MINISTRY OF ENERGY AND MINERAL RESOURCES
REPUBLIC OF INDONESIA

No.

THE STUDY
ON
ENERGY CONSERVATION
AND EFFICIENCY IMPROVEMENT
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT
ENERGY EFFICIENCY IMPROVEMENT
AND CONSERVATION GUIDELINE
Draft Version

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JAPAN INTERNATIONAL COOPERATION AGENCY

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1. Outline of Management for Energy Efficiency Improvement and Conservation (EE&C)

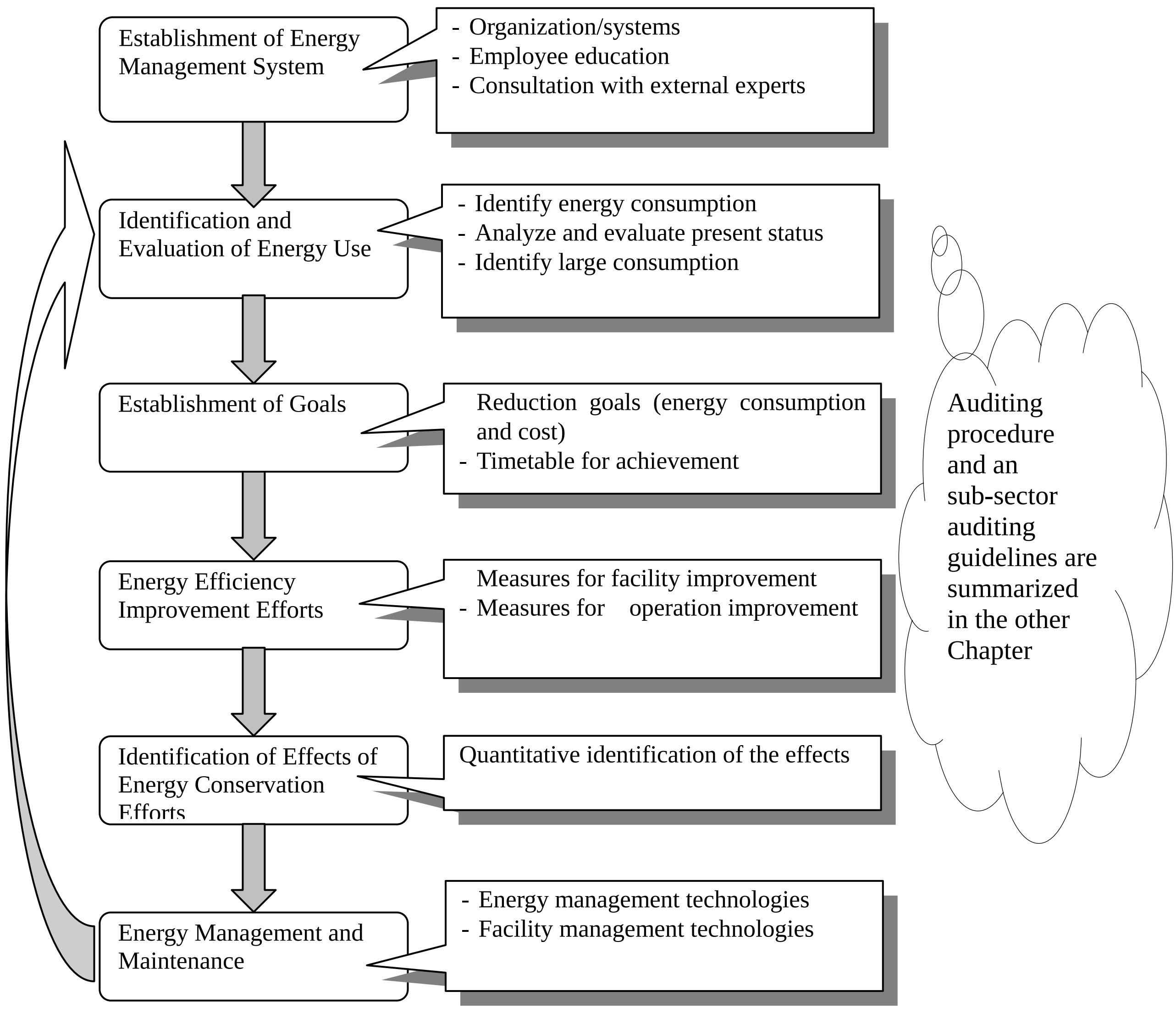
In order to promote Indonesian Energy Efficiency Improvement and Conservation activity, "Energy Efficiency Improvement and Conservation Guideline (draft)" was drawn up.

The contents of Guideline is as follows：

1. Outline of management for Energy Efficiency Improvement and Conservation (EE&C)
2. Methodology of conducting an energy audit
3. Guideline for energy efficiency improvement and conservation on specified industries and commercial buildings
   - 3.1 Common technology .
   - 3.2 Guideline for energy efficiency improvement and conservation for iron and steel-making industry
   - 3.3 Guideline for energy efficiency improvement and conservation for textile industry, especially dyeing and finishing process
   - 3.4 Guideline for energy efficiency improvement and conservation for commercial buildings

In this chapter, 1. Outline of management for Energy Efficiency Improvement and Conservation (EE&C) shall be drawn up.

This figure shows the most effective procedure to promote energy efficiency improvement and conservation sustainably.



Flow of Effective Procedure to Promote Energy Conservation and Efficiency Improvement

1.1 Establishment of Energy Management Systems

1.1.1 Setting up of a Promotion Committee for EE&C

Since our individual abilities are limited, energy saving efforts on an individual basis may not yield satisfactory results. Therefore, a promotion committee for Energy Efficiency Improvement and Conservation (EE&C) led by top management, e.g., a president of company or a plant manager, should be established to ensure that all individuals' activities can be utilized as a large and single force toward successful improvement of energy efficiency.

The promotion committee for EE&C is responsible for performing management cycles (Plan → Do → Check → Action →) continually by defining (approving) energy saving goals and effective implementation plans and, reviewing results periodically.

1.1.2 Setting up of an Energy Efficiency Office and its Authority and Responsibility

As an implementation organization of EE&C, an energy efficiency office should be set up in the organization. In the case of small organizations that do not need to set up a new organization for EE&C, person(s) in charge of EE&C should be appointed.

In many situations, the energy efficiency office needs coordinating with other offices and obtaining approval from the board. To ensure quick and smooth progress of energy saving, staff members who are responsible for reducing energy consumption should be given an appropriate level of authority to make decisions.

Another important point is that there should be a clear definition of the items for which the promotion committee for EE&C is responsible, and of the demarcation of responsibility among related departments.

1.1.3 Employee Education

It is necessary to define the qualifications and skills that the staff members of the energy efficiency office should obtain, and education and training for obtaining these qualifications/skills should be planned and executed. Energy saving technologies and skills range over various technical fields and they are continually changing with new technologies and products coming one after another on the market. With this in mind, staff members must continue monitoring them and updating their own knowledge and skills accordingly.

Outsourcing employee education is also effective.

1.1.4 EE&C Efforts through the Full Participation of all Concerned

In cooperation with the energy efficiency office, the full participation of all individuals concerned, from the plant manager to the front line workers in each department, in cooperation with the energy related department, e.g., TQC Activity, is effective in picking out problems and working out countermeasures (EE&C efforts).

A company-wide employees contest that gives them opportunities to make a presentation on their efforts and results and gives awards to individuals and groups who achieved large energy saving will be effective to enhance employees' awareness toward energy saving.

1.1.5 Use of External Experts

In the preparatory stage and the early stage of energy saving activities, advice of external experts is very helpful for establishing an effective energy saving system and making it take root in the organization. External experts are available also for regular activities such as technical judgments and employee education.

1.2 Identification and Evaluation of Energy Use

1.2.1 Collection of Data and Materials

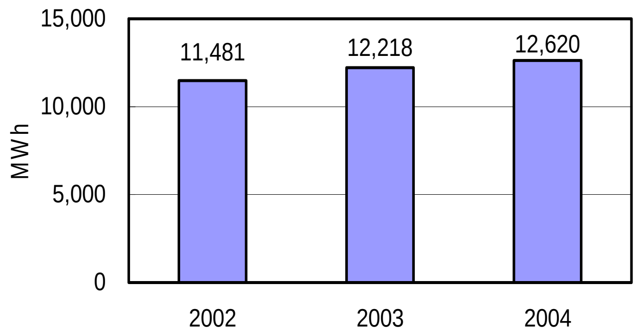
As the basic information for identifying and evaluating energy usage, the following data/materials should be collected by using the check list shown in Appendix-1.

(1) As-built drawings of the facilities/equipments
(2) Energy consumption data (oil, electricity, water, etc.)
(3) Operation status of facility (operating hours, amount of production, etc.)
(4) Operation parameters of facility (air/water temperatures, illuminance, etc.)
(5) Specifications of facility (capacity, efficiency, etc.)

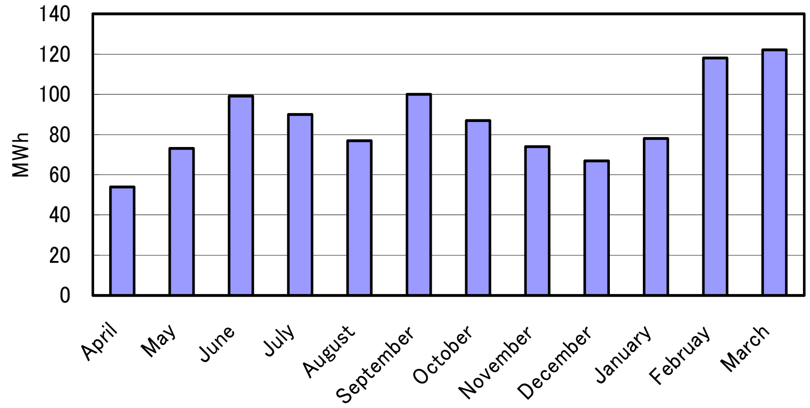
1.2.2 Energy Consumption Analysis

(1) Preparation of Basic Data

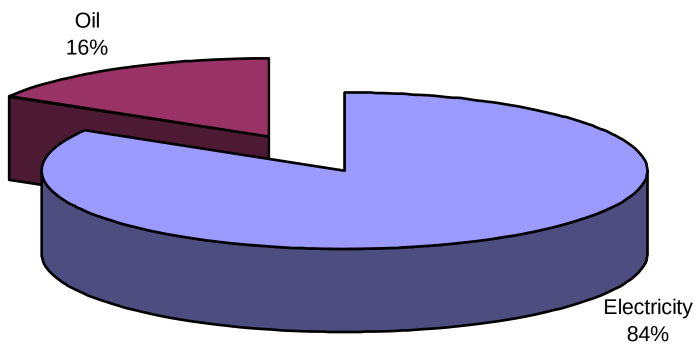
1) Prepare a graph showing annual energy consumption (electricity, oil, water, etc.)



2) Prepare a graph showing monthly energy consumption (electricity, oil, water. etc.)

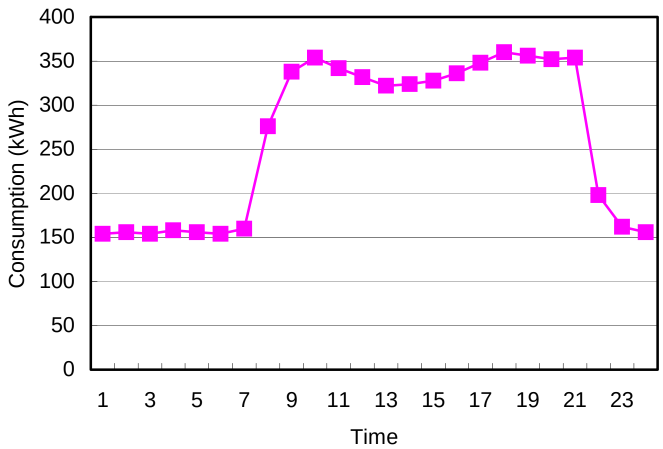


3) Prepare a graph showing annual energy consumption by energy sources.Calculate annual consumption of each energy source in units of mega joule (MJ).



4) Prepare a graph showing hourly energy consumption in the representative day.

If hourly energy consumption data in the representative day is available, or if it is possible to read watt-hour meters to assess electrical consumption, calculate the hourly consumption and present it graphically.



5) Calculate the energy intensity

(e.g., per floor area, per guest room, per production, etc.)

For offices, government buildings and supermarkets, energy consumption per floor area (MJ/m^2/year) should be calculated.

For hotels, energy consumption per guest room (MJ/room/year) should be calculated.

