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LADWP Load Forecast Methodology

Electric Demand and Sales Forecast

LOAD FORECASTING GROUP

Contents

Overview

The Retail Sales and Demand Forecast (Forecast) is a long-run projection of electrical energy consumption, peak demands and energy production in the City of Los Angeles and Owens Valley.

Signature Authority

The General Manager, the Chief Operating Officer, Power System and the Chief Financial Officer have final signature authority on the Retail Sales and Peak Demand Forecast (Forecast).

Schedule

The signed Forecast is typically published once a year in the Spring. It includes actual data through December of the previous calendar year. Management reserves the right to revise and publish a new signed Forecast at any time. Forecasts are subject to the phenomenon of displacement. A displacement is an external shock to a system pushing the System off its current trends and establishing new relationships among variables. Two historic displacements for LADWP were the Northridge earthquake and the California Energy Crisis. Displacements can also be policy-driven. The adoption of a new Energy Efficiency strategy is an example of a policy-driven displacement. After a displacement, Management may request the development a new Forecast.

Peer Review

The Load Forecasting group has developed a forecast peer review group based on previous audit recommendations. The Peer Review Group includes the principal users of the Forecast within LADWP. The main goal of the Peer Review Process is to evaluate the Forecast inputs and outputs for accuracy and usefulness. The Forecasting Group presents its assumptions before a subject matter expert panel and builds consensus for the assumptions. The other major objective to the Peer Review Process is to review the reasonableness of the Forecast. End users make good reviewers because they understand how change in the forecast can affect their perspective areas of operations. Criticism of the Forecast can be communicated either directly to the Load Forecast group or through management channels. Out of the Peer Review Process evolves the final forecast for senior management to review and sign.

End Users

The signed Forecast is distributed throughout LADWP and the Power System. Primary internal users include:

- Financial Planning & Scenario Development – Revenue forecast and Fuel Budget
- Integrated Resource Planning
- Distribution Planning
- Transmission Planning
- Environment and Efficiency
- Wholesale Marketing and Planning

Externally, the forecast is required to be sent either annually or biannually to:

- Energy Information Agency
- California Energy Commission
- Western Electric Coordinating Council

Population Forecast

Data Sources

Primary

State of California, Department of Finance

Background

- US Census
- US Census American Community Survey
- UCLA Anderson Forecast
- Southern California Association of Governments
- City of Los Angeles Documents

Methodology

LADWP ties its population projections to the State of California, Department of Finance, Population Projections for California and Its Counties 2010-2060, Sacramento, California, December 2014 commonly known as the P-1 report.

The P-1 report is at the County level and LADWP needs to make adjustments to capture the service area which City of Los Angeles only. The methodology used to make the adjustments is ratio analysis. To estimate the ratios LADWP uses the State of California, Department of Finance, E-5 Population and Housing Estimates for Cities, Counties and the State, 2011-2013, with 2010 Benchmark, Sacramento, California, May 2014 commonly known as the E-5 report.

Historically, it is noted that the ratio between Los Angeles City and Los Angeles County population is not constant and at different times the ratio is either decreasing or increasing. Two simplifying assumptions are made to create the forecast. First assumption is that current change rate in ratio will persist sometime into the future. Second assumption is that in the long-run City population will grow at the same rate as County or that the ratio between the two will be a constant.

Economic Forecast

Data Sources

Primary

- UCLA Anderson Forecast
- State of California, Economic Development Department, Labor Market Information
- State of California, Department of Finance, Demographic Unit
- McGraw-Hill Construction Forecast

Background

- US Census American Community Survey
- Los Angeles Economic Development Council (LAEDC)
- Real Estate Research Council
- Barrons, BusinessWeek, The Economist and other Business Journals

City of Los Angeles - Los Angeles County Data

Economic data is commonly aggregated at the Metropolitan Statistical Area (MSA). The current local MSA includes both Los Angeles and Orange counties. Before 2004, the MSA included only Los Angeles County. Fortunately, Los Angeles County is a large enough entity that numbers are still being reported at the County level.

The LADWP service includes only the City of Los Angeles and Owens Valley. Since Owens Valley is a slow growth area, LADWP forecasts Owens Valley as a separate sales class. The problem then is to apportion economic growth between City of Los Angeles and the rest of Los Angeles County.

