

Developing an Hourly Profile for a Monthly Forecast

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Background

The LG&E Forecasting and Market Analysis Department is responsible for developing a forecast of Gas and Electric Sales volumes and revenues each year. After these forecasts have been developed, an hourly profile of the retail electric loads must be constructed for use by the Operations Planning group.

Basic Methodology

The following steps are followed to produce the new load profile for planning.

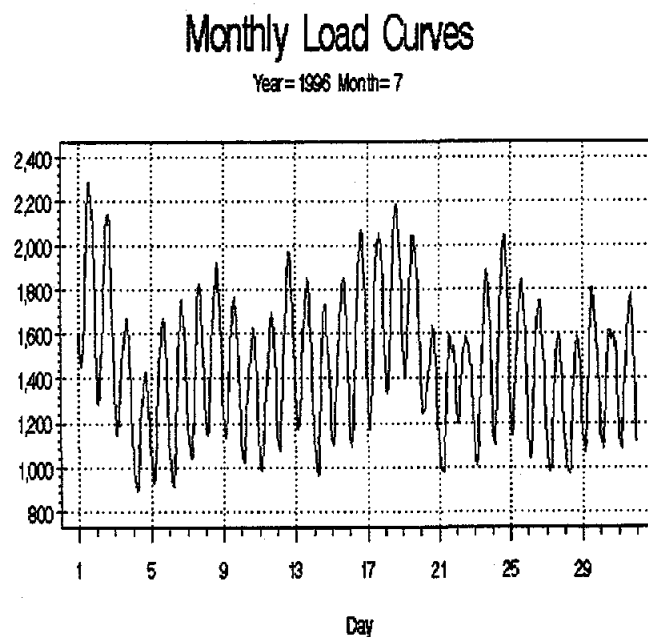
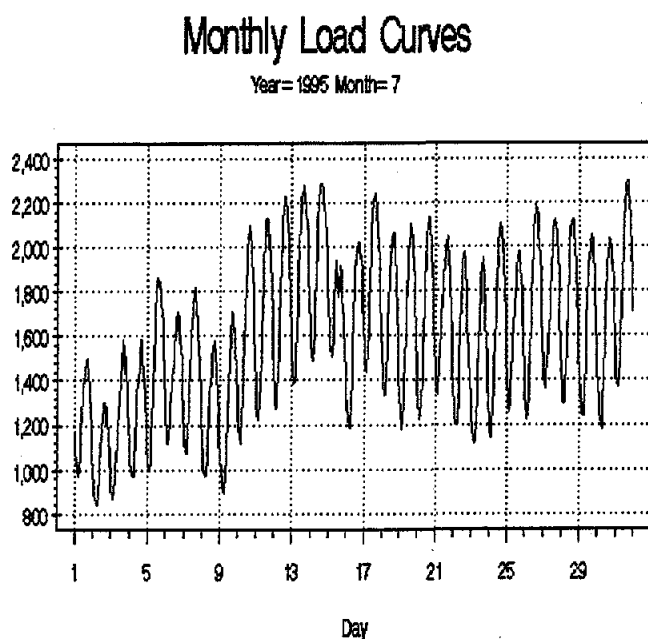
- Collect information from the forecast and recent actual hourly retail loads
- Develop monthly per unit duration profiles and compute the average profile
- Group the retail loads into consecutive 52-week periods and compute the average profile
- Produce a template for the forecast year using the average group profile

- Merge the template with the monthly duration profiles
- Adjust the template demand and energy according to the load forecast to produce the new profile

The remainder of the paper explains the methodology in greater detail along side the SAS program which performs the task. To illustrate the methodology, the following sections include graphs and tables for the month of July. The graphs and tables were produced following each step of the procedure to show the results of each step.

