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SMUD

IRP Load Forecast and Methodology

2018-2030

Load Research and Forecasting

Sacramento Municipal Utility District

March 2019

SMUD 2018 Retail Sales, Load and Customer Forecast

This report presents the results of SMUD's Forecast for 2019 to 2030. The forecast includes retail sales, system energy, system peak and customer accounts for SMUD's retail service territory. Table 1 presents SMUD's system energy, system peak, retail sales and net customers. The forecast includes the impacts of SMUD's energy efficiency programs, behind the meter photovoltaic program, and electric vehicle charging. Additional forecast adjustments include load shifting from the mandatory residential time of use program beginning in 2019, new commercial development, and incremental. The Net Customer forecast includes residential, commercial, agricultural, and streetlight accounts and excludes nightlight accounts.

Table 1

Summary of Managed Load and Sales Forecasts

Year	Sales (GWH)	Energy (GWH)	Peak (MW)	Net Customers
2019	10,349	10,835	2,855	633,731
2020	10,293	10,777	2,847	639,578
2021	10,260	10,743	2,850	645,473
2022	10,265	10,748	2,851	651,328
2023	10,261	10,743	2,850	657,463
2024	10,290	10,774	2,851	663,385
2025	10,263	10,746	2,849	669,396
2026	10,259	10,741	2,845	675,690
2027	10,278	10,761	2,838	681,592
2028	10,354	10,840	2,825	687,155
2029	10,366	10,853	2,811	692,642
2030	10,419	10,909	2,795	698,107
Annual Growth Rates				
2019 - 2024	-0.11%	-0.11%	-0.03%	0.92%
2019 - 2030	0.06%	0.06%	-0.19%	0.88%

The growth in SMUD loads and sales are predicted to be relatively flat over the next 10 years due to the slow growth in net additions to the housing stock and business activity, SMUD's energy efficiency programs (EE), and the installation of customer owned/lease photovoltaic (PV) panels. The market penetration of electric vehicles (EV) and building electrification (EB) efforts will help reduce the impact of these forces in the long term. The forecasted impact of SMUD's residential TOU (RTOU) program will result in a modest reduction in both sales and system energy but will have a major impact on system peak due to the structure of the time of day periods and electricity

prices. SMUD's effort to increase sales from existing customers, and new customers will also help compensate for the slow growth in retail sales.

In this report, retail sales are measured at the customer's meter. System energy and peak are measured at the SMUD EMS system.

Table 2 below presents unmanaged and managed system energy forecast.

Gross EMS is a trend forecast based on current EMS system data. EMS data includes gross thermal generation, SMUD hydro generation, net purchase power, and behind the meter private generation for PV and CHP facilities with installed capacity greater than 500 kW.

Net EMS (unmanaged) is gross ems adjusted for station service at SMUD thermal generation units and private generation metered in SMUD EMS system.

Managed EMS system energy is net EMS unmanaged adjusted for SMUD's distributed energy resource (DER) impacts that includes energy efficiency (EE), behind the meter PV, electric vehicle battery charging (EV), and building electrification (EB). SMUD's EB program provides incentives for customers to switch from natural gas appliances to electrical appliances.

The Scenario forecast is the Managed EMS forecast adjusted for load shifting resulting from the mandatory residential time of day pricing (RTOD) beginning in 2019, incremental sales from existing customers, and sales from new commercial development and indoor cannabis cultivation projects.

SMUD's residential time of day (TOD) program is mandatory for all residential customers effective January 1, 2019. See SMUD Resolution 17-06-09, adopted June 15, 2017. The TOD rate tariff features a summer (June 1 to September 30) season and winter season (October to May). The summer season includes a peak period price of 28.35 cents per kWh on weekdays from 5 to 8 PM, a mid-peak price of 16.11 cents/kWh on weekdays from noon to 5PM, and from 8PM to midnight, and an off-peak price of 11.66 cents/kWh for all other hours including holidays. The winter season includes a peak period price of 13.38 cents per kWh on weekdays from 5 to 8 PM, and an off-peak price of 9.69 cents/kWh for all other hours including holidays.

Incremental sales are the additional sales from existing customers who have informed SMUD of their intentions to increase their loads.

New commercial develop loads are based on developers who have contacted SMUD economic development group regarding their intent to locate in the SMUD service territory.

The net impact of SMUD's DER programs and other market impacts reduces the annual growth rate from .79 percent to .06 percent over the 12-year forecast period.

Table 2

System Energy Forecast with DER and Scenario Adjustments (MWH)

Year	Gross EMS	Net EMS (unmanaged)	EE	PV	EV	EB	Storage	Managed EMS	RTOD	Incremental
2019	11,367,115	11,040,005	(118,929)	(69,233)	8,774	1,469	467	10,862,554	10,855,523	10,834,917
2020	11,455,580	11,127,615	(218,759)	(150,507)	17,450	5,228	941	10,781,969	10,774,469	10,776,994
2021	11,514,213	11,187,176	(313,430)	(190,280)	32,351	11,373	1,295	10,728,484	10,721,130	10,742,671
2022	11,604,600	11,277,570	(408,714)	(240,958)	65,951	22,258	1,752	10,717,858	10,710,423	10,747,583
2023	11,700,317	11,373,308	(514,482)	(292,061)	86,013	42,187	2,363	10,697,327	10,690,078	10,742,858
2024	11,825,618	11,497,671	(614,856)	(335,621)	108,902	68,989	3,013	10,728,097	10,721,149	10,774,073
2025	11,892,289	11,565,135	(727,925)	(375,883)	131,843	102,670	3,897	10,699,738	10,692,872	10,745,652
2026	11,995,284	11,668,159	(854,641)	(423,682)	158,250	142,398	5,142	10,695,626	10,688,247	10,741,027
2027	12,095,913	11,768,876	(961,523)	(473,601)	187,971	187,037	6,889	10,715,649	10,708,531	10,761,311
2028	12,227,813	11,899,945	(1,086,085)	(525,614)	258,901	238,385	8,953	10,794,486	10,787,539	10,840,463
2029	12,293,246	11,966,114	(1,194,909)	(576,712)	296,545	305,114	11,236	10,807,388	10,800,686	10,853,466
2030	12,389,944	12,062,752	(1,316,301)	(629,302)	338,634	393,119	13,747	10,862,650	10,856,165	10,908,945
Annual Growth Rates										
2019 - 2024	0.79%									-0.11%
2019 - 2030	0.79%									0.06%

Table 3 presents gross ems, net ems (unmanaged), managed and scenario system peak loads. The system peak load forecast is the coincident system peak for the SMUD retail service territory. SMUD's system peak usually occurs during summer months of July or August between the hours of 5 and 6 P.M. For forecasting purposes, the system peak forecast is designed to occur on a Wednesday during the month of July where the maximum daily temperature reaches 106 degrees Fahrenheit. The peak forecast results follow the same adjustments process described in the system energy section. The impact of DER and the scenario sales adjustments reduced the growth in system peak from 0.89 percent to -0.19 percent.

Table 3

System Peak Forecast with DER and Scenario Adjustments(MW)

Year	Gross EMS	Net EMS (unmanaged)	EE	PV	EV	EB	Storage	Managed EMS	RTOD	Incremental
2,019	3,042	2,982	(21)	(17)	0	0	(3)	2,941	2,858	2,855
2,020	3,070	3,010	(38)	(37)	0	0	(5)	2,930	2,846	2,847
2,021	3,097	3,038	(55)	(46)	1	1	(7)	2,931	2,847	2,850
2,022	3,125	3,065	(71)	(58)	1	2	(10)	2,929	2,845	2,851
2,023	3,154	3,094	(89)	(70)	2	3	(14)	2,927	2,843	2,850
2,024	3,182	3,122	(106)	(79)	2	6	(17)	2,927	2,844	2,851
2,025	3,210	3,150	(125)	(89)	3	8	(22)	2,925	2,842	2,849
2,026	3,239	3,180	(146)	(99)	3	12	(29)	2,920	2,838	2,845
2,027	3,267	3,208	(164)	(111)	4	15	(40)	2,912	2,831	2,838
2,028	3,293	3,234	(186)	(123)	5	19	(52)	2,898	2,818	2,825
2,029	3,319	3,260	(208)	(135)	6	25	(64)	2,883	2,804	2,811
2,030	3,345	3,285	(232)	(147)	7	32	(79)	2,866	2,788	2,795
Annual Growth Rates										
2019 -2024	0.90%									-0.03%
2019 - 2030	0.87%									-0.19%

Table 4 presents unmanaged, managed and scenario adjusted retail sales. Retail sales are the electricity sales to SMUD's retail customers measured at the customer's meter. The difference between net system energy and unmanaged sales is the system loss factor. Each of the sales adjustments follow the approach used in the energy forecast. In the long run, these impacts decrease the annual growth rate from 0.81 to 0.06 percent per year.

Table 4

Retail Sales Forecast with DER and Scenario Adjustments (MWH)

Year	Unmanaged	EE	PV	EV	EB	Storage	Managed EMS	RTOD	Incremental
2019	10,544,417	(113,590)	(66,125)	8,380	1,403	446	10,374,932	10,368,217	10,348,536
2020	10,628,095	(208,938)	(143,751)	16,667	4,993	899	10,297,965	10,290,801	10,293,213
2021	10,684,981	(299,360)	(181,739)	30,899	10,863	1,237	10,246,881	10,239,857	10,260,431
2022	10,771,318	(390,367)	(230,142)	62,990	21,259	1,673	10,236,731	10,229,630	10,265,122
2023	10,862,758	(491,387)	(278,951)	82,151	40,293	2,257	10,217,122	10,210,199	10,260,610
2024	10,981,539	(587,255)	(320,555)	104,013	65,892	2,878	10,246,511	10,239,875	10,290,423
2025	11,045,974	(695,248)	(359,009)	125,924	98,061	3,722	10,219,425	10,212,867	10,263,278
2026	11,144,373	(816,276)	(404,663)	151,146	136,005	4,911	10,215,497	10,208,450	10,258,860
2027	11,240,569	(918,360)	(452,341)	179,533	178,640	6,580	10,234,622	10,227,824	10,278,234
2028	11,365,755	(1,037,331)	(502,019)	247,279	227,684	8,551	10,309,919	10,303,285	10,353,833
2029	11,428,953	(1,141,269)	(550,823)	283,233	291,418	10,731	10,322,243	10,315,842	10,366,252
2030	11,521,253	(1,257,212)	(601,053)	323,433	375,472	13,130	10,375,024	10,368,830	10,419,241
Annual Growth Rates									
2019 - 2024	0.82%								-0.11%
2019 - 2030	0.81%								0.06%

SMUD Distributed Energy Resources

SMUD DER program includes energy efficiency measures, behind the meter PV installation, electric vehicle battery charging, and building electrification.

Energy Efficiency Savings

SMUD's energy efficiency goals are described in the SMUD Board Policy for Strategic Direction for Resource Planning (SD-9). (see: https://www.smud.org/-/media/Documents/Corporate/About-Us/Board-Meetings-and-Agendas/2018/Oct/Policy-SD-9.ashx?la=en&hash=EE6661597B8B3DBDD641D03B1106FD2E0DB05E80).

The policy states:

> *SMUD's goal is to achieve Energy Efficiency equal to 15 percent of retail load over the next 10-year period. On an annual basis, SMUD will achieve energy efficiency savings of 1.5% of the average annual retail energy sales over the three-year period ending with the current year.*

Table 5 presents SMUD's expected EE savings from 2018 to 2030. EE savings are measured at the customer's meter. For the system energy forecast, the EE savings are adjusted by 4.19 percent (system level EE = 1.047*EE retail savings) to reflect line and voltage losses. The figures presented in Table 5 are first year EE impacts and cumulative impacts which accounts for the decay in saving based on the measured life of the programs.