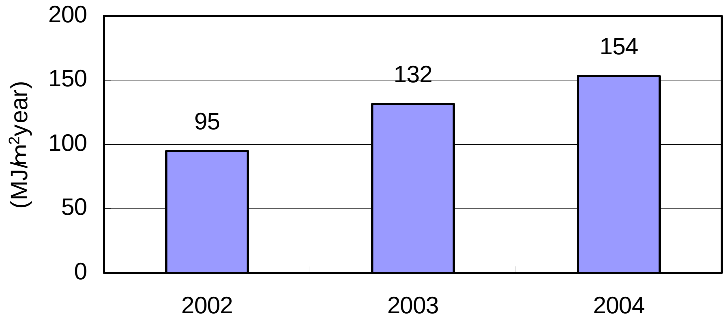
For manufacturing plants, energy consumption per production

(MJ/unit production/year) should be calculated.

<Calculation example: Office>

$$\frac{\text{Annual energy consumption (MJ/year)}}{\text{Total building floor area (m}^2\text{)}} = \text{Energy intensity (MJ/m}^2\text{/year)}$$

6) Prepare graphs showing annual and monthly energy intensity. Compare the annual energy intensity with those in previous years, and the monthly energy intensity with those in the same months in previous years.



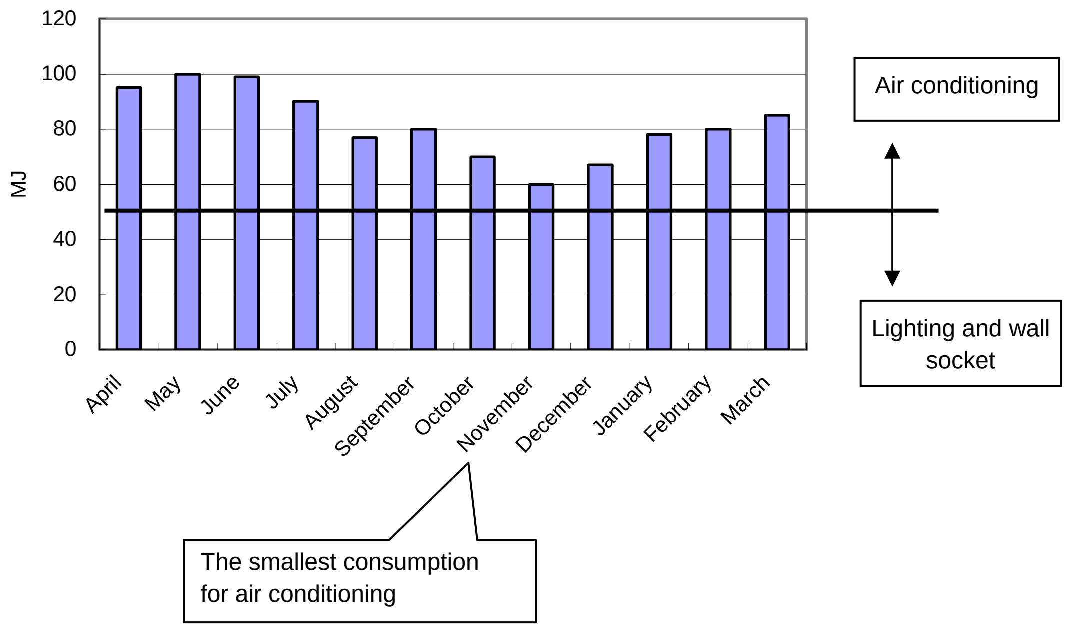
7) Identification of Physical Conditions of Facilities

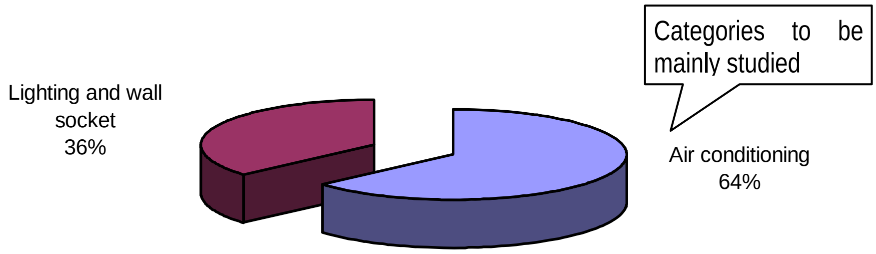
- Measure the distribution of illumination level in each room
- Measure the temperature distribution in each room
- Measure the actual terminal voltage

(2) Data Analysis

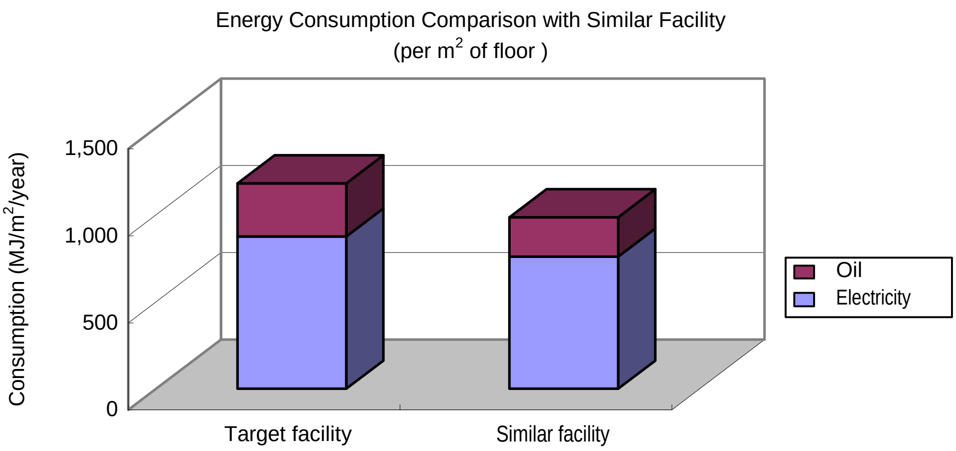
1) Identify Large Consumption items (extract ECEI targets)

Based on the monthly energy consumption data, identify energy consumption by air conditioning, lighting, and other categories of energy consumption. Subsequently, study ECEI measures mainly for large consumption categories.



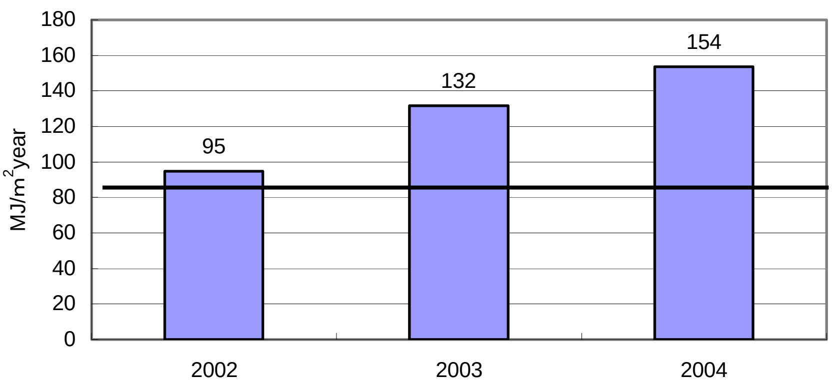


2) Compare energy intensity with those in other buildings of the same type.



Identify whether or not the energy consumption of the facility is greater than that of other buildings of the same type.

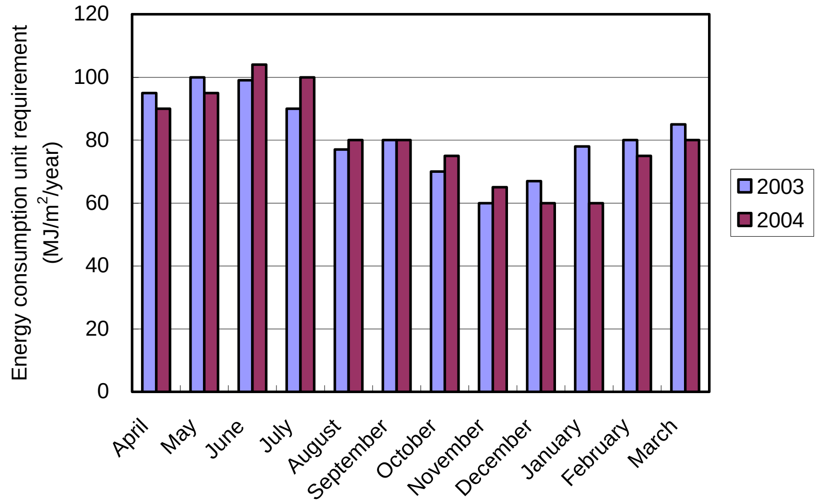
3) Figure out trend of energy intensity



Why did it increase (or decrease)?
- Additional facility
- Change in operating hours
- Difference in outside temperature (annual average temp.)

Extra consumption due to factors other than the above is considered wasteful (and to be eliminated by improvement).

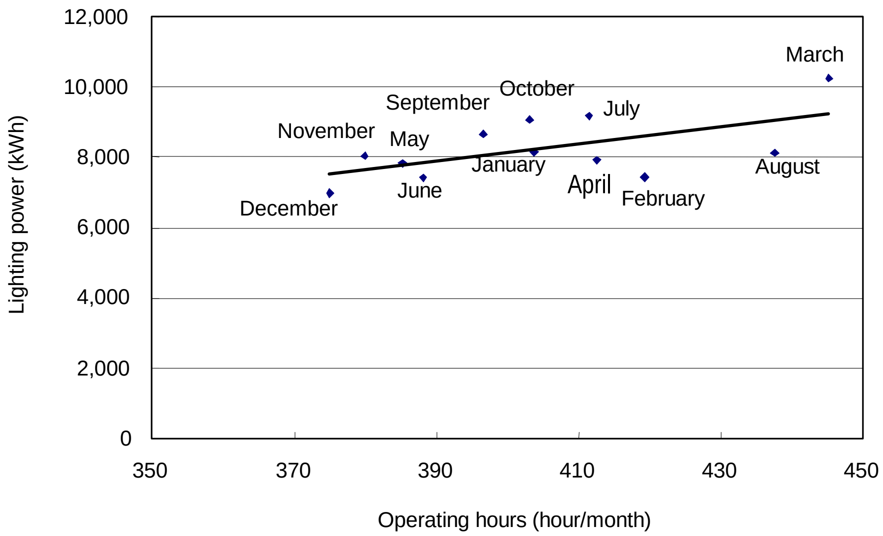
4) Identify reasons for the monthly differences in energy intensity
(compare with other data such as outside temperature, operational data, etc.)



Why did it increase (or decrease)?

- Addition of facility
- Change in operating hours
- Difference in outside temperature (annual average temp.)

Extra consumption due to factors other than the above is considered wasteful (to be eliminated by improvement)



1.3 Establishment of Goals

1.3.1 Establish Energy Saving Policies (Goals, Timetables and Financial Resources for Improvement) by the Top Management

To ensure the smooth progress of energy saving, the committee for EE&C should define the energy saving policies in the presence of the company's top management. The policy should detail the goals, timetables and financial resources, A typical policy statement is, e.g., "Achieve an energy saving by 10% in three years with an annual budget of one million yen, subject to the condition that the simple pay back period of the measures should not exceed five years."

1.3.2 Define a Specific Target for Each Department and Implementation Plan, and Implement

Each department should define its own energy saving targets stage by stage based on the aforementioned company's goals, and define implementation schedules, then go to the implementation stage.

On the occasion when the department's targets are defined, the company's current status of energy use should be firstly figured out, then quantitative targets that are best suited to the company's business activities should be established.

