.41** %


Imperial Consumption By Customer Class
Residential, 18.201, 100%

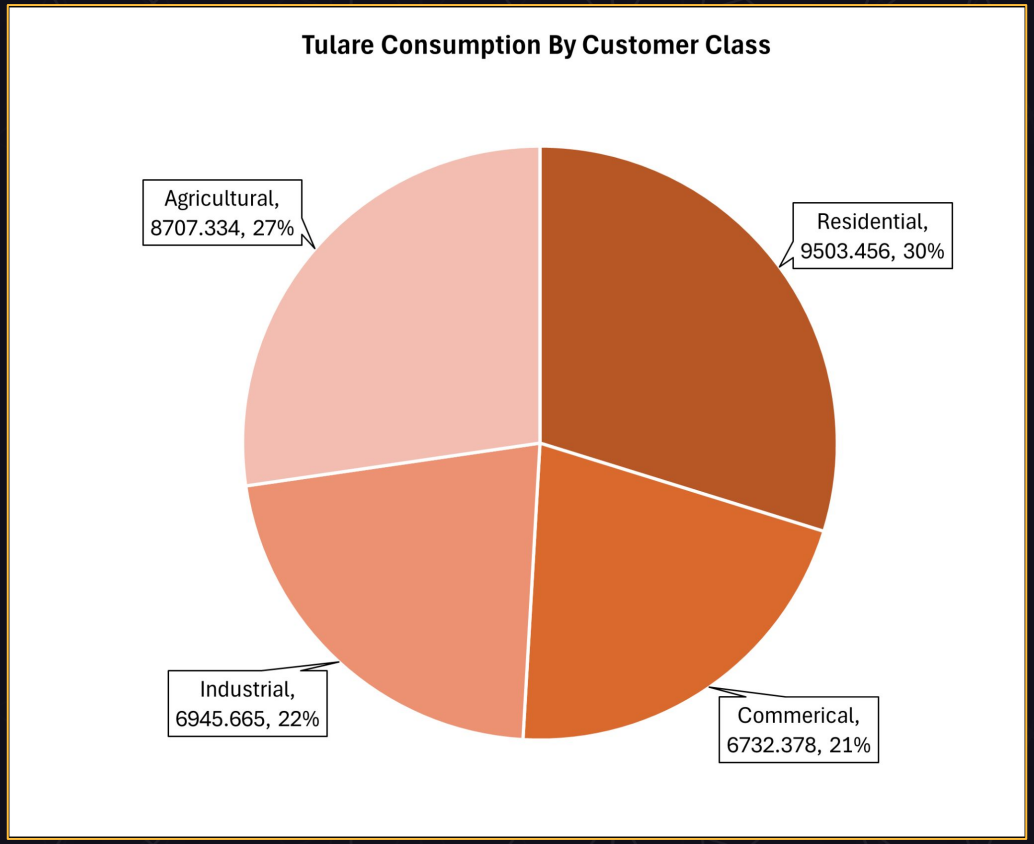


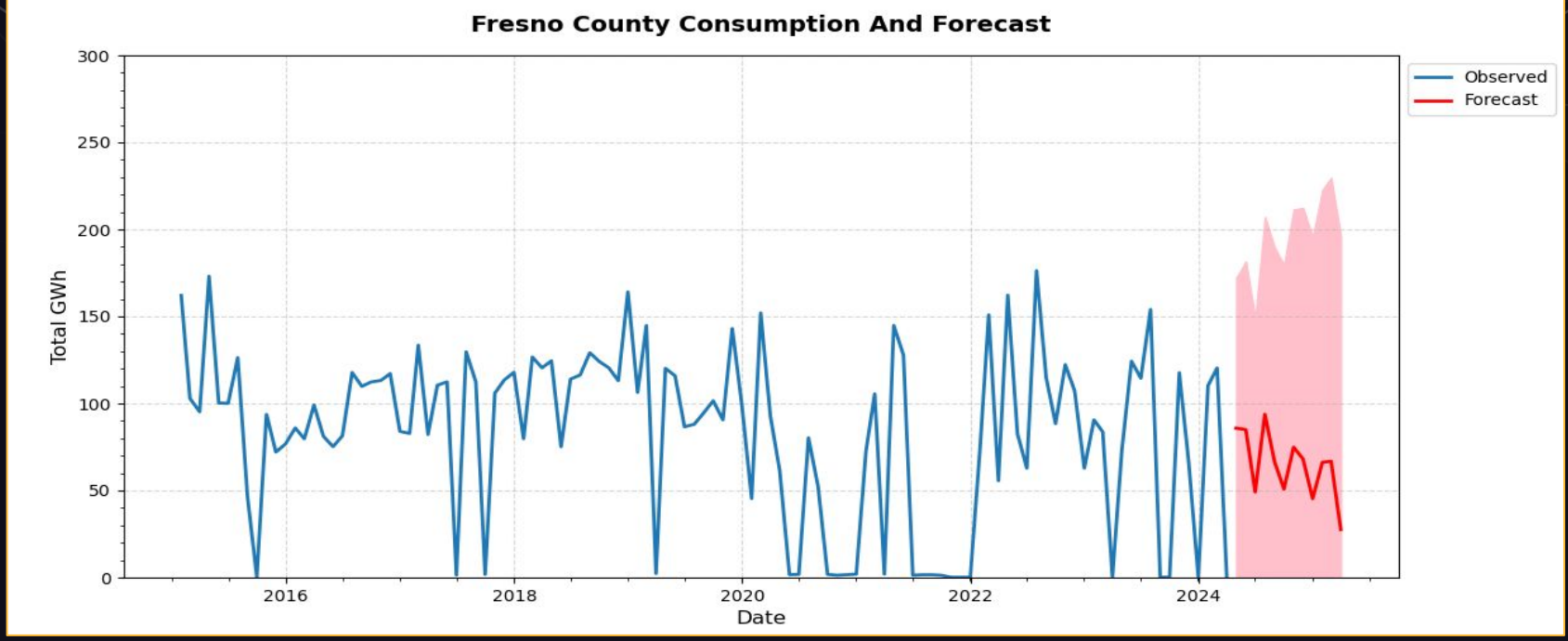
Date	Observed (GWh)
30-Apr-23	114.883
31-May-23	237.492
30-Jun-23	236.479
31-Jul-23	266.210
31-Aug-23	417.030
30-Sep-23	295.853
31-Oct-23	311.857
30-Nov-23	147.923
31-Dec-23	144.474
31-Jan-24	275.591
29-Feb-24	123.848
31-Mar-24	153.148

Date	Forecasted (GWh)
30-Apr-24	169.310
31-May-24	214.523
30-Jun-24	254.360
31-Jul-24	312.753
31-Aug-24	339.845
30-Sep-24	345.275
31-Oct-24	247.002
30-Nov-24	185.609
31-Dec-24	154.799
31-Jan-25	170.942
28-Feb-25	165.654
31-Mar-25	141.944

Total Observations
6768
MAE
44.91
RMSE
52.39

Total Observed	2,724.79
Total Forecasted	2,702.02
Difference	**- 0.84** %


Tulare Consumption By Customer Class
Agricultural, 8707.334, 27%
Residential, 9503.456, 30%
Industrial, 6945.665, 22%
Commerical, 6732.378, 21%



