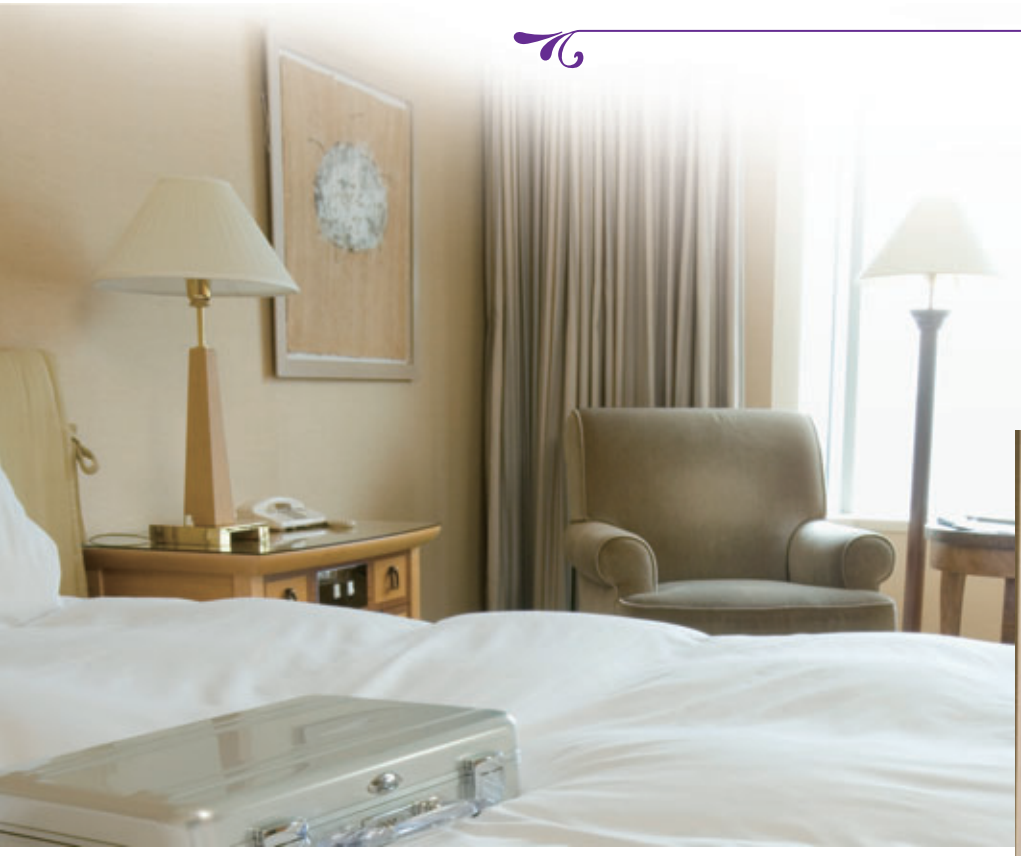
Energy Conservation for Hotels

Major points, measures, and successful cases of energy conservation for hotels



The Energy Conservation Center, Japan

Introduction

The first commitment period of Kyoto Protocol started in FY2008, which requires us to achieve a target of reducing greenhouse gas emissions to 6% below the base year (FY1990) levels by FY2012. Approximately 87% of the greenhouse gas is comprised of carbon dioxide (CO_2) from energy consumption. The CO_2 emissions have been significantly growing especially in civilian business sectors and enhancement of drastic measures has become an urgent need.

This brochure is intended for owners of hotels and persons in charge of energy conservation promotion or energy facility management, explaining the points, measures and the case examples of energy conservation. We hope that you will find the information taking account of characteristics in energy consumption particularly seen in hotel operations helpful for your activities toward better energy conservation practices.

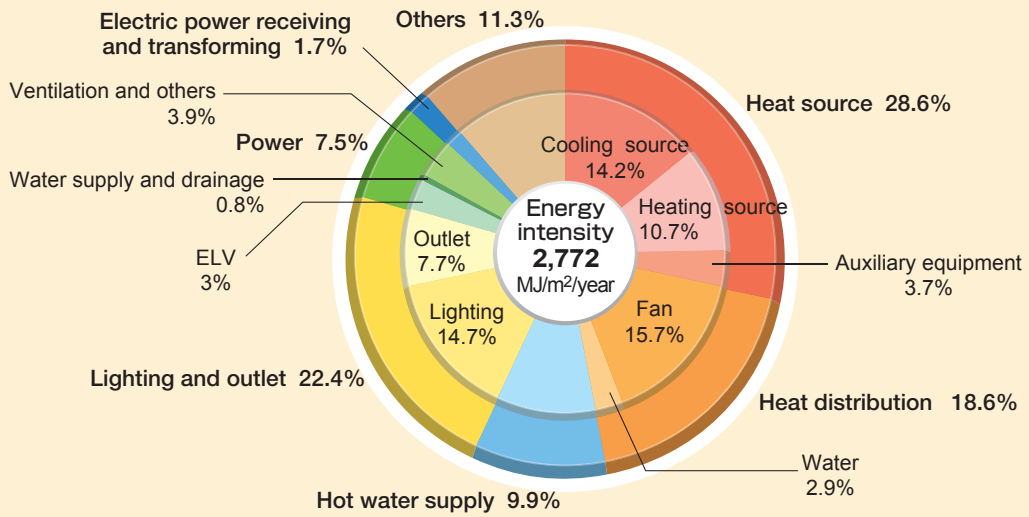
Table of Contents

1 Characteristics of Energy Consumption at Hotels

1.1 Energy consumption for different purposes of use and annual and hourly energy consumption patterns of hotels

The following pie chart shows the results from an analysis and estimation on energy consumption structure of a hotel with a total floor area of 70,000 m² (heat source is DHC District Heating and Cooling). It illustrates that hot water supply and lighting occupy a big ratio.
The graphs below shows the annual/hourly energy consumption of major energy used in the hotel. The hot water supply has two peaks around 22:00 and in the morning.