Table 5

EE Impacts Retail Sales Impacts (MWH)

Year	Cumulative Savings
2019	118,929
2020	218,759
2021	313,430
2022	408,714
2023	514,482
2024	614,856
2025	727,925
2026	854,641
2027	961,523
2028	1,086,085
2029	1,194,909
2030	1,316,301

Table 6 presents the cumulative EE savings impacts on system energy and system peak.

Table 6

Cumulative EE Energy and Peak Savings

Year	EE Energy (MWH)	EE Peak (MW)
2019	123,912	21
2020	227,924	38
2021	326,563	55
2022	425,839	71
2023	536,039	89
2024	640,618	106
2025	758,425	125
2026	890,450	146
2027	1,001,811	164
2028	1,131,592	186
2029	1,244,975	208
2030	1,371,454	232

Behind the Meter Photovoltaic Impacts

Table 7 presents the annual installation of PVs beginning in 2019. By the end of 2017, about 142 MWs of PV capacity was installed under SMUD's SB1 program. PV savings are based on the expected installation of PV systems for residential and non-residential customers. The reductions in sales, system energy and peak from PV installation prior to 2019 are assumed to be incorporated in the unmanaged forecasts. The figures for PV installed capacity and generation are measured at the billing meter. The annual capacity factor for both residential and commercial PV systems is about 18 percent. The system peak impact is about 40 percent of the installed PV capacity.

Table 7 waiting for data

Customer Installed PV

Year	Annual PV Installed Capacity (MW)	Cumulative PV Installed Capacity (MW)	Total Generation (MWH)	Peak Impact (MW)
2019	42	42	66,125	17
2020	91	133	143,751	36
2021	115	248	181,739	46
2022	146	394	230,142	58
2023	177	571	278,951	71
2024	203	775	320,555	81
2025	228	1,002	359,009	91
2026	257	1,259	404,663	103
2027	287	1,546	452,341	115
2028	318	1,864	502,019	127
2029	349	2,213	550,823	140
2030	381	2,595	601,053	152

Capacity and Generation

Electric Vehicle Battery Charging

Table 8 presents the plug-in electric vehicle forecast for light duty vehicles and the electricity sales from battery charging. The sales forecast is based on metered interval data for customers who were receiving service on one of SMUD's SPO electric vehicle charging TOU rate schedules. On the average, battery charging for these vehicles was 8.8 kwh per day.

The forecasted peak impacts assume that electric vehicle owners will charge very little during the time of day peak period and will most likely charge during the mid-peak and off-peak periods. To encourage off-peak charging, SMUD offers customers with registered electric vehicles a 1.5 cent per kWh discount during the hours of midnight to 6AM.

Table 8

Electric Vehicle and Retail Sales Forecast

Year	EV vehicle forecast	Sales Impacts (MWH)	Energy Impact (MWH)	Peak Impact (MW)
2019	2,597	8,380	8,732	0.17
2020	5,150	16,667	17,365	0.34
2021	9,573	30,899	32,193	0.63
2022	19,516	62,990	65,629	1.29
2023	25,453	82,151	85,594	1.68
2024	32,138	104,013	108,371	2.12
2025	39,015	125,924	131,201	2.57
2026	46,829	151,146	157,479	3.08
2027	55,624	179,533	187,055	3.66
2028	76,405	247,279	257,640	5.03
2029	87,754	283,233	295,101	5.78
2030	100,209	323,433	336,985	6.60

Building Electrification

SMUD electrification program is designed to encourage customers to switch from equipment that utilizes fossil fuels to electricity. Example of equipment change outs include heat pump water heaters and HVAC equipment.

Table 9 show the annual impacts of these end-uses. The peak impacts are minor since it was assumed that the major impacts would be during the winter as household shift from gas water heating to heat pump water heating and from gas space heating to heat pump space heating. During the summer months, we assume that electricity use during the peak period with heat pump cooling would be equivalent to conventional HVAC loads.

Table 9

Building Electrification Impacts

Year	Sales (MWH)	Energy (MWH)	Peak (MW)
2019	1,403	1,462	0.12
2020	4,993	5,202	0.43
2021	10,863	11,318	0.93
2022	21,259	22,150	1.81
2023	40,293	41,981	3.44
2024	65,892	68,653	5.61
2025	98,061	102,170	8.41
2026	136,005	141,704	11.67
2027	178,640	186,125	15.25
2028	227,684	237,224	19.39
2029	291,418	303,628	24.99
2030	375,472	391,205	32.19

Scenario Adjustments to Managed Forecasts

Residential Time of Day Impacts

The mandatory residential TOD rate tariff is the default tariff beginning January 1, 2019. The load impacts from the introduction of TOD pricing are based on price elasticity estimates from the SMUD Smart Pricing Option (SPO) pilot conducted from 2012 to 2013. In this study, a random selection of residential customers was placed on a default time of day rate schedule but could opt-out of the program by contacting SMUD. One of the important finding from this study was that very few customers opted out of the TOD rate offering.

To calculate the TOD price elasticities, the price elasticities from the SPO study were adjusted to reflect the 2019 TOD prices approved by the SMUD Board of Directors, relative to the 2017 residential electricity prices. In the SPO study, price elasticities were estimated for both standard rates and energy assistance program rates (EAPR). The group elasticity is the weighted average of the both rates where the weights are the share of customers on each rate program.

Please note that the base prices for 2018 were revised from .1291 in 2017 to .1310 for the 2018 summer period and from .1128 to .1145 for the winter period.

Table 10 shows the derivation of the elasticity estimates based on the price differential discussed above. Net Impact figures are the percentage change in electricity use during each TOD time period.

TABLE 10

Calculation of Price Elasticities for TOD impacts

	summer			Winter	
TOD Shares	Peak	Mid-Peak	Offpeak	Peak	Offpeak
Base price ($/kWh)	0.1291	0.1291	0.1291	0.1128	0.1128
TOU price ($/kWh)	0.2835	0.1611	0.1166	0.1338	0.0969
Own Price Elasticities					
LN chg price	79%	22%	-10%	17%	-15%
elasticity - Standard	(0.069)	(0.069)	(0.031)	(0.069)	(0.031)
elasticity - eapr	(0.011)	(0.011)	-	(0.011)	-
group elasticity	-5.9%	-5.9%	-2.5%	-5.9%	-2.5%
Price Impacts	**-4.6%**	**-1.3%**	**0.3%**	**-1.0%**	**0.4%**
Cross Price Elasticity					
pct change cross price (offpeak impact from a change in on peak price)		79%	54%		17%
elasticity - Standard		0.001	0.001		0.001
elasticity - eapr		0.013	0.013		0.013
group elasticity (weighted average)		0.00316	0.00316		0.00316
Price Impacts		**0.2%**	**0.2%**		**0.1%**
Net Impact (=own price + cross price)	**-4.6%**	**-1.0%**	**0.4%**	**-1.0%**	**0.4%**

For additional information on SMUD Smart Pricing Option study, see

https://www.smartgrid.gov/project/sacramento_municipal_utility_district_smartsacramento.html

Incremental Sales

Incremental sales are based on the additional sales from current SMUD customers who are expected to expand their operations. SMUD's customer account staff provided the expected expansion plans for 5 customer accounts. For the incremental sales and load forecast, it is assumed that the full expansion is achieved in 2022 and is constant for the remainder of the forecast period.

Table 11 shows the annual kwh for the incremental sales.

Table 11

Incremental Sales and Loads

Year	Incremetal Sales (MWH)	Incremental Energy (MWH)	Peak Impact (MW)
2019	10,348,536	10,834,917	(2.21)
2020	10,293,213	10,776,994	1.02
2021	10,260,431	10,742,671	3.32
2022	10,265,122	10,747,583	5.21
2023	10,260,610	10,742,858	7.10
2024	10,290,423	10,774,073	7.10
2025	10,263,278	10,745,652	7.10
2026	10,258,860	10,741,027	7.10
2027	10,278,234	10,761,311	7.10
2028	10,353,833	10,840,463	7.10
2029	10,366,252	10,853,466	7.10
2030	10,419,241	10,908,945	7.10

Forecast Methods Overview

SMUD's forecast models are based on statistical regression techniques which normalized electricity use for variation in temperatures, seasonal use, number of customer accounts, and recent trends in electricity use behaviors. The forecast is based on four regression models: daily system energy, daily system peak, system hourly loads (24 separate equations), and the retail class sales models. In each model, loads and retail sales are normalized by customer accounts.

The daily energy and peak models serve as the foundation for the load forecast. These models normalize SMUD's EMS system loads for variations in daily temperatures, weekdays and weekends, months, seasons and holidays. The system hourly load equations provide a daily load shape which is calibrated to daily energy and peak model estimates with the following restrictions:

- Maximum of estimated hourly loads for day (i) = estimated peak for day (i) for each day of the forecast year.
- Sum of the estimated hourly estimate loads for day (i) = estimated daily energy for day(i) for each day of the forecast year.

The predicted values from these models are:

- kwh/day/account,
- peak kW/day/account, and
- kW/hour/account.

The retail sales model includes separate regression equations for each major rate class (major rate codes in parentheses). They are:

- Residential Electric Space Heat (Rate Codes RSE, RSC, RWE, RWC)
- Residential Non-Electric Space Heat (RSG, RWG)
- Small General Services with maximum demands below 20 kW (GSN)
- Small General Services with maximum demands between 20 and 299 kW (GSS)
- Small General Service Time of Use with maximum demands between 300 and 499 kW (GSTOU3)
- Medium General Service Time of Use with maximum demands between 500 and 999 kW (GSTOU2)
- Large General Service Time of Use with maximum demands greater than 1,000 kW (GSTOU1)
- Other includes Agricultural (AGR), Street (ST and TF) and Night Lighting (NL) accounts.

The dependent variable for the sales models is kWh/customer per billing period. The regression model normalized class sales for variations in monthly use, temperature conditions (monthly heating and cooling degree days), and for recent sales trend with a binary variable. For the small

general service classes (under 299 kW maximum demands), commercial vacancy rates were included in the regression equation to explain the recent trends in economic activity.

For residential customer accounts, the ITRON Statistically Adjusted End-Use (SAE) modeling framework is used to simulate end-use saturations and efficiency standards. This model is applied separately to residential customer with electric space and with non-electric space heat. The SAE modeling framework incorporates end-use energy use, appliance saturations and efficiencies to develop heating, cooling and "other" appliances end-use indices. The indices are used as independent variables in a regression model where the dependent variable is electricity sales per account. Simulation of energy use is based on the indices, which change overtime to incorporate marginal saturation rates and improvements in efficiency standards. For the residential model, saturations are based on the SMUD 2013 RASS survey results

The regression models, estimated parameters, and summary statistics are presented in the appendix

Load and Sales projections

The monthly retail sales forecast for each rate class is projected by multiplying the forecasted sales per customer times the forecasted number of customers for each rate class. The unmanaged retail sales forecast in Table 4 is the sum of the rate class sales forecast. For system energy, peak and hourly loads, the forecast is based on the estimated loads per account times the net customer forecast (total customers minus nightlight customer accounts). System energy, peak and hourly loads are calibrated to the unmanaged sales forecast after adjusting for line and voltage distribution losses (i.e. system energy = 1.047*unmanaged sales forecast).

Economic and Demographic Data

The primary driver for the sales and load forecasts is the customer account forecast. Table 13 presents the customer account forecast for the major customer classes.

