Study of the Electric Energy Consumption of the Science Center Building

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Abstract: This research aimed to study the status of energy consumption in terms of electric energy consumption and specific energy consumption (SEC) of the Science Center Building, Suan Sunandha Rajabhat University, Bangkok, Thailand. It was found the electric energy consumption in 2012 was 77,818 kWh. The specific energy consumption was 27.91 MJ/m^2. It needed to have an energy conservation measure for the electric system for short-term measures. For the long-term, the electric system installation was regularly improved and maintained.

Keywords: Electric energy consumption, specific energy consumption.

Introduction

Electric energy involves to the daily life of human beings. The increasing of world population effected on high energy usage. In 2012, the commerce accounted for high electricity consumption was as follows: department stores, hotels, apartment, retail trade and real estate services, respectively. This involved an increase of the GDP about by 6.5 and final energy consumption of 5.2 kTOE (Department of Alternative Energy Development and Efficiency, 2010, 2012). Conventional energy is mostly used for the electric energy generation which has an effect on decreasing the energy resources. Furthermore, decreasing energy resources will lead to the crisis of an energy shortage that directly affects rising energy costs and fluctuations in energy prices. Therefore, all countries realize the problem and try to solve the problem by reducing energy consumption or choosing energy equipment.

The situation of the energy in Thailand in 2012 showed that the energy consumption was higher than in 2011 by about 3.9% (Department of Alternative Energy Development and Efficiency, 2010, 2012). The trend of energy usage in 2013, based on the economic growth in the country, was approximately 4.5 to 5.5% with global crude oil prices about 108 to 113 dollars per barrel. The electric consumption in 2013 increased with the commercial energy margin by about 5.4% when compared with 2012. For the electric energy consumption in buildings, an energy conservation law for buildings with a transformer size from 1,000 kW or more was enacted. The energy management for buildings was reported to the Ministry of Energy. The report showed the energy usage of buildings and guidelines for saving energy. Furthermore, the Prime Minister's Cabinet promoted a policy of energy conservation by reducing the energy use in government buildings. The Prime Minister's Cabinet had agreed to closely monitor the situation in global energy prices and found ways to mitigate the economic impact. In a cabinet meeting on March 16, 2012, the government had to reduce energy consumption by at least 10 % in order to reduce oil imports (Energy Policy and Planning Office, 2013). Pochkao (2005) researched energy savings in the education buildings of Vongchavalitkul University in Nakhon Ratchasima province, Thailand (Pochkao, 2005). This research studied and evaluated the energy consumption in the terms of the lighting systems, air conditioner systems and other systems. The energy usage could be divided into three categories such as lighting (14%), air conditioner systems (75%) and the other systems (11 %).

This research was to study the energy consumption and specific energy consumption (SEC) of the Science Center Building, Suan Sunandha Rajabhat University, Bangkok, Thailand. After the study, guidelines for energy management were determined.

Methodology

This research was conducted by collecting the data of electric energy consumption of science center building, Suan Sunandha Rajabhat University, Bangkok, Thailand in 2012. The data were then analyzed to determine energy consumption. The details of the research were shown as follows:

Collection of Data

The data of electric energy and information of the area of the Science Center Building were collected.

The data was gathered by surveying, observing and studying the behavior of the electric appliances, staff, students, and general users. Types of electric equipment of the science center building were also surveyed. The data of electrical equipment were collected.

- The equipment and the behavior of user, staff, students, the electric devices such as electric lamps, air conditioning systems, and other systems in everyday use were explored.
- Information (air conditioner systems and a label campaign to switch off lights after use) from surveying the area around the building was implemented. The temperature of the air conditioner was not to be set below 25°C.

Data Analysis

- The data of electric energy consumption and the information of area layout were analyzed.
- The specific energy consumption (SEC) could be calculated from the determination of the ratio of the amount of electricity (kWh) and total area.
- The specific energy consumption was calculated using the following equation:

$$SEC = \frac{[\text{electric energy consumption (kWh)} \times 3.6]}{\text{total area } (m^2)}$$

Analysis of the theoretical approaches for saving the energy was done for the determination of what measures could be implemented for energy savings in the building in the short and long term.

