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LEG 2013-0273
April 15, 2013

Via E-mail: docket@energy.state.ca.us

California Energy Commission
DOCKETED
13-IEP-1C
TN # 70319
APR 15 2013

California Energy Commission
Docket Office
Attn: Docket 13-IEP-1C
1516 Ninth Street, MS 4
Sacramento, CA 95814-5512

Re: Sacramento Municipal Utility District IEPR; Docket No. 13-IEP-1C SMUD Demand Forecast

Attached please find the Sacramento Municipal Utility District's (SMUD) Electricity Demand Forecast and related information submitted in the above-referenced matter. SMUD is submitting Forms 1-7 (all parts) and 8.2 in the formats requested by the CEC in its Forms and Instructions, with the exception of Form 5 which has been prepared as an Excel document for purposes of clarity. Attached are two Excel documents and one Word document

Please note that SMUD is not seeking to protect or designate information provided herein as Confidential.

If you have any questions, please contact Nate Toyama at 916-732-6685, or myself at 916-732-6124. Thank you.

Sincerely,

Andrew Meditz

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Enclosures
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Corporate Files

CEC 2013 IEPR

Form 4: Demand Forecast Methods and Models

Sacramento Municipal Utility District

April 15, 2013

Demand Forecast Methods and Models

SMUD's forecast is based on statistical regression models that normalized electricity use for variation in temperatures, seasonal use, customer growth, and trends in electricity use behavior. The following models define SMUD's system in terms of daily system energy, daily system peak, system hourly loads (24 separate equations), and the retail class sales (14 separate equations).

The daily energy, peak and hourly load models normalize SMUD's EMS system loads for variations in daily temperatures, weekdays and weekends, months, seasons and holidays. The hourly load model provides a daily load shape which is calibrated to daily energy and peak 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 of the following rate classes:

- Residential Electric Space Heat
- Residential Non-Electric Space Heat
- Small General Services with maximum demands below 20 kW
- Small General Services with maximum demands between 20 and 300 kW
- Small General Service Time of Use with maximum demands between 300 and 500 kW
- Medium General Service Time of Use with maximum demands between 500 and 1000 kW
- Large General Service Time of Use with maximum demands greater than 1,000 kW
- Other includes Agricultural, Street and Night Lighting accounts.

The predicted values from these models are sales per customer per billing month.

The regression models normalize class sales for variations in seasonal patterns, temperature conditions (monthly heating and cooling degree days), and recent sales trends. For residential and small commercial (below 20 kW maximum demands) customers, employment and small commercial office vacancy rates are included in the regression equations to explain the recent trends in retail sales.

In the long term (2018-2024), the sales forecast includes changes in end-use saturations, federal efficiency standards, and new construction. The ITRON Statistically Adjusted End-Use (SAE) modeling framework is used to simulate end-use saturations and efficiency standards. The SAE model is applied to residential and small commercial customer accounts with maximum demands below 300 kW. The SAE modeling framework incorporates end-use electricity use, saturation, appliance efficiency, and building shell information 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, building standards, and improvements in efficiency standards. For the residential model, saturations are based on the SMUD 2008 RASS survey results. For the commercial model, appliance saturations are from the ITRON database for the Pacific Region. Energy use per appliance and appliance efficiency levels are from the ITRON database. For the residential models, the price and income elasticity parameters are assumed to be zero.

Residential non-electric sales and small commercial sales (between 21 and 299 kW) are further adjusted by new construction energy use factors. Based on SMUD's billing data between 2007 and 2011, the average monthly electricity use of new construction residential and commercial accounts are approximately 22 percent and 6 percent lower than their average class sales, respectively. For these two rate classes, the SAE adjustments are made to current customer sales, with the new construction adjustments applied to incremental customer growth beginning in 2018.

Model parameter, standard errors, model statistics, and input variables are included in the MS Excel spreadsheet "SMUD 2013 IEPR Demand Forecast Models and Data 4-15-2013.xls

Unmanaged Load and Sales projections

The monthly retail sales forecast for each rate class is projected by multiplying the forecasted sales per customer account times the forecasted number of customers. 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 adjusted to the unmanaged sales forecast assuming a seven percent adjustment to account for line and voltage distribution losses (e.g. system energy = 1.07*unmanaged sales forecast).

