Roseville Electric Utility Statistically Adjusted End Use Model

WLRA

April 2016

CITY OF ROSEVILLE CALIFORNIA

Roseville Electric Utility

- Municipal Utility located east of Sacramento CA.
- 57,000 customer (50,000 residential customers)
- 340 MW annual system peak
- High concentration of rooftop solar, 6% of single family homes have rooftop solar
- Adding approximately 700 customers per year due to greenfield development of new homes

California Policy Impacting Forecasts

- Rooftop solar adoption
- Electric vehicle adoption
- Net zero energy homes
  - All new home construction after 2020 will be net zero energy
  - All new commercial after 2030 will be net zero energy
- SB350 - Doubling of Energy Efficiency savings in existing buildings by 2030

Electric Vehicles

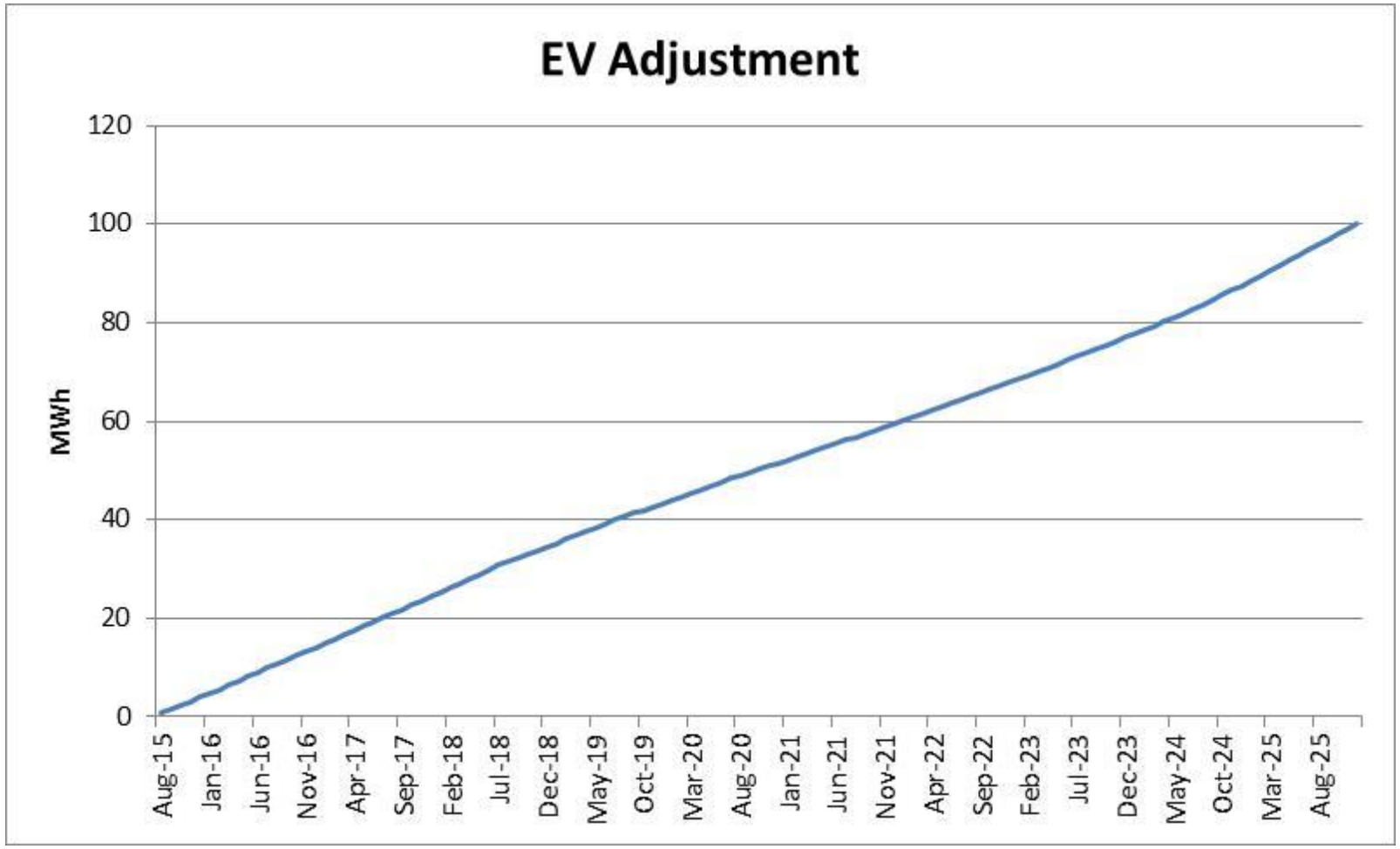
EV Assumption

- Currently Roseville has approximately 270 registered electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs).

- The stock of electric vehicles is allowed to grow at the annual growth rate forecasted by the Energy Information Administration (EIA).
  - The growth rate for 2016 is ≈ 21%; growth declines annually, reaching ≈ 9% in 2025.

- Assume that on average an electric vehicle uses 2,084 kWh of energy annual. (Vermont study on EV kWh usage)
  - Based on 12,000 miles annually and the potential mix of EVs and PHEVs.

Resulting EV Impact-update



Rooftop Solar

PV Assumption

- Currently Roseville has approximately 2,360 residential solar customers; with a total installed capacity of ≈ 8.3 MW.
  - Assume that 50 new residential solar systems will be added each month, representing new construction.
  - Additionally, 10 retrofits of existing housing stock will occur each month.
  - Average solar system size of retrofits will be 3.5 kW. Average size of new residential solar will slowly increase to be net zero for new homes by 2020.

- Given the assumptions regarding additional customers and average system size a monthly installed capacity forecast (MW) is generated.
- Solar is generation is then used as a variable in the Residential Use Per Customer regression model.

