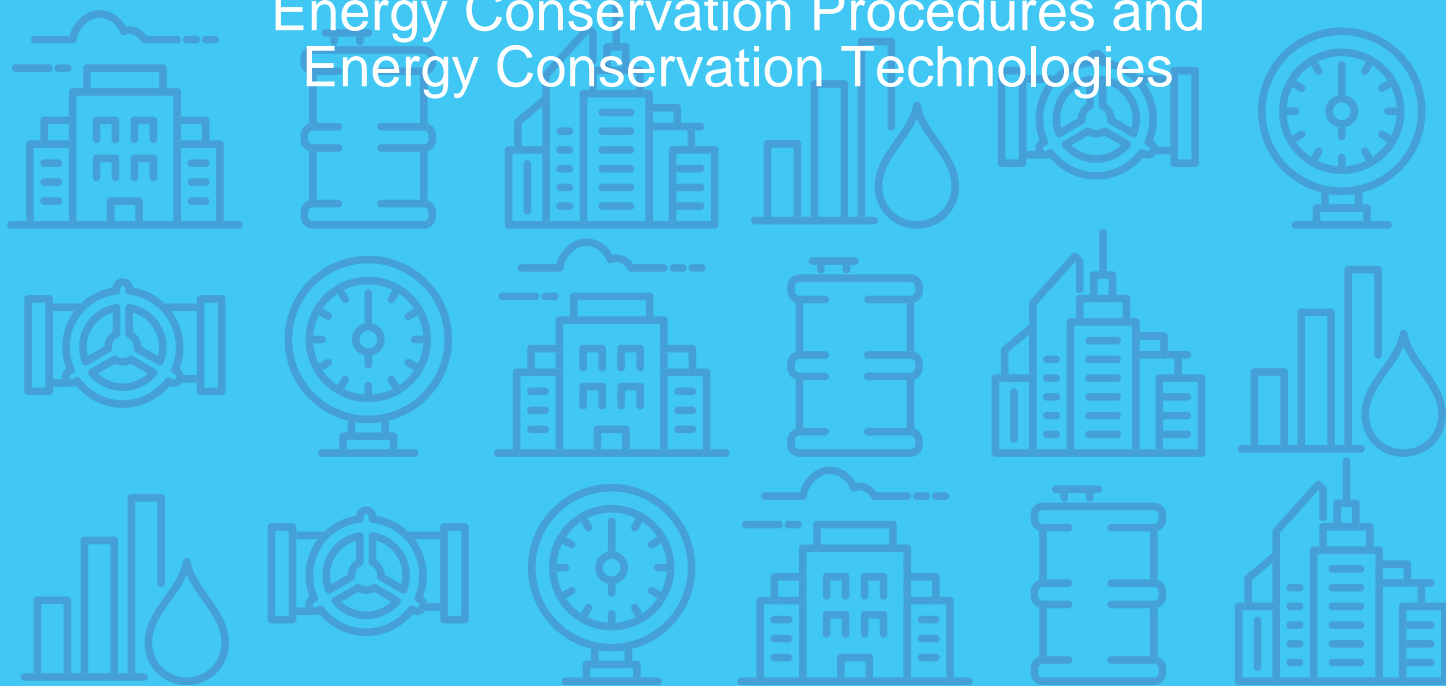


First Step for Carbon Neutrality

Energy Conservation Guidebook for Buildings 2022

Energy Conservation Procedures and
Energy Conservation Technologies



The Energy Conservation Center, Japan

The Guidebook has been prepared by the Energy Conservation Center, Japan as a part of energy conservation support for the purpose of providing information so that small- and medium-sized businesses can address energy conservation autonomously. It includes the energy conservation procedures, basic energy conservation measures and effect estimation, tuning method, and so on. Together with our other energy conservation support measures, we hope you will make use of the Guidebook to improve your energy efficiency.

Contents

I. Significance and Procedures of Energy Conservation

1. First-step Energy Conservation Activities for Carbon Neutrality.....	1
2. Energy Conservation Procedure	2
3. Energy Conservation Check List for Buildings	3
4. Utilization of Energy Audit	7

II. Energy Audit of Buildings and Results

1. Outline of Audited Buildings	8
2. Number of Audit Cases by Type of Industry and Intended Use of Building	9
3. Energy Intensity by Type of Industry and Intended Use of Building	9
4. Energy Consumption by Type of Industry and Intended Use of Building	10
5. Improvement Proposal Items by Audit.....	11
6. Energy Conservation Potentials by Type of Industry and Intended Use of Building.....	12
7. Presentation Meeting of Energy Audits and Technologies	12
8. Utilization of Energy Conservation and Power-saving Portal Site.....	13

III. Energy Conservation Improvement Proposals

A. Energy Conservation Activities, Management Structure, etc.	
Case A-1: Practice of "Positive Energy Conservation" with Full Participation of the Employees and Operational Improvement of Air Conditioning by Utilization of IoT	14
Case A-2: Activation of the Energy Conservation Activities by the Audit.....	15
Case A-3: Energy Conservation Activities in View of the Facility Renewal Plan.....	15
B. Heat Source and Heat Transfer Facilities, etc.	
Case B-1: Adjusting the Cold Water Outlet Temperature of the Gas Absorption Type Water Heater/Chiller	16
Case B-2: Introducing Inverter-based Control for Chiller Cooling Water Pump	18
Case B-3: Controlling the Cooling Water Setting Temperature of the Chiller.....	20
Case B-4: Introducing the Inverter for the Air Conditioner Fan	21
Case B-5: Controlling the Boiler Combustion Air Ratio	22
C. Air Conditioning and Ventilation Facilities, etc.	
Case C-1: Stopping an Outside Air Intake during Warming Up Air Conditioning	24
Case C-2: Reducing the Solar Radiation Load through the Window Glass	25
Case C-3: Improving the Total Heat Exchanger.....	26
Case C-4: Reducing the Outside Air Intake Volume by Indoor CO ₂ Concentration Management	27
Case C-5: Changing the Operating Method of the Ventilation Fan in the Parking Lot.....	28
D. Lighting Facilities, etc.	
Case D-1: Replacing the Fluorescent Lamp Fixture with the LED.....	29
Case D-2: Introducing the LED Guide Light.....	30
Case D-3: Introducing Task Ambient Lighting	31
E. Power Receiving and Transforming Facilities, Power Leveling Facilities, etc.	
Case E-1: Renewing and Integrating the Transformers	32
Case E-2: Peak Power Demand Control by Demand Monitoring	34
Case E-3: Improving Waste Heat Utilization of the Cogeneration System	36
F. ZEB, etc.	
Case F-1: Realizing the Dissemination Type ZEB by Renewal of Medium-sized Office Buildings	38
G. Solar Power Generation, etc.	
Case G-1: Introducing the Self-consumption Solar Power Generation System.....	40
Reference	
Description of the common matters	41



1. First-step Energy Conservation Activities for Carbon Neutrality

Of energy environmental issues, the most crucial one will be to realize "carbon neutrality" toward 2050. To this end, it is imperative to switch fossil fuels accounting for the most of current energy supply/demand to carbon-free energy such as renewable energy, while moving forward with thorough energy conservation. The first-step energy conservation activities for "carbon neutrality" have the following advantages.

Social viewpoint

- Fundamental measure for carbon neutrality

Toward "carbon neutrality" intended for zero emission of greenhouse gas totally by 2050, energy conservation as well as introduction of renewable energy is a fundamental measure for low carbonization and decarbonization.

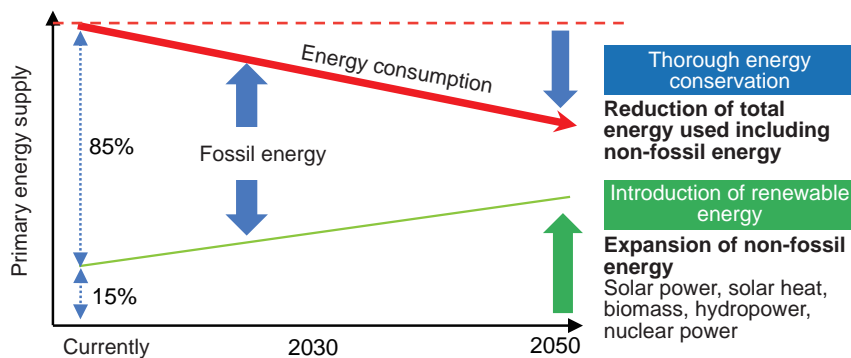
Economic viewpoint

- Cost reduction

"Profits" can be secured by the costs saved by energy conservation. This effect is similar to a sales increase. Once an energy conservation measure is taken, its effect continues for years.

- Compatibility with service improvement

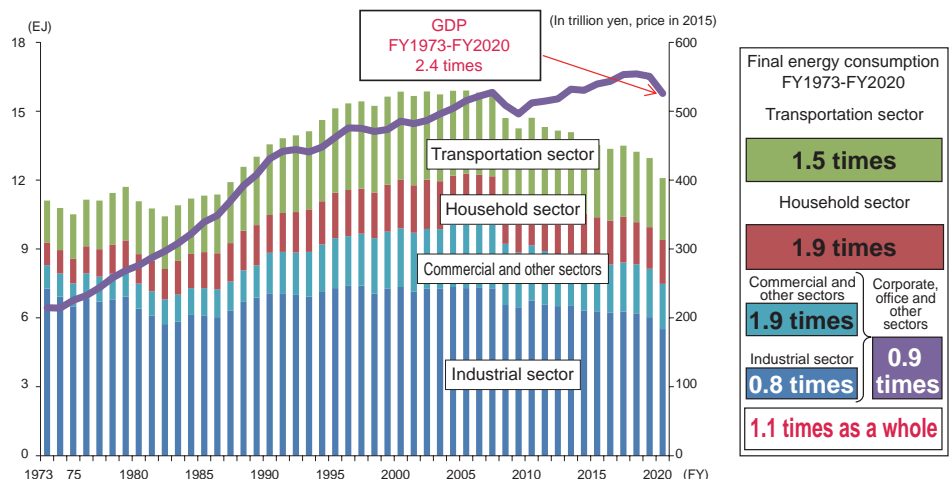
Energy conservation and CO₂ reduction are made compatible with service improvement by reviewing the service methods from a viewpoint of energy conservation.



[Reference] Energy Consumption Trend in Japan

Compared with the first oil crises in 1973, total energy consumption has been restrained to approximately 1.1 times with respect to the growth of the GDP, approximately 2.4 times; the industrial sector has decreased its ratio (0.8 times) and commercial (1.9 times), household (1.9 times) and transportation (1.5 times) sectors have increased their ratios.

Transition of Final Energy Consumption and Actual GDP



Source: "Energy White Paper 2022" (Fig. [No. 211-1-1]), Ministry of Economy, Trade and Industry

2. Energy Conservation Procedure

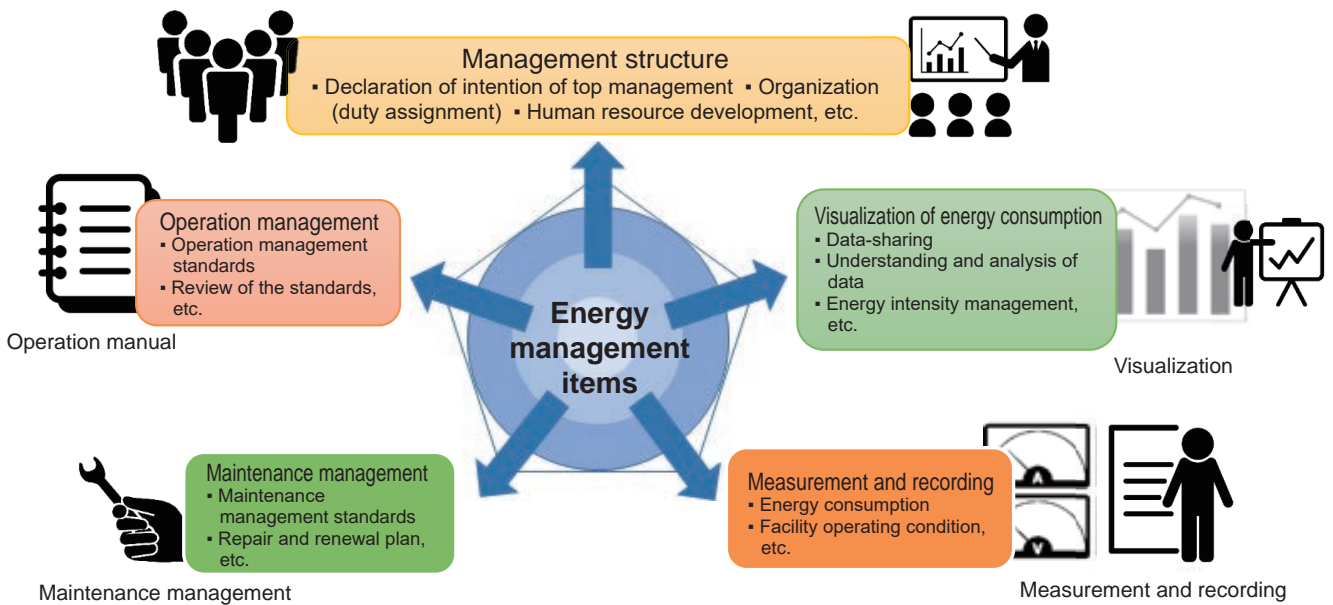
(1) Energy conservation technologies

Energy conservation technologies are intended to enhance energy usage efficiency and widely available for improvement of usage and energy management methods as well as higher equipment efficiency. Main items are shown in Section 3 "Energy Conservation Check List".

"Energy optimized audit" provided by the Energy Conservation Center, Japan and presented in Section 4 is optimal to the business operators who are going to address energy conservation.

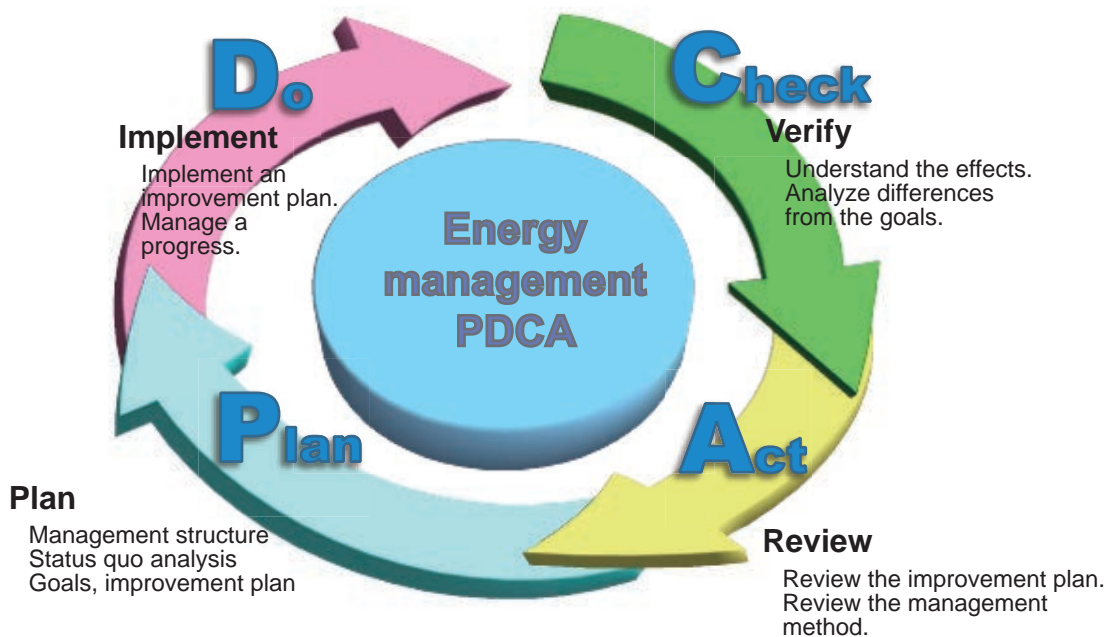
(2) Energy management

Energy conservation requires implementation of steady energy management. Enhance a management structure, visualize energy consumption and improve operation and maintenance of facilities, equipment, etc.



(3) PDCA

It is important to continuously upgrade energy management efforts through a PDCA cycle.



3. Energy Conservation Check List for Buildings

As the first step of energy conservation efforts, begin with [I] What can be implemented in daily operations, etc. As the next step, proceed from [II] Self-practicable efforts based on an expert's advice to [III] Efforts requiring capital investment.

[Legend] I. Efforts practicable in daily operations (almost no technological hurdle)
 II. Self-practicable efforts (requiring technological knowledge such as short-term measurement, etc.) based on an expert's advice
 III. Efforts requiring capital investment

Classification		I	II	III	Check item
[1] General management items	1. Energy management organization	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you have a system capable of continuing energy conservation activities (energy conservation committee, etc.)? [Case A-2] [Case A-3]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you implement PDCA for energy conservation activities on the premise of participation of the management?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you decide a responsible person or a leader who promotes energy conservation?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you set energy conservation goals (reduction of XX%, reduction of XX tons, etc.)?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you post the energy consumption status so that employees can understand? [Case A-2]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you set a policy and implementation plan for energy conservation measures? [Case A-3]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you educate the personnel and conduct an energy conservation awareness campaign?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you observe Cool Biz*1 and Warm Biz*2?
	2. Measurement, recording and maintenance	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you secure a time and a budget for addressing energy conservation? [Case A-3]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you manage documents such as an equipment ledger and drawings?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you identify the energy conservation equipment to be concentratedly managed? [Case A-1]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you have the operation records (daily reports monthly reports, etc.) of main facilities?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you decide the management values for checking the operating status and their ranges? [Case A-3]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you conduct daily inspection and maintenance of the facilities?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you have the Energy Management Manuals of main facilities (air conditioning, ventilation, lighting, production facilities, etc.)?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you periodically calibrate the measuring instruments?
	3. Energy management	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you periodically clean and replace the filters, strainers, etc.?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you periodically repair the piping, etc. and check for a leakage (water, steam, compressed air, etc.)?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you aggregate (graph, etc.) and visualize monthly and annual energy consumptions?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you measure and record energy consumption by type and usage purpose to always monitor (visualize)?
	4. Energy intensity, etc. management	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you measure hourly power consumption to manage peak power?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you analyze the energy consumption status in view of the outside temperature, etc.?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you calculate the unit prices of energy common to business establishments (e.g.: yen/kWh, yen/liter, yen/m ³)?
	5. Management cycle PDCA	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you manage the energy intensity ("energy consumption/total floor area", "energy cost/total floor area", etc.)?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you manage the energy intensity and cost by department?
<input type="radio"/>		<input type="checkbox"/>	<input type="checkbox"/>	Do you review energy conservation goals?	
[2] Heat source and heat transfer facilities	1. Energy conservation of heat source facilities	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you examine the effects of the improvement measures that have been implemented in the past?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you review implementation plans for future facility improvements and measures?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you stop the equipment "at the office closing time" in compliance with the operation rules?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you stop the heat source one hour before ending heating/cooling and operate only the transfer equipment?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you relax the cold water outlet temperature when a cooling load is low? [Case B-1]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you adjust the cooling water inlet temperature to an appropriate value? [Case B-3]
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you cover cold heat demand in the interim and winter periods by producing cold water in a cooling tower?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you consider renewal to the high-efficiency heat source facilities?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Chiller/Water heater/chiller] Do you introduce a heat storage system (nighttime heat storage) when an air conditioning load is high in summer?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Steam boiler] Do you make efforts to ensure an adequate blow rate such as managing the water quality?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Steam boiler] Can you lower a steam pressure setting value?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Steam boiler] Do you implement manual adjustment/automatic control to ensure that an efficient number of units are running?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Steam boiler] When a load fluctuates greatly, do you introduce an accumulator and a hot water storage tank?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Steam boiler] Do you consider introduction of the higher-efficiency boilers?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Combustion equipment] Do you check whether an air ratio is adequate, based on oxygen concentration in an exhaust gas? [Case B-5]
<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Combustion equipment] Do you carry out maintenance and inspection of the burners (cleaning, replacement of worn parts)?		
<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Combustion equipment] Do you consider optimizing a burner capacity according to a changed load capacity, etc.?		

