Survey and Analysis of Energy Consumption in University Campuses

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ABSTRACT

Today, the amount of energy consumption at the university campuses is huge. The effort for the energy consumption reduction in university campuses is certainly needed by the following reason; first, contribution for the reduction request about green house gas emission. Second, energy cost reduction in university campus. Third, emotional spreading influence consideration as the maximum higher educational institutions. For the energy consumption reduction in university campus, the energy consumption analysis of current situation has to be executed. The energy reduction possibility in which it exists in university campus can be understood through the energy consumption analysis. And the application is possible as fundamental data of the policy establishment for the effective energy reduction in university campuses. This research analyzed the energy consumption present state of the major university campus of the Korea as the fundamental research for the energy consumption reduction plan preparation of the university campus. Moreover, surveys were performed and analyzed for the energy manager in charge of the university campus.

KEYWORDS: University campus, Energy consumption, Electricity end-use

1. INTRODUCTION

Environmental changes due to global warming, carbon dioxide emissions due to climate change can be seen through the recent worldwide have focused attention on the environment. Because of this, towards reducing energy consumption of the various efforts of all walks of life are conducted consistently. In particular, the university campus with the bulk waste and excessive emissions and a huge waste of energy consumption activities are conducted.

Korea Energy Management Corporation published 'The energy consumption of domestic institutions' in 2006. According to statistics 22 university was ranked as huge energy-consuming domestic institutions of all 190 institutions. In addition, the university's energy usage are accounted for 13.8%(24 2895 TOE) of the total amount of the entire institutions. Meanwhile, Green Korea Union calculated carbon dioxide emissions based on huge energy-consuming domestic institutions' electricity consumption data(2006) which was submitted by Korea Energy Management Corporation. As a result, Green Korea Union concluded universities as principal offender of greenhouse gas emissions. At this point, universities have a duty to solve the climate change issues and should be a model of society as important member of society and institutions of higher education.

Fundamental device to reduce energy consumption in university campuses is reducing energy consumption in buildings. Reduction of energy consumption in buildings is expected to bring in big profits. If universities reduce energy consumption in buildings, they can be expected big profits such

as energy conservation, reduced operating costs etc. Such university's efforts are even more important considering the ripple effect to society.

Therefore, this paper surveyed of energy consumption in university campuses as leading research to derive method to reduce energy consumption in university campuses. And university campus's energy consumption was analyzed. These results will can be used as a fundamental data to establish a energy reducing direction in university campuses.

2. OVERVIEW OF ENERGY CONSUMPTION SURVEY

2.1 Methodology

In this study, the energy consumption survey of person in charge of each university's energy management was conducted to analyse energy consumption in university campuses. Surveys was included the author's statement of personal information questions and perform a telephone interview to ensure survey accuracy.

2.2 Survey substances

Overview about the university campus was investigated as fundamental information to analyse energy consumption in each university campuses. In addition, the following 2 details were surveyed; 1) general information related energy consumption 2) energy consumption data for last 4 years.

Each survey details are shown in Table 1.

Table 1. Energy consumption survey details

Categories	Survey substances
University campus Overview	The number of buildings / gross floor area (whole campus buildings)
	Gross air-conditioning area (whole campus buildings)
	The number of university personnel
General information related energy consumption	General air-conditioning operation conditions
	History of the air-conditioning systems
	Energy saving efforts for campus buildings
	Opinion about applying renewable energy on campus buildings
	The factors that hinder energy saving in campus building
	Personal information
Energy consumption data	Monthly energy usage (whole campus buildings)
	Monthly energy usage in representative building
	HVAC equipment status
	Chronological air-conditioning system
	Chronological energy usage

2.3 Survey response

Total of 85 survey was conducted and analysis of energy consumption in university campuses was based on 7 replied data. Why the poor response rate is judged by the following three reasons; 1) The inspection of a meter in the university buildings is insufficient 2) People in charge of each university's energy management are in negative to exposure university energy consumption data 3) The survey is not mandatory.