1.4 EE&C Efforts

1.4.1 EE&C Audit Check List

<Example>

Facility Type		Check Item	Importance	Effect	Check	Conditions for requiring detailed studies	Now to study
Control status	(1)	Energy management system established?	++	++	Yes No	No	According to the guidelines
	(2)	Energy saving campaign being performed?	++	++	Yes No	No	
	(3)	Energy saving goals defined?	++	++	Yes No	No	

1.4.2 EE&C Techniques: Summary

(1) Facility Improvement Check List<Example>

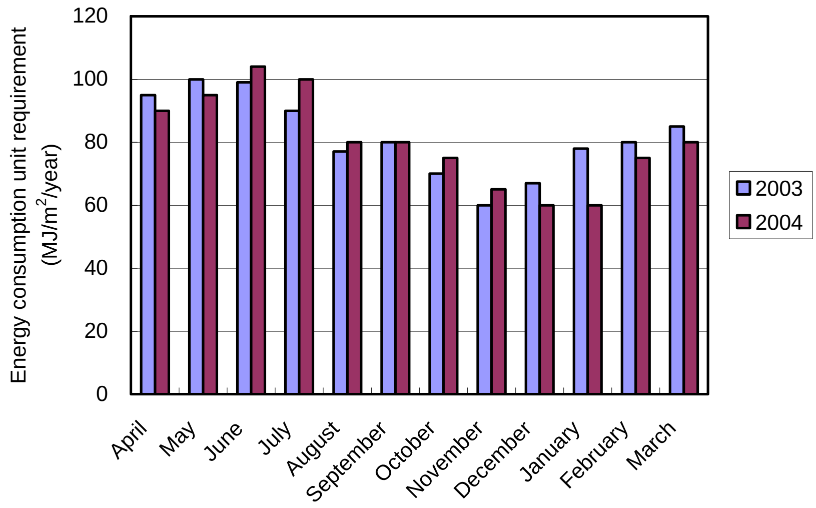
Item		Energy saving measures	Examples of energy saving measures specifications	Effect (per unit, %)	Cost factor	Return-of-investment years	Cost
Air conditioning system	(18)	Use high-efficiency air conditioning units	Select with energy saving type air conditioning units	Replacing COP2.5 with a COP3.25 inverter can reduce power consumption by about 30%	normal type:300US$ energy saving type:400US$	3.8 (COP2.5→3.3)	Medium
Air conditioning system	(19)	Employing a high-efficiency air-conditioner system	Update an air conditioner into natural-coolant high-efficiency screw chiller (stepless control).	Energy consumed for air conditioning is reduced by 10 to 30% in comparison to devices without capacity control (turbo, etc.).	Natural-coolant high-efficiency screw chiller	1.1 (COP4→6)	Large
Lighting	(1)	Use higher-efficiency lighting fixtures (inverter control or other)	Replace with electric ballast (check EMC problems for electronic equipment)	Energy consumption reduced by 15 to 30% (subject to lower brightness)	Electric ballast	3.4	Medium
Lighting	(2)	Replace with energy saving type lamps	Select incandescent lamps with compact self-ballasted fluorescent lamps (CFL) (e.g., for hotels, households)	Replacing a 60W incandescent lamp with a 14 W CFL can reduce the lighting energy consumption by 77%	Incandescent lamp: 0.5US$/unit CFL: 2.5US$/unit	0.4	Small
Lighting	(2)	Replace with energy saving type lamps	Replace mercury lamps with metal halide or Sodium lamps (e.g., for factory and street lighting)	Replacing a 125W mercury lamp with a 70W MHL can reduce the lighting energy consumption by 44%	Mercury lamp MHL or Sodium lamp	→1.4 (Sodium vapor lamps)	Small

(2) Operation Improvement Check List<Example>

Item	Energy saving measures		Examples of energy saving measures specifications	Effect (per unit, %)	Cost factor	Return-of-investment years	cost
Air conditioning system	(6)	Efficient operation of heat source equipment	Adjust the condenser, evaporator, and compressor to appropriate coolant pressures and temperatures.	Higher the value of coefficient of performance	No cost increase		Operating
Air conditioning system	(6)	Efficient operation of heat source equipment	Spray water uniformly on the condenser.	Co-efficient of performance increases.	No cost increase		Operating
Lighting	(3)	Optimize room brightness to eliminate the wasteful use of energy	Reduce brightness by means of initial brightness correction	Fluorescent lamp wattage x Number of lamps that can be turned off	No cost increase		Operating
Lighting	(3)	Optimize room brightness to eliminate the wasteful use of energy	Turn off lighting fixtures (passages, unused rooms, etc.)	Fluorescent lamp wattage x Number of lamps that can be turned off x Operating time	No cost increase		Operating
Lighting	(3)	Optimize room brightness to eliminate the wasteful use of energy	Need-oriented on/off control of lighting fixtures (keep them turned off during the lunch break)	Fluorescent lamp wattage x Number of lamps that can be turned off x Operating time	No cost increase		Operating
Pump and fan	(1)	Optimize pump and fan capacity		Reduce transport power	No cost increase		Operating

1.5 Identification of the Effects of EE&C Effects

Compare pre- and post-energy saving measures to identify the effects of the measures.



1.6 Energy Management and Maintenance

1.6.1 Energy Management

(1) Measuring Points and Frequency

1) Electricity

- Install watt-hour meters to measure consumption of electricity from both utility and private generating equipment
  Measuring frequency: once a month, and once a day in the representative week

- Install watt-hour meters separately for each of the lighting and wall socket and air-conditioning system switchboards.
  Measuring frequency: once a month, and once a day in the representative week

- Install watt-hour meters for all major equipment (refrigerating machines etc.).
  Measuring frequency: once a month, once a day in the representative week, and once a hour in the representative day

2) Steam

- Install fuel consumption meters on the fuel supply lines to the boilers.
  Measuring frequency: once a month, once a day in the representative week, and once a hour in the representative day

- Install water flow meters to the boilers.
  Measuring frequency: once a month, once a day in the representative week, and once a hour in the representative day

3) Measure Temperature and Pressure

- Install temperature gauges to measure the temperature of the refrigerant and the cooling water lines to/from the refrigerating machines.
- Install pressure gauges to measure the temperature on the steam lines from the boilers.

(2) Maintenance

Facilities/equipment do not work with their full capacity without keeping good condition by continual inspection and repair. Periodical and scheduled maintenance is not only useful for energy saving, but also very effective for prevention of failure and expansion of lifetime.

Equipment	Component	Check and Maintenance	Frequency
Lighting	Lamp	Cleaning	Once a year
		Change	Once in two years
	Reflector	Cleaning	Once a year
Air-conditioning equipment	Air filter	Cleaning	As needed
	Drain pan	Cleaning	As needed
	Cooling coil	Cleaning	Twice a year
	Outdoor unit	Cleaning	Twice a year
	Fan	Adjustment of (or change of) tensile force of V-belts	Twice a year
		Lubrication to (or change of) bearings	Twice a year
	Refrigerant circuit	Check on refrigerant circuit	Twice a year
	Cooling water	Change of cooling water (Check on conductivity)	Twice a year
	Electric circuit	Check on temperature controllers	Once a year
Boiler	Burner	Adjustment of air ratio	Twice a year
	Tube	Check on crud	Once a year
Turbo chiller	General	Check on temperatures, pressures, vibration, noise, etc.	Once a day
	Condenser	Adjustment of condensing pressure Cleaning of tubes	Once a year
	Evaporator	Adjustment of evaporating pressure Change of refrigerant	Once a year

2. Methodology of Conducting an Energy Audit

2.1 Introduction

Energy audit for factories and commercial buildings (hereinafter referred to as Factories) is to clarify the energy utilization situation in Factory firstly, improve energy utilization efficiency and reduce energy loss by strengthening energy management, remodeling the equipment and changing the process.

In order to grasp to the energy utilization situation in Factory, it is necessary to get the following data, such as the consumption amount of the fuel and the electricity, the temperature of materials be heated and the element of exhaust gas etc. And it is possible to be read and recorded by the measurement instrument in Factory. However, in some Factories, though the measurement instrument to measure the production and operation is installed, the measurement instrument concerning energy management is not installed fully. And in the energy audit, it is necessary to offer measuring data gained from Factory to the audit team and obtain all data from measurement instrument in the Factory. In the measurement period of Factory, it is necessary to obtain accurate measurements within a limited time, and it is very important to install measurement instruments and sensors, confirm and record the data, and confirm the reliability of the data.

This audit and measurement manual were made based on the investigation results for steel factories, textile factories and commercial buildings (private office building, government office building, hotel, hospital, and shopping mall) in Indonesia in 2007. It includes mainly procedure of energy auditing of Factory, measurement technology for Factory, analysis technique of the data, method to conduct the audit report. It is expected that the engineer in Indonesia is able to promote the energy conservation by referring to this manual.

2.2 Procedure of Energy Audit (Abstract)

Figure 2.2-1 shows the general procedure of energy audit for Factories.

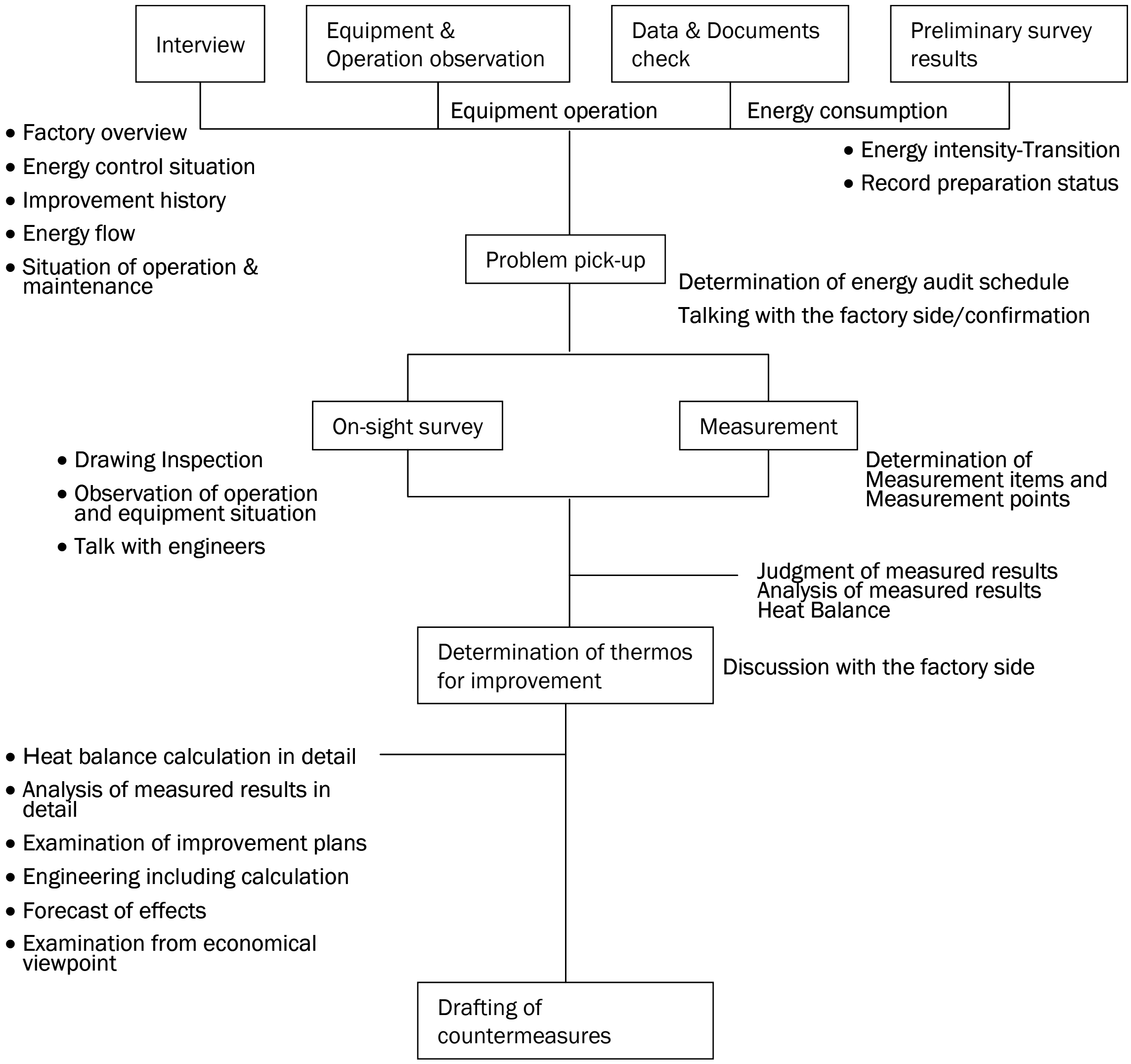


Figure 2.2-1 Flow Chart of Energy Audit for Factory

2.2.1 Outline of Factory

The auditor must understand the matter described as follow; the scale, production, and energy consumption of Factory, etc. At the same time, the auditor must grasp the manager’s stance for energy conservation, current approach, problems and basic strategy of the Factory.

