SUSTAINABLE SOCIETY: ENERGY SAVING CONSTRUCTION

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Introduction

Japan has suffered from an unprecedented disaster because of the 3.11 earthquake and tsunami. A big accident rated as Level 7 took place at the Fukushima No. 1 nuclear power plant, resulted in the suspension of all of the nuclear power plants in Japan scheduled in April of 2012. This accident has led to electricity shortage, giving a huge impact to our comfortable life. At the same time, the future of energy has become a public concern. This accident has reminded us how energy is essential to our life and how important it is to develop a sustainable infrastructure.

Accordingly, I thought it is significant to examine the direction of future energy supply and to recognize the importance of energy saving activities. For this purpose, I carried out a field survey of energy consumption change and energy saving activities in one of office buildings, which have consumed more and more energy, so as to estimate the potential of future energy saving.

For this estimation, Umeda Center Building was picked up, which was completed in 1987. This building is the first example and defined the concept of intelligent building reflecting the social situation of those days, equipped with various kinds of latest energy saving technology. After recent replacement of facilities such as lighting and air conditioning systems a few years ago, this building is positioned as one of the most advanced energy saving building even now.

Methods: Saving and Selection of Energy

Now that the myth of the safety of nuclear power plants was shattered, this is a turning point of selecting energy. Nuclear power generation was attractive for Japan, which is poor in fossil fuel, in the way that inexpensive, stable electricity is supplied and almost no CO^2 is emitted. At the 1st and 2nd oil crises in the 1970', Japan drastically changed its

energy policy from dependence of the primary energy on oil to pro-nuclear-energy policy and extrication from dependence on oil. As a result, the dependency rate dropped to 46% in 2008 from the original level of 77%. Nuclear power generation has developed so much that it covers one fourth of electricity peak and one third of electricity energy. However, the issue of disposing radioactive waste has not been solved and left to the next generation. Future direction has to wait decision by the government after the summary of the nuclear power plant accident and enough discussion for reflecting public opinion on the future energy.

On the other hand, for reducing energy consumption in buildings, it is most important to decrease usage irrespective of electricity generation method. As a professional of construction, I believe energy saving is the first step for attaining sustainable construction. With less energy use and further technological innovation, the environment could be preserved with recyclable energy while comfortable life would be enjoyed in a sustainable way.

There are three key stages for saving energy.

1) When Building is Completed = Design Performance

When designing by adopting the latest energy saving technology based on the social situation and the building needs, the performance influenced by the architectural elements such as heat insulation and opening portions like glass surface and ventilation holes is important. This performance will be kept until the building is torn down.

2) When Facilities are Replaced

Because of the end of the life, facilities such as lighting and air conditioning systems are replaced around 20 years after the installation. 20 years is enough long for technological advancement. During such a period, efficiency can improve and a new facility system can appear. This is the time for reviewing energy saving considering the next 20 years.

3) Daily Operation Stage

It is determined by operation if the energy saving technology introduced in 1) and 2) works efficiently. The Energy Saving Act requires saving 1% of energy on an annual basis. On top of that, it is significant to attain comfortable environment based on the needs of the user and to eliminate waste by careful operation and fine tuning of facilities for saving energy. Also, the results of such daily efforts are utilized in the replacement in 2).

Result: Investigation Results of Umeda Center Building

Umeda Center Building is an office building completed in March of 1987. Fig.1 is a picture of the building and Table 1 the building specification.

Fig.1: Umeda Center Building

Location	Kita-ku, Osaka city
Total Floor Area	80,108.8m^2
Size	32F B2F
Design	Takenaka Corporation
Maintenance	Asahi Facilities Inc.
Lighting	FL40W, 500lx
Air Conditioning Lower Floors Standard Floors	 Air Chilling Heat Pump Chiller Ice Thermal Storage Gas Absorption Chiller Pakaged air conditioning system
Other Facilities	Fuel Cell 200Kw Water Recycling Facility

Table 1: Building Specification (when Completed)

At the time of designing, it is required to improve office productivity, use more OA equipment, and make the building available around the clock due to globalization. As a result, packaged air conditioning system was developed and installed in the building as the first application to a skyscraper because individual air conditioning system was considered reasonable to control the time and space of air conditioning. Based on the concept of energy saving is deep rooted in Japan, which is not rich in natural resources, leading edge energy saving technology was adopted such as heat reflecting glass for the exterior and 200kw phosphoric acid fuel cell cogeneration system for looking for the future of urban energy.

Fig.2 shows the energy consumption change and renovation history after the completion. From the completion to 2001, electricity demand and energy consumption increased because more and more OA equipment was rapidly installed at that time. 2001 to 2003, energy consumption decreased because major tenants using much amount of electricity such as an IT company left the building and the number of people in the building declined accordingly. Then, energy consumption and electricity demand gradually went down because of the renovation of the air conditioning systems at the standard floors 2007 to 2009 and the renovation of the heat source at the lower floors.

The fuel cell cogeneration system was removed in 2008 because of the end of the life. More specifically, the system was not efficiently run because 80% of the generated heat was wasted due to changes in the tenants who use the hot water from the system.
Currently, electricity demand is lower than the time of completion after the air condition system renovation. Also, primary energy consumption is lower than the peak time of 2001 by 30% to lower than 1,800MJ/m^2/year. This is a favorable situation as an energy saving building.

