SMUD 2011 IEPR: Form 4 Demand Forecast Methods and Models

Demand Forecast Methods

SMUD's forecast includes retail sales and hourly system loads. The SMUD system peak for its retail service territory is the maximum of the hourly system loads.

SMUD forecast models are based on statistical regression techniques which attempt to normalized electricity use for variation in temperatures, months, number of customer accounts, and recent trends in electricity use behaviors. The estimated normalized sales per account are multiplied by the number of forecasted accounts in each rate class to produce the SMUD's retail sales forecast.

The peak forecast is based on a hourly system load model. 24 hourly equations are estimated which normalizes SMUD's system hourly loads for variations in daily temperatures, days of the week, months in the years, seasons and holidays. The hourly load model incorporates two additional models, a daily peak and energy model, to improve the overall accuracy of the forecast. The restrictions imposed by these auxiliary models are:

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

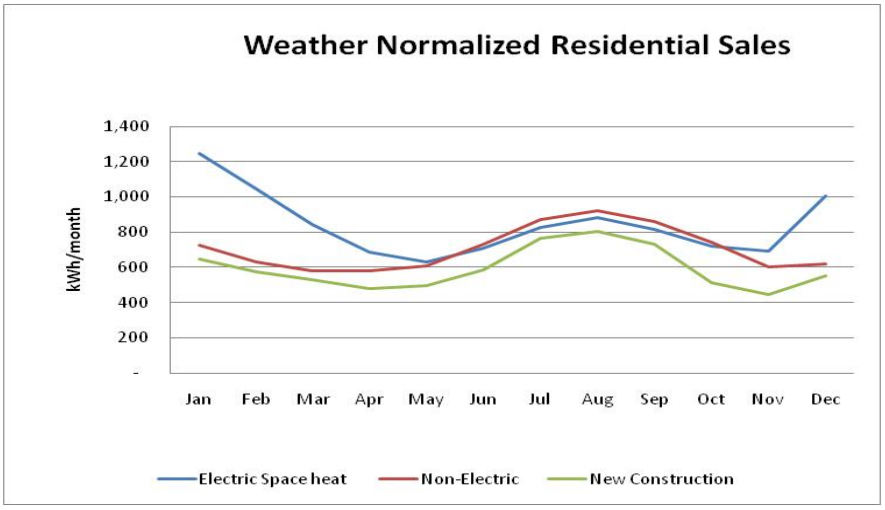
SMUD customer classes forecasting models are:

- Residential Electric Space Heat
- Residential Non-Electric Space Heat
- Small General Services with kW maximum demand below 20 kW (rate code GSN)
- Small General Service with maximum demand between 20 and 300 kW (GSS)
- Small General Service Time of Use with maximum demands between 300 and 500 kW (GSTOU3)
- Medium General Service Time of Use with maximum demands between 500 and 1,000 kW (GSTOU2)
- Large General Service Time of Use with maximum demands greater than 1,000 kW (GSTOU1)
- Agriculture
- Street and Night Lighting.

Note: in the SMUD forms, the small general service accounts are presented as a single class.

Residential SAE and New Construction Models

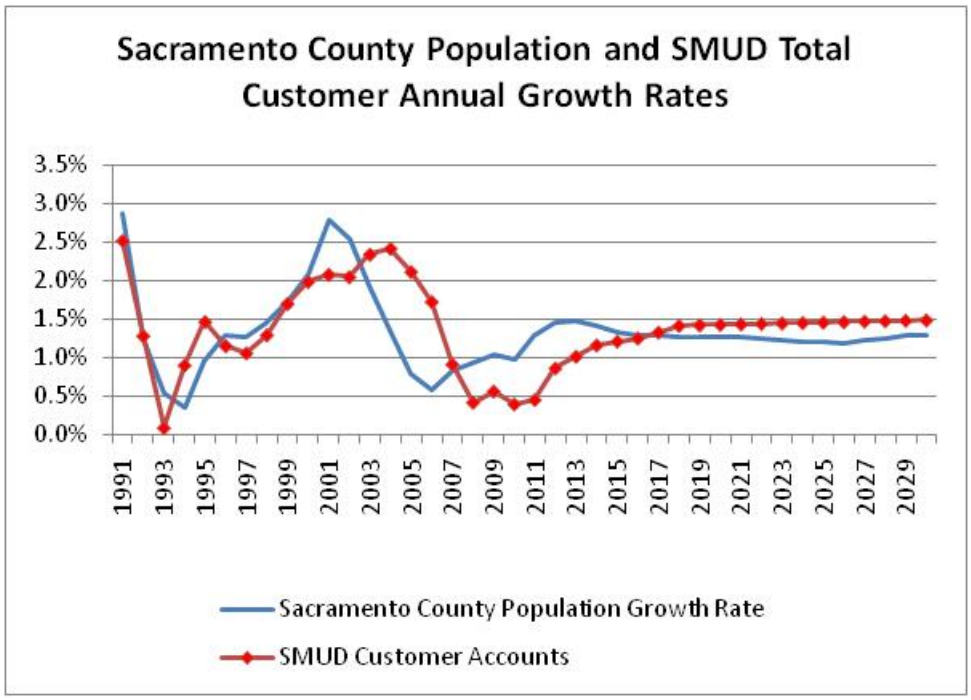
The residential sales forecast is based on two modeling frameworks. In the short run (2011-2014) static models are estimated where energy use behaviors is relatively constant from the 2009-2010 period. After 2014, the Statistically Adjusted End-Use (SAE) modeling framework is use for current residential customers. This framework allows for changes in the saturation of the appliance stock for existing homes. New residential construction is modeled separately due to their lower energy use based on SMUD data for homes constructed between 2004 and 2010. The chart below shows the relationship between the current stock of homes with electric space heat and non-electric space heat and new construction homes with non-electric space heat.