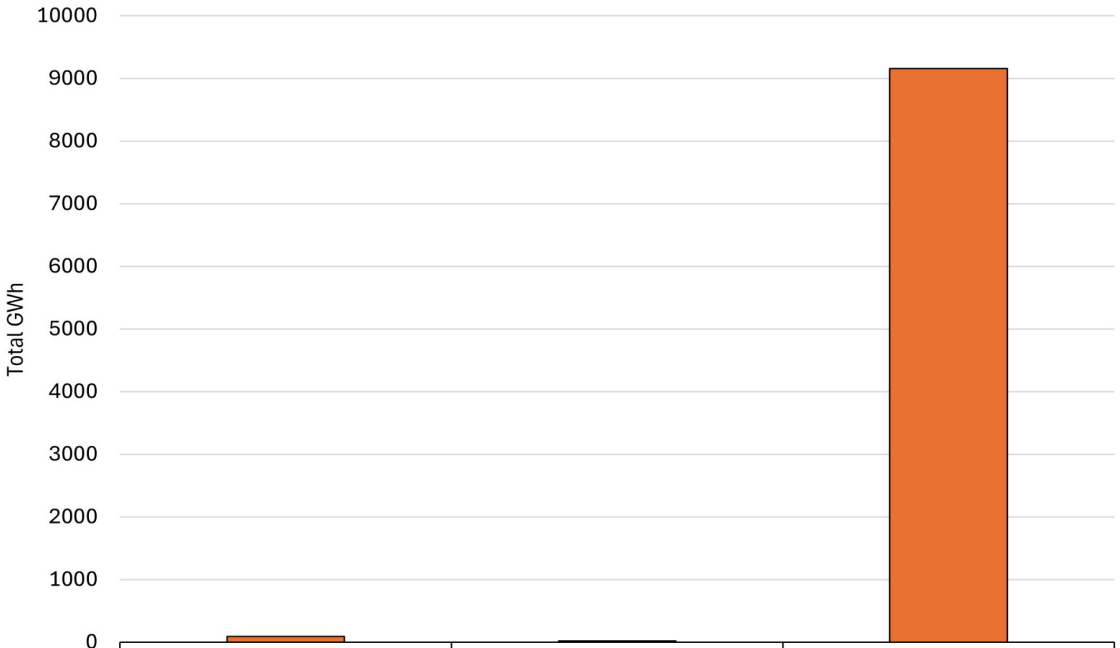
Date	Observed (GWh)
30-Apr-23	72.789
31-May-23	124.279
30-Jun-23	114.516
31-Jul-23	154.037
31-Aug-23	0.167
30-Sep-23	0.151
31-Oct-23	117.692
30-Nov-23	66.502
31-Dec-23	0.170
31-Jan-24	110.219
29-Feb-24	120.384
31-Mar-24	0.223

Date	Forecasted (GWh)
30-Apr-24	85.817
31-May-24	85.005
30-Jun-24	49.180
31-Jul-24	93.798
31-Aug-24	66.532
30-Sep-24	50.811
31-Oct-24	74.910
30-Nov-24	68.176
31-Dec-24	45.302
31-Jan-25	66.190
28-Feb-25	66.836
31-Mar-25	27.594