California Senate Bill 350

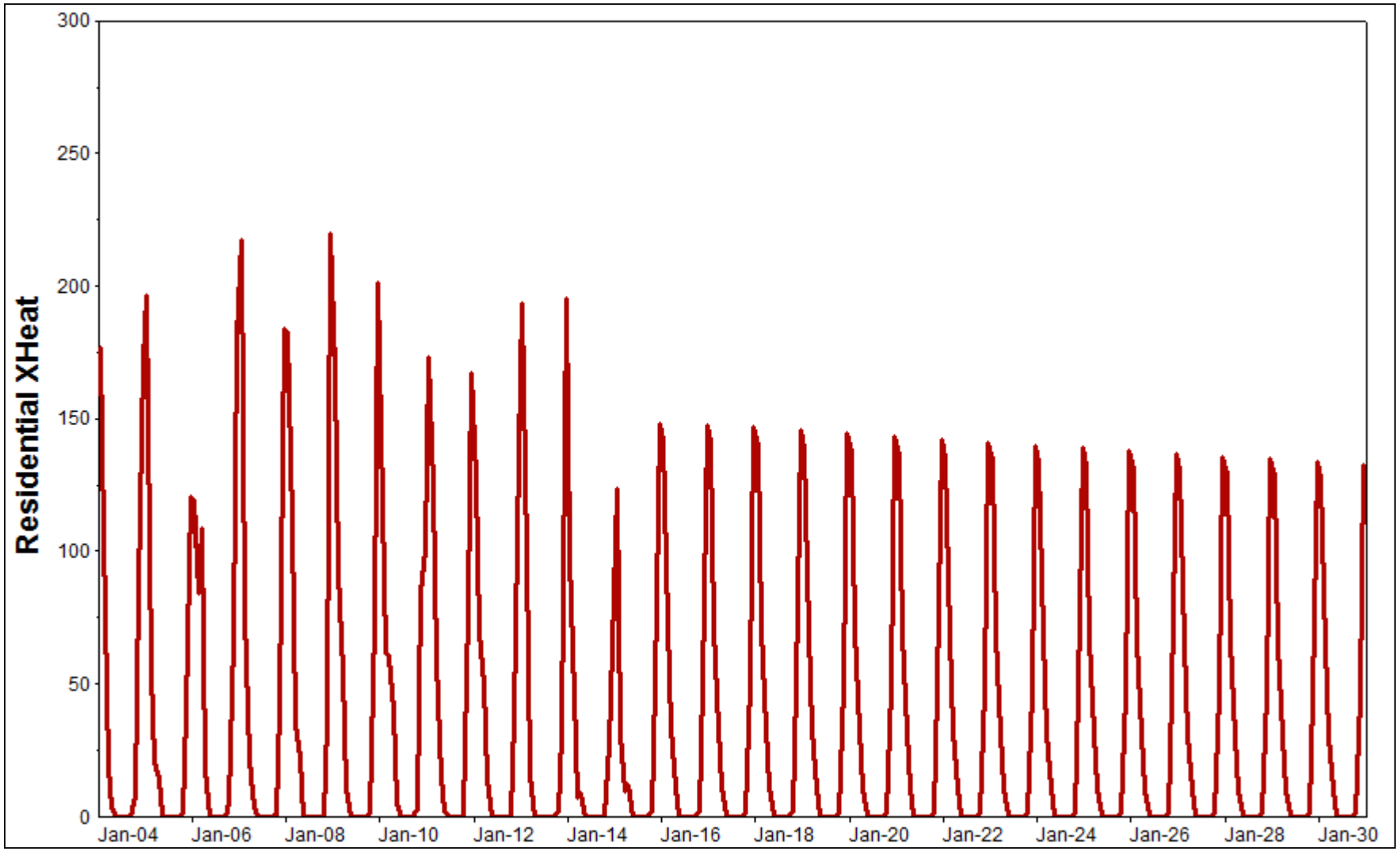
SB 350 Assumptions

SB350

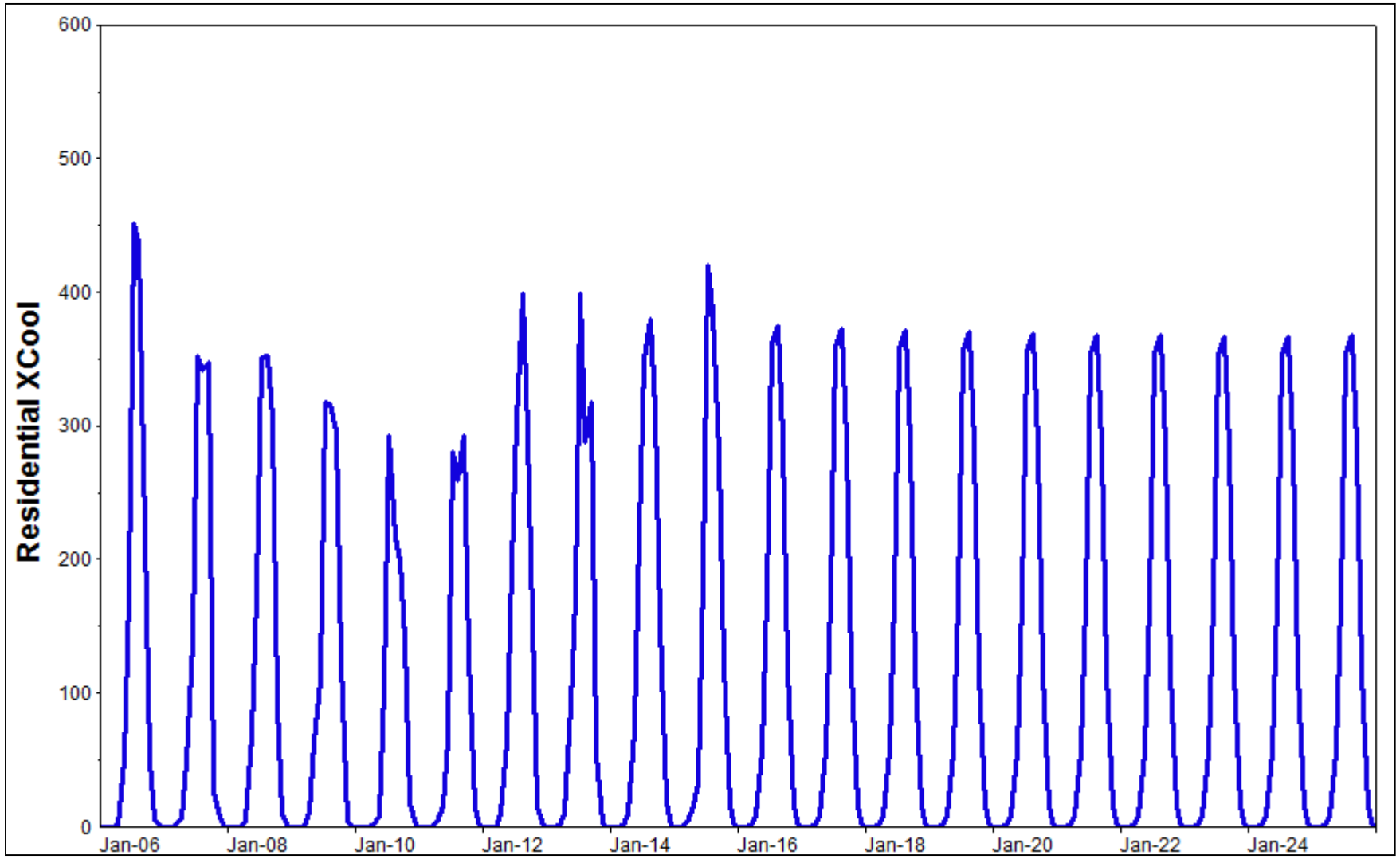
- Increasing energy efficiency in the small and medium commercial classes. The class as a whole will reduce load by 2.5% per year starting in 2024.
- Additional data on the implementation of SB350 will likely change the way this law is forecasted. Very little data exists today.