Step 1. Data Collection

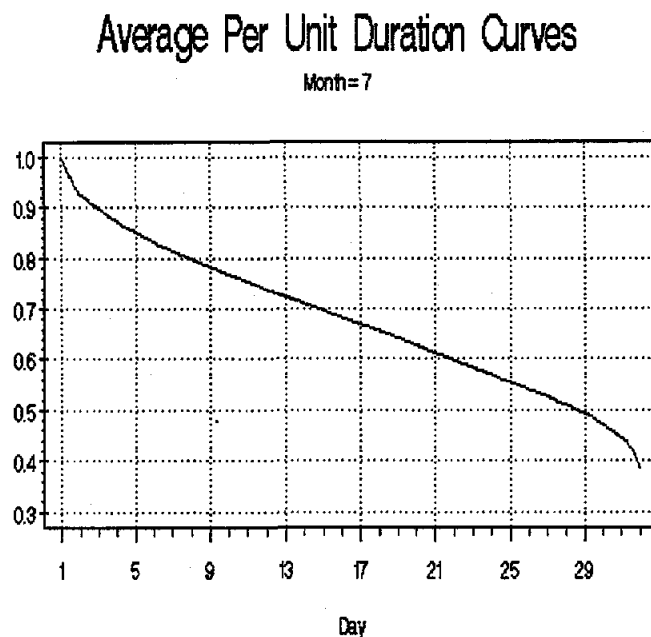
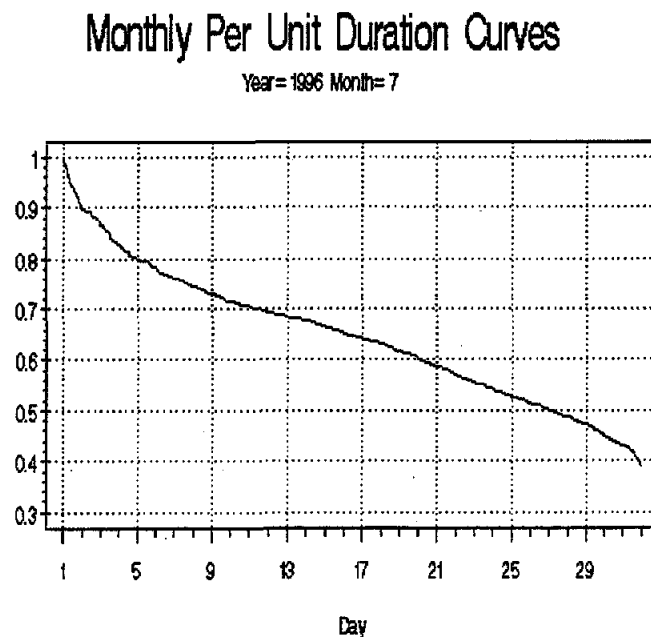
Historical hourly retail load data is obtained from an LG&E Generation Database and stored in the datasets, HISTHR and HISTMON. The most recent twelve years of retail load data is collected to develop the forecast load profile. The historic loads for the month of July 1995-1996 are shown in Figure 1.

Figure 1. Hourly Load Curves for July.

Step 2. Develop Duration Profiles and Find the Average

Once the information has been collected, the historic load data has to be manipulated prior to developing an average. The first step is to sort the monthly data by the level of the retail load. The result is a Monthly Duration Curve. The monthly duration profile is then adjusted by dividing each value by the maximum value to

create a Monthly Per Unit Duration Curve. Now, the resulting maximum value for the month is one and the average of the values is the load factor for the month.

Figure 2. Monthly Per Unit Duration Curves for July.

Monthly per unit duration curves are averaged together to obtain an average monthly per unit duration curve. The average curves are used to

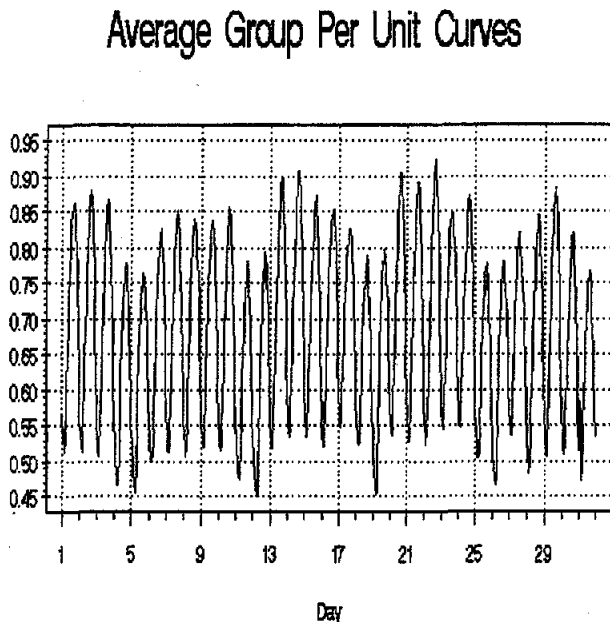
develop the monthly duration curves for the forecast profile.