(1) Outline of the Factory

a. Outline of the Factory (Name, category, capital, sales, number of employees, organization, share in their filed and locations, etc.)
b. Production of the main product in past five years
c. Energy consumption in past five years
d. Manufacturing process charts of the main products

e. Capacity and operation situation of the main energy consumption equipment such as boilers
f. Energy flow in the factory
g. Chart of single-line diagram for electrical system and the situation of the power receiving equipment specifications
h. Layout of the factory
i. Problems of the factory and request of audit items
j. Past implemented items for energy conservation
k. Implementation plan for energy conservation in the future
l. Condition of the factory and the same industrial filed, as well as the obstruction factors of energy conservation

(2) Outline of the building

a. Outline of the building (Name, category, owner, floor area, number of employees, organization, history, and tenant, etc.)
b. Energy consumption during past five years
c. Capacity and operation situation of the main energy consumption equipment such as air-conditioning units
d. Energy flow in the building
e. Energy management responsibility between tenants and an owner
f. Chart of single-line diagram for electrical system and the situation of the power receiving equipment specifications
g. Layout of the building
h. Problems of the building and request of audit items
i. Past implemented items for energy conservation
j. Implementation plan for energy conservation in the future
k. Condition of the building, as well as the obstruction factors of energy conservation

2.2.2 Conduct the Audit Plan

(1) Preparation of checklist

The auditor lists up the items to be measured and investigated in the Factory firstly, so that the deficit of information should not occur; and should make the checklist based on the preliminary auditing sheet and the data be obtained from the Factory manager by prior interviewing. The checklist is distributed to the member of audit team (sector specialist of process, heat, electricity and measurement), and the policy and the work partipation of the measurement and the audit are discussed at an internal meeting. Table 2.2.2-1 and Table 2.2.2-2 show the example of the energy audit check items of the factory and the commercial buildings

(2) A general inspection is done by hearing the explanation of the Factory. At the same time, the follwing contents should be grasped by the preliminary auditing sheet and the record data on the production and consumption of energy.

- Problems in equipment and operation
- Point which should be given priority in energy audit
- Technical level of factory
- Level of aging and maintenance of equipments
- Fluctuation of operation rate
- Energy intensity and its trend

(3) Determination of energy audit program The auditor should revise and add the content in the checklist according to the above-mentioned, then accept some advice from the audit team and decide the following contents

- Measurement and auditing schedule
- Equipment or process which should be given priority in energy audit
- Measuring point, measuring items, measuring schedule
- Work participation

(4) The audit plan is explained to the Factory and the following cooperation is requested also from the Factory.

- Adjustment with production plan
- Preparation of the hole to insert measuring sensor and collect sample.
- Power supply preparation
- Attendance person's nomination of the Factory

2.2.3 The Measurement and Investigation are Executed Based on the Audit Plan.

- Selection and arrangement of measurement instruments
- Setting of measurement condition in the measuring instrument
- Check the proceeding of data collection
- Investigation of detailed structure and dimention of equipments by equipment drawing or actual measurement
- Grasping problem by observation of operation
- Hearing from engineers
- Investigation on the necessary data to evaluate economic effect of improvement measures（energy prices, fund, and cost, etc.）

2.2.4 Consensus Billing on the Effective Measures

When the measurement result and the investigation data are collected, energy conservation measures in the future are analysed. And the measures are explained to the Factory and to be finalised.

2.2.5 Study of Improvement Measures

Based on the following information such as the data in the checklist, the measurement record form, the data logging memory (floppy disk, PC card, CDR, and USB thumb drive, etc.) and the drawings, etc, the heat management and the electric management analyses such as the calculation of heat balance, heat transfer and the fluid conveying power are made. The energy conservation measures by the modification or the addition of equipment should be made. The most reasonable measures should be decided.

At the same time, the economic analysis for each improvement measures and the expected effect is estimated. Based on the above estimation results, the economy for each improvement measure is evaluated by using a common index and method. And their practicability and priority are clarified.

Moreover, the environmental influence with the improvement measure execution is examined and the point to be noted in execution should be shown.

Table 2.2.2-1 Factory Energy Audit Checklist

1. General Management Items

Check items and contents
General Management Items
1. Energy Management Organization - Maintenance of an organization, capacity building - Adjustment with environmental management - Energy conservation target, investment budget - Medium and long term plan - Use of governmental incentive system - Energy conservation activity
2. Implementation of Measurement and Record - Installation and operation of measuring instrument, - Maintenance and inspection of measuring instrument - Implementation of periodical measurement and record
3. Maintenance Management of Equipment - Periodical inspection, daily inspection - Repairing of leakage (water, air and steam) - Heat insulation - Cleaning of equipment (filter and strainer)
4. Energy Consumption Management - Daily report record - Daily consumption, daily load curve - Monthly consumption, Consumption graph comparing with previous year
5. Energy Intensity Management of Main Products - Energy intensity per shipment amount - Energy intensity per Production amount
6. Environmental Management - Implementation of CO_2 emission reduction measure - Practical use of Life Cycle Assessment (LCA): Purchasing → manufacture → use → disposal and recycling - Waste processing (measure for loss in quantity, separating and recycling) - Waste water treatment

2. Air-conditioning / Freezing Equipment

A check item and contents
Air Conditioning and Freezing Equipment
1. Operation Management of Air-conditioning - Optimization of setting temperature and humidity - Operation number control of heat source equipment - Outlet temperature setting change of chilled water - Scheduled operation - Outside air invasion interception and ventilation condition - Radiant heat interception of high temperature equipment
2. Energy Conservation Measures of Air-conditioning - Reinforcement of building heat insulation - Outside air use - Exhaust heat recovery and heat pump - Variable speed control (VAV etc.) of conveying equipment (pump and fan) - Local cooling and local ventilation - Stratification of air condition, Reduction of room air volume for air condition - Use of ice thermal storage
3. Operation Control of Cooling Equipment - Operation power of a chiller - Inlet and outlet pressure of coolant - Inlet and outlet temperature and pressure of water
4. Operation Control of Auxiliary Chilling Equipment - Operation power of a cooling tower - Water quality control (electrical conductivity) - Operation power of pump (water flow-rate and head)
5. Cold Keeping and Chilling Equipment - Management at the in-and-out of goods and persons - Heat keeping management - High efficiency equipment

3. Pump Fan, Compressor, etc.

A check item and contents
1. Operation Management of Pump and Fan - Valve opening-and-closing condition - Improvement of a route (piping and duct) - Flow-rate and pressure in operation - Check of margin of design specification - Variable speed control and operation number control

A check item and contents
2. Operation Management of Air Compressor - Review of type (Screw type / Reciprocating type / Blower) - Matching of capacity and type - Reduction of delivery pressure and end using pressure - Separation of high and low pressure line - Ventilation equipment and circumference temperature - Review of pipe diameter and piping route - Installation of an air receiver - Operation number control - Optimal capacity control - Measure against leakage

4. Boiler, Industrial Furnace, Steam System, Heat Exchanger, Waste Heat, Waste Water, etc.

A check item and contents
Boiler and Industrial Furnace
1. Combustion Control - Excess air ratio and exhaust gas control - Burner, fuel and ventilation system - Combustion control unit - Regenerative type combustion system - Fuel conversion **2. Operation and Efficiency Control of furnace** - Load factor, starting/stop condition - Operation number control - Thermal efficiency, heat balance and heat distribution - Water quality control and blow water control **3. Heat Insulation, and Heat Dissipation Prevention** - Temperature of outside surface of furnace wall and duct - Heat insulation and insulation material (thermal storage loss) - Opening seal and inside pressure of furnace **4. Exhaust Gas Temperature Control and Exhaust Heat Recovery** - Exhaust gas temperature - Heat recovery (Supply water and air preheating) - Exhaust gas circulation
Steam System
5. Operation Control of Steam System - Steam dryness and carry over. - Setting steam pressure and temperature of equipment - Steam flow-rate

A check item and contents
6. Management of Steam Leakage and Heat Insulation - Piping system, tank etc. - Load equipment
7. Optimization of Steam Piping System - Route and piping size - Removal of unnecessary piping - Integration of two or more steam system **8. Load Leveling of Steam System** - Installation of an accumulator - Replacement of ejectors with vacuum pumps - Measures in demand side
9. Steam Condensate Recovery - Steam pressure recovery (Back pressure turbine) - Steam trap management - Condensate recovery place, recovery system - Flash steam use
Heat Exchanger
10. Operation Control of Heat Exchanger - Optimization of type - Optimization of the use condition and heat medium - Maintenance situation (dirty and pressure loss) - Heat medium and heated material temperature - Temperature efficiency
Waste Heat Recovery
11. Waste Heat and Waste Water Reduction - Heat recovery from warm water - Rationalization of the exhaust duct - Circulation use of cooling water - Impurities concentration control of water

5. Receiving and Transformation Equipment, Electric Motor, Lighting, Electric Heating Equipment

A check item and contents
Receiving and Transformation
1. Receiving Facility Management - Demand power, load factor and power factor management - Power consumption management - Power charge management (Contract power) - Use of night electricity **2. Transformation Facility Management** - Transformer capacity and voltage - Demand rate / load adjustment - Unnecessary load interception
Electric Motor
3. Electric Motor Capacity and Operation Control - Equipment capacity, voltage and numbers - Variable speed control - Stop of no-load operation
Lighting Equipment
4. Operation Management of Lighting Equipment - Adoption of an high efficiency lamp and apparatus - Adoption of automatic ON/OFF and local lighting - Position of lighting apparatus and circuit division - Management of optimum illumination - Putting out of lights at unnecessary time and use of daylight - Cleaning and exchange of lighting apparatus
Electric Heating Equipment
5. Operation Management of Electric Heating Equipment - Supply voltage and power factor improvement - Product in-and-out and material preheating - Temperature control and heating control - Heat insulation management - Improvement of load factor - Continuous operation - Reuse of exhaust heat
6. Load Leveling Measures - Review of operation condition (Operating hours, operating ratio, load factor etc.) - Review of equipment (Thermal storage unit, absorption type chiller and water heater etc.)

A check item and contents
7. Introduction Plans of Cogeneration System etc. - Equipment type, capacity and fuel - Load change by season - Rate of use and heat/electricity ratio - Inspection, electric power and antipollution measures
8. Alternative Energy etc. - Fuel cell - Solar photovoltaic power generation - Solar heat

6. Improvement of Process

A check item and contents
1. Operation Improvement **2. Review of Process Line** **3. High Efficiency, Continuous Operation etc.**

Table 2.2.2-2 Building Energy Audit Checklist

Item	Check matter
Commonness	1. Are there an organization and a committee, etc. for the energy conservation promotion?
	2. Is the energy conservation target managed?
	3. Is energy always measured with the measuring instrument?
	4. Is the management standard of energy conservation made?
	5. Is the operating hour of equipment proper compared with work hour?
	6. Is the energy management system introduced?
Electric equipment	1. Is a high efficiency transformer introduced?
	2. Is a high efficiency electric motor adopted?
	3. Is the load factor of the transformer proper? (maximum load factor 30% or more)
	4. Is the power factor at the receiving end near 100%?
	5. Is the demand supervisor control introduced?
	6. Isn't there the voltage drop at the distributing line end?
	7. Has the power factor improvement capacitor been controlled automatically?
	8. Are the energy conservation measures of the office automation apparatus done?
Illumination equipment	1. Is the lighting with inverter system introduced?
	2. Is the daylight used?
	3. Is the lighting of the working place enough?
	4. Is the division of the on-off switch proper?
	5. Has blinking of the light in the place not used been controlled automatically? (a sensor which perceives person, a time switch etc.)
	6. Isn't there dirt of the lighting apparatus and the wall?
	7. Is the high brightness guided light introduced?
	8. Has the incandescent lamp of the door way and the passages been changed to the fluorescent lamp?
	9. Isn't there a too bright place ? (Compared with the standard of JIS.)
	10. Is a plane brightness balance proper?

Item	Check matter
Air-conditioning equipment	1. Is the insulation of the rooftop and the roof considered?
	2. Is the insulation of the outside wall considered?
	3. Is the insulation of the window considered?
	4. Are the draft measures at the door way etc. done?
	5. Is the temperature in the room proper?
	6. Are the position and the number of temperature sensors proper?
	7. Is there a standard of the operation management of the heat source? (Outside temperature management and operating time, etc.)
	8. No air-conditioning at an unnecessary place and time?
	9. Isn't there difference of the temperature by the place in the room?
	10. Isn't there decrease in the operation efficiency with a cause of dirt etc of the fan?
	11. Is the water treatment of the cooling tower carried out?
	12. Is the inlet and outlet temperature of the cooling water of the cooling tower proper?
	13. Is the cold water setting temperature properly managed?
	14. Is the thermal storage system introduced?
	15. Is the low temperature supplying hot water system of the abolition heat at air-conditioning (cooling) introduced?
	16. Is the co-generation system introduced?
	17. Is air-conditioning by the air taking of the middle period done?
	18. Is the total enthelpy heat exchanger introduced?
	19. Is the air taking amount control carried out? (The minimum air taking amount control and the air taking is stopped at pre-cooling and pre-heating.
	20. Has the total replacement with natural air at nighttime?
	21. Is the COP management of the heat source machine carried out?
	22. Is the air ratio of combustion proper?
	23. Will the setting temperature of supplying hot water be too high (Is 60°C exceeded.)
	24. Is the device which uses the abolition heat of combustion equipment adopted?
	25. Is the drain collection introduced?