Residential Forecast

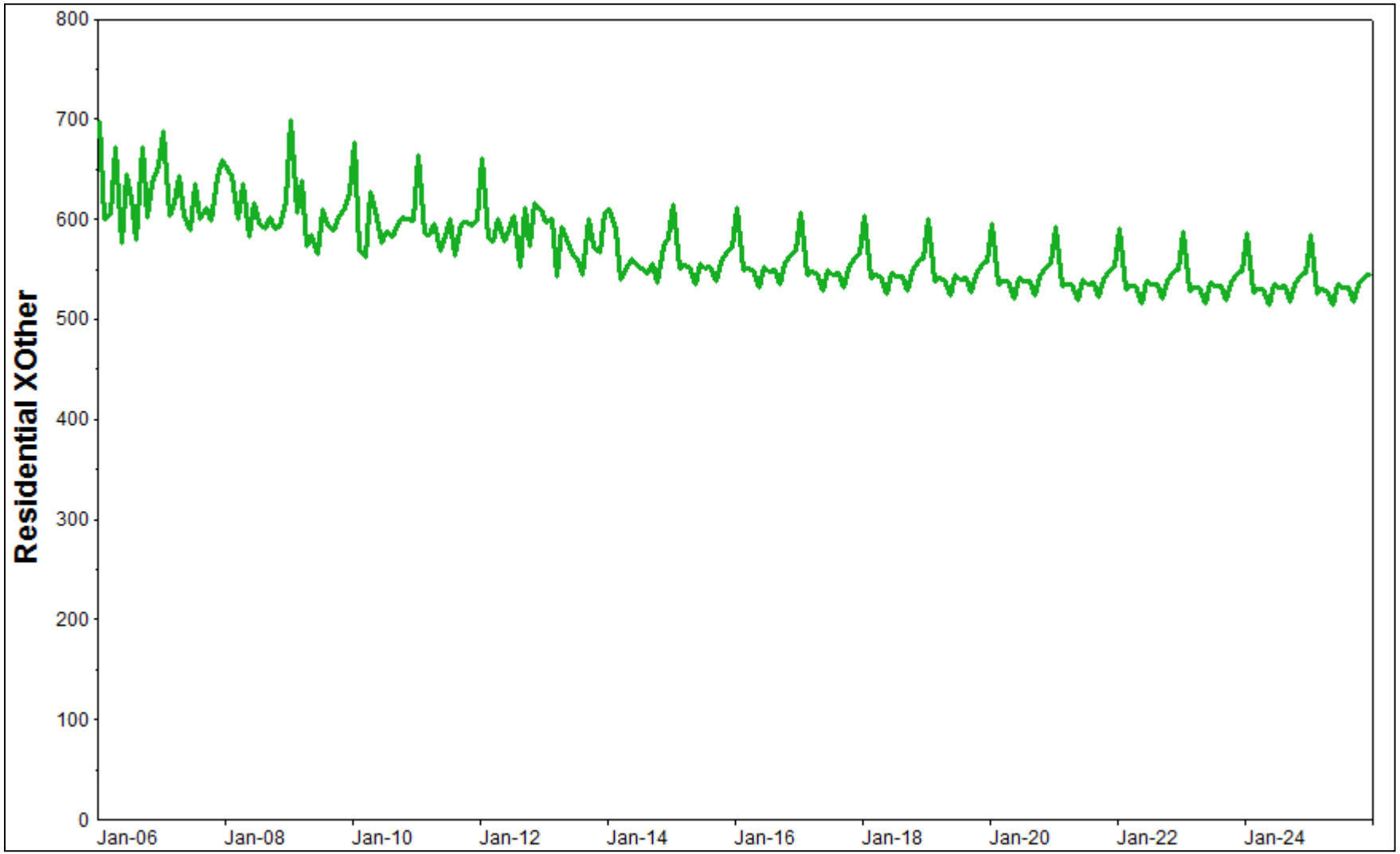
Residential Heating Variable



Residential Cooling Variable

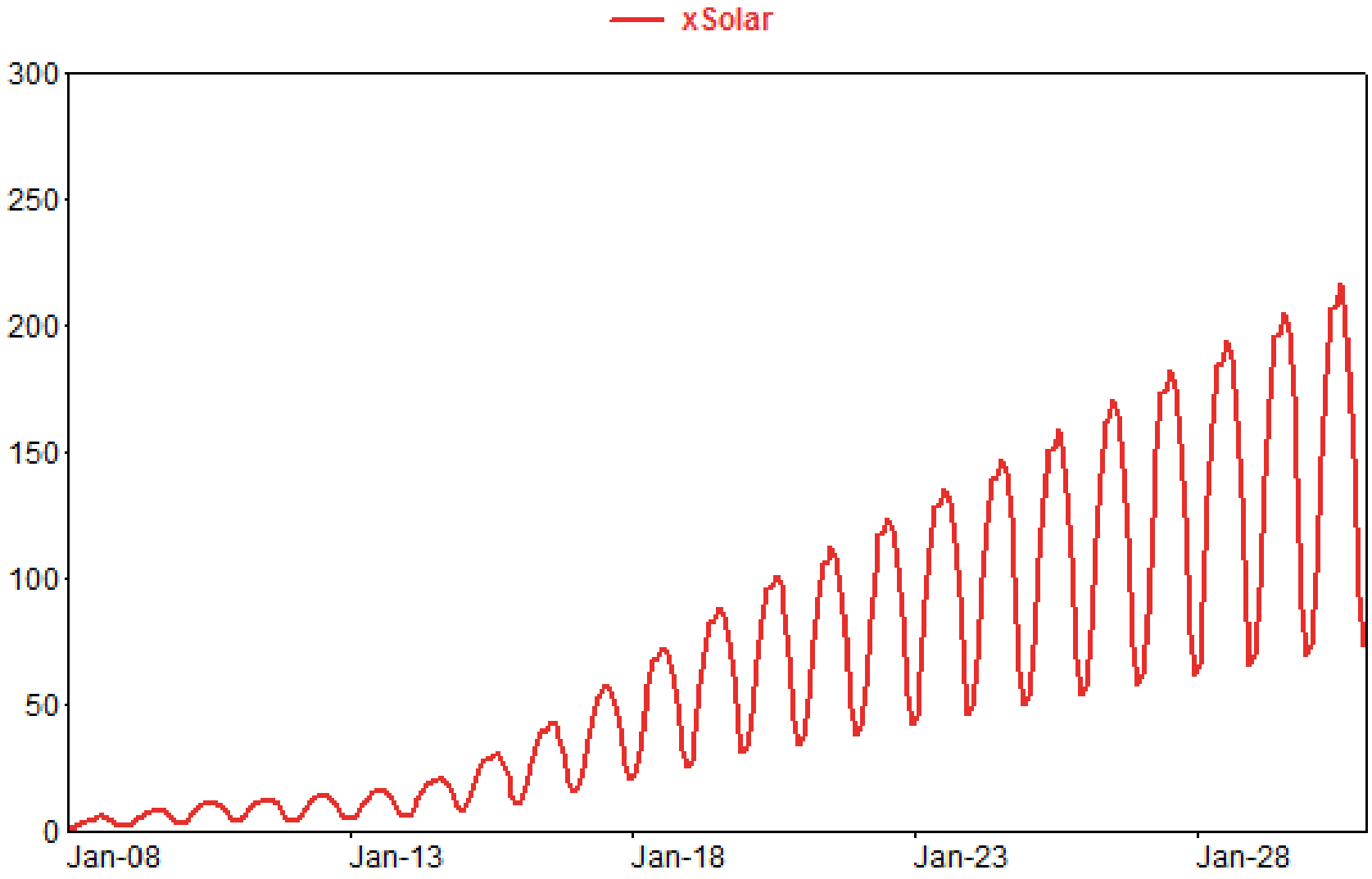


Residential XOther Variable



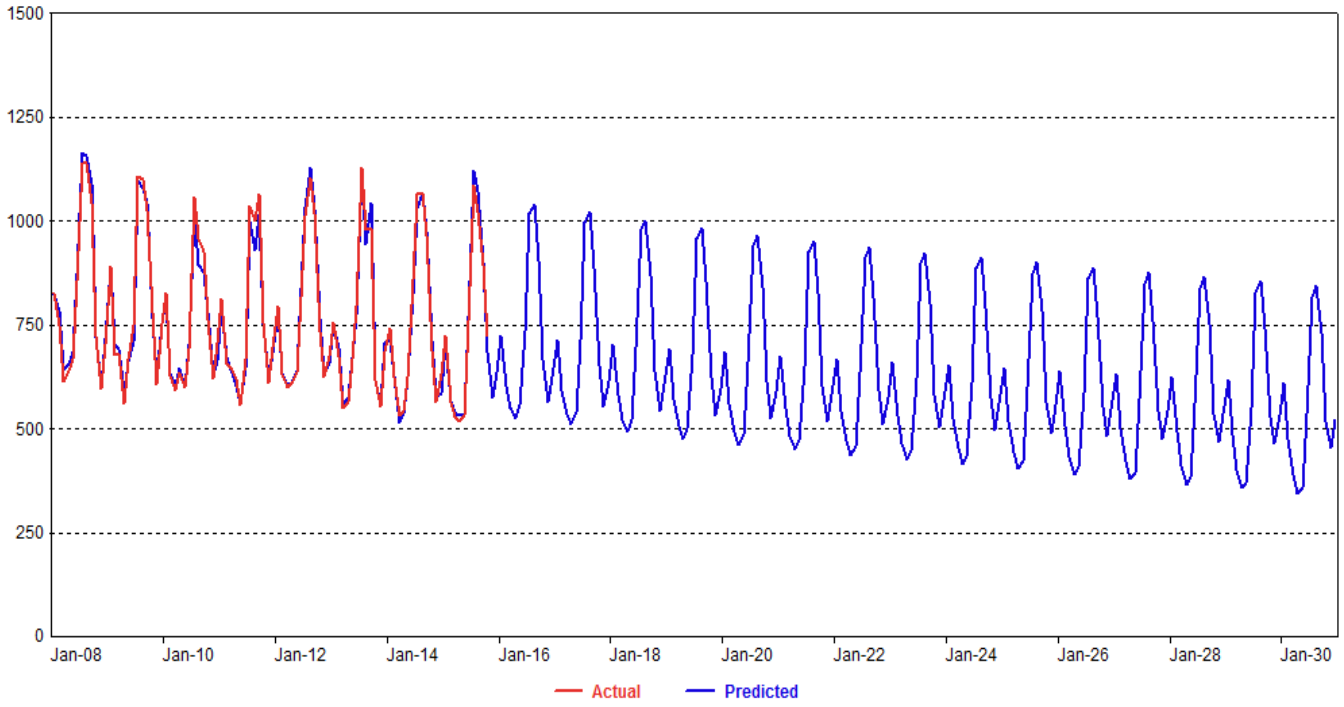
Xother includes the economic variables HHSize, HHIncome, and Electricity Price

Residential Xsolar Variable



Residential Average Use Model

Model Statistics	
Iterations	1
Adjusted Observations	94
Deg. of Freedom for Error	89
R-Squared	0.982
Adjusted R-Squared	0.981
AIC	6.47
BIC	6.605
Log-Likelihood	-432.48
Model Sum of Squares	3,027,195.30
Sum of Squared Errors	54,562.90
