

## Case Study of Energy Saving and Smart Management for the Small and Mid-size Offices

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### Abstract

*Energy saving and lowering the greenhouse gas emission is now the major agenda not only for the large scale offices but also for the small and mid-size offices. However, the majority (roughly about 80%) of the buildings existing in Japan is about 10-story high, that is not the size affordable for the expensive energy management system or intelligent facility control system. The study shows two cases of investigation of effect by the installation of a facility control system, named “BX-Office”, which is capable to communicate with the facilities equipments such as sensors, illumination system, air conditioner, and power measurement device. The result of the two cases, the energy saving can be made 10% or more, and the utilization of multiple information such as motion detecting sensor data, lighting status data, reservation time data in groupware scheduler is important to clarify the useless use of energy and program the logic of control to make an optimal operation of facility.*

### Background

For global warming measures, a number of international actions including the post-Kyoto Protocol and U.N. Framework Convention on Climate Change are advancing. The reform bill of the law about the rationalization of the use of the energy, so-called “the energy saving law” was approved in the Diet of 2008 in Japan, and it was enforced from April, 2009. Grasp, improvement and report of the energy use in actual situation that had to grasp it every business

establishment every company was obliged to so far by this revised energy saving law.

Therefore a system such as BA (Building Automation) and BEMS (Building Energy Management System) which could manage the amount of energy with utilizing IT was introduced in recent large-scale buildings, and energy saving control came to be practiced [1]. On the other hand, the number of medium size or small size buildings less than 10 stories that an small-mid size enterprise office and a sales agent of the big company seem to rent as a tenant occupy approximately 80% [2] in Japan, and there are few cases which BEMS which is high-cost in such a medium size or small size building is introduced into, and it makes the difficult situation to grasp the energy consumption actual situation of the whole company. In order to push forward energy saving of the whole society in such situation, it is demanded that a system is capable to measure the energy use actual situation of the discrete office in the building where is lower than a middle scale, and a measurement function needs to be handled without experts of the facilities management, and a system is capable to handle multiple office measurement so as to plan a total energy saving.

### System Overview (what the BX-Office is)

Ubiteq developed a system called BX-Office with the facilities control function that could be introduced into a medium or small size building and/or the tenant office. BX-Office is located between an IP network and a network for facilities equipments, and it is a device able to communicate all in IP. The network protocol of the existing facilities equipments uses proprietary serial

communication and wireless communication, but BX-Office absorbs those different protocols and provides connectivity and the information acquisition functions from the outside to facilities systems by an IP based coherent method. In addition, BX-Office enables that IP surveillance camera cooperation, email automatic transmission by the pre-defined trigger, and confirmation of the meeting room reservation with a groupware scheduler \*1.

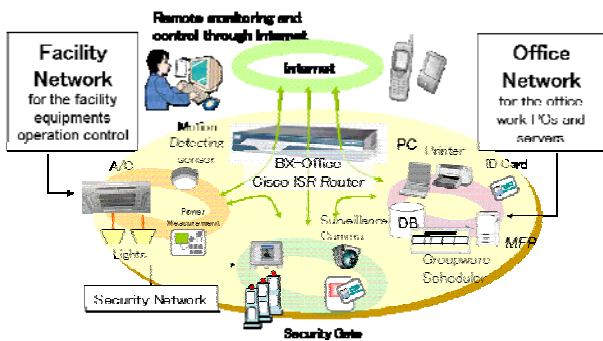


Figure 1. BX-Office System Concept

The origin of BX-Office was the gateway system developed jointly in cooperation with Matsushita Electric Works (existing Panasonic Electric Works) named as BX (Building eXchange) to monitor and operate the facilities equipments in the building remotely. It was equipped with a functional enhancement to realize comfort and convenience control functions, and the energy saving realization function in the office, the security enhancement function afterwards as BX-Office.

BX-Office is application software installed on AXP module of the router "Cisco ISR series" made in Cisco Systems, Inc. BX-Office communicate with a pc terminal and/or a handheld unit of users with IP network via ISR router, and communicate with the facilities equipments such as sensors and illumination equipment, air conditioner, power measurement device \*2 using a serial port equipped with on ISR router.