Economic and Demographic Data

The historical and projected economic and demographic data are presented in Table 1. They include non-farm employment, population and personal income for Sacramento County.

Table 1

Economic and Population Data

Sacramento County	Employment (NAICS), Total Nonfarm (Thous.)	Population (Thous.)	Personal Income (Millions)
2000	566	1,239	36,176
2001	575	1,271	38,606
2002	584	1,305	40,307
2003	584	1,331	42,567
2004	590	1,351	45,282
2005	606	1,363	47,560
2006	619	1,372	50,167
2007	619	1,383	52,574
2008	604	1,396	54,077
2009	572	1,410	52,028
2010	558	1,424	52,778
2011	550	1,438	54,357
2012	554	1,451	56,115
2013	563	1,466	58,222
2014	574	1,483	61,159
2015	587	1,502	64,560
2016	600	1,521	68,236
2017	610	1,542	71,453
2018	618	1,562	74,733
2019	625	1,583	78,172
2020	632	1,602	81,829
2021	639	1,622	85,784
2022	646	1,642	90,129
2023	653	1,661	94,655
2024	661	1,680	99,142

Data Sources

The regression models were estimated with data from SMUD's billing system for the period 2001-2012. The hourly load, daily peak and daily energy models were estimated using hourly load data from SMUD's Energy Management System (EMS) for the retail service territory from 1-1-2005 to 8-31-2012.

Unmitigated Forecast

In this forecast, the unmanaged forecast includes the savings from both new construction and building and appliance standards modeled in the SAE framework. From 2013 to 2017, the Mitigated and Unmanaged Forecast are the same. Beginning in 2018, the incremental impacts of new construction and SAE standards are included in the forecast. Table 2 shows the impact of new construction accounts and the SAE results on the Unmanaged Sales forecast.

Table 2

Unmitigated and Unmanaged Retail Sales Forecast (GWH)

Year	Unmitigated	New Construction	SAE Standards	Unmanaged
2013	10,630	-	-	10,630
2014	10,747	-	-	10,747
2015	10,880	-	-	10,880
2016	11,066	-	-	11,066
2017	11,200	-	-	11,200
2018	11,374	13	34	11,328
2019	11,537	28	62	11,447
2020	11,728	43	90	11,594
2021	11,855	58	137	11,660
2022	12,013	73	160	11,781
2023	12,171	87	174	11,909
2024	12,359	102	165	12,092

Historical efficiency and building standards and SMUD EE and SB1 program savings are not explicitly used in the regression models. The full impacts from these programs are assumed to be incorporated into SMUD's billing and EMS load data.

Managed Forecast Adjustments

The managed forecasts are based on the unmanaged forecasts after adjusting for energy efficiency, SB1 PV generation, departing loads, and EV charging. The managed forecast in this report is the forecast used to develop SMUD's resource portfolio in the 2013 IEPR Resource Plans supply forms and are consistent with the plans submitted to the WECC.

The Electricity Demand Forms, however, include updated projections for SMUD's 2013 EE and SB1 programs. SMUD resource plans were develop in 2012 where the EE impacts were based on SMUD's Board Goals approved in 2010 and the PV impacts that were based on projections developed in 2012. The PV figures in the Demand Forms also show the program ending in 2016 when the current funding surcharge is scheduled to end. In the Resource Plan forms, PV installations extend beyond 2016 to meet SMUD's Board SB1 goals of 125 MW.

Historical energy efficiency, building standards, and SMUD's EE and SB1 program saving are not explicitly used in the regression models. The full impacts of these programs are assumed to be incorporated into SMUD's billing and EMS load data. Historical savings are not used to adjust sales by sectors in both the historical period and the forecast period. Other electrification end-uses that may occur during the forecast period are omitted from this forecast.

Table 3 presents the managed sales and load forecast. Tables 4-6 show the derivation of the managed forecast for system energy, peak, and retail sales.