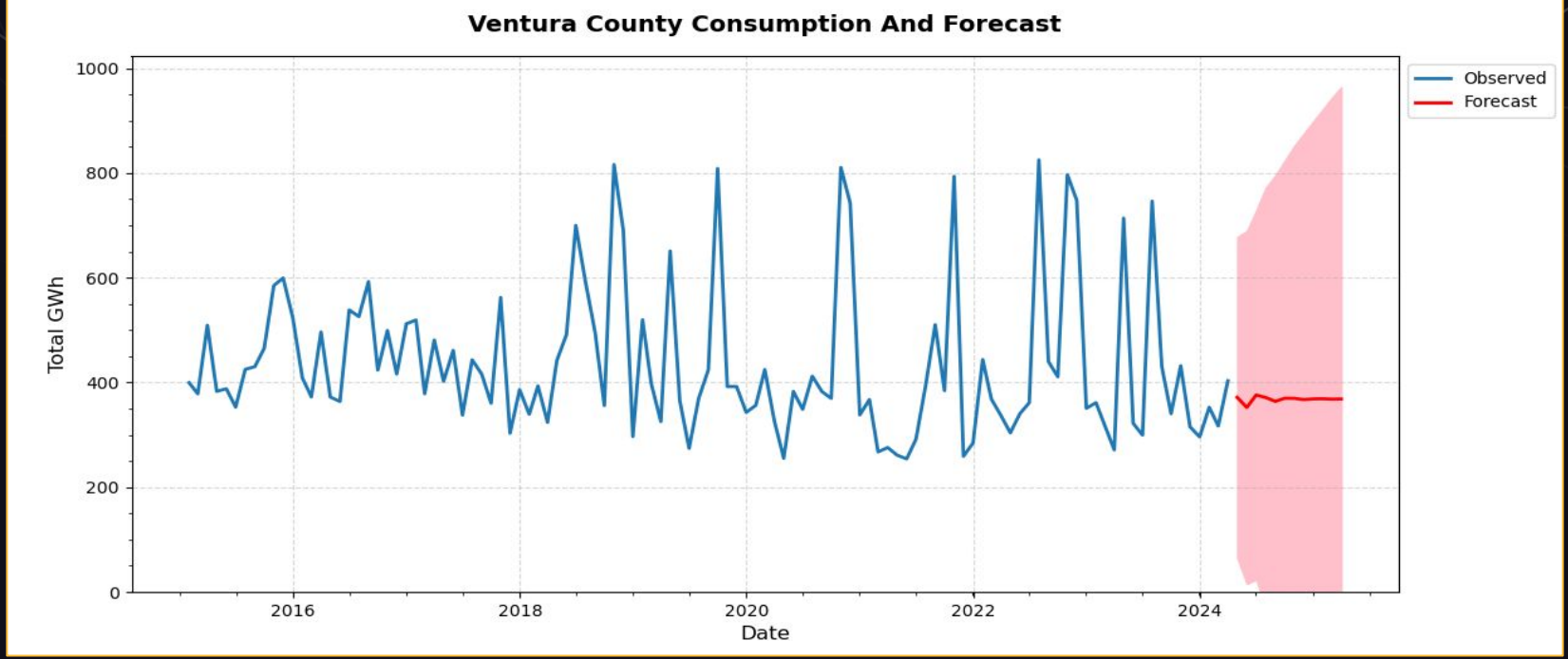
Total Observations
406
MAE
42.45
RMSE
46.55

Total Observed	881.13
Total Forecasted	780.15
Difference	**- 11.46 %**

Fresno Consumption By Customer Class



	Residential	Commerical	Industrial
Fresno	96.757	23.137	9159.605



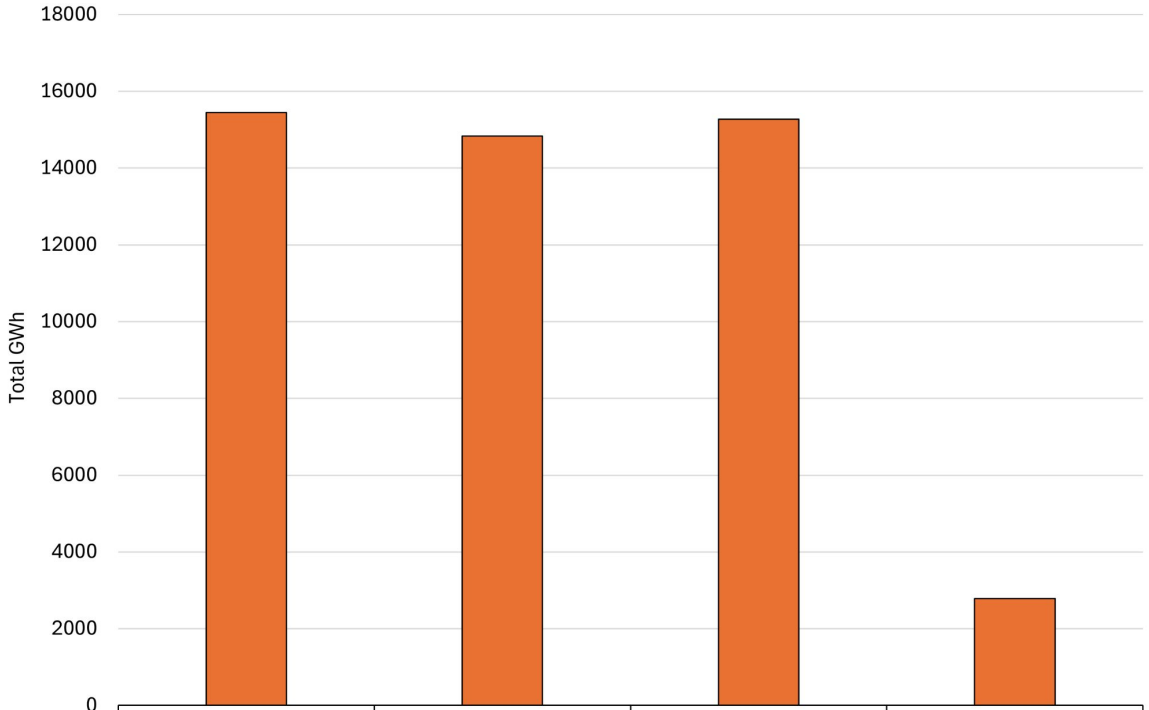
Date	Observed (GWh)
30-Apr-23	713.766
31-May-23	321.825
30-Jun-23	299.496
31-Jul-23	746.334
31-Aug-23	430.502
30-Sep-23	340.429
31-Oct-23	431.967
30-Nov-23	315.261
31-Dec-23	296.089
31-Jan-24	352.580
29-Feb-24	316.846
31-Mar-24	403.144

