Building Energy Management System based on Smart Grid

KyungGyu Park
SD Department
KT
Seoul, Korea
kgpark@kt.com

Yoonkee Kim, SeonMi Kim, KwangHo Kim,
and WookHyun Lee, HwaChoon Park
SD Department, KT, Seoul, South Korea,
KIER, Deajeon, South Korea
lwhok@kier.re.kr

Abstract—**Buildings are important contributors to energy consumption accounting for around one-third of energy consumed in cities, where large public buildings are the dominant energy consumers and energy consumption might be significantly decreased through Building Energy Management Systems (BEMS). KT has developed SG-BEMS(Smart Grid Building Energy Management System) solution to reduce building energy usage, costs and carbon emissions, and installed on smart grid test bed in Jeju Island recently. The paper first introduce the architecture of SG-BEMS including its function and then presents the effectiveness of next generation monitoring, analysis, and control functions. This building energy efficiency solution based on smart grid expected to be a critical part of the future smart grid.**

Keywords-component; BEMS; energy efficiency; smart grid;

I. INTRODUCTION

South Korea has been seeking a sustainable growth while dealing with climate change issues.

As a part of these efforts, South Korea launched the plan to build a smart grid test bed on Jeju Island December 2009.

Smart grid allows real-time monitoring of electricity output and demand. The system is designed to incorporate solar panels and wind power generators into the main power grid, and lets consumers store energy and sell it back to the power company.

Currently, multiple consortiums led by Korea Telecom(from now on, KT), SK Telecom, LG Electronics and Korea Electric Power Corporation are operating their own smart grid system in this region.

KT, the largest telecommunication company in South Korea, has researched various energy management technologies from an ICT perspective for several years. Launching a remarkable smart grid project, KT aims to provide energy management service as one of its future energy businesses.

KT has developed SG-BEMS(Smart Grid Building Energy Management System) solution to reduce building energy usage, costs and carbon emissions, and installed on smart grid test bed in Jeju Island recently.

SG-BEMS solution is a combination of building energy management systems and advanced software that control the facility in a more energy efficient way to provide demand response controls when situations within the power grid demand it.

In this paper, the configuration, the main functions and features for the newly developed SG-BEMS solution are described.

Also, this paper provides useful information of energy efficiency method and the effectiveness of SG-BEMS.

II. BEMS BASED ON SMART GRID

The BEMS provides monitoring and control of many of the Building's heating and ventilation systems. It reduces energy consumption and enables efficient control of building environments.

This helps us to lower emissions, by reducing our energy consumption. By monitoring what we use, we can use energy more efficiently and become a greener Building.

Monitoring and Targeting is basic function of BEMS, it is a management technique in which all building and plant utilities such as electricity, fuel, water, steam and refrigeration are managed as controllable resources in the same way that raw materials, finished product inventory, building occupancy, personnel and capital are managed.

The BEMS collecting the data automatically from the meters in larger buildings, and BEMS can also provide information on the running time and condition monitoring of the building plant.

This information can be incorporated into a scheduled maintenance program suited to the individual building.

The BEMS gives a wide range of options which can improve the energy efficiency of building without compromising the comfort of the occupants in the building.

978-1-4577-1250-0/11/$26.00 ©2011 IEEE

SG-BEMS, a building energy efficiency solution is a technology guarantees clean and economic environment based on information including inside building condition and environment. This technology also minimizes energy consumption through the monitoring of the amount of energy usage and intellectual control of not only inside building energy equipments but also overall energy using equipments including office appliances and information devices.

This solution maximizes energy efficiency through the energy market connection and distributed power connection such as smart grid.

A. SG-BEMS Architecture

SG-BEMS architecture comprise three levels :

Level 1. Management level - supervisory computers.

Service Server, Data Management Server

Level 2. Automation level – Smart G/W (gateway)

Level 3. Field level - sensors, actuators, controllers

SG-BEMS comprises service serve which provides a data service, data management server, and smart gateway to measure, monitor and control the various equipment & devices.

Group BEMS architecture consists of service server and data management server which are installed at building control center as shown in the Fig. 1, it provide the energy efficiency service. Smart gateway which is installed inner building, collect the energy consumption through the smart devices such as meters, sensors and actuators, etc., it is coupled with building operating system including the control system of electricity, HVAC, thermal source and lights.

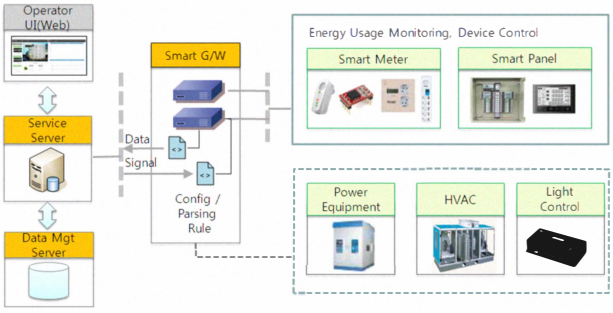

Figure 1. SG-BEMS Architecture

Especially, smart gateway implements function of middle ware which support major industrial standard protocol to couple with various field facilities and outside system, and major protocol are ModBus, ZigBee, BACnet, Wi-Fi, SNMP, IEC61850, DNP3, etc..