The basic technique is to trend a ratio of an economic or demographic variable between city and county.

The naïve approach is to assume that the City and County are growing at the same rates. This is the constant trend approach. In the absence of better information this is the assumption used.

Employment Forecast

The basis for the forecast is the UCLA Anderson Forecast Los Angeles County Forecast. For employment, LADWP assumes a constant share of Los Angeles County employment. We have attempted to forecast City employment only but found the time series to be too erratic to make definitive conclusions. UCLA Anderson's employment forecast is seasonally adjusted. However in the LADWP sales forecast we want to capture seasonal effects. Therefore we use non-seasonally adjusted data historical data from the EDD and preserve the seasonally influences by using UCLA Anderson YOY employment growth rates rather than the actual forecast itself.

Higher detail data is available if needed but employment forecasts are developed for the following industry sector 2-digit NAICS codes:

- Natural Resources
- Construction
- Manufacturing
- Trade, Retail and Utilities
- Information
- Finance
- Professional
- Education & Health
- Leisure & Hospitality
- Other
- Government

Real Personal Income Forecast

The basis for the forecast is the UCLA Anderson Forecast. LADWP assumes that Real Personal Income in the service areas will grow as a constant share of Los Angeles County personal income. We acknowledge that incomes within the City are below that of the County.

Housing Forecast

The State of California Demographic Unit E-5 report is used to benchmark the time series. The data is available annually. To convert it to months, we use linear extrapolation.

To forecast housing supply, City of Los Angeles building permits are trended against the McGraw-Hill Construction history and forecast. These time series trends are developed for both single-family and multi-family. Since 2001, multi-family units are being built at a far faster rate than single family housing at an approximate 3 to 1 rate. The McGraw-Hill forecast is a five-year forecast and is a construction forecast reflecting the supply of new housing coming on-line. Beyond five years, at the long-term average rate.

Commercial Floorspace

To forecast commercial floorspace, City of Los Angeles data is trended against the McGraw-Hill Construction history and forecasts. Time series data is developed for the following sectors:

- Office
- Retail
- Warehouse
- Health
- Hotels
- Education
- Miscellaneous

The McGraw-Hill forecast is a five-year forecast and is a construction forecast reflecting the supply of new commercial floorspace coming on-line. After five years, in the absence of better knowledge such as a school build out plan, we assume that commercial floorspace will grow at its long-term average.

Electric Prices

Data Sources

- Analysis of Consumption & Earnings
- LADWP Financial Planning Unit
- UCLA Anderson Forecast

Methodology

LADWP uses Revenue divided by Retail Sales as its electric prices metric. Economic theory says that customers will react to marginal costs rather than average costs. To establish marginal costs at the macro level is highly difficult so most in the industry use the average cost method. The biggest distortion will lie in the time-of-use rates. Electricity, however, is a derived demand from mostly staple goods so it is considered relatively inelastic. LADWP measures elasticity below 0.25 in all our sectors. The problem is not considered great as real electric price increases are typically modest over time.

The electric price forecast through the budget period is developed by the Financial Planning group. After the budget period, the nominal prices are assumed to grow at the inflation rate. The nominal electric prices are deflated to create real electric prices

The fact that after the budget period LADWP increases nominal prices at the inflation rate means that long-term real electric prices are constant and there is no long-term price elasticity effect in the Forecast. For the residential sector, CPI is used as the deflator. For commercial and industrial, a broader statewide deflator based on Gross State Product is used.

LADWP incorporates the Utility Tax into the electric price for purposes of the modeling. The reason is that the tax is included on what the customer pays. The overall rate of the utility tax for a customer class can change over time. A major change occurred in the Residential sector when 60,000 low-income customers were removed off the low income rate as a result of an audit. Customers qualifying for the low-income rate are forgiven the utility tax. To forecast utility tax rates, LADWP uses long-term trends in the absence of any specific know information.