Mean Squared Error	613.07
Std. Error of Regression	24.76
Mean Abs. Dev. (MAD)	18.37
Mean Abs. % Err. (MAPE)	2.32%
Durbin-Watson Statistic	1.243
Ljung-Box Statistic	30.71
Prob (Ljung-Box)	0.1622
Skewness	0.562
Kurtosis	3.44
Jarque-Bera	5.712
Prob (Jarque-Bera)	0.0575



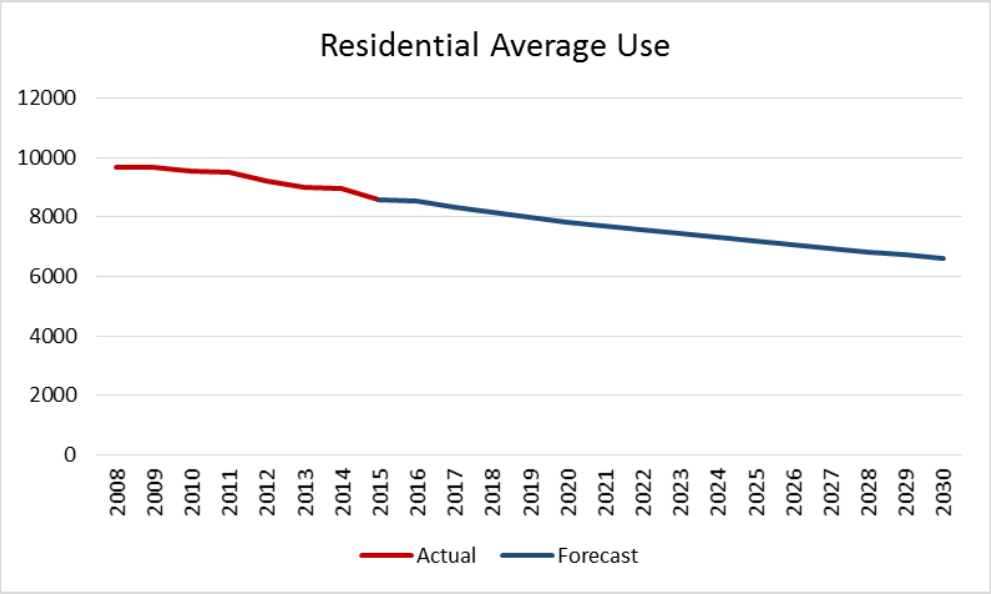
Variable	Coefficient	StdErr	T-Stat	P-Value
mStructResCyc.XHeat	0.99	0.068	14.669	0.00%
mStructResCyc.XCoolJul_Sep	1.18	0.018	63.934	0.00%
mStructResCyc.XCool_Shoulder	1.11	0.046	24.242	0.00%
mStructResCyc.XOther	0.99	0.013	77.362	0.00%
mStructResCyc.xSolar	-1.026	0.432	-2.377	1.96%