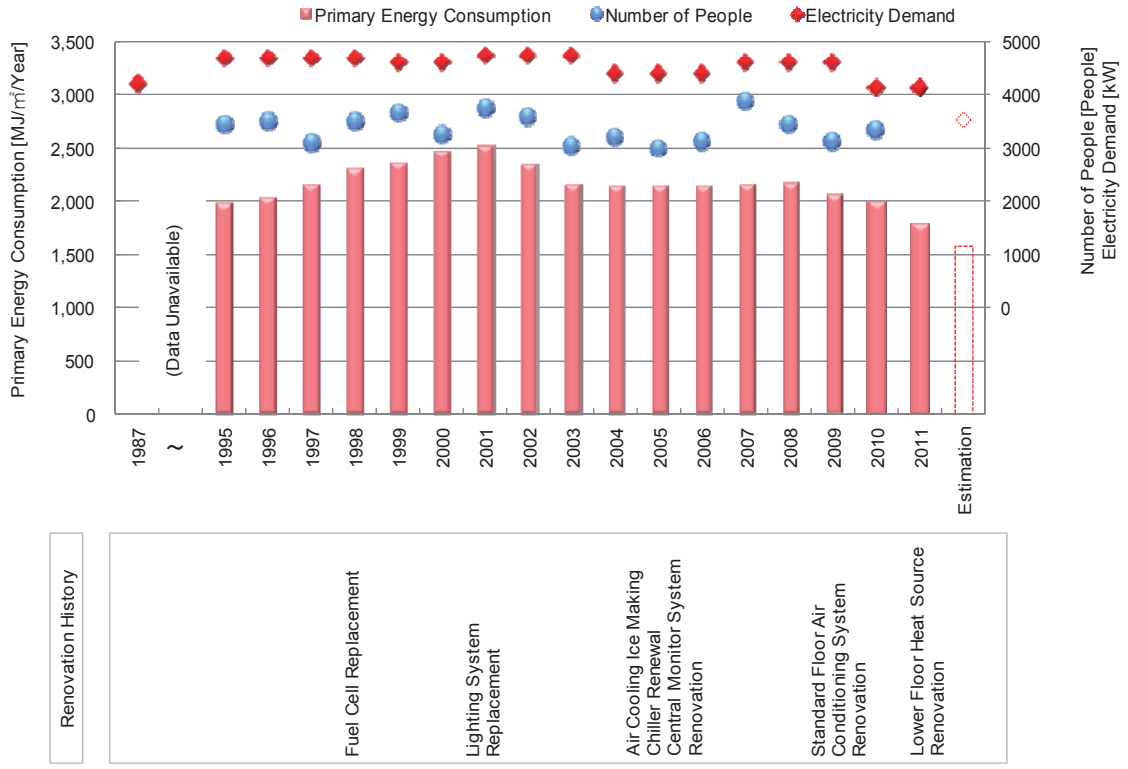

Fig.1: Energy Consumption Change and Renovation History

Discussion: Study of Potential of Future Energy Saving

Umeda Center Building has finished renovating its major facilities relating to energy consumption. Fig.3 is the breakdown of the energy consumption in 2011. This chart shows the lighting sockets consume a lot of electricity. In the next renovation, further energy saving should be attained through lighting system and OA equipment.

(1) Estimation of Energy Saving with Lighting System

LED lighting system has been required to improve its efficiency. Over the past year, this system has become accessible to the public because of drastic initial cost decline and wider variety of products. LED lighting is more efficient than fluorescent lighting in not only the rating but also in dimming control.
Also, the same criterion has been used for deciding the lighting intensity at the desk and aisle spaces in the office. Rather, different lighting intensity should be adopted for desk (task) space and room (ambient) space.
When estimating with the assumption that LED lighting system is installed, the lighting intensity is set at 400Lx for ambient space and 700Lx task space, and daylight and motion sensor controls are combined, 65% of the electricity for lighting, 505kW of the electricity demand, and 184MJ/m^2/year of the primary energy consumption could be reduced. In addition, LED lighting system would reduce internal heat generation and cooling load, resulting in around 10% of decrease in annual air conditioning load, 111kW in the electricity demand, and 25MJ/m^2/year in the primary energy consumption. Accordingly, it is expected to reduce the electricity demand by 616kW and the primary energy consumption by 209MJ/m^2/year in total.

(2) Estimation of Energy Saving with IT Technology

The electricity consumption for using IT devices at the tenants would be reduced by 50% resulting from wider use of thin client systems due to higher access to Cloud computing. Visualization driven by BEMS (Building Energy Management System) is expected to contribute to further energy saving through elimination of waste.

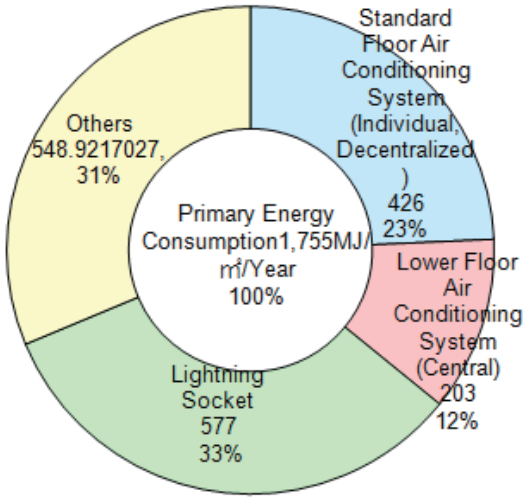

Fig.3 the breakdown of the energy consumption in 2011

Conclusion

Although this is the energy consumption only in one office building, the actual operation performance over 24 years is presented. It was estimated that energy consumption can be surely reduced without damaging comfortable environment through further energy saving efforts to the level lower than the time of completion of the building (in terms of peak and consumption).

So far it has been believed that energy consumption in office buildings would increase so as to improve productivity and comfortability. However, energy consumption will go down for sure. This is a turning point of the energy policy for attaining a sustainable society. It is important to make thorough efforts for realizing sustainable construction.

In conclusion, I would like to express appreciation to Umeda Center Building Inc., Asahi Facilities Inc., and Takanaka Corporation for having provided me with materials of energy consumption.

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