3. ANALYSIS OF ENERGY CONSUMPTION IN UNIVERSITY CAMPUSES

Received 7 energy consumption data in university campuses were analyzed. Data were analyzed divided into general information related energy consumption and energy consumption data. Energy consumption data were derived the uniform range due to differences in the range of available each campuses' data.

3.1 General information related energy consumption

3.1.1 General air-conditioning operation condition

In the university campuses, both of air-conditioning period and set temperatures are considered as typical air-conditioning condition. Cooling is operated during the mid-June to mid-September and set temperature is 27℃. Heating is operated during the mid-November to mid-March and set temperature is 18℃. A typical air-conditioning period is similar to other general buildings. But cooling set temperature is 1℃ higher then general buildings' set temperature 26℃, and heating set temperature is 2℃ lower then general buildings' set temperature 20℃.

3.1.2 History of the air-conditioning systems

The air-conditioning system at most university campuses are changing GHP to EHP system due to changes in energy costs to reduce energy costs. Educational facilities, the electricity price is very chip then other energy prices. So application of EHP system will be increased. Because of this, the electricity consumption in university campuses might be increase continuously.

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┌─────────────────────────┐      ┌──────────────────────────┐      ┌──────────────────────────┐
│ - Cooling               │      │ - Cooling and Heating    │      │ - Cooling and Heating    │
│   : Package air-conditioner │ ⇨  │   : GHP                  │ ⇨  │   : EHP                  │
│ - Heating               │      │                          │      │                          │
│   : The bunker C oil boiler │   │                          │      │                          │
│ or the kerosene boiler. │      │                          │      │                          │
└─────────────────────────┘      └──────────────────────────┘      └──────────────────────────┘
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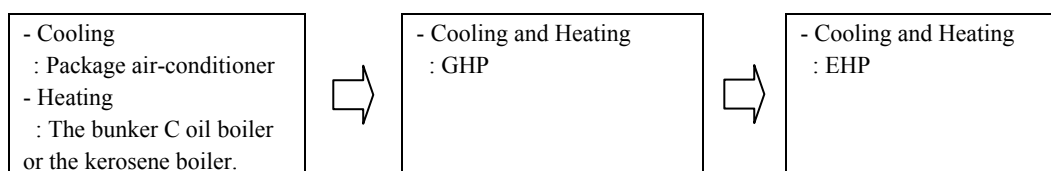
Figure 1. History of the air-conditioning systems

3.1.3 Others

People in charge of each university's energy management makes an diverse efforts to reduce energy consumption in university campus. In particular, central controlling of air-conditioning system, installing the sensor for electrical energy conservation, renewable energy usage are focused.

People in charge of each university's energy management are presented a negative feedback for applying a renewable energy. The reasons are following 2 reasons; 1) low technology level 2) payback period is too long because of expensive initial investment cost. As an answers for a question about obstructing factor for energy saving in university campuses, they mentioned lack of ownership, individual controlled air-conditioning system, and obsolete facilities.

3.2 Energy consumption data

Surveyed energy consumption data was compared to analyse of energy consumption in university campuses. The main source of energy, chronological electricity consumption and monthly electricity consumption data was analyzed. And predictor variables for energy consumption prediction in university campuses were derived. As mentioned previously, data were derived the uniform range due to differences in the range of available each campuses' data.

Analysis results are as follows.

3.2.1 Main source of energy

Electricity consumption has increased in university campuses due to increasing price of kerosene and city gas and relatively cheap educational electricity price. In addition, the electricity power occupies the specific gravity which is largest in the university campus with the energy source consuming the fixed consumption always. Therefore, in this paper, the energy consumption present state of the university campus was analyzed around the power consumption.