Weather Normalization and Billing Days

Data Sources

- National Weather Service using Schneider as the consolidator
- Pierce College Weather Station
- Billing Cycle Schedule

Methodology

LADWP collects weather from 6 weather stations – Civic Center, Hawthorne, LAX, Burbank, Van Nuys and Woodland Hills. Woodland Hills is a non-automated station run by Pierce College. We have a long history of Woodland Hill's data that we have manually collected. It is considered more representative of Valley weather since it is closer to the floor of the Valley then either Burbank or Van Nuys.

In 1998, Title 20 divided the City of Los Angeles into three climate zones where previous it had only been two. Typically, LADWP uses Civic Center, Woodland Hills and LAX to represent the three zones.

For customers billed monthly, LADWP reads meters on a 21 meter read day cycle. For bimonthly customers, it is a 42 meter read day cycle. To successfully model sales, you need to measure weather by revenue month. To make this measurement, we sum Cooling Degree Days (CDD) and Heating Degree Days (HDD) for each billing cycle. The CDD and HDD are then summed for all the billing cycles in the revenue month.

The number of days in a revenue month will vary depending on number of work days it takes to do a full 21 day billing cycle. The days in the billing cycle are counted in similar manner to the CDD and HDD. The days in each billing cycle are added to give total billing days in the revenue month.

In some models, LADWP uses average billing rather than total billing days. To find average, you divide by the number of billing cycles (21 for monthly bills and 42 for bimonthly bills).

Electric Sales

Data Sources

- Analysis of Consumption and Earnings RP77
- Banner Report
- Traffic Control Estimate
- Power System Consumption and Earning Monthly Summary
- CCB Reporting

Methodology

Total Sales to Retail Customers is the base unit from which we forecast. Total Sales to Retail Customers is divided into six customer classes:

- Residential
- Commercial
- Industrial
- Intradepartmental Sales
- Streetlight
- Owens Valley

The Forecasted customer classes are slightly different than reported by General Accounting but every month the Forecast Group reconciles its total sales number to the Power System Consumption and Earning (C&E) Monthly Summary report.

In September 2013 LADWP implemented a change in its billing system from a mainframe based system to an Oracle based architecture called Customer Contact & Billing (CCB). The new C&E report (CMR095_RPT) initially made available in February 2015 classifies sales by the following customer categories:

- Residential
- Apartment
- Commercial
- Industrial
- Municipal
- Government

In March 2015, Load Forecasting mapped all the sales to the old classification in order to continue the consistency in the long-term forecast until there is at least five years of sales data available in the new classifications. The largest difference is in common area apartment bills. General Accounting categorizes this load as commercial whereas the load is put into residential for forecasting purposes.

Forecasting also treats Owens Valley sales as separate class although in reality it includes Residential, Commercial, Industrial, Intradepartmental and Streetlight sales. The load is small and not growing very fast so to develop a separate model does not meet a cost benefit test. Sales are reported in revenue month not calendar month.

Net Energy for Load (NEL) and Losses

Data Sources

Power System Wholesale Energy Reconciliation Management Database

Methodology

Hourly NEL data is reported by the Wholesale Energy Reconciliation Documentation group at the Energy Control Center.

Monthly NEL is a calendar month rather than a revenue month.

Losses are defined NEL minus Total Sales to Ultimate Customers.

Losses from the Load Forecasting perspective include not only the engineering losses associated with the transport and transformation of power but also include Purpose of Enterprise Sales, Energy Theft and energy accruals associated with the billing cycle.

Retail Sales Models

Tools

- Metrix ND Software
- Forecast Manager

References

- Forecasting in Business and Economics by C.W.J. Granger
- Statistics for Economists by Ralph E. Beals
- Metrix ND Software Manual

Methodology

The Retail Sales Models are primarily econometric models using Ordinary Least Squares (OLS) Regression techniques. OLS Regression is a common technique. The methodology can be found in many texts.

Load Forecast uses Metrix ND software developed and owned by Itron. . The Metrix ND software was developed with the Power Industry sales forecasting groups as its target market. It performs OLS modeling and has other techniques available such as ARIMA models and Neural Networks. It is fully compatible with Window-type software which makes data manipulation easier. It produces a full set of statistics necessary for validating econometric models. Full documentation on use of the software is available on-line and in on-site user manuals.