Also, lego-block structure with component types constitute the smart gateway, it is made up of 'connector' which is in charge of protocol and 'connection' which is in charge of devices, it is also specialized in time data processing, error

B. Main function

The basic function of SG-BEMS is focus on minimizing energy consumption by means of catching up with unnecessary energy use through the monitoring of detail energy use in building.

And, it provides various control function of energy saving such as maximum power demand control, time control, dimming control, window-side light control by means of daylight sensor, light control influenced by occupant and power demand control to keep within the its maximum contract demand according to the priority of power load.

Above all, SG-BAMS provides energy efficiency function through the analysis of energy consumption such as analysis of previous energy consumption trend, comparing with optimal data and benchmarking with similar facilities, it also provides smart energy services such as load shift to low price time by means of smart grid function, connecting with renewable energy sources and power exchange function.

And, it enable to select the optimal tariff system which appropriate to the pattern of building energy consumption for the various price such as real time price of smart grid.

Figure 2. Building Energy Monitoring

Figure 3. Energy Demand Analysis

Fig. 2, 3 shows the user interface of SG-BEMS, these data can be used as basic references for energy saving and management

system by suggestion of energy consumption characteristics at each zone.

C. Differientiation Strategy

SG-BEMS has Group BEMS function to manage poly synthetically energy system in a company or building groups, demonstration of energy efficiency services and developing of biz. model are being carried out in smart grid demonstration site.

Group BEMS is highly effective in saving costs by providing the environment to manage energy system in a number of buildings at the same time, it also contribute to standardize energy management through the comparing energy consumption rate in each building, analysis of the patterns of devices operation and evaluation of each devices.

Also, it provides energy management system with energy efficiency platform based on not 'In building BEMS' of SI type but 'Center type' for the saving of IT investments, continuous extension of function and evolution of system considering barrier of introduction of BEMS.

In the near future, introduction of distributed power generation system such as photovoltaic system, fuel cell and EV charging infrastructure will be constructed, efficient solution of building energy system also should be diversified to distributed power generation, optimization of energy consumption, B2G(Building to Grid) and VPP(Virtual Power Plant) based on energy saving function.

III. Intelligent Energy Efficiency By SG-BEMS

General energy efficient building methods are the control of energy consumption such as peak load control and temperature control, but there are difficulties in actual applying because energy management have something to do with productivity.

In this paper, intelligent energy efficiency method not with simplified energy saving logic but with load shift concept and selection of price was considered.

And, verification and simulation results about actual building and factory such as 'convention center building' and 'mineral water factory' were suggested.

A. Case 1 : Load Shift

Mineral water factory is running twenty-four hours a year, energy cost comprise a large portion of total manufacturing cost, yield is very important.

3 steps TOU(Time of Use, TOU_3) are applied to this site by season and time, Fig. 4 show the simulation results about energy cost saving through the load shift method without decrease of energy consumption.

When partial load(10%, 30%) of TOU peak load time zone was shifted to light load time zone(14~17 hr → 6~9 hr), simulation results show that electricity fee in case of 10% shift was 10,056.6 USD(1.7% saved from 10,230.48 USD a day), one in case of 30% shift was 9,708.86 USD(5% saved).

From the results, energy consumption rate and yield rate in this mineral water factory are directly linked, load shift is very effective method to reduce energy consumption rate.

If additional load shift ranges or characteristics were founded, it is considered that more energy savings than 5% will be possible in this site.

For reference, simulation results were generated at the condition that cap manufacturing process in day time was shifted to night time in this mineral water factory.

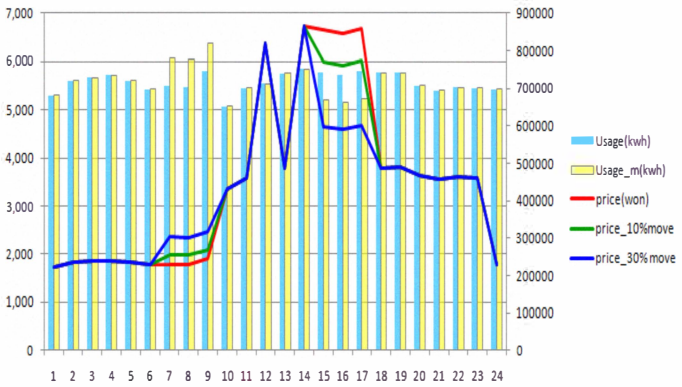

Figure 4. Price change according to the load shift (day)

B. Case 2 : Price change

1 steps TOU(Time of Use, TOU_1) are applied to the convention center building presently, one of the features of this site, energy consumption rate is completely influenced by holding events in their site.

When smart grid TOU_3 price was applied to convention center building, simulation result about power price shows that there was slight difference between existing TOU and CPP price in spring & autumn, but a lot of difference in summer & winter.