3.2.2 Chronological and monthly electricity consumption

As shown in Figure 2, a difference is in the increment as a result of analyzing the chronological power consumption. However, in the most of university campuses, the electricity consumption increases. This is determined as the scale of an university and increment of the number of member and thing due to EHP system installation.

4 university campuses in which the data range and reliability are secured for the monthly electricity consumption pattern analysis were selected and analyzed. The monthly electricity consumption result of each university campus are shown on figure 3 to figure 6.
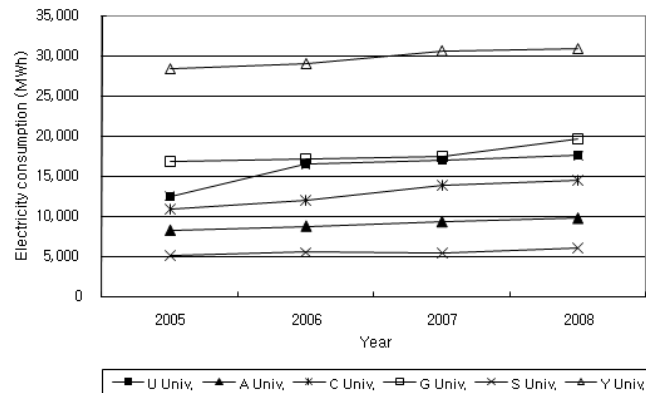
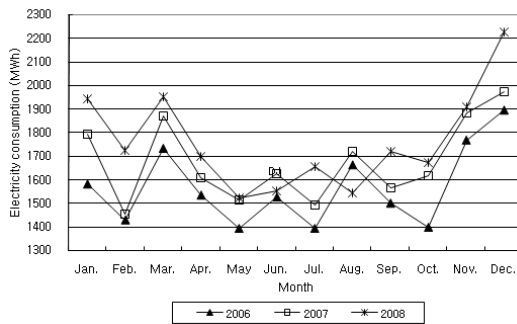Figure 2. Chronological electricity consumption

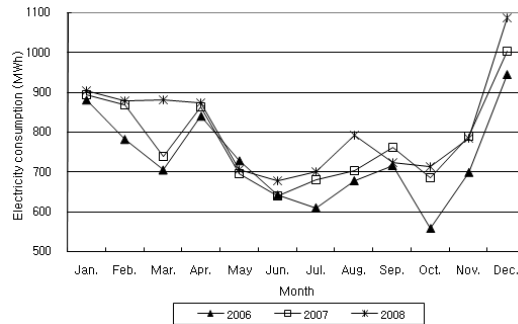Figure 3. D university monthly power consumption

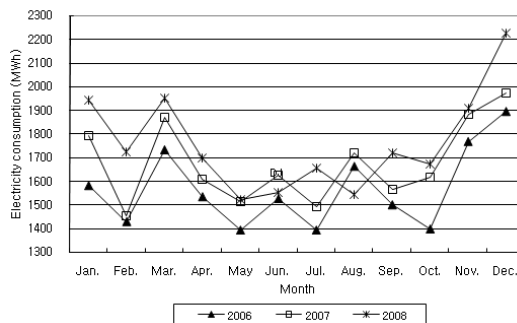Figure 4. A university monthly power consumption

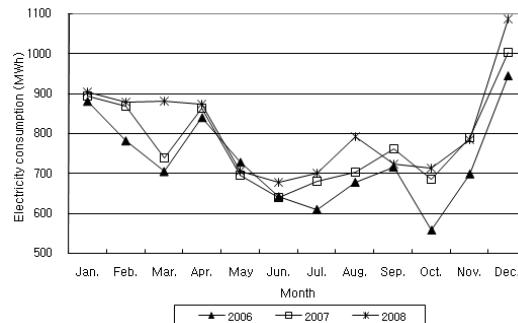Figure 5. C university monthly power consumption

Figure 6. Y university monthly power consumption

The monthly electric consumption pattern which each university campus is whole shows the some extent difference due to the individual property of each university campus. However, the pattern of consumption which is partly qualitatively similar could be looked for. The drawn similar pattern of consumption is as follows.