BX-Office realizes the visualization of energy consumption and the facility operation situation of each

institution by web-based mash-up the collected information of the state of each facility and the scheduler.

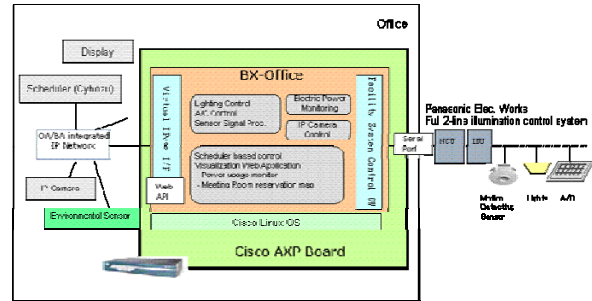


Figure 2. BX-Office System

\*1: support Cybozu Office8

\*2: Support model:

- illumination: Full 2-line type lighting system (NMAST) of Panasonic Electric Works, [3]
- Air Conditioner: Device which equips JEM1427 of the Japan Electrical Manufacturers Association, so-called JEM-A (HA) terminal [4]
- Electrical Power Measurement Device: Product made by Panasonic Electric Works, Multi-circuit Energy Monitor (MEWTOCOL) [5]

### Case Study 1: Study at the Ubiteq Office

The analysis conducted to know the installation effect of this system in the Ubiteq office. The office of Ubiteq does the general office use in a tenant asking for 1 floor which is approximately 750 square meters in the 10-story building.

[Issue] So far, it is only the level of campaign to employees not to do useless energy consumption by the use of facility to cut illumination / air conditioning after finish using, it is up to an individual action till now in Ubiteq, but after all the left-it-on (not turning the switch off when leaving) did not dissolve. In addition, it was used a meeting room without reservation, which leads ineffective meeting room use.

Then, the study conducted to inspect an energy saving effect. It additionally installed illumination control

equipment in the entrance area, business talk space and the meeting rooms of Ubiteq Office.

[Result] The result is described below with quantity of energy reduction in the Ubiteq office by BX-Office.

The measurement place that is applied is illumination / air conditioning of the office entrance, the business talk room (two rooms) and a meeting room (six rooms). And the measurement of electricity energy consumption was conducted through the office floor. The methods for reduction of the amount of energies in place were the automatic control with the motion detecting sensor and the visualizing energy saving information showing each facility which was normally ON to employees.

### 1. The facilities operation time for the meeting rooms in one month

Before BX-Office was installed, illumination / air conditioning operated always ON during the office hours for approximately nine hours from 9am till about 18:00 on weekdays.

An installation effect:

- CO2 discharge                    656.477 [kg] reduction
  - Electric energy                 1554.652[kwh] reduction
  - crude oil conversion         397.130 [liter] reduction,
- approximately 29% reduction operation time

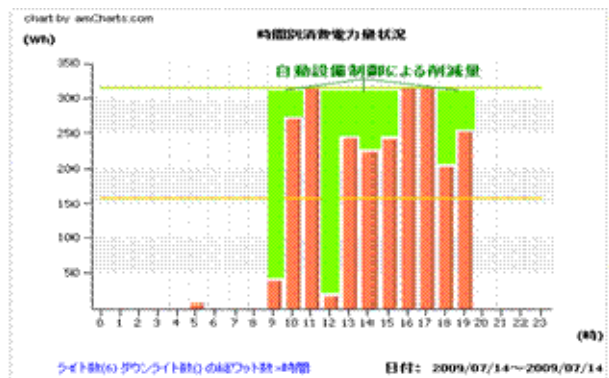


Figure 3. Graph of Power Usage at Meeting Rooms

### 2. Lighting time for entrance illumination (daily)

Before BX-Office was installed, lighting turned on for approximately ten hours from 9am till about 19:00 regularly.

An installation effect: 1.125kWh/day reduction, which will be about 22.5kWh reduction effect in one month (working days = 20-day a month). And it reduces approximately 75% of lighting time.