*1 Cool Biz: Japanese government campaign encouraging the people to wear lighter clothes and the companies to set their air conditioners to 28°C
 *2 Warm Biz: Japanese government campaign encouraging the companies to set their heater thermostats to 20°C during the winter

I Significance and Procedures of Energy Conservation
 II Energy Audit of Buildings and Results
 III Energy Conservation Improvement Proposals

Classification		I	II	III	Check item
[2] Heat source and heat transfer facilities	2. Energy conservation of heat transfer facilities	<input type="radio"/>			[Pump] Do you stop the pump "at the office closing time" in compliance with the operation rules?
		<input type="radio"/>			[Pump] Do you cut down on an excessive flow rate (margin ratio) by adjusting a valve and an impeller?
			<input type="radio"/>		[Pump] Do you lower a flow rate on weekdays and holidays, and during nighttime with an inverter, etc.?
				<input type="radio"/>	[Pump] Do you adjust a flow rate by using the inverter, controlling the number of running units and using the sensors? [Case B-2] [Case B-4]
				<input type="radio"/>	[Pump] Do you improve a route and seal the piping?
		<input type="radio"/>			[Fan] Do you stop the fan "at the office closing time" in compliance with the operation rules?
		<input type="radio"/>			[Fan] Do you cut down on an excessive airflow rate (margin ratio) by adjusting a damper?
			<input type="radio"/>		[Fan] Do you adjust an airflow rate on weekdays and holidays, and during nighttime with an inverter, etc.?
	3. Prevention of heat losses and heat recovery			<input type="radio"/>	[Fan] Do you adjust an airflow rate by a combination of the inverter and sensors?
				<input type="radio"/>	[Fan] Do you improve a route and seal the ducts?
		<input type="radio"/>			[Piping system, load facilities] Do you check for a steam leak, etc. and take a measure?
		<input type="radio"/>			[Piping system, load facilities] Do you check the heat retaining material for peeling, wetting, etc. and repair or newly coat it?
			<input type="radio"/>		[Piping system, load facilities] Do you inspect and replace a steam trap regularly?
			<input type="radio"/>		Do you change an outside air inlet rate according to the season?
	4. Cleaning and installation environment			<input type="radio"/>	Do you periodically manage the exhaust gas temperature and take a measure when it is high?
		<input type="radio"/>			Do you recover the steam drain and the heat from the exhaust gas?
<input type="radio"/>				Do you periodically clean the fins of the outside units?	
[3] Air conditioning and ventilation facilities	1. Operation management of air conditioning	<input type="radio"/>			Do you periodically clean the heat exchanger and the heat transfer surface and remove scales?
			<input type="radio"/>		Are there no objects blocking ventilation of the outside units?
		<input type="radio"/>			Do you properly manage the room temperature and humidity according to the season?
		<input type="radio"/>			Do you set weekly and annual rules and observe the scheduled operation (prevention of forgetting to turn off the switch)?
		<input type="radio"/>			Do you stop air conditioning in an unused area (including a stop of air conditioning after a meeting)?
		<input type="radio"/>			Do you ensure that air conditioning starts just before the office opening time (e.g. 15 min. before opening the office)?
		<input type="radio"/>			Do you manage air conditioning during overtime hours?
			<input type="radio"/>		When cooling is required during an intermediate period or winter, do you utilize cooling with the outside air?
			<input type="radio"/>		Is an outside air inlet rate adequate (example of the management standard: Indoor CO ₂ concentration = 800 to 950 ppm)?
			<input type="radio"/>		[At warming up before daily operation] Do you stop an intake of the outside air? [Case C-1]
			<input type="radio"/>		[At warming up before daily operation] Can you shorten an operating time?
	2. Improvement of air conditioning efficiency			<input type="radio"/>	Do you shut off an entry of the outside air from an opening such as a door, which is left open all the time?
				<input type="radio"/>	Do you quantitatively understand the irregularity of indoor temperature distribution?
		<input type="radio"/>			Do you shield the outdoor units from the sunshine and sprinkle water to them in summer?
		<input type="radio"/>			Do you restrain an entry/leak of the heat from a window during daytime and in the early morning by utilizing a window blind?
		<input type="radio"/>			Do you periodically clean the filters?
			<input type="radio"/>		Do you attach light-shielding films to the window glasses, and plant by the windows? [Case C-2]
			<input type="radio"/>		Do you allow the low-temperature outside air into the room at night in summer (nighttime purge)?
			<input type="radio"/>		Do you prevent mixture of heating and cooling in an identical room?
				<input type="radio"/>	Is it possible to reduce an air-conditioned area (partitions, lining of the high ceiling, etc.)?
				<input type="radio"/>	When there are not many people in a spacious air-conditioned area, do you use a spot cooler?
		3. Management and efficiency improvement of the ventilation facilities			<input type="radio"/>
				<input type="radio"/>	Are the window glasses properly heat-insulated (double glass, etc.) and airtight?
				<input type="radio"/>	Do you prevent an entry of draft into the air-conditioned area?
				<input type="radio"/>	Do you upgrade to the higher-efficiency air conditioners?
	<input type="radio"/>				Do you stop ventilation of an unused area or when not used?
			<input type="radio"/>		Do you introduce and utilize the total heat exchanger? [Case C-3]
	<input type="radio"/>			Do you adjust a ventilation rate by an optimized ventilation frequency, intermittent operation, etc.?	
	<input type="radio"/>			For ventilation fans in the electric room, machine room, etc., do you implement room temperature control operation?	
		<input type="radio"/>	Do you locally exhaust for the heat generation equipment?		

Classification		I	II	III	Check item
[3] Air conditioning and ventilation facilities	3. Management and efficiency improvement of the ventilation facilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you control an outside air inlet rate with a CO ₂ sensor, etc.? [Case C-4]
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you change ventilation rate control from a damper system to an inverter system?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	As a measure to prevent an excessive ventilation rate in a parking lot, do you implement intermittent operation or ventilation rate control based on the CO and CO ₂ concentrations? [Case C-5]
[4] Freezing/refrigeration facilities	1. Freezers and refrigerators	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you set adequate setting temperature rules for the goods and cargos in the freezers and refrigerators to manage them?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Can you reduce a door opening/closing frequency, door opening time and take-in/-out frequency?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you secure a cold air flow in the freezers and refrigerators (overloaded or not)?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Can you reduce frequency of defrosting according the season?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you install an air curtain, etc. to the door to reduce an entry of the outside air?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you reduce heat generation of facility internal lighting (e.g. introduction of LEDs)?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Are there any frozen parts due to heat insulation failure in heat insulation treatment of the wall surface or door?
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you introduce the higher-efficiency freezers and refrigerators?	
	2. Showcases	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you close a nighttime cover at night?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Can you reduce frequency of defrosting according the season?
<input type="checkbox"/>		<input type="checkbox"/>	<input type="radio"/>	Do you install an air curtain?	
<input type="checkbox"/>		<input type="checkbox"/>	<input type="radio"/>	Do you upgrade to the higher-efficiency showcases?	
[5] Water heating and water supply/drain systems	1. Water heating system	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the hot water tank temperature adequate?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you stop the water heating system and a circulation pump during nighttime and on holidays?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you stop feeding hot water during other than the winter (for washing hands, etc.)?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Do you periodically remove inner scales from a water heater?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you utilize the waste heat of the combustion exhaust gas (preheat of the combustion air, feedwater, etc.)?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	When heating less water, can you change from a centralized water heating system to an individual water heating system?
	2. Water supply/drain system	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you employ a higher-efficiency water heater (latent heat recovery type water heater, EcoCute, etc.)?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you install a water-saving device (water-saving packing, water-saving shower head, etc.) in a bathroom, kitchen, hand-washing sink, etc.?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Are the feed water flow rate and pressure adequate?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you recycle drainage (toilet flushing, water sprinkling, floor cleaning, car washing, etc. after drainage treatment)?
[6] Lighting, power receiving and transforming facilities, electric facilities	1. Management and energy conservation of the lighting facilities	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you decide and manage a luminosity standard for each room?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you turn off the lights by the windows (utilization of daylight)?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you turn off the lights when they are unnecessary such as in an empty room and during a lunch break?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you adjust the lighting time and number of outdoor lights according to daylight hours?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you clean the lighting apparatuses and replace the old lamps?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Do you use a motion detector to turn on/off the lighting in toilets, warehouses, etc.?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Are the lighting fixtures properly positioned (height and layout) with respect to required luminosity?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you subdivide a lighting circuit to turn off the lights in an empty area, etc.?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you dim or turn off the lights with automatic dimmer control?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Do you replace with LED lighting? [Case D-1] [Case D-2] [Case D-3]
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	Have you considered task ambient lighting? (All-room lighting → Overall + Hand lighting) [Case D-3]	
	2. Management and energy conservation of the power receiving and transforming facilities	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	Do you manage power consumption for each department (monthly and daily) (understanding of the actual situation, graph, etc.)?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Do you use a demand monitoring device to reduce contract demand? [Case E-2]
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Is the power-receiving end of the electric equipment at the rated voltage (necessary to adjust the voltage when too high or low)?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	Is a power factor adequate (e.g. a measure is necessary if it is less than 95%)?
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	When load fluctuations are great (low nighttime power, etc.), do you install an automatic power factor regulator?
		<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	[Transformer] Do you shut off the primary-side power of an unnecessary transformer?
		<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	[Transformer] When a load factor has a margin, do you integrate the transformers or optimize the transformer capacity? [Case E-1]
<input type="checkbox"/>		<input type="radio"/>	<input type="checkbox"/>	[Transformer] Do you strike a load balance among three phases?	
<input type="checkbox"/>	<input type="radio"/>	<input type="checkbox"/>	[Transformer] Do you examine the load factor to level the load (load control)?		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/>	[Transformer] Do you upgrade to the higher-efficiency transformers? [Case E-1]		

Classification		I	II	III	Check item
[6] Lighting, power receiving and transforming facilities, electric facilities	3. Energy conservation of the automatic vending machines	<input type="radio"/>			Do you turn off the backlight?
		<input type="radio"/>			Do you stop operation on holidays and during nighttime (timer function)?
				<input type="radio"/>	Do you request a supplier to upgrade to an energy-saving type (heat pump type, etc.)?
	4. Management of the OA equipment	<input type="radio"/>			Do you turn off the power when unnecessary (holidays, etc.)? [Except for fax machines]
			<input type="radio"/>		Do you set to the energy-saving mode (nighttime/holidays)?
				<input type="radio"/>	Do you replace with a power-saving type?
[7] Elevators, etc.	1. Management of the elevators	<input type="radio"/>			During a lower-use period on holidays, at night and on weekdays, do you operate fewer units?
			<input type="radio"/>		Do you stop them less frequently at the floors with lower use frequency?
	2. Management of the escalators	<input type="radio"/>			Do you operate fewer units on holidays and at night?
				<input type="radio"/>	Are they automatically operated with a motion detector?
[8] Optimized energy utilization	1. Load leveling		<input type="radio"/>		Have you considered peak shifting in power use? Have you reviewed an operation form (working hours, operation system, operation rate, load factor, etc.)?
			<input type="radio"/>		Have you considered lowering demand response and raising demand response in view of your own daily power load curve?
				<input type="radio"/>	Have you considered introduction of a heat storage unit?
				<input type="radio"/>	Have you considered introduction of an absorption type water heater/chiller?
				<input type="radio"/>	Have you considered introduction of storage batteries (lithium-ion batteries, NAS batteries, etc.)?
	2. Cogeneration		<input type="radio"/>		Do you improve the operation after checking an operating condition (dependency rate, power generation efficiency, exhaust heat utilization rate, overall efficiency, etc.)?
				<input type="radio"/>	Have you considered introduction of a cogeneration system? [Case E-3]
	3. Renewable energy	<input type="radio"/>			Have you considered purchasing various menus of renewable energy electricity?
		<input type="radio"/>			Have you considered purchasing a certification of renewable energy electric power?
			<input type="radio"/>		Have you considered introduction of wood-burning stoves and pellet-burning stoves?
				<input type="radio"/>	Have you considered introduction of solar power generation? [Case G-1]
				<input type="radio"/>	Have you considered introduction of a solar water-heating system?
				<input type="radio"/>	Have you considered introduction of earth thermal/underground water heat pump air conditioning?
	4. Utilization of unused heat		<input type="radio"/>		Have you considered switching to heat supply by a heat pump?
			<input type="radio"/>		Have you considered utilization of the waste heat from the building (electrical room) for heating and hot water supply?
			<input type="radio"/>		Have you considered utilization of the low-temperature waste heat, using a heat pump or a binary power generator?

4. Utilization of Energy Audit

"Energy optimized audit" conducted by ECCJ is a project by the Agency of Natural Resources and Energy, "Subsidies for Promotion of Optimized Energy Utilization for Small- and Medium-sized Enterprises in FY2022".

Energy conservation is the most effective means for decarbonization. Moving one step further forward, "energy optimized audit" is a new service intended to accelerate decarbonization by adding "renewable energy proposals" to reduction of energy consumption by "energy audit".

(1) Flow of the audit

- Apply for an audit menu suitable to the usage of electricity and fuels of the factory, building, etc. to be audited.
- After confirming payment of an audit expense, our visit schedule will be coordinated to dispatch experts.
- At site, we will check the actual operating status and management status of the facility to prepare an audit report.
- We will explain the audit results at a briefing and give advice for implementation of proposals.



Audit menu

	Audit content	Guide of annual energy consumption (crude oil equivalent)	Audit expense
Audit A	Menu to be audited by one expert	Less than 300 kl	¥10,450 (tax included)*1
Audit B *2	Menu to be audited by two experts (briefing held by one expert)	300 kl to less than 1,500	¥16,500 (tax included)*1
Extensive audit	Menu to be audited by two experts after a prearrangement meeting (with one expert)	1,500 kl or more	¥23,100 (tax included)*1

*1 A bank transfer fee for the audit expense shall be borne by an applicant.

*2 Even the annual energy consumption is less than 300 kl, business establishment having a lot of equipment using the heat such as boilers and large air conditioners, or relatively large-scale business establishment

(2) Business operators eligible for the audit

Those meeting one of the following conditions

- Small- and medium-sized enterprises (those stipulated by the Small and Medium-Sized Enterprise Basic Act)

Those falling under *1 are excluded.

(The small- and medium-sized enterprises falling under the conditions in *1 are also acceptable if they meet the following conditions.)

- Factories, buildings, etc. with annual energy consumption (crude oil equivalent) of 100 kl to less than 1,500 kl in principle

(Even if less than 100 kl, acceptable in case of receiving low-voltage power, high-voltage power or extra high-voltage power)

- *1
- ① Small- and medium-sized business operators whose stocks are directly or indirectly possessed 100% by a corporate body with a capital or investment of ¥500,000,000 or more
 - ② Small- and medium-sized business operators whose annual average taxable income of each year or each fiscal year of the most recent past 3 years exceeds ¥1,500,000,000

■ Application form

Select "Energy Optimized Audit" at the Energy Conservation and Power-saving portal site (<https://www.shindan-net.jp>), followed by "Factory" or "Building". Particularly, in the case of a small-scale building, select and download an application form for "Simplified Version for Buildings" and send it by e-mail, fax or postal mail to apply.

■ Address (Contact information)

Igarashi Building 5F, 2-11-5 Shibaura, Minato-ku, Tokyo 108-0023 Japan

Secretariat of Energy Audit, The Energy Conservation Center, Japan

Phone: +81-3-5439-9732

Fax: +81-5439-9738

E-mail: ene@eccj.or.jp

Energy optimized audit
Free dispatch of lecturer
Download each
application form from here

Energy Conservation and Power-saving Portal Site


<https://www.shindan-net.jp/>



* Download the application form at the website, fill in with necessary information and send it to each secretariat by e-mail or fax to apply.



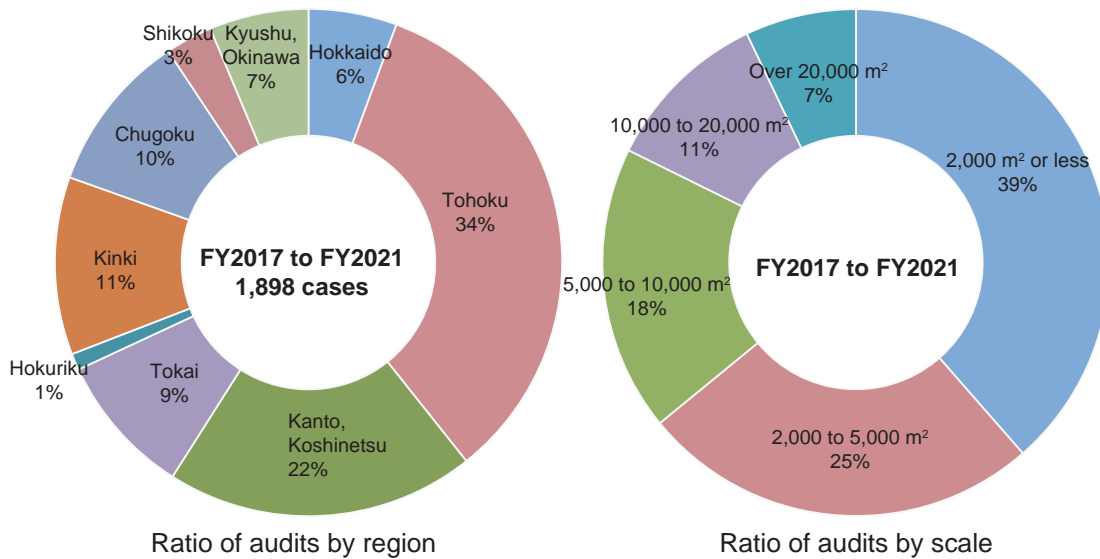
Energy Audit of Buildings and Results



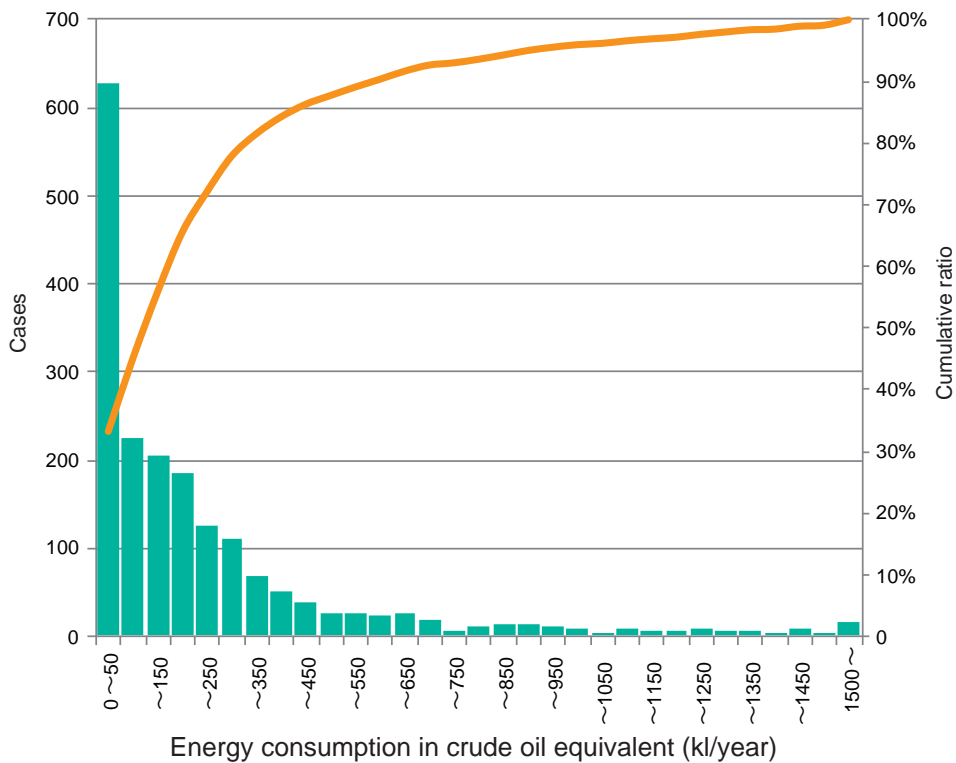
The following outlines the energy audits of buildings (commercial facilities) implemented by the Energy Conservation Center, Japan. Utilize them as reference data for management of the energy consumption and energy intensity, and consideration of improvement proposals.

1. Outline of Audited Buildings

The left figure below shows the ratio of energy audits of buildings (FY2017 to FY2021) by region. The right figure below classifies the scale of audited buildings by total floor area.