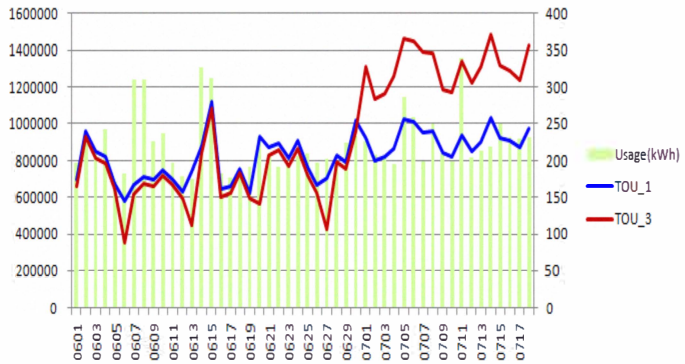

Figure 5. Price change according to the power consumption

Fig. 5 shows the analysis results utilizing the SG-BEMS of price change according to the power consumption in convention center building. There is a large difference in price even though using same electric energy according to the price

step. SG-BEMS is designed to analyze optimized price step to energy consumption pattern.

Due to the nature of this field, there are many events in weekend, because energy consumption increase, it not suitable TOU_3 which having a similar power price in weekdays and weekend, RTP unit price was less than other steps, because weekend demand of power decrease. Fig. 6 and 7 shows analyzed results of power price according to price step in weekdays and weekend.

Consequentially, in spite of the much energy consumption, it is possible to save energy usage price. That is, Due to the nature of convention center, it is possible to keep down the energy price increase with RTP price step, around 3% energy cost could be saved compared to TOU_3 in weekend.

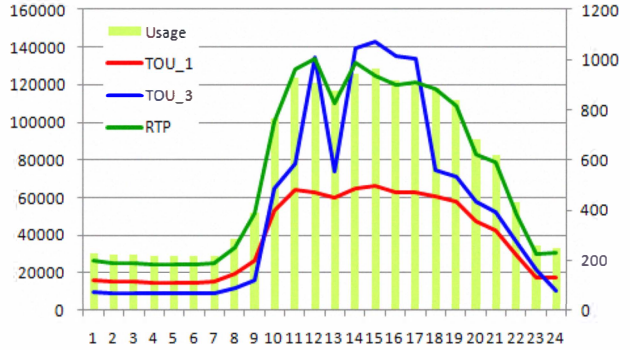

Figure 6. Price in weekdays

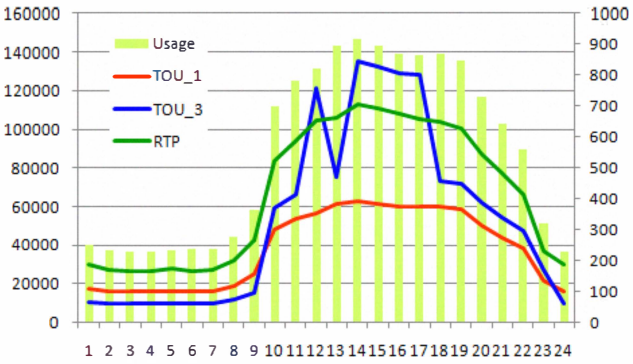

Figure 7. Price in weekend

IV. CONCLUSION

BEMS(Building Energy Management System) is actual solution to settle not only energy saving in building but also the global energy and environmental problem, its needs and importance have increased as smart grid, renewable energy sources have come into wide use.

Also, with development of IT technology, energy price and usage information will be widely, bilaterally shared, open energy market environment will be build including smart grid which consumers can join the energy markets.

Therefore, it is positively necessary to introduce not only simplified energy saving technology but also energy management systems to interconnect actively with energy market including dynamic management technology of building energy demand, selecting skill of optimal price step, for reducing energy cost.

Technical field of BEMS is highly developed area including intelligent services based on behavior of user and spatial perception, energy consulting, equipment diagnosis with expert function. Highly developed function technology will be achieved through the 'Context Aware', 'Smart Application', 'Open Platform', 'Cloud', etc., this means that ICT company have discriminative competitiveness about technology & business in energy domain.

In this paper, it was shown that a lot of energy cost were reduced through the management of peak load and load shift after smart system installed at customer site, control center monitored energy consumption rate, real time price information was provided to customer site. And, additional energy saving will be expected through the management of load equipment, control of light, etc..

V. ACKNOWLEDGMENT

The SG-BEMS and Smart Green Building Service was developed by KT, and is being conducted as a one of the National Smart Grid Demonstration Projects. This project is designed by the Korean Ministry of Knowledge Economy.

REFERENCES

[1] Jisun Lee, Smart Grid Solutions, Services, and Business, August, 2010

[2] Kong Dong-Seok, "Artificial Neural Network based Energy Demand Prediction for the urban District Energy Planning, August, 2009

[3] Minister of Knowledge and Economy, "Green Energy Strategy Roadmap: Power IT," Apr. 2009