Item	Check matter
Transportation power(fan)	1. Is the parking lot ventilation fan controlled (CO_2 control and time control, etc.)?
	2. Is the ventilation fan such as the machine rooms controlled? (temperature control and operation time control, etc.)?
	3. Is the inverter system for to the general air-conditioning machine introduced (The shortening plan of the operating time is included)?
	4. Is a high efficiency fan adopted?
Transportation power(pump)	1. Are the cooling water and cooling-heating water pump controlled with the inverter system?
	2. Is the heat source synchronization control of the cooling water pump done?
	3. Have measures for the piping resistance decrease been executed?
	4. Is a directly connected system for water supply equipment adopted?
	5. Is the water saving apparatus introduced?
	6 The pressurizing water supply pressure will be too high.
	7. Is the closed operation of the cooling-heating water pipe possible?
Elevator equipment	1. Is a high efficiency elevator (with the inverter system) adopted?
Maintenance	1. Isn't there the dirt of the air filter?
	2. Isn't there the dirt of the fin coil of AHU and FCU?
	3. Is the heat source machine maintenance such as the tube cleaning etc. of the heat exchanger proper?
	4. Is the cooling tower properly maintained?
	5. Is the grease filter of the kitchen cleaned?
	6. Is the insulation of the piping and duct excellent?

2.3 Points to be Noted for Energy Audit

In Japan, for the purpose of ensuring the Factory to optimize the energy utilization with a potential technology, the Minister of Economy, Trade and Industry has established and published the evaluation criteria for the main items.

In this evaluation criteria, the energy conservation technology is classified into the following six categories and the adherence standard and the target level for the main items are shown as follows:

(1) Rationalization of combustion of fuels
(2) Rationalization of heating and cooling as well as heat transfer.
(3) Recovery and utilization of waste heat.
(4) Rationalization of conversion of heat into power, etc.
(5) Prevention of Energy loss due to emission, conduction, resistance, etc.
(6) Rationalization of conversion of electricity into power, heat, etc.

The target level is an adherence standard for the new equipments and for the existing equipments it becomes a non-binding target. So it leads to a better result for energy conservation. As a reference data, the adherence standard and the target level enforced on April 1, 2008 in the criteria of Japan is described as follows. Moreover, the example of the rationalization improvement measures for each item is enumerated.

(1) Rationalization of Combustion of Fuels

No.	Judgment standard and target level	Rationalization improvement measures
(1)-1-1	Air ratio control improvement	The target level value, combustion control equipment
(1)-1-2	Improvement of heat efficiency for multi-equipments	Combustion load adjustment and multi-unit control
(1)-1-3	Improvement of combustion efficiency of fuels	Adjustment of atomized size, moisture and viscosity of fuels
(1)-1-4	Combustion control equipments	Installation of measurement instrument (fuel supply volume, exhaust gas temperature, oxygen content in exhaust gas) Combustion control by using computer
(1)-1-5	Burner selection	Model, capacity, turn down ratio, maintenance, Tip wearing, Air ratio adjustment, regenerative burner introduction
(1)-1-6	Draft unit	Draft volume adjustment Combustion chamber pressure control

(2) Rationalization of Heating and Cooling as well as Heat Transfer.

No.	Judgment standard and target level	Rationalization improvement measures
(2)-1	Heating equipment etc.	
(2)-1-1	Steam heating	Prevention of the steam excessive supply by steam The stop of valve at unnecessary of steam
(2)-1-2	Dryness of steam	Prevention of heat radiation in steam transfer system Introduction of a steam separator
(2)-1-3	Improvement of heat efficiency	Load distribution to multi-equipments, Heat effective utilization by control method improvement of heating equipment, Miniaturization, decentralization arrangement and thermal storage of boilers and freezers
(2)-1-4	Optimization of heat load	The amount of materials heated Arrangement of material in the furnace
(2)-1-5	Optimization of the capacity	Selection of equipment capacity to correspond to necessary ability according to temperature of furnace, operation characteristics and operation situation
(2)-1-6	Successive heating process	Shortening of waiting time of process, Making continuously and integration, process shortening, and hot charge
(2)-1-7	Intermittent operating equipment	Accumulated operation
(2)-1-8	Prevention of scaling of steam piping	Water quality control for boiler water supply
(2)-1-9	Heat exchanger	Use of material with high thermal conductivity, Improvement of the heat efficiency by optimizing the arrangement
(2)-1-10	Cooler and condensation	Heat recovery at the target temperature less than 200^{0}C at inlet
(2)-1-11	Heat transfer surface	Improvement of transfer ratio by improving the properties and shape
(2)-1-12	Reduction of thermal capacity of furnace body and transportation tool	Light weighted
(2)-1-13	Direct Heating	Direct flame burner, submerged combustion, direct power supply
(2)-1-14	Cascade use of heat	Multi-effect evaporator, Increase th steps of evaporator, Reduction of return flow ratio by adding distillation tower Steam re-compression, Combination of industrial furnaces with high temperature and low temperature

No.	Judgment standard and target level	Rationalization improvement measures
(2)-1-15	Heat medium transportation	Reduction of heat radiation area by rationalizing the pipeline route Open type steam use equipment Installation of cover in high temperature material transportation equipment
(2)-1-16	Preliminary treatment	Prior removal of moisture, preheating, and preliminary crushing of material to be heated
(2)-1-17	Heating unit of hot water medium	Heating by vacuum steam medium
(2)-2	Air-conditioning equipment and hot water supply equipment, etc.	
(2)-2-1	Management of air-conditioning	Limitation of air-conditioning zone, Reduction of load by introducing window shade management, Equipment operation time, indoor temperature, air ventiration rate, humidity, Building energy management system (BEMS)
(2)-2-2	Temperature of heating and cooling	Setting temperature of government recommendation
(2)-2-3	Heat source management of air-conditioning equipment	Energy efficiency of equipment like heat source equipment, heat pump and cooling tower, Multi-units control for heat source equipment, Energy efficiency improvement by equipment selection Heat regenetave type heat pump gas heating system introduction, Waste heat drive type heat source machine, Multi-unit control according to load fluctuation, high efficient equipment at partial load, thermal storage system, Variable speed control of fan and pump according to load fluctuation
(2)-2-4	Management of air-conditioning	Multi-unit control according to load fluctuation, energy efficiency improvement by selecting equipment, Capacity to correspond to change according to heat demand, Control respectively according to each zone, Reduction of air flow volume and circulation water volume by large temperatures difference system, Equipment with higher efficiency than Top Runner Standard
(2)-2-5	Insulation strengthening of piping duct	Low thermal conductivity insulator material

No.	Judgment standard and target level	Rationalization improvement measures
(2)-2-6	Insulation improvement of air-conditioning zone	Increasing the thickness of wall and roof, low thermal conductivity insulator material, double- insulated system, Reduction of the isolation by using the window shade, heat reflecting glass and penetration film
(2)-2-7	Outdoor flesh air utilization	Introduction volume of outdoor flesh air control by using CO_2 sensor, load reduction by introduction total enthalpy heat exchanger, energy consumption reduction by using outdoor flesh air in intermediate seasons or cooling tower to thermal energy for cooling
(2)-2-8	Indoor parking area, machine room and electricity room	Introduction of ventilation to be controlled by airflow with a sensor
(2)-2-9	Hot water supply equipment management	Operation according to the change of hot water supply efficiency and heat load of the hot water temperature and pressure in different seasons, , Introduction of partly hot water supply system for a little demand
(2)-2-10	Heat source management of hot water supply equipment	Energy efficiency improvement of heat source and heat pump, Energy efficiency improvement of heat source equipment by multi-unit control Heat pump system and condensation heat collection method introduction
(2)-2-11	Introduction of gas hot water heater	Adoption of higher efficiency type more than Top Runner Standard
(2)-2-12	Introduction of oil hot water heater	Adoption of higher efficiency type more than Top Runner Standard
(2)-2-13	Introduction of gas cooking equipment	Adoption of higher efficiency type more than Top Runner Standard
(2)-2-14	Introduction of stove	Adoption of higher efficiency type more than Top Runner Standard

(3) Recovery and Utilization of Waste Heat

No.	Judgment standard and target level	Rationalization improvement measures
(3)-1-1	Waste gas temperature, waste heat recovery ratio	The criteria to be target value
(3)-1-2	Waste energy	Waste gas, exhaust gas, drain, and waste liquid, Temperature, volume and properties of condensate, Sensible heat, latent heat and pressure of the high temperature solid (coke) and fluid, Recovery range of combustible element, Mechanical energy(water head), Exhaust pressure (Blast furnace、fluid coker), By-product gas (steel converter), Cold thermal energy (liquefied natural gas), Natural energy (sun light, solar heat and outdoor flesh air temperature)
(3)-1-3	Utilization	Material and raw material heating, combustion air, supply air heating, Boiler water supply preheating, fuel preheating (oil), Steam generation and power generation, Air-conditioning, district heat supply and refrigeration, Fish cultivation, greenhouse heating and snow melting
(3)-1-4	Method	Heat exchanger, flow layer, Heat pipe, heat pump, heat medium use, Waste heat boiler, Pressure reduction type recovery boiler, Turbine (organic solvent and steam), Total enthalpy heat exchanger and Regenerative burner, Improvement of shape and properties for heating surface, increase heat transfer area, Introduction of the thermal storage equipment
(3)-1-5	Waste heat transportation equipment	Prevention of air infiltration of chimney and piping, high temperature of waste heat to be maintained by strengthening insulation.

(4) Rationalization of Conversion of Heat into Power, etc.

No.	Judgment standard and target level	Rationalization improvement measures
(4)-1	Power generation facilities	
(4)-1-1	Improvement of energy efficiency improvement	High efficiency operation, Load distribution by multi-unit power generation running parallel, Pressure reduction operation at the partial load of steam turbine Steam condition improvement (temperature, pressure, and dryness), Combined system, Power recovery at reduction of steam pressure (example: Back pressure turbine)
(4)-1-2	rationalization of power plant running	Turbine and nozzle shape improvement, Condenser vacuum tube management (cleaning, water temperature and leakage), Generator running management and unit control of accessory equipment, Variable speed control, optimization of back pressure and extraction pressure , Peak shift (Electric power use of the mid-night hour and holiday, thermal storage)
(4)-2	Cogeneration	
(4)-2-1	Cogeneration equipment	Increase and decrease of running load for the boiler, gas turbine, steam turbine, gas engine and diesel engine, Allowable lowest value of extraction pressure and back pressure of extraction pressure turbine and back pressure turbine
(4)-2-2	Utilization of exhaust heat	Cogeneration to be introduced when it is possible to use large amount of the exhaust heat for steam and hot water demand

(5) Prevention of Energy loss due to Radiation, Conduction, Resistance, etc.

No.	Judgment standard and target level	Rationalization improvement measures
(5)-1	Prevention of energy loss due to radiation and conduction etc.	
(5)-1-1	Insulation	Insulation work of heat medium transportation piping and heating equipment according to JISA9501 and furnace wall surface temperature of industrial furnace according to Judgemnet Standard Strengthening the heat insulation of flanges and valves Low thermal conductivity heat insulator to be used and reduce the emission of the cover, Cover and lid installation, the maintenance of insulation area Use of light weighted heat insulation material in batch type furnace heat insulation (bulk specific gravity =1.0)
(5)-1-2	Furnace wall of industrial furnaces	Heat emission improvement by adjusting properties and shape, Outside temperature of furnace wall is to be less than the standard value, Use of heat insulator for the intermittent running furnace with the bulk specific gravity below 0.75
(5)-1-3	Insulation strengthening of heat use equipment	Thickness increase of heat insulator, heat insulator to be used with low thermal conductivity, double-insulated construction
(5)-1-4	Openings of heat use equipment	Reduction of openings or sealing up, Installation of the double-entry doors, Interception the air flow from inside
(5)-1-5	Prevention of the leakage of heat transfer medium	Rotation part and seal to be strengthened
(5)-1-6	heat radiation part to be decrease	Improvement of piping route Removal of unnecessary piping Stop of un-use valve and blind plate setting
(5)-2	Prevention of power loss due to resistance, etc (Power receiving and distribution equipment)	
(5)-2-1	Transformer and uninterruptible power supply	A proper demand rate to be maintained, Adjustment of running units and proper distribution of load, a new installation transformer should be higher efficient than Top Runner Standard.
(5)-2-2	Reduction of electric power distribution loss	Shortening of power distribution line length Optimization of power distribution voltage

No.	Judgment standard and target level	Rationalization improvement measures
(5)-2-3	Power factor improvement	Power factor at receiving end is to be more than 90%, Power factor of new equipment is to be more than 95%, Power factor of transfer is to be improved by capacitance arrangement, Capacitance is to be ON-OFF operation in synchronizing with the operation ON/OFF
(5)-2-4	Improvement of three-phase circuit unbalance	Prevention of the voltage unbalance when the single phase load be connected in the three-phase circuit power
(5)-2-5	Mitigation of the maximum electric power	Load leveling and demand control
(5)-2-6	Power supply Management	Reduction of electricity loss such as distribution voltage and current of distribution in electric used equipment

(6) Rationalization of Conversion of Electricity into Power, Heat, etc.