Table 3

Summary of Managed Loads and Sales Forecasts

	Sales (GWH)	Energy (GWH)	Peak (MW)	Net Customers
2013	10,432	11,163	2,946	605,888
2014	10,363	11,089	2,946	610,618
2015	10,336	11,059	2,951	616,030
2016	10,376	11,103	2,969	623,401
2017	10,383	11,110	2,990	631,871
2018	10,397	11,125	3,009	640,332
2019	10,419	11,148	3,025	648,721
2020	10,479	11,212	3,038	656,966
2021	10,477	11,212	3,053	665,176
2022	10,540	11,278	3,074	673,263
2023	10,625	11,369	3,100	681,320
2024	10,793	11,548	3,138	689,296

Table 4 presents unmanaged and managed system energy. System energy is measured as net energy imports plus generation from SMUD-owned natural gas generation plants, hydro, wind, and PV generation and energy losses for final delivery to SMUD customers. The managed loads include the impact of SMUD’s EE Board Goals, SB1 programs, EV penetration, and departing customer loads.

Table 4

Managed and Unmanaged System Energy (MWH)

Year	Unmanaged	EE	SB1	EV	Departing Loads	Managed
2013	11,374,403	(182,997)	(8,335)	1,271	(21,715)	11,162,627
2014	11,499,652	(355,634)	(24,687)	4,449	(35,103)	11,088,677
2015	11,642,015	(517,502)	(42,296)	12,391	(35,182)	11,059,425
2016	11,840,562	(668,412)	(54,607)	20,391	(35,288)	11,102,647
2017	11,983,594	(805,291)	(66,668)	33,044	(35,098)	11,109,581
2018	12,120,804	(929,063)	(78,854)	47,170	(35,054)	11,125,003
2019	12,247,903	(1,039,985)	(91,040)	66,235	(35,047)	11,148,066
2020	12,405,999	(1,139,228)	(103,461)	84,121	(35,297)	11,212,133
2021	12,477,338	(1,223,880)	(115,411)	109,121	(35,196)	11,211,972
2022	12,605,465	(1,295,766)	(127,597)	130,954	(35,171)	11,277,883
2023	12,742,764	(1,353,768)	(139,783)	155,054	(35,098)	11,369,169
2024	12,938,704	(1,397,133)	(140,102)	181,931	(35,121)	11,548,278

Table 5 presents unmanaged and managed system peak loads. The system peak load forecast is the coincident system peak for the SMUD retail service territory. The managed system peak is net of EE, PV, EV and departing customer load impacts. The PV impacts on system peak are about half of its installed capacity. EV peak load impacts, in comparison to energy impacts, are negligible because of the assumption that EV battery charging will occur at night or in the early morning.

Table 5

Unmanaged and Managed System Peak (MW)

Year	Unmanaged	EE	SB1	EV	Departing Load	Managed
2013	2,981	(29)	(2)	0	(4)	2,946
2014	3,013	(57)	(7)	0	(4)	2,946
2015	3,049	(83)	(12)	0	(4)	2,951
2016	3,095	(108)	(15)	1	(4)	2,969
2017	3,141	(130)	(19)	1	(4)	2,990
2018	3,175	(141)	(22)	1	(4)	3,009
2019	3,211	(159)	(26)	2	(4)	3,025
2020	3,241	(173)	(29)	2	(4)	3,038
2021	3,270	(184)	(32)	3	(4)	3,053
2022	3,304	(194)	(36)	4	(4)	3,074
2023	3,341	(202)	(39)	4	(4)	3,100
2024	3,383	(207)	(39)	5	(4)	3,138

Table 6 presents unmanaged and managed retail sales. Retail sales are the electricity sales to SMUD's retail customers measured at the customer's meter. Managed sales are net of EE, SB1, departing loads and EV impacts.