Residential Model Specification

Variable	Coef	StdErr	T-Stat	P-Value	Definition
CONST	-281.465	67.477	-4.171	0.01%	Constant term
ForecastVariables.Res_Billing_Days	10.429	0.807	12.925	0.00%	Total Billing Days/Number of Billing Cycles
ForecastVariables.Res_HDD	0.224	0.012	18.632	0.00%	Total Cooling Degree Days/Number of Billing Cycles
ForecastVariables.Res_CDD	0.367	0.011	33.578	0.00%	Total Heating Degree Days/Number of Billing Cycles
NRG_Economics.YPR_LA	0.342	0.094	3.644	0.04%	Real Personal Income in LA County
EPrice2014.EPriceRes96	-781.569	167.061	-4.678	0.00%	Real Average Price - Cents / kWh

Model Statistics	
Iterations	1
Adjusted Observations	164
Deg. of Freedom for Error	158
R-Squared	0.915
Adjusted R-Squared	0.912
AIC	5.705
BIC	5.818
F-Statistic	340.715
Prob (F-Statistic)	0.0000
Log-Likelihood	-694.52
Model Sum of Squares	493,683.79
Sum of Squared Errors	45,787.20
Mean Squared Error	289.79
Std. Error of Regression	17.02
Mean Abs. Dev. (MAD)	13.44
Mean Abs. % Err. (MAPE)	2.65%
Durbin-Watson Statistic	1.965

The dependent variable in this equation is sales per occupied household. To get the sales forecast, multiply predicted sales per occupied household times the forecast for occupied households.

Commercial Model Specification

Variable	Coef	StdErr	T-Stat	P-Value	Definition
CONST	-0.540	0.176	-3.062	0.26%	Constant term
BillingDays.BDays	0.042	0.004	10.159	0.00%	Total Billing Days/Number of Billing Cycles
Weather_Variables.RevHDD	-0.000	0.000	-3.998	0.01%	Total Cooling Degree Days/Number of Billing Cycles
Weather_Variables.RevCDD	0.001	0.000	13.758	0.00%	Total Heating Degree Days/Number of Billing Cycles
EPriceCom_96.EPriceCom96	-1.799	0.415	-4.332	0.00%	Average Price per kWh
NRG_ECON.Ecom1kSqFt	0.199	0.017	11.763	0.00%	Employment in Commercial Services/000 Square Feet of Commercial Buildings

Model Statistics	
Iterations	1
Adjusted Observations	164
Deg. of Freedom for Error	158
R-Squared	0.855
Adjusted R-Squared	0.850
AIC	-5.804
BIC	-5.691
F-Statistic	186.443
Prob (F-Statistic)	0.0000
Log-Likelihood	249.22
Model Sum of Squares	2.71
Sum of Squared Errors	0.46
Mean Squared Error	0.00
Std. Error of Regression	0.05
Mean Abs. Dev. (MAD)	0.04
Mean Abs. % Err. (MAPE)	2.23%
Durbin-Watson Statistic	2.312

The dependent variable in this equation is sales per thousand square feet of commercial buildings floorspace. Other commercial sales (Transportation, Communications, Utilities and National Defense) are included in the commercial sales. To get the sales forecast, we multiply predicted sales per square foot times the forecast for commercial floorspace. HDD has an unexpected negative sign but the variable has minimal effect so it is left in the model for consistency.

Industrial Model Specification

Variable	Coef	StdErr	T-Stat	P-Value	Definition
CONST	107562.856	40439.524	2.660	0.87%	Constant term
BillingDays.BDays	1831.574	1188.102	1.542	12.54%	Total Billing Days/Number of Billing Cycles
Weather_Variables.RevCDD	81.450	17.142	4.751	0.00%	Total Cooling Degree Days/Number of Billing Cycles
Weather_Variables.RevHDD	11.849	19.078	0.621	53.55%	Total Heating Degree Days/Number of Billing Cycles
NRG_ECON.Manufacturing	0.199	0.016	12.435	0.00%	Employment in Manufacturing Sector
October_2013_Model.RPEI_96_MA3	-6316.372	1381.083	-4.573	0.00%	Average Price / kWh
Binary.April2001	91860.760	15534.282	5.913	0.00%	Dummy Variable to account for a billing adjustment
Binary.March2004	-39537.478	15379.746	-2.571	1.12%	Dummy Variable to account for a billing adjustment
Binary.April2004	39267.755	15403.110	2.549	1.18%	Dummy Variable to account for a billing adjustment
Binary.July2004	21721.114	15322.901	1.418	15.85%	Dummy Variable to account for a billing adjustment
Binary.November2003	42182.423	15272.069	2.762	0.65%	Dummy Variable to account for a billing adjustment
Binary.November2004	52625.184	15341.934	3.430	0.08%	Dummy Variable to account for a billing adjustment