No.	Judgment standard and target level	Rationalization improvement measures
(6)-1	Management of electric power application equipment and electric heating equipment, etc.	
(6)-1-1	Electric motor	Adoption of high efficiency electric motor, Capacity selection according to running characteristics and operation situation of load machine
(6)-1-2	running	Setting of management standard to prevent idling running, Stop at unnecessary time, Multi-unit control and distribution of load in multi-electric motor to be used
(6)-1-3	Fluid transportation	Pump, fan, blower and compressor
(6)-1-4	Load reduction of fluid machinery	Review of use end pressure and delivery volume, Change of the rotational speed, Multi-unit control, piping size change, impeller cut, Variable speed control (VVVF, clutch and pole change), Flow-rate decrease (leakage prevention), Suction temperature decrease, Piping resistance decrease (piping route rationalization and cleaning)
(6)-1-5	Compressor installation	Miniaturizing and decentralization arrangement, Change the lower pressure use for high-pressure air into the blower installation

No.	Judgment standard and target level	Rationalization improvement measures
		of the low pressure.
(6)-1-6	Electric heating	Induction furnace, arc furnace and resistance furnace
(6)-1-7	Heat efficiency improvement of electric heating equipment	Material charging method improvement, Hot charge, Decrease of electric loss due to no load operation, insulation and waste heat recovery utilization, Contact resistance decrease
(6)-1-8	Efficiency improvement of electrolysis equipment	Adoption of electrode with suitable shape and characteristic, inter-electrode distance, density of electro-bath, and contact resistance of conductor
(6)-1-9	Measurement management	Consumption of electricity, state of power and heat obtained due to conversion of electricity, Measurement management of temperature of exhaust gas by computer
(6)-2	Lighting equipment, elevator, office appliance, and consumer appliance, etc.	
(6)-2-1	Proper illumination of lighting unit	JISZ9110 illumination standard, Exclusion of lighting by reduce lighting using lighting control or lights out, lights out by using daylight, Adoption of lighting automatic control device, Installation of human detective sensor, the use of timer
(6)-2-2	Maintenance of lighting	Cleaning of illuminator and lamp, replacement of lamp
(6)-2-3	Selection of illuminator	Fluorescent lamp (Hf fluorescent lamp) with electronic ballast(inverter), Adoption of high efficiency lamps like HID lamp, Illuminator of easy cleaning and replacement of lamp, Selection of illuminator by overall illumination efficiency including luminous efficiency, efficiency of lighting circuit and lighting efficiency to the area , The circuit of the illuminator for the daylight be used to be use other illuminator and another circuits Illuminator is higher efficient more than Top Runner Standard
(6)-2-4	Elevator operation	Multi-unit control,

No.	Judgment standard and target level	Rationalization improvement measures
		Escalator to be stopped when having no passengers by introducing the human detective sensor
(6)-2-5	Maintenance of elevator	Reduce mechanical loss of electric motor and power transmission part
(6)-2-6	office appliance running	Power OFF when unnecessary, Low power mode setting
(6)-2-8	Selection of copy machine	adoption of high efficiency type
(6)-2-9	Selection of computer	adoption of high efficiency type
(6)-2-10	Selection of magnetic disk	adoption of high efficiency type
(6)-2-11	Selection of television receiver	adoption of high efficiency type
(6)-2-12	Selection of video tape recorder	adoption of high efficiency type
(6)-2-13	Selection of refrigidaire	adoption of high efficiency type
(6)-2-14	Selection of electric freezer	adoption of high efficiency type
(6)-2-15	Selection of electric toilet seats	adoption of high efficiency type
(6)-2-16	Selection of vending machine	adoption of high efficiency type
(6)-2-16	Vending machine running	Nighttime and holiday suspension of sales according to timer of the vending machine for the can and bottle
(6)-3-1	BEMS	Energy management at every year, month, day and time for every system in building equipments, Energy consumption trend to be understood by the numerical value and the graph, etc, Integrated energy control of air-conditioning equipment and electric equipment , Deterioration situation and maintenance time of the equipment to be understood from data

2.4 Factory Outline

It is necessary to know the outline of the Factory shown in above-mentioned 2 (1) before Factory audit. To grasp the outline of the Factory, the following preliminary investigation sheet are distributed and basical information should be collected. In addition, Clarification of uncertain points by interviewing the manager and engineer of the Factory are very effective for the audit preparation.

Table 2.4-1 and Table 2.4-2 show the example of questionnaire to be distributed before energy audit of the factory and the commercial building.

Table 2.4-1 Questionnaire before Energy Audit in Industrial Sector

September 2007
JICA Study Team

Company	***/ President***
Name ***Section*** ***Phone***	 ***/ Email***
Date	

1. General

Name of factory	
Address	
Factory Manager name	
Energy Manager name	
Kind of products	
Annual production capacity	
Number of engineers	
Number of employees	
Fuel consumption in 2006 (kilo liter of oil equivalent)	
Power receiving transformer capacity in 2006 (kVA)	

2. Annual Energy Consumption and Energy Intensity

	2002	2003	2004	2005	2006
Production (ton, sets)					
Sales Amount (Rp)					
Fuel oil (kilo liter)					
Fuel gas (1,000 m^3N)					
Coal (ton)					
Other fuel (ton)					
Electricity (MWh)					
Contract demand (kVA)					
Fuel intensity					
Electricity intensity					

Note 1. Other fuel means saw dust, rice husks, palm oil shell etc.
Note 2. Fuel intensity = Fuel consumption (kilo liter, ton, m3N) / (Production or Sales amount)
Note 3. Electricity intensity = Electricity consumption (kWh) / (Production or Sales amount)

3. Annual Energy Cost and Energy Cost Ratio

	2002	2003	2004	2005	2006
Fuel oil (Rp)					
Fuel gas (Rp)					
Electricity (Rp)					
Total energy cost (Rp)					
Sales Amount (Rp)					
Energy cost ratio (%)					

Energy cost ratio = Total energy cost / Sales amount × 100

4. Energy Consuming Equipment and Operation Condition

4.1 Energy Consuming Equipment

No.	Equipment	Quantity	Main specifications
1	Steam boiler, Hot water boiler		
2	Heat media boiler, Downtherm boiler		
3	Industrial furnace		
4	Air compressor		
5	Pump		
6	Blower		
7	Chiller		
8	Power receiving transformer		Capacity in total : kVA, Voltage: kV Power factor:
9			
10			
11			
12			

4.2 Contents of Factory's Request on Energy Audit

Request items for energy audit from the factory: Selection of request items:

a. General management items:

1) Energy management system
2) Activity of measurement and record
3) Maintenance of equipment
4) Management of energy consumption
5) Energy intensity management of main products
6) Improvement of process
7) Measures of load leveling
8) Others

b. Air-conditioning unit and freezing equipment:

1) Overall operation control
2) Energy conservation measures
3) Operation control of cooling equipment
4) Operation control of anxiety equipment
5) Cold holding and freezing equipment
6) Space heating equipment
7) Others

c. Pump, fan, compressor, cogeneration system:

1) Operation control of pumps and fans
2) Operation control of compressed air equipment
3) Introduction plan of cogeneration system etc.
4) Others

d. Boiler and industrial furnace:

1) Combustion control
2) Operation and efficiency control
3) Insulation and heat holding
4) Temperature control of exhaust gas
5) Others

e. Steam system, heat exchanger, waste gas and waste water:

1) Operation control of steam
2) Management of steam leakage and heat insulation
3) Optimization of piping
4) Load leveling
5) Condensate recovery of steam
6) Operation control of heat exchangers
7) Reduction of waste water and waste heat
8) Others

f. Electricity equipment:

1) Power receiving station control
2) Power transformation equipment control
3) Operation control and capacity of motors
4) Management of lighting equipment
5) Operation control of power heating equipment
6) Others

4.3 Working Time

1) Production section:
   Annual operation days
   Operation hour to Break hour minutes
   to
   to
2) Office section
   Start and close time to Break hour: minutes

4.4 Production Flow Diagram

4.5 Energy use Conditions

1) Electricity

Equipment name	Power use ratio (%),

2) Heat

Fuel name	Combustion unit	Heat use equipment and heat use ratio (%)

Table 2.4-2 Questionnaire before Energy Audit in Commercial Building Sector

September 2007
JICA Study Team

Company	*/ President*
Replied by *Name* *Section* *Phone*	 */ Email*
Date	

1. Building Outline

Name of building	
Address	
Building Manager	
Energy Manager	
Usage of building	Public office, Only for office, Department store, Food supermarket, Hotel, Hospital, Shopping center, School, Laboratory, Others (________________)
Number of visitor	Weekday ______ persons (Holiday ________persons)
Number of enrollment	
Operating time of building	Opening time_________Closing time _______________
Operating time of air conditioning	[Heating] Opening time ______ Closing time ________ [Cooling] Opening time ______ Closing time ________
Setting temperature and humidity of air conditioning	[Heating]_____________°C ___________________% [Cooling]_____________°C ___________________%
Building structure	Steel-frame / Reinforced concrete /_____________
Building scale	Ground ____ floors, Basement _________floors
Area which relates to building	Site area________m^2, Building area _______ m^2 Gross floor space________m^2

2. Energy Consuming Equipment

No.	Equipment	Qty	Main specifications
1	Receiving system		Receiving voltage ______ kV, Contract demand ___kW
2	Receiving transformer		Voltage ___/_____ , capacity____kVA
3	Private generator		Type _____ , Capacity _________ kW _____ kV
4	Heat or cold source		Type _____ , Capacity _________ USRT
5	Air conditioning		System ___ Central/Individual, Indoor unit____
6	Thermal storage tank		System ___ Water/Ice , Capacity ____ t
7	Elevator		Speed ____ m/m Capacity _____ kg ____ Persons
8	Boiler		Type ___________ Capacity _________ MJ/h
9	Air compressor		Type ___________ Capacity _________ kW
10	Pump		Type ___________ Capacity _________ kW
11	Ventilation fan		Type ___________ Capacity _________ kW

3. Annual Data

3.1 Annual Energy Consumption

Gross floor space (m^2)				
Fuel oil (kilo liter)				
Fuel gas (1,000 m^3N)				
Electricity (MWh)				
City water (Ton)				
Fuel intensity (MJ/m^2)				
Electricity intensity (kWh/m^2)				
Energy basic unit (MJ/m^2)				
Water intensity (kg/m^2)				

Note 1. Fuel intensity = Fuel consumption (MJ) / (Gross floor space (m^2))
Note 2. Electricity intensity = Electricity consumption (kWh) / (Gross floor space (m^2))
Note 3. Energy basic unit = Fuel intensity (MJ/m^2) + Electricity intensity (MJ/m^2)
Note 4. Water intensity = City water consumption (kWh) / (Gross floor space (m^2))

3.2 Annual Energy Cost

	2004	2005	2006	Total
Fuel oil (Rp)				
Fuel gas (Rp)				
Electricity (Rp)				
City water (Rp)				

4. EE&C for Buildings

If you have ever introduced following countermeasures for EE&C, please check them.

a) Heat exchanger for outdoor air inlet
b) Heat recovering heat pump
c) High efficiency heat pump or air conditioner
d) Outdoor air inlet control (Minimum supply of outsmeasureir)
e) Drive control of pumps and fans (Inverter controller)
f) High efficiency belt for fans
g) High quality heat insulation on piping and ducting
h) High efficiency illumination (Inverter ballast)
i) Compact fluorescent lamp
j) High quality reflector for lighting fixtures
k) Automatic photo-electric switch for illumination system
l) High efficiency transformer
m) Inverter control for elevators
n) Power factor improvement condenser
o) Double glassing for windows
p) Heat reflection film on glass
q) High quality heat insulation for wall and roof
r) Water conservation device

2.5 Measurement Plan

The measurement work should be done according to the operation condition of the Factory and it is necessary to make an elaborate measurement plan to obtain high accuracy data within a limited time.

The measurement plan is made according to preliminary investigation table of the Factory, a prior interview with the manager of the Factory, a checklist and an internal conference of the audit team and decided by obtaining the consent of the Factory.

(1) Finalizing measurement schedule

The measurement schedule is decided by Factory's operation plan and the audit investigation items of the Factory. The work partition is decided by consulting between the energy audit specialists with the measurement specialist and. Table 2.5-1 shows an example of the measurement schedule.

The adjustment of the load and the prevention of accidents during the measurement time, etc. are requested to the Factory considering the running plan of the Factory. When continuous measurement is more than eight hours, watching of the record meter and recording of the meter is requested to the Factory. It is important not to obstruct the production of the Factory.