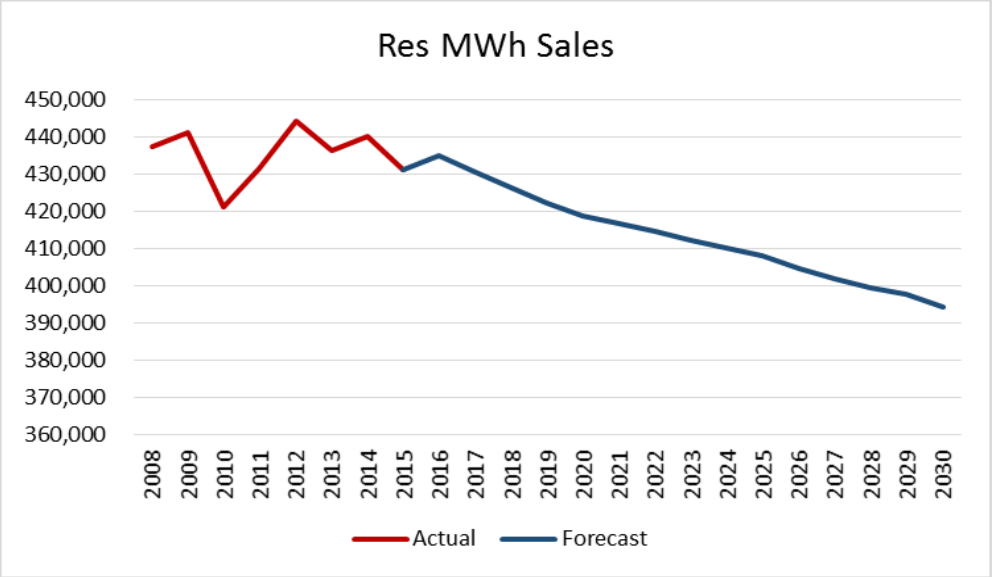
Adjusted Residential Sales Forecast

Year	ResMWh	Growth Res MWh	Res MWh Minus PV	Growth Res MWh Minus PV	Res MWh Plus EV	Growth Res MWh plus EV
2008	439,506		437,332		437,332	
2009	444,675	1.18%	441,226	0.89%	441,226	0.89%
2010	426,061	-4.19%	421,330	-4.51%	421,330	-4.51%
2011	436,912	2.55%	431,527	2.42%	431,527	2.42%
2012	450,420	3.09%	444,346	2.97%	444,346	2.97%
2013	443,323	-1.58%	436,253	-1.82%	436,253	-1.82%
2014	449,360	1.36%	440,160	0.90%	440,160	0.90%
2015	444,767	-1.02%	431,240	-2.03%	431,251	-2.02%
2016	453,623	1.99%	434,695	0.80%	434,809	0.82%
2017	455,876	0.50%	430,155	-1.04%	430,391	-1.02%
2018	458,777	0.64%	425,881	-0.99%	426,243	-0.96%
2019	462,012	0.70%	421,557	-1.02%	422,030	-0.99%
2020	465,415	0.74%	418,314	-0.77%	418,888	-0.74%
2021	468,978	0.77%	416,053	-0.54%	416,723	-0.52%
2022	472,678	0.79%	413,720	-0.56%	414,488	-0.54%
2023	476,567	0.82%	411,400	-0.56%	412,274	-0.53%
2024	480,690	0.87%	409,171	-0.54%	410,160	-0.51%
2025	485,039	0.90%	407,045	-0.52%	408,176	-0.48%
2026	487,893	0.59%	403,321	-0.91%	404,610	-0.87%
2027	491,583	0.76%	400,340	-0.74%	401,804	-0.69%
2028	495,960	0.89%	397,968	-0.59%	399,621	-0.54%
2029	500,688	0.95%	395,876	-0.53%	397,737	-0.47%
2030	503,805	0.62%	392,112	-0.95%	394,199	-0.89%

Residential equation: ResMWh=(Forecast average use * forecast customers) + EV

Residential

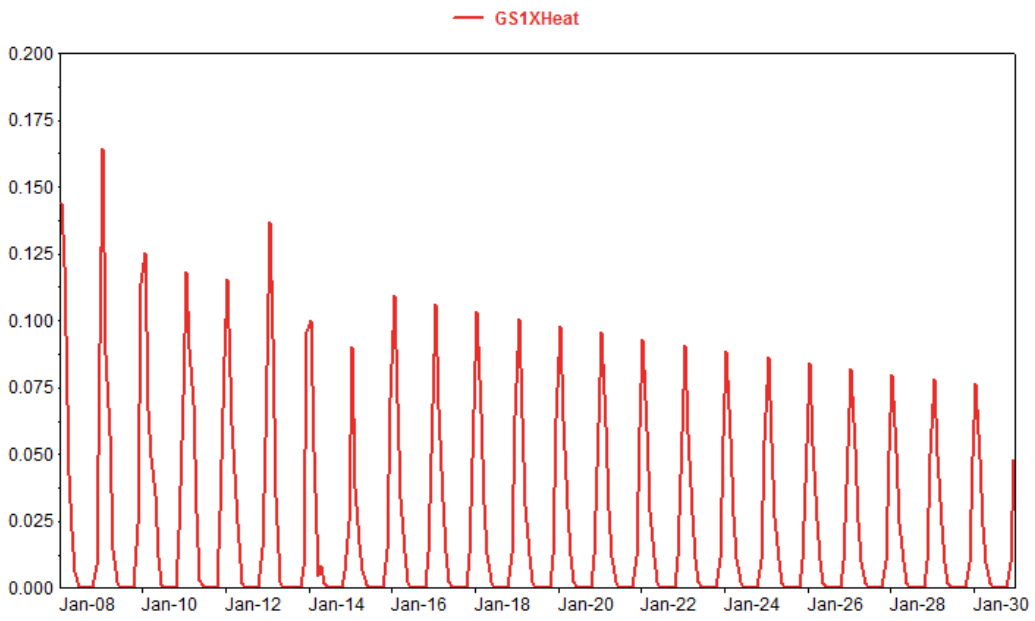


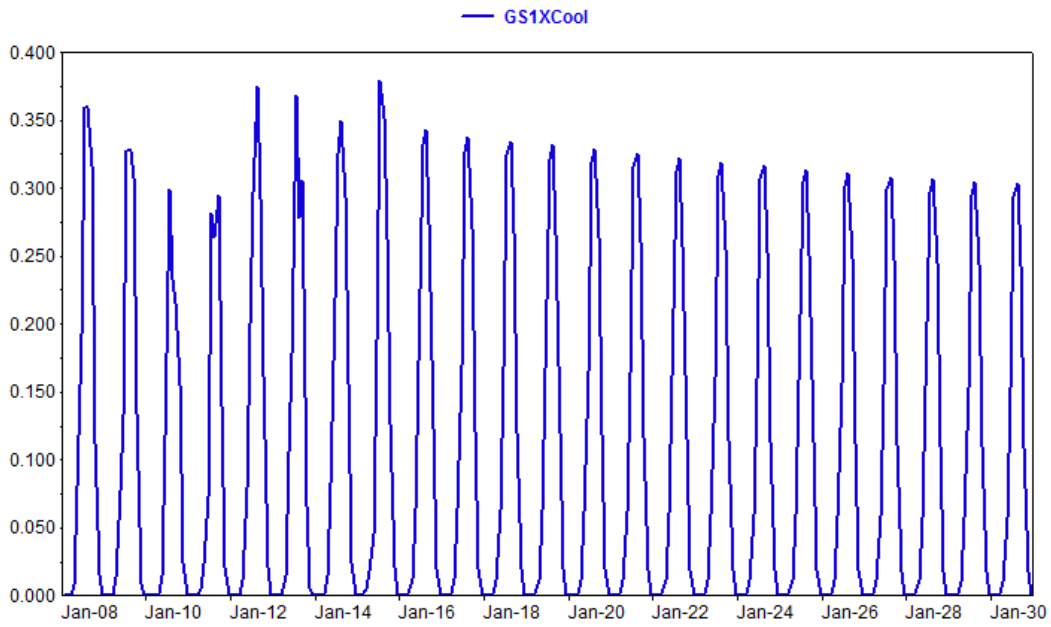


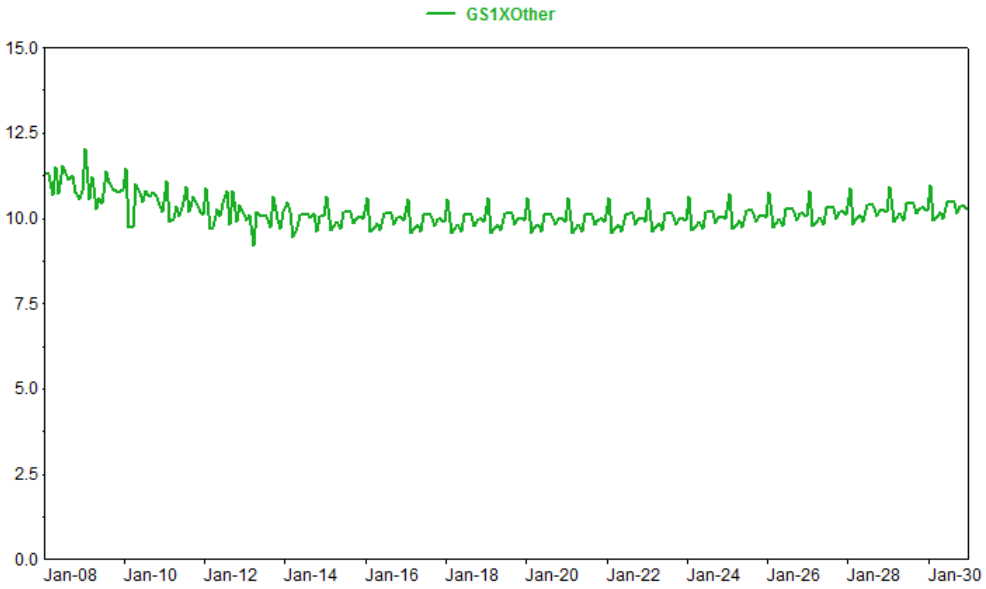
Year	Res MWh	Growth ResMWh	Res AvgUse (kWh)	Growth Res Avg Use
2008	437,332		9,660.24	
2009	441,226	0.9%	9,670.44	0.1%
2010	421,330	-4.5%	9,552.11	-1.2%
2011	431,527	2.4%	9,500.26	-0.5%
2012	444,346	3.0%	9,222.20	-2.9%
2013	436,253	-1.8%	8,994.12	-2.5%
2014	440,160	0.9%	8,936.14	-0.6%
2015	431,251	-2.0%	8,590.91	-3.9%
2016	434,809	0.8%	8,519.60	-0.8%
2017	430,391	-1.0%	8,336.39	-2.2%
2018	426,243	-1.0%	8,156.26	-2.2%
2019	422,030	-1.0%	7,977.08	-2.2%
2020	418,888	-0.7%	7,820.94	-2.0%
2021	416,723	-0.5%	7,686.49	-1.7%
2022	414,488	-0.5%	7,557.39	-1.7%
2023	412,274	-0.5%	7,434.04	-1.6%
2024	410,160	-0.5%	7,316.18	-1.6%
2025	408,176	-0.5%	7,203.00	-1.5%
2026	404,610	-0.9%	7,064.46	-1.9%
2027	401,804	-0.7%	6,941.83	-1.7%
2028	399,621	-0.5%	6,832.45	-1.6%
2029	397,737	-0.5%	6,730.84	-1.5%
2030	394,199	-0.9%	6,603.70	-1.9%

