

Energy Conservation of Commercial Facilities

(Department Stores, General Merchandise Stores, and Shopping Centers)

Major points, measures, and successful cases of energy
conservation of commercial facilities



The Energy Conservation Center, Japan

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Energy Conservation Measures for Different Departments of Commercial Facilities

The following are energy conservation measures for different departments, which are helpful for you to promote your energy conservation initiative.

Commodity Sales department

This department has the largest share of floor area in a facility. In a department store, the commodity sales section on the first floor has particularly high lighting illuminance and a wide use of incandescent lamps, leading to significantly large electric power consumption for lighting. Another issue is that outdoor-air blowing into the building from entrances on the first floor puts a significant burden on its air-conditioning load.

Important points for the measures

Adopt air-break room at door way.
Improved arrangement of lighting equipments with effective impact should be made so that the number of incandescent lamps can be reduced. Utilization of daylight for lighting purpose around entrances and near windows should also be considered.
Energy-saving lighting equipments with inverter device should be installed.
Excess air cooling or heating should be avoided.
Outside air cooling should be implemented during winter and intermediate seasons.
Proper amount of outside air intake should be taken in to the building in proportion to the number of occupant, with CO₂ concentration level control during air-conditioning.

Administrative department

A majority of energy consumption in office is air-conditioning, lighting, and outlets. Unlike sales floor, where entirely turning lights on and off as scheduled is an effective measure, lighting equipments in administrative department are usually controlled separately using a switch on the wall. A company cafeteria has an energy consumption structure similar to food and drink service department.

Important points for the measures

Since offices and the back yards have different operating hours for different purposes, an individual air-conditioning should be adopted.
Lighting area should be divided into smaller partitions to turn off lights wherever unnecessary.
Temperature setting for air-conditioning should be at 20 during winter and 28 during summer.
Lighting equipments should be replaced to inverter type.
Daylight should be utilized for lighting in the office. A motion sensor device should be installed to turn on/off lights for such as locker rooms, etc.

Car parking space

Department stores often have a basement parking area, a mechanical parking lot and a three-dimensional parking lot, and a majority of large shopping centers has outdoor parking lot or outdoor parking with semi-open walls. A shopping centers with station buildings typically do not have their own car parking space and often share a public parking space with other facilities.
The major energy consumption of car parking space is for ventilation and lighting, and it has fairly smaller energy density than other departments.

Important points for the measures

In addition to securing minimum necessary lighting level, the lighting area should be divided into smaller partitions to allow strict control based the number of cars parked in the area.
A CO sensor device should be installed to control ventilation system based on the standard CO level.
Alert drivers to encourage to stop idling practice.
Some improvements which could make driving speed slower should be added in the drive ways in order to reduce exhaust gas emissions.

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Energy Conservation Measures for Different Installations and Equipment at Commercial Facilities

The following are energy conservation measures for the equipments (machines, lights, etc.) installed at commercial facilities.

1. Energy conservation measures for heat source equipment

Required capacity of equipment, such as boilers, chillers, chilled/hot water generators, should be divided into several units.

Thermal insulation of bodies of boilers, steam headers, and valves should be enhanced.

Replacement of centrifugal (turbo) chillers using specified CFCs with the ones using CFC alternatives should be considered, striving for improved coefficient of performance (COP) and reduced environmental impact.

Inspections and preventive measures should be taken to see outdoor condensing units for short-circuited.

2. Energy conservation measures for heat-conveying (fans, pumps, piping) equipment

Quantity control of equipment should be adopted.

VAV (variable air volume) system should be adopted.

VWV (variable water volume) system should be adopted.

Chilled-water conveyance system with large temperature difference should be implemented.

Inspection and improvement should be made on insulating performance of ducts, piping, and other parts.

An inverter device should be installed to chilled water pumps. And grasp the a total chilled water flow and set a proper frequency according to the required flow

Three-way valves of chilled water system in air handling unit (AHU) should be replaced with two-way valves so that amount of circulated chilled water is reduced and, thus, power for water conveyance is reduced accordingly.

In an establishment with a heat storage tank such as for chilled water storage, a semi-closed chilled water system with a plate-type heat exchangers and other devices should be adopted to reduce energy consumption of chilled water pumps.