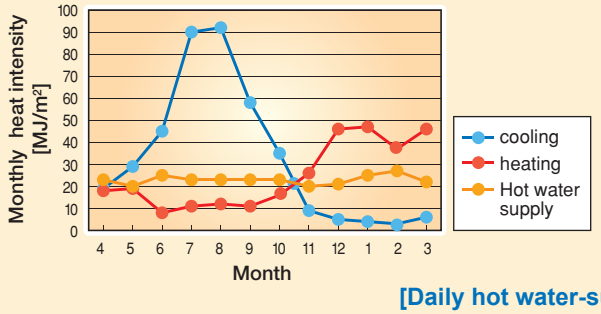
Energy consumption structure of a hotel



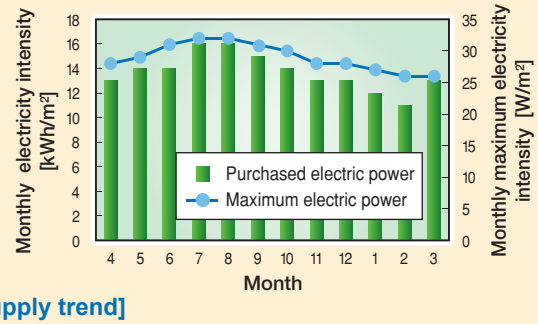
In the above data, conversion of the heat quantity from the local energy supply system is based on 1GJ/GJ.

Major energy consumption trends

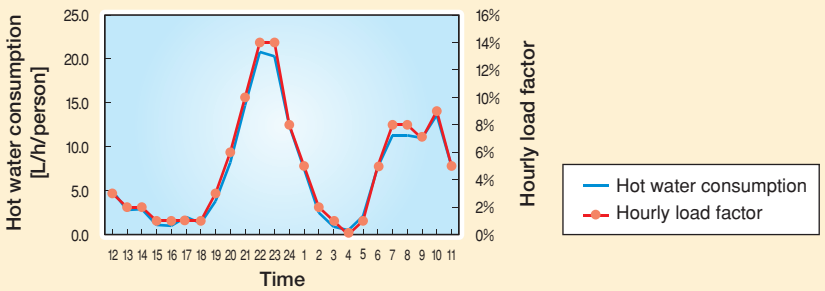
[Annual heating load trend]



[Annual electricity consumption trend]



[Daily hot water-supply trend]

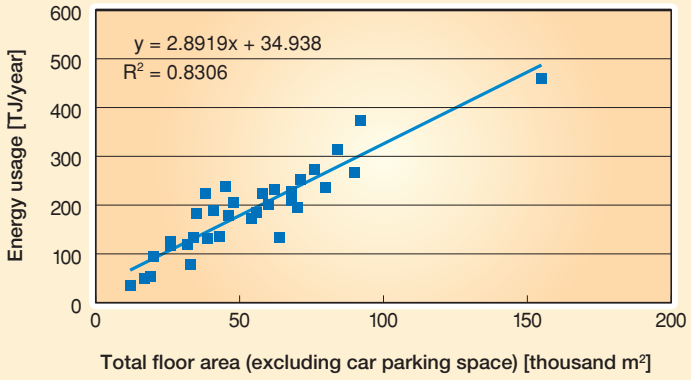


1.2 Relationship between energy/water consumptions and size of hotels

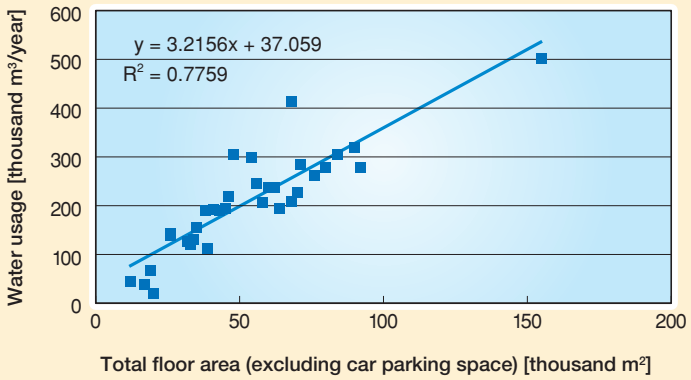
Hotels' energy consumption is characterized by a large amount of water use as well as energy and water usage proportionate to the size of the hotel facilities.

Findings from analysis related to energy usage of hotels

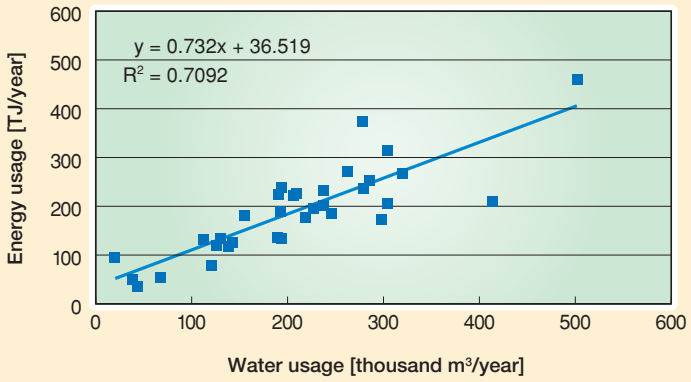
[Size of hotel and energy usage]



[Size of hotel and water usage]



[Energy and water usage]



The above graphs were prepared based on the data from studies on 33 hotels across the country in FY2003. The investigated hotels had floor area (a total floor area excluding car parking space) between 12,000 and 155,000 m² and a total number of guest rooms between 100 and 1,600.

1.3 Department structure and characteristics of hotels

General characteristics of departments of typical hotels are shown in the table below.

Guest room service department

(1) The department generally has the largest energy consumption although its energy intensity is relatively small.

(2) It also has the largest usage of water and hot water. The usage grows especially in winter when outside air temperature goes lower.

Banquet service department

The department has large energy intensity.

Food and drink service department

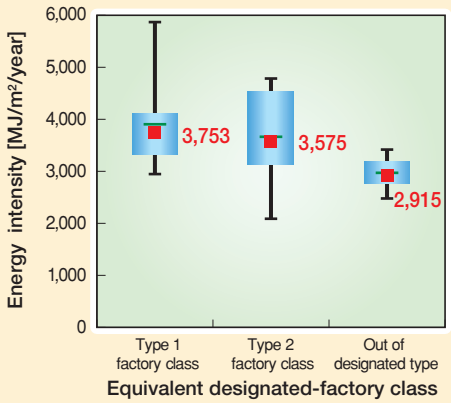
The department has large energy intensity.