- Decrease is driven by solar adoption and new zero energy homes.

Small Commercial Variables

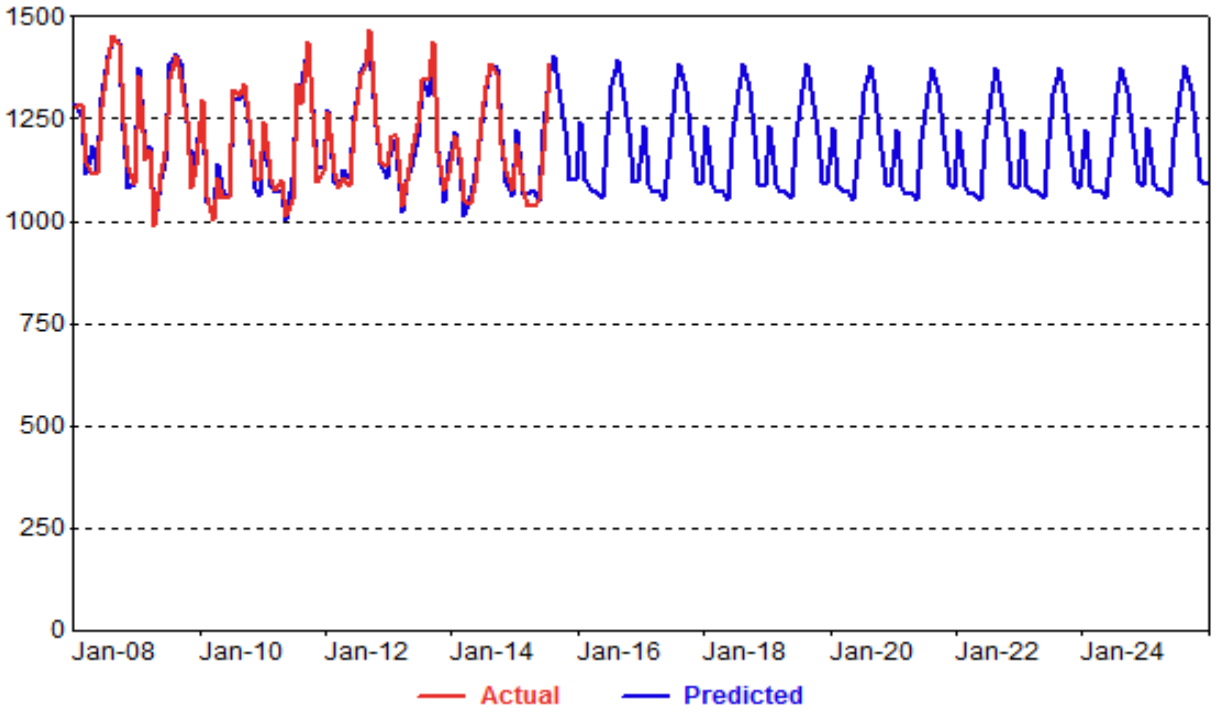






Small Commercial Average Use Model

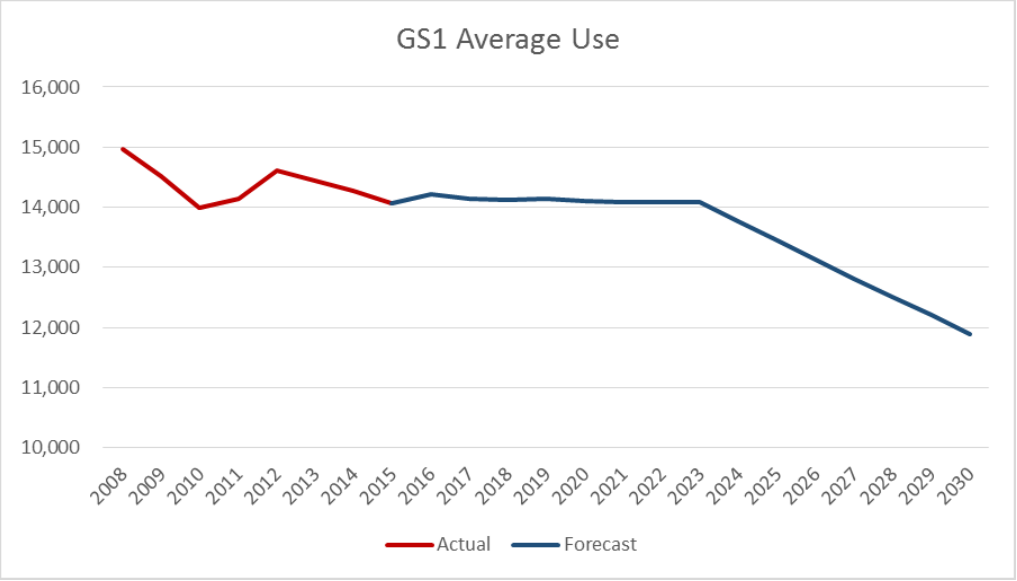
Model Statistics	
Iterations	1
Adjusted Observations	91
Deg. of Freedom for Error	79
R-Squared	0.96
Adjusted R-Squared	0.96
AIC	6.67
BIC	7.00
Log-Likelihood	-420.47
Model Sum of Squares	1,352,591
Sum of Squared Errors	54,947
Mean Squared Error	695.54
Std. Error of Regression	26.37
Mean Abs. Dev. (MAD)	19.54
Mean Abs. % Err. (MAPE)	1.67%
Durbin-Watson Statistic	1.99
Ljung-Box Statistic	28.36
Prob (Ljung-Box)	0.25
Skewness	-0.34
Kurtosis	2.83
Jarque-Bera	1.91
Prob (Jarque-Bera)	0.385