3. Energy conservation measures for HVAC equipment

Total heat exchanger with outdoor air intake should be installed.

Optimized outdoor-air intake in accordance with indoor CO₂ concentration level should be achieved through some measures such as adoption of outsider cooling during winter and intermediate seasons.

A patterned outside air-intake control based on the number of customers in the building should be adopted to allow only minimum necessary amount of air is taken into the building.

Ventilation for parking space should be controlled by a CO sensor device.

Inverter device should be installed for further energy conserving operations.

An evaporation unit should be installed where their piping for coolant can be as short as possible and be arranged as straight as possible.

If there are any walls or obstacles near the outdoor condensing units, a proper space between them should be kept. Also the units should be installed where they would not be exposed to radiation heat from sunlight or other types of heat sources.

Anemostats and blind-shaped openings for air-conditioning or ventilation should be properly maintained so that outlets and inlets of rooms would not be blocked.

Wind direction control device of air outlet, if any, should be adjusted so that the cooled air is blown in horizontal direction and the warm air is blown to downward direction. Effective and efficient operations with such measure could eliminate temperature differences between the room air in upper and lower layers.

☞ Direct entry of outdoor heated (or cold) air into the store should be prevented by way of installing air-break room or air curtains at the doorway of the store.

☞ Improved heat insulation measures should be added to walls, roof, and glass windows of the building.

☞ Cleaning of ducts, inspection for leakage, and appropriate repair should be made regularly.

☞ Filters and coils of air-conditioning units should be cleaned frequently.

☞ Maintenance for clogged filter alarm (manometer) should be made properly.

☞ Heat exchangers should be cleaned regularly.

☞ When operation of air-conditioning units is stopped for a long period, such as during off-season, the main power switch should be turned "OFF".

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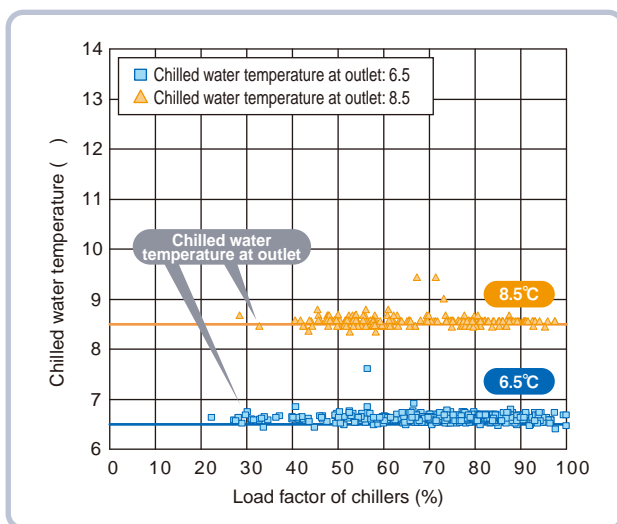
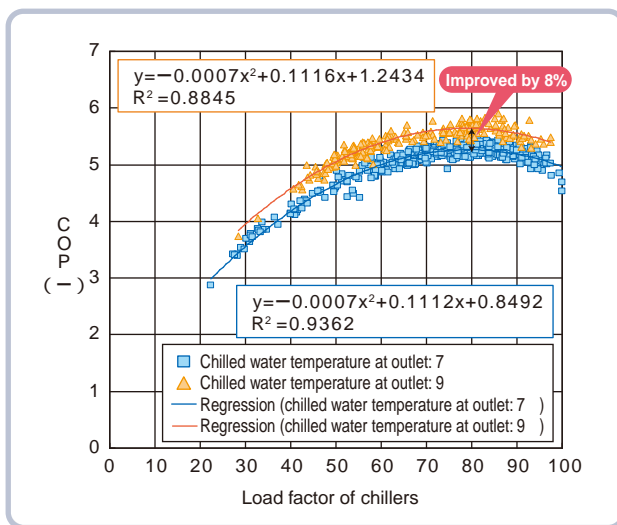
Successful Cases of Energy Conservation Measures of Commercial Facilities (3)

Successful energy conservation measure at department store - 3

Energy conservation was achieved by raising temperature setting, by 2 °C, for chilled water at an outlet of a centrifugal (turbo) chiller, which is heat source equipment for air-conditioning units, during winter and other seasons with moderate climate.