Sections	City hotel	Resort hotel	Economy hotel	Period of time in use	Floor space	Energy intensity
Public space (entrance hall, lobby, coffee shop, restrooms)	○	○	○	0～24	Medium	Small
Guest rooms (including bathroom and lavatory)	○	○	○	15～10	Large	Medium
Banquet halls/exhibition halls (small to large spaces, including meeting rooms and ballroom)	○	○	○	10～22	Large	Large
Marriage ceremonial hall	○	○		10～22	Small	Large
Recreation hall (game arcade, table tennis room, etc.)		○		10～22	Small	Large
Bathhouse and sauna		○		0～24	Medium	Large
Shops and eating and drinking lacing braid	○	○		10～20	Medium	Large
Entertainment facilities (bars, restaurants, Karaoke, etc.)	○	○		10～22	Small	Large
Hair salon, esthetic salon, refreshment zone	○	○		10～20	Small	Large
Athletic	○	○		10～22	Small	Large
Swimming pool	○	○		0～24	Medium	Large
Back-office	○	○	○	7～23	Small	Medium
Indoor car parking space	○	○	○	0～24	Large	Small
Common space (corridor, stairs, elevator hall, etc.)	○	○	○	0～24	Large	Small
Utility/service area (machine room, electric room, elevator machine room, etc.)	○	○	○	0～24	Medium	Small

1.4 Energy intensity for different hotel sizes, heat source systems, and composition ratios of department

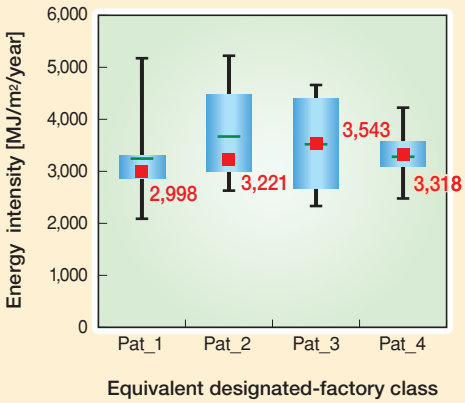
The following graphs show primary energy intensity of 41 hotels in urban areas categorized by their scale, heat source system, and composition ratio of department. They shows that the energy intensity is smaller as either floor area for guest room service department is in smaller proportion or the area for banquet service and food and drink departments is in larger proportion. Another tendency seen here is that the larger hotel has the larger energy intensity.

Energy intensity per scale of hotel



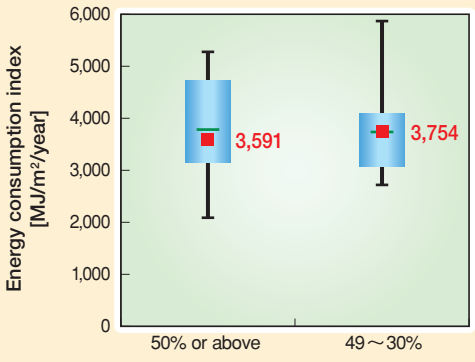
* Criteria for the designated factory classes: classified based on the following annual electric usage
Type 1 factory class: 12,000 MWh or above
Type 2 factory class: between 6,000 and 12,000 MWh
Out of designated type: less than 6,000 MWh

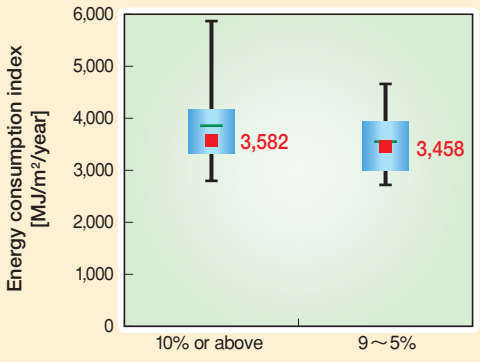
Energy intensity per heat source system

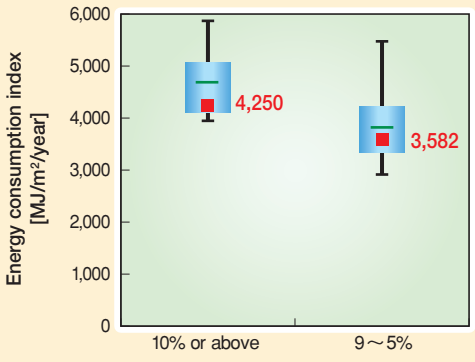


* Types (patterns) of heat source system:
Pat_1: DHC Pat_2: Centrifugal (turbo) chiller
Pat_3: Absorption type cool and warm water generator
Pat_4: Absorption chiller

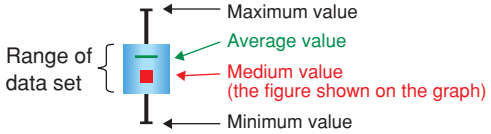
Energy intensity per composition ratio of department







Interpretation of the box-shaped graphs



The floor space used for calculation of energy intensity is excluding car parking space.
Size of subject hotels:
Floor space: between 10,000 and 155,000 m²
Number of guest rooms: between 100 and 1,700
(Source: FY2003 study)

2 Major Points of Energy Conservation for Hotels

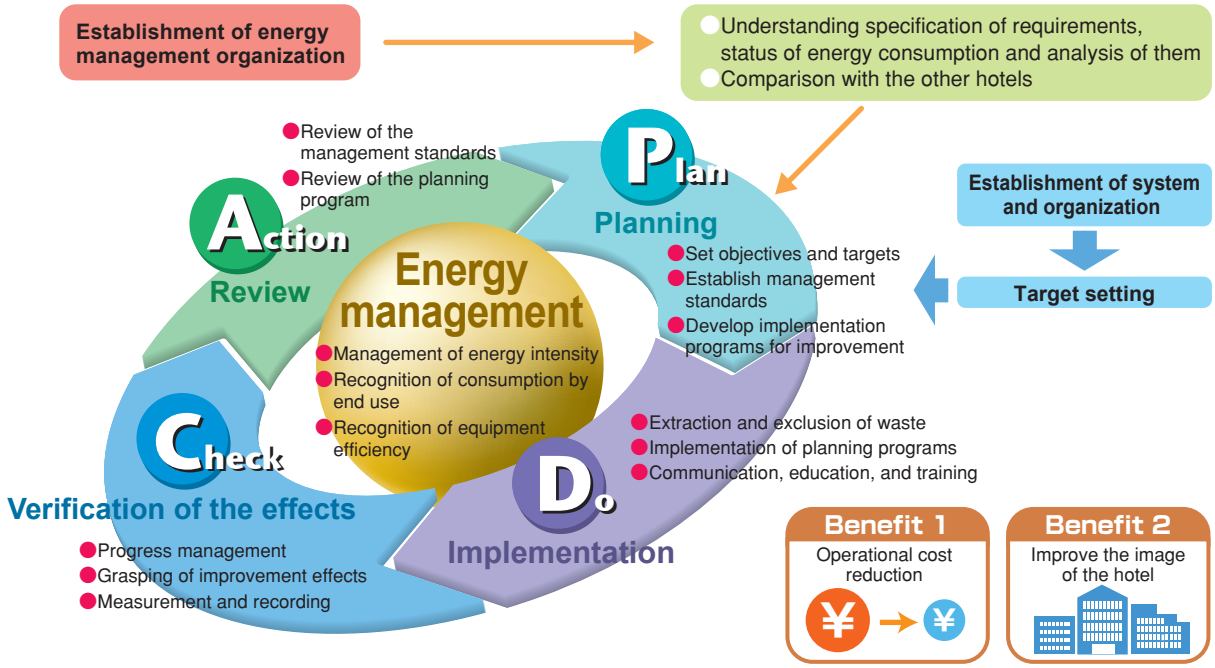
It is recommended that you promote your energy conservation activities utilizing a PDCA cycle as shown below.