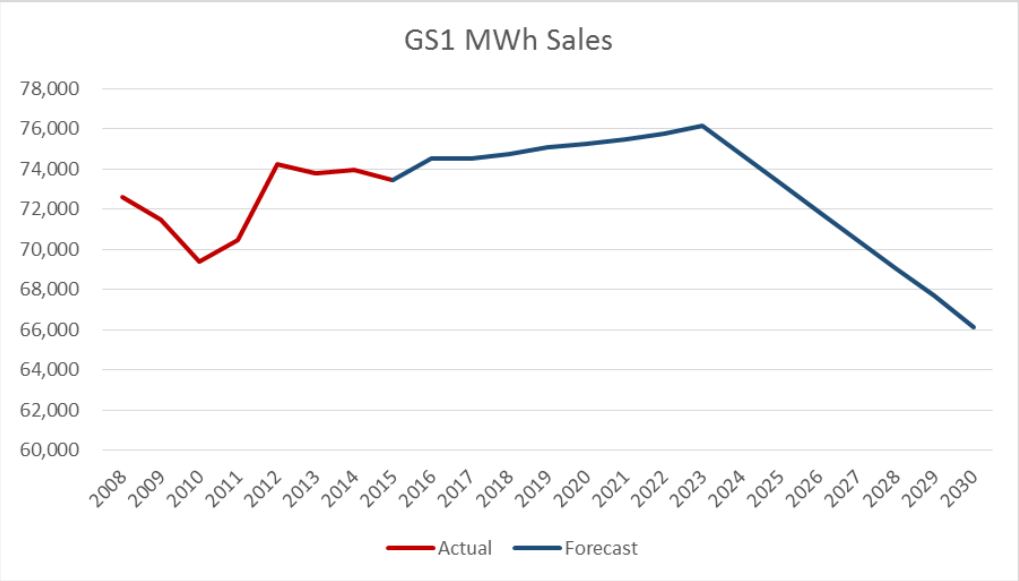


Variable	Coefficient	StdErr	T-Stat	P-Value
GS1XHeat	1045.542	94.302	11.087	0.00%
GS1XCool	742.021	34.755	21.35	0.00%
GS1XOther	100.099	0.727	137.595	0.00%

*Additional monthly binary variables included

Small Commercial Forecast



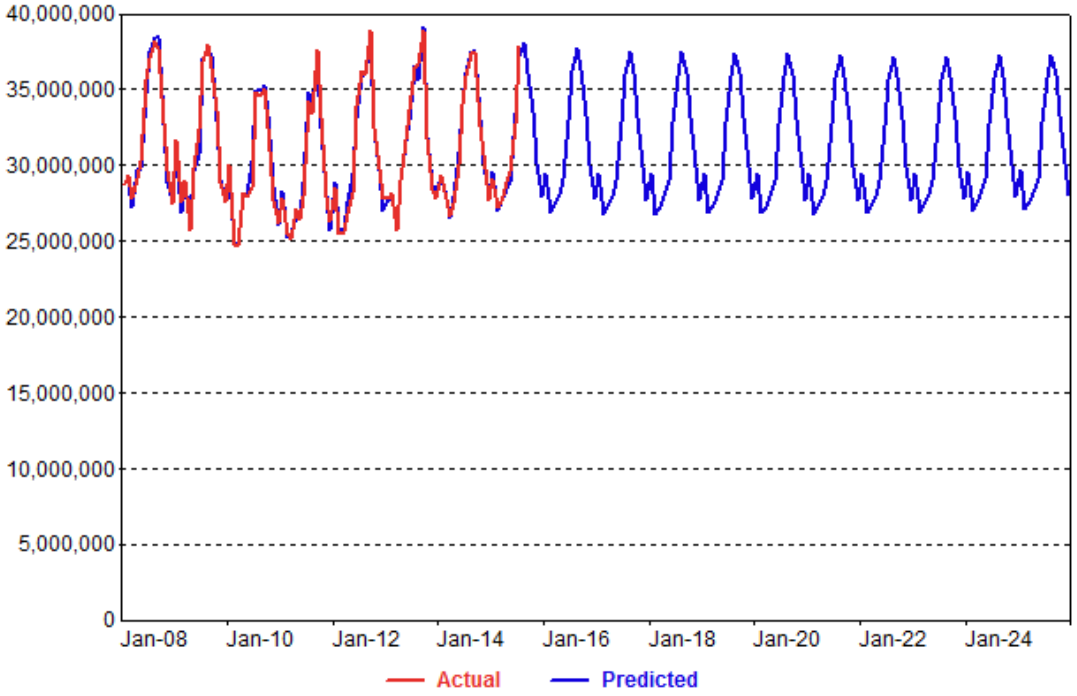


Year	GS1MWh	Growth GS1MWh	GS1 AvgUse (kWh)	Growth GS1 AvgUse
2008	72,613		14,963	
2009	71,484	-1.6%	14,514	-3.0%
2010	69,413	-2.9%	13,991	-3.6%
2011	70,473	1.5%	14,134	1.0%
2012	74,213	5.3%	14,617	3.4%
2013	73,756	-0.6%	14,444	-1.2%
2014	73,944	0.3%	14,270	-1.2%
2015	73,469	-0.6%	14,069	-1.4%
2016	74,520	1.4%	14,219	1.1%
2017	74,487	0.0%	14,150	-0.5%
2018	74,721	0.3%	14,133	-0.1%
2019	75,080	0.5%	14,139	0.0%
2020	75,259	0.2%	14,111	-0.2%
2021	75,454	0.3%	14,086	-0.2%
2022	75,734	0.4%	14,077	-0.1%
2023	76,142	0.5%	14,093	0.1%
2024	74,730	-1.9%	13,772	-2.3%
2025	73,310	-1.9%	13,453	-2.3%
2026	71,881	-1.9%	13,136	-2.4%
2027	70,442	-2.0%	12,820	-2.4%
2028	69,058	-2.0%	12,516	-2.4%
2029	67,687	-2.0%	12,217	-2.4%
2030	66,146	-2.3%	11,891	-2.7%

- Decrease is driven by SB350 assumption
- Average use and class totals are decreasing
- If solar becomes more common in the GS1 class this forecast will need to be updated

Medium Commercial Total Sales Model

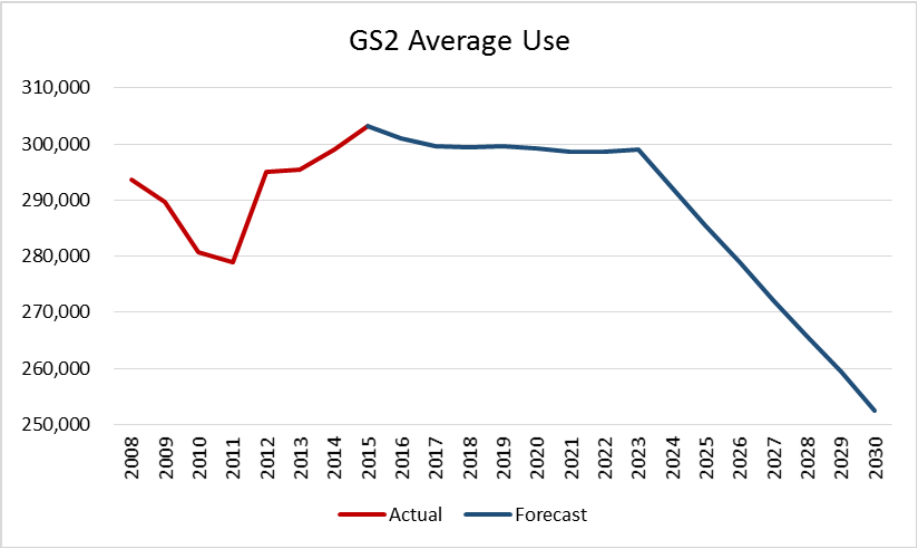
Model Statistics	
Iterations	1
Adjusted Observations	91
Deg. of Freedom for Error	83
R-Squared	0.98
Adjusted R-Squared	0.98
AIC	26.72
BIC	26.94
Log-Likelihood	-1336.77
Model Sum of Squares	1.43E+15
Sum of Squared Errors	3.06E+13
Mean Squared Error	3.69E+11
Std. Error of Regression	607,348.91
Mean Abs. Dev. (MAD)	454,275.68
Mean Abs. % Err. (MAPE)	1.48%
Durbin-Watson Statistic	1.99
Ljung-Box Statistic	30.27
Prob (Ljung-Box)	0.18
Skewness	0.04
Kurtosis	3.15
Jarque-Bera	0.11
Prob (Jarque-Bera)	0.948

