3D BIM-BASED ENERGY MANAGEMENT FOR ENHANCING BUILDING ENERGY EFFICIENCY

Kee-Jung Kwon, M.S., kjpatriot@gmail.com
Dong-hwan Lee, Ph.D., ycleedh@paran.com
Ki-chun Cha, M.S., ckckicun@naver.com
Department of u-City Design and Engineering, Sungkyunkwan University, Suwon, Korea

Seung-Hee Park, Assistant Professor, shparkpc@skku.edu
Department of Civil and Environmental Engineering, Sungkyunkwan University, Suwon, Korea

ABSTRACT

Recently, as increasing the building energy consumption according to climate change, energy efficiency is getting worse. In response to that, increasing of the building energy efficiency and reducing of power usage are prevented a blackout by the control system of urban unit using the Integrated Management Platform (IMP). Korea Government is establishing Smart Green City (SGC) with the purpose of saving energy consumption in Sejong City called Multinational Administrative City. There are four public buildings operated by the IMP. The buildings are operated in the Integration Control Center (ICC) syntagmatically. The ICC of four public buildings is coupled with each of Building Automation System (BAS) and maintain for the usage of the power using digital meters, occupancy sensors, and other equipment for optimization operation of the building energy. This paper present optimization operation technique of the building energy using the control monitor based the Building Information Modeling (BIM) for the efficient operation of the Integration Control System (ICS). BIM is one of the approaches that can be solved by visual representation of the building and quickly interchanging of that's information. The building energy control system should have to explain the data that results from many building information efficiently, and the operator maintaining it could have to acquire the results of the data for handling it promptly. The detailed study of optimization operation technique could suggest the practice of maximizing energy efficiency through the building consumption energy management by utilizing BIM on the ICS of Sejong City and the way of being comprehensive to evaluate the whole energy performance through the IMP. Also, it could suggest the forecasting of improving whole energy performance, reducing operating costs, and reducing the environmental impact associated with energy consumption, which is controlled to maximize the building energy efficiency by BAS.

Keywords: BIM, BAS, integration control system

1. INTRODUCTION

According to UN report, 3E (Economy, Environment and Energy) issues come to the fore (GSPInformation 2010). Especially, in a case of the energy, it much influences on the economy and energy so that the issue related with energy is much important. The increase of the energy demand contributes to the growth of CO2, and it exerts a bad influence on the environment. Also, the waste of power use makes a nation's resource unnecessarily squandered, and as a result, it will diminish the economy. Being aware of the aggravation of environmental problem, the Korean government has been concerned about the field of Green technology for enhancing energy efficiency. According to the energy consumption structure in Korea, the energy consumption incurred by the equipments of the building accounted for 25 percent of the total energy consumption in Korea at the national level. Although this figure did not reach the usage of America which took 39 percent of the total energy consumption, this figure is in-

creasing rapidly (KETEP 2011). Moreover, according to the research conducted by IEA, considering that Japan spend 1 percent of total energy to produce US$1 GDP, Korea spend 3.2 percent of its total energy to produce the same amount of value. This indicates that compared to Japan, the energy efficiency in Korea is relatively low. Thereby, the presidential committee on green growth established in 2009, recognized to the importance of increasing the energy efficiency as one of the ways of enhancing the national competitiveness and announced national strategic five years plan for pursuing the green growth (KETEP 2011).

Based on the report about the energy consumption in accordance with the lifecycle of the building environment, it shows that 80 percent of the total energy is utilized at the stage of maintaining while 50 percent of the total energy is being utilized for HVAC. Accordingly, to reduce the building energy consumption, it is desperately necessary to acquire the technology to save the energy used for HVAC. Considering the situation, the government are attempting to encourage to develop the related technology by including it in the agenda of the strategy of Green IT nation (KETEP 2011),(MKE) .