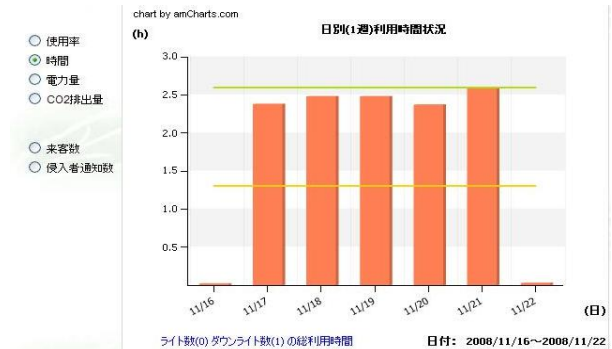


Figure 4. Graph of Power Usage at Entrance

### 3. Lighting time for the business talk room #1 and #2 (daily)

Before BX-Office was installed, lighting turned on for approximately ten hours from 9am till about 19:00 regularly.

- Business talk room #1: Quantity of use 11.53 hours / week (77% of reduction)
- Business talk room #2: Quantity of use 9.49 hours / week (81% of reduction)

An installation effect:

- 40 hours x 80W x 2 = 6.4kWh reduction
- Approximately 80% of reduction in total

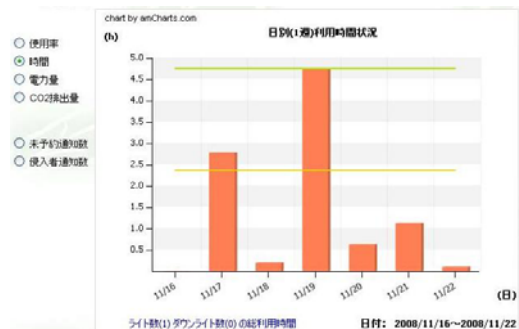


Figure 5. Graph of Power Usage at Business talk room #1

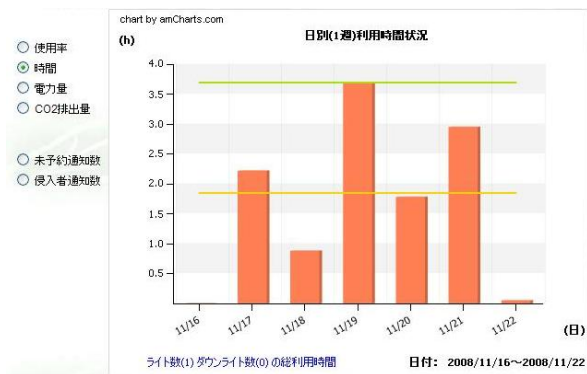


Figure 6. Graph of Power Usage at Business talk room #2

#### 4. Electricity Measurement of the Ubiteq office

A sample result of the electricity measurement on one day at the Ubiteq office is shown below.

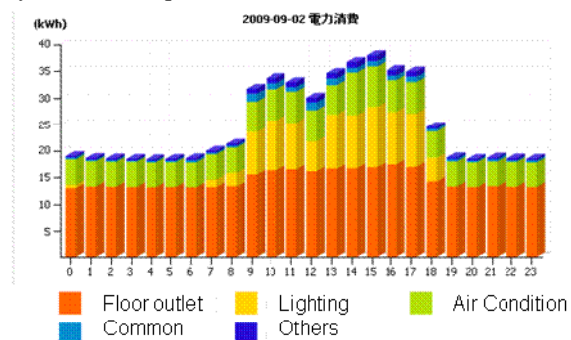


Figure 7. Graph of Electricity Consumption at Ubiteq

From this graph, the minimum usage amount is rather large at night compared to the daytime in overall consumption. This means that the cause of this result seem to be from the server room usage. And it tells that the first action to take should be from the server room in order to achieve the effective energy saving.

#### Case study 2: Study at the University of Tokyo, Department of Engineering Building No. 2

Through collaborative investigation activity with the University of Tokyo, Ubiteq participated in the Green University of Tokyo Project and inspected it about an installation effect of BX-Office in the educational institution.

Department of Engineering Building No. 2 of the University of Tokyo in the Hongo campus is comprised in a lecture room, a meeting room, a laboratory, the professor's office room, and is constructed in the one floor basement and the twelve floors above the ground.