Table 6

Unmanaged and Managed Retail Sales

(MWH)

Year	Unmanaged	EE	SB1	EV	Departing Load	Managed
2013	10,630,283	(171,025)	(7,790)	1,188	(20,294)	10,432,362
2014	10,747,338	(332,368)	(23,072)	4,158	(32,806)	10,363,250
2015	10,880,388	(483,646)	(39,529)	11,581	(32,881)	10,335,912
2016	11,065,946	(624,664)	(51,034)	19,057	(32,979)	10,376,326
2017	11,199,620	(752,608)	(62,307)	30,883	(32,802)	10,382,786
2018	11,327,854	(868,283)	(73,695)	44,084	(32,761)	10,397,199
2019	11,446,639	(971,949)	(85,084)	61,902	(32,754)	10,418,754
2020	11,594,391	(1,064,699)	(96,693)	78,617	(32,987)	10,478,629
2021	11,659,725	(1,143,813)	(107,861)	101,982	(32,893)	10,477,140
2022	11,780,808	(1,210,997)	(119,250)	122,387	(32,871)	10,540,078
2023	11,909,125	(1,265,203)	(130,638)	144,911	(32,802)	10,625,392
2024	12,092,246	(1,305,732)	(130,937)	170,029	(32,823)	10,792,783

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Table 7 presents SMUD's 10 year EE goals approved by the SMUD Board of Directors in 2010. The Board EE goals are measured at the customer's meter. For the system energy forecast, the EE savings are adjusted by seven percent to reflect line and voltage losses. The figures presented in Table 7 are first year EE impacts.

Table 7

SMUD 10 Year EE Board Goals

Year	Annual Energy Savings Goal (GWH)	Annual Demand Reduction (MW)
2011	166	26.5
2012	169	27.1
2013	171	27.3
2014	175	28.0
2015	179	28.7
2016	183	29.2
2017	185	29.6
2018	187	30.0
2019	190	30.5
2020	194	31.0
Total	1798	287.7

The 10 Year SMUD EE Board Goals are based on achieving 1.5 percent of retail sales with energy efficiency. For the years beyond 2020, the annual savings are based on 1.5 percent of the 2010 unmanaged retail sales forecast. Cumulative EE savings are based on an average annual decay rate of eight percent. Table 8 shows the relationship between first year EE savings and cumulative savings.

Table 8

First Year EE Savings and Cumulative Savings

Year	First Year Savings (GWH)	Cumulative Savings (GWH)
2013	171	171
2014	175	332
2015	179	484
2016	183	625
2017	185	753
2018	187	868
2019	190	972
2020	194	1,065
2021	197	1,144
2022	200	1,211
2023	203	1,265
2024	205	1,306

Table 9 presents the first year peak savings and cumulative savings based on the assumption of eight percent annual decay rate.

Table 9

First Year EE Peak Demand Savings and Cumulative Savings (System level)

Year	First Year Savings (MW)	Cumulative Savings (MW)
2013	29	29
2014	30	57
2015	31	83
2016	31	108
2017	32	130
2018	32	141
2019	33	159
2020	33	173
2021	33	184
2022	34	194
2023	34	202
2024	35	207

Table 10 presents the annual installation of PVs beginning in 2013. PV savings are based on the expected installation of PV systems under SMUD's SB1 program. SMUD's SB1 program provides a monetary incentive for customers to install a PV system on their premise. Approximately 41 MWs of PV capacity were installed between 2007 through 2012. The addition of 83 MW between 2013 and 2023 will meet the District's goal of 125 MW by 2023. In Demand Forms 3.3, PV installations end in 2016. Once the program goals are met, PV generation remains constant over the forecast range. PV generation is based on an 18 percent annual capacity factor. Finally, for generation at the system level, a loss factor of seven percent is applied reflecting line and voltage losses.

Table 10

SB1 Installed PV Capacity and Generation

Year	Installed MW	Cumulative MW	Generation (GWH)
2013	5	5	7,790
2014	10	15	23,072
2015	11	25	39,529
2016	7	32	51,034
2017	7	40	62,307
2018	7	47	73,695
2019	7	54	85,084
2020	7	62	96,693
2021	7	69	107,861
2022	7	76	119,250
2023	7	83	130,638
2024	0	83	130,937

Table 11 presents the plug-in electric vehicle forecast and the electricity sales from battery charging. The sales forecast is based on SMUD's billing records for customers who are currently receiving service on one of SMUD's electric vehicle charging rate schedules. On the average, EV charging amounts to about 7.2 kWh per day/vehicle.