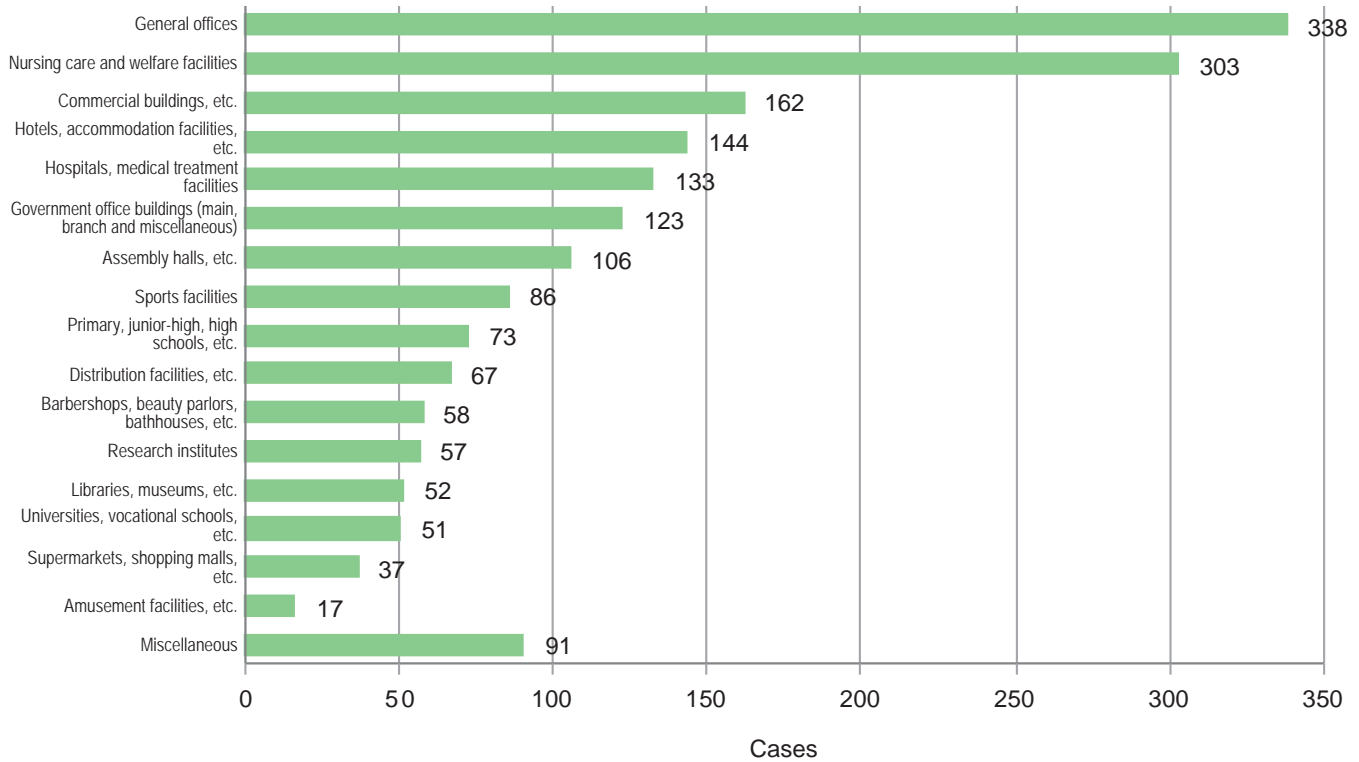


The following shows the distribution of annual energy consumption (crude oil equivalent value) of the audited buildings (FY2017 to FY2021). The number of cases of less than 50 kl is the highest.



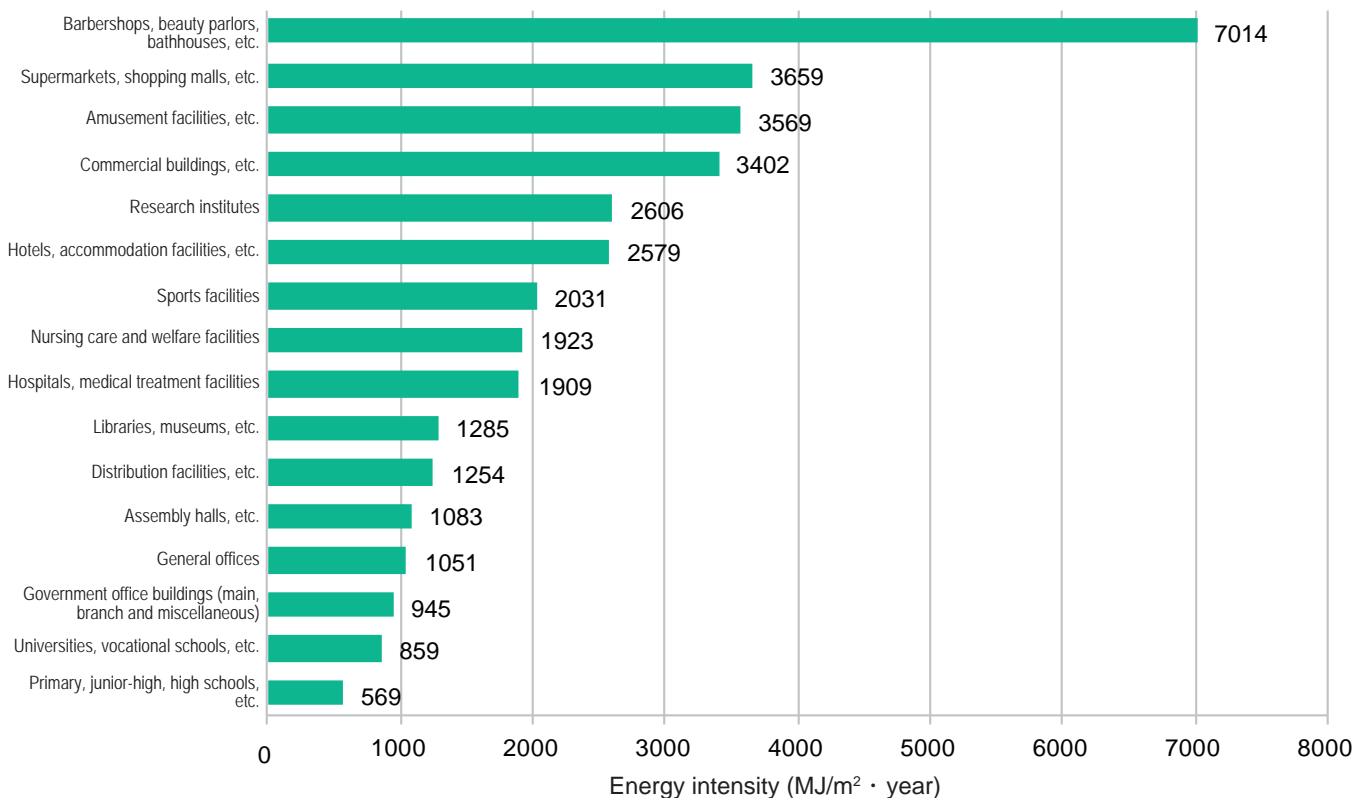
2. Number of Audit Cases by Type of Industry and Intended Use of Building

The following shows the number of energy audit cases of buildings by intended use in FY2017 to FY2021.



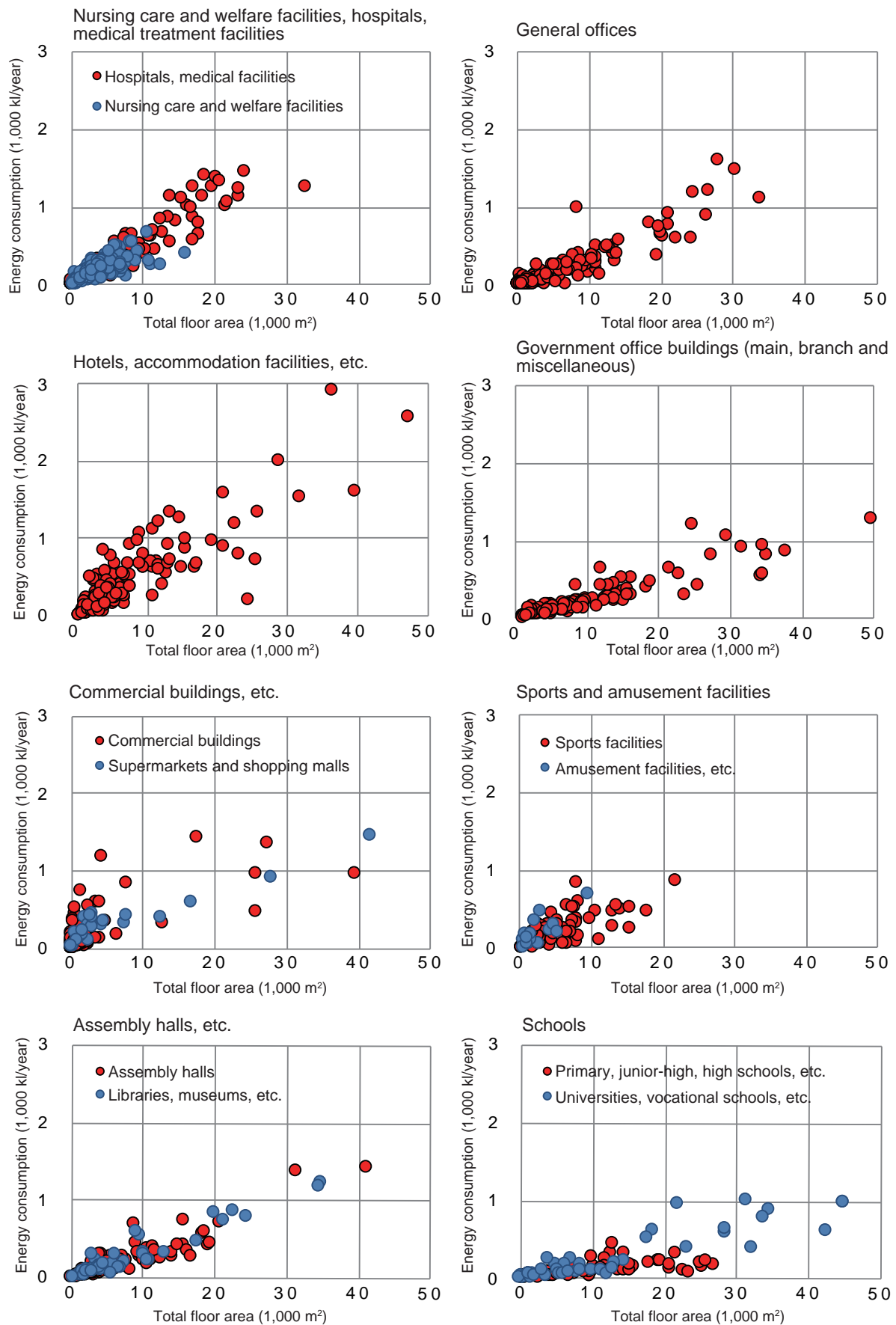
3. Energy Intensity by Type of Industry and Intended Use of Building

The energy intensity is an important index for evaluating the energy management status. This is indicated by energy consumption per total floor area in the following. Refer to the following values when evaluating the energy intensity.



4. Energy Consumption by Type of Industry and Intended Use of Building

The following shows the energy consumption of the audited buildings in FY2017 to FY2021 in the form of the scatter diagram based on the total floor area. Refer to it when comparing with other facilities.



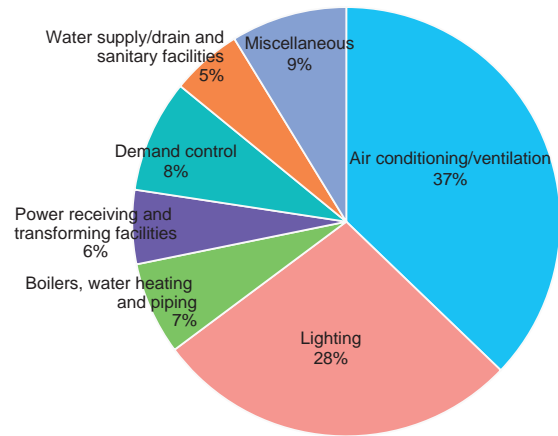
5. Improvement Proposal Items by Audit

After investigating the status quo of the building, the energy audit presents an improvement proposal.

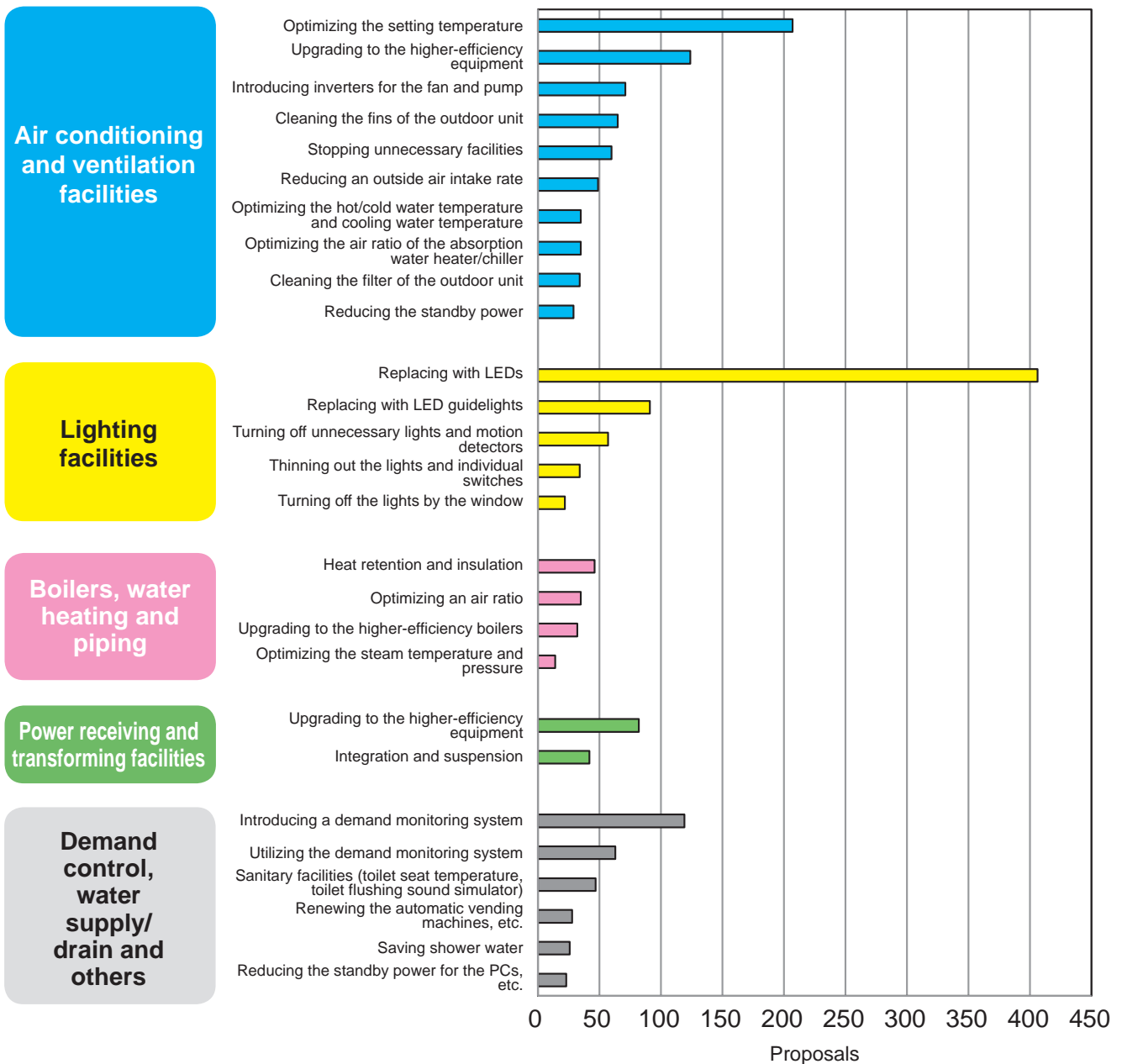
The right pie chart shows the ratio of the recent improvement proposals for each facility. There are many proposals for the air conditioning and lighting facilities, basically reflecting the ratio of energy consumption of the buildings.

The following figure itemizes the proposals for each classification of target facility.

For the air conditioning/ventilation facilities, optimization of the setting temperature is proposed much more than the others. For lighting, renewal to LEDs is proposed very much.

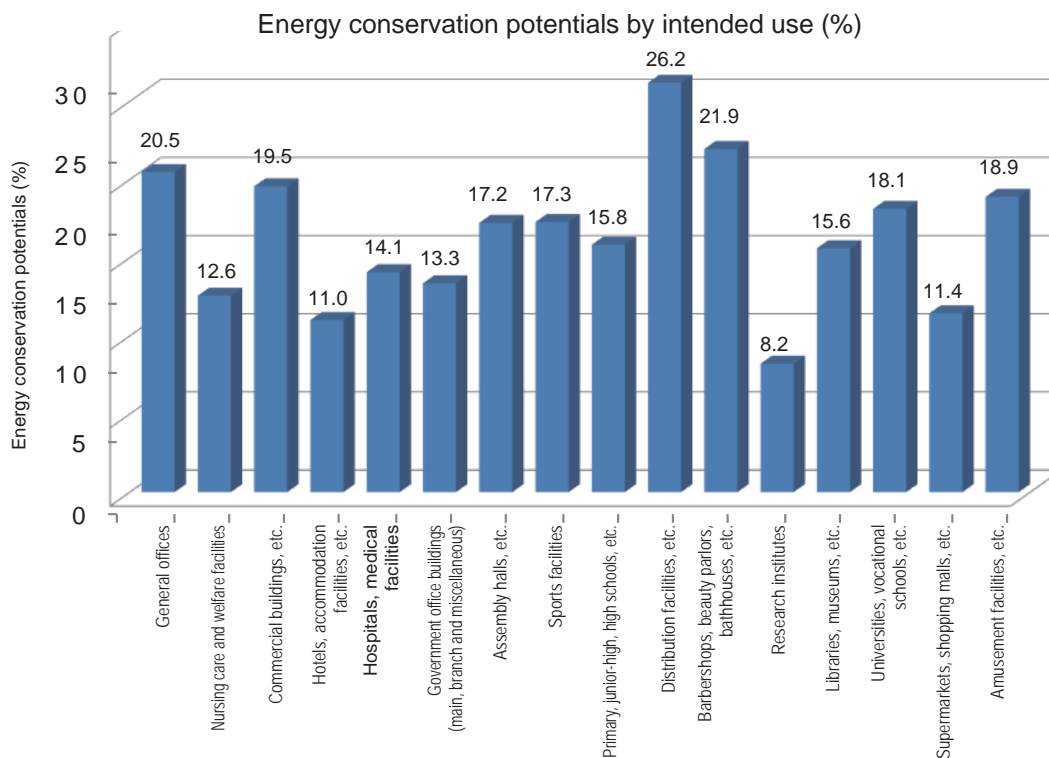


Improvement proposals by energy audits of buildings



6. Energy Conservation Potentials by Type of Industry and Intended Use of Building

The following compiles the energy conservation rate of the improvement proposals based on the energy audits for each industry type and intended use. This energy conservation rate is a ratio of proposed energy conservation to energy consumption of the audited facilities. This indicates an energy conservation potential for that facility. Refer to it when addressing energy conservation activities.



7. Presentation Meeting of Energy Audits and Technologies

The "Presentation Meeting of Energy Audits and Technologies" has been held throughout the country since FY2014 for the purpose of providing energy conservation technologies and information for small- and medium-sized businesses across Japan.

It provides the information on the successful energy conservation cases with an energy audit as an opportunity, latest energy conservation technologies, viewpoints of energy conservation promotion and specific implementation methods. The Presentation Meeting for FY2022 is planned to be held in Tokyo and Osaka regions with attendance of presenters and be streamed online at a later date. For the dates and details of presentation, see the Energy Conservation and Power-saving portal site "shindan-net.jp".



Appearance of the meeting in FY2019

省エネ診断・技術事例発表会

公開動画へのアクセス手順

動画視聴は簡単! わずか3ステップです!

- 1 PC, スマホで「省エネ診断・技術事例発表会視聴サイト」にアクセスします。
- 2 簡単な登録事項を入力していただきます。
- 3 ご覧になりたいテーマをクリックすると動画をご覧いただけます。

Held online in FY2021 (video streaming)

8. Utilization of Energy Conservation and Power-saving Portal Site

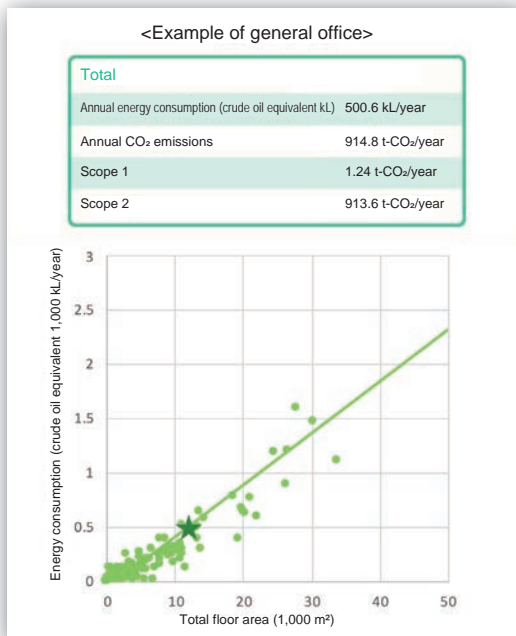
Useful information is provided for promoting energy conservation and power-saving, such as introduction of audit cases and video-based tuning methods in addition to introduction of detailed energy conservation support services and application methods. Also, a self-audit tool allows you to compare the energy intensity with other company in the same industry.

Energy conservation support service

Different services are presented such as the energy optimized audit and free dispatch of lecturer. Apply for them from here.

Self-audit tool

By inputting the information of your own facility, you can easily calculate CO₂ emissions and see the position of energy intensity and specific energy conservation measures with respect to other company in the same industry.