(2) Determining measurement item and measuring method

The priority order should be decided from the planed investigation items. The items are classified by the one to be measured and be recorded by the meter from the Factory, as well as the one to be output signal from the meter and be obtained from operating record of the Factory. The measurement item is decided by the schedule, the number of worker and the measurement working environment. The measuring method is decided by the selection of the measuring instrument be used, the measurement place and the measurement object.

(3) Determining measurement points

The measurement points are decided based on the measurement items and it should be decided on the site in consideration of the measurement environment, such as the representative measurements to be able to be taken, sensor installation nozzle, situation of work platform, high carriage, water leak, dust and electric shock. The new establishment or location change of the nozzle are requested to the Factory when a current nozzle location and shape are inapposite, because it is important to select the location of sensor installation nozzle for gas sampling nozzle, thermometer installation nozzle, wind volume meter installation nozzle and pressure gauge installation nozzle. It is necessary to cut piping and install a vortex Flow-meters etc when high-pressure gases like steam and compress air are measured. Therefore, it is necessary to request construction to the Factory side early time in consideration of the construction period of piping.

(4) Determining measurement time

These parameters with the change day and night, such as the power load, air compressor load, and freezer load and boiler load, should be measured continuously over 24 hours. The measurement is continuously done with several hours from 30 minutes for the equipment with few changes of the load. The measurement is done at the spot with a few minutes from 30 to every one hour for the equipment to not be continuous recorded.

(5) Preparing forms for measurement record

Measurement recording means that the person in charge of the measurement writes the measurement record in the recording form excluding the one be recorded by recording equipment like magnetic disks in the measuring instrument and the one be recorded by recording paper of record meter and magnetic disks. The recording form is made before measurement beginning and requests the measurement record to the person in charge of the measurement.

The style of form is preferable to use the one that the flow seat and the equipment cross section because this make it is easy to collate the measurement point with the measurement data and find abnormality of the recorded data. Figure 2.5-1 shows the example of the recording form.

(6) Analysis of measurement data

The measurement data after primarily processed by the measurement specialist, with the original measurement record, is handed over to the audit specialist. As for processing method of measurement data, the output form should be decided reflecting the opinion of the audit specialist。

Table 2.5-1　AAA Factory Measurement Schedule（Example）

No.	Equipment	Measuring items	Team	Factory	1st day		2nd day		3rd day		Remarks
					AM	PM	AM	PM	AM	PM	
1	Reheating furnace	Heat balance									
1.1		Fuel flow rate	A	M		▬	▬				
1.2		Fuel temperature	A	M		▬	▬				
1.3		Combustion air temperature	A	M		▬	▬				
1.4		Exhaust gas 02	B & C	M		▬	▬				
1.5		Exhaust gas temperature	B & C	M		▬	▬				
1.6		Furnace temperature	A	M		▬	▬				
1.7		Furnace 02	B & C	M		▬	▬				
1.8		Billet temp	B & C	M		▬	▬				
1.9		Billet volume		M		▬	▬				
1.10		Pee surface temp.	B&C	M		▬	▬				
1.11		Air fan motor Amp	D&E	M		▬	▬				
1.12		Cooling waiter temp.	B&C	M		▬	▬				
1.13		Cooling waiter volume	D&E	N		▬	▬				
2	Sub-station										
2.1		Electricity demand	D&E	N	▬	▬	▬				
3	Water pump										
3,1		Motor electricity	D&E	N				▬	▬		
3.2		Water flow-rate	B&C	N				▬	▬		
3.3		Water pressure	B&C	N				▬	▬		
3.4		Water temperature	B&C	N				▬	▬		
4	Report to Factory		A,B, D&E							▬	

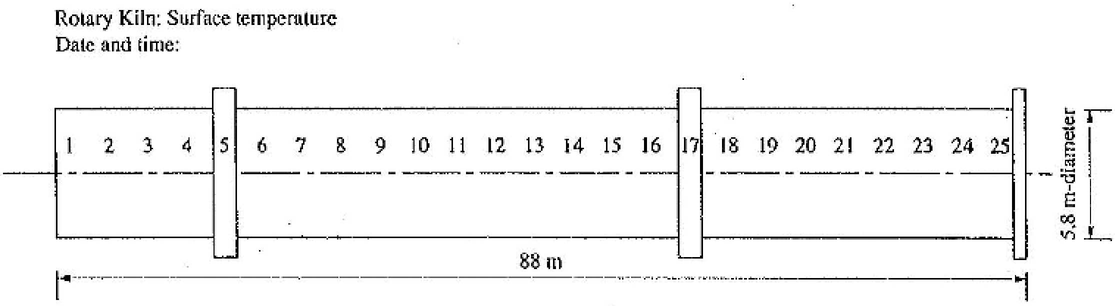


Figure 2.5-1 Measurement Recording Sheet（Example）

Table 2.5-2 Measuring Data Record

No.	Maximum (C)	Average (C)	Minimum (C)	Maximum to Minimum (C)
1	279	271	264	15
2				
3				
6				
8				
10				
12				
14				
20				
22				
24				
Measuring equipment: Portable radiation pyrometer				

2.6 Explanation of Measuring Instrument

The explanation of the outline of the measuring instruments used for the energy audit of the factory and the commercial building is prepared.

2.6.1 Measuring Instrument List

Table 2.6.2-1 shows the list of the measuring instrument used for the energy audit executed in 2007 of the factory and the commercial building in Indonesia.

2.6.2 Measuring Instrument Outline

It explains the measurement principle and the feature of the measuring instrument as follows:

(1) Pressure gauge (Bourdon tube)

A widely used elastic type pressure gauge assembled into the piping line for pressure measurement. It offers four measurement ranges; 0 to 1.0 MPa, 0 to 2.0 MPa, 0 to 3.5 MPa, and 0 to 5.0 MPa.

(2) Digital low pressure indicator

A handy digital low pressure indicator used to measure the pressure of a gas. the pressure measurement range is between -50 and 50 mm H_2O for both positive and negative pressures. This gauge is mainly used to measure the pressure in furnaces such as a rehearing furnace. Data is output as an analog signal of 1 to 5 V DC and can be stored in a recorder,

(3) Pressure transmitter

This pressure transmitter uses a semiconductor strain gauge for the detecting part. Pressure is converted into an electrical signal and transmitted. The measurement range is between 0 to 10kg/cm^2 or between-0 and 50 kg/cm^2. Data is output as an analog signal of 4 to 20 mA DC and can be stored in a recorder.

(4) Glass thermometer

A widely used liquid-sealed glass thermometer. The measurement range is between –20 and 100°C .

(5) Thermo-hygrometer

A widely used therm-hygrometer. Humidity is measured from the dry bulb temperature and wet bulb temperature. The measurement range is between -20 and 50°C.

(6) Sheathed thermocouple

This thermometer uses the Seebeck effect. A metal strand is protected by a sheath member.

Type K is a thermocouple made of chromel and alumel and has a measurement range of 0 to 1,000°C . Type R is a thermocouple made of platinum and platinum + rhodium (13 %) and has a measurement range of 0 to 1,300°C.

Table 2.6.2-1 Measuring Instrument List

No.	Instrument	Q'ty	Requirement	
			Measuring range	Specifications
1	Exhaust gas O2 analyser	1	Oxygen: 0 to 25%	Measuring hour: Max. 12 hours continuous
2	Surface thermo-meter	2	Temperature: 0 to 500 degC	Digital type
3	Radiation thermo-meter	2	Temperature: 0 to 1000 degC	Infrared type
4	Infrared camera	1	Temperature: 0 to 900 degC	Memory for data saving
5	Differencial pressure meter	1	Pressure: -1 to 1 kPa	Digital type
6	Ultra super sonic flowmeter	2	Pipe diameter: 20mm to 1000mm	Temperature: Max. 100 degC, Liquid in pipe: Water or oil
8	Steam trap checker	1	Detedter of performance of steam trap	
9	Power meter	3	380V, 300A,	Memory for data saving, Output signal: 1 to 5V or 4 to 20mA DC
10	Ultra super sonic leak detecter	1	laekage of compressed air and steam	Up to 10×10^{-10} cc/s
11	Pressure tansmitter	2	Pressure: 0 to 15 bar	Compressed air and steam pressure measurement
12	pH meter	1	pH: 0 to 14, temperature: 0 to 100 degC	
13	Conductivity meter	1	Conductivity: 0 to 5000 μS/cm	
14	Wet and dry hygrometer	3	Dry and wet bulb type	
15	Digital hygrometer	1	Range 5 to 98% RH	Relative humidity
16	Lux meter	1	Luminance: 20 to 5000 Lx	
17	Pitot tube	1	Range -05 to +2.5 Inc water	Western type
18	Hot wire anemometer	1	Gas speed: Max.50m, temperature: 400 degC	Length: 1m
19	Data logger	2	8-channel, input: V-DC, mA-DC, thermo-couple	Output signal: RS232C
20	Lap-top personal computer	1	Data receiving, data analysis	
21	Stop watch	1		
22	Tape measure (10m)	1		
23	Multi tester	1	V-DC, mA-DC, V-AC, Ohm	
24	Thermocouple	2	K type	SUS theath 2mm dia. Theath length: 1m or more
25	Bourdon tube	2	1 Mpa	Pressure measurement of compressed air

(7) Surface thermometer

This handy type: thermometer employs a thermocouple and is used to measure the furnace surface temperature, etc. Since the object to be measured comes in direct contact with the sensor, the exact temperature can be measured easily. The measurement range is from –50 to 600°C.

(8) Radiation thermometer

This noncontact thermometer uses an infrared rays sensor to enable remote measurement.

It can evaluate and store up to 100 sets (total 200) of the measured temperature value and the maximum value during the measurement period. With the low temperature type, the measurement range is from -30 to 1,200°C. With the high temperature type, the measurement range is from 600 to 3,000°C.

(9) Suction pyrometer

The suction pyrometer is used to measure hot gas temperature in the boiler, combustion furnace, etc. A platinum rhodium thermocouple is used as the sensor and the effects of radiation from the hot furnace wall are minimized by the radiation shield: At the same time, the other thermal effects are minimized by aspirating the gas to be measured at high speed through the space between thermocouple and protection tube to measure the temperature.

Data is output as an analog signal of 1 to 5V DC and can be stored in a recorder.

(10) Infrared thermovideo

The temperature of an object can be measured without coming in contact with it and a thermal image can be displayed on the built-in color monitor. The measurement range is from -10 to 950°C . Data can be stored on a floppy disk and can be analyzed by using the dedicated personal computer software.

(11) Ultrasonic flowmeter

This flowmeter is used to measure the flow rate of a liquid such as water supplied to the boiler or fuel oil. Since ultrasonic waves are used for measurement, measurement can be performed from outside the piping. The meter does not come in direct contact with the liquid, which effectively prevents pressure loss. The measurement range is from -16 to 0 to +16 m/s. Data is output as an analog signal of 1 to 5 VDC and can be stored in a recorder.

(12) Vortex flowmeter

This flowmeter is assembled into the piping line to measure the flow rate. The flow rate is measured by detecting the Karman vortex street. All liquids, gases, and steam are objects to be measured. Data is output as an analog signal of 4 to 20 mA DC and can be stored in a recorder.

(13) Hot-wire anemometer

This hot-wire anemometer is used to measure the exhaust gas flow rate in a boiler or combustion furnace. Hot air flow at up to 500°C can be measured in a range of 0 to 50m/s. Data is output as an analog signal of 0 to I V DC and can be stored in a recorder.

(14) Solution conductivity meter

This handy conductivity meter is used to measure the quality of water supplied to or drained from the boiler, etc. The measurement range is 0 to 200 mS/cm. The temperature of the liquid to be measured is 0 to 80°C. Liquid temperature and conductivity can be measured at the same time.

(I5) PH meter

This handy PH meter is used to measure the quality of water supplied to or drained from a boiler, etc. The measurement range is pH0 to pH14. The temperature of the liquid to be measured is 0 to 80 ^{0}C. The liquid temperature and pH can be measured at the same time.

(16) Sampling gas treatment unit

This supplementary device for a gas analyzer is used to remove dust and water vapor from exhaust gas and cool the gas before it is analyzed with an oxygen analyzer or CO-CO_2 meter. The major components of this device are the drain separator; gas suction pump, filter, electronic cooler, and flowmeter.

(17) Portable oxygen analyzer (continuous type)

This analyzer is used to measure oxygen content in the exhaust gas from a boiler, combustion furnace; etc. The measurement range is 0 to 25%. The zirconia method using electrochemical redoz (oxidation-reduction) reaction is employed for measurement. Data is output as an analog signal of 0 to 1 V DC and can be stored in a recorder.