Establishment of management standards

A management standard is an instruction manual for carrying out a PDCA (Plan, Do, Check, and Action) cycle for energy conservation activities. Following the manual, clear standardization (including conversion into numerical values) of major points of energy conservation program (Plan), implementation of the improvement plan (Do), and verification of its effectiveness based on measurement results (Check) should be carried out, followed by regular inspections and maintenance to keep the conditions. To gain better energy conservation effect, a periodical review on the management standard should also be performed (Action).

An example is an establishment of some rules in a manual, such as temperature setting rule defining that outdoor air-conditioning units for guest rooms should be set at 20℃ in heating mode during winter, at 26℃ in cooling mode during summer, and between the two seasons be set at in fan mode . In the Act on the Rational Use of Energy (Energy Conservation Act), establishment of a management standard is required for the purpose of more rationalization of energy use.

Start your energy conservation control with implementation of PDCA cycle promotion



◆Energy conservation activities promoted by a hotel, following a management standard similar to the one described above

There is an exemplary case of a resort hotel that achieved remarkable energy-saving by firstly listing up all lighting fixtures and air-conditioning equipment (packaged air conditioner) all over the hotel and identifying every location of their switches, and then established specific rules on who should operate them, when to operated them, and how long they should be used. Launched in 2005, the project saved electricity consumption by 15% in 2005 and 30% in 2007 against 2004 (before the energy conservation program was launched).

In this case, the project plan was reviewed and modified by the group of employees mainly from the sections which actually manage and control the fixtures and equipment in order to establish feasible and sustainable rules that would be able to obtain high degree of understanding and effectiveness.

The above case was presented at Shikoku regional competition for 2008 National Competition of Successful Case of Energy Conservation in Factory & Building. For more details, please refer to the report (http://www.eccj.or.jp/succase/08/c/pdf/skk06.pdf).

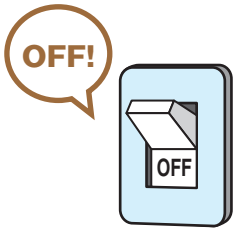
Energy conservation activities be carried out by employees in various departments other than Type 1 energy manager

Turning off lights and air-conditioning in the rooms not in use

The first step of energy conservation activities is elimination of waste. Being aware of importance of making thorough efforts to small matters will result in great energy conservation.

Energy conservation during guest room cleaning

In guest rooms, even when indoor air-conditioning units (fan coils and others) are turned off, outdoor air-conditioning units are still working. Therefore, turning off the fan coils during room cleaning would not cause poor work environment. Try to open curtains whenever possible to let sunlight in the rooms during the cleaning work, so that a lamp should be lit only in a dark place, such as a bathroom. It is an important point of energy conservation for a section in charge of the cleaning work takes initiatives in documenting these practices in a manual.

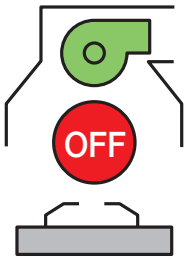


Lighting control in banquet halls

Lights in banquet halls are categorized into two: those for general lighting to keep enough illuminance in the rooms, and those for directive illumination such as chandeliers. The latter consume larger electricity than the former. An important energy conservation point in this area is to try to use only general lighting during preparation and clean-up period and turn off the directive one during such period. This practice has already been implemented in a large number of hotels.

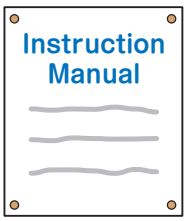
Ventilation fan control in kitchen area

Air-intake and exhaust fans in a kitchen area are generally operated by cooking staff. The fan operation gives a great impact on energy conservation, and it is often seen that the conditioned air in a dining area is also discharged when the exhaust fans are operated in the kitchen. The point of energy conservation here is to make the fan operation time as short as possible. Closing an inlet for fresh air would cause a bad influence on indoor air quality of other rooms.



Documentation of departmental procedures in a manual

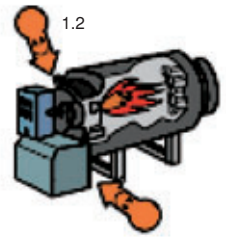
Each of the guest room service, banquet service, and food and drink departments should prepare documented energy conservation manual and post it where employees can easily see, such as a wall of a staff room. It is important to develop an environment where employees can take an approach toward further energy conservation having common perception among them.



Energy conservation activities to be carried out by Type 1 energy managers

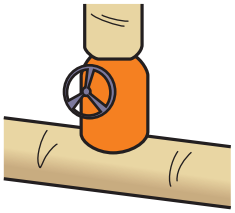
Rationalization of combustion

Since hotels consume a great amount of steam and hot water for the purpose of hot water supply and air-conditioning, most of them use boilers. The Act on the Rational Use of Energy (Energy Conservation Act) sets out a standard air ratio (between 1.2 and 1.3) for rationalization of combustion. This standard can be achieved by making an adjustment to the boiler setting during its periodical inspection (usually twice a year). This is an energy conservation measure without any expense.