Results and Discussion

A. Area of the Science Center Building

The west-side of the Science Center Building was near a parking and exposed to natural light. It directly exposed to the sun in the afternoon which resulted in the increasing of temperature in the building. The south-side of the Science Center Building could take the advantages of natural light and wind. The north-side of the building connected to the Social Sciences Building. The east-side of the Science Center Building was shaded by tall buildings which blocked the wind and natural light in the morning.

The area of the science center building is divided into seven floors. There are various rooms, such as classrooms, laboratories, conference rooms, computer rooms, the Office of the Dean, a library room, a staff room, a storage room, parking and restrooms. The total area of the university is 128,001.14 square meters (m^2). The area of the Science Center Building is 10,038 m^2.

The area of the Science Center Building is divided to two parts such as the air conditioned area of 6,216 m^2 and the non-air conditioned area of 3,822 m^2. The electric system for air conditioners, lighting and other systems were 1,584.25, 68.16 and 162.14 kW, respectively.

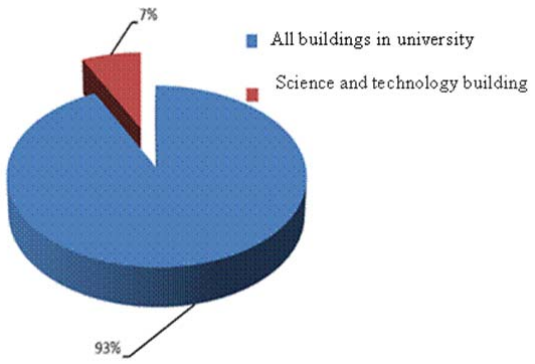

Figure 1. The area of Science Center Building compared with the university.

Those of areas the Science Center Building were divided into two parts: such as the air conditioned areas of 62% and non-air conditioned areas of 38% as shown in Figure 2.

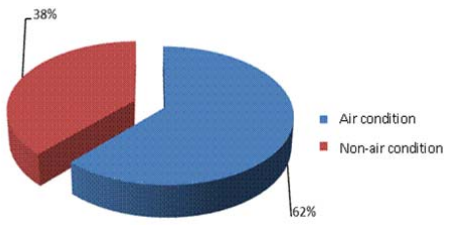

Figure 2. The area of the air conditioned and non-air conditioned areas of the Science Center Building.

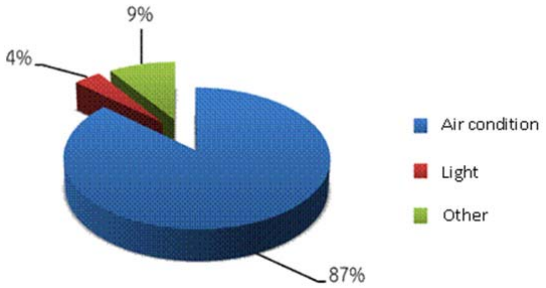

Figure 3. The electric power load in the Faculty of Science and Technology.

Figure 3 shows the proportion of the electric load in the science center building. It was divided into three systems, such as air conditioners, lighting and other systems, about 87%, 4% and 9%, respectively. The "other" systems consisted of official equipment (computers, printers and projectors).

Table 1. The proportion of electrical devices on each floor.

Floor	Total area (m^2)	Air conditioner system (kWh)	Light system (kWh)	Total (kWh)
1	10,038	1,861.14	91,04	1,952.18
2		2,025.22	87,64	2,112.87
3		2,072.10	92,45	2,164.55
4		2,653.41	98,08	2,751.49
5		4,062.15	176,77	4,238.92
A1-A2*		NA	20,45	20,45
B1-B2*		NA	16,99	16,99
Total	10,038	12,674.02	583,42	13,257.44

Note: NA is not applicable.
* A1-A2, B1-B2 is the parking lot.