Table 13

SMUD Customer Account Forecast

Year	Residential	Small GS	Medium GS	Large GS	Other	Net Customers.
2018	557,621	64,626	253	163	5,436	628,098
2019	563,035	64,827	253	160	5,456	633,731
2020	568,542	65,127	255	161	5,492	639,578
2021	574,068	65,455	258	163	5,530	645,473
2022	579,535	65,800	261	165	5,568	651,328
2023	585,140	66,287	264	167	5,606	657,463
2024	590,428	66,875	267	168	5,647	663,385
2025	595,777	67,488	270	170	5,691	669,396
2026	601,405	68,106	273	172	5,735	675,690
2027	606,631	68,733	276	173	5,779	681,592
2028	611,522	69,355	279	175	5,825	687,155
2029	616,372	69,939	282	177	5,872	692,642
2030	621,229	70,494	285	179	5,920	698,107
Annual Growth Rate						
	0.90%	0.73%	0.99%	0.79%	0.71%	0.88%

Notes:

Residential includes both electric and non-electric space heat accounts.

Small General Service (GS) includes accounts on rate schedules GSN (0-20 kW maximum demands), GSS (20-299 kW maximum demands), and GSTOU3 (300 to 499 kW maximum demands).

Medium GS includes customers on rate schedule GSTOU2 (500-1,000 Maximum Demands).

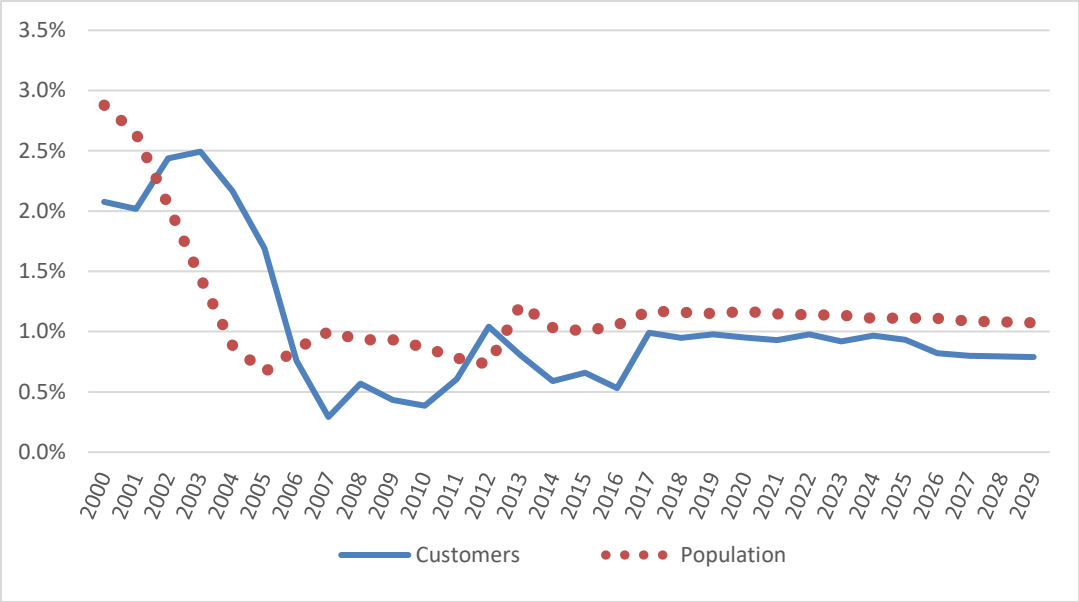
Large GS includes customers on rate schedule GSTOU1 (Maximum Demand >=1,000kW).

Other includes customers on the Agriculture, street lighting and traffic signals rate schedules.

The forecast for residential customer accounts is based on the population forecast for Sacramento County. Figure 1 shows the historical and forecasted growth rates for the Sacramento County's population and SMUD's residential customer accounts.

Figure 1

Sacramento County Population and Residential Customer Annual Growth



During the last residential building cycle, Sacramento county population acted as a leading indicator for new residential customer growth. For the forecast period, however, residential customer growth is expected to keep pace with the population growth.

The forecast for Small General Service accounts are based on economic driver such as employment and gross county product. The Medium General Service accounts (between 500 and 1,000 kW maximum demands) and Large General Service accounts (greater than or equal to 1,000 kW maximum demands), and other customer accounts (Agriculture and Lighting) are based on their historical growth rates.

Sacramento Weather

A key component in normalizing sales and loads is weather. Both sales and load models use cooling degrees and heating degrees as independent variables in the regression equations. In the load model, daily high temperatures are also used to explain the rapid change in loads during heat storms.

Temperature data is from the National Weather Service's Sacramento City and Executive Airport weather stations. The daily temperatures from these weather stations are averaged to develop a composite temperature index for the Sacramento area. Daily composite temperatures are used to construct cooling and heating degree day variables in the regressions models.

Table 14 presents the normal temperatures and degree days used in forecast based on temperature data from 1981 to 2010. The average daily temperature is the average of the daily high and low

temperatures. The High and Low temperatures are the maximum and minimum daily temperatures, respectively, for each month. The cooling degree (CDD65) and heating degree (HDD65) variables are the sum of the daily cooling and heating degrees for the calendar month with 65 degrees Fahrenheit as the base temperature. The SumCdd65 and SumHdd65 are the sum of the cumulative degree days for the previous 30 days for each day during the month. The Sumcdd65 and SumHdd65 are used to reflect the number of degrees days over the billing month period.

Table 14

Normal Average Daily Temperatures

	Avg Daily	Avg High	Avg Low	High	Low
January	48	55	40	65	32
February	52	61	43	72	33
March	56	67	45	79	34
April	62	76	49	89	41
May	67	81	53	97	45
June	74	90	58	104	51
July	78	95	60	106	54
August	76	93	60	105	55
September	73	88	58	101	51
October	65	78	52	93	44
November	55	65	44	77	34
December	47	55	40	65	30

Table 14 (continued)

Normal Cooling and Heating Degree Days per Month

	CDD65	HDD65	SumCdd65	SumHdd65
January	-	542	-	18,275
February	-	361	-	13,886
March	2	277	18	10,813
April	25	165	313	6,975
May	112	52	2,072	3,425
June	239	6	5,355	804
July	362	0	10,142	61
August	339	0	11,369	4
September	240	5	9,407	56
October	69	65	5,069	799
November	1	318	734	5,507
December	-	551	4	14,432

Variability of Load Forecast: Extreme Temperature Scenarios

The normal temperature scenario is referred to as the "1 in 2" load condition scenario. That is, there is a 1 in 2 chance of this weather scenario occurring. Because the Sacramento area often experiences extremes in temperatures during the summer months, extreme temperature scenarios are used to examine these changes in system peak loads. Table 15 below presents the extreme temperatures for each load condition scenario.

Table 15

Extreme Temperature Scenarios

Load Condition Scenario	Daily High Temperature
1 in 2	106
1 in 5	108
1 in 10	110
1 in 20	112
1 in 40	114

The peak load forecasts under extreme conditions are estimated using the parameter estimates from daily peak model. Table 16 presents the 1 in 10 unmanaged and managed system peak load forecast.

Table 16

1 in 10 Unmanaged and Managed System Peak Loads

Year	Gross EMS	Net EMS	EE	PV	EV	EB	Storage	RTOU	Incremental	Managed Net EMS
2019	3,042	2,982	(21)	(17)	0	0	(3)	(84)	9	2,866
2020	3,070	3,010	(38)	(37)	0	0	(5)	(84)	14	2,860
2021	3,097	3,038	(55)	(46)	1	1	(7)	(84)	20	2,867
2022	3,125	3,065	(71)	(58)	1	2	(10)	(84)	21	2,866
2023	3,154	3,094	(89)	(70)	2	3	(14)	(84)	21	2,864
2024	3,182	3,122	(106)	(79)	2	6	(17)	(83)	21	2,865
2025	3,210	3,150	(125)	(89)	3	8	(22)	(83)	21	2,863
2026	3,239	3,180	(146)	(99)	3	12	(29)	(82)	21	2,859
2027	3,267	3,208	(164)	(111)	4	15	(40)	(81)	21	2,852
2028	3,293	3,234	(186)	(123)	5	19	(52)	(80)	21	2,839
2029	3,319	3,260	(208)	(135)	6	25	(64)	(79)	21	2,825
2030	3,345	3,285	(232)	(147)	7	32	(79)	(78)	21	2,809

Table 17 presents the managed peak loads for the weather scenarios in Table 15. The DER, RTOU and scenario adjustments are the same for each extreme weather scenario.

Table 17

Managed System Peak Loads for Load Condition Scenarios

Year	1 in 2	1 in 5	1 in 10	1 in 20
2019	2,865	3,020	3,125	3,235
2020	2,867	3,024	3,130	3,241
2021	2,878	3,035	3,143	3,254
2022	2,879	3,038	3,146	3,259
2023	2,879	3,039	3,148	3,262
2024	2,880	3,042	3,152	3,267
2025	2,878	3,042	3,153	3,269
2026	2,874	3,039	3,151	3,268
2027	2,867	3,033	3,146	3,264
2028	2,854	3,022	3,136	3,255
2029	2,840	3,009	3,124	3,244
2030	2,824	2,995	3,111	3,232

Forecast Errors

Tables 18, 19, and 20 present the annual errors (actual – predicted) for the retail sales, system peak, and customer forecasts, respectively.

Table 18

Retail Sales Errors

(MWH)

Years	Actual	Forecast	% Error
2007	10,913,372	10,940,472	-2.6%
2008	10,959,168	11,238,188	-2.6%
2009	10,757,807	10,358,626	0.2%
2010	10,389,858	10,560,255	2.5%
2011	10,459,022	10,527,298	1.9%
2012	10,519,497	10,513,856	0.0%
2013	10,480,762	10,432,362	0.7%
2014	10,585,750	10,572,551	-0.1%
2015	10,523,765	10,548,236	-0.5%
2016	10,530,677	10,628,118	0.9%
2017	10,519,686	10,348,905	-1.7%
2018	10,297,311	10,514,975	2.1%

Note: Retail sales based on SMUD's 21-day cycle read billing data

Table 19

System Peak Errors

Years	Actual	Forecast	% Error
2007	3,099	3,124	0.8%
2008	3,086	3,062	-0.8%
2009	2,848	3,038	6.7%
2010	2,990	2,976	-0.5%
2011	2,840	2,979	4.9%
2012	2,953	2,974	0.7%
2013	3,014	2,946	-2.3%
2014	3,003	2,987	-0.5%
2015	2,956	3,008	1.8%
2016	2,972	2,998	0.9%
2017	3,157	3,006	-5.0%
2018	2,944	3,019	2.5%

In general, the peak model does not perform as well as the retail sales mode where the sales errors range from -2.6 to 2.5 % with an average error of about 0.01%. The peak model errors range from -5.0% to 6.7% with an average error of .8 %.

Table 20

Customers Account Forecast Errors

Years	Actual	Forecast	% Error
2007	572,107	595,130	1.2%
2008	590,607	598,717	1.4%
2009	593,971	594,838	0.1%
2010	596,367	593,975	-0.4%
2011	598,730	599,098	0.1%
2012	602,141	600,904	-0.2%
2013	607,997	605,887	-0.3%
2014	612,592	614,694	0.3%
2015	615,930	618,560	0.4%
2016	619,882	626,243	1.0%
2017	623,119	627,000	0.6%
2018	632,841	628,098	-0.8%

The remainder of the report presents historical SMUD statistics.

Table 21 includes historical retail sales, system energy, system peak and net customers.

Table 22 presents sales by retail rate classes.

Table 23 presents the number of customer accounts by retail sales classes.

Table 24 presents bill determinants by rate schedule.

Table 25 presents historical and projected population, non-farm employment, and personal income for Sacramento County.