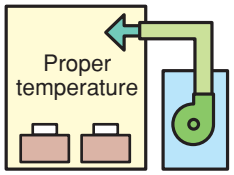
Prevention of steam heat loss

It is said that approximately 20% of produced steam is lost. As one of the measures against it, maintenance and inspection of steam trap are effective to prevent the loss. In other words, it is important to keep traps normal condition which tends to have a problem. The second effective measure is insulation of steam valves and flanges. Leaving them without insulation would naturally cause heat loss. As a measure against to the problem, appropriate insulation on valves, etc enables you to achieve large amount of energy conservation effect.



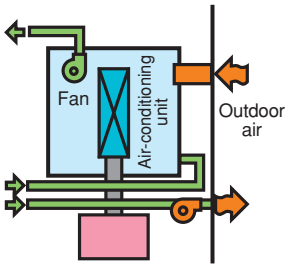
Temperature setting of outside air-conditioning unit for guest rooms

Outdoor air-conditioning units for guest rooms are operated for 24 hours a day in a majority of hotels. Energy consumption in guest room service department is largely depending on the unit's operation hours and process temperature (heat or cool outside air) setting. The temperature should be set appropriately, considering the temperature of outdoor air.



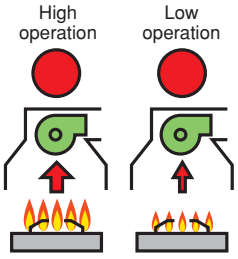
Air-conditioning control for banquet halls

Banquet halls are used any time of the day for various purposes including wedding, meeting, and conference. In the hotels located in urban areas, the cooling is required throughout the year. Considering this situation, outside air cooling is applied during winter, intermediate season for energy conservation. From the standpoint of securing various and variable indoor air quality conditions, a large number of hotels have adopted a 4-pipe air-conditioning system in which both cooling and heating are available throughout the year (in other words, a system which allows use of both chilled and hot water simultaneously and selection of cooling or heating at any time). However, this system could generate a large amount of loss, depending on operation method or temperature setting. A typical example of the loss is called "mixing loss" which is seen in a case where heating and cooling are operated simultaneously in the same system. An effective measure to solve the problem (an important energy conservation point) is proper temperature setting depending on the situation and maintenance and inspection of automatic control system.



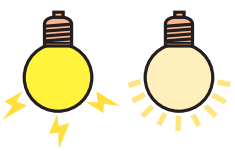
Balance of air-intake and exhaust in kitchen area

In a kitchen, it is ideal to keep the inside air pressure slightly negative in order to prevent the odor leaking from kitchen to outside. However, the air pressure is in fact strongly negative in many cases, and it is sometimes observed that the conditioned air in a dining area is also being discharged. In the worst case, the entire hotel has negative air pressure, leading to a situation that outdoor air is blown into the building from an entrance. An important energy conservation point in this area is to avoid operating exhaust fan more than actually needed so that air-intake and exhaust in a kitchen is regularly balanced under ideal conditions. In order to allow the system to make an improved operation for more energy conservation, it is ideal to install an air-intake/exhaust fan for individual cooking equipment when any modification is made to the kitchen facilities.



Changing incandescent lamps to fluorescent type

Since hotel business is under 24-hour-per-day operation, lights in common use area are turned on for a long period of time. Considering the situation, replacing incandescent lamps currently used for lighting fixtures with fluorescent type in such area, especially in a lobby, elevator halls on guest room floors, and hallways where the lights are always on, would lead to a considerable energy conservation effect. In addition, the investment for the change is collected in a short term.



3 Check List for Hotels' Energy Conservation

☆ means the measure is applicable to small hotel facilities

			Energy conservation effect	Checkbox
1. Energy management	Establishment of energy management organization, and employee education	☆	○	□YES
	Energy conservation targets, and investment budget setting	☆	○	□YES
	Grasp status of implementation of energy conservation	☆	○	□YES
	Measurements and recording of monthly usage (electricity, gas, oil, and water)	☆	○	□YES
	Preparation of statistics, including graphs showing differences from previous month or year	☆	○	□YES
	Grasp of energy intensity (MJ/m²/year)		○	□YES
	Establishment of management standards		○	□YES
2. Heat source and heat-conveying equipment	Temperature control for chilled water, cooling water, and hot water	☆	○	□YES
	Adjustment of the flow rate and pressure of pumps and fans	☆	○	□YES
	Steam leakage and insulation management	☆	○	□YES
	Management of air ratio and exhaust gas of combustion equipment		◎	□YES
	Control of steam pressure and blow-down		△	□YES
	Cooling water quality control (electrical conductivity)		△	□YES
	Control of opening of valves and dampers (e.g. automatic valves)		△	□YES
3. Air-conditioning and ventilation equipment	Proper temperature setting	☆	○	□YES
	Turning off air-conditioning for rooms not in use or unoccupied	☆	○	□YES
	Adjustment of appropriate outside air intake volume	☆	○	□YES
	Review of operating hours	☆	○	□YES
	Effective operation of total heat exchanger (e.g. Rosunai)	☆	○	□YES
	Local cooling and local exhaust	☆	○	□YES
	Indoor air quality control (e.g. CO_2)		○	□YES
	Installation of (manual or automatic) inverter device to ventilation fans		◎	□YES
	Suspending either of the operation of a 4-pipe air conditioning system, if used		○	□YES
	Control of ventilation in car parking space (CO concentration control)		○	□YES
4. Water supply/drainage and sanitation equipment	Control of supplied water flow and pressure	☆	△	□YES
	Water saving measures (e.g. water-saving top and automatic flashing)	☆	○	□YES
	Change temperature and pressure setting on the heat source equipment depending on the season	☆	○	□YES
	Operation with intervals in hot water supply circulation pump	☆	△	□YES
	Utilization of rain water and well water	☆	△	□YES
	Management of kitchen equipment (e.g. cooking and washing machines)	☆	△	□YES
5. Management of electric power receiving and transforming facilities	Optimization of demand	☆	○	□YES
	Usage control	☆	△	□YES
	Voltage adjustments		△	□YES
	Power factor management		△	□YES
6. Operation management of lighting equipment	Optimum illumination control	☆	○	□YES
	Switching off lights when they are not necessary (use of daylight)	☆	◎	□YES
	Cleaning of lighting fixtures and change to more energy-saving fixtures	☆	◎	□YES
	Replace incandescent lamps to fluorescent lamps	☆	◎	□YES
	Adoption of energy-saving FFE (furniture, fixture, and equipment)	☆	△	□YES
7. Operation management of elevating machines	Operation		○	□YES
	Adoption of inverter control		○	□YES
	Adoption of human motion sensors to escalator		○	□YES
8. Buildings	Blocking of sola radiation on the windows (e.g. shading curtains and light-shielding films)	☆	○	□YES
	Blocking of sola radiation on the roof (heat reflection coating)	☆	○	□YES
9. Others	Maintain the place around the condensing units for air-conditioning and chillers	☆	○	□YES
	Utilization of heat from hot spring	☆	◎	□YES
	Installation of boilers using waste materials as fuel	☆	◎	□YES
	Utilization of solar heat	☆	△	□YES
	Wind, solar, and small hydro power generation		○	□YES
	Use late-night electricity		○	□YES
	Co-generation		◎	□YES