Conditions

- Energy consumption performance was compared before and after changing temperature setting for chilled water at an outlet of the centrifugal chiller from 6.5 to 8.5 °C. The following graph illustrates changes in COP of the chillers when load factor varied between 20 and 100% at 6.5 and 8.5 °C of temperature setting. Actual temperature range for the 6.5 °C setting was between 6.4 and 7.6 °C, and for the 8.5 °C setting was between 8.4 and 9.4 °C.



Results

- As shown in the upper-left graph, the change of the temperature setting of chilled water at an outlet from 6.5 to 8.5 °C has improved COP of the centrifugal chiller at 80% load from 5.27 to 5.69, demonstrating a 8% increase.
- During winter and other seasons with moderate climate, this measure could achieve reduction of power consumption by heat source equipment for cooling.
- Only the primary pump is used to send the chilled water, without requiring additional heat-conveying power.

Conditions for data selection

- Only the data which satisfied the following conditions were selected and used for the comparison.
- Cooling water temperature: between 25.7 and 26.3 °C
- Load factor of chiller: between 20 and 100%

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Successful Cases of Energy Conservation Measures of Commercial Facilities (1)

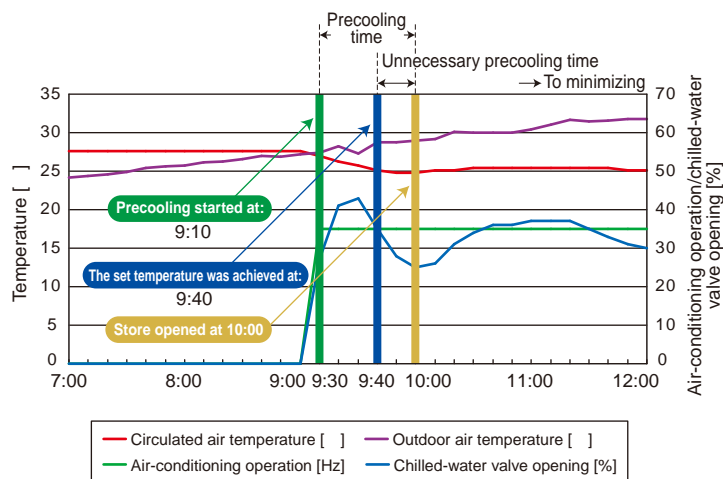
Successful energy conservation measure at department store - 1

A modification was made to have different time settings for starting air-conditioning units to precool or warm up the store before its opening at 10:00 am in different seasons. It was found that, during the seasons with moderate climate, the air-conditioning operation could be started 15 minutes later than during summer and winter, and therefore such delayed operation would require less energy consumption. Assuming that 26 units in the store are operated following the new rule, annual energy conservation for 6,672 kWh in electricity and 24,000 MJ of heat quantity (regional cooling) could be achieved.

◆ Calculation of electricity reduction

Electricity for air-conditioning equipment (26 units) $178\text{kW} \times 1/4\text{H (15 mins)} \times 5 \text{ months} \times 30 \text{ days} = 6,672\text{kWh}$

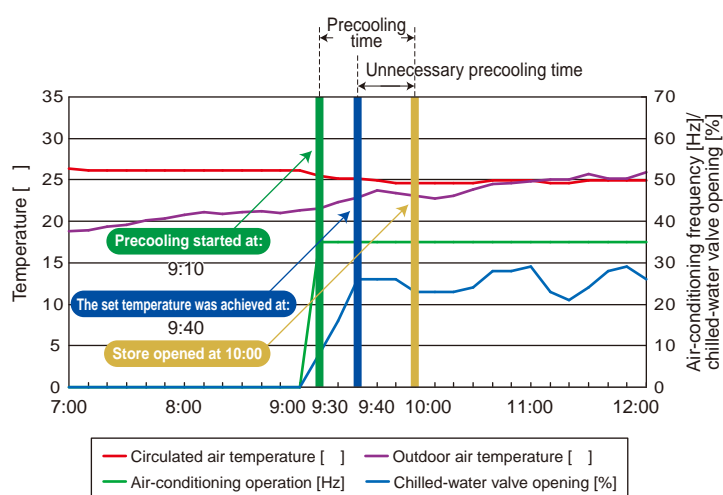
Data on air-conditioning operations on September 22, 2007