Table 1 shows the proportion of electronic devices on each floor of the Science Center Building. The 5th floor had the greatest electronic load (kWh), because it was used for the offices of all lecturers and classrooms. All of the area on the 5th floor was the air conditioned area. On the other floors, it showed the electronic loads (kWh) were smaller than the 5th floor, because they had the laboratory rooms which were non-air conditioned area.

B. The Energy Consumption of Science Center Building

The electric energy consumption of the Science Center Building on each floor was considered. The energy usage was different for each floor. Thus, the energy requirement for each activity was not equal and depended on the activity. Two systems were considered, such as air conditioner systems of 12674.02 kWh, and lighting systems of 583.42 kWh.

The energy consumption of the Science Center Building is shown in Table 2.

Table 2. The energy consumption and energy cost of the Science Center Building compared with the university.

Month	Science Center Building		Suan Sunandha Rajabhat University	
	Electric energy (kWh)	Price (THB)	Electric energy (kWh)	Price (THB)
Jan	7,54	28,459.22	859,54	3,255,774.74
Feb	6,061	22,848.74	926,68	3,653,987.80
Mar	6,497	24,455.91	726,669	3,796,505.90
Apr	6,497	24,455.91	313,389	1,102,000.32
May	6,27	23,663.33	861,294	3,226,924.38
Jun	6,479	25,052.71	1,421,927	5,658,128.61
Jul	6,479	25,887.47	1,082,032	4,293,891.67
Aug	6,479	25,887.47	985,722	3,923,280.72
Sep	6,27	26,260.31	812,089	4,007,111.78
Oct	6,497	30,422.35	352,049	1,581,012.29
Nov	6,27	29,434.78	1,277,451	5,755,237.84
Dec	6,479	30,422.35	618,087	2,727,029.46
Total	77,818	317,251.00	10,236,929	42,980,885.51

Table 2 shows the relationship between electric energy consumption and electric cost in 2012 of the Science Center Building and all of the buildings in the university.

The highest power consumption occurred in January, because there were events, including a New Year festival and building maintenance. June and November were the beginning of the semesters. April and May were the summer semester. The amount of energy use in other

months remained similar because of regular teaching schedules. In each month, the energy use was not consistent with the amount of electricity cost.

C. Specific Energy Consumption of Science Center Building

The specific energy consumption (SEC) involved the energy usage and the production unit. The production unit of the building used a living space. Monitoring and controlling of the SEC were the way to manage building energy conservation.

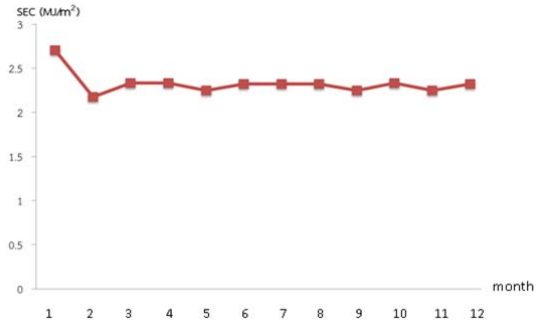

Figure 4. The specific energy consumption of Science and Technology Building in 2012.

Figure 4 shows the specific energy consumption of the Science Center Building in 2012. The SEC of January was equal to 2.70 MJ/m^2. It shows that the energy consumption was the highest because of maintenance of the building. Other months had an average SEC of 2.29 MJ/m^2. The SEC of the building was related to the events, weather at the university, and opening-closing during the semesters. This result corresponded to the energy consumption of the Science and Technology Building of Sripatum University (Srimode, 2011).

Conclusions

The SEC of the science center building was equal to 27.91 MJ/m^2. The analysis of energy use could provide a method for saving money and energy conservation measures. Conservation measures were divided into two phases: the short and long term. It required using energy conservation measures for air conditioner systems, lighting and elevators in the short-term. In the long-term, the electrical equipment and electric systems installation were regularly improved and maintained.

Acknowledgements

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