"Operating Procedures for Energy-Conservation Projects in Hotel Business" - energy conservation effect was added in March 2008

Energy conservation effect (rough indicator for the level of effectiveness)

◎: Large ○: Medium △: Small

The level of the impact is very rough. It's depending on some factors such as characteristics of installations of the facility.

4 Successful Cases of Energy Conservation Measures of Hotels

4.1 Successful case of energy conservation measures of a hotel

Covering windows with light-shielding materials (e.g. curtains and films), replacing down light bulbs, restricting outdoor air intake to banquet hall, and other measures

Location: Fukuoka prefecture
Size: 138,000 m² floor area, B2F to 36F
Heat source: DHC (District Heating and Cooling), (chilled and hot water), flue and smoke tube boilers (5t x 2)

An example of a hotel which planned and implemented effective measures developed from complaints and problems and taking energy conservation into account

Covering outside window with light-shielding curtain, film, and board

Since restaurants and wedding halls were fitted with glass in order to secure outside views for the guests, excessive air cooling was required to control elevated temperature due to sunlight into the rooms between spring and early autumn.
To minimize energy consumption on air-conditioning, light-shielding curtains were hung in an atrium to block the solar radiation heat, and light-shielding films were attached to the windows of a chapel, restaurants and wedding hall. Plastic cardboards were attached to windows facing a backyard for further heat insulation.

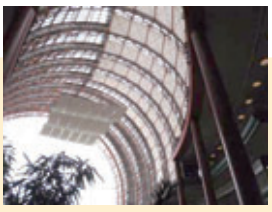
Changing down light bulbs

The halogen bulbs were main stream when the hotel was completed. However, halogen bulbs consume a great deal of electricity and generate a large cooling load. To reduce the energy consumption for lighting, the halogen bulbs with E17 or E26 base were replaced with bulb-type fluorescent lights by janitors wherever possible and those with E11 base or pin-type lights were replaced with fluorescent lamp fixtures or LED fixtures.

Restricting outside air intake for banquet hall

The air-conditioning unit for a large banquet hall was equipped with a all heat exchanger and outside air was not controlled during preparation for banquet service or when the unit was idling. In order to mitigate the wasteful operation, a damper was installed at its outside-air inlet, and stopped outside air intake during preparation for banquet service.

Other measures taken by the hotel include: pump system modification by installing an inverter-control device to a pump for a fish tank in a Japanese cuisine restaurant for fresh fish preservation; modification of aircraft warning lights; review on inverter setting of cooling water pumps for refrigerators; and replacement of traps, control valves, and gate valves of steam pipes. After taking all these measures, energy consumption in the entire building was reduced by 5% against the previous year.

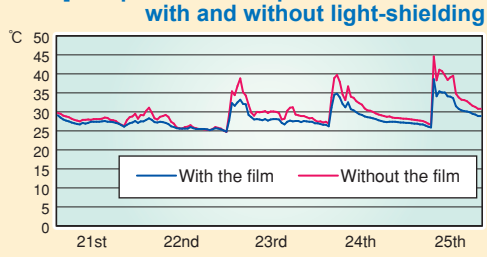


Hung light-shielding curtains

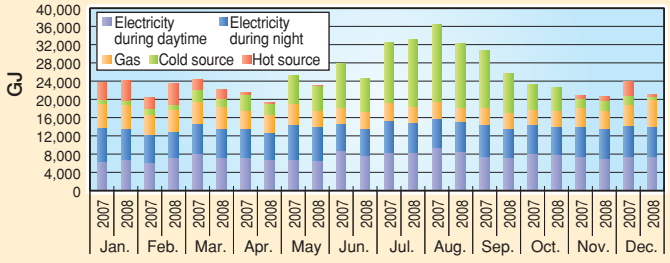
Light-shielding films on the windows

Light-shielding board attached to the windows

[Comparison of temperature in front of the windows with and without light-shielding film]



[Comparison of monthly energy consumptions between 2007 and 2008]



The above case was included in the report of energy conservation project presented at Kyushu regional competition for 2008 National Competition of Successful Case of Energy Conservation in Factory & Building. For more details including effectiveness of each measure (incl. estimation), please refer to the report (http://www.eccj.or.jp/succase/08/c/pdf/ksu13.pdf).

4.2 Successful case of energy conservation measures of a hotel

Changing outlet temperature setting of chilled water from absorption chiller

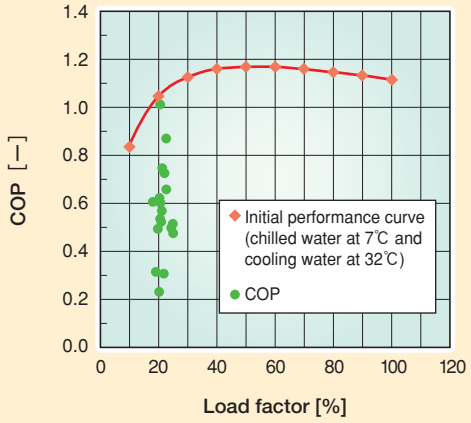
Location: Tokyo
Size: 74,000 m², B3F to 15F
Heat source: steam heating type absorption chiller, flue and smoke tube boiler

Efficiency of the chiller (COP) was improved by raising the outlet temperature setting of chilled water from the chiller, from 9℃ to 11℃, during spring and autumn when climate is moderate.

