Analysis of Electric Load Characteristics of Commercial and Public Buildings Based on Big Data

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Abstract. This article is based on the power load data of several typical commercial and public buildings collected by electric power companies, analyzes its characteristics in terms of time dimension, load change rate, and temperature. The conclusions obtained indicate that, although the types of electricity load and user activity time used by commercial and public buildings are similar, their daily load characteristics are still quite different and need to be independently analyzed. The conclusions obtained provide some theoretical guidance for the future planning and operation of the electricity market.

1. Introduction

The analysis of the load composition and characteristics of the power system is an important aspect of the power market analysis work, and it is also an important basis for power supply planning, peaking planning and power balance analysis. Commercial and public building power loads are an important part of the power system load. Commercial power load mainly refers to the sum of the electrical loads of various electrical equipment in commercial buildings. According to the functional classification, commercial buildings mainly include the following types: more than ten types of functions such as shopping malls, office buildings and hotels. Its main load includes: air conditioning, lighting, elevators, ventilation equipment, water heaters, office appliances, cooking appliances and so on. Public buildings are mainly powered by non-profit public institutions and schools. Their main loads include: lighting, ventilation, and office appliances. In the past, due to the insufficiently developed acquisition, measurement, and storage technologies, it was not possible to accurately collect electricity load conditions for various types of buildings. In recent years, with the rapid development of computer technology, various areas of the electricity consumption information collection system have been widely used. The power company has acquired a large number of various types of user power load data, and can use these data to analyze the load characteristics in detail.

2. Load time dimension analysis

2.1. Daily characteristics of load

The load curve of a typical office building working day is shown in Figure 1. It can be seen that the office building load has obvious time regularity. The daily load from midnight to six o'clock in the morning is relatively low and stable. Starting from 6:00 in the morning, the load gradually began to...
rise and reached a steady state around 9:00 in the morning and continued until around 5:00 in the afternoon. Then it began to gradually decline until about 11 o'clock in the evening, the load is low and tends to be stable.

Figure 1. Daily load curve of a typical office building

The load curve of a typical school day is shown in Figure 2. It can be seen that the school’s load has obvious time regularity. The daily load of 1:00-7:00 is relatively low and stable. Starting from 7:00, the load gradually increases, reaching the maximum power load at around 13:00, and continuing until around 15:00. Then it gradually began to decline. At around 18:00, the downward trend in load slowed down. From 21:00 to 22:00, the load suddenly dropped. After 22:00, the load was low and stabilized.

Figure 2. Daily load curve of a typical office school

2.2. Weekly characteristics of the load

The load curve of the office building from Monday to Sunday is shown in Figure 3. It can be seen that there is a significant difference between the load on the working day and the load on the weekend. There are great similarities between the loads on the 5th day of the workday, and there are certain similarities between the loads on Saturdays and Sundays and they are obviously different from the load on the working day.
Figure 3. Weekly load curve of a typical office building

3. Daily change rate analysis
The formula for calculating the rate of change of load is shown as equation (1).

\[ \Delta = \left| \frac{P_2 - P_1}{P_1} \right| \]  

(1)

In the formula, \( \bar{P} \) is the average daily load, \( P \) is the load at a certain moment.

Figure 4. Load change rate curve of a typical office building

Figure 4 shows the daily load change rate curve of the office building. It can be seen that the daily load change rate of the office building on the working day is between 5% and 60%, the average change rate is 44%, and the randomness and volatility of the load are relatively large. 7:00, 17:00, and 23:00 are sudden changes in the load change rate.
Figure 5. Load change rate curve of a typical school

Figure 5 shows the daily load change rate curve of the school. It can be seen that the school’s daily load change rate on the working day is between 0% and 90%, and the average rate of change is 49%. The randomness and volatility of the load are large. 8:00, 18:00, and 22:00 are sudden changes in the load change rate.

4. Effect of temperature on load

The correlation between load and temperature is obvious. Through long-term experience, we conclude that when the temperature is too low or the temperature is too high, the load of electricity will increase, but the influence of temperature on different regions and different loads will be different. With the collected data, specific temperature effects are analyzed for different loads. This article selects several typical industry loads in a certain area and studies the relationship between daily average temperature and daily maximum load.

Figure 6. The relationship between daily average temperature and daily maximum load of a hotel, (a) holiday (b) workday

Figure 6 shows the relationship between daily average temperature and daily maximum load of a hotel on working days and non-working days. It can be seen that on the working day, the effect of temperature on the daily maximum load is obvious and there is a clear linear increasing relationship between them. On non-working days, the uncertainty of user activities is large, and the regularity is weaker than that of working days. Therefore, there are two inconspicuous linear relationships.
However, as a whole, the daily maximum load increases with the increase of the daily average temperature.

Figure 7. The relationship between daily average temperature and daily maximum load of a warehouse, (a) holiday (b) workday

Figure 7 shows the daily average temperature and daily maximum load of a warehouse on working days and non-working days. It can be seen that on the working day, when the average temperature on the day is between 5-20 degrees Celsius, the temperature has no effect on the daily maximum load. When the average temperature on the day is greater than 20 degrees Celsius, the temperature and daily maximum load show a linear and increasing relationship. On non-working days, between 0-20 degrees Celsius, part of daily maximum load has no relation with temperature change, and some daily maximum load has a linearly decreasing relationship with temperature. When the temperature is greater than 20 degrees Celsius, the daily maximum load increases linearly with the temperature.

5. Conclusion
Based on the typical commercial and public building power load data collected by electric power companies, the characteristics of load are analyzed from the time dimension, load change rate and temperature. The analysis conclusions obtained can provide theoretical guidance for future power market analysis work, power supply planning, peaking planning and power balance analysis.

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