Introduction of the energy audit cases

Based on the energy audit cases, many successful cases are presented as to the viewpoints and specific practicable methods of energy conservation promotion, company-wide energy management, approaches to energy conservation, etc. The cases can be searched for each major type of industry, facility, energy conservation technology, etc.

Energy conservation animation channel

Auditing and a typical energy conservation tuning method are presented in videos for easy understanding.



Energy optimized audit
Free dispatch of lecturer
Download each application form from here

Energy Conservation and Power-saving Portal Site

<https://www.shindan-net.jp/>


* Download the application form at the website, fill in with necessary information and send it to each secretariat by e-mail or fax to apply.



Energy Conservation Improvement Proposals



The following describes the typical energy conservation improvement cases and helpful energy conservation activity cases in the energy audits provided by the Energy Conservation Center, Japan (the information has been changed for the public).

A. Energy Conservation Activities, Management Structure, etc.

Case A-1: Practice of "Positive Energy Conservation" with Full Participation of the Employees and Operational Improvement of Air Conditioning by Utilization of IoT

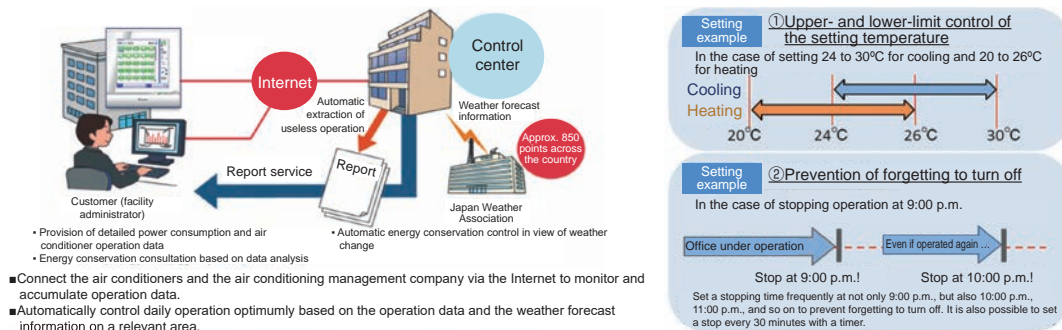
1. Background to approaching the activities

Since the facilities prioritize comfort of users, energy conservation activities had not been promoted because of different anxieties such as "We have awareness of energy conservation, but we are too busy to spare time", "There is no full-time administrator", "How we can manage to strike a balance between comfort and energy conservation?" and "How we can continue to greatly save energy in operation and management of air conditioners". With the opportunity of having known the IoT-based energy conservation measures for air conditioning, however, they addressed those activities.

2. Improvement measure

Measure	Implementation items and effects
General management items Implemented by facility personnel	Business was conducted in casual wear (Cool Biz) with cooperation of the users in extremely hot summer to manage the setting temperature goal of the air conditioners. When casual wear was not enough, the setting temperature was changed to cope with the situation.
	The air conditioners and floor heating are combinedly used in winter. Since floor heating consumes much electric power, however, a rule was made to increase the setting temperature of the air conditioners and reduce the use of floor heating with cooperation of the users when it is cold.
Energy conservation for air conditioning and ventilation facilities (employment of IoT)	The air conditioners which often failed or malfunctioned due to aging were put through maintenance work such as replacement of parts to restore normal performance.
	Because there were no full-time personnel for the air conditioners, a controller was added to automatically operate them.
	A management company employed IoT to visualize the operating status of the air conditioners of the facilities, thereby setting the temperature suitable for the facilities and automating the setting to cut down on useless operation. This allows immediate remote response to a sudden change of a facility operation schedule and utilization of weather forecast information to implement optimum automatic energy conservation operation for the day.

Visualization of the operating status connecting the air conditioners and the control center of the management company (overview of IoT)



3. Results

All employees addressed these energy conservation activities together to "work out usage so as to maintain minimum comfort". As a result, their awareness of energy conservation was heightened to produce different ideas of energy conservation. Electric power cost was reduced by optimized air conditioning, allowing the surplus to be allotted for maintaining and improving services. From now on, we would like to think about development to demand management.

Case A-2: Activation of the Energy Conservation Activities by the Audit

1. Background to approaching the activities

As a result of taking the energy audit as an opportunity and launching an Energy Conservation Promotion Committee to address, energy conservation has been greatly enhanced throughout the facilities, changing the employees' awareness of energy conservation.

2. Improvement measure

Measure	Implementation items and effects
Energy conservation promotion structure (Full-participation energy management structure)	Taking the energy audit as an opportunity, the Energy Conservation Promotion Committee was launched to enhance the facility employees' awareness of energy conservation. As a result of activities, tap water and power consumptions and their costs were actively posted to enlighten the personnel.

The following readily practicable measures were addressed first as the activities.

- Turn off unnecessary lighting by the window, etc. during daytime.
- Reduce an annual lighting time by thorough management of lighting time.
- Stop an electric toilet seat in a warm season.
- Adjust a water volume for adjustable water faucets.

3. Results

Awareness of energy conservation awakened by the energy audit has prevailed throughout the facilities. The wastes were numerically indicated to motivate the employees to do what they can do now. A change of awareness of energy conservation has an effect on the daily remainders to the employees (paying attention to the switches for lighting and air conditioning, and so on). The significance of energy conservation was realized in view of the numerical values of implemented energy conservation effects.

Case A-3: Energy Conservation Activities in View of the Facility Renewal Plan

1. Background to approaching the activities

This is a case of preparing a long-term (12 years) facility renewal plan to promote energy conservation in a planned way, addressing high-efficiency lighting and introduction of the demand monitoring equipment.

2. Improvement measure

Measure	Implementation items and effects
Management structure, goal setting and capital investment plan	The long-term facility renewal plan (12-year plan) has been prepared for major facilities. In line with the plan, they have been addressing the capital investment (higher-efficiency lighting, introduction of the demand monitoring equipment).
Energy Management Manuals for major facilities	For the practicable measures for workers such as stopping the AHU fans in the lobby during nighttime and thinning out the lights in the corridor, the rules have been prepared and the responsible personnel were appointed to implement. For boiler units control and optimization of the air ratio, the operation and management standards have been prepared to manage.
Management structure and assessment of energy conservation by the review meeting	On the bases of the usage of electricity, gas and tap water, energy conservation has been evaluated every other month as to how it reflected the impact of the climate, number of users and renewal of facility during the term. If an error is found, it has been verified and improved together with the personnel in each department and on-site personnel.

3. Results

A long-term plan will be prepared and implemented for energy conservation cases expected of large effects and associated with capital investment. It is planned to introduce the demand monitoring equipment, replace the fluorescent lamps with the LEDs, renew the evacuation guide lamps and introduce the absorption chillers.

B. Heat Source and Heat Transfer Facilities, etc.

Case B-1: Adjusting the Cold Water Outlet Temperature of the Gas Absorption Type Water Heater/Chiller

1. Current problem

In certain elderly welfare facilities (total floor area of 3,900 m²), a water heater/chiller has its cold water outlet temperature set to 7°C during a cooling period without being changed.

2. Improvement measure

Alleviate the cold water outlet temperature within the range of not running short of an air conditioner's capacity in an intermediate period during which a cooling load drops, thereby lowering the energy consumption of a chiller. Raise the cold water outlet temperature from 7 to 9°C during the low-load period in May to June and October to reduce the fuel consumption of the gas absorption type water heater/chiller.

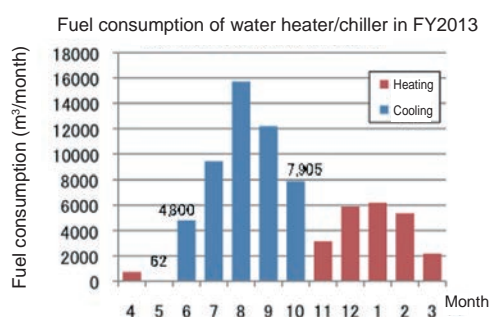


Fig. 1 Fuel consumption of water heater/chiller

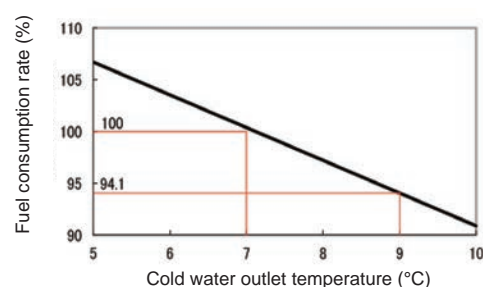


Fig. 2 Cold water outlet temperature and fuel consumption rate

3. Effect estimation

(1) Calculation formula

Fuel reduction: Current fuel consumption (m³/year) x (Current fuel consumption rate (%) – Improved fuel consumption rate (%))

(2) Prerequisites for calculation

Fuel consumption in the intermediate period: 12,800 m³/year, See Fig. 1 (62 m³ (May) + 4,800 m³ (Jun.) + 7,905 m³ (Oct.) = 12,767 m³)

Fuel consumption rate: See Fig. 2 (Currently 7°C, 100% → 9°C, 94.1% after improvement)

Fuel heating value: City gas 13A

4. Effects

①	Fuel consumption (current)	12,800	m ³ /year	Fig. 1
②	Fuel consumption (improved)	12,040	m ³ /year	
③	Reduced fuel consumption	760	m ³ /year	
④	Energy conservation rate	5.9	%	③ / ①
⑤	Saved amount of money	78	¥1,000/year	③ x ¥102/m ³
⑥	Reduction in crude oil equivalent	0.9	kL/year	③ x 44.8 MJ/m ³ x 0.0258 kL/GJ
⑦	CO ₂ reduction	1.7	t-CO ₂ /year	③ x 44.8 MJ/m ³ x 0.0136 x (44 / 12) t-CO ₂ /GJ

[Reference] Comfort of air conditioning

Energy conservation is achieved by optimizing the air conditioning setting temperature, but you may feel uncomfortable depending on the room requirements. To improve comfort in such a case, there is a method to utilize an air current with a circulator, etc. If an air conditioner can vary the evaporation temperature of its refrigerant, you can maintain comfort by separately controlling the temperature and humidity. One of comfort indicators is PMV. In the following cases, it is possible to make energy conservation compatible with comfort.

(1) Improvement of comfort

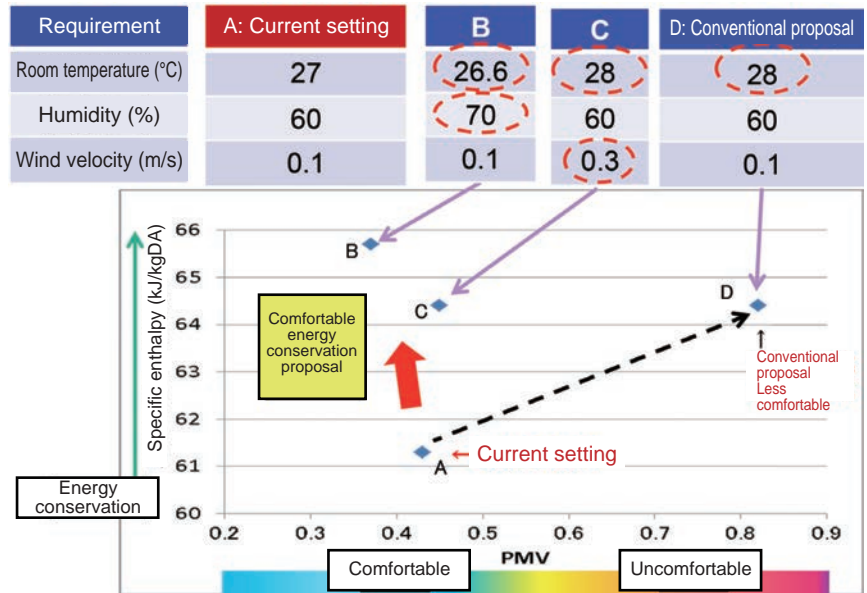
When the room temperature setting is increased to 28°C, you may feel uncomfortable (A → D). Comfort can be further enhanced by methods such as the following compared to the conventional ones.

- ① 28°C setting + Effective utilization of the air current (circulator, fan, etc.) (D → C)
- ② Increase the humidity and decrease the temperature when the humidity can be controlled. (D → B)

◎ Humidity control method (outline)

- i) When cold water is utilized for air conditioning: Increase the cold water outlet temperature of the chiller.
- ii) When the refrigerant is utilized for air conditioning: Adjust an expansion valve to increase the evaporation temperature of the refrigerant.

(Note: For details of adjustment, consult or inquire a professional contractor.)



(Note) Enthalpy (EH): Indicates the total energy of the atmosphere. Cooling is performed to lower EH.

Fig. 3 Relations among temperature, humidity, wind velocity and comfort

(2) PMV (Predicted Mean Vote)

PMV is a windchill index proposed by Professor Fanger of Technical University of Denmark as evaluation of human feelings. It is calculated from 6 elements: temperature, humidity, average radiation temperature, air current velocity, amount of clothing and amount of activity (Fig. 4).

PMV = 0 indicates a state neither hot nor cold and free from thermal discomfort, with which 95% of residents are satisfied. In the range of PMV = -0.5 to +0.5, 9 of 10 persons feel comfortable (Fig. 5).

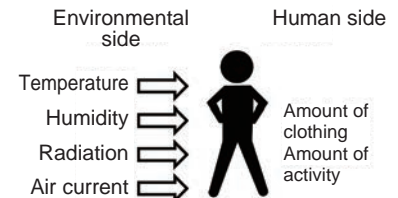
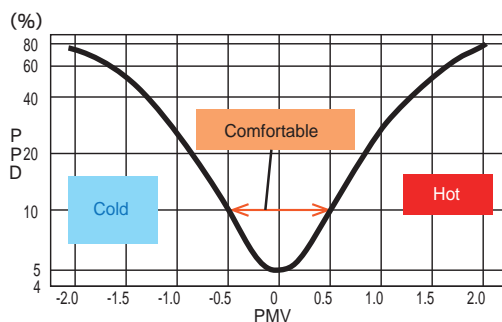


Fig. 4 Six elements of PMV calculation



PMV	Hot/cold feeling
1.51 or more	Hot
0.51 to 1.51	Slightly hot
-0.50 to 0.50	Neutral
-1.51 to -0.50	Slightly cold
-1.51 or less	Cold

Fig. 5 PMV and hot/cold feeling

Case B-2: Introducing Inverter-based Control for the Chiller Cooling Water Pump

1. Current problem

A chiller in a commercial building (total floor area: 12,900 m²) has high piping pressure losses because the discharge valve of a cooling water pump is throttled to control a flow rate.

2. Improvement measure

Valve-based flow rate control is done by changing a piping resistance. To the contrary, inverter-based flow rate control changes pump characteristics, producing high energy conservation effects. Introduce the inverter to control the flow rate by controlling the rotating speed of the pump, and open the valve fully to save the energy.

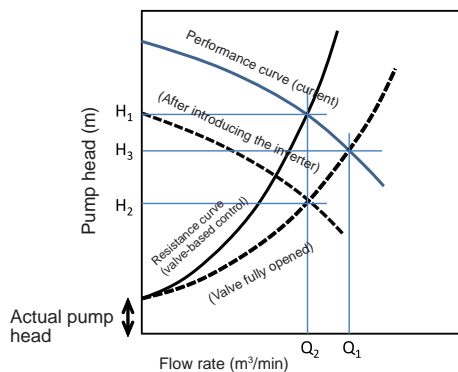


Fig. 1 Pump characteristic curve

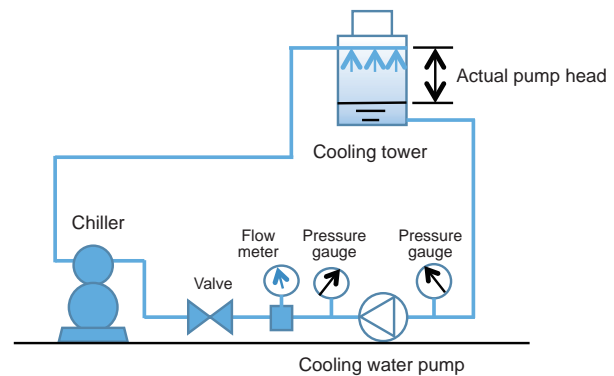


Fig. 2 Conceptual diagram of cooling water piping

3. Effect estimation

(1) Calculation formula

Current power consumption: Pump motor power (kW) x Operating time (h/year)

Improved power consumption: Power consumption (current) x Ratio of current power to improved power / Inverter efficiency

(2) Prerequisites for calculation

Pump motor power (current): 30.6 kW

Inverter efficiency: 0.95

Operating time: 800 h/year

Pump power (valve fully opened): 37 kW

Flow rate ratio (Q_2/Q_1): 1/1.25, See Fig. 1.

Pump head (H_3): 30 m, Ditto

Actual pump head: 3 m, See Fig. 2

Ratio of current power to improved power (H_2/H_1): 0.654, See Fig. 1.

4. Effects

①	Power consumption (current)	24,500	kWh/year	
②	Power consumption (improved)	16,900	kWh/year	
③	Reduced power consumption	7,600	kWh/year	① - ②
④	Energy conservation rate	31	%	③ / ①
⑤	Saved amount of money	144	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	2.0	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	3.4	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

5. Implementation of the proposal and tuning

In implementing the proposal, measure the current flow rate, pressure (pump head), power consumption, etc. to examine energy conservation effects thoroughly. After installing the inverter, control the rotating speed to a conventional cooling water rate and measure the actual results of energy conservation effects.

(1) Tuning point

Change flow rate control from a method to control opening with a control valve to the one to control the flow rate by controlling the rotating speed of the pump with the inverter. Gradually opening the valve, lower the pump rotating speed by the inverter. Checking that there is no abnormality, fully open the valve at the end. (See Fig. 3.)

(2) Measurement items (See Fig. 4.)

- ① When a flowmeter is not installed, install an external ultrasonic flowmeter, etc. which is not accompanied by facility remodeling.
- ② Utilize an existing pressure gauge for the pressure (pump head). When continuous measurement is required, remove and reinstall the existing pressure gauge.
- ③ Use a pump current and power for monitoring a pump overcurrent and checking an energy conservation volume. There is also a clamp type wattmeter which measures a voltage with a clip.

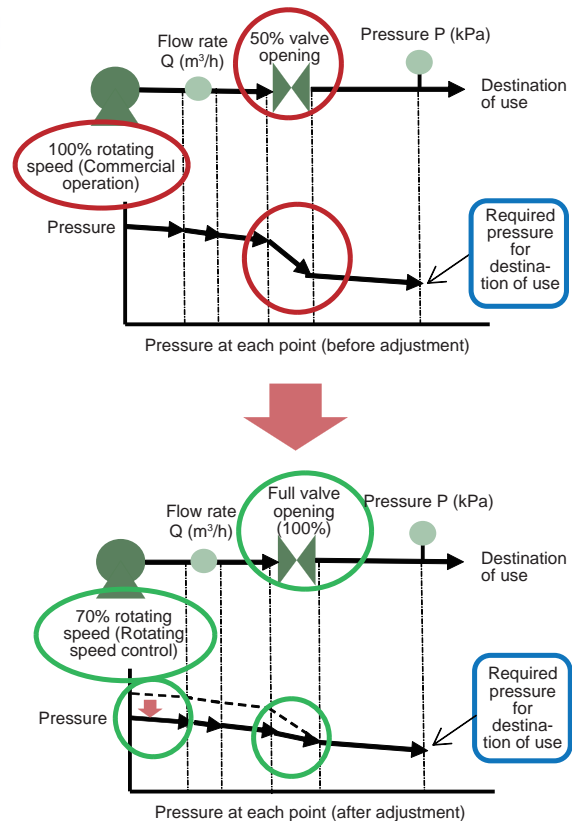


Fig. 3 Concept of inverter frequency control

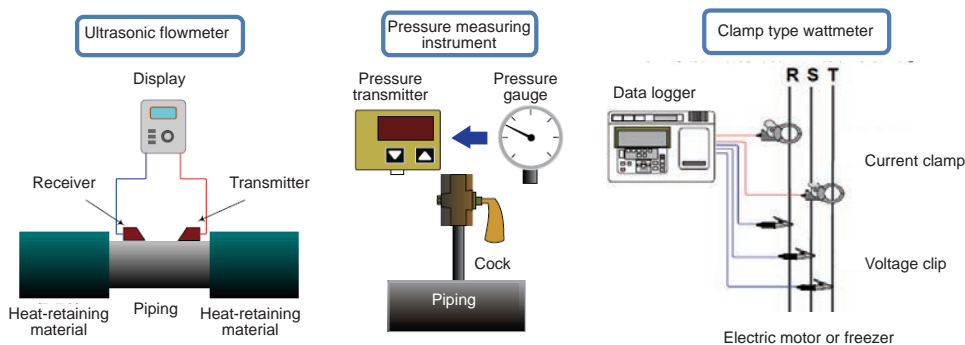


Fig. 4 Main measuring instruments

(Source: Newly published Energy Conservation Tuning Manual, The Energy Conservation Center, Japan)

(3) Tuning procedure

① Preparation (understanding of the status quo)

- Check and record the current operating condition through measurement. To make it double sure, record the valve opening so as to restore the status quo.
- Check the current operating level on the pump performance curve.