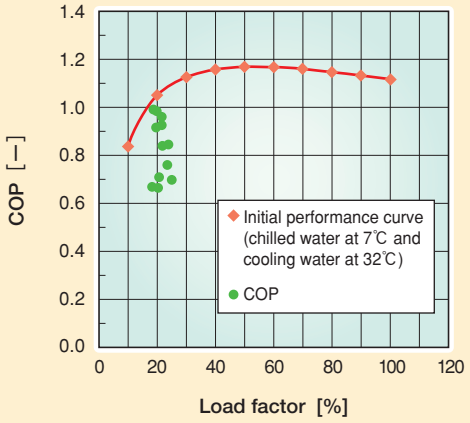
Measurement results

[Load factor and COP of the chiller]

Measurement: every five minute
Load factor and input ratio: hourly average data
* The extracted data includes only the ones of which cooling water temperature at inlet of the chiller is between 21 and 22℃.



Chilled water temperature at outlet: 9°C
Average load factor: 21.4%
Average COP: 0.49



Chilled water temperature at outlet: 11°C
Average load factor: 17.1%
Average COP: 0.83

When the outlet temperature was 11°C, the chiller was operated with higher COP

From the findings of the study, it is assumed that the higher effectiveness was achieved as a result of not only the reduced steam consumption by the raised outlet temperature of chilled water from the chiller, but also, even more importantly, mitigated impact from the degraded performance of the chiller.
Measurements of temperature of air supplied form all outside air-conditioning units in the system have found no change in terms of the system control. This result demonstrates that the modification has made no impact to indoor air quality.
The measurements were made under the conditions that the chiller was operated with low load (ON/OFF operation mode). In addition, temperature of cooling water was fluctuated in an ejector cooling tower, and therefore, the verification was made on the results with relatively small number of samples. Since the ejector cooling tower is not capable of controlling cooling water temperature by turning its fan on and off, it could cause largely varied cooling water temperatures depending on outside wet-bulb temperature.

The above case was presented in the third Energy Conservation Seminar for Buildings for Business Use held in 2007.

4.3 Successful case of energy conservation measures of a hotel

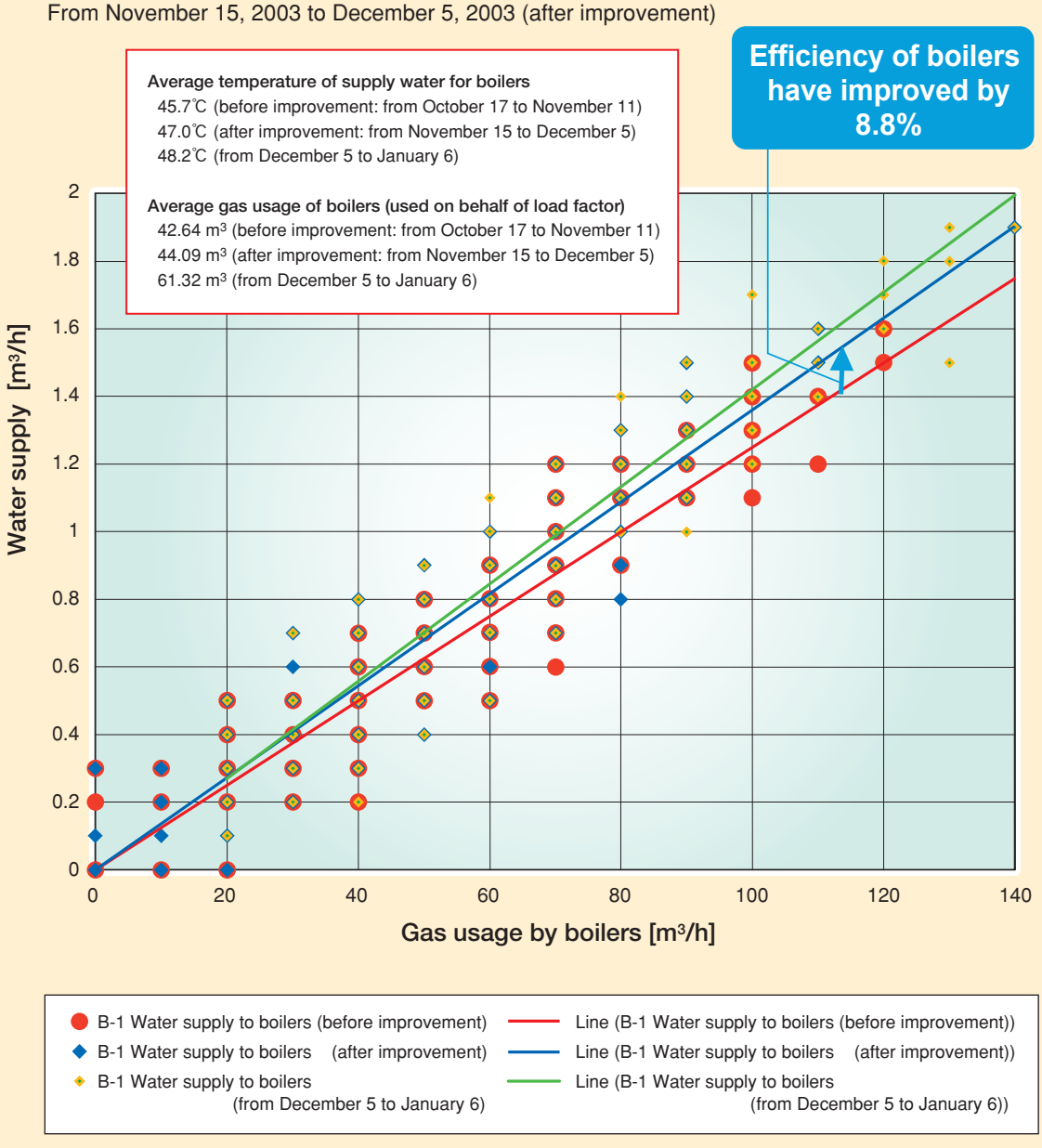
Improvement to proper air ratio of boiler combustion

Location: Chugoku region
Size: 35,000 m², B2F to 21F
Heat source: flue and smoke tube boiler, CGS, centrifugal (turbo) chiller

Average air ratio of two flue and smoke tube boilers were modified form 2.3 to 1.3

Boiler No. 1 - Correlation between gas usage and water supply

From October 17, 2003 to November 11, 2003 (before improvement)
From November 15, 2003 to December 5, 2003 (after improvement)



The above case was presented at the first Energy Conservation Seminar for Buildings for Business Use held in FY2006.