Table 21

Retail Sales, System Energy, Peak, and Customer Accounts

Year	Sales(GWH)	System Energy (GWH)	System Peak (MW)	Net Customers	System Load Factor
2000	9,578	10,269	2,688	513,644	43.6%
2001	9,406	9,781	2,484	524,348	44.9%
2002	9,485	10,094	2,779	535,118	41.5%
2003	9,955	10,583	2,809	547,667	43.0%
2004	10,206	10,894	2,672	560,937	46.5%
2005	10,604	11,133	2,959	572,832	42.9%
2006	10,892	11,688	3,280	582,745	40.7%
2007	10,913	11,643	3,099	588,107	42.9%
2008	10,959	11,718	3,086	590,607	43.3%
2009	10,758	11,448	2,848	593,971	45.9%
2010	10,390	11,085	2,990	596,367	42.3%
2011	10,459	11,193	2,840	598,730	45.0%
2012	10,519	11,239	2,953	602,141	43.4%
2013	10,481	11,378	3,014	607,997	43.1%
2014	10,586	11,259	3,003	612,592	42.8%
2015	10,525	11,251	2,956	615,930	43.4%
2016	10,477	11,246	2,972	619,934	43.2%
2017	10,930	11,598	3,157	623,119	41.9%
2018	10,515	11,209	2,944	632,841	43.5%
Annual Growth	0.52%	0.49%	0.51%	1.17%	

Table 22

Sales by Retail Classes

Y+A31:F47ear	Residential	C&I Small	C&I Medium	C&I Large	Other	Total
2000	4,126	3,192	761	1,358	141	9,578
2001	4,019	3,193	744	1,307	142	9,406
2002	4,087	3,260	709	1,286	143	9,485
2003	4,362	3,319	773	1,363	138	9,955
2004	4,404	3,362	799	1,495	147	10,206
2005	4,557	3,482	814	1,610	140	10,604
2006	4,742	3,536	779	1,694	141	10,892
2007	4,631	3,524	821	1,790	147	10,913
2008	4,690	3,478	828	1,806	157	10,959
2009	4,704	3,340	793	1,770	151	10,758
2010	4,500	3,222	755	1,768	144	10,390
2011	4,600	3,224	717	1,776	142	10,459
2012	4,644	3,243	680	1,799	153	10,519
2013	4,635	3,236	655	1,804	151	10,481
2014	4,660	3,233	647	1,883	162	10,586
2015	4,638	3,165	621	1,952	146	10,524
2016	4,678	3,157	587	1,920	136	10,477
2017	4,996	3,217	581	2,007	127	10,930
2018	4,653	3,159	576	1,998	128	10,515
Annual Growth	0.67%	-0.06%	-1.53%	2.17%	-0.52%	0.52%

Table 23

Average Monthly Customer Accounts by Class

Year	Residential	C&I Small	C&I Medium	C&I Large	Other	Total
2000	455,455	53,055	293	130	4,712	513,644
2001	464,909	54,306	291	128	4,715	524,348
2002	474,293	55,682	289	126	4,728	535,118
2003	485,858	56,656	304	125	4,725	547,667
2004	497,969	57,743	320	130	4,775	560,937
2005	508,760	58,832	315	131	4,794	572,832
2006	517,369	60,099	307	136	4,834	582,745
2007	521,300	61,452	330	141	4,883	588,107
2008	522,819	62,353	332	149	4,955	590,607
2009	525,784	62,686	331	155	5,016	593,971
2010	528,065	62,781	316	156	5,049	596,367
2011	530,104	63,064	294	154	5,114	598,730
2012	533,318	63,238	291	152	5,142	602,141
2013	538,863	63,510	282	157	5,185	607,997
2014	543,177	63,784	264	149	5,217	612,592
2015	546,383	63,856	254	155	5,282	615,930
2016	549,980	64,163	248	158	5,334	619,882
2017	552,897	64,412	249	157	5,405	623,119
2018	557,621	64,626	253	163	5,436	628,098
Annual Growth	1.13%	1.10%	-0.83%	1.26%	0.80%	1.12%

Table 24

2018 Billing Determinates by Rate Schedule

Rate Class	Description	Customers	Avg. kWh/mth	Annual GWh	Share of Total Sales
Residential	Electric Space Heat	124,001	931	1,155	11%
Residential	Non-Electric Space He	419,177	835	3,498	32%
GSN	Max kW <=20	55,456	1,349	748	7%
GSS	21 to 299 Max Kw	7,839	23,391	1,834	17%
GSTOU3	300 to 499 Max Kw	489	118,156	577	5%
GSTOU2	500 to 999 Max Kw	264	218,419	576	5%
GSTOU1	>=1000 Max Kw	149	1,337,469	1,998	18%
AGR	0 to 499 Max Kw	2,420	2,936	71	1%
Street/Traffic		2,809	1,913	54	0%
Nightlights		4,836	74	4	0%
Total		617,439		10,930	100%
Net Customers		612,603			

Table 25

Sacramento County Economic and Populations History and Forecast			
Year	Population	Non-Farm Employment (1,000)	Personal income ($Mil)
2000	1,235,492	570,837	36,273
2001	1,271,059	580,217	39,495
2002	1,304,626	589,833	41,016
2003	1,331,368	591,928	43,406
2004	1,350,629	598,831	46,184
2005	1,362,610	616,765	48,166
2006	1,371,641	629,951	50,965
2007	1,383,397	630,986	52,725
2008	1,396,379	618,058	54,773
2009	1,410,321	587,249	53,826
2010	1,423,361	572,818	54,665
2011	1,436,131	568,930	57,494
2012	1,448,504	581,092	59,784
2013	1,461,631	593,742	61,654
2014	1,479,513	606,317	65,392
2015	1,497,371	620,974	69,872
2016	1,513,423	633,312	73,112
2017	1,530,179	646,482	76,550
2018	1,549,046	656,837	80,822
2019	1,569,014	667,237	85,411
2020	1,588,677	675,587	89,770
2021	1,607,744	682,161	94,387
2022	1,625,925	689,389	99,098
2023	1,643,434	697,056	103,994
2024	1,660,853	704,673	109,144
2025	1,678,009	711,845	114,443
2026	1,694,734	718,389	119,913
2027	1,712,229	725,772	125,763
2028	1,730,144	733,937	131,910
2029	1,748,416	742,530	138,304
2030	1,766,639	751,727	144,899
2031	1,785,308	760,798	152,223
2032	1,803,746	769,693	159,685
2033	1,821,924	778,389	167,498
2034	1,839,744	787,517	175,861
2035	1,857,275	796,844	184,653

Data and Sources

The regression models retail sales were estimated with data from SMUD's billing system for the period 2007-2018. SMUD billing data includes monthly kWh and customer accounts by SMUD 21-day cycle reads. The hourly load, daily peak and daily energy models were estimated using hourly load data from SMUD's Energy Management System (EMS) for its retail service territory for the period 1-1-2006 to 07-31-2018.

The population, personal income, and employment data is from the IHS Global Insight Regional Forecast for Sacramento County (June2018).

Office building vacancy rates are from the Sacramento Business Journal, On Real Estate Section, selective publication dates.

Appendix

This appendix presents the regression model estimated parameters and summary statistics for each regression equation.

The regression results include the daily energy model, the daily peak model, and the hourly load models for each hour retail class sales models.

Appendix

Regression Parameters Coefficients, Standard Errors, and Summary Statistics

Regression Parameters Coefficients, Standard Errors, and Summary Statistics					
Daily System Energy Model Parameters					
Variable		Coefficient	StdErr	T-Stat	P-Value
CONST	Constant Variable	45.40	0.16	291.45	0.00
loads.monday	if day=Monday then =1, else=0	4.11	0.09	44.57	0.00
loads.Tuesday	if day=Tuesday then =1, else=0	3.85	0.11	34.23	0.00
loads.Wednesday	if day=Wednesday then =1, else=0	3.88	0.12	32.55	0.00
loads.Thursday	if day=Thursday then =1, else=0	3.82	0.12	32.03	0.00
loads.Friday	if day=Friday then =1, else=0	3.68	0.11	32.87	0.00
loads.Saturday	if day=Saturday then =1, else=0	0.34	0.09	3.66	0.00
loads.February	if month=February then=1, else=0	0.26	0.30	0.87	0.38
loads.March	if month=March then=1, else=0	0.65	0.18	3.58	0.00
loads.April	if month=April then=1, else=0	-0.59	0.17	-3.46	0.00
loads.May	if month=May then=1, else=0	-1.32	0.20	-6.68	0.00
loads.June	if month=June then=1, else=0	-1.41	0.24	-5.92	0.00
loads.July	if month=July then=1, else=0	-1.14	0.30	-3.81	0.00
loads.August	if month=August then=1, else=0	-1.00	0.29	-3.40	0.00
loads.September	if month=September then=1, else=0	-1.25	0.24	-5.21	0.00
loads.December	if month=December then=1, else=0	2.23	0.35	6.38	0.00
loads.summer_monday	if day=Monday and season=Summer then =1, else=0	0.71	0.12	6.03	0.00
loads.summer_tuesday	if day=tuesday and season=Summer then =1, else=0	0.99	0.14	6.91	0.00
loads.summer_wednesday	if day=wednesday and season=Summer then =1, else=0	0.91	0.15	5.96	0.00
loads.Summer_thursday	if day=thursday and season=Summer then =1, else=0	1.12	0.15	7.33	0.00
loads.summer_friday	if day=friday and season=Summer then =1, else=0	0.80	0.14	5.59	0.00
loads.summer_saturday	if day=saturday and season=Summer then =1, else=0	0.25	0.12	2.10	0.04
loads.winter_monday	if day=Monday and season=winter then =1, else=0	-0.25	0.12	-2.11	0.03
loads.winter_tuesday	if day=tuesday and season=winter then =1, else=0	-0.05	0.15	-0.37	0.71
loads.winter_wednesday	if day=wednesday and season=winter then =1, else=0	-0.15	0.15	-0.97	0.33
loads.winter_thursday	if day=thursday and season=winter then =1, else=0	-0.29	0.15	-1.88	0.06
loads.winter_friday	if day=friday and season=winter then =1, else=0	-0.34	0.14	-2.33	0.02
loads.winter_saturday	if day=saturday and season=winter then =1, else=0	-0.04	0.12	-0.35	0.73
loads.cdd65	Cooling Degree Day Base 65º	0.34	0.02	13.89	0.00
loads.cdd70	Cooling Degree Day Base 70º	0.28	0.03	9.50	0.00
loads.lag1_cdd65	Cooling Degree Day Lagged 1 day Base 65º	0.28	0.01	35.07	0.00
loads.lag2_cdd65	Cooling Degree Day Lagged 2 day Base 65º	0.03	0.01	4.43	0.00
loads.lag3_cdd65	Cooling Degree Day Lagged 3 day Base 65º	0.02	0.01	2.65	0.01
loads.lag4_cdd65	Cooling Degree Day Lagged 4 day Base 65º	0.03	0.01	4.12	0.00
loads.cdd65_may	Cdd65*May	0.22	0.03	8.11	0.00
loads.cdd65_june	Cdd65*June	0.40	0.03	14.68	0.00
loads.cdd65_july	Cdd65*July	0.41	0.03	13.99	0.00
loads.cdd65_august	Cdd65*August	0.32	0.03	10.82	0.00
loads.cdd65_september	Cdd65*September	0.18	0.03	6.40	0.00
loads.holiday	if day=Calif. or Federal holiday then=1, else=0	-1.81	0.08	-21.73	0.00
loads.Hdd65_Novermber	Hdd65*November	0.16	0.02	9.69	0.00
loads.Hdd65_December	Hdd65*December	0.15	0.02	6.86	0.00
loads.Hdd65_January	Hdd65*February	0.26	0.01	18.17	0.00
loads.hdd65_February	Hdd65*January	0.17	0.02	7.89	0.00
loads.hdd50	Heating Degree DayBase 50º	0.04	0.03	1.27	0.20
loads.hdd65	Heating Degree DayBase 65º	0.03	0.01	3.12	0.00
loads.cai	exp(.2+2*(max daily temps-95))/(1+exp(.2+2*max daily te	6.32	0.35	18.17	0.00
loads.mintemphdd	Heating Degree Day with Min Temp, Base = 40	0.09	0.02	4.62	0.00
loads.maxtemphdd	Heating Degee Day with Max temp, base = 55	0.19	0.03	7.43	0.00
loads.maxtemp_105	if Maxtemp >=105, then= 1, else=0	1.42	0.17	8.42	0.00
loads.holiday_july	if day=Calif. or Federal holiday in July then=1, else=0	-1.79	0.27	-6.57	0.00
loads.year_2008	If year=2008 then=1, else=1	-0.63	0.16	-3.88	0.00
loads.Year_2009	If year=2009 then=1, else=0	-2.06	0.16	-12.65	0.00
loads.year_2010	If year=2010 then=1, else=0	-2.69	0.16	-16.49	0.00
loads.year_2011	If year=2011 then=1, else=0	-2.93	0.16	-17.98	0.00
loads.year_2012	If year=2012 then=1, else=0	-3.83	0.16	-23.53	0.00
loads.Year_2013	If year=2013 then=1, else=0	-4.33	0.16	-26.59	0.00
loads.year_2014	If year=2014 then=1, else=0	-5.00	0.16	-30.58	0.00
loads.year_2015_trend	If year>=2015 then=1, else=0	-5.30	0.13	-41.86	0.00
AR(1)	Autoregressive rho Estimate	0.59	0.01	46.64	0.00
Observations: January 2006 to August 2017					

