## Section B3: Electricity Load Shapes

### B3.1. Electricity Load Shape Coefficients

In representing electricity generation and use, EIA's models account for the fact that electricity generating capacity must be sufficient to meet demand during *peak* time periods, e.g., summer days when electricity use increases because of high demand for space cooling. The models therefore estimate electricity *load shape coefficients* and *load shape curves,* which are then used to project the quantity and types of new electricity generating equipment that electricity suppliers will install. Suppliers often use different generating technologies for peak load generation than they use for the continuous *base* load generation.

To compute electricity system load shape coefficients, the models divide the year into seasons, e.g., summer, winter, and intermediate (including spring and fall). For each season, the models identify a seasonal base period, a seasonal middle period, and a seasonal peak period. The load shape coefficient for each time period and end-use demand sector is defined as the proportion of the total annual electricity demand accounted for by time period and end-use sector, e.g., residential, commercial, industrial. The coefficients determine the load shapes and the load shape curves, which vary by geographic area. Tables 1 and 2 show examples of load shape coefficients for the United States and China.

**Table 1. Example of Load Shape Coefficients for the United States**

| | Summer base | Summer middle | Summer peak | Winter base | Winter middle | Winter peak | Inter-mediate base | Inter-mediate middle | Inter-mediate peak |
|---|---|---|---|---|---|---|---|---|---|
| Residential | 0.206 | 0.104 | 0.010 | 0.270 | 0.100 | 0.009 | 0.207 | 0.086 | 0.007 |
| Commercial | 0.185 | 0.137 | 0.015 | 0.192 | 0.139 | 0.014 | 0.170 | 0.134 | 0.015 |
| Industrial | 0.247 | 0.080 | 0.007 | 0.245 | 0.080 | 0.007 | 0.247 | 0.080 | 0.007 |
| Transportation | 0.226 | 0.101 | 0.007 | 0.227 | 0.098 | 0.007 | 0.229 | 0.100 | 0.006 |

**Table 2. Example of Load Shape Coefficients for China**

| | Summer base | Summer middle | Summer peak | Winter base | Winter middle | Winter peak | Inter-mediate base | Inter-mediate middle | Inter-mediate peak |
|---|---|---|---|---|---|---|---|---|---|
| Residential | 0.200 | 0.086 | 0.011 | 0.258 | 0.107 | 0.014 | 0.218 | 0.094 | 0.013 |
| Commercial | 0.185 | 0.114 | 0.009 | 0.218 | 0.130 | 0.010 | 0.205 | 0.120 | 0.010 |
| Industrial | 0.247 | 0.080 | 0.007 | 0.245 | 0.080 | 0.007 | 0.247 | 0.080 | 0.007 |
| Transportation | 0.242 | 0.082 | 0.010 | 0.229 | 0.091 | 0.012 | 0.235 | 0.088 | 0.012 |

The base load electricity generating capacity is used continuously throughout the year. The middle period capacity is used during the middle and peak periods in each season, and the peak period capacity is used only during the peak period in each season.

The annual load proportions are ultimately multiplied by the actual annual loads in kilowatthours (or in Btu) to compute the actual load in each time segment. Similarly, the fraction of a year is multiplied by the total hours in a year (8,760) to compute the actual number of hours in each time segment. These values can then be used together to create a load duration curve, where the height of the curve (capacity) at each point is the number of kilowatthours used per hour, which simplifies to kilowatts.

## B3.2. Electricity Load Shape Curves

To create electricity load shape curves, we first compute weighted averages, across the end-use sectors $s$, of the electricity demand ratios. For each season $a$ and each time period $g$ (base, middle, or peak), let

$$PropLoad(a,g) = \frac{\sum_s [Demand(s) \times PropLoad(s,a,g)]}{\sum_s Demand(s)}, \qquad \text{(B3.2.1)}$$

where

$PropLoad(s,a,g)$ = proportion of the electricity demand accounted for by end-use sector $s$ and time period $g$ in season $a$;

$PropLoad(a,g)$ = proportion of the electricity demand accounted for by time period $g$ in season $a$; and

$Demand(s)$ = total electricity demand accounted for by end-use sector $s$.

We weight each end-use sector's proportional load by the total annual consumption in the sector within each region.

For each time period $g$ in each season $a$, we divide the proportion of the demand load by the proportion of hours within the time period to compute the *load height* or capacity for the time period:

$$LoadHeight(a,g) = \frac{LoadProp(a,g)}{TimeProp(a,g)}, \qquad \text{(B10.21)}$$

where

$LoadHeight(a,g)$ = system height or capacity needed to meet the electricity demand in time period $g$ of season $a$; and

$TimeProp(a,g)$ = proportion of hours in time period $g$ in season $a$.

Two examples of the resulting load shapes are shown in the two graphs below, as load duration curves for the United States. and China. Although the system load shapes in EIA's models are represented for three seasons and for three time periods within each season, the seasonal data have been added together in the graphs to illustrate the use of the load shapes.