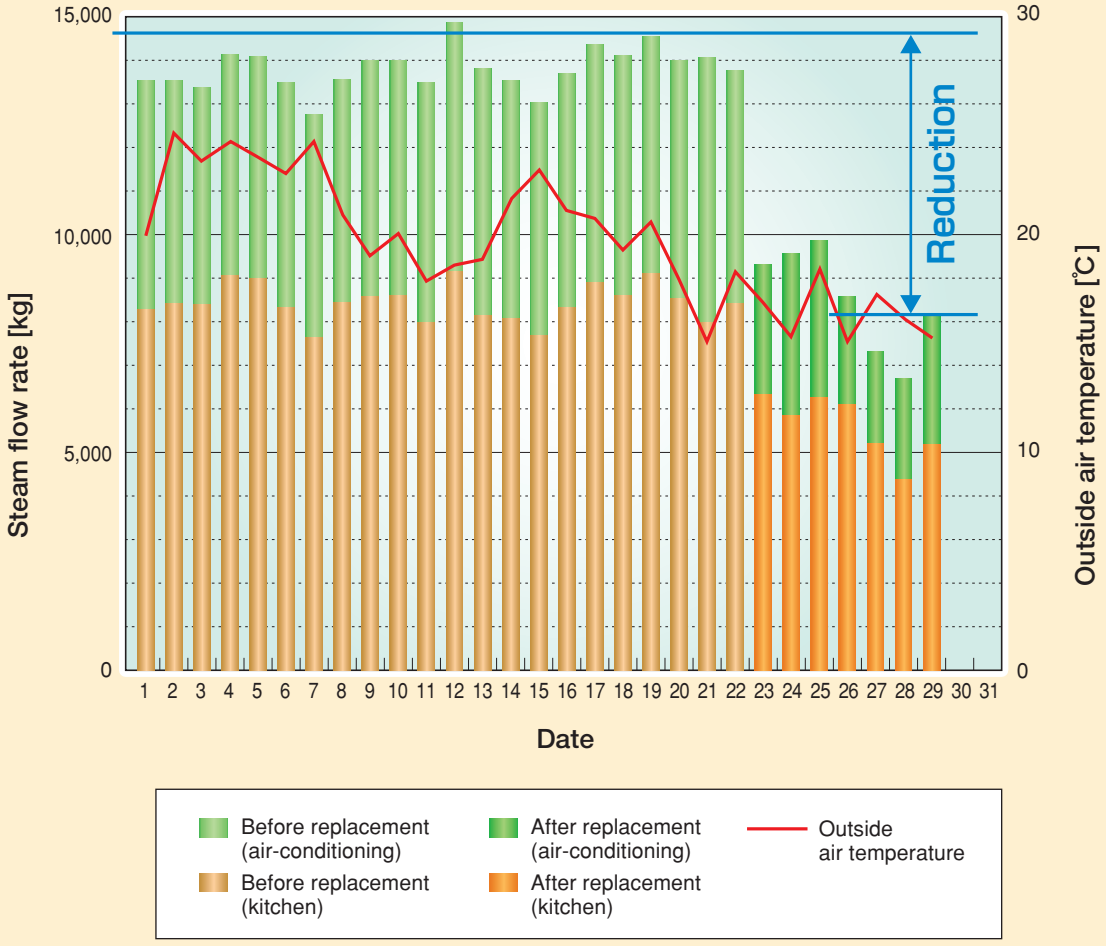
4.4 Successful case of energy conservation measures of a hotel

Avoided loss during steam heat transfer

Location: metropolitan area
Size: 98,000 m², B3F to 37F
Heat source: DHC (District Heating and Cooling), (steam and chilled water)

Even though it was during summer, steam usage was increased compared with previous year. In order to solve the problem, an investigation was made for steam leakage caused by degradation or damage of traps and their bypass valves in the systems for air-conditioning units and kitchen facilities. The degraded traps and valves were replaced with new ones.

Term: October 2002



Upon completion of the replacement of traps and other parts for air-conditioning and kitchen systems, steam usage dropped significantly. The repair of the systems successfully reduced the amount of steam received from DHC approximately 6,000 kilograms per day and 2,190 tons per year.

This case was presented at the first Energy Conservation Seminar for Buildings for Business Use held in FY2006.

5 Effective Tools and Techniques for Promoting Energy Conservation by Improved Operation

ECCJ provides tools and techniques for further energy conservation useful for improving operations of large-scale buildings for business use without charge.
The three tools and techniques are:

(1) ESUM: **E**nergy **S**pecific **U**nit **M**anagement Tool
ESUM is computer software which estimates energy consumptions of a building and compares the consumptions before and after implementing an energy conservation measure to demonstrate the energy reduction effect.

(2) TuBE: **Tu**ning of **B**uilding Systems for **E**nergy Conservation
TuBE is a document which defines how to select and carry out operational improvement actions among various energy conservation measures.

(3) EAST: **E**nergy **A**nalysis **S**upport **T**ool
EAST is computer software which compiles operation process data of air-conditioning units and heat source equipment and make a graphic presentation of the trends to help you analyze their operation conditions.

Combined use of the above three tools helps your making smoother energy conservation activities throughout the necessary steps for the activities; analysis on operation status and conditions, selection of improvement method, estimation of its effectiveness, and implementation of the measure.

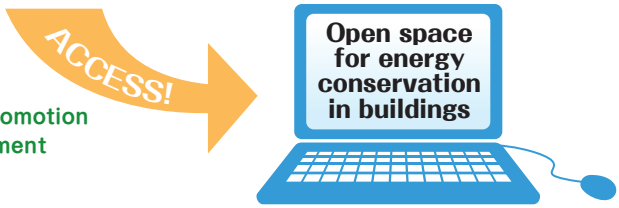
How to obtain more detailed information on energy conservation of buildings for business use

ECCJ has a website to provide various kind of information on energy conservation of buildings.

The site includes:
- inputs from actual users of tools (e.g. ESUM and EAST) useful for enhancing your energy conservation activities for buildings;
- various forums for different types of facilities (e.g. office buildings, commercial facilities, hotels, and hospitals), which serve as an information exchange forum among members; and
- invitations to seminars and lecture classes which provides information on successful cases of improved energy conservation of buildings for business use and examples of effective use of various tools as well as materials for those seminars and lectures

URL **http://eccj06.eccj.or.jp/bldg/index.php**

Owners of buildings for business use
Persons in charge of energy conservation promotion
Persons in charge of energy facility management
Energy conservation business operators



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This is translated from the original Japanese document.
For precise information and nuances, please refer to the original.