② Implementation

- Start operation under the current operating requirements (control the flow rate with a regulating valve and ensure 100% rotating speed of the pump).
- Checking that there is no abnormality with the pump current, etc., open the regulating valve gradually and lower the rotating speed of the pump to adjust the destination pressure to the same as the status quo.
- After fully opening the regulating valve, check that the flow rate, pressure (pump head), current (electric power), etc. are compatible with the characteristics of the pump performance curve.
- Changing the rotating speed within the possible range, measuring the flow rate, pressure and pump electric energy, and organizing them in a graph, etc. will be useful for future operation.
- By forecasting the rotating speed and pump electric energy for each operating condition throughout the year, it is possible to calculate reduced electric energy when the pump is controlled by the inverter.

Case B-3: Controlling the Cooling Water Setting Temperature of the Chiller

1. Current problem

A turbo chiller in an office building (total floor area: 22,400 m²) operates with the cooling water inlet temperature of 30°C throughout the year.

2. Improvement measure

Chiller efficiency is improved by lowering the cooling water temperature. Finely control the cooling water setting temperature at the peak cooling load time and during other light cooling load period to improve chiller efficiency.

3. Effect estimation

(1) Calculation formula

For the required power (%) after changing the cooling water temperature, read the value at the predetermined refrigeration capacity in Fig. 1.

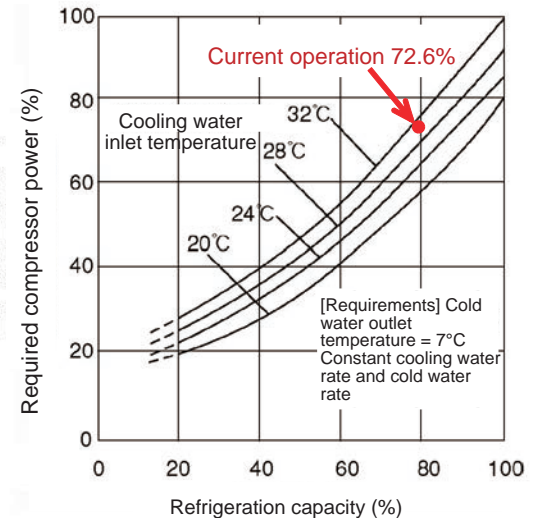


Fig. 1 Cooling water temperature and compressor power

(Source: Air conditioning and Sanitary Engineering Handbook (1987))

Table 1 Compressor power and cooling water temperature of turbo chiller

Month	Current power consumption kWh	Average temperature °C	Relative humidity %	Wet-bulb temperature °C	Cooling water inlet temperature °C			Required power %	Reduction rate %	Reduced electric energy kWh
					Current	Improved	Improvement value			
6	27,936	23.8	66.8	19.4	30	25	5.0	66	9.1	2,542
7	26,862	27.3	68.0	22.8	30	28	2.0	70	3.6	967
8	29,011	28.9	65.0	23.7	30	29	1.0	71	2.2	638
9	25,788	25.6	66.7	21.1	30	27	3.0	68	6.3	1,625
Total	109,597									5,772

The reduction rate indicates reduction from the current required power (%). Lower cooling water temperature results in higher power for a cooling tower fan, but it was excluded from the effect estimation because it is assumed to be approximately several percent of the overall reduced electric energy.

(2) Prerequisites for calculation

Current cooling water inlet temperature setting: 30°C
 Chiller load factor (refrigeration capacity): 80%
 Current required power: 72.6% (See Fig. 1.)
 Improved cooling water inlet temperature setting: 25 to 29°C (See Table 1.)

4. Effects

①	Power consumption (current)	109,600	kWh/year	Table 1
②	Power consumption (improved)	103,800	kWh/year	① - ③
③	Reduced power consumption	5,800	kWh/year	Table 1
④	Energy conservation rate	5.3	%	③ / ①
⑤	Saved amount of money	110	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	1.5	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	2.6	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

Case B-4: Introducing the Inverter for the Air Conditioner Fan

1. Current problem

The airflow rate of the air conditioners in an airport lobby remains set to 80% (constant damper opening) regardless of busy and quiet hours of departure and arrival.

2. Improvement measure

Rotating speed control of an air conditioner fan can reduce more power consumption than airflow rate control by damper opening. Introduce an inverter and control the rotating speed in 2 stages during busy and quiet hours.

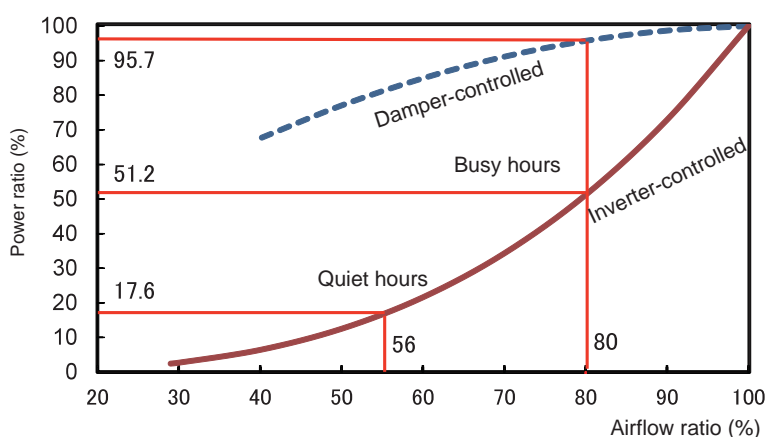


Fig. 1 Airflow ratio and power ratio of fan

3. Effect estimation

(1) Calculation formula

Current power consumption: Fan motor capacity (kW) x Motor load factor (%) x Power ratio (current) x Operating time (h/year)
 Improved power consumption: Power consumption (current) x Ratio of current power to improved power / Inverter efficiency

(2) Prerequisites for calculation

Fan motor capacity: 55 kW

Motor load factor: 80%

Air feed ratio: (Current) 90% (Improved) Busy hours 80%, Quiet hours 56%

Power ratio: (Current) 95.7% (Improved) Busy hours 51.2%, Quiet hours 17.6%

Motor operating time: (Current) 2,736 h/year (Improved) Busy hours 2,052 h/year, Quiet hours 684 h/year

Inverter efficiency: 0.95

Ratio of current power to improved power: $0.447 = (2,052 \times 0.512 + 684 \times 0.176) / (2,736 \times 0.957)$

4. Effects

①	Power consumption (current)	129,600	kWh/year	
②	Power consumption (improved)	60,980	kWh/year	
③	Reduced power consumption	68,620	kWh/year	① - ②
④	Energy conservation rate	53	%	③ / ①
⑤	Saved amount of money	1,304	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	17.6	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	31.1	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

Case B-5: Controlling the Boiler Combustion Air Ratio

1. Current problem

A hot water boiler for air conditioning in an education facility (total floor area: 10,400 m²) has 8.8% high exhaust gas oxygen concentration, being operated at an excessive air ratio*. If a combustion facility has an excessive air ratio, its combustion temperature and efficiency drop.

(* Air ratio: Ratio of a theoretical air volume to an actually used air volume)

2. Improvement measure

Control the air ratio to 1.3, the range specified by the EC Guideline of the Energy Conservation Act (fuel is a city gas).

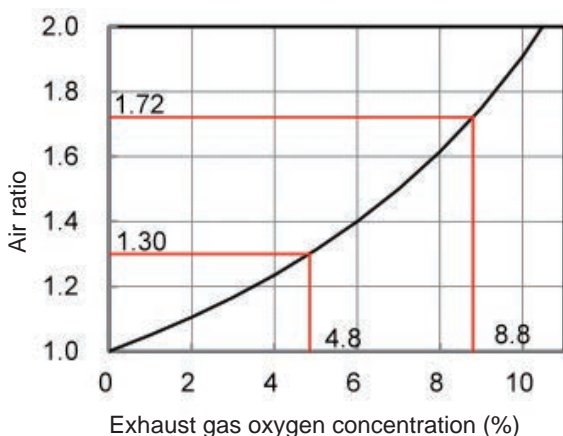


Fig. 1 Exhaust gas oxygen concentration and air ratio (13A gas)

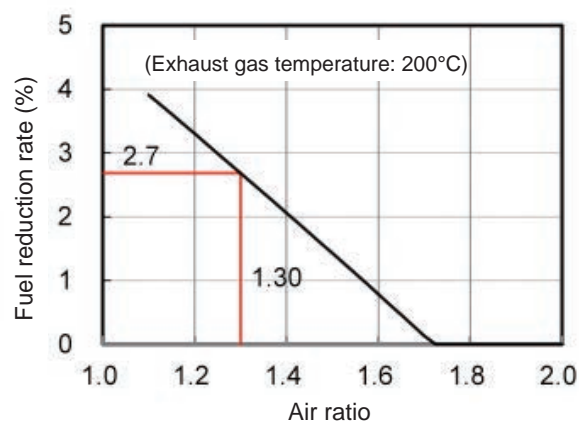


Fig. 2 Air ratio and fuel reduction rate (13A gas)

3. Effect estimation

(1) Calculation formula

Air ratio: $21 / (21 - \text{Exhaust gas oxygen concentration } (\%))$

Fuel reduction: Current fuel consumption (m³/year) x Fuel reduction rate by improved air ratio (%)

(2) Prerequisites for calculation

Current boiler fuel consumption: 72,100 m³/year (city gas 13A)

Exhaust gas oxygen concentration: Currently 8.8%, Improved to 4.8%

Air ratio: Currently 1.72, Improved to 1.30

Exhaust gas temperature: 200°C (constant)

Fuel reduction rate by improved air ratio: 2.7%, See Fig. 2.

4. Effects

①	Fuel consumption (current)	72,100	m ³ /year	
②	Fuel consumption (improved)	70,200	m ³ /year	
③	Reduced fuel consumption	1,900	m ³ /year	
④	Energy conservation rate	2.6	%	③ / ①
⑤	Saved amount of money	194	¥1,000/year	③ x ¥102/m ³
⑥	Reduction in crude oil equivalent	2.2	kL/year	③ x 44.8 MJ/m ³ x 0.0258 kL/GJ
⑦	CO ₂ reduction	4.2	t-CO ₂ /year	③ x 44.8 MJ/m ³ x 0.0136 x (44 / 12) t-CO ₂ /GJ

5. Implementation of the proposal and tuning

(1) EC Guideline of the Energy Conservation Act

The Energy Conservation Act stipulates the standard air ratio and standard waste gas temperature as the "EC Guidelines" as listed in Table 1 as to boiler combustion management and the like. Check if the boiler meets these Guidelines (O₂ concentration corresponding to the air ratio is added for your reference by the Energy Conservation Center, Japan).

Table 1 Standard air ratio and standard waste gas temperature of boilers (excerpts*¹)

Category		Load factor (%)	Liquid fuel			Gaseous fuel		
			Air ratio	O ₂ concentration (%)	Waste gas temperature (°C)	Air ratio	O ₂ concentration (%)	Waste gas temperature (°C)* ²
General boilers* ²	Evaporation volume of 30 t/h or more	50 to 100	1.1 to 1.25	1.9 to 4.2	200	1.1 to 1.2	1.9 to 3.5	170
	10 t/h or more and less than 30 t/h	50 to 100	1.15 to 1.3	2.7 to 4.8	200	1.15 to 1.3	2.7 to 4.8	170
	5 t/h or more and less than 10 t/h	50 to 100	1.2 to 1.3	3.3 to 4.8	220	1.2 to 1.3	3.3 to 4.8	200
	Evaporation volume of less than 5 t/h	50 to 100	1.2 to 1.3	3.5 to 4.8	250	1.2 to 1.3	3.5 to 4.8	220
Small once-through boilers* ³		100	1.3 to 1.45	4.8 to 6.5	250	1.25 to 1.4	4.8 to 6.0	220

*¹ Public notice by METI: Excerpted from EC Guideline of Business Operators for Rationalization of Energy Use at Factories, etc., Appendix Table 1(A), (1) for air ratio, and Appendix Table 2(A), (1) for waste gas temperature.

- The standard air ratio values in this table set the air ratio measured at the exhaust outlet of the furnace when combusting at near the rated load after inspection or repair.
- The standard waste gas temperature sets the waste gas temperature in combustion at a 100% load factor under the 20°C inlet temperature of the boiler ventilator after periodic inspection.

*² Boilers other than small ones (See the Order for Enforcement of the Industrial Safety and Health Act, Article 1, Paragraph 4.)

*³ Of small boilers, those defined by the Order for Enforcement of the Air Pollution Control Act, Table 1 (Article 2 related), Clause 1. There are exemptions of the air ratio and the waste gas temperature. See "Remarks" in their respective tables.

(2) Boiler combustion control

Operate a fuel and an air volume required for combustion in order to maintain the steam pressure in a constant range, which fluctuates depending on steam consumption.

(3) Measurement of the exhaust gas oxygen concentration

Small- and medium-capacity boilers used for general industries and buildings are not provided with an oxygen densitometer, and most of them do not have feedback operation by continuous measurement. To check if the air ratio is adequate, accordingly, it is necessary to prepare an oxygen densitometer to measure oxygen concentration in the exhaust gas. You may ask a boiler manufacturer, etc. for measurement in many cases. In measurement, however, note the following.

- Even if multiple boilers are installed, measurement needs to be conducted so that the values of individual boilers will be correctly evaluated. With other boilers stopping, if measurement is made in the exhaust gas collecting piping, etc., the oxygen concentration may become higher than the reality due to leak air.
- It is necessary to measure when a boiler load is stable in the range in Table 1. Generally, the oxygen concentration is higher at low load.
- When measuring air pollution such as dust and soot, and NO_x, care should be taken to check if these requirements are met.

(4) Air ratio control

Because the air ratio fluctuates depending on the load factor, season (outside air temperature), etc., it is necessary to consult a boiler manufacturer, etc. to control it. Too low the air ratio results in troubles such as dust and soot or heat losses due to imperfect combustion (Fig. 4).

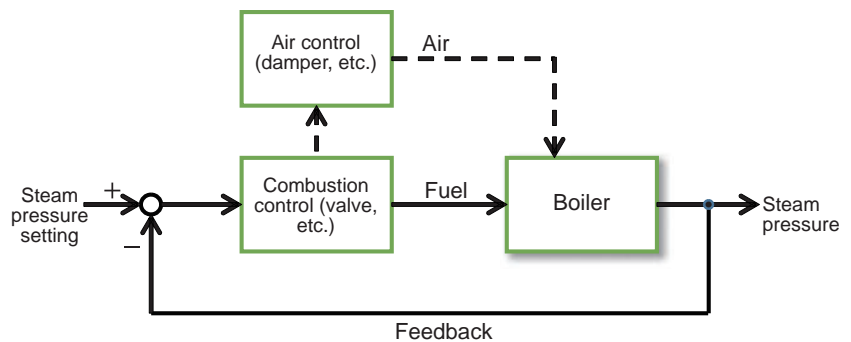


Fig. 3 Boiler combustion control

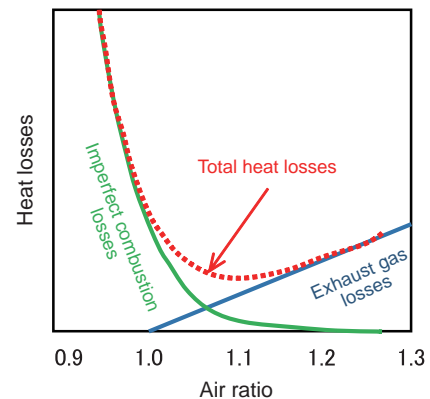


Fig. 4 Composition of combustion losses (example)

C. Air Conditioning and Ventilation Facilities, etc.

Case C-1: Stopping an Outside Air Intake during Warming Up Air Conditioning

1. Current problem

In an office building (total floor area: 14,500 m²), a total heat exchanger is also operated to take in the outside air during warming-up operation one hour before (8:00 a.m.) starting daily work. At start-up time when there is almost no one in the rooms, it is hardly necessary to take in the outside air, wasting air conditioning energy by taking in the outside air in the high-temperature, high-humidity state in summer and low-temperature dry state in winter (Fig. 1).

2. Improvement measure

Stop operating the total heat exchanger during warming-up operation not to take in the outside air, thereby reducing power consumption of air conditioning and that of the total heat exchanger.

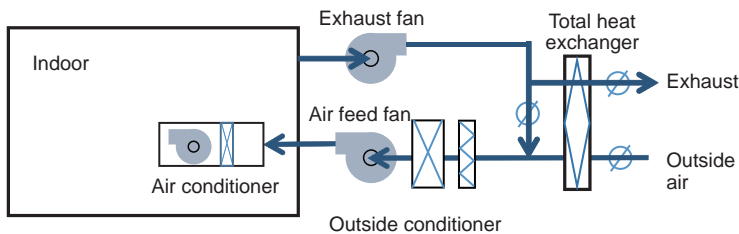


Fig. 2 Example of total heat exchanger system

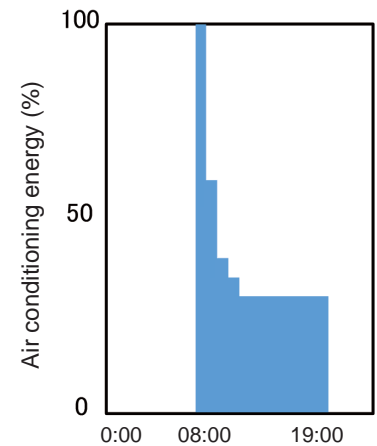


Fig. 1 Start-up image

Table 1 Current outside air intake volume

Type	Specifications of total heat exchanger
Area 1	Air feed 20,720 m ³ /h x 15 kW Exhaust 16,400 m ³ /h x 11 kW
Area 2	Air feed 21,220 m ³ /h x 15 kW Exhaust 16,900 m ³ /h x 11 kW

3. Effect estimation

(1) Calculation formula

Reduced power consumption is as follows.

Air conditioner: Outside air intake volume (kg/h) x Difference in specific enthalpy of indoor and outdoor air (kJ/kg) x (1 – total heat exchanger efficiency) x Operating time (h/year) / Air conditioning facility COP / 3,600 (kJ/kWh)

Total heat exchanger: Total heat exchanger fan power (kW) x Operating time (h/year)

(2) Prerequisites for calculation

Outside air intake volume: 41,940 m³/h (See Table 1.) → 50,328 kg/h (air density at 20°C: 1.2 kg/m³)

Total heat exchanger efficiency: 0.55, Total fan motor capacity: 52 kW (See Table 1.)

Operating time: 176 h/year for heating, 88 h/year for cooling

Air conditioning facility COP: 3.5 for heating, 3.0 for cooling

Difference in specific enthalpy of indoor and outdoor air: 17.8 kJ/kg (average value) for heating, 8.7 kJ/kg (average value) for cooling

(Note) Specific enthalpy of the air: Total heat quantity possessed by the air including steam (with reference to 0°C, 1-kg dry air)

4. Effects

①	Reduced power consumption	21,000	kWh/year	
②	Energy conservation rate	—	%	
③	Saved amount of money	399	¥1,000/year	① x ¥19/kWh
④	Reduction in crude oil equivalent	5.4	kL/year	① x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑤	CO ₂ reduction*	9.5	t-CO ₂ /year	① x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

Case C-2: Reducing the Solar Radiation Load through the Window Glass

1. Current problem

In the buildings located in the areas where cooling consumes more power than heating does, there is a high solar radiation load through the southwestern windows during a cooling season, consuming high electric power during cooling.

2. Improvement measure

Apply a light-shielding film to the window glass to reduce the solar radiation load in summer. (When heating in winter, heating energy increases.)

3. Effect estimation

(1) Calculation formula

Incident heat quantity: Amount of solar radiation (kWh / (m²·day)) x Solar radiation heat acquisition rate x Glass area (m²)

Reduced air conditioning heat quantity: When cooling, current indoor heat input (kWh) – Improved indoor heat input (kWh); reversed when heating

Reduced power consumption: Total of reduced air conditioning heat quantity / Air conditioner COP

* Amount of solar radiation: Data cited from NEDO "National Solar Radiation Data Map" (Azimuth: 45° from the due south, Angle of inclination: 90°).