The horizontal axis in each graph represents the hours of the year, and the vertical axis represents the generation capacity requirements during that period as a proportion of average capacity requirements.  Note that the average height in each graph is 1.0.  Each graph shows the system load shapes in 2005, based on the mix of sector consumption in that year, and the projected system load shapes for 2035, based on the changed mix of sectoral consumption between 2005 and 2035.

A key detail to notice is that the load shape for the United States has a higher peak than the load shape for China.  This is largely a consequence of the mix of end-use sectoral consumption in the two countries.  In the United States, the residential and commercial sectors account for a large part of the electricity consumption. In China, most of the electricity consumption is in the industrial sector.  The residential and commercial sectors typically have load shapes with peaks higher than the industrial sector peak.  China therefore needs more baseload electricity generation, while the United States needs more peak electricity generation.

**Figure 1.  Electricity Load Shapes in USA, 2005 and 2035**

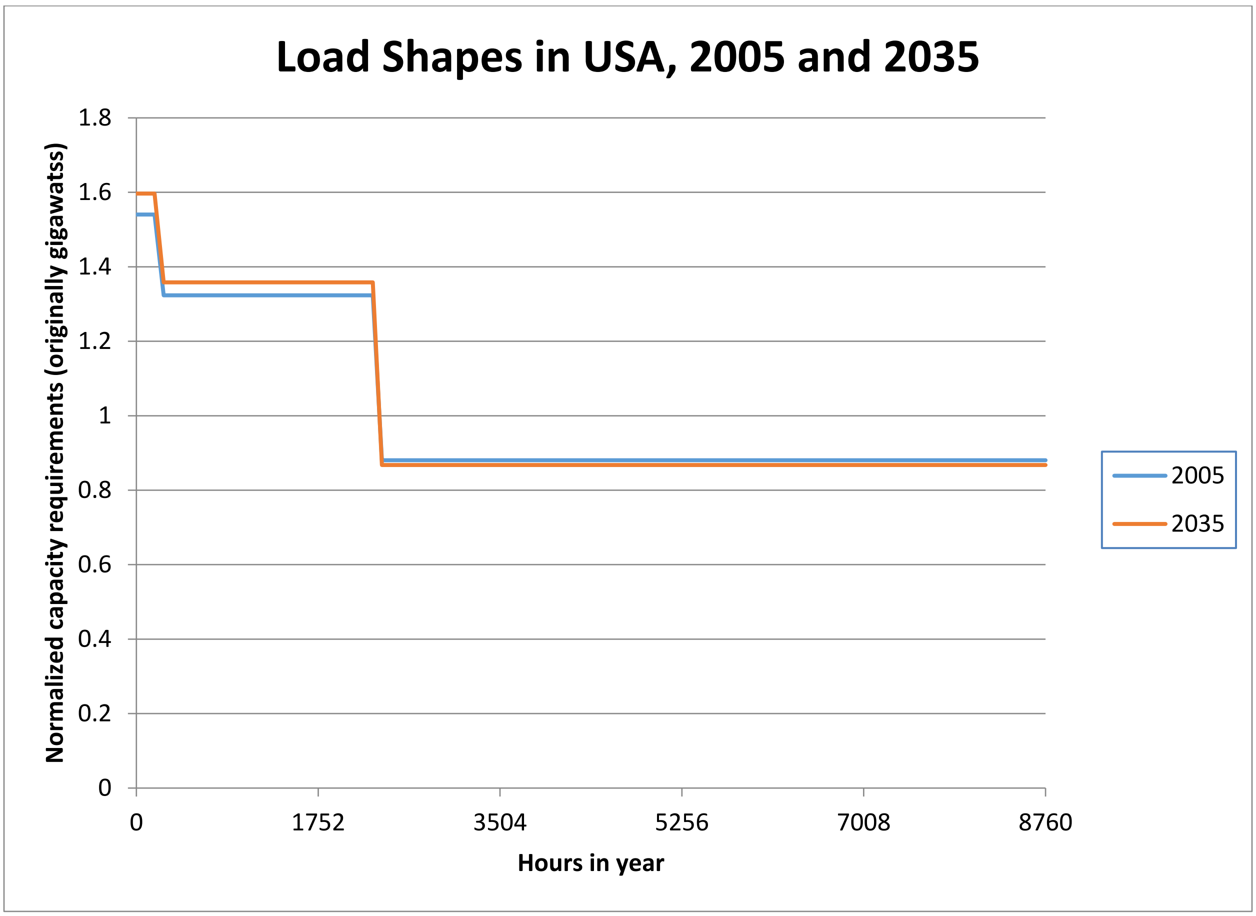
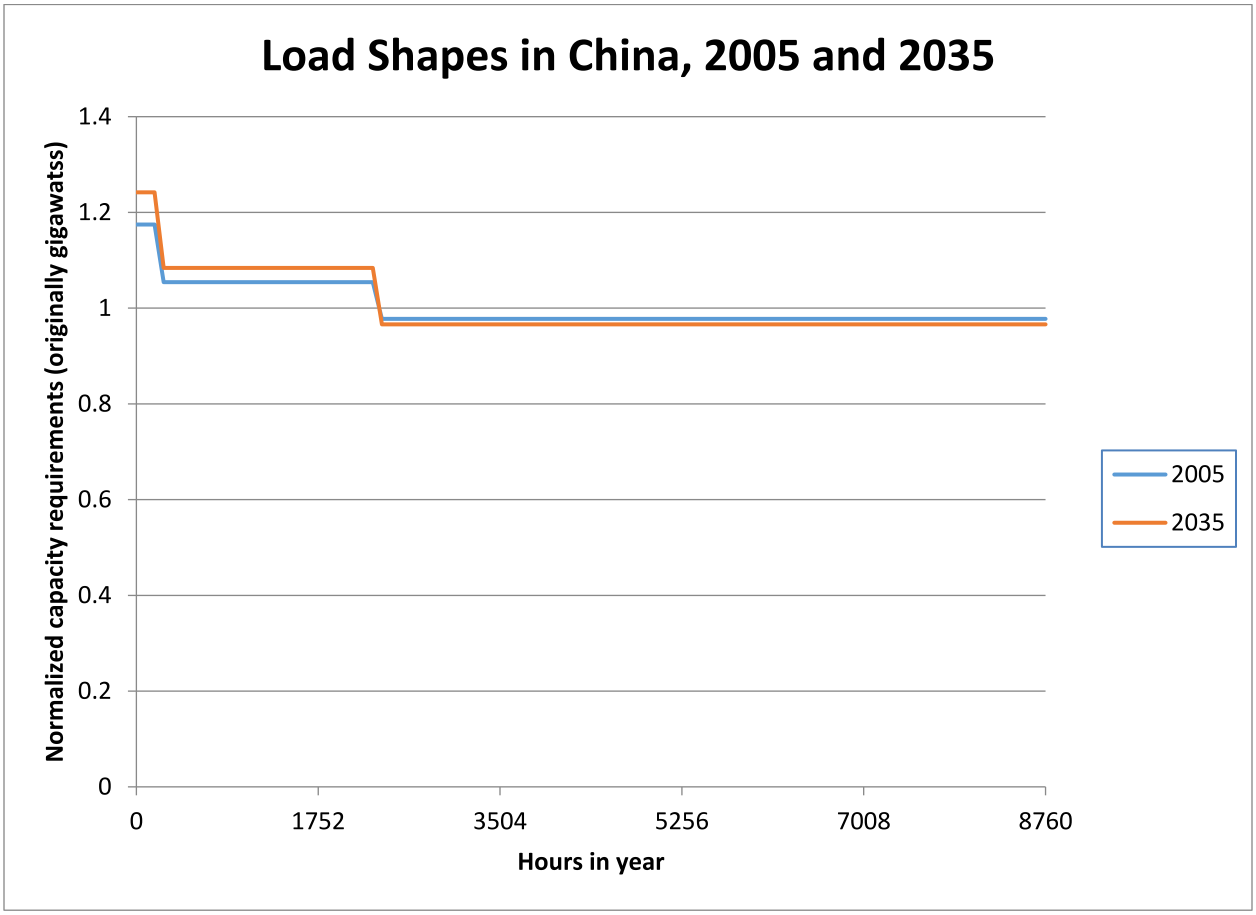