Building Energy Management System (BEMS) is the technology used for energy efficiency of the building environment by adapting the ICT technology into the building environment. The BEMS is based on the BAS which is the automation technology for the existed building equipment. The buildings equipped with the BAS enable to monitor the status of energy consuming effectively by adapting the metering and sensing which track the current energy consumption and other related information(Jeong 2010),(ETRI 2010). However, the domain of the building energy equipment has been occupied by the global firms up to the 70 percent of the domestic market (KETEP 2011). To overcome this difficulties in the domestic industry, this paper will present the total of energy management and operating system which has been equipped in the four public buildings of Cheotmaeul in Sejong City, so called Korea Micro Energy Grid.

2. EXISTING PROCESSES AND USE OF QR CODE AND MOBILE TEMINALS

2.1 Digital Meters

By the number of a room at each floor in the each building, digital meters was set up to monitor electricity usage in detail. By doing so, the users can see how much energy is used by a floor and facility, per 15minutes. For reference, the displays play a role to show the information of energy usage in installed place, which makes users easily to check on it.

2.2 Occupancy Sensors and Counter Sensors

To more efficiently manage lights in buildings, occupancy and counter sensors were set up in the places where the rooms are often used by occupants. The principle of controlling the light is as follows. When the occupant passes the door into the room, the counter sensors sense it and turn on the light. And when the people get out of the room through the door, counter sensors sense it; in the case that the occupant is in the room, the motion sensor is activated and sense where there are any motions; and of there are no motions, the light is be turned off. By doing so, it is expected to reduce the power consumption used for the lights.

Table 1: Device I:nformation

Building	Location	Digital Meters	ECS
Office of Community Centre	B1	2	1
	B1	27	-
	F1	26	-
	F2	2	-
	F3	15	-
	F4	-	-
Postal Office	B1	15	1
	1F	2	-
	2F	2	-
Police Station	B1	14	1
	1F	2	-
	2F	2	-
Fire Station	B1	14	1
	1F	2	-
	2F	2	-
Total		127	4

Building	Location	Counter Sensor	Motion Sensor	On-off Swithch
Office of Community Centre	B1 Parking		4	1
	B1 electric& equipment Room		6	2
	F1 Reference Room	1	2	1
	F2 U-City Server Room	1	1	1
	F2 Culture Education Room	1	1	1
	F3 Toilet	2	2	2
Postal Office	1F Toilet	2	2	2
Police Office	1F Toilet	2	2	2
	2F a staff lounge	1	1	1
Total		10	21	13

2.3 Energy Control System (ECS)

On 4 building in Sejong-city, Building Automation System (BAS) was already installed; Light & Electricity, Geothermal Heat, and Air-conditioning and heating system were separately installed. For, the building's easy control, Energy Control System (ECS) was established at each building. ECS is a system which unites the BAS to one systems and makes the users to be wirelessly access on the energy usage on anywhere and anytime through XML and network. What is more, in a case of the test bed, the data of energy usage was really huge and must be stored in a server which has large capacity so that for the transmission of data to the server, ECS was used as a transmission system.