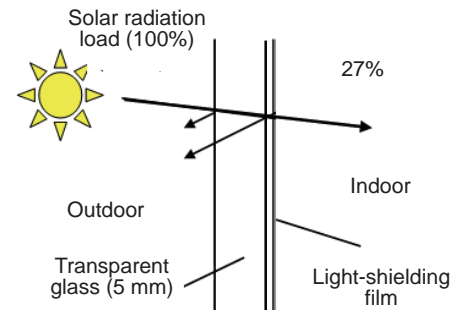


Fig. 1 Window glass and light-shielding film

Table 1 Calculation of indoor heat input

[Data point: Hiroshima]

Month	Amount of solar radiation* (kWh/m ² ·day)	Incident heat quantity (kWh/day)		Air conditioning Mode	Air conditioned days [Days]	Indoor heat input (kWh)		Reduced air conditioning heat qty. (kWh)
		Current	Improved			Current	Improved	
1	2.44	420	130	Heating	18	7,554	2,342	-5,212
2	2.55	439	136	Heating	19	8,333	2,583	-5,750
3	2.66	458	142	No heating/cooling				
4	2.80	482	149	Cooling	10	4,816	1,493	3,323
5	2.73	470	146	Cooling	19	8,922	2,766	6,156
6	2.41	415	129	Cooling	22	9,119	2,827	6,292
7	2.51	432	134	Cooling	20	8,634	2,677	5,957
8	2.92	502	156	Cooling	23	11,552	3,581	7,971
9	2.50	430	133	Cooling	20	8,600	2,666	5,934
10	2.85	490	152	Cooling	10	4,902	1,520	3,382
11	2.60	447	139	No heating/cooling				
12	2.49	428	133	Heating	18	7,709	2,390	-5,319
						104,986	47,579	22,734

(2) Prerequisites for calculation

Window glass: Azimuth = 45° from the due south, Angle of inclination = 90°, Thickness = 5 mm, Area = 200 m²

Solar radiation heat acquisition rate: (5-mm glass) 0.86, (Glass + light-shielding film) 0.27

Air conditioner COP: 3.5 for cooling, 3.7 for heating

4. Effects

①	Reduced power consumption	6,495	kWh/year	
②	Energy conservation rate	—	%	
③	Saved amount of money	127	¥1,000/year	① x ¥19/kWh
④	Reduction in crude oil equivalent	1.7	kL/year	① x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑤	CO ₂ reduction*	2.9	t-CO ₂ /year	① x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

[Reference] Introduction of new technology

A technology of spraying transparent coating on a glass surface to form a film and use it to reduce a load from insolation has been developed. The film can be formed on special glasses, such as a curved glass on which a normal film cannot be pasted properly. Another one is a "Low-E pair glass" with improved thermal insulation in addition to an improved heat shield property.

Case C-3: Improving the Total Heat Exchanger

1. Current problem

In an assembly hall (total floor area: 5,200 m²), a total heat exchanger in a hall air conditioning line is not functioning. A heat load due to the outside air accounts for 20 to 30%, there is a high ratio of an air conditioning load in general office buildings. Furthermore, more outside air is required in a room with many people such as an assembly hall, with the heat load accounting for higher percentage of the air conditioning load.

2. Improvement measure

Recover the function of the total heat exchanger and enable heat recovery from air conditioning exhaust to reduce an outside air load.

The total heat exchanger is an effective measure to achieve both precautions for COVID-19 and reduction of the air conditioning load through ventilation. Recently, some total heat exchanger models with higher flexibility in installation are commercialized. They include a model having a humidifying function with low energy consumption and a model consuming less power during partial load operation by controlling air volume using a high efficiency motor.

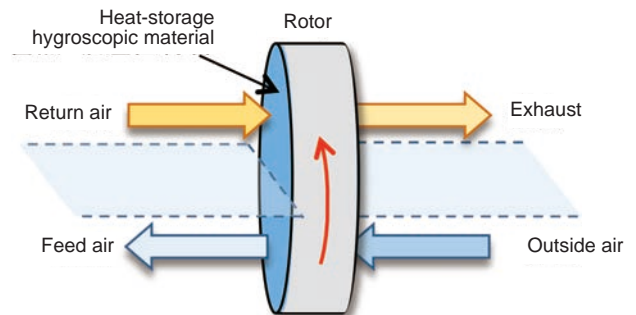


Fig. 1 Rotary total heat exchanger

3. Effect estimation

(1) Calculation formula

Calculate for heating operation and cooling operation by the following formula and totalize the results.

Heat source gas reduction: Outside air intake volume (kg/h) x Difference in specific enthalpy of indoor and outdoor air (kJ/kg) x Heat exchange efficiency of total heat exchanger (%) x Operating time (h/year) / Lower heating value of fuel (MJ/m³) / Hot/cold water generator COP

(2) Prerequisites for calculation

Outside air intake volume: 26,352 kg/h (21,960 m³/h)

Air conditioning time (h/year): 170 h/year for cooling, 170 h/year for heating (2 hours/day)

Hot/cold water generator COP: 1.0 for cooling, 0.8 for heating

Difference in specific enthalpy of indoor and outdoor air: 13.9 kJ/kg (average value) for cooling, 31.5 kJ/kg (average value) for heating

(Note) Specific enthalpy of the air: Total heat quantity possessed by the air including steam (with reference to 0°C, 1-kg dry air)

Heat source fuel heating value: City gas 13A, 40.5 MJ/m³ (lower heating value)

Heat exchange efficiency of total heat exchanger: 60%

4. Effects

①	Reduced fuel consumption	3,500	m ³ /year	City gas 13A
②	Energy conservation rate	—	%	
③	Saved amount of money	357	¥1,000/year	① x ¥102/m ³
④	Reduction in crude oil equivalent	4.0	kL/year	① x 44.8 MJ/m ³ x 0.0258 kL/GJ
⑤	CO ₂ reduction	7.8	t-CO ₂ /year	① x 44.8 MJ/m ³ x 0.0136 x (44 / 12) t-CO ₂ /GJ

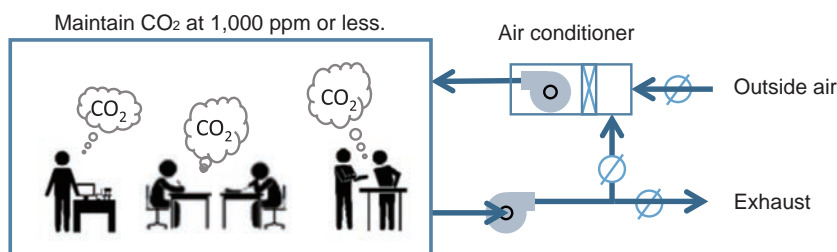
Case C-4: Reducing the Outside Air Intake Volume by Indoor CO₂ Concentration Management

1. Current problem

The indoor CO₂ concentration of an assembly hall (total floor area: 19,600 m²) is 600 ppm, well below the concentration standard (1,000 ppm or less) specified by the "Act on Maintenance of Sanitation in Buildings" (an outside air intake volume is excessive). An excessive intake of the outside air increases a cooling load in summer and a heating load in winter.

2. Improvement measure

Increase an indoor CO₂ concentration control value to 800 ppm and control an outside air intake volume within the range of not exceeding this standard value to lower an outside air load during heating/cooling. An effective measure to prevent COVID-19 requires the environment that is not a "closed and ill-ventilated space". Note that a space with the indoor CO₂ concentration equal to or less than 1,000 ppm is considered to be not the "closed and ill-ventilated space".



* Personal CO₂ emissions range from 10 to 90 L/(h · person), depending on an amount of activity.

Fig. 1 CO₂ concentration control by introduction of outside air

3. Effect estimation

(1) Calculation formula

Totalize the respective outside air reductions in cooling and heating operations.

Outside air reduction rate: $1 - \{(\text{Current indoor CO}_2 \text{ concentration} - \text{CO}_2 \text{ concentration of outside air}) / (\text{Improved indoor CO}_2 \text{ concentration} - \text{CO}_2 \text{ concentration of outside air})\}$

Reduced outside air volume: Current outside air intake volume (kg/h) x Outside air reduction rate

Fuel reduction: Reduced outside air volume (kg/h) x Difference in specific enthalpy of indoor and outdoor air (kJ/kg) x (1 – Heat exchange efficiency of total heat exchanger) x Operating time (h/year) / Lower heating value of fuel (MJ/m³) / Hot/cold water generator COP

(2) Prerequisites for calculation

CO₂ concentration: Current indoor air 600 ppm, Improved indoor air 800 ppm, Outside air 400 ppm

Air density (20°C): 1.2 kg/m³

Current outside air intake volume: 20,000 m³/h x 1.2 kg/m³ = 24,000 kg/h

Heat exchange efficiency of the total heat exchanger: 55%

Air conditioner operating time: 750 h/year for cooling, 1,000 h/year for heating

Hot/cold water generator COP: 1.0 for cooling, 0.8 for heating

Difference in specific enthalpy of indoor and outdoor air: 12.1 kJ/kg (average value) for cooling, 30.2 kJ/kg (average value) for heating

(Note) Specific enthalpy of the air: Total heat quantity possessed by the air including steam (with reference to 0°C, 1-kg dry air)

Fuel heating value: City gas 13A, 40.5 MJ/m³ (lower heating value)

4. Effects

①	Reduced fuel consumption	6,200	m ³ /year	City gas 13A
②	Energy conservation rate	—	%	
③	Saved amount of money	632	¥1,000/year	① x ¥102/m ³
④	Reduction in crude oil equivalent	7.2	kL/year	① x 44.8 MJ/m ³ x 0.0258 kL/GJ
⑤	CO ₂ reduction	13.9	t-CO ₂ /year	① x 44.8 MJ/m ³ x 0.0136 x (44 / 12) t-CO ₂ /GJ

Case C-5: Changing the Operating Method of the Ventilation Fan in the Parking Lot

1. Current problem

To feed and exhaust the air into/from the underground parking lot of a government office building, both air feed and exhaust fans are intermittently operated 3 times a day in the time period during which official vehicles enter and leave intensively.

2. Improvement measure

Because there is a vehicle approach path widely open to outside the parking lot, stop the air feed fans and operate only the exhaust fans. As a result of checking the CO concentration in the parking lot in this state, it was found out that this approach path could be utilized to introduce a required outside air volume and maintain an environment. When the CO concentration increases, operate the air feed and exhaust fans temporarily.

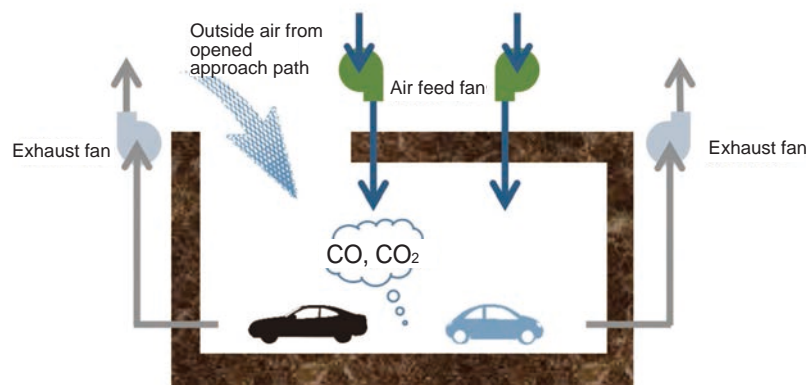


Fig. 1 Schematic diagram of parking lot

3. Effect estimation

(1) Calculation formula

Electric energy consumption: Fan power (kW) x Average load factor (%) x Operating time (h/year)

(2) Prerequisites for calculation

Status quo: All the air feed fans and exhaust fans are operated.

After improvement: Only the exhaust fans are operated.

Air feed fan: 5.5 kW x 2 units

Exhaust fan: 5.5 kW x 2 units

Average load factor: 80%

Fan operating time: 1 h/each x 3 times/day x 310 days/year = 930 h/year

4. Effects

①	Power consumption (current)	16,400	kWh/year	
②	Power consumption (improved)	8,200	kWh/year	
③	Reduced power consumption	8,200	kWh/year	① - ②
④	Energy conservation rate	50	%	③ / ①
⑤	Saved amount of money	156	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	2.1	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	3.7	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

D. Lighting Facilities, etc.

Case D-1: Replacing the Fluorescent Lamp Fixture with the LED

1. Current problem

Conventional fluorescent lamps are used in the conference rooms, lobby, guest rooms, offices of the hotel-type facilities intended for lodging and training. Having been 15 years since their installation, it is about time to replace them.

2. Improvement measure

Replace the conventional fluorescent lamps with LED lamps to enhance energy conservation. In response to the request of the facility side, use the reflectors, frames, etc. of the current fluorescent lamp fixtures without changing the appearance of the ceiling, replace a stabilizer with a DC power unit, replace plug sockets, and attach straight-tube LEDs. These replacement work requires a qualified electrician.

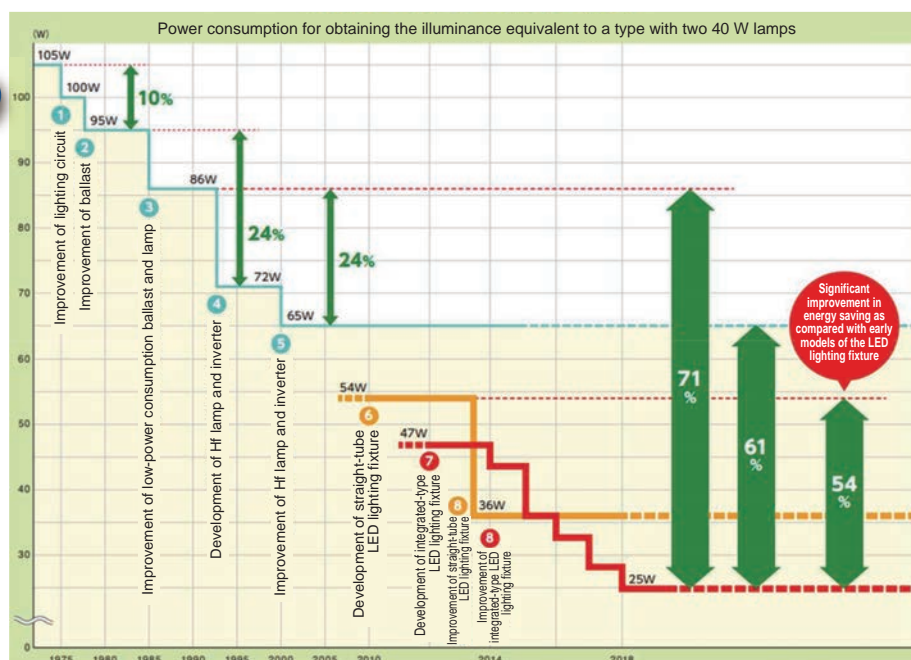


Fig. 1 Transition of power consumption of lighting fixture
(Example of power consumption for obtaining the illuminance equivalent to two 40 W lamps)
(Source: Japan Lighting Manufacturers Association)

3. Effect estimation

(1) Calculation formula

Current power consumption: Power consumption (current) (W/unit) x Quantity (units) x Lighting time (h/year)

Improved power consumption: Power consumption (improved) (W/unit) x Quantity (units) x Lighting time (h/year)

(2) Prerequisites for calculation

Power consumption (current): 86 W/unit

Power consumption (improved): 30 W/unit

Quantity: 800 units

Lighting time: 8.3 h/day x 358 days/year = 2,970 h/year

4. Effects

①	Power consumption (current)	204,300	kWh/year	
②	Power consumption (improved)	59,400	kWh/year	
③	Reduced power consumption	144,900	kWh/year	① - ②
④	Energy conservation rate	71	%	③ / ①
⑤	Saved amount of money	2,753	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	37.3	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	65.6	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

Case D-2: Introducing the LED Guide Light

1. Current problem

Many conventional fluorescent guide lights are installed in a certain museum. Being continuously energized and inefficient, they consume plenty of electric power.

2. Improvement measure

Replace them with high-efficiency LED guide lights to enhance energy conservation. They shall be replaced with the guide lights of the same class. When replacing, it is necessary to notify the competent fire station in advance.

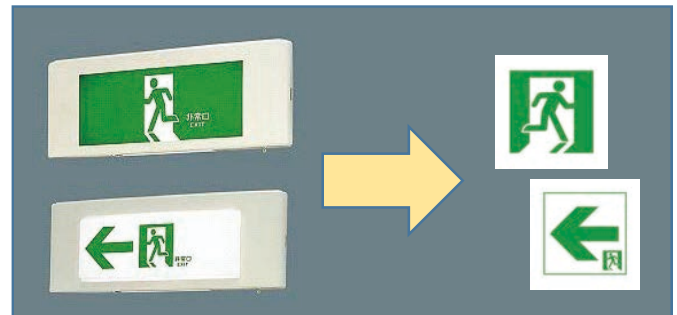


Fig. 1 Appearance of fluorescent (left) and LED (right) guide lights

3. Effect estimation

(1) Calculation formula

Current power consumption: Power consumption/unit (current) (kW) x No. of installed units x Energizing time (h/year)

Improved power consumption: Power consumption/unit (improved) (kW) x No. of installed units x Energizing time (h/year)

(2) Prerequisites for calculation

Table 1 lists the detailed specifications of the guide lights.

Lighting time: 24 h/day x 365 days/year = 8,760 h/year

Table 1 Current and improved power consumption and reduced electric energy of guide lights

Specifications	Current		Improved		No. of units	Power consumption		
	Type	Power consumption (W)	Type	Power consumption (W)		Current (kWh/year)	Improved (kWh/year)	Reduction (kWh/year)
B-class large-sized, one-sided	40 W fluorescent lamp	43.0	LED	3.5	3	1,130	92	1,038
B-class medium-sized, one-sided	20 W fluorescent lamp	23.0	LED	2.7	60	12,089	1,419	10,670
C-class one-sided	10 W fluorescent lamp	15.0	LED	2.3	8	1,051	161	890
Total					71	14,270	1,672	12,598

4. Effects

①	Power consumption (current)	14,300	kWh/year	
②	Power consumption (improved)	1,700	kWh/year	
③	Reduced power consumption	12,600	kWh/year	① - ②
④	Energy conservation rate	88	%	③ / ①
⑤	Saved amount of money	239	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	3.2	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	5.7	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

Case D-3: Introducing Task Ambient Lighting

1. Current problem

Fluorescent lamps are attached to the ceiling of an office. Because they double as task lighting to illuminate the working surface, the entire room has high illuminance, including an empty area, wasting the lighting power.

2. Improvement measure

Thin out the existing fluorescent lamps attached to the ceiling to switch to ambient lighting which illuminates the entire room, and newly install a low-power consumption LED desk lamp at each desk for task.

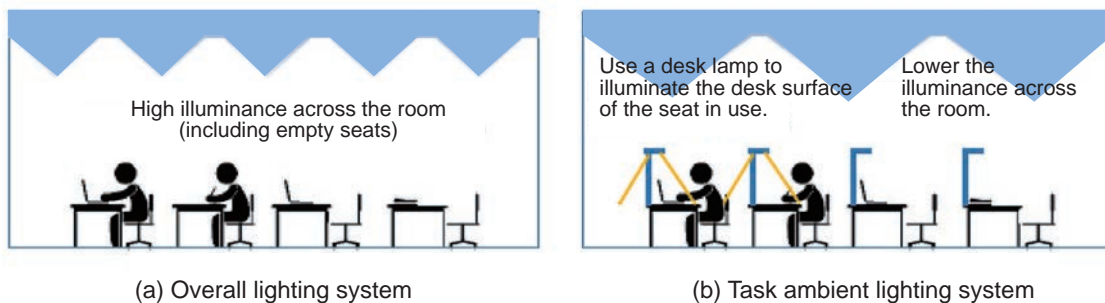


Fig. 1 Overall lighting system and task ambient lighting system

3. Effect estimation

(1) Calculation formula

Current power consumption: Power consumption of the fluorescent lamp (W/unit) x Current quantity (units) x Lighting time (h/year)

Improved power consumption: Power consumption of the fluorescent lamp (W/unit) x Improved quantity (units) x Lighting time (h/year) + Power consumption of the desk lamp (W/unit) x Quantity (units) x Lighting time (h/year) x Lighting rate

(2) Prerequisites for calculation

Power consumption: Fluorescent lamp 86 W/unit, LED desk lamp 12 W/unit

Quantity (current): 33 fluorescent lamps (current)

Quantity (improved): 17 fluorescent lamps (improved) (16 units thinned out), 36 LED desk lamps

Lighting time: Daily work hours of 13 h x 293 days/year = 3,800 h/year

Desk lamp lighting rate: 50% (assumed to be a seat occupancy rate)

Note: Completely shut off the power for the thinned-out lamps.

4. Effects

①	Power consumption (current)	10,800	kWh/year	
②	Power consumption (improved)	6,400	kWh/year	
③	Reduced power consumption	4,400	kWh/year	① - ②
④	Energy conservation rate	41	%	③ / ①
⑤	Saved amount of money	84	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	1.1	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	2.0	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

[Reference] Introduction of new technology

A new lighting system capable of reducing LED ambient power consumption based on three elements (sensor, light dimming, and lighting duration) are commercialized. The system allows a user to check the power consumption of lighting on a tablet. It also has a function of visualizing low-traffic areas detected by sensors and controlling illumination in the areas.