[Issues] Exclusion of the useless use that illumination / air conditioning are left tuned on after usage and the arbitrary lecture room use without reservations in the University of Tokyo was a problem in the institution management. At present, there was no mean to identify the operation situation of illumination and the air conditioning of each room, and it was grasp impossibility to know if there was a person there or not. So far, the institution management takes the method of timer setting on equipments on every facility to operate and the method of dispatching a person to patrol.

Then, the investigation at the University of Tokyo was conducted by taking one lecture room and one meeting room as sample with additional construction of motion detecting sensors over the existing illumination control system and integration of illumination status, sensor status and reservation information on the scheduler, air conditioning status information in BX-Office. BX-Office has a capability of automatic prevention function to do air conditioning and illumination turning off when no one remain in the room from the information of motion detecting sensor and a reservation information of scheduler. However in this study, it disabled the automatic control function to grasp the everyday use actual situation and how much useless use there was by monitoring illumination status and the motion detecting sensor.

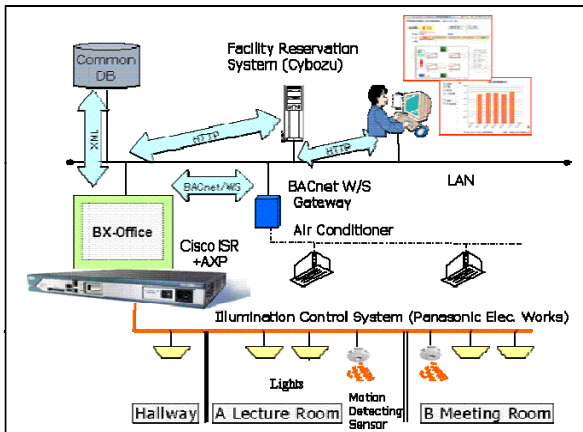


Figure 8. System Overview at the Univ. of Tokyo

[Result] The result of monitoring the use of rooms from July 1st to 31st for a month is described below.

The data collected:

- The reservation time with the scheduler (Cybozu)
- The time stamp of the notice of non-reservation use email transmitted from BX-Office
- Daily records of an illumination lighting rate based on the time in BX-Office

Analysis technique:

- Assuming the use of time with non-reservation as the useless operation time
- Estimating a pattern of useless time classified in three kinds as following:
  1. Early Bird  
Operation by the admission (with a notice of non-reservation) just before the reservation time
  2. Left-it-On (Not turning the switch off when leaving)  
Operation (with no notice of non-reservation) just after the reservation time
  3. Non-reservation use  
Operation by the admission (with a notice of non-reservation) outside the reservation time

Result of analysis:

<A Lecture Room>

Total reservation time: 9,220 min. (153 hrs. 40 min.)

Total time of usage: 16727.6 min. (278 hrs. 47.6 min.)

Utilizing efficiency: 181% against the total reservation time

Total time of useless operation : 8201.9 min. (136 hrs. 41.9 min.)

Useless use rate: 49% against the total time of usage

1. Early Bird: 1941.3 min. (32 hrs. 21.3 min.), <24%>
2. Left-it-On: 4221.6 min. (70 hrs. 21.6 min.), <51%>
3. Non-reservation use: 2,039 min. (33 hrs. 59 min.), <25%>

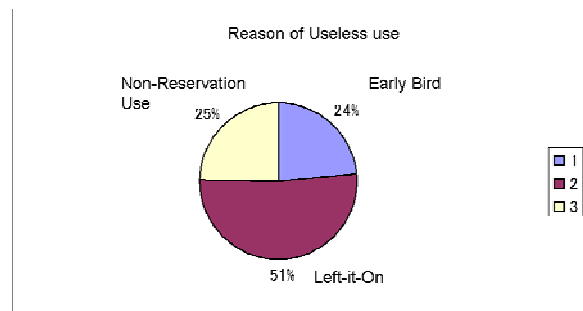


Figure 9. Graph of Ratio for Reason of Useless use (A Lecture Room)

<B Meeting Room>

Total reservation time: 16855 min. (280 hrs. 55 min.)