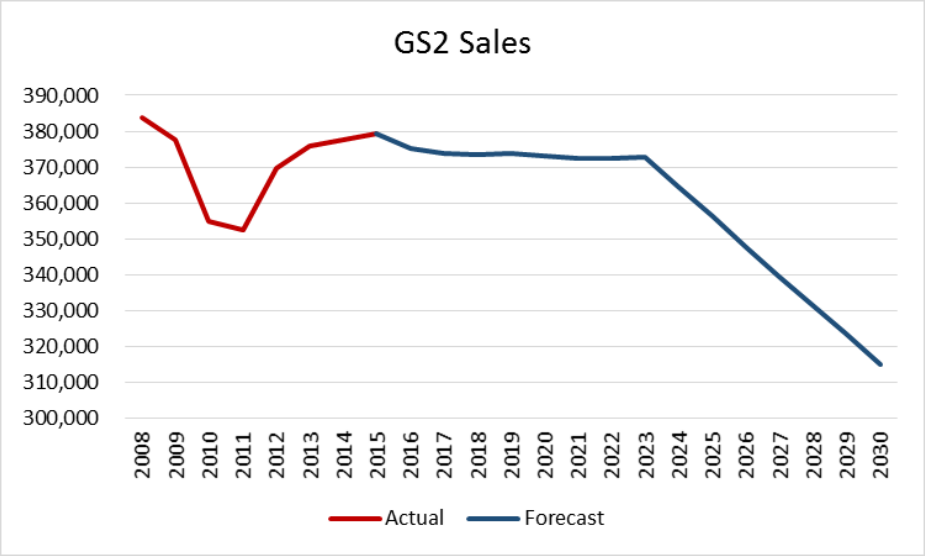


Variable	Coefficient	StdErr	T-Stat	P-Value
mStructComCyc.GS2XCool	26,020,414	712,322	36.529	0.00%
mStructComCyc.GS2XOther	2,549,774	10,263	248.438	0.00%

*Additional monthly binary variables included

Medium Commercial Forecast

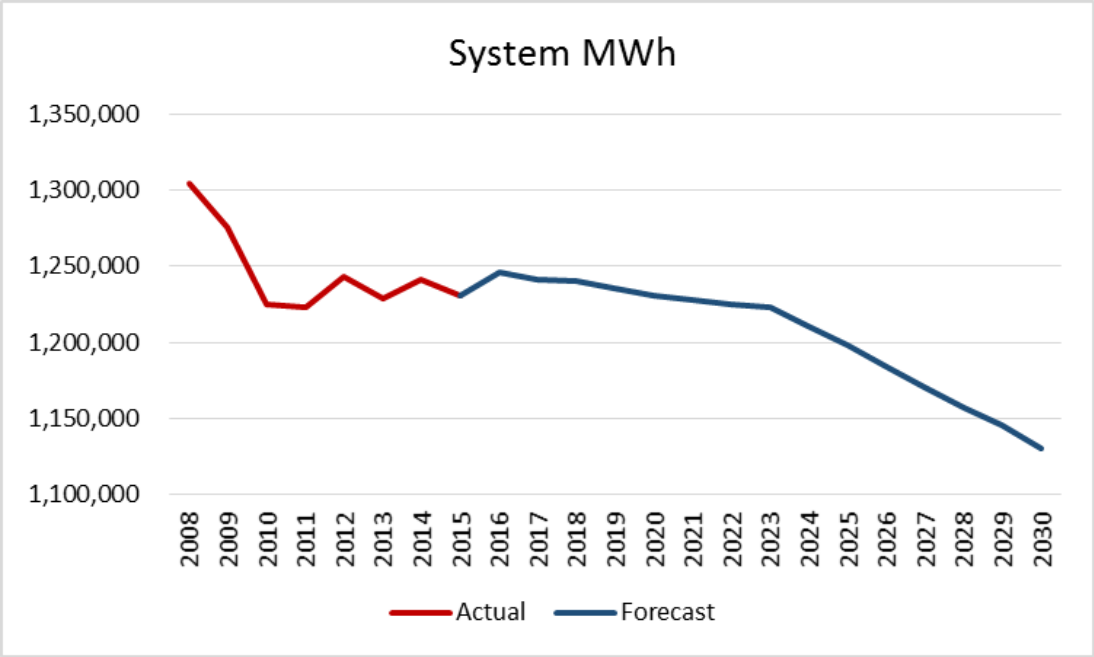




Year	GS2MWh	Growth GS2MWh	GS2 AvgUse (kWh)	Growth GS2 AvgUse
2008	383,864		293,656	
2009	377,442	-1.7%	289,672	-1.4%
2010	354,943	-6.0%	280,656	-3.1%
2011	352,474	-0.7%	278,821	-0.7%
2012	369,694	4.9%	294,987	5.8%
2013	376,011	1.7%	295,445	0.2%
2014	377,625	0.4%	299,040	1.2%
2015	379,472	0.5%	303,213	1.4%
2016	375,357	-1.1%	300,952	-0.7%
2017	373,716	-0.4%	299,636	-0.4%
2018	373,395	-0.1%	299,379	-0.1%
2019	373,677	0.1%	299,604	0.1%
2020	373,083	-0.2%	299,127	-0.2%
2021	372,562	-0.1%	298,709	-0.1%
2022	372,446	0.0%	298,616	0.0%
2023	372,936	0.1%	299,009	0.1%
2024	364,522	-2.3%	292,262	-2.3%
2025	356,141	-2.3%	285,542	-2.3%
2026	347,783	-2.3%	278,839	-2.3%
2027	339,451	-2.4%	272,159	-2.4%
2028	331,437	-2.4%	265,733	-2.4%
2029	323,552	-2.4%	259,411	-2.4%
2030	314,947	-2.7%	252,512	-2.7%

- Customer forecast is flat
- Sales move based on SAE trends and SB350 Assumptions

System Forecast



- Largest impact is SB350 and net zero energy homes drop forecast in Residential, GS1, and GS2

Year	System MWh	Growth SysMWh
2008	1,303,837	
2009	1,275,500	-2.2%
2010	1,225,438	-3.9%
2011	1,223,381	-0.2%
2012	1,243,266	1.6%
2013	1,228,931	-1.2%
2014	1,241,559	1.0%
2015	1,231,058	-0.8%
2016	1,245,897	1.2%
2017	1,241,260	-0.4%
2018	1,240,116	-0.1%
2019	1,235,496	-0.4%
2020	1,231,105	-0.4%
2021	1,227,956	-0.3%
2022	1,225,315	-0.2%
2023	1,223,513	-0.1%
2024	1,210,693	-1.0%
2025	1,198,011	-1.0%
2026	1,183,678	-1.2%
2027	1,170,128	-1.1%
2028	1,157,593	-1.1%
2029	1,145,494	-1.0%
2030	1,130,724	-1.3%