E. Power Receiving and Transforming Facilities, Power Leveling Facilities, etc.

Case E-1: Renewing and Integrating the Transformers

1. Current problem

Transformers in an electric room have been installed and used for 25 years or more. Compared with the recent ones, they are less efficient and subject to higher power losses. One of them is used under a considerably light load; its power losses are not low.

2. Improvement measure

Integrate low-load No. 2 with No. 1 and renew No. 1, No. 3, No. 4 and No. 5 to high-efficiency top runner II transformers.

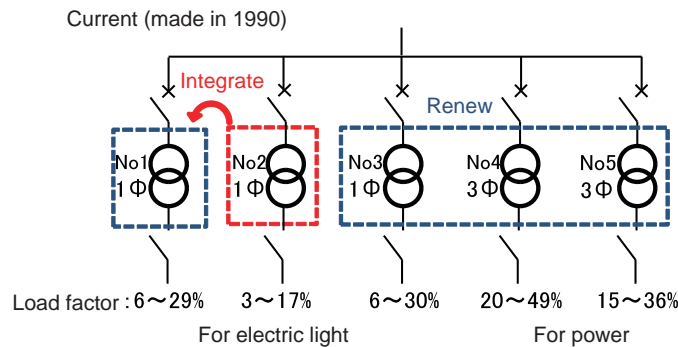


Fig. 1 Configuration of transformers

3. Effect estimation

(1) Calculation formula (Calculate on each of current and improved transformers. Fig. 2 shows the results.)

Load losses: Load losses (W) x {(Working load factor)² x Working hours (h/year) + (Load factor on holidays and at night)² x Nighttime and holiday hours (h/year)}

No-load losses: No-load losses (W) x Energizing time (h/year)

Power consumption (Total losses): Load losses (kWh/year) + No-load losses (kWh/year)

(Total losses)

(2) Prerequisites for calculation

Table 1 shows the specifications and load factor of the transformer.

Working hours: 14 h/day x 364 days/year = 5,096 h/year

Energizing time: 24 h/day x 365 days/year = 8,760 h/year

Nighttime and holiday hours: 8760 h – 5,096 h = 3,664 h/year

Table 1 Current and improved specifications and load factor of transformers

Name	Transformer rating	Current (made in 1990)				Improved (Top runner II)			
		Generated losses at rating (W)		Load factor (%)		Generated losses at rating (W)		Load factor (%)	
		Load losses	No-load losses	During working hours	Nighttime and holiday	Load losses	No-load losses	During working hours	Nighttime and holiday
No.1	500 kVA, single phase, 60 Hz	5,262	817	29	6	3,540	430	39	8
No.2	300 kVA, single phase, 60 Hz	3,372	562	17	3	Integrated with No.1			
No.3	300 kVA, single phase, 60 Hz	3,372	562	30	6	2,195	340	30	6
No.4	500 kVA, three-phase, 60 Hz	6,685	998	49	20	3,710	565	49	20
No.5	300 kVA, three-phase, 60 Hz	4,250	784	36	15	2,530	415	36	15

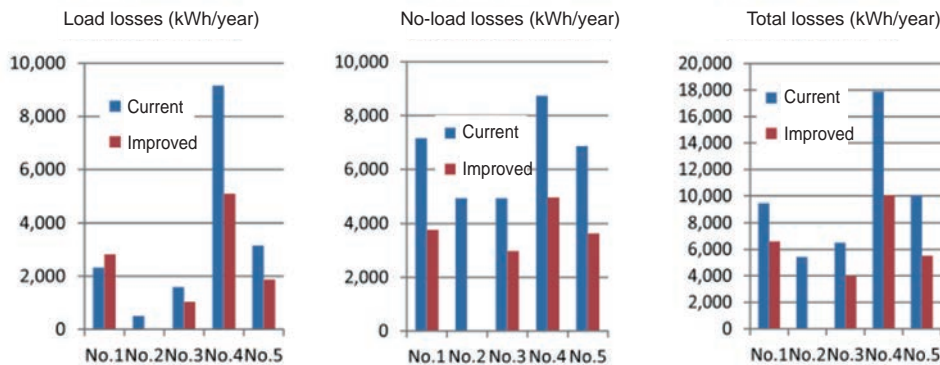


Fig. 2 Power losses of each transformer (current and improved)

4. Effects

①	Power consumption (current)	49,400	kWh/year	
②	Power consumption (improved)	26,200	kWh/year	
③	Reduced power consumption	23,200	kWh/year	① - ②
④	Energy conservation rate	47	%	③ / ①
⑤	Saved amount of money	441	¥1,000/year	③ x ¥19/kWh
⑥	Reduction in crude oil equivalent	6.0	kL/year	③ x 9.97 GJ/1,000 kWh x 0.0258 kL/GJ
⑦	CO ₂ reduction*	10.5	t-CO ₂ /year	③ x 0.453 t-CO ₂ /1,000 kWh

(* For the CO₂ emission coefficient, use the one provided by your contracted power company.)

[Reference] Structure and losses of the transformer

(1) Principle and structure of the transformer
 Fig. 3 shows the structure of the transformer. An iron core made of layered thin silicon steel sheets is insulated and a conductor (normally, copper wire) is coiled around it. If an AC voltage is applied to the primary coil, a magnetic flux is generated in the iron core, and the AC voltage is induced to the secondary coil. The figure illustrates quantitative relations between the AC voltages E_1 and E_2 , and coil turns N_1 and N_2 .

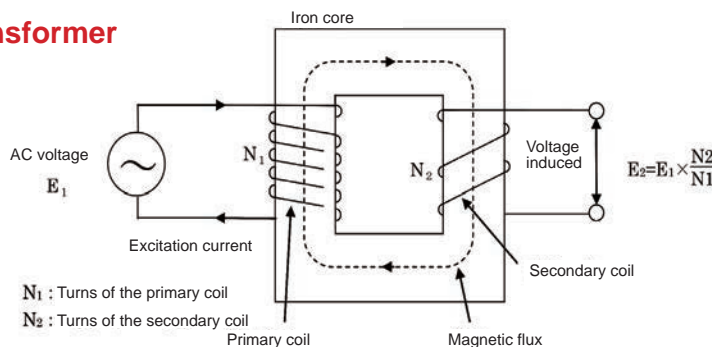


Fig. 3 Structure of transformer

(2) Losses of the transformer, and highest-efficiency load factor

Once the AC voltage is applied to the primary coil to generate the magnetic field in the iron core, there occur the losses (iron losses: no-load losses) due to an alternating magnetic field generated in the iron core. Furthermore, the induced voltage generated on the secondary side causes a load current to run to the secondary coil, producing Joule losses (copper losses: load losses) to the primary and secondary coils.

These two points are the main losses of the transformers. Because the operating time of the transformer is long, no-load losses and load losses tend to be considerably high; energy conservation measures are effective. The highest-efficiency load factor k depends on no-load losses and load losses, having the relations of the following formula. In the conventional transformers, k was largely around 0.5. In the recent high-efficiency transformers, however, it tends to be 0.3 to 0.4, getting closer to a low-load operating point.

$$k^2 \times \text{Load losses (at rating) (W)} = \text{No-load losses (W)}$$

Case E-2: Peak Power Demand Control by Demand Monitoring

1. Current problem

The maximum demand power of a certain inn was 300 kW in the previous year. It has been increasing year after year because of insufficient demand (maximum demand power) control, adding to the basic charge of the power cost.

2. Improvement measure

Monitor a demand to control it under a target value. When it is likely to exceed the target value, stop the allowable facilities. Aim to reduce 10 kW from the status quo to 290 W.

This measure corresponds to lowering demand response (DR) in optimization of electricity demand.

Concept of prioritizing the stoppable facilities

List and prioritize the stoppable facilities. The following describes the general consideration procedure.

- ① Organize the rated power consumption, actual working load power (load factor), quantity, etc. of main facilities (Fig. 1).
- ② Examine the season (Fig. 2) and time period when the maximum power is required. Hourly power consumption data will be collected by installing a demand monitor, etc. in the future (Fig. 3).
- ③ The demand is calculated every 30 minutes. Taking the above season and time period into account, consider if any equipment can be stopped for about 1 hour at that time.
- ④ For air conditioning, there are other methods such as tentatively alleviating the setting temperature (raise in summer and lower in winter) and reducing an outside air intake volume, in addition to stopping. However, note that the effects change depending on the indoor-outdoor temperature difference, etc.

Equipment	Installation site	Specification	Power consumption (kW)	Qty.	Total power consumption (kW)	Load factor (at peak, %)	Electric power (kW)	Power saved at peak
Lighting	Office	Fluorescent lamp FLR 40	0.085	200	170	100	170	*
	Common area	Fluorescent lamp FDL18	0.022	500	110	100	110	*
	Guest room	Halogen lamp	0.04	20	0.8	100	0.8	
	Bath room	330 W	0.33	9	3	100	3	*
	Parking lot	330 W	0.33	5	1.7	100	1.7	
	Entire building	Guide light	0.015	36	0.5	100	0.5	
Air conditioner	Office	Air conditioner 1	10	2	20	80	16	*
	Common area	Air conditioner 2	20	4	80	80	64	*
	Guest room	Air conditioner 3	15	10	150	70	105	
	Banquet hall	Air conditioner 4	25	2	50	70	35	*
	Bath room	Air conditioner 5	10	3	30	80	24	*
Freezer/Refrigerator	Kitchen	.	.	.	.	.	.	.
	Butler	.	.	.	.	.	.	.

Fig. 1 List of main equipment

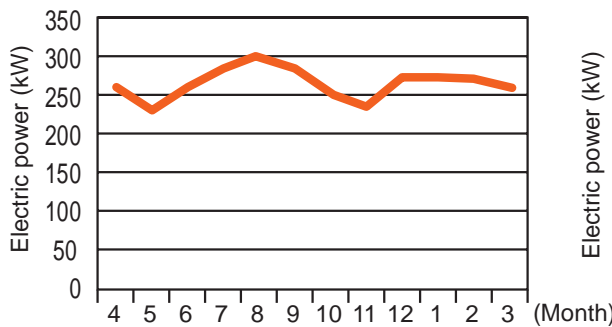


Fig. 2 Example of monthly power consumption

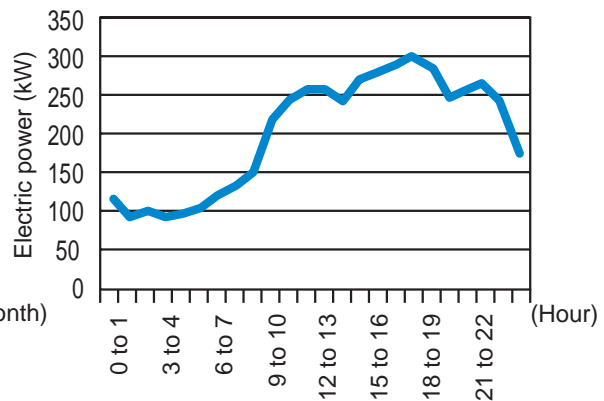


Fig. 3 Example of hourly power consumption

3. Effect estimation

(1) Calculation formula

Basic charge: Contract demand (kW) x Basic charge rate (yen/kW•month) x (185 – pf) / 100

(2) Prerequisites for calculation

Contract demand: Current 300 kW, Target 290 kW (Reduced power 10 kW)

Power factor (pf), basic charge rate: 100%, ¥1,500/kW•month (amount of money depends on the contract)

4. Effects

①	Contract demand (current)	300	kW	
②	Contract demand (improved)	290	kW	
③	Reduced contract demand	10	kW/year	①-②
④	Reduction rate	3.0	%	③ / ①
⑤	Saved amount of money*	153	¥1,000/year	③ x ¥1,500/kW x (185-100) / 100 x 12

(* For the basic charge rate, use the value provided by your contracted power company.)

[Reference] Demand monitor and peak power demand control

(1) Outline of the demand monitor

Fig. 4 shows the configuration of the demand monitor (also referred to as a demand control system).

This device counts the pulses output from the commercial watt-hour meter of the power company according to electric energy and outputs an alarm, etc. when approaching a preset demand. Normally, this device can be connected to a PC to "display", "output a warning", "output a load opening/closing signal", and "record and tabulate data". Furthermore, it allows the remote operation by utilizing IoT technology, such as stop of unnecessary facilities according to an alarm signal, etc. output from the demand monitor.

(2) Optimization of electricity demand

In recent years, variable renewable energies such as solar power generation, are significantly increasing, resulting in a surplus of renewable energy.

It is provided in the revised Energy Conservation Act that electricity demand should be optimized by: during the period with the surplus, shifting the demand to the period (raising DR); during the period with tight electricity supply, limiting the demand (lowering DR: corresponding to the conventional measure against demand peak) (Fig. 5).

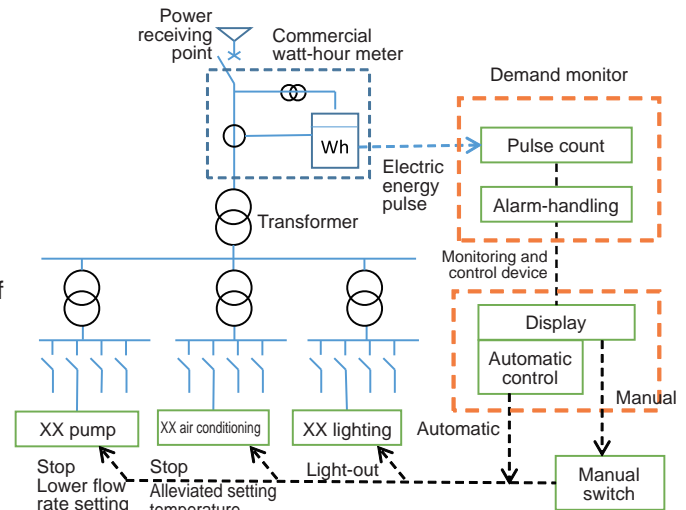
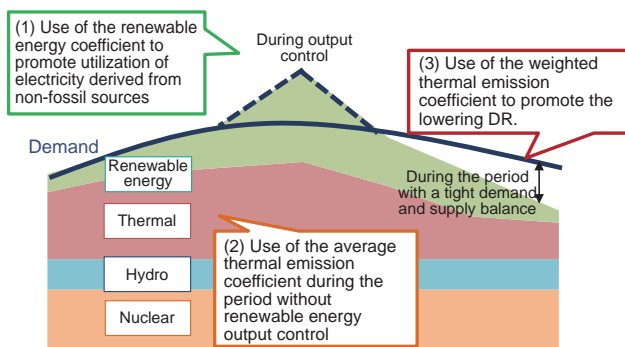


Fig. 4 Configuration of demand monitoring control (Source: Energy Management Training, "New Training" textbook)

Exemplary image of the optimization of electricity demand



Outline of the system (Draft)

Basic concept (Objectives)	<ul style="list-style-type: none"> Utilizing surplus power from renewable energy (raising DR) Limiting demand during the period with a tight demand and supply balance (lowering DR)
Specific measures	<ul style="list-style-type: none"> Evaluate the demand shift to the period with the renewable energy output control and the reduction of demand during the period with a tight demand and supply balance, such as an improvement in intensity with optimized electricity demand. Reporting of the intensity with optimized electricity demand is required, and it is evaluated along with the improvement of regular intensity. The government develops calculation rules and tools for supporting the report. Study for establishing a simple reporting method.
Electricity conversion coefficient	<ul style="list-style-type: none"> The coefficient takes account of the situation on the supply side. For example, the following are applied. <ol style="list-style-type: none"> A renewable energy coefficient is used during the period with the renewable energy output control. An average thermal emission coefficient is used during other time. A weighted average thermal emission coefficient (α) is used during the period with a tight demand and supply balance.

Fig. 5 Optimization of electricity demand

(Source: Agency for Natural Resources and Energy, "Act on the Rational Use of Energy in the Future (Dec. 24, 2021)")

Case E-3: Improving Waste Heat Utilization of the Cogeneration System

1. Current problem

A research institute (total floor area: 24,000 m²) has a cogeneration system (CGS), utilizing its waste heat for air conditioning through heating/cooling switching GENELINK^(Note).

Because there is a demand for both cooling and heating in the intermediate period (spring and autumn), however, a simultaneous heating/cooling type gas absorption water heater/chiller is separately used in place of GENELINK.

Accordingly, the CGS waste heat is radiated from a cooling tower and not used in the intermediate period.
(Note) GENELINK is an alias of the waste heat input type absorption water heater/chiller which uses waste heat hot water generated from the cogeneration system as a heat source. (Source: Japan Society of Refrigerating and Air Conditioning Engineers)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Remark
GENELINK type gas absorption water heater/chiller	Heating					Cooling						Heating	
Simultaneous heating/cooling type gas absorption water heater/chiller				Simultaneous heating/cooling						Simultaneous heating/cooling			
Gas consumption (m ³ /day)				850	1,100					900	750		900 (m ³ /day) on average

Fig. 1 Operating condition of simultaneous heating/cooling type gas absorption water heater/chiller

2. Improvement measure

In order to respond to a simultaneous demand for heating and cooling in the intermediate period, utilize a waste heat-based heat exchanger to produce hot water out of the waste heat. GENELINK allows you to produce both hot and cold water by producing cold water. The waste heat can be recovered in the intermediate period as well (Fig. 2).

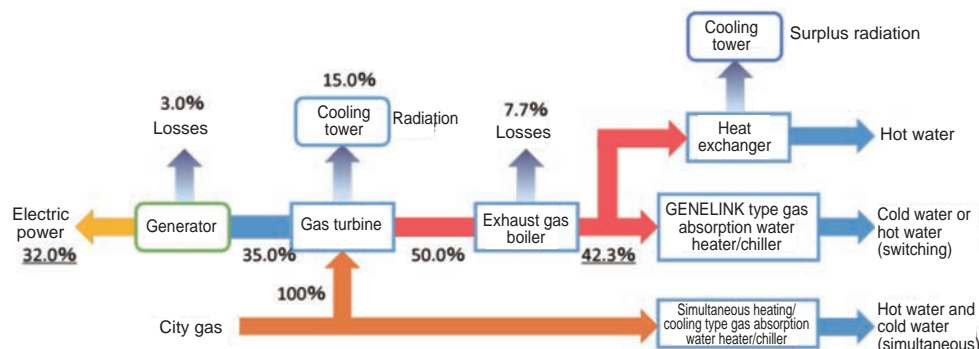


Fig. 2 CGS energy flow

3. Effect estimation

(1) Calculation formula

Concerning the simultaneous heating/cooling type gas absorption water heater/chiller in the intermediate period

Heating gas reduction: Heating load (MJ/day) / Lower heating value of gas (MJ/m³) / Hot water production COP

Cooling capacity by the waste heat: (CGS waste heat recovery (MJ/day) – Heating load (MJ/day)) x GENELINK COP^(Note)

Cooling gas reduction: (Cooling capacity by cooling load or by exhaust heat, whichever is lower) (MJ/day) / Lower heating value of gas (MJ/m³) / Cold water production COP

Fuel reduction: (Heating gas reduction (m³/day) + Cooling gas reduction (m³/day)) x No. of annual operating days (days/year)

(Note) The CGS waste heat is first used for the waste heat-based heat exchanger to produce hot water, and the remaining waste heat is used for GENELINK to produce cold water. When the cooling capacity exceeds the cooling load, utilize it, taking the cooling load as an upper limit.

(2) Prerequisites for calculation

Concerning the simultaneous heating/cooling type gas absorption water heater/chiller in the intermediate period

No. of annual operating days: 22 days/month x 4 months/year = 88 days/year

Gas consumption: 900 m³/day (Fig. 1)

COP: 0.85 for hot water production, 1.0 for cold water production

Fuel use ratio: Cooling : Heating = 50% : 50%

Heating load: 900 m³/day x 50% x 40.5 MJ/m³ x 0.85 = 15,491 MJ/day

Cooling load: 900 m³/day x 50% x 40.5 MJ/m³ x 1.0 = 18,225 MJ/day

CGS power output: 4,000 kWh/day (operation record)

CGS efficiency: 32.0% (power generation efficiency), 42.3% (heat recovery efficiency) (Fig. 2)

CGS waste heat recovery: 4,000 kWh/day x (42.3% / 32.0%) x 3.6 MJ/kWh = 19,035 MJ/day

GENELINK COP: 0.5

Lower heating value of gas (13A): 40.5 MJ/m³

4. Effects

①	Fuel consumption (current)	79,200	m ³ /year	(Fig. 1) 900 m ³ /day x 88 days/year
②	Fuel consumption (improved)	35,700	m ³ /year	
③	Reduced fuel consumption	43,500	m ³ /year	
④	Energy conservation rate	55	%	③ / ①
⑤	Saved amount of money	4,437	¥1,000/year	③ x ¥102/m ³
⑥	Reduction in crude oil equivalent	50.3	kL/year	③ x 44.8 MJ/m ³ x 0.0258 kL/GJ
⑦	CO ₂ reduction	97.2	t-CO ₂ /year	③ x 44.8 MJ/m ³ x 0.0136 x (44 / 12) t-CO ₂ /GJ

[Reference] Energy efficiency of the cogeneration system

The CGS is a system to simultaneously obtain electricity and heat from an internal combustion engine (gas turbine, gas engine, etc.) or a fuel cell. By fully utilizing electric energy and thermal energy generated by the CGS, energy efficiency is improved compared to a conventional system which separately feeds the heat from a boiler and the electric power from the grid power (see Fig. 3).