Model Statistics	
Iterations	1
Adjusted Observations	156
Deg. of Freedom for Error	144
R-Squared	0.683
Adjusted R-Squared	0.659
AIC	19.332
BIC	19.566
F-Statistic	28.250
Prob (F-Statistic)	0.0000
Log-Likelihood	-1,717.23
Model Sum of Squares	71,785,505,958.11
Sum of Squared Errors	33,265,594,815.76
Mean Squared Error	231,011,075.11
Std. Error of Regression	15,199.05
Mean Abs. Dev. (MAD)	11,133.96
Mean Abs. % Err. (MAPE)	5.88%
Durbin-Watson Statistic	1.923

The independent variable is industrial sales. Many billing adjustments exist in the Industrial time series because of the size of customers and the number of special contracts.

Miscellaneous Sectors

Streetlight Model Specification

Streetlight sales are not metered. The sales are estimated by counting the number of streetlight lamps on the system, using the energy rating of the lamps and assuming a load shape. The forecast is based on a simple time trend. The forecast is adjusted by the installation of LED lamps which is provided by the City of Los Angeles Department of Streetlights.

Owens Valley Model Specification

For forecasting purposes, all Owens Valley sales are rolled into a single class. It is a slow growth area. The forecast is a simple time trend. The sales are allocated to the months based on historical patterns. There was a significant shift upward in sales in 2005 due to a reclassification of load from Purpose of Enterprise consumption to Intradepartmental Sales.

Plug-in Hybrid Electric Vehicles

The Forecast is based on the California Energy Commission statewide forecast.

Energy Efficiency and Solar Roof Program Forecast

Forecasting energy efficiency saving is difficult because of the lack of measurement of historical savings. Historical energy efficiency savings are embedded in the historical sales numbers. When using econometric models to forecast, the implied assumption is that future relationships between endogenous and exogenous variables will be similar to past. In the absence of additional information, the most efficient, cost-effective forecast is the naïve forecast. The naive forecast is that the future period is simply equal to the last period's value. There is a problem applying the naïve forecast to energy efficiency since we know that the time series of energy efficiency installments is not stable. Therefore we modify the naive forecast to say the future period is equal to the average monthly installation of energy efficiency over the study period. For energy efficiency savings from building and appliance standards, technological change and push back, LADWP assumes the future will mirror the past. Thus the savings are implied and captured by the econometric models.

LADWP identified two areas where there is additional information on energy efficiency programs. They include LADWP energy efficiency programs and the impacts of the Huffman Bill.

To include the savings from LADWP programs in the Forecast, the technique is to find the incremental difference of the projected installations and the historical average installed. Projected installations are developed from an Energy Potential Study that is performed every three years. The Forecast only includes the first five years of projected installations which is tied to LADWP's budget cycle. Energy Efficiency installed beyond the budget cycle is considered a resource. The incremental difference is subtracted from the results of the econometric model. If projected energy efficiency installations are lower than average historical energy efficiency savings then sales will actually increase. This result is due to the implied underlying assumption that the energy efficiency savings being installed at the historical average rate. Energy efficiency savings are usually quoted as an annualized number so the annual savings need to be allocated to the months. Also we assume that energy efficiency savings will installed uniformly throughout the year.

The Huffman Bill refers to the new lighting standard that greatly increases the efficiency of light bulbs of disallows the sale of inefficient light bulbs. The Forecast relies on the energy savings estimated to occur due to Huffman from the 2013 Energy Potential Study. The technique for introducing the savings is the same. Actual savings from the Huffman Bill began in 2012. Since the Huffman Bill is a lighting program affecting the residential sector, the monthly allocation is different.