Total time of usage: 6438.8 min. (107 hrs. 18.8 min.)

Utilizing efficiency: 39% against the total reservation time

Total time of useless operation : 745.8 min. (12 hrs. 25.8 min.)

Useless use rate: 11% against the total time of usage

1. Early Bird: 331.8 min. (6 hrs. 31.8 min.), <44%>
2. Left-it-On: 49.2 min., <7%>
3. Non-reservation use: 364.8 min. (6 hrs. 4.8 min.), <49%>

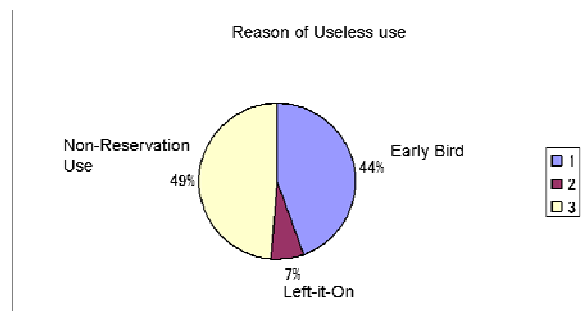


Figure 10. Graph of Ration for Reason of Useless use (B Meeting Room)

**Consideration:**

As two case studies said above, this analysis was able to be realized by unifying the motion detecting sensor signal of the illumination control system, lighting operation log data and the reservation data. The value of the integration of the multi-vender information that dispersed in individual systems was able to be confirmed. By quantifying the useless use of energy, it was able to make one step forward to lead to the concrete reduction plan.

Up until now, it has been assumed that there is serious useless use, but the study succeeded to show the situation of useless use quantitatively and visualized. 11% of meeting rooms and 49% of the lecture room was able to be confirmed as the useless use over the total usage time. In addition, it is supposed that there might be the possibility that an institution manager patrols the room from the log of the motion detecting sensor in an early morning and the night, and he or she might do On/Off of facilities. So, it is thought that reduction (labor saving / a cost cut) of the management work load by the person is possible from this fact.

**Summary:**

The study confirmed the potential that could realize 10% or more energy saving by introducing a system such as BX-Office, having a function to integrate the information of the IT system with facilities information, into a medium size or small size building and the tenant office.

It is considered that it is able to plan further energy saving by making full use of such IT system and unified various information of the facilities information in future. For that purpose, the system will pile up a function of visualization and a control logic promoting the energy saving in future. For example, it makes clear the electricity consumption in which room with no one, in other words, whether useless use of illumination and air

condition occur by showing the graph plotting the data of motion detecting sensor and with overlaying the data of electricity consumption at a glance by user. Thus, it is expected to gain the effect that an energy-saving countermeasure is easy to come to work out by putting various information that BX-Office acquired on top of one another.

In addition, BX-Office provides user to manage energy management even from the remote place because BX-Office is able to be managed through the Internet. Therefore the multiple operation sites can unify the energy management data dispersed in every office. And the management can compare the energy use actual situation in every office and can plan the energy saving effect that cooperated by analyzing it.

**References:**

- [1] "Award Winning, Less Energy Case Study Contest", Matsushita Electric Works, 2007 (in Japanese)  
<http://panasonic-denko.co.jp/corp/news/0701/0701-13.htm>
- [2] "Introduction of BA Business at Hitachi Building Systems", Hitachi Building Systems Co., Ltd, 2005
- [3] Panasonic Electric Works Proprietary Full2-line Illumination Control System (in Japanese)  
<http://denko.panasonic.biz/Ebox/full2/index.html>
- [4] HA terminal adopter (in Japanese)  
[http://denko.panasonic.biz/Ebox/full2/pdf/full2pdf/065\\_068.pdf](http://denko.panasonic.biz/Ebox/full2/pdf/full2pdf/065_068.pdf)
- [5] MEWTOCOL Specification  
[http://panasonic-denko.co.jp/ac/download/fasys/plc/plc/manual/mewtocol\\_spec\\_f11-1.pdf](http://panasonic-denko.co.jp/ac/download/fasys/plc/plc/manual/mewtocol_spec_f11-1.pdf)