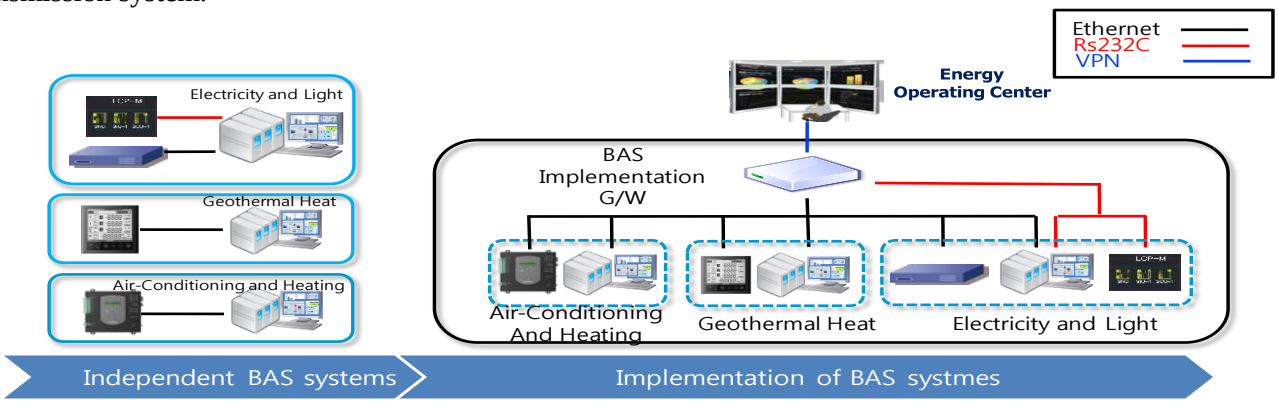

Figure 1: BAS G/W System's Concept

3. BUILDING ENERGY OPERATING TECHNOLOGIE

3.1 Energy Operation Service (EOS)

Until now BAS systems can be operated in large building which substantially consumes energy. However, smart grid technology can allow small building to be managed for the optimization of energy uses by tele-management.

Previously, to operate BAS system, a manager must reside in a building's room so that at least one manager is needed to operate energy consumption at each building. However, in that case, the data of energy use at each building is sent to operation centers through BAS Gateways built in each building; therefore it makes possible to syntagmatically manage multi-building energy uses at operation center, but not that of one building.

Likewise, at EOC, Cheotmaeul's four public buildings can be remotely managed through ECSs. All data from the four buildings are updated to EOC, monitored and controlled at EOC. Therefore, instead of at least four managers, just one manager who is at EOC is required.

Just because ECS and digital meters are required to add one building for energy management (for it, one more manager are not needed), it is very economic and effective. In addition to economic way, energy saving has a positive effect on environment.

As noted above, EOC will be linked with TOC and TOC will provide the electric exchange service and the information of Real Time Pricing that electric fee is changed according to electric demand. Therefore, EOS will contribute to reduce down the risk of blackout caused by energy peak. Furthermore, Korea Electric Power Corporation which is in deficit because of inexpensive fees can make profits by flexibly running electric fees.