Month	Monthly Allocators
January	9.8%
February	8.8%
March	8.8%
April	8.8%
May	8.0%
June	7.0%
July	7.0%
August	7.0%
September	8.0%
October	8.0%
November	8.8%
December	10.0%

Solar Incentive Program Forecast

The forecast for the Solar Program follows the same technique as the energy efficiency program. Solar PV output is degraded at a 0.5% per year rate. The monthly allocators are as follows:

Month	Monthly Allocators
January	5.8%
February	6.9%
March	8.4%
April	9.8%
May	9.8%
June	9.8%
July	10.8%
August	10.4%
September	9.0%
October	7.6%
November	6.4%
December	5.5%

NEL Forecast

The NEL forecast is a function of the Retail Sales Forecast. In the long-run, the average Loss-to-NEL ratio is 12 percent. The 12 percent ratio is higher than most electric utilities due to the facts that LADWP operates two long range DC transmission lines and that power is transformed to 34.5 KV and 4.7 KV for retail delivery. To forecast annual NEL, we divide the annual Retail sales forecast by .885 to maintain the 11.5 loss ratio. Since sales are based on revenue month and NEL is based on calendar month, the annual NEL is distributed to the months based on historical patterns. The monthly allocators are in the following table. An adjustment is made for leap year.

Month	Monthly Allocators
January	8.1%
February	7.3%
March	8.0%
April	7.7%
May	8.2%
June	8.3%
July	9.5%
August	9.7%
September	8.9%
October	8.4%
November	7.8%
December	8.2%

Annual Peak Demand Forecast

LADWP assumes that the annual Peak Demand will occur on the fourth Thursday of August. Historically, 40 percent of all annual peaks have occurred between August 15 and September 7. The majority of the rest of the peaks have occurred in the summer months June, July and the first half of August. There have been two annual peak outliers - one each in April and in October.

The Peak Demand Forecast is built around a temperature response function. The function is non-linear because as daily temperatures increase the demand for electricity increases at a declining rate. The estimators in ordinary least square (OLS) regression are linear which does not fit with the non-linearity of the temperature response function so the spline method is used to estimate the function. In the spline method, the function is divided into segments. For each segment, we use the linear OLS techniques. The splines are spliced together to create the non-linear curve.

Variable	Coefficient	T-Stat	P-Value	Definition
Capped_Weather_No_humidity2.Weather_75	59.106	11.378	0.00%	Weighted Average Maximum Temperature >= 75 and < 80
Capped_Weather_No_humidity2.Weather_80	60.218	12.512	0.00%	Weighted Average Maximum Temperature >= 80 and < 85
Capped_Weather_No_humidity2.Weather_85	73.672	17.651	0.00%	Weighted Average Maximum Temperature >= 85 and < 90
Capped_Weather_No_humidity2.Weather_90	52.306	10.041	0.00%	Weighted Average Maximum Temperature >= 90 and < 95
Capped_Weather_No_humidity2.Weather_95	81.364	10.331	0.00%	Weighted Average Maximum Temperature >= 95 and < 100
Capped_Weather_No_humidity2.Weather_100	29.049	1.131	25.85%	Weighted Average Maximum Temperature >= 100 and < 105
Capped_Weather_No_humidity2.Weather_105	136.811	3.481	0.05%	Weighted Average Maximum Temperature >= 105 and < 110
Month_Variables.Jun	3364.294	152.368	0.00%	June Binary Weather-Insensitive Load
Month_Variables.Jul	3438.440	132.463	0.00%	July Binary Weather-Insensitive Load
Month_Variables.Aug	3445.980	133.793	0.00%	August Binary Weather-Insensitive Load
Month_Variables.Sep	3408.376	140.354	0.00%	September Binary Weather-Insensitive Load
Year_Variables.Year2002	-48.841	-2.214	2.71%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2003	57.460	2.376	1.77%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2004	125.974	5.726	0.00%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2005	21.307	0.977	32.87%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2006	78.191	3.442	0.06%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2007	146.691	6.615	0.00%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2008	295.827	13.266	0.00%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2009	155.423	7.102	0.00%	Economic Trend Adjustment to Weather Sensitive Load
Year_Variables.Year2010	-38.106	-1.731	8.39%	Economic Trend Adjustment to Weather Sensitive Load
Capped_Min_Temp.Min_Temp_60	66.254	18.103	0.00%	Weighted 3-Day Moving Average Minimum Temperature < 65
Capped_Min_Temp.Min_Temp_65	36.596	4.175	0.00%	Weighted 3-Day Moving Average Minimum Temperature >= 65 and <70
Capped_Min_Temp.Min_Temp_70	90.096	3.546	0.04%	Weighted 3-Day Moving Average Minimum Temperature >= 70 and <75