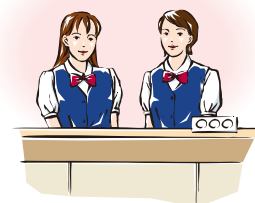
- On September 22, following the start of air-conditioning operation, temperature of circulated air was raised to the set temperature (25 °C) at 9:40.
- On October 12, the set temperature was achieved at 9:30, or 10 minutes earlier, although the air-conditioning operation started at the same time as September 22.
- In October, the set temperature can be achieved without any problem even though the start of air-conditioning operation is delayed by 10 minutes or longer compared to September.



Data on air-conditioning operations on October 12, 2007



- It was found out that the precooling time could be shortened for about 15 minutes during winter and other seasons with moderate climate.



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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:

ESUM: Energy Specific Unit Management 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.

TuBE: Tuning of Building Systems for Energy Conservation

TuBE is a document which defines how to select and carry out operational improvement actions among various energy conservation measures.

EAST: Energy Analysis Support Tool

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



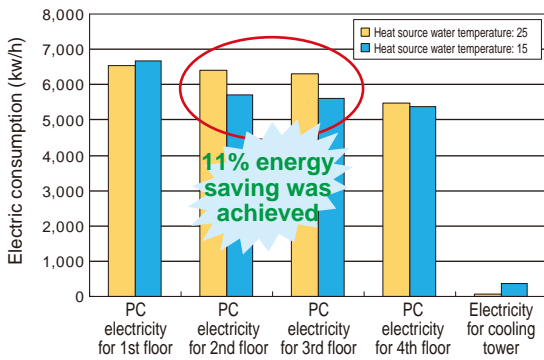
URL <http://eccj06.eccj.or.jp/bldg/index.php>

Successful Cases of Energy Conservation Measures of Commercial Facilities (2)

Successful energy conservation measure at department store - 2

(1) Heat source (for cooling) of individual water-cooling heat pump packages was operated and regulated to maintain its water temperature at or above 25 throughout the year. However, by lowering the temperature to 15, which is the minimum temperature guaranteed by its manufacturer, during winter and the following season with moderate climate (from November to April), an energy conservation was achieved.

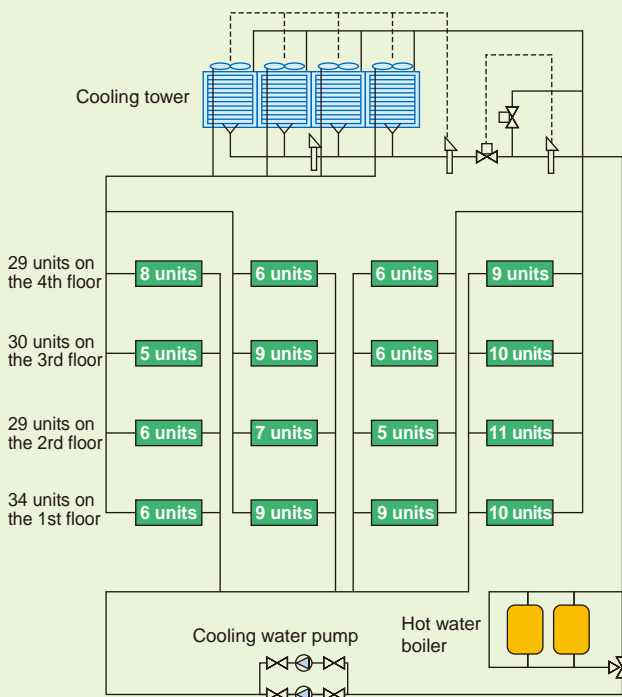
Impact by the changed temperature setting of heat source



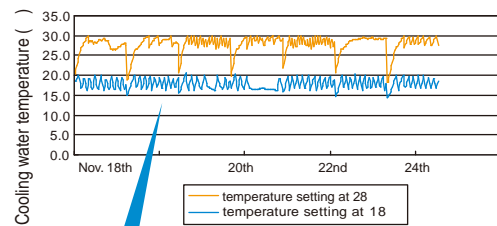
11% energy saving was achieved on the 2nd and 3rd floors. Only low impact was given on the 1st and 4th floors since heating and cooling were required on those floors.