(1) The power consumption of the heating period is considerably bigger than that of the cooling period. In the case of the university campus, this is determined that relatively the heating side occupies area is wide in comparison with the cooling area. In addition, relatively the heating load is bigger than the cooling load, it is determined that the electricity consumption of EHP system increases.

(2) In the case of the university campus, according to be classified among the term middle and vacation, the power consumption decreases for a vacation and it increases among a term. Particularly, electricity consumption is the most in the March and September when a term begins.

(3) The electricity consumption reduces on February, June and October. June and October are determined that the consumption reduces as an interim because relatively the cooling and heating load is small compared with the other month. Meanwhile, in the case of February, it is determined that it has ahead the commencement season and new term beginning and the residing number of students is few and so the consumption reduces.

(4) A monthly electric power consumption pattern for each university campus doesn't show the big change although a solution is expired.

3.2.3 energy consumption prediction variables

The electricity consumption increment of the university campus, most, the major factor was expected as the number of member and total gross floor area increment. Therefore, the mutual correlation was analyzed.
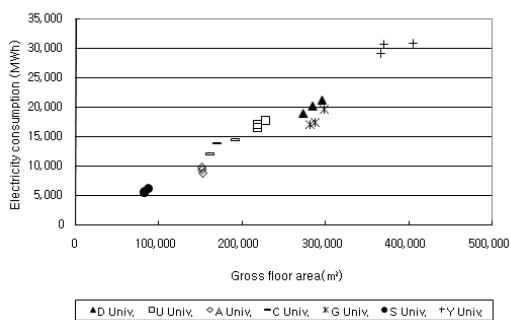

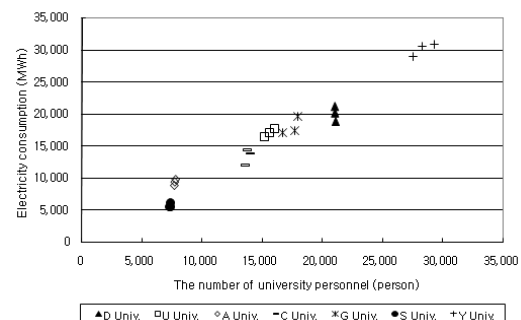Figure 7. The relation scatter plot between the total gross floor area and the power consumption

Figure 8. The relation scatter plot of the number of member and power consumption

As shown in the relation scatter plot of the electricity consumption and number of member and relation scatter plot of the power consumption and total gross floor area, it is each other the linear proportional relation. It is judged as the variable in which the increase of the increase of the number of member or the total gross floor area exerts an effect on the university campus electricity consumption.

4. CONCLUSION

The energy consumption present state of the university campus was analyzed through energy consumption data survey. A results are as follows.

(1) In the case of the university campus, the air-conditioning is mainly run considering both of the cooling-and-heating period and outside air temperature. Cooling is operated during the mid-June to mid-September and set temperature is 27℃. Heating is operated during the mid-November to mid-March and set temperature is 18℃.

(2) The cooling-and-heating method changes gradually to EHP system. As to new and renewable energy application, the negative opinion was presented due to the profitability lack.

(3) The electricity occupies the large-scale specific gravity due to the fluctuation in price for each energy source and the cheap electricity power for education among the consumption for each energy source.

(4) The electricity consumption shows the continued tendency of increase. In heating period the electricity consumption is bigger in comparison with the cooling period. In addition, the power consumption is decreased while going on vacation and electricity consumption is the biggest in March and September when a term begins.

(5) A relation between number of member or the total gross floor area and power consumption were analyzed. Consequently, it drew to be the mutual linear proportional relation. The unit total area average electricity consumption amount of the university campus is about 71.34kWh / ㎡ yr. It is determined based on the according to result in a plan and expansion of the university campus that the power consumption prediction becomes available.

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