Model Statistics	
Iterations	1
Adjusted Observations	830
Deg. of Freedom for Error	807
R-Squared	0.939
Adjusted R-Squared	0.937
AIC	9.949
BIC	10.080
Log-Likelihood	-5,283.56
Model Sum of Squares	250,999,845.20
Sum of Squared Errors	16,436,460.23
Mean Squared Error	20,367.36
Std. Error of Regression	142.71
Mean Abs. Dev. (MAD)	101.16
Mean Abs. % Err. (MAPE)	2.36%

The temperature variable is a weighted average of Civic Center (50%), Woodland Hills (40%) and LAX (10%).

The dependent variable in the model is weekday peak demand. The maximum weekday daily demand occurs between 1500 and 1600 hours. Splines are created each 5 degrees of the temperature variable. The model only includes data for the months June through September. LADWP does not have a significant winter peak so we only model summer demands. The year variables adjust for sales growth. June and September tend to have lower weather response than July and August.

To find the peak demand, LADWP inputs historical annual peak day weather into the weather response model which gives us 49 observations of peak demand based on current year underlying electricity demand. From the 49 observations, the mean and standard deviation are calculated. The mean is considered to be the weather-normalized peak for the year on which the temperature response model is based. To forecast the peak demand, we input the mean peak day weather into the weather response function. To forecast peak demand, we grow the peak demand at the rate of NEL growth. This technique assumes all load growth will assume the current system shape. However we know that all new energy growth or energy savings is not load following. Therefore we make adjustments for known differences. Currently, these include adjustments for PHEV load growth, Huffman Bill energy efficiency savings and photovoltaic distributed generation growth.

LADWP also uses the weather response function to calculate the weather-sensitivity cases for peak demand. From the 49-year peak day observations, we calculate the mean and standard deviation. We assume the normal distribution based on the Central Tendency Theorem. Knowing the mean and the standard deviation means that we can calculate the expected peak for any probability using the inverse normal function. For example, the 1-in-10 case is where 90% of the time the peaks will fall below the expected peak based on the normal curve.

Monthly Peaks and Minimum Demands

The annual peak demand is forecasted to occur in August of each year. LADWP also forecasts peaks and minimum demands for each calendar month. The method is fairly simplistic. We calculate load factors for each month since 1980. The load factor is calculated separately for the maximum and minimum peak. For the historical load factors, we then calculate the mean load factor for each month for both the maximum and minimum. To calculate the forecasted peaks and minimum demands, we multiply the mean load factors times the forecasted NEL for that month. To check the work, trends are calculated and results are evaluated for reasonableness. Small adjustments may be made based on the analysis.

8760 Hour Forecast

The Energy Production models require that Load Forecast produce an hourly forecast. 8760 hours refers to the number of hours in the year not including leap years.

The LOADFARM algorithm is used to create the forecast. The LOADFARM documentation is available onsite.

There are four inputs into the LOADFARM algorithm:

- Monthly NEL
- Monthly Peak Demand
- Monthly Minimum Demand
- 8760 Load Shape

The load shape is created using a ranked average procedure. The ranked-average procedure preserves the extremities in the data better than would a simple average. We take a historical sample of annual load shapes. Currently the sample is from calendar year 2008 forward. The historical data is permutated so that all the peaks line up on the fourth Thursday in August. We average the NEL across the hours and assign each hour a rank 1 through 8760. This ranking creates an index. Next we rank each year in the study 1 through 8760 and average the NEL across the rankings. The ranked-average NEL is assigned its spot according to the index.