Table 11

Electric Vehicles and Charging

Year	Plug-In Vehicles	Sales (MWH)
2013	450	1,188
2014	1,575	4,158
2015	4,387	11,581
2016	7,200	19,057
2017	11,700	30,883
2018	16,700	44,084
2019	23,450	61,902
2020	29,700	78,617
2021	38,633	101,982
2022	46,367	122,387
2023	54,900	144,911
2024	64,233	170,029

Historical Forecast Performance

In this section we use SMUD's previous 2011 IEPR forecast to assess the historical forecast performance. While the elements of the forecast have changes between the 2011 and 2013 IEPR forecasts, the basic forecast structure has remained relatively similar. Table 12 presents SMUD's 2011 IEPR forecast submittal with the actual and weather adjusted retail sales and peak demand for 2011 and 2012. In all cases, the forecasted values overestimated the actual sales and peak demands.

Table 12

Historical Sales and Peak Performance

Retails Sales (GWH)				
Year	IEPR Forecast	Actual	Error	Pct Error
2011	10,638	10,459	(179)	-1.7%
2012	10,813	10,544	(270)	-2.6%
Year	IEPR Forecast	Weather Adjusted	Error	Pct Error
2011	10,638	10,505	(133)	-1.3%
2012	10,813	10,558	(255)	-2.4%
System Peak (MW)				
Year	IEPR Forecast	Actual	Error	Pct Error
2011	3,001	2,840	(161)	-5.7%
2012	3,041	2,953	(88)	-3.0%
Year	IEPR Forecast	Weather Adjusted	Error	Pct Error
2011	3,001	2,942	(58)	-2.0%
2012	3,041	2,960	(81)	-2.7%

Estimates of Departing Loads

The departing load estimates are based on customer accounts that plan to close down their facilities beginning in 2013. The departing load and sales estimates are based on the customer's 2011-2012 billing and load data. The forecast assumes that the vacated facilities will not be in service during the forecast period.

Local Private Supply Estimates

The historical CHP private supply estimates are based on recorded interval or billing data. In cases where load or billing data were not available, generation and peak loads were based on the planned operations of the unit.

The digester gas electricity generation is based on the assumption of 24 percent capacity factor.

The installed SB1 generation is from SMUD's records. The PV system peak impacts are based on a prototypical solar load shape. The annual generation impacts are based on an 18 percent capacity factor.

Forecast Calibration

Two calibrations procedures are used in the forecast. The first calibration is for the forecasted monthly peak where the forecasted peaks is adjusted by the average percent error (=actual peak/forecasted peak within sample) for each month. The second adjustment is the relationship between system energy and retail sales. In the forecast, annual system energy is equal to system losses plus retail sales (annual system energy = 1.07 * forecasted retail sales).

Energy and Peak Loss Estimates

Energy losses are based on the historical relationship between system energy and retail sales. Table 13 shows the difference between sales and system energy is approximately seven percent. The difference represents line and voltage losses and station service for SMUD's generation facilities. SMUD does have separate estimates for system peak losses.

Table 13

Historical Sales and System Energy

Year	Retail	System Energy	Difference	% Difference
2006	10,892	11,688	796	7%
2007	10,913	11,644	730	7%
2008	10,959	11,718	759	7%
2009	10,758	11,448	690	6%
2010	10,390	11,086	696	7%
2011	10,459	11,193	734	7%
2012	10,519	11,210	690	7%
Average				7%

The Total System Loads in Forms 1.6 are for the SMUD retail service territory. The service territory includes most of Sacramento County and a portion of Placer County. Table 14 lists the service areas and accounts served by SMUD based on current billing records.