Date	Forecasted (GWh)
30-Apr-24	371.545
31-May-24	352.384
30-Jun-24	375.994
31-Jul-24	371.288
31-Aug-24	363.919
30-Sep-24	369.873
31-Oct-24	369.751
30-Nov-24	367.318
31-Dec-24	368.683
31-Jan-25	368.967
28-Feb-25	368.241
31-Mar-25	368.514

Total Observations
6524
MAE
100.8
RMSE
154.33

Total Observed	4,968.24
Total Forecasted	4,416.48
Difference	**- 11.11 %**

Ventura Consumption By Customer Class



	Residential	Commerical	Industrial	Agricultural
Ventura	15444.865	14841.867	15278.166	2786.434

Madera County

Date	ZipCode	County	Month	Year	CustomerClass	TotalkWh	TotalGWh
2017-06-01	93643	Madera County	6	2017	Commercial	179924.0	0.179924
2015-10-01	93643	Madera County	10	2015	Commercial	152547.0	0.152547
2019-10-01	93643	Madera County	10	2019	Commercial	177920.0	0.177920

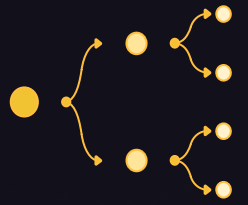
Not Enough Data

Limitations Possibly Affecting Models

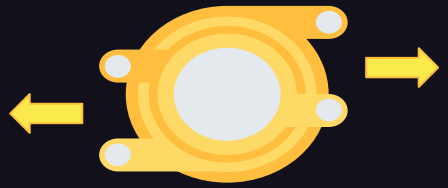
Limited Historical Data

Scope

Drastic Seasonality



Unpredictable Events



Resource Allocation Strategies

- Involves optimizing operational processes, enhancing customer service, adopting innovative technologies, and promoting sustainability

Data-Driven Decision Making

- Use data analytics tools to collect and analyze data on consumption patterns, peak demand time, and customers' preferences
- Predictive analytics to forecast future demand and identify areas for resource optimization
- Real-time monitoring systems could help respond to fluctuations in supply and demand

Regulatory Compliance and Risk Management

Requirements

Stay up to date on energy regulation utilities and addresses risks and limitations

Mitigating Risk

Plans related to supply chain disruptions, cyber threats, and natural disasters should be prepared

Infrastructure Investment

Renewables

Prioritize investments in renewables to **diversify the energy mix** and reduce reliance on fossil fuels

Distribution

Upgrade **transmission and distribution networks** to improve efficiency, reliability, and resilience against extreme weather events and cyber threats

Technologies

Invest in **smart grid technologies** like advanced metering infrastructure (AMI) and distribution automation, to enable remote monitoring and control of energy distribution