Regression Parameters Coefficients, Standard Errors, and Summary Statistics					
Daily System Peak Model Parameters					
Variable		Coefficient	StdErr	T-Stat	P-Value
CONST	Constant Variable	2.248	0.011	205.717	0.00%
loads.monday	if day=Monday then =1, else=0	0.109	0.008	13.242	0.00%
loads.Tuesday	if day=Tuesday then =1, else=0	0.084	0.010	8.462	0.00%
loads.Wednesday	if day=Wednesday then =1, else=0	0.078	0.010	7.458	0.00%
loads.Thursday	if day=Thursday then =1, else=0	0.070	0.010	6.747	0.00%
loads.Friday	if day=Friday then =1, else=0	0.025	0.010	2.504	1.23%
loads.Saturday	if day=Saturday then =1, else=0	-0.086	0.008	-10.486	0.00%
loads.February	if month=February then=1, else=0	0.009	0.025	0.346	72.90%
loads.March	if month=March then=1, else=1	0.052	0.014	3.615	0.03%
loads.April	if month=April then=1, else=0	-0.044	0.014	-3.220	0.13%
loads.May	if month=May then=1, else=0	-0.132	0.015	-8.992	0.00%
loads.June	if month=June then=1, else=0	-0.010	0.016	-0.636	52.50%
loads.July	if month=July then=1, else=0	0.094	0.018	5.296	0.00%
loads.August	if month=August then=1, else=0	0.058	0.017	3.353	0.08%
loads.September	if month=September then=1, else=0	-0.119	0.016	-7.383	0.00%
loads.December	if month=December then=1, else=0	0.182	0.028	6.444	0.00%
loads.summer_monday	if day=Monday and season=Summer then =1, else=0	0.129	0.010	12.412	0.00%
loads.summer_tuesday	if day=tuesday and season=Summer then =1, else=0	0.144	0.013	11.421	0.00%
loads.summer_wednesday	if day=wednesday and season=Summer then =1, else=0	0.147	0.013	10.963	0.00%
loads.Summer_thursday	if day=thursday and season=Summer then =1, else=0	0.168	0.013	12.551	0.00%
loads.summer_friday	if day=friday and season=Summer then =1, else=0	0.179	0.013	14.226	0.00%
loads.summer_saturday	if day=saturday and season=Summer then =1, else=0	0.060	0.010	5.803	0.00%
loads.winter_monday	if day=Monday and season=winter then =1, else=0	0.049	0.011	4.550	0.00%
loads.winter_tuesday	if day=tuesday and season=winter then =1, else=0	0.055	0.013	4.355	0.00%
loads.winter_wednesday	if day=wednesday and season=winter then =1, else=0	0.053	0.013	3.989	0.01%
loads.winter_thursday	if day=thursday and season=winter then =1, else=0	0.042	0.013	3.129	0.18%
loads.winter_friday	if day=friday and season=winter then =1, else=0	0.048	0.013	3.760	0.02%
loads.winter_saturday	if day=saturday and season=winter then =1, else=0	0.027	0.011	2.522	1.17%
loads.cdd65	Cooling Degree Day Base 65º	0.049	0.001	34.041	0.00%
loads.lag1_cdd65	Cooling Degree Day Lagged 1 day Base 65º	0.016	0.001	22.610	0.00%
loads.lag2_cdd65	Cooling Degree Day Lagged 2 day Base 65º	0.003	0.001	3.895	0.01%
loads.lag3_cdd65	Cooling Degree Day Lagged 3 day Base 65º	0.002	0.001	2.152	3.15%
loads.lag4_cdd65	Cooling Degree Day Lagged 4 day Base 65º	0.003	0.001	5.123	0.00%
loads.holiday	if day=Calif. or Federal holiday then=1, else=0	-0.086	0.007	-11.523	0.00%
loads.Hdd65_Novermber	Heating Degree Day in November Base 65º	0.008	0.001	6.131	0.00%
loads.Hdd65_December	Heating Degree Day in December Base 65º	0.004	0.002	2.596	0.95%
loads.Hdd65_January	Heating Degree Day in January Base 65º	0.012	0.001	10.975	0.00%
loads.hdd65_February	Heating Degree Day in February Base 65º	0.008	0.002	4.287	0.00%
loads.maxtemphdd	Heating Degree Day with Daily High Temp Base 55^{O}	0.012	0.002	7.526	0.00%
loads.hdd65	Heating Degree Day Base 65º	0.004	0.001	5.093	0.00%
loads.cai	exp(.2+2*(max daily temps-95))/(1+exp(.2+2*max daily te	1.173	0.027	43.021	0.00%
loads.holiday_july	if day=Calif. or Federal holiday in July then=1, else=0	-0.147	0.024	-6.041	0.00%
loads.year_2010	If year=2010 then=1, else=0	-0.118	0.011	-10.255	0.00%
loads.year_2011	If year=2011 then=1, else=0	-0.135	0.011	-11.784	0.00%
loads.year_2012	If year=2012 then=1, else=0	-0.178	0.011	-15.478	0.00%
loads.Year_2013	If year=2013 then=1, else=0	-0.211	0.011	-18.342	0.00%
loads.year_2014	If year>=2014 then=1, else=0	-0.245	0.012	-21.150	0.00%
loads.year_2015_trend	If year>=2015 then=1, else=0	-0.268	0.008	-32.235	0.00%
AR(1)	Autoregressive rho Estimate	0.540	0.013	40.854	0.00%
Observations: January 2006 to August 2017					

Daily Model				
Model Statistics			Forecast Statistics	
Iterations	15		Forecast Observations	28
Adjusted Observations	4223		Mean Abs. Dev. (MAD)	1.2212
Deg. of Freedom for Error	4163		Mean Abs. % Err. (MAPE)	1.88%
R-Squared	0.984		Avg. Forecast Error	0.8510
Adjusted R-Squared	0.984		Mean % Error	1.31%
AIC	0.08318		Root Mean-Square Error	1.6120
BIC	0.17338		Theil's Inequality Coefficient	0.0127
F-Statistic	4305.785		-- Bias Proportion	27.87%
Prob (F-Statistic)	0.0000		-- Variance Proportion	1.24%
Log-Likelihood	-6,107.8134		-- Covariance Proportion	70.89%
Model Sum of Squares	272,209.37			
Sum of Squared Errors	4,460.72			
Mean Squared Error	1.0715			
Std. Error of Regression	1.0351			
Mean Abs. Dev. (MAD)	0.7662			
Mean Abs. % Err. (MAPE)	1.46%			
Durbin-Watson Statistic	2.029			
Durbin-H Statistic	#NA			
Ljung-Box Statistic	115.63			
Prob (Ljung-Box)	0.0000			
Skewness	0.036			
Kurtosis	4.896			
Jarque-Bera	633.125			
Prob (Jarque-Bera)	0.0000			

Peak Model				
Model Statistics			Forecast Statistics	
Iterations	10		Forecast Observations	28
Adjusted Observations	4223		Mean Abs. Dev. (MAD)	0.1129
Deg. of Freedom for Error	4174		Mean Abs. % Err. (MAPE)	2.98%
R-Squared	0.982		Avg. Forecast Error	0.0719
Adjusted R-Squared	0.982		Mean % Error	1.92%
AIC	-4.78751		Root Mean-Square Error	0.1348
BIC	-4.71385		Theil's Inequality Coefficient	0.0176
F-Statistic	4838.911		-- Bias Proportion	28.48%
Prob (F-Statistic)	0.0000		-- Variance Proportion	2.57%
Log-Likelihood	4,165.6547		-- Covariance Proportion	68.95%
Model Sum of Squares	1,913.33			
Sum of Squared Errors	34.38			
Mean Squared Error	0.0082			
Std. Error of Regression	0.0908			
Mean Abs. Dev. (MAD)	0.0646			
Mean Abs. % Err. (MAPE)	2.35%			
Durbin-Watson Statistic	2.077			
Durbin-H Statistic	#NA			
Ljung-Box Statistic	159.25			
Prob (Ljung-Box)	0.0000			
Skewness	-0.090			
Kurtosis	7.457			
Jarque-Bera	3501.782			
Prob (Jarque-Bera)	0.0000			

Hourly Model											
Model Statistics											
Hour	Obs	DF	AdjRSq	DW	StdErr	MAD	MAPE	FObs	FMAD	FMAPE	FAvgErr
Hour1	4230	4185	0.910	1.231	0.065	0.042	2.29%	28	0.071	3.22%	0.066
Hour2	4226	4181	0.836	1.551	0.076	0.040	2.21%	28	0.065	3.19%	0.062
Hour3	4229	4184	0.901	1.035	0.049	0.034	2.09%	28	0.067	3.50%	0.065
Hour4	4230	4185	0.898	0.981	0.047	0.033	2.03%	28	0.067	3.61%	0.066
Hour5	4230	4185	0.901	0.936	0.047	0.034	2.03%	28	0.062	3.35%	0.062
Hour6	4230	4185	0.908	0.871	0.054	0.039	2.24%	28	0.062	3.23%	0.062
Hour7	4230	4185	0.917	0.827	0.071	0.052	2.73%	28	0.074	3.75%	0.074
Hour8	4230	4185	0.916	0.845	0.077	0.057	2.80%	28	0.073	3.56%	0.070
Hour9	4230	4185	0.908	0.860	0.073	0.053	2.55%	28	0.057	2.59%	0.051
Hour10	4230	4185	0.898	0.917	0.076	0.055	2.54%	28	0.063	2.61%	0.044
Hour11	4230	4184	0.901	0.966	0.085	0.061	2.71%	28	0.076	2.88%	0.043
Hour12	4230	4185	0.918	1.007	0.096	0.069	2.96%	28	0.093	3.31%	0.053
Hour13	4230	4184	0.939	1.078	0.104	0.074	3.09%	28	0.122	4.04%	0.083
Hour14	4230	4185	0.957	1.124	0.107	0.077	3.15%	28	0.133	4.14%	0.107
Hour15	4230	4186	0.970	1.128	0.107	0.078	3.15%	28	0.148	4.37%	0.127
Hour16	4230	4186	0.973	1.209	0.115	0.084	3.31%	28	0.149	4.22%	0.124
Hour17	4230	4186	0.977	1.009	0.114	0.085	3.30%	28	0.157	4.27%	0.131
Hour18	4230	4185	0.971	0.932	0.124	0.094	3.62%	28	0.176	4.74%	0.130
Hour19	4230	4185	0.966	0.836	0.122	0.092	3.53%	28	0.193	5.34%	0.142
Hour20	4230	4184	0.963	0.909	0.109	0.080	3.10%	28	0.174	5.09%	0.141
Hour21	4230	4184	0.958	1.016	0.098	0.071	2.76%	28	0.127	3.88%	0.105
Hour22	4230	4184	0.951	1.091	0.093	0.066	2.68%	28	0.108	3.54%	0.094
Hour23	4229	4184	0.941	1.121	0.082	0.057	2.55%	28	0.097	3.56%	0.093
Hour24	4230	4184	0.921	1.278	0.075	0.049	2.40%	28	0.094	3.85%	0.092