Table 14

Service Areas and Accounts 2012

Service Areas	Accounts
ANTELOPE	15,361
CARMICHAEL	28,611
CITRUS HEIGHTS	38,345
COURTLAND	444
ELK GROVE	59,407
ELVERTA	1,987
FAIR OAKS	19,005
FOLSOM	29,723
GALT	10,940
GOLD RIVER	1
HERALD	1,092
HOOD	142
LOCKE	1
MATHER	1,584
MCCLELLAN	689
NORTH HIGHLANDS	12,332
ORANGEVALE	13,388
RANCHO CORDOVA	29,902
RANCHO MURIETA	2,381
RIO LINDA	5,816
ROSEVILLE	1,888
SACRAMENTO	337,058
SLOUGHHOUSE	793
W SACRAMENTO	2
WALNUT GROVE	603
WILTON	3,231
Total	614,726

The Control Area Loads are for the Balancing Authority of Northern California (BANC). BANC includes SMUD, Modesto Irrigation District, Redding Electric and Roseville Electric utilities.

Customer Projections

Table 15 presents the customer forecast for the major rate classes. The forecast for residential customers is based on the population forecast for Sacramento County. The forecast for Small General Service (GSS, GSS, and GSTOU3) accounts is based on economic drivers such as employment and gross county product. The Medium and Large General Service, and other accounts (agriculture, streetlights, and traffic signal) are based on their historical growth rates.

Table 15

SMUD Customer Account Forecast

Year	Residential	Small GS	Medium GS	Large GS	Other	Net Customers
2012	533,318	63,238	291	152	5,142	602,141
2013	536,347	63,975	294	154	5,119	605,888
2014	540,207	64,798	297	156	5,159	610,618
2015	544,714	65,651	301	160	5,206	616,030
2016	551,157	66,520	306	163	5,256	623,401
2017	558,687	67,402	310	166	5,307	631,871
2018	566,217	68,281	314	170	5,350	640,332
2019	573,647	69,182	317	173	5,401	648,721
2020	580,927	70,089	321	177	5,453	656,966
2021	588,165	71,002	324	180	5,505	665,176
2022	595,274	71,921	329	184	5,557	673,263
2023	602,345	72,847	333	187	5,608	681,320
2024	609,329	73,780	337	190	5,661	689,296

Sacramento Weather

A key component in normalizing sales and loads is weather. Both sales and load models use cooling degrees and heating degrees days or months 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 reading for the Sacramento area. Daily composite temperatures are used to construct cooling and heating degree day variables in the regressions models. Table 16 presents the normal temperatures used in the forecast based on temperature data from 1981 to 2010. The average daily temperature is the average of the daily high and low temperatures. The average high temperature is the average daily high temperature which usually occurs between 2 and 4 PM. The average low temperature is the average daily low temperatures which usually occur between 5 and 7 AM. The High and Low temperatures are the maximum and minimum daily temperatures, respectively, for each month.

Table 16

"Normal" 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

The sales and system energy forecasts are based on the "normal temperature" scenario. No additional considerations were taken to evaluate the potential impact of climate change during the forecast period.

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 above normal temperatures during the summer months, extreme temperature scenarios are used to examine the changes in system peak loads. Table 17 presents the extreme temperature scenarios.

Table 17

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 1 in 2 scenario is based on the average of the maximum daily temperatures for July over the 30 year weather history (1981-2010). The extreme temperature scenarios were based on the frequency distribution of maximum July temperatures between 1961 and 2010. The 1 in 40 scenario is 114 degrees which occurred in 1970. The 1 in 20 scenario is 112 degrees observed in 1986 and 1989. The 1 in 5 and 1 in 10 scenarios were based on the confidence intervals under a normal distribution with z values equal to .84 (20%) and 1.28 (10%), respectively.

Forecast Errors

Tables 18 and 19 present the annual and monthly errors (=actual – predicted) for both the system energy and system peak forecasts. Overall, both the annual and monthly system energy models perform well for the with-in sample variation.