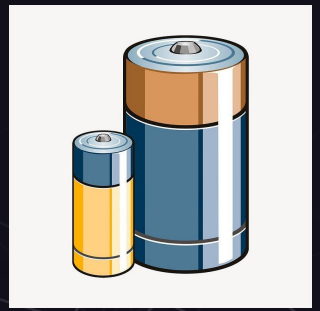
Energy Storage Solutions

Battery Storage Solutions:

- Lithium-Ion Batteries:
  - high energy density,fast response times, scalable.
  - Better for smaller scale projects (residential, commercial, or industrial)
- Flow Batteries (vanadium redox):
  - long cycle life and scalable.
  - Better for larger scale projects (Grid-scale)

Pumped Hydro Storage Solutions:

- Existing Reservoirs:
  - leverage existing reservoirs and hydroelectric facilities for pumped hydro storage.
- New Pumped Storage Projects:
  - constructing new reservoirs or repurposing existing infrastructure to create a closed-loop pumped hydro storage system.
  - Significant cost implications



Sustainability Initiatives

- Create sustainability goals and include targets for reducing greenhouse gas emissions, increasing renewable energy capacity, and promoting energy efficiency
- Interact with stakeholders to support and align with sustainability efforts

Energy-Saving Initiatives

- Designing customized energy-saving initiatives for high electricity consumption areas involves a multifaceted approach

Data Analysis & Assessment

Data Collection

Collect data on target areas for energy consumption including residential, commercial, and industrial sectors

Assessment

Identify peak times of energy consumption, major factors to the latter, and areas with most potential to improve

Demand Response & Time-of-Use Pricing

- Implement demand response programs to incentivize participants in targeted areas to reduce electricity usage during peak demand periods
- Time-of-use pricing plans that encourage customers to shift energy-intensive activities to off-peak hours would reduce strain on the grid and lower energy costs