Note: Hourly model estimated parameters and standard errors available upon request

Residential Electric Space Heat Sales (SAE)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
Bin.Jan	Binary = 1 in Jan	83.61	9.39	8.90	0.00
Bin.Feb	Binary = 1 in Feb	14.60	7.68	1.90	0.06
Bin.Mar	Binary = 1 in Mar	-54.80	8.64	-6.35	0.00
Bin.Apr	Binary = 1 in Apr	-90.05	10.39	-8.67	0.00
Bin.May	Binary = 1 in May	-91.47	11.91	-7.68	0.00
Bin.Jun	Binary = 1 in Jun	-29.74	13.80	-2.16	0.03
Bin.Jul	Binary = 1 in Jul	43.19	18.98	2.28	0.02
Bin.Aug	Binary = 1 in Aug	13.66	19.32	0.71	0.48
Bin.Sep	Binary = 1 in Sep	0.41	18.55	0.02	0.98
Bin.Oct	Binary = 1 in Oct	-78.28	13.70	-5.71	0.00
Bin.Nov	Binary = 1 in Nov	-90.53	11.21	-8.07	0.00
RSAE_AllElec_Vars.XOther	Res XOther SAE Variable	25.07	0.43	57.84	0.00
RSAE_AllElec_CycWthr.XHeat	Res XHeat Cycle Month	36.97	1.47	25.18	0.00
RSAE_AllElec_CycWthr.XCool	Res XCool Cycle Month	27.55	1.75	15.75	0.00
nate.trend_2015	If year>=2015 then=1, else=0	-14.59	5.66	-2.58	0.01
nate.year_2017	If year=2017 then=1, else=0	30.09	7.45	4.04	0.00
nate.year_2016	If year=2016 then=1, else=0	11.93	7.25	1.65	0.10
Data Series: January 2006 to July 2018.					

Residential Non-Electric Space Heat Sales (SAE)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
Bin.Jan	Binary = 1 in Jan	42.85	8.71	4.92	0.00
Bin.Feb	Binary = 1 in Feb	-31.32	7.13	-4.39	0.00
Bin.Mar	Binary = 1 in Mar	-67.81	8.07	-8.41	0.00
Bin.Apr	Binary = 1 in Apr	-90.12	10.05	-8.97	0.00
Bin.May	Binary = 1 in May	-84.20	11.79	-7.14	0.00
Bin.Jun	Binary = 1 in Jun	-24.85	13.69	-1.82	0.07
Bin.Jul	Binary = 1 in Jul	21.93	18.55	1.18	0.24
Bin.Aug	Binary = 1 in Aug	-16.38	18.95	-0.86	0.39
Bin.Sep	Binary = 1 in Sep	-19.88	18.17	-1.09	0.28
Bin.Oct	Binary = 1 in Oct	-75.04	13.75	-5.46	0.00
Bin.Nov	Binary = 1 in Nov	-83.52	11.02	-7.58	0.00
RSAE_Gas_Vars.XOther	Res XOther SAE Variable	25.74	0.50	51.72	0.00
RSAE_Gas_CycWthr.XHeat	Res XHeat Cycle Month	5.93	1.21	4.91	0.00
RSAE_Gas_CycWthr.XCool	Res XCool Cycle Month	38.92	1.61	24.20	0.00
nate.trend_2015	If year>=2015 then=1, else=0	20.90	3.38	6.18	0.00
Data Series: January 2006 to July 2018.					

Table 18 (continued)

Small Commercial Sales (<20kW)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	1078.79	24.73	43.62	0.00
Account_Forecast.january	If month=1 then=1, else=0	59.83	8.99	6.65	0.00
Account_Forecast.february	If month=2 then=1, else=0	50.79	7.41	6.86	0.00
Account_Forecast.april	If month=4 then=1, else=0	-37.12	7.41	-5.01	0.00
Account_Forecast.may	If month=5 then=1, else=0	-40.07	7.50	-5.35	0.00
Account_Forecast.year_2014	If year=2014 then= 1, else=0	158.68	10.82	14.66	0.00
Account_Forecast.year_2016	If year=2016 then= 1, else=0	16.39	12.78	1.28	0.20
Account_Forecast.year_2015	If year>2015 then= 1, else=0	58.54	13.47	4.34	0.00
Account_Forecast.sumhdd65	Sum HDD base 65°	0.01	0.00	13.94	0.00
Account_Forecast.sumcdd65	Sum CDD base 65°	0.03	0.00	29.64	0.00
Account_Forecast.year2016plus	If year>2016 then= 1, else=0	8.92	15.13	0.59	0.56
Account_Forecast.Vacancy	Annual Vancancy Rate .	-12.64	1.13	-11.21	0.00
AR(1)	Autoregressive rho estimate	0.37	0.09	4.27	0.00
Data Series: January 2006 to July 2018.					

Small Commercial Sales (21-299 kW)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	15606.91	598.66	26.07	0.00
Account_Forecast.year_2010	If year=2010 then= 1, else=0	-234.77	275.26	-0.85	0.40
Account_Forecast.year_2011	If year=2011 then= 1, else=0	-517.12	295.63	-1.75	0.08
Account_Forecast.year_2012	If year=2012 then= 1, else=1	-692.16	306.71	-2.26	0.03
Account_Forecast.year_2013	If year=2013 then= 1, else=2	-5.04	302.08	-0.02	0.99
Account_Forecast.sumcdd65	Sum HDD base 65°	0.41	0.02	25.86	0.00
Account_Forecast.sumhdd65	Sum CDD base 65°	0.06	0.01	5.28	0.00
Account_Forecast.year_2014	If year=2014 then= 1, else=2	4718.22	243.52	19.38	0.00
Account_Forecast.year_2015	If year=2015 then= 1, else=2	3722.29	272.05	13.68	0.00
Account_Forecast.year2016plus	If year>2016 then= 1, else=0	3038.31	301.17	10.09	0.00
Account_Forecast.Vacancy	Annual Vancancy Rate .	-154.86	33.35	-4.64	0.00
Account_Forecast.Dec2013	If year=2013 and month=Dec. then= 1, else=0	5793.71	463.66	12.50	0.00
AR(1)	Autoregressive rho estimate	0.38	0.09	4.39	0.00
Data Series: January 2006 to July 2018.					

Small Commercial Sales (300-499 kW)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	97126.27	4296.92	22.60	0.00
Account_Forecast.year_2013	If year=2013 then= 1, else=2	24366.29	2016.16	12.09	0.00
Account_Forecast.year_2014	If year=2014 then= 1, else=2	31385.84	2059.93	15.24	0.00
Account_Forecast.year_2015	If year=2015 then= 1, else=2	21785.25	2489.44	8.75	0.00
Account_Forecast.year_2016	If year=2016 then= 1, else=0	15879.50	2806.99	5.66	0.00
Account_Forecast.Jan2015	If year=2015 and month=Jan. then= 1, else=0	-27740.65	3916.86	-7.08	0.00
Account_Forecast.year2017plus	If year>2017 then= 1, else=0	12581.76	2715.80	4.63	0.00
Account_Forecast.sumcdd65	Sum CDD base 65°	1.24	0.11	11.09	0.00
Account_Forecast.LagVacancy	Vacancy Rate lag 1-month	-1401.17	208.85	-6.71	0.00
AR(1)	Autoregressive rho estimate	0.43	0.09	4.90	0.00
Data Series: January 2006 to July 2018.					

Medium Commercial Sales (500-999 kW)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	213916.12	4632.05	46.18	0.00
Account_Forecast.january	If month=1 then=1, else=0	6088.89	2556.97	2.38	0.02
Account_Forecast.april	If month=4 then=1, else=0	-13756.28	2152.84	-6.39	0.00
Account_Forecast.may	If month=5 then=1, else=0	-11128.56	2203.16	-5.05	0.00
Account_Forecast.year_2012	If year=2012 then= 1, else=0	-8121.98	2203.05	-3.69	0.00
Account_Forecast.year_2013	If year=2013 then= 1, else=0	-9168.69	2156.37	-4.25	0.00
Account_Forecast.year2015plus	If year>2015 then= 1, else=1	-8713.53	2203.31	-3.95	0.00
Account_Forecast.year2017plus	If year>2017 then= 1, else=2	-9861.45	2093.68	-4.71	0.00
Account_Forecast.sumcdd65	Sum CDD base 65°	1.82	0.24	7.66	0.00
Account_Forecast.sumhdd65	Sum HDD base 60°	-0.75	0.19	-3.90	0.00
Account_Forecast.Feb2014	If year=2014 and month=Feb. then= 1, else=0	-25142.10	6575.35	-3.82	0.00
Account_Forecast.Vacancy	Vacancy Rate	-519.64	210.19	-2.47	0.01
Data Series: January 2006 to July 2018.					

Large Commercial Sales (>1000 kW)					
Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	1122251.41	17578.61	63.84	0.00
Account_Forecast.january	If month=1 then=1, else=0	49437.99	15014.18	3.29	0.00
Account_Forecast.april	If month=4 then=1, else=0	-52996.33	14945.79	-3.55	0.00
Account_Forecast.may	If month=5 then=1, else=0	-62608.24	14528.66	-4.31	0.00
Account_Forecast.sumcdd65	Sum CDD base 65°	7.61	0.98	7.75	0.00
Vacancy.Unemployment	Unemployment Rate	-16048.89	1754.70	-9.15	0.00
Account_Forecast.Oct2011	If year=2011 and month=Oct. then= 1, else=0	198700.27	47275.78	4.20	0.00
Account_Forecast.year_2013	If year=2013 then= 1, else=0	-45006.18	14317.32	-3.14	0.00
Account_Forecast.year2016plus	If year>2016 then= 1, else=2	-32318.70	11871.15	-2.72	0.01
Data Series: January 2006 to July 2018.					

Agricultural Sales

Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	971.50	67.44	14.41	0.00
Account_Forecast.april	If month=4 then=1, else=0	350.33	73.00	4.80	0.00
Account_Forecast.may	If month=5 then=1, else=0	1186.89	102.27	11.61	0.00
Account_Forecast.June	If month=6 then=1, else=0	2258.21	156.84	14.40	0.00
Account_Forecast.July	If month=7 then=1, else=1	2751.48	262.78	10.47	0.00
Account_Forecast.August	If month=8 then=1, else=2	2785.13	274.58	10.14	0.00
Account_Forecast.September	If month=9 then=1, else=3	2158.12	250.21	8.63	0.00
Account_Forecast.October	If month=10 then=1, else=4	1011.44	148.39	6.82	0.00
Account_Forecast.November	If month=11 then=1, else=5	392.04	77.28	5.07	0.00
Account_Forecast.sumcdd65	Sum CDD base 65°	0.11	0.02	4.71	0.00
AR(1)	Autoregressive rho estimate	0.61	0.07	8.49	0.00
Data Series: January 2006 to July 2018.					

Streetlight Sales

Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	2364.326	56.56	41.81	0.00
Account_Forecast.year_2013	If year=2013 then= 1, else=0	-269.281	126.46	-2.13	0.04
Account_Forecast.year_2015	If year=2015 then= 1, else=0	-463.838	126.46	-3.67	0.00
Account_Forecast.year_2016	If year=2016 then= 1, else=0	-678.94	126.46	-5.37	0.00
Account_Forecast.year2017plus	If year>2017 then= 1, else=0	-876.462	110.59	-7.93	0.00
Data Series: January 2006 to July 2018.					