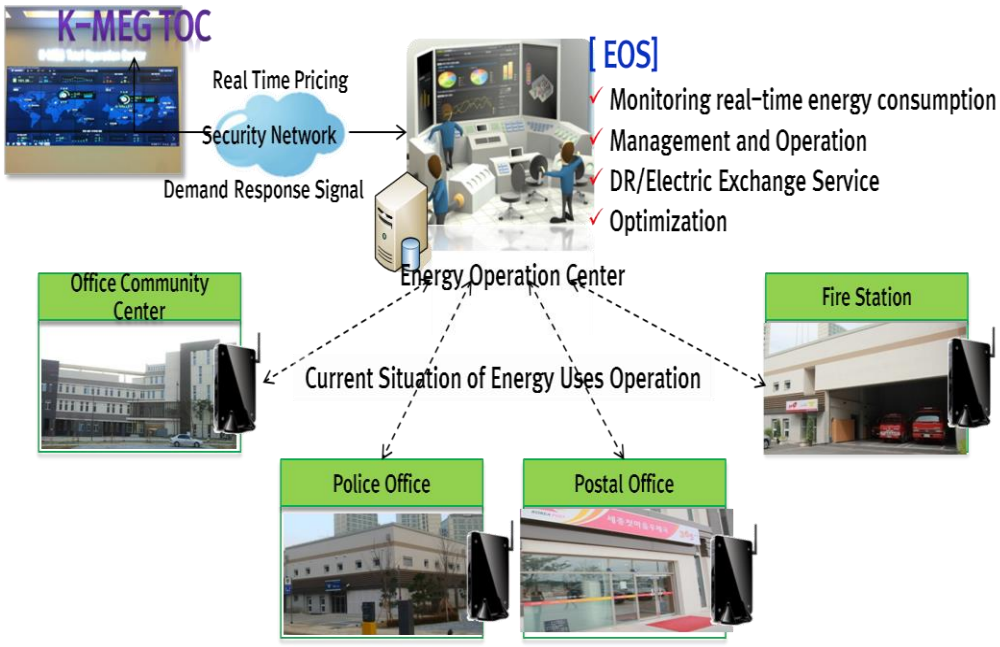

Figure 2: EOS's plaform at the four public buildings

3.2 Energy Operation Center (EOC)

All the data from the buildings are transmitted to Energy Operation Center, and in it, an operator monitors and controls all energy usage at once. Because of that, just one operator can operate multiple buildings so that operating expenses can be largely saved. Especially, in the case of the four public buildings, building's energy management was not done at all because of operating cost. To give you an opinion, if 15% energy is saved in the office of community center which consumes energy the most among the four buildings, the 600 dollars can be saved each month but this amount is much less than the hiring wage. For reference, the 2500 dollars are needed for hiring BAS expert at least. Therefore, until now, energy management service is difficult to be applied in the small buildings which consume energy a little bit. However, by ICT, each building's energy management can be syntagimatically operated so that the energy management becomes possible in small buildings. Especially because energy optimization automation system will be applied, one operator can manage many buildings. So, the more building is added, the less overall cost is, like economic effect.

Figure 3: GUI screen of Sejong City's Energy Operation Center

3.3 Building Information Modeling (BIM)

The Associated General Contractors of America (AGC) defines building information modeling, or BIM, as "a data-rich, object-oriented, intelligent and parametric digital representation of the facility(Lawrence 2010). In the case of Cheotmaeul's four public buildings, BIM is required; the role of BIM can offer the shape of the building to the building energy performance analysis program. The application of BIM makes simulator to implement simulation easily. Through BIM, power usage can be saved. For example, the degree of air-conditioning and heating is different according to location in a building. Also, in same building, each room can exist the global irradiance. So, given the fact, it can be controlled based on BIM analysis with ECOTECH which is one of the building design energy performance simulations. For reference, in COEX's building case which is progressed by K-MEG project, 10%~15% energy is saved by BIM analysis.

Although about 10%~15% energy is saved in COEX case, there is another reason to apply this technology to the four public buildings. The reason is that Heating, Ventilation, Air-Conditioning (HVAC) comprises a large portion of energy consumption in a building. In a case of the USA, HVAC occupies 50% in building energy consumption and 20% in total energy consumption (Luis 2008). In the case of the four public buildings, 40% of all energy consumption is air-conditioning and heating.

Figure 4: BIM (police office, fire station, postal office and office of community center-from left)

4. CONCLUSION AND FUTURE WORK

The energy saving technologies integrating real-time energy consumption monitoring operated at EOC with BIM-based Optimization technique have been introduced. Additionally, as already noted, the energy optimization system will achieve 10~15% energy saving in the four public building. If the project is finished successfully, these technologies will be applied over the whole buildings in Sejong City and will be able to be managed

remotely and automatically. For reference, according to an economic analysis; if 10% energy saving is achieved in 500,000 homes, 40 million dollar (400,000 kWh) can be saved per year. Therefore, energy saving, Smart Grid, should be actively invested and be spread over, as a green technology and a technology of growth driver.
To deal with the lack of the experts about energy efficiency for medium sized buildings and the issues of maintenance cost, it requires to continuously improve the building energy management and to train experts of energy efficiency in more integrated and systemic way by adapting EOC.

ACKNOWLEDGMENTS

This paper is supported by Korea Micro Energy Grid (KMEG) of the Office of Strategic R&D Planning (OSP) grant funded by Korea government Ministry of Knowledge Economy (NO.2011T100100022) and u-City Master and Doctor support project funded by Ministry of Land, Transport and Maritime Affairs (MLTM).

REFERENCES

GSP. http://www.un.org/gsp/

KETEP (2011), “Green energy strategy roadmap”.

Ministry of Knowledge Economy(MKE). “100 대 전략 후보기술”. Korea.

Jeong,Y.K., Park, W.K., Han, J.S., Choi, C.S., Yoon, H.J., Lee, I.W.(2010). "An architecture of the remote building management and control platform for high-efficient low-cost building energy management". *The Fall Conference of Korean Institute of Communications and Information Sciences*, 11.

ETRI(2010). "Energy Management Sensing EMM platform Technology Development for High Energy-Efficient Building". 4.

Lawrence, C. B., Michael, M. C., Benjamin, P. T., Carol, C. M,(2010). *International Conference on Sustainable Urbanization*. ICSU.

Luis, P.L., Jose, o., Christine, P.(2008). "A review on building energy consumption information". *Journal of Energy and Building*, vol. 40, pp.384~398.