Figure 2.  Electricity Load Shapes in China, 2005 and 2035




**B10.3.  Interpreting Electricity Load Shape  Curves**

For each season, EIA's models calculate the overall proportion of electricity demand load and time for each time period (base, middle, and peak) within the season.  For the demand load, this is the sum of the proportions of load for the time periods within the season:

$$PropLoad(a) = \sum_{g} PropLoad(a, g), \tag{B3.3.1}$$

where $PropLoad(a)$ is the proportion of electricity demand accounted for by season $a$.  The models also add the proportions of time in the three time periods:

$$TimeProp(a) = \sum_{g} TimeProp(a, g), \tag{B3.3.2}$$

where $TimeProp(a)$ is the proportion of the year accounted for by season $a$.

The models also compute cumulative times and marginal loads for the time periods (base, middle, and peak) in each season. The peak electricity generating capacity is used only during the peak period. The height of the curves in Figures 1 and 2 indicate the relative amount of generating capacity needed during the three time periods, while the area under the curve is the total amount of generation (or load) that is needed. The marginal load (or generation) for the peak period is the area under the curve for the peak period that lies above the capacity height for the middle period. This is the additional generation needed to meet peak demand, relative to the amount needed for middle period demand.

The middle period generating capacity is used during both the middle and peak periods of each season. The height of the curve in the middle period indicates the amount of generating capacity needed, while the area under the curve is the total amount of generation needed. The marginal load for the middle period is the area under the curve for the middle period that lies above the curve for the base period.

The base period capacity is used continuously during the entire year. The height of the curve indicates the capacity needed, while the area under the curve is the total amount of generation needed to meet the baseload demand. For the base period, the marginal load is the area under the curve, which is the same as the total load. For each year and each geographic area considered, the models compute the height, total load, and marginal load for each season and time period. They use these quantities to project the addition of new electricity generating capacity, by equipment type, in each time period. For the peak time period, the models add a reserve margin (based on historical data and expert judgment) to the peak capacity, to guarantee sufficient projected generating capacity for peak periods.