Nightlights Sales

Variable	Definition	Coefficient	StdErr	T-Stat	P-Value
CONST	Constant term	64.281	0.066	977.707	0.00%
Account_Forecast.June	If month=5 then=1, else=0	-0.210	0.073	-2.897	0.43%
Account_Forecast.january	If month=1 then=1, else=0	-0.261	0.071	-3.689	0.03%
Account_Forecast.february	If month=2 then=1, else=1	-0.170	0.072	-2.378	1.86%
Account_Forecast.march	If month=3 then=1, else=2	-0.291	0.072	-4.055	0.01%
Account_Forecast.april	If month=4 then=1, else=3	-0.218	0.072	-3.034	0.28%
Account_Forecast.may	If month=5 then=1, else=4	-0.161	0.074	-2.178	3.10%
Account_Forecast.July	If month=6 then=1, else=5	-0.154	0.069	-2.234	2.69%
Account_Forecast.year_2004	If year=2004 then= 1, else=0	-2.641	0.109	-24.128	0.00%
Account_Forecast.year_2005	If year=2005 then= 1, else=0	-2.319	0.104	-22.227	0.00%
Account_Forecast.year_2006	If year=2006 then= 1, else=0	-1.561	0.105	-14.937	0.00%
Account_Forecast.year_2007	If year>2007 then= 1, else=0	-1.475	0.104	-14.140	0.00%
Account_Forecast.year_2008	If year>2008 then= 1, else=1	-1.044	0.104	-10.009	0.00%
Account_Forecast.year_2009	If year>2009 then= 1, else=2	-0.716	0.104	-6.873	0.00%
Account_Forecast.year_2010	If year>2010 then= 1, else=3	-0.456	0.103	-4.418	0.00%
Account_Forecast.year_2013	If year>2013 then= 1, else=4	0.293	0.103	2.838	0.52%
Account_Forecast.year_2014	If year>2014 then= 1, else=5	0.766	0.104	7.356	0.00%
Account_Forecast.year_2015	If year>2015 then= 1, else=6	0.926	0.104	8.880	0.00%
Account_Forecast.year_2016	If year>2016 then= 1, else=7	1.249	0.104	11.966	0.00%
Account_Forecast.year2017plus	If year>2017 then= 1, else=8	1.853	0.095	19.401	0.00%
Account_Forecast.may2017	If year=2017and month=May then= 1, else=0	-1.848	0.262	-7.054	0.00%
AR(1)	Autoregressive rho estimate	0.211	0.090	2.338	2.07%
Data Series: January 2006 to July 2018.					

Model Statistics	Residential Electric Space Heat	Residential Non-Electrical Space Heat	Small Commercial Sales (<20 kW)	Small Commercial Sales (21-299 kW)	Small Commercial Sales (300-499 kW)
Iterations	1	1	11	13	12
Adjusted Observations	131	131	136	136	136
Deg. of Freedom for Error	114	116	123	123	126
R-Squared	0.991	0.988	0.970	0.979	0.948
Adjusted R-Squared	0.990	0.987	0.967	0.977	0.945
AIC	5.853	5.696	6.382	12.361	16.629
BIC	6.226	6.026	6.661	12.639	16.843
F-Statistic	#NA	#NA	325.878	481.506	257.061
Prob (F-Statistic)	#NA	#NA	0.0000	0.0000	0.0000
Log-Likelihood	-552.23	-543.99	-613.98	-1,020.51	-1,313.76
Model Sum of Squares	4,012,775.10	2,556,946.67	2,111,858.99	1,231,940,695.75	35,939,389,364.23
Sum of Squared Errors	35,182.45	31,024.89	66,425.32	26,224,809.91	1,957,321,615.22
Mean Squared Error	308.62	267.46	540.04	213,209.84	15,534,298.53
Std. Error of Regression	17.57	16.35	23.24	461.75	3,941.36
Mean Abs. Dev. (MAD)	12.73	11.08	17.29	359.25	2,762.59
Mean Abs. % Err. (MAPE)	1.53%	1.57%	1.65%	2.27%	3.19%
Durbin-Watson Statistic	1.566	0.934	2.019	1.859	2.152
Durbin-H Statistic	#NA	#NA	#NA	#NA	#NA
Ljung-Box Statistic	27.32	156.97	34.32	134.75	26.50
Prob (Ljung-Box)	0.2899	0.0000	0.0792	0.0000	0.3281
Skewness	0.293	0.261	0.090	0.254	0.749
Kurtosis	3.454	5.580	3.217	2.814	4.866
Jarque-Bera	2.992	37.813	0.451	1.657	32.457
Prob (Jarque-Bera)	0.2241	0.0000	0.7983	0.4367	0.0000

Model Statistics	Medium Commercial Sales (500-999 kW)	Large Commercial Sales (>1000kW)	Agricultural Sales	Streetlight Sales	Nightlight Sales
Iterations	1	1	7	1	14
Adjusted Observations	137	137	136	101	172
Deg. of Freedom for Error	125	128	125	96	150
R-Squared	0.848	0.651	0.979	0.449	0.972
Adjusted R-Squared	0.834	0.629	0.977	0.426	0.968
AIC	17.634	21.568	11.008	11.990	-2.747
BIC	17.889	21.759	11.243	12.119	-2.345
F-Statistic	63.168	29.841	579.242	19.543	246.872
Prob (F-Statistic)	0.0000	0.0000	0.0000	0.0000	0.0000
Log-Likelihood	-1,390.30	-1,662.77	-930.51	-743.80	14.19
Model Sum of Squares	29,095,457,830.06	521,245,373,130.15	323,495,583.20	12,002,208.97	295.11
Sum of Squared Errors	5,234,104,812.22	279,476,702,450.51	6,981,015.81	14,739,089.05	8.54
Mean Squared Error	41,872,838.50	2,183,411,737.89	55,848.13	153,532.18	0.06
Std. Error of Regression	6,470.92	46,726.99	236.32	391.83	0.24
Mean Abs. Dev. (MAD)	4,908.86	36,101.78	169.55	210.39	0.16
Mean Abs. % Err. (MAPE)	2.46%	3.61%	9.76%	10.84%	0.25%
Durbin-Watson Statistic	2.062	2.137	1.726	2.303	2.065
Durbin-H Statistic	#NA	#NA	#NA	#NA	#NA
Ljung-Box Statistic	37.74	23.93	37.24	28.34	42.34
Prob (Ljung-Box)	0.0368	0.4654	0.0414	0.2461	0.0118
Skewness	-0.035	0.305	0.360	1.689	-0.673
Kurtosis	2.910	2.693	4.034	9.673	5.850
Jarque-Bera	0.074	2.663	9.002	235.422	71.203
Prob (Jarque-Bera)	0.9636	0.2641	0.0111	0.0000	0.0000

Residential Gas Heat Equipment Shares

Year	EFurn	HPHeat	GHPHeat	SecHt	CAC	HPCool	GHPCool	RAC	EWHeat	ECook	Ref1	Ref2	Frz	Dish	CWash	EDry	TV	FurnFan
2000	0.0%	0.0%	0.0%	23.2%	74.4%	9.3%	0.0%	16.0%	0.1%	50.0%	100.0%	0.1%	24.0%	75.0%	85.1%	70.5%	100.0%	100.0%
2001	0.0%	0.0%	0.0%	23.4%	75.8%	9.4%	0.0%	16.0%	0.1%	50.0%	100.0%	0.1%	24.0%	75.5%	85.3%	70.7%	100.0%	100.0%
2002	0.0%	0.0%	0.0%	23.6%	77.2%	9.5%	0.0%	15.8%	0.1%	50.0%	100.0%	0.1%	24.0%	76.1%	85.4%	71.0%	100.0%	100.0%
2003	0.0%	0.0%	0.0%	23.8%	78.7%	9.6%	0.0%	15.7%	0.1%	50.0%	100.0%	0.1%	24.0%	77.0%	85.4%	71.7%	100.0%	100.0%
2004	0.0%	0.0%	0.0%	24.0%	80.1%	9.8%	0.0%	15.5%	0.1%	50.0%	100.0%	0.1%	24.0%	78.1%	85.5%	72.4%	100.0%	100.0%
2005	0.0%	0.0%	0.0%	24.2%	81.6%	9.9%	0.0%	15.4%	0.1%	50.0%	100.0%	0.1%	24.0%	79.2%	85.6%	73.2%	100.0%	100.0%
2006	0.0%	0.0%	0.0%	24.2%	82.5%	10.0%	0.0%	15.3%	0.1%	50.0%	100.0%	0.1%	24.0%	79.8%	85.6%	73.4%	100.0%	100.0%
2007	0.0%	0.0%	0.0%	24.2%	83.9%	10.2%	0.0%	15.2%	0.1%	50.0%	100.0%	0.1%	24.0%	80.5%	85.6%	73.7%	100.0%	100.0%
2008	0.0%	0.0%	0.0%	24.2%	85.1%	10.3%	0.1%	15.2%	0.1%	50.0%	100.0%	0.1%	24.0%	81.0%	85.6%	73.9%	100.0%	100.0%
2009	0.0%	0.0%	0.0%	24.2%	86.3%	10.4%	0.1%	15.2%	0.1%	50.0%	100.0%	0.1%	24.0%	81.6%	85.6%	74.1%	100.0%	100.0%
2010	0.0%	0.0%	0.0%	24.2%	86.6%	10.6%	0.1%	15.1%	0.1%	50.0%	100.0%	0.1%	24.0%	82.0%	85.7%	74.2%	100.0%	100.0%
2011	0.0%	0.0%	0.0%	24.1%	87.1%	10.7%	0.1%	15.1%	0.1%	50.0%	100.0%	0.1%	24.0%	82.6%	85.8%	74.4%	100.0%	100.0%
2012	0.0%	0.0%	0.0%	24.1%	87.5%	10.9%	0.1%	15.1%	0.1%	50.0%	100.0%	0.1%	24.0%	83.3%	85.9%	74.7%	100.0%	100.0%
2013	0.0%	0.0%	0.0%	24.0%	88.0%	11.0%	0.1%	15.0%	0.1%	50.0%	100.0%	0.1%	24.0%	84.0%	86.0%	75.0%	100.0%	100.0%
2014	0.0%	0.0%	0.0%	23.9%	88.4%	11.2%	0.1%	14.9%	0.1%	50.0%	100.0%	0.1%	24.0%	84.7%	86.1%	75.3%	100.0%	100.0%
2015	0.0%	0.0%	0.0%	23.8%	88.9%	11.4%	0.1%	14.9%	0.1%	50.0%	100.0%	0.1%	24.0%	85.4%	86.3%	75.6%	100.0%	100.0%
2016	0.0%	0.0%	0.0%	23.8%	88.4%	11.6%	0.1%	14.8%	0.1%	50.0%	100.0%	0.1%	24.0%	86.2%	86.4%	76.0%	100.0%	100.0%
2017	0.0%	0.0%	0.0%	23.7%	88.2%	11.8%	0.1%	14.7%	0.1%	50.0%	100.0%	0.1%	24.1%	87.0%	86.6%	76.4%	100.0%	100.0%
2018	0.0%	0.0%	0.0%	23.6%	88.0%	12.0%	0.1%	14.7%	0.1%	50.0%	100.0%	0.1%	24.1%	87.9%	86.9%	76.8%	100.0%	100.0%
2019	0.0%	0.0%	0.0%	23.5%	87.8%	12.2%	0.1%	14.6%	0.1%	50.0%	100.0%	0.1%	24.2%	88.7%	87.1%	77.2%	100.0%	100.0%
2020	0.0%	0.0%	0.0%	23.4%	87.6%	12.4%	0.1%	14.5%	0.1%	50.0%	100.0%	0.1%	24.2%	89.6%	87.3%	77.6%	100.0%	100.0%
2021	0.0%	0.0%	0.0%	23.3%	87.3%	12.7%	0.1%	14.4%	0.1%	50.0%	100.0%	0.1%	24.2%	90.4%	87.5%	78.0%	100.0%	100.0%
2022	0.0%	0.0%	0.0%	23.2%	87.1%	12.9%	0.1%	14.3%	0.1%	50.0%	100.0%	0.1%	24.2%	91.3%	87.8%	78.5%	100.0%	100.0%
2023	0.0%	0.0%	0.0%	23.1%	86.9%	13.1%	0.1%	14.3%	0.1%	50.0%	100.0%	0.1%	24.3%	92.1%	88.0%	78.9%	100.0%	100.0%
2024	0.0%	0.0%	0.0%	23.0%	86.7%	13.3%	0.1%	14.2%	0.1%	50.0%	100.0%	0.1%	24.3%	93.0%	88.2%	79.3%	100.0%	100.0%
2025	0.0%	0.0%	0.0%	22.9%	86.5%	13.5%	0.1%	14.1%	0.1%	50.0%	100.0%	0.1%	24.3%	93.8%	88.5%	79.7%	100.0%	100.0%
2026	0.0%	0.0%	0.0%	22.8%	86.3%	13.7%	0.1%	14.0%	0.1%	50.0%	100.0%	0.1%	24.4%	94.6%	88.7%	80.2%	100.0%	100.0%
2027	0.0%	0.0%	0.0%	22.8%	86.1%	13.9%	0.1%	14.0%	0.1%	50.0%	100.0%	0.1%	24.4%	95.4%	88.9%	80.6%	100.0%	100.0%
2028	0.0%	0.0%	0.0%	22.7%	85.9%	14.1%	0.1%	13.9%	0.1%	50.0%	100.0%	0.1%	24.4%	96.1%	89.1%	81.0%	100.0%	100.0%
2029	0.0%	0.0%	0.0%	22.6%	85.7%	14.3%	0.1%	13.8%	0.1%	50.0%	100.0%	0.1%	24.4%	96.9%	89.3%	81.4%	100.0%	100.0%
2030	0.0%	0.0%	0.0%	22.5%	85.5%	14.5%	0.1%	13.8%	0.1%	50.0%	100.0%	0.1%	24.4%	97.6%	89.5%	81.8%	100.0%	100.0%