Monthly Per Unit Duration Curves for July 1996 and the Average Curve are shown in Figure 2.

Step 3. Group the Retail Loads and Find the Average

After the average load duration curve is developed, there must be some mechanism to distribute the values of the duration curve among the hours of the forecast month. One way to distribute load among hours of the month is to recognize patterns or cycles within and among the months of the year. Figure 1 shows that electric loads follow a daily and weekly pattern. In order to match the weekly pattern to monthly periods, a time period of 52 weeks was used. This is approximately one year (364 days). The third step of the process is to group the historic per unit profile data into periods of 52 weeks. The Average Curve which roughly corresponds to July is shown in Figure 3.

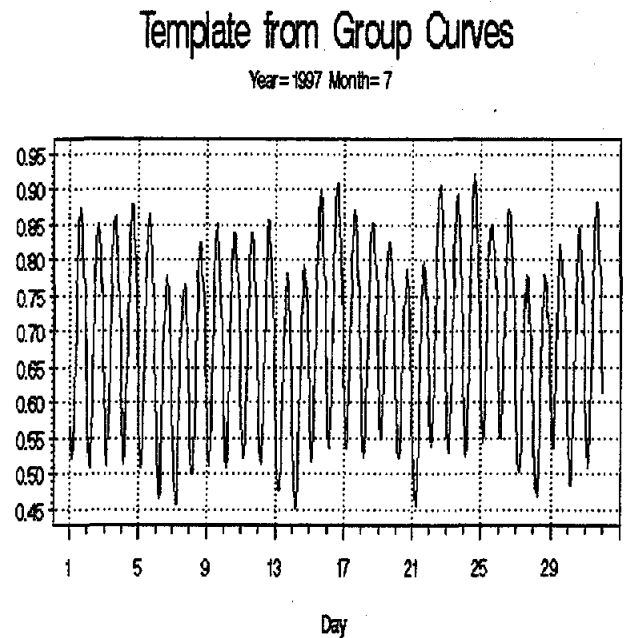
Figure 3. Group Curves for July.



Step 5. Producing the Template with the Average Group Curve

After the Average Monthly Per Unit Duration Curves and the Average Group Per Unit Curves are developed, a template shape for the years of the forecast can be constructed. The construction begins by developing the years of the forecast period without profile information. For each calendar year in the template, January 1 is matched with the Average Group profile according to the day of the week. If January 1 is a Saturday, then it is matched with the first Saturday in the Average Group profile. Any remaining days at the end of December will be matched with the first few days of the Average Group profile. Refer to Figure 4 to see the result of the matching for July.

Figure 4. Forecast Template Resulting from the Average Group Profile.



Merging the Template and the Monthly Duration Curves

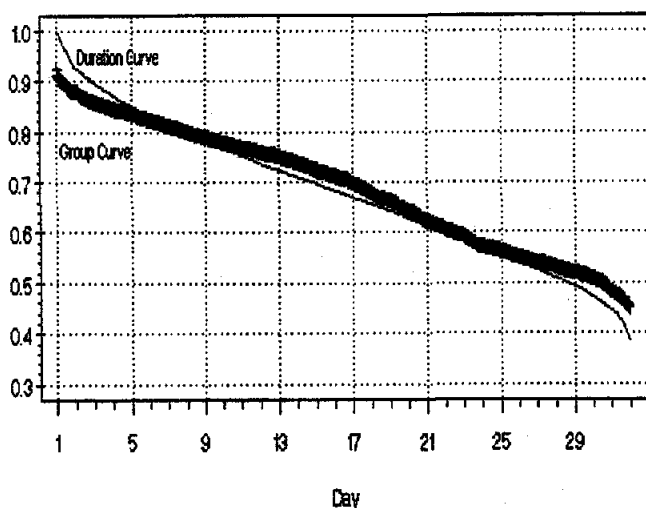
By producing the template with the years of the forecast period and the Average Group profile, the template now contains the month, day and hour to allow merging with the Average Monthly Per Unit Duration profiles. After the

merge, the Average Group Curve can be compared to the Average Monthly Duration Curve as shown in Figure 5.