Table 18

System Energy Errors ((GWH)

Annual System Energy				
Year	Actual	Predicted	Error	Pct Error
2005	11,133	11,133	(0.95)	0.0%
2006	11,688	11,687	0.56	0.0%
2007	11,643	11,642	0.44	0.0%
2008	11,718	11,718	0.00	0.0%
2009	11,448	11,448	0.09	0.0%
2010	11,059	11,084	(25.48)	-0.2%
2011	11,193	11,164	29.24	0.3%
Monthly System Energy				
Month	Actual	Predicted	Error	Pct Error
January	954	952	1.68	0.2%
February	822	822	(0.07)	0.0%
March	867	872	(4.26)	-0.5%
April	826	826	(0.01)	0.0%
May	909	910	(0.49)	-0.1%
June	1,002	1,002	0.06	0.0%
July	1,179	1,179	0.56	0.0%
August	1,139	1,139	0.01	0.0%
September	995	996	(0.39)	0.0%
October	873	874	(1.14)	-0.1%
November	856	857	(0.98)	-0.1%
December	974	972	1.21	0.1%

Table 19

System Peak Errors

(MW)

Annual System Peak				
Year	Actual	Predicted	Error	Pct error
2005	2,959	2,976	-17	-1%
2006	3,280	3,313	-33	-1%
2007	3,099	3,053	46	1%
2008	3,086	3,136	-50	-2%
2009	2,848	2,880	-32	-1%
2010	2,990	2,981	9	0%
2011	2,840	2,786	54	2%
2012	2,953	2,928	25	1%
Average	3,007	3,007	0	0%
Monthly System Peak				
Month	Actual	Predicted	Error	Pct Error
January	1666	1668	-3	0%
February	1589	1560	29	2%
March	1513	1485	28	2%
April	1645	1620	25	2%
May	2152	2137	15	1%
June	2752	2744	7	0%
July	2978	2973	4	0%
August	2834	2830	4	0%
September	2551	2541	10	0%
October	1647	1693	-46	-3%
November	1583	1569	14	1%
December	1722	1697	25	1%

In general, the peak model does not perform as well as the daily energy where the average errors range from -3% to 2% for the annual and monthly peak estimates.

Table 19 presents historical statistics on system energy, peak, sales and customer accounts.

Table 19

System Energy, Peak, Sales (billing cycle) and Customer History

SMUD Historical Sales and System Statistics				
Year	Sales	Energy	Peak	Net
	GWH	GWH	MW	Customers
2000	9,578	10,269	2,688	513,644
2001	9,406	9,781	2,484	524,348
2002	9,485	10,094	2,779	535,118
2003	9,955	10,583	2,809	547,667
2004	10,206	10,894	2,672	560,937
2005	10,604	11,133	2,959	572,832
2006	10,892	11,688	3,280	582,745
2007	10,913	11,644	3,099	588,107
2008	10,959	11,718	3,086	590,607
2009	10,758	11,448	2,848	593,971
2010	10,390	11,086	2,990	596,367
2011	10,459	11,193	2,840	598,730
2012	10,519	11,210	2,953	602,141

Class Sales by Rate Class (GWH)						
	Residential	Small C&I	Medium	Large	Other	Total
2000	4,132	3,192	761	1,358	136	9,578
2001	4,024	3,193	744	1,307	137	9,406
2002	4,092	3,260	709	1,286	138	9,485
2003	4,366	3,319	773	1,363	133	9,955
2004	4,409	3,362	799	1,495	142	10,206
2005	4,562	3,482	814	1,610	136	10,604
2006	4,747	3,536	779	1,694	136	10,892
2007	4,635	3,524	821	1,790	143	10,913
2008	4,694	3,478	828	1,806	153	10,959
2009	4,708	3,340	793	1,770	147	10,758
2010	4,504	3,222	755	1,768	140	10,390
2011	4,604	3,224	717	1,776	138	10,459
2012	4,648	3,243	680	1,799	149	10,519

Customer Accounts by Rate Class						
	Residential	Small C&I	Medium	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

The attached MS excel spreadsheet “SMUD 2013 IEPR Demand forecast Models and Data 4-15-2013.xls” presents parameters, statistics, and input data for the daily energy, the daily peak, hourly loads, and monthly retail sales models.