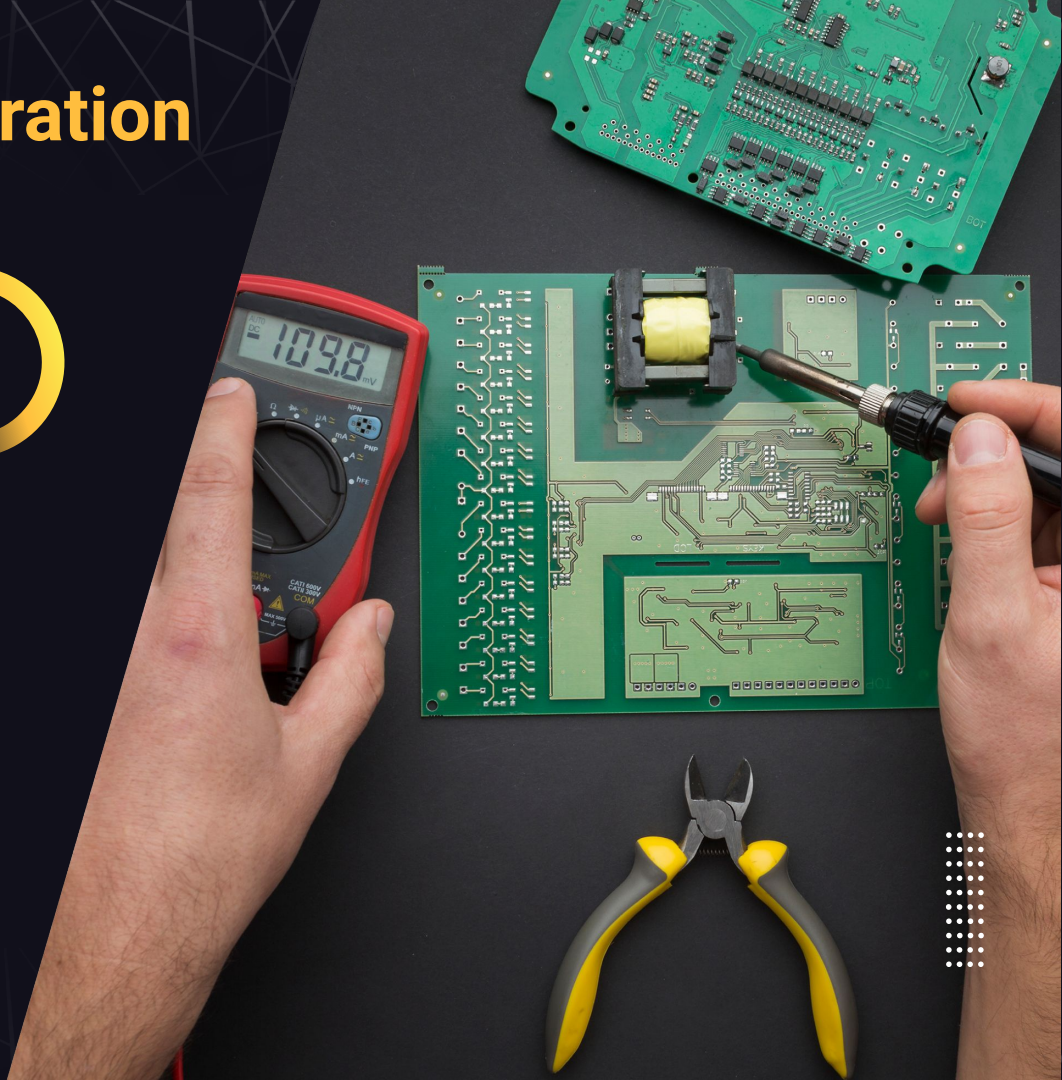
Monitoring Feedback

- Implement real-time monitoring of energy consumption and savings systems to track effectiveness
- Provide feedback to participants and stakeholders on energy usage and savings to determine successes and areas for improvement

Technology Integration

Introduce energy-efficient technologies such as ***LED lighting, smart thermostats, and energy-efficient appliances*** *through subsidized or discounted programs*

Provide ***training and support*** *for the installation, operation, and maintenance of these technologies to ensure maximum effectiveness.*



Incentive Programs

- Encourage adoption of energy-efficient technologies
- Make sure incentives match the needs and preferences of target demographic such as income level, property household, & customer class

Business Energy Assessments & Incentives

Offer financial incentives, rebates, or low-interest loans to businesses for implementing energy-saving measures such as lighting upgrades, equipment optimizations, and building envelope improvements.

Partner with local businesses to conduct energy assessments and identify opportunities for efficiency improvements

Continuous Improvement

Internal Culture Development:

- Actively seek feedback from employees
- Use suggestion boxes, forums, and recognition programs
- Incentivize and reward innovative ideas and contributions

Cross-Sector Collaboration:

- Collaborate with research institutions, universities, and startups
- Exchange ideas, share knowledge, and collaborate on research and develop initiatives

Training and Development:

- Invest in training and development programs to enhance employees
- Provide workshops, seminars, and conferences focus on the and emerging technology within the energy industry

Data-Decision Making:

- Leverage data analytics, machine learning, and predictive modeling techniques to identify opportunities for optimization and efficiency improvement.

Policy Support

Advocacy

Get support for policies at local, regional, and national levels to create an enabling environment for energy conservation

What does it include?

Building codes that mandate energy-efficient construction standards, incentives for renewable energy adoption, or demand-side

Partnerships and Collaboration

Government Agency Collaborations:

- Collaborate with government agencies at the local, state, and federal levels to align efforts in promoting energy efficiency, renewable energy adoption, and regulatory compliance.
- Benefits: Regulatory Compliance and Support, Access to Funding and Incentives, Public Policy Advocacy

Non-Profit Organization Partnerships:

- Partner with non-profit organizations focused on sustainability, energy conservation, and community development to leverage their expertise, networks, and community outreach capabilities. (Environmental Defense Fund, Sierra Club, Alliance to Save Energy)
- Benefits: Access to Expertise and Resources, Expanded Reach and Community Engagement, Enhanced Credibility and Trust

THANK YOU