The peak and the minimum regions of the Average Monthly Duration Curve are higher and lower, respectively, than the same regions of the Average Group Curve. In the average group profile, the retail load for the same hour of the same day of the week for the same week of the same month was averaged across different years. Rarely will extreme values occur at the same point in time in different years. In this case, the extremes are mitigated by the averaging. To compensate for this effect, the monthly per unit duration curves are created and averaged. The resulting average profile preserves the extreme values to be used to develop the forecast shape.

Figure 5. Merged Forecast Template and Monthly Duration Curves.

Template from Group + Duration Curves
Year=1997 Month=7



Step 6. Producing the New Profile from the Forecast Information

At this point of the process all that is left to complete is to adjust for the difference in the load factors between the historic periods and the

forecast. The load factor is the average value for each of the hourly per unit loads. There is also a standard deviation among the load values. Using the load factor and standard deviation from the monthly per unit duration curves, a Z score, or standardized value, can be calculated for each point on the curve. The Z score is difference between the value and the mean, divided by the standard deviation. The information for July is shown in the following table.

Average Load Factor	Average Stand. Dev.	Z score of the Peak
0.6792	0.1396	2.2987

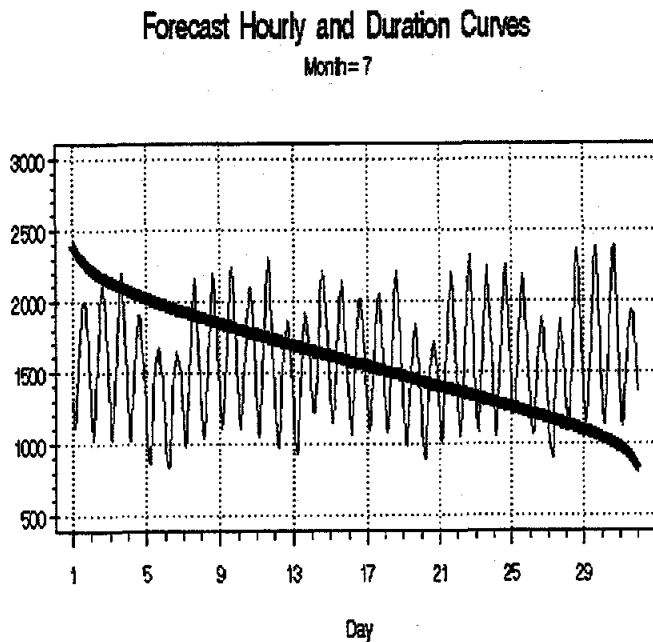
The forecast curve is computed from the Z scores, the forecast load factor and the forecast standard deviation. At this point, the standard deviation of the forecast is unknown. However, it can be computed from the Z score of the peak, since the average per unit peak value for both the historic period and the forecast is one. The forecast information for July is shown below.

Forecast Load Factor	Stand. Dev.	Z score of the Peak
0.6595	0.1481	2.2987

The adjustment mechanism assumes that the frequencies of the hourly loads in a month are normally distributed. If the load duration curves are rotated 90 degrees, the "S" shape suggests that the distribution is normally distributed. The assumption of normality was statistically tested for each of the average monthly per unit duration curves. The result was that each month was between 92.3 and 97.2 percent of normal.

After the per unit values for the forecast are developed, they are simply multiplied by the forecast's monthly peak demand to obtain the forecast load curve. The final product, the forecast profile, is shown in Figure 6.

**Figure 6. Forecast Hourly and Duration Curves
Curves for July.**



Conclusion

The methodology developed by the LG&E Forecasting and Market Analysis Department to produce an hourly profile for the electric forecast focuses on two underlying methods. The first method averages monthly duration profiles. This method preserves the extreme values to be incorporated into the forecast profile. The second method averages the hours of the same week of the year by year. This method preserves the cyclic nature of electric consumption. By combining the two methods into one procedure, LG&E receives the benefit of the best features of each method to produce the forecast profile.