Economic and Demographic Data

The SMUD forecast primary driver is the customer account forecast. The population forecast for Sacramento County determines the number of residential accounts based on the assumed number of persons per account. Small commercial customer accounts are based on the residential forecasts. The medium and large general service customer growth rates are based on their historical annualized growth rates. Economic variables, such as personal income and prices, are not explicitly accounted for in the forecast input data.

The chart below shows the historical relationship between Sacramento County population and SMUD total customers. The pattern for these series follows very closely with alternating leads and lags. During this recent recession, SMUD has experienced a severe slow down in customer growth, while at the same time a slight increased population growth. As the local economy recovers, customer growth will surpass population growth, although not at the level that SMUD witnessed during the 1990's.



Forecast Area

The forecast presented in SMUD demand forms are for its own retail service territory. It does not include the forecasts for POU's within the Balancing Authority of Northern California (formally known as the SMUD Balancing Authority).

Data and Sources

Historical sales and account data come from SMUD billing system for the period 2001-2010. In some cases, data from 2005-2010 were used due to the reorganization of SMUD's General Service rate schedules which limited the amount of consistent data history. System hourly loads are from SMUD's Energy Management System (EMS) for the SMUD retail service territory for the period 1-1-2005 to 8-31-2010.

The "California & Metro Forecast" from the University of the Pacific's Eberhardt School of Business (July 2010) and the California Construction Review (July 2010) were used to develop the short term (2011-2014) forecast of new customer accounts.

The population forecast from IHS Global Insight Regional Forecast for Sacramento County (August 2010) was use to develop the long term customer account forecast.

Weather adjustments

Weather adjustments are based on a typical weather year scenario. The typical year scenario is based on temperature data from the National Weather Service Sacramento City and Executive Airport weather stations. The daily high and low temperatures from these weather stations are averaged to estimate Sacramento Area temperatures (SAT). The SAT data is used to construct temperature variables, such as CDD and HDD, which are the independent variables in the regressions models.

The construction of the typical weather year is based on the relative ranking of the daily temperatures for the period 1971 to 2000. For example, the hottest day in the typical weather year is the average of the hottest days observed in each of the years from 1971 to 2000. The period 1971 to 2000 is consistent with the National Weather Service "Normal" temperature statistics.

In the sales models, temperature variables include monthly CDD and HDD with 65 degree F base temperatures. In the hourly load models, daily CDD and HDD with multiple base temperatures (CDD =65,70, 75; HDD = 65,60,55) and lag structures (days1-day3), a temperature step functions at 90, 95, 100, 105 and 110 degrees, and a non-linear temperature variable based on the daily high temperature (= (exp(.2+.2*(Daily Max Temp-95)))/(1+exp(.2+.2*(Daily Max Temp-95))), is constructed to estimate the non-linearity in system loads as temperatures increase above 95 degrees.

Extreme Temperature Scenarios

The extreme temperature scenarios are based on the monthly high SAT for the month of July between 1961 and 2000. The high temperature were grouped into categories and assigned the load condition ranking below.

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

Forecast Calibration

The forecasts are not calibrated as in the typical back-cast framework. The sales and load regression models are estimated to reflect normal weather condition and recent trends in electricity use. The calibration of the retail sales models and the hourly load models are

judged solely on the values of the parameter estimates and standard errors, and on the model fit such as the adjusted R-square statistics. The only ad-hoc adjustment made is to ensure that the system losses average 6.8 percent for the forecast period.

Energy and Peak Losses

SMUD does not calculate meter loads between its transmission and distribution networks and the end user to allow for a comprehensive evaluation of hourly losses. The losses included in this forecast are based on the historical relationship between system energy and retail sales on an annual basis. Retail sales are based on SMUD's 21- day billed cycle reads. System energy is measured as gross generation plus imports minus exports. The table below presents historical "losses" between 2000 and 2010.

SMUD Historical Energy and Sales Statistics

Year	System Energy	Retail Sales	Losses (as % of sales)
2000	10,269	9,578	7.2%
2001	9,781	9,406	4.0%
2002	10,094	9,485	6.4%
2003	10,583	9,955	6.3%
2004	10,894	10,206	6.7%
2005	11,133	10,604	5.0%
2006	11,688	10,892	7.3%
2007	11,644	10,913	6.7%
2008	11,718	10,959	6.9%
2009	11,448	10,758	6.4%
2010	11,086	10,390	6.7%

Energy Efficiency

In the historical period, retail sales data are not adjusted for SMUD historical energy efficiency program savings. Therefore, SMUD energy efficiency program savings, as well as building and appliance standards, are implicitly embodied in the sales and load forecast.

In the forecast period, committed 2011 energy efficiency program savings are subtracted directly from the unmanaged forecast. Beginning in 2013, the 2011 savings are degraded annually. Per the Instructions in the "Protocols for Submitted Demand Forecast" uncommitted energy efficiency program savings are not included in the demand forecasts.