(18) Portable oxygen analyzer (spot type)

This analyzer is used to measure the oxygen content in exhaust gas from a boiler, combustion furnace, etc. The measurement range is 0 to 25 %.

Since this is a compact galvanic cell type oxygen analyzer, it is suitable for short-term measurement.

(19) Steam trap checker

This checker records the steam trap running status. Up to 800 pieces of data can be stored. The stored data can be transferred to a PC (personal computer) and analyzed by dedicated software.

(20) Low-voltage detector

This handy, compact voltage detector has a measurement range of 50 to 600 V,

(21) Tester

This tester is widely used. The measurement ranges are as follows:

DC: 200 mV/2 V/20 V/200 V/1000 V
200 /μA/20 mA/10 A
AC: 2 V/20 V/200 V/750 V
200 μA/20 mA/10 A
Ω: 200Ω/2 kΩ/20 kS2/200 kΩ/2000 kΩ/20 MΩ

(22) Clamp-on power meter (Hioki Denki: 3166)

This clamp type watt-meter allows single-phase to 3-phase 4-wire type measurement. The calculated reactive power; apparent power, and power factor are output to the printer based on the measured voltage, current, and effective or active power. Data is recorded in the attached FDD unit and can be analyzed using the PC's spreadsheet software.

(23) Clip-on AC power meter (Yokogawa Electric Corporation: 2433-11)

This handy power meter allows measurement of kW; Vrms, and Arms of single-phase or balanced three-phase circuits with a clamp sensor. The circuit voltage is up to 600 V (AC).

(24) Transducer

The transducer is installed between the power supply and the electric equipment to be measured. Analog signals can be output so that the power value; etc. can be directly recorded by a recorder.

Power transducer (3p-4w 1000 W, 100 V/5 A)
AC current transducer (5A AC)
AC voltage transducer (1l0 V AC)
Reactive power transducer (3p-3w lag 1000 - lead 1000 var 100 V/5 A)
Power transducer (3p-3w 1000 W, 110 V/5 A)

(25) Tachometer

This tachometer provides both contact and contactless measurement methods. The measurement range is 60 to 30,000 rpm.

(26) Lux meter

This handy, compact Lux meter uses a silicon photo diode as a sensor.

The measurement range is 0 to 19,999 Lux.

(27) Hybrid recorder

Up to 20 analog signal outputs from measuring equipment can be received. The built-in floppy drive can be used to record the data on a floppy disk. The data can also be printed out by the built-in color printer. The data recorded on the floppy disk can be converted into data for the spreadsheet software using the dedicated software.

(28) Data logger

The analog signal from each measuring instrument and thermo-couple up to 8-16 points can be output. The LCD monitor can observe the change of measurements data and at the same time record the data in its memory and its PC card. The data recorded with the PVC card can be converted into data for the spreadsheet with special software.

(29) CO/CO_2 meter

This meter is used to measure CO/CO_2 content in exhaust gas from a boiler, combustion furnace, etc. The measurement range is 0 to 0.5 vol% for CO, and 0 to 15 vol% for CO_2.

The measurement is performed by a non-separated type infrared ray absorption method using the infrared ray absorption percentage. Data is output as an analog signal of 0 to 1 V DC and can be stored in a recorder.

(30) Pitot tube type flowmeter

This flowmeter is used to measure the flow rate of liquids, gases, etc. Differential pressure is obtained from the total pressure and static pressure to calculate the flow rate. Data is output as an analog signal of 1 to 5 V DC and can be stored in a recorder.

2.7 Measurement Data Processing

2.7.1 Measurements and Errors

Various types of errors may occur when actually taking measurements with measuring equipment. Since it is not possible to obtain the true value by a measurement, measurement values that include a margin of ertor are normally used in an analysis. Thus, it is important to understand the nature of errors in order to minimize them.

Errors can generally be attributed to the following 4 factors.

(1) Errors due to measurement principles and methods

Errors occur because a physical principle or theory used is not appropriate for the actual object or method of the measurement.

(2) Errors due to the measuring instrument

An imperfection or trouble in the measuring equipment cruces a "bias" or "dispersion" in the measurement value.

(3) Errors due to the condition and environment of measurement

An error is caused by the interaction (electrical and mechanical impedance) between the measuring instrument and an object of measurement, influence from the environment or condition of the power source, or by changes and instability that occur to the measurement object itself due to changes in the environment.

(4) Errors due to the reading method

An error may occur due to cognitive limitations or peculiarities in individual reading habits of the measuring person, or as the result of "rounding up" by the A-D converter, etc.

2.7.2 Measurement Data Collection and Data Processing Procedure

In order to conduct an analysis based on various tnensurement data, the data must be collected and processed correctly.

(1) Data Process Flow

The process flow for measurement data is as shown in Figure 2.7.2-1.

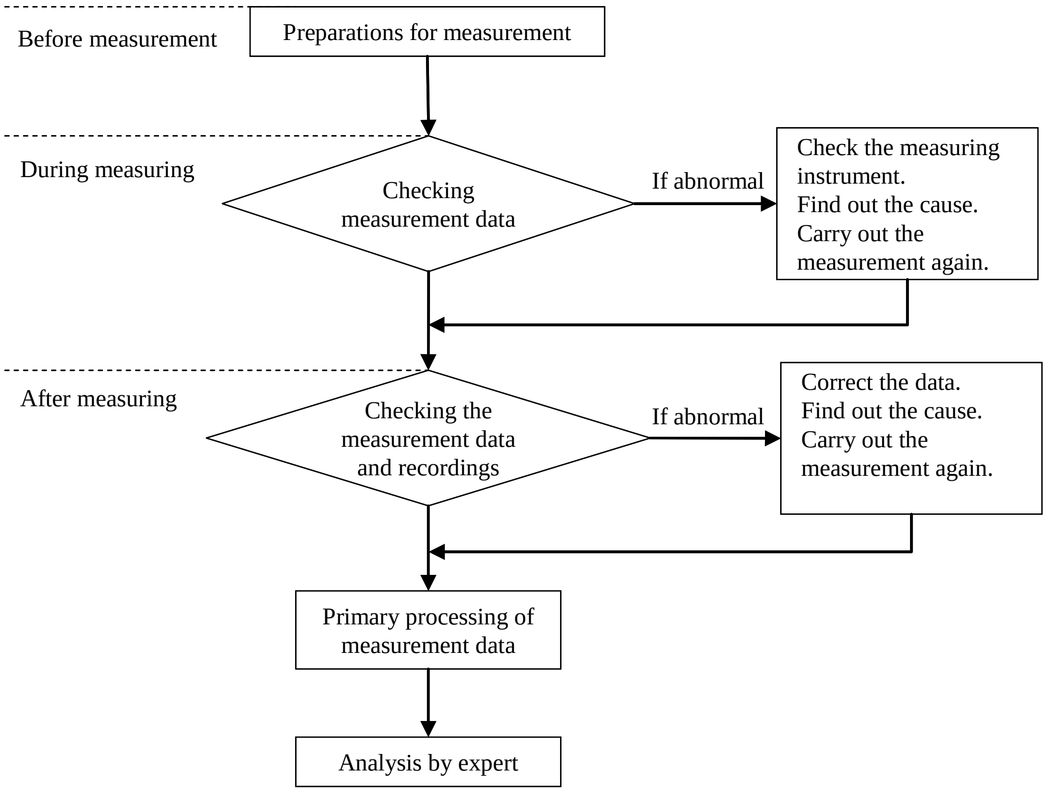


Figure 2.7.2-1 Process Flow for Measurement Data

(2) Verifications of Data Processing and Notes to be Taken

1) Verifications and notes to be taken before starting a measurement

- Carry out maintenance work on the measuring instruments periodically.
- Calibrate the measuring instruments before starting the measurement (Zero point calibration, span calibration, eic.)
- Check whether or not the wiring and sensor installations, etc., .u'e carried out properly.
- Make sure that the measuring instrument itself is correctly set.

2) Verifications and notes to be taken during a measurement

- Compare the measurement value with the normal value and theoretical value, and find out whether any abnormality is present
  If there is an abnormality; find out its cause and carry out the measurement again.

- Compare the findings with those on other existing meters. (If there is an existing meter)
- Take the measurement with a number of types of measuring instruments, and compare each measurement data.
- Compare the measurement with the values obtained from interviews with responsible personnel at the factory.
  Make sure that there is no difference depending on measurement point (location).
- In case of prolonged measurements, make sure that there is no abnormality to the measuring instrument.
- If any abnormality or change occurred to the object of measurement (facility, line, etc.), record its details and time.
- Prohibit all non-authorized personnel from operating the measuring instrument.

3) Verifications and notes to he taken after the measurement

Plot the measured data on a spreadsheet and grnph, and verify whether or not any abnormality exists. If an abnormality occurs, find out its cause, and then consult an expert, and either correct the data or carry out the measurement again.

- When analyzing recorded data, display it on a table or graph so that it can be viewed easily. In doing so, indicate the date, factory name, measurement object, and other particular remarks.
- If the measurement object (facility, line, etc.) was subject to a temporary hale due to an incident, such as an accident, immediately before the start of operation or immediately after the end of operation, there will be a large fluctuation in Yhe measurement data. In such a case, carry out steps that will enhance ease of analysis such as removing the affected part of the data, or consult with an expert.
- An example of a primary processing of measurement data is shown in Table 2.7.2-1 and Figure 2.7.2-2

Table 2.7.2-1 An Example of Data Processing

Date / Time: 09-04-2006 12:12:12							
Factory: ABC Factory							
Facility: No.2 Boiler 02, Gas Temp & Ainbient Temp							
Date	Time			Data 1 Ambient Temp (deg C)	Data 2 Gas Temp. (deg C)	Data 3 Gas 02 (%)	
2006/09/04	13	26	42	29.8	197.4	19.72	
06/09/04	13	26	44	9.9	197.2	19.74	
06/09/04	13	26	46	29.9	197.8	19.77	
06/09/04	13	26	48	29.9	197.3	19.86	
06/09/04	13	26	50	29.8	197.0	20.01	
06/09/04	13	26	52	31.0	196.6	20.09	
06/09/04	13	26	54	9.6	7.3	20.15	
06/09/04	13	26	56	29.9	197.0	20.19	
06/09/04	13	26	58	29.9	196.8	20.22	
06/09/04	13	27	00	29.2	197.0,	20.25	
06/09/04	13	27	02	30.0	197.2	20.26	
06/09/04	13	27	04	29.9	197.3	20.28	
06/09/04	13	27	06	30.0	197. 2	20.29	

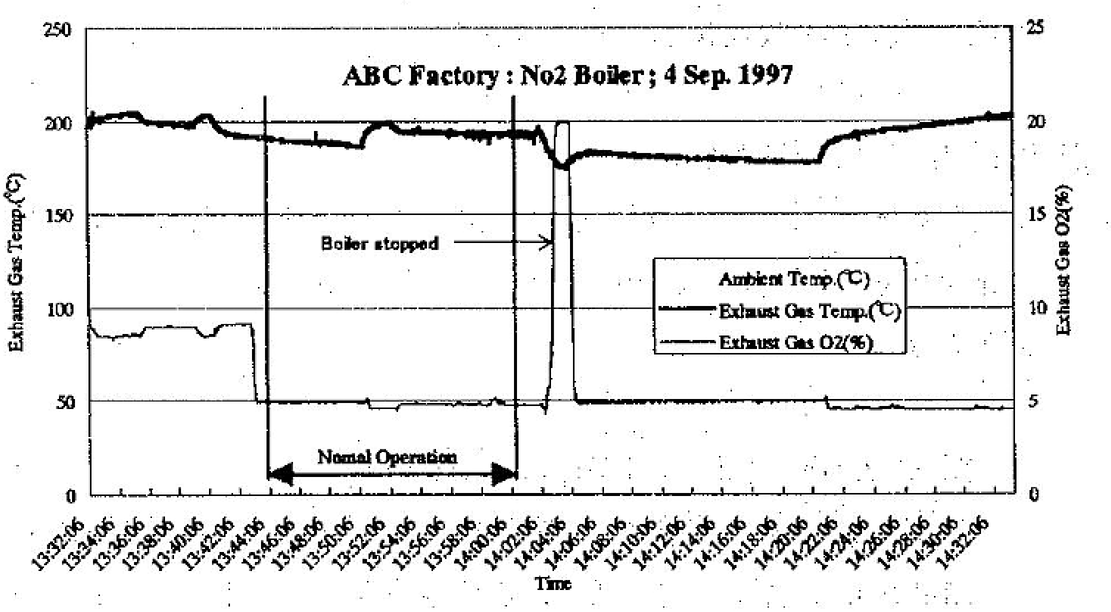


Figure 2.7.2-2 An Example of