Residential Electric Heat Equipment Shares

Year	EFurn	HPHeat	GHPHeat	SecHt	CAC	HPCool	GHPCool	RAC	EWHeat	ECook	Ref1	Ref2	Frz	Dish	CWash	EDry	TV	FurnFan	Light	Misc	Heating	Cooling	Ref
1995	93.0%	8.7%	0.0%	22.2%	67.2%	8.7%	0.0%	16.0%	98.6%	93.9%	100.0%	0.1%	26.1%	73.6%	84.6%	82.8%	100.0%	0.0%	100.0%	100.0%	101.6%	75.8%	
1996	92.5%	8.9%	0.0%	22.4%	68.6%	8.9%	0.0%	16.0%	98.8%	95.1%	100.0%	0.1%	25.6%	73.6%	84.6%	82.8%	100.0%	0.0%	100.0%	100.0%	101.4%	77.5%	
1997	92.1%	9.2%	0.0%	22.6%	70.0%	9.2%	0.0%	16.0%	99.1%	96.3%	100.0%	0.1%	25.1%	73.6%	84.6%	82.9%	100.0%	0.0%	100.0%	100.0%	101.3%	79.2%	
1998	91.6%	9.2%	0.0%	22.8%	71.5%	9.2%	0.0%	16.0%	99.4%	97.6%	100.0%	0.1%	24.7%	74.1%	84.8%	83.0%	100.0%	0.0%	100.0%	100.0%	100.9%	80.7%	
1999	91.2%	9.2%	0.0%	23.0%	72.9%	9.2%	0.0%	16.0%	99.7%	98.8%	100.0%	0.1%	24.4%	74.6%	84.9%	83.3%	100.0%	0.0%	100.0%	100.0%	100.4%	82.2%	
2000	90.7%	9.3%	0.0%	23.2%	74.4%	9.3%	0.0%	16.0%	100.0%	100.0%	100.0%	0.1%	24.0%	75.0%	85.1%	83.5%	100.0%	0.0%	100.0%	100.0%	100.0%	83.6%	
2001	90.6%	9.4%	0.0%	23.4%	75.8%	9.4%	0.0%	16.0%	100.0%	100.0%	100.0%	0.1%	24.0%	75.5%	85.3%	83.7%	100.0%	0.0%	100.0%	100.0%	100.0%	85.2%	100.1%
2002	90.5%	9.5%	0.0%	23.6%	77.2%	9.5%	0.0%	15.8%	100.0%	100.0%	100.0%	0.1%	24.0%	76.1%	85.4%	84.0%	100.0%	0.0%	100.0%	100.0%	100.0%	86.8%	100.1%
2003	90.3%	9.6%	0.0%	23.8%	78.7%	9.6%	0.0%	15.7%	100.0%	100.0%	100.0%	0.1%	24.0%	77.0%	85.4%	84.7%	100.0%	0.0%	100.0%	100.0%	100.0%	88.3%	100.1%
2004	90.2%	9.8%	0.0%	24.0%	80.1%	9.8%	0.0%	15.5%	100.0%	100.0%	100.0%	0.1%	24.0%	78.1%	85.5%	85.4%	100.0%	0.0%	100.0%	100.0%	100.0%	89.9%	100.1%
2005	90.1%	9.9%	0.0%	24.2%	81.6%	9.9%	0.0%	15.4%	100.0%	100.0%	100.0%	0.1%	24.0%	79.2%	85.6%	86.2%	100.0%	0.0%	100.0%	100.0%	100.0%	91.5%	100.1%
2006	89.9%	10.0%	0.0%	24.2%	82.5%	10.0%	0.0%	15.3%	100.0%	100.0%	100.0%	0.1%	24.0%	79.8%	85.6%	86.4%	100.0%	0.0%	100.0%	100.0%	100.0%	92.6%	100.1%
2007	89.8%	10.2%	0.0%	24.2%	83.9%	10.2%	0.0%	15.2%	100.0%	100.0%	100.0%	0.1%	24.0%	80.5%	85.6%	86.7%	100.0%	0.0%	100.0%	100.0%	100.0%	94.1%	100.1%
2008	89.6%	10.3%	0.1%	24.2%	85.1%	10.3%	0.1%	15.2%	100.0%	100.0%	100.0%	0.1%	24.0%	81.0%	85.6%	86.9%	100.0%	0.0%	100.0%	100.0%	100.0%	95.5%	100.1%
2009	89.5%	10.4%	0.1%	24.2%	86.3%	10.4%	0.1%	15.2%	100.0%	100.0%	100.0%	0.1%	24.0%	81.6%	85.6%	87.1%	100.0%	0.0%	100.0%	100.0%	100.0%	96.8%	100.1%
2010	89.3%	10.6%	0.1%	24.2%	86.6%	10.6%	0.1%	15.1%	100.0%	100.0%	100.0%	0.1%	24.0%	82.0%	85.7%	87.2%	100.0%	0.0%	100.0%	100.0%	100.0%	97.3%	100.1%
2011	89.2%	10.7%	0.1%	24.1%	87.1%	10.7%	0.1%	15.1%	100.0%	100.0%	100.0%	0.1%	24.0%	82.6%	85.8%	87.4%	100.0%	0.0%	100.0%	100.0%	100.0%	97.9%	100.1%
2012	89.0%	10.9%	0.1%	24.1%	87.5%	10.9%	0.1%	15.1%	100.0%	100.0%	100.0%	0.1%	24.0%	83.3%	85.9%	87.7%	100.0%	0.0%	100.0%	100.0%	100.0%	98.5%	100.1%
2013	88.9%	11.0%	0.1%	24.0%	88.0%	11.0%	0.1%	15.0%	100.0%	100.0%	100.0%	0.1%	24.0%	84.0%	86.0%	88.0%	100.0%	0.0%	100.0%	100.0%	100.0%	99.1%	100.1%
2014	88.7%	11.2%	0.1%	23.9%	88.4%	11.2%	0.1%	14.9%	100.0%	100.0%	100.0%	0.1%	24.0%	84.7%	86.1%	88.3%	100.0%	0.0%	100.0%	100.0%	100.0%	99.7%	100.1%
2015	88.5%	11.4%	0.1%	23.8%	88.9%	11.4%	0.1%	14.9%	100.0%	100.0%	100.0%	0.1%	24.0%	85.4%	86.3%	88.6%	100.0%	0.0%	100.0%	100.0%	100.0%	100.4%	100.1%
2016	88.3%	11.6%	0.1%	23.8%	88.4%	11.6%	0.1%	14.8%	100.0%	100.0%	100.0%	0.1%	24.0%	86.2%	86.4%	89.0%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2017	88.1%	11.8%	0.1%	23.7%	88.2%	11.8%	0.1%	14.7%	100.0%	100.0%	100.0%	0.1%	24.1%	87.0%	86.6%	89.4%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2018	87.8%	12.0%	0.1%	23.6%	88.0%	12.0%	0.1%	14.7%	100.0%	100.0%	100.0%	0.1%	24.1%	87.9%	86.9%	89.8%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2019	87.6%	12.2%	0.1%	23.5%	87.8%	12.2%	0.1%	14.6%	100.0%	100.0%	100.0%	0.1%	24.2%	88.7%	87.1%	90.2%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2020	87.4%	12.4%	0.1%	23.4%	87.6%	12.4%	0.1%	14.5%	100.0%	100.0%	100.0%	0.1%	24.2%	89.6%	87.3%	90.6%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2021	87.2%	12.7%	0.1%	23.3%	87.3%	12.7%	0.1%	14.4%	100.0%	100.0%	100.0%	0.1%	24.2%	90.4%	87.5%	91.0%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2022	87.0%	12.9%	0.1%	23.2%	87.1%	12.9%	0.1%	14.3%	100.0%	100.0%	100.0%	0.1%	24.2%	91.3%	87.8%	91.5%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2023	86.8%	13.1%	0.1%	23.1%	86.9%	13.1%	0.1%	14.3%	100.0%	100.0%	100.0%	0.1%	24.3%	92.1%	88.0%	91.9%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2024	86.6%	13.3%	0.1%	23.0%	86.7%	13.3%	0.1%	14.2%	100.0%	100.0%	100.0%	0.1%	24.3%	93.0%	88.2%	92.3%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2025	86.4%	13.5%	0.1%	22.9%	86.5%	13.5%	0.1%	14.1%	100.0%	100.0%	100.0%	0.1%	24.3%	93.8%	88.5%	92.7%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2026	86.2%	13.7%	0.1%	22.8%	86.3%	13.7%	0.1%	14.0%	100.0%	100.0%	100.0%	0.1%	24.4%	94.6%	88.7%	93.2%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2027	86.0%	13.9%	0.1%	22.8%	86.1%	13.9%	0.1%	14.0%	100.0%	100.0%	100.0%	0.1%	24.4%	95.4%	88.9%	93.6%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2028	85.8%	14.1%	0.1%	22.7%	85.9%	14.1%	0.1%	13.9%	100.0%	100.0%	100.0%	0.1%	24.4%	96.1%	89.1%	94.0%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2029	85.6%	14.3%	0.1%	22.6%	85.7%	14.3%	0.1%	13.8%	100.0%	100.0%	100.0%	0.1%	24.4%	96.9%	89.3%	94.4%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%
2030	85.4%	14.5%	0.1%	22.5%	85.5%	14.5%	0.1%	13.8%	100.0%	100.0%	100.0%	0.1%	24.4%	97.6%	89.5%	94.8%	100.0%	0.0%	100.0%	100.0%	100.0%	100.1%	100.1%