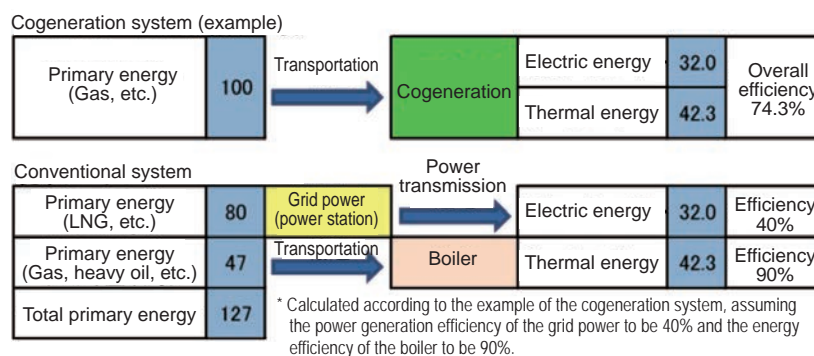


Fig. 3 Efficiency comparison between cogeneration system and conventional system (example)

F. ZEB, etc.

Case F-1: Realizing the Dissemination Type ZEB by Renewal of Medium-sized Office Buildings

1. Current problem

Aiming at carbon neutrality in 2050, Japan has been emphasizing the ZEB (Net Zero Energy Building) as an energy policy in order to greatly reduce energy consumption in the buildings and establishing subsidized projects, certification systems and registration systems to promote it. Constructed 23 years ago, the said building needs realization of the ZEB, but there are many issues.



4 stories above the ground plus 1-story penthouse, total floor area of 2,620 m²
Medium-scale office building (Fukuoka prefecture)

2. Improvement measure

Various energy conservation technologies are easily introduced and spread in new buildings. However, renewal has many restrictions, setting back realization of the ZEB. Accordingly, we have tried to realize the ZEB by simply renewing the equipment combined with general-purpose technologies. As a procedure, we have analyzed and considered the existing equipment, etc. based on the actual energy usage, selected highly general-purpose products, and taken the initiative in the dissemination type ZEB such as building a management system, thereby achieving this.

3. Effect estimation

We have achieved the ZEB Ready by employing highly general-purpose products and technologies, and building a management system.

(1) Employment of a latent-sensible heat separation air conditioning system by high-efficiency multi air conditioners for buildings and desiccant outdoor units

By processing the humidity through the desiccant outdoor units and specializing in processing of the sensible heat through the multi air conditioners for buildings, temperature control and humidity control have been separated and individually controlled by high-efficiency equipment respectively, realizing compatibility between energy conservation and comfort.

(2) Employment of a unified management system of air conditioning, ventilation and lighting by a high-function controller
By controlling air conditioning, ventilation and lighting with one controller, schedule control was allowed such as prevention of being left turned on even in small- and medium-sized buildings with no administrator.

(3) Capacity optimization of air conditioners by analyzing air conditioning data with a remote monitoring system
In order to avoid inefficient operation (overengineering) by renewing the equipment to an air conditioning system with the same capacity as before, we have measured the operating condition of the air conditioners before renewal through a remote monitoring system, reviewed design requirements in comparison with before renewal, and considered and selected the air conditioning equipment, thereby renewing them.

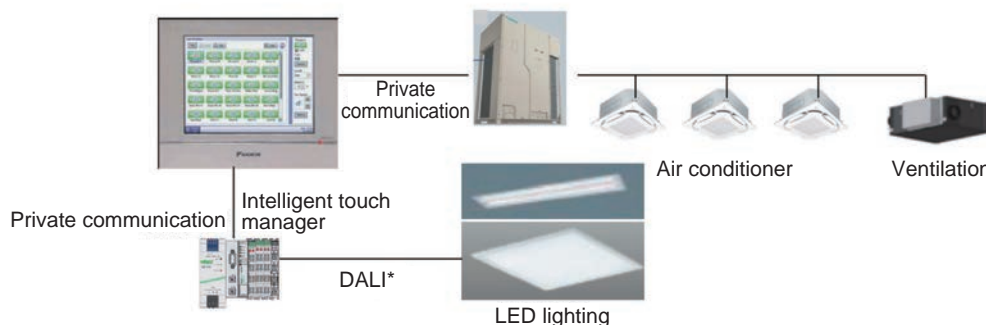


Fig. 1 Unified management system of air conditioning, ventilation and lighting

* General-purpose and extensible international standard for communication specifications for lighting control. Bidirectional communications and control are enabled even between the products of different manufacturers, allowing high-level lighting control using a dimming function.

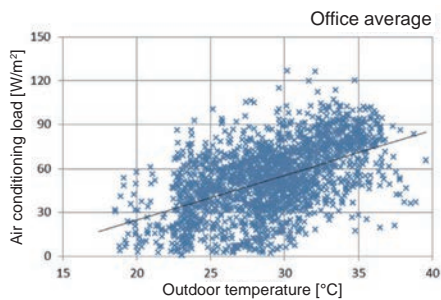


Fig. 2 Analysis of air conditioning data (Before renewal)

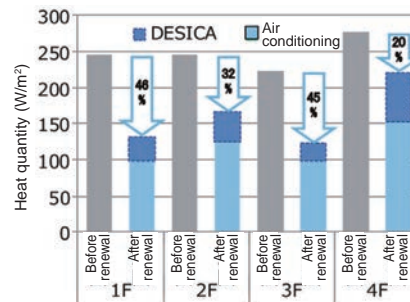


Fig. 3 Selection of air conditioning equipment

(4) Approaches to further energy conservation

① Introduction of a solar power generation system

Aiming at the Nearly ZEB, a solar power generation system has been introduced to try additional 6% energy conservation to a reference value.

② Arrangement of inner windows

In order to improve amenity and control a setting temperature change, double windows have been introduced into an office area. An overall heat transmission coefficient has been improved from 5.0 W/(m²•K) to 3.0 W/(m²•K).

③ Installation of a hot/cool space for outside personnel

A cool space has been installed near the 1st-floor entrance to control a setting temperature change of air conditioners by cooling down before entering the office.

④ Thorough visualization by a ZEB monitor

- Battery-free temperature, humidity and CO₂ sensors have been connected to an air conditioning monitoring controller to manage an indoor environment.
- In order to understand power consumption by purpose such as air conditioning, ventilation, lighting and elevators, totally 130 wattmeters have been attached to the distribution boards on each floor to improve operation by measurement and analysis.
- Measurement data have been displayed on the ZEB monitor installed in front of the 1st-floor elevator to improve the employees' awareness of energy conservation.

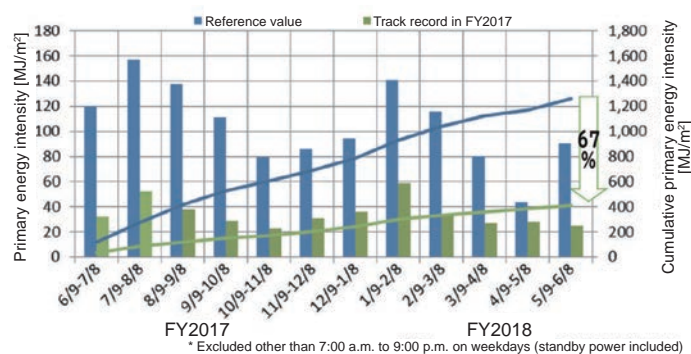


Fig. 4 Transition of primary energy intensity

4. Effects

①	Reduced energy	32	kL/year	
②	Saved amount of money	2,600	¥1,000/year	

In renewing air conditioning of a medium-scale office building with a total floor area of 2,620 m² constructed in September 1996 (25 years ago), only already marketed air conditioners, ventilators and lighting equipment have been used to realize the ZEB Ready.

(1) Primary energy consumption calculated by the WEBPRO (energy consumption performance calculation program (non-housing version)) has achieved 55% reduction in comparison with the reference value, 1,267 MJ/(m²•year), by simply renewing lighting equipment, air conditioners and ventilators.

(2) Solar power generation, double windows, ZEB monitor, etc. have been installed, further energy conservation has been addressed by operational improvement, and primary energy consumption has been reduced 61% from the reference value (67% including solar power) one year after renewal, achieving the ZEB Ready.

G. Solar Power Generation, etc.

Case G-1: Introducing the Self-consumption Solar Power Generation System

1. Current problem

Introduction of a solar power generation system is under consideration, however, it involves some issues such as a large initial investment cost, time and expense required for management and maintenance, and time-consuming internal procedures/approvals.

2. Improvement measure

A general configuration of a solar power generation system is as shown in Fig. 1. A self-consumption solar power generation system is designed in principle to self-consume the entire amount of electricity it generates. However, it is also possible to sell electricity while it has a low power load during a non-business day. The methods of introducing the system are classified as shown on Table 1. In the case of using the on-site PPA model or a lease model, none of the initial investment cost and expenses for management and maintenance during a contract period are needed as a rule.

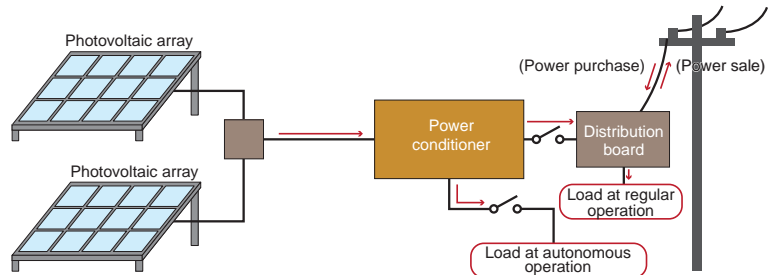


Fig. 1 Example of solar power generation system configuration

Table 1 Methods of introducing solar power generation system

Methods	Advantages	Disadvantages
Self-investment on the system	<ul style="list-style-type: none"> Best investment recovery efficiency in the long term. It is possible to dispose or replace the system with internal decisions only. Surplus electricity exceeding self-consumption can be sold. 	<ul style="list-style-type: none"> An initial investment cost is needed. An impact on the financial indicator occurs due to an increase in fixed assets. Time and expense for operation, management, and maintenance are required.
On-site PPA model	<ul style="list-style-type: none"> No initial investment cost is needed as a rule. Time and expense for operation, management, and maintenance are not required. Only self-consuming part of the entire amount of generated power can be purchased. The system is not considered as an asset and kept off the balance sheet. Low-price carbon-free power can be used without spending any initial investment costs. 	<ul style="list-style-type: none"> A lot of arrangements and coordination with a PPA operator are required. It is not possible to replace or dispose the system internally. A long-term contract must be concluded (typically for 17 years or longer). After expiration of the contract, additional time and expense are required for operation, management, and maintenance of the system.
Lease model	<ul style="list-style-type: none"> No initial investment cost is needed as a rule. Expense for operation, management, and maintenance is not required. Surplus electricity exceeding self-consumption can be sold. 	<ul style="list-style-type: none"> It is not possible to replace or dispose the system internally. A long-term contract must be concluded. A lease fee must be paid even when no power is generated. The system must be managed and recorded as a leased asset.

3. Effect estimation

An effect obtained in a case where a solar power generation system with a 50 kW capacity is introduced in a business establishment with a contract power demand of 200 kW is calculated.

(1) Calculation formula

Calculation of generated electric energy (kWh) at an intended facility

Reduced electric energy: Daily generated electric energy (kWh/day) x Self-consumption rate (%) of daily generated electric energy x No. of operating days (days/year)

Daily generated electric energy: Photovoltaic array output (kW) x Daily amount of solar radiation of array surface (kWh/(m²·day))^{*1} x Total design coefficient^{*2} / Intensity of solar radiation (1 kW/m²)

*1: NEDO "Solar Radiation Amount Database Browsing System", *2: JIS C 8907:2005 "9. Total Design Coefficient of Photovoltaic Array"

(2) Prerequisites for calculation

Installation condition of photovoltaic array: Location in Chiyoda-ku, Tokyo, Array azimuth 0° (due south), Inclination angle 30°

Operating condition: No. of annual operating days 365, Self-consumption rate 100%

Amount of solar radiation of array surface: 4.39 (kWh/(m²·day)), Total design coefficient 0.8

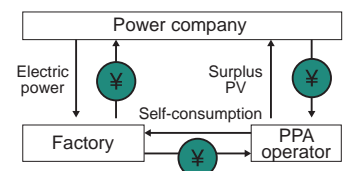
4. Effects

①	Reduced power consumption	64,094	kWh/year	
②	Energy conservation rate	—	%	
③	Saved amount of money	1,218	¥1,000/year	① x ¥19/kWh
④	Reduction in crude oil equivalent	16.5	kL/year	① x 9.97GJ/1,000 kWh x 0.0258 kL/GJ
⑤	CO ₂ reduction*	29.0	t-CO ₂ /year	① x 0.453 t-CO ₂ /1,000 kWh

(* For the basic charge rate, use the value provided by your contracted power company.)

[Reference] What is on-site Power Purchase Agreement (PPA) model?

It is a mechanism, based on a PPA Agreement concluded between an electricity generation utility (PPA operator) and an owner of a facility, in which the PPA operator installs a solar power generation system on-site and is responsible for the entire operation, maintenance, and management of the system, and is also called "third-party-owned model" or "power selling contract model". The power generation system is owned by the PPA operator, and the facility is only required to provide a space for installing the solar power generation system. Without spending any initial investment costs, the facility can purchase the electric power from renewable energy generated by the system at a fixed price from the PPA operator for a long time.



[Reference] Description of the common matters

(1) Electric energy unit price and fuel unit price

The electric energy unit price (average unit price including a basic charge) and fuel unit price are unified in the cases. Use your actual unit prices for your on-site consideration.

(2) Crude oil equivalent

This is used to evaluate energy amounts of electricity and different fuels by a common scale.

- Convert the heat quantity of the fuel (quantity x heating value), 1 (GJ), as crude oil, 0.0258 (kL).
- For electric power, convert the heat quantity of fuel required for generating and transmitting that electric energy into crude oil. (Energy of electric power, not heat quantity)

Fuel and electric power in crude oil equivalent (example)					Crude oil equivalent volume (kL)	
Type	Qty.		Heating value*	Heat qty. (GJ)	×0.0258 (kL/GJ)	
Heavy oil A	1 (kL)	×	39.1 (GJ/kL)	⇒ 39.1		⇒ 1.009
LPG	1 (t)	×	50.8 (GJ/t)	⇒ 50.8		⇒ 1.311
City gas 13A**	1 (1,000 m ³)	×	44.8 (GJ/1,000 m ³)	⇒ 44.8		⇒ 1.156
Electric energy (daytime)***	1 (1,000 kWh)	×	9.97 (GJ/1,000 kWh)	⇒ 9.97		⇒ 0.257
Electric energy (nighttime)***	1 (1,000 kWh)	×	9.28 (GJ/1,000 kWh)	⇒ 9.28	⇒ 0.239	

(The calculations in the cases are partly simplified. For official reports such as periodical ones, comply with the respective methods.)

*: The heating value is defined by the enforcement regulations for the Act on the Rational Use of Energy.

** : The heating value of the city gas uses the actual value of the supplied gas. Figures shown in the table are cited from the ministerial ordinance related to calculation of greenhouse gas emissions associated with the business activities of the business operators.

***: In the cases provided in this Guidebook, the electric power is always converted on the basis of daytime values.

(3) CO₂ emissions

[For the fuel]

As mentioned above, multiply a fuel amount by the heating value to calculate the heat quantity. Multiply this by a carbon emission coefficient to calculate a carbon amount. Furthermore, for conversion of molecular weight, multiply by 44/12 to calculate a carbon dioxide amount.

Type	Qty.	Heat qty. (GJ)	Carbon emission coefficient* (t-C/GJ)	CO ₂ emissions (t)
Heavy oil A	1 (kL) ⇒	39.1	× 0.0189	⇒ 2.71
LPG	1 (t) ⇒	50.8	× 0.0161	⇒ 3.00
City gas 13A	1 (1,000 m ³) ⇒	44.8	× 0.0136	⇒ 2.23

* Figures shown in the table are cited from the ministerial ordinance related to calculation of greenhouse gas emissions associated with the business activities of the business operators (Ministerial Ordinance No. 3, 2006 by the Ministry of Economy, Trade and Industry/the Ministry of the Environment, Ministerial Ordinance related to Calculation of Greenhouse Gas Emissions associated with the Business Activities of the Business Operators, Appended Table 1).

[For electric energy]

Multiply the electric energy by the CO₂ emission coefficient.

Electric energy	CO ₂ emission coefficient*	CO ₂ emissions	Remarks
1 (1,000 kWh)	× 0.453 (t-CO ₂ /1,000 kWh)	⇒0.453 (t)	The emission coefficient 0.453 is used in the cases, but normally, use the value of the contracted power company.

* The Act on Promotion of Global Warming Countermeasures obligates a business operator exceeding a certain scale or output to report the CO₂ emissions of the previous year. The actual emission coefficient and post-adjustment emission coefficient used for reporting should be annual values for each electric utility (**).

For the latest emission coefficient, see "Pages Related to Emission Coefficient by Electricity Utility" (<https://ghg-santeikohyo.env.go.jp/calc/denki>), etc. The emission coefficient, 0.453 (t-CO₂/1,000 kWh), mentioned/used in this guidebook is an alternative value (most recent 5-year average, calculated by the government, of the total emission coefficient of utility generation and private power generation in Comprehensive Energy Statistics) in "Emission Coefficient by Electricity Utility (results in FY2020, published by the Ministry of the Environment and the Ministry of Economy, Trade and Industry on Jan. 7, 2022, partially revised on Feb. 17, 2022, partially added and updated on Jul. 14, 2022)".

Where to Apply and Contact for Energy Audit

The Energy Conservation Center, Japan provides an energy optimized audit
(there are certain requirements).

Download an application form from the Energy Conservation and Power-saving portal site
(<https://www.shindan-net.jp>) and send it to the following address by fax, postal mail or E-mail.

■Headquarters (Energy Audit Department)	Igarashi Building, 2-11-5 Shibaura, Minato-ku, Tokyo 108-0023	Phone: +81-3-5439-9732 Fax: +81-3-5439-9738
■Hokkaido Branch	Hokkaido Keizai Center Building, 2-2 Kitaichijo-Nishi, Chuo-ku, Sapporo 060-0001	Phone: +81-11-271-4028 Fax: +81-11-222-4634
■Tohoku Branch	Main Denryoku Building, 3-7-1 Ichibancho, Aoba-ku, Sendai 980-0811	Phone: +81-22-221-1751 Fax: +81-22-221-1752
■Tokai Branch	Ito Building, 3-23-28 Marunouchi, Naka-ku, Nagoya 460-0002	Phone: +81-52-232-2216 Fax: +81-52-232-2218
■Hokuriku Branch	Toyama Kogin Building, 5-13 Sakurabashi-dori, Toyama 930-0004	Phone: +81-76-442-2256 Fax: +81-76-442-2257
■Kinki Branch	Yotsuhashi KF Building, 1-13-3 Shinmachi, Nishi-ku, Osaka 550-0013	Phone: +81-6-6539-7515 Fax: +81-6-6539-7370
■Chugoku Branch	Inoue Building, 8-20 Kamihacchobori, Naka-ku, Hiroshima 730-0012	Phone: +81-82-221-1961 Fax: +81-82-221-1968
■Shikoku Branch	Takamatsu Kotobukicho Prime Building, 2-2-10 Kotobukicho, Takamatsu 760-0023	Phone: +81-87-826-0550 Fax: +81-87-826-0555
■Kyushu Branch	Asako Hakata Building, 1-11-5 Hakataeki-Higashi, Hakata-ku, Fukuoka 812-0013	Phone: +81-92-431-6402 Fax: +81-92-431-6405

Energy Conservation and Power-saving Portal Site


<https://www.shindan-net.jp/>



The Energy Conservation Center, Japan

Energy Conservation Technology Division

Phone: +81-3-5439-9733 Fax: +81-3-5439-9738

<https://www.eccj.or.jp/>


E-mail: ene@eccj.or.jp

Unauthorized reproduction prohibited, all rights reserved
Copyright (C) The Energy Conservation Center, Japan 2022

This booklet has been prepared in the project by the Agency for Natural Resources and Energy, "Subsidies for Promotion of Optimized Energy Utilization for Small- and Medium-sized Enterprises in FY2022".



This print uses
environmentally-friendly
vegetable oil ink.

Recyclability 
This print is recyclable
into printing paper.