System diagram of individual water-cooling heat pump package

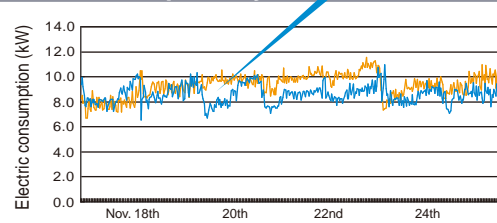


Cooling-water temperature (temperature settings from 28°C to 18°C)



11% energy saving can be achieved by lowering the temperature setting of heat source water by 10°C

Cooling water temperatures and electric consumption by individual PAC



*Note: Thermal load of the air-conditioning was considered to be the same due to the fact that difference in outdoor air temperatures before and after implementing the measure was within 1.

4. Energy conservation measures for lighting equipment

Measures such as adopting lighting control system, dividing lighting switches into smaller partitions, and turn off the area unnecessary and to reduce lighting hours before/after store hours. Installation of occupancy sensors in to the hallways of backyard and locker rooms should be considered. Daylight should be utilized for lighting. Lighting reflectors or shades should be installed to lighting fixtures. Lighting fixtures should be cleaned periodically. Colors of ceilings, walls, and floors should be changed to lighter tone with higher reflection rate. Lighting fixtures with high efficiency (e.g. inverter-controlled lights) device should be installed. More efficient lighting fixtures with higher light reflection and transmission should be installed. Fluorescent lamps should be replaced periodically.

5. Energy conservation measures for water supply/ drainage and sanitation facilities and equipment

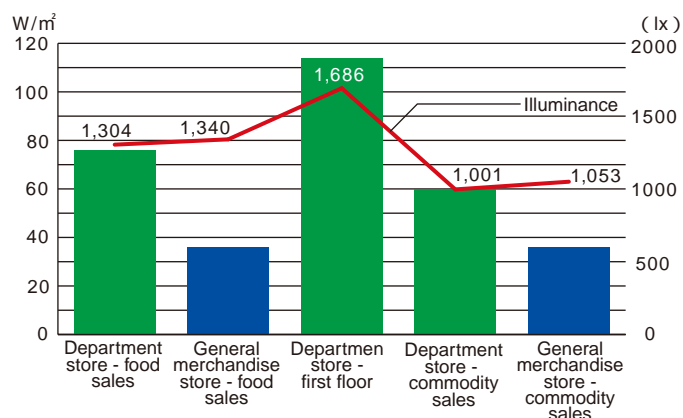
Water-saving equipment should be installed. Water reservoirs level should be controlled to prevent frequent on/off of pumps for discharge sewage water, general service water, spring water, or rainwater. Installation of facilities and equipment which use recycled wastewater or well water should be considered. Leakage due to degraded packing of water taps should be prevented. Capacity of water lifting pump should be checked to see if it is appropriate. If it turns out to be too high, installation of inverter device should be considered. Improvement of the pump to the unit with appropriate capacity should also be considered when replacement is needed, striving for reduction of peak power. If a large difference between designed inflow rate and actual rate is found in recycled wastewater facilities, sewage treatment tank (abatement system), etc., it could cause excess operation of blowers and others, leading to higher DO (dissolved oxygen) level and excessive aeration. To solve the problem, measures to reduce aeration power, such as intermittent operations, should be sought.

6. Energy conservation measures for electric power receiving and transforming equipment

Electric transformers should be replaced with the higher efficiency transformer in order to reduce a total loss. Replacement or improvement should be made starting from older equipment or equipment with lower annual load factor, so that higher improvement effect can be expected. Unbalanced load per bank should be addressed. In order to maintain proper indoor temperature, a control method for air-conditioning or ventilation of electric room should be changed from a timer-controlled to thermostatic controlled. The temperature setting should be around 35 . Energy conservation measures and data analysis through implementation of building and energy management system (BEMS) and reconstruction of measurement and control functions should be promoted.

Comparison of illuminance between general merchandise stores and department stores

Although department stores and general merchandise stores have similar level of illuminance, there is a significant difference between their electric consumptions. It is assumed that the gap is attributable to the difference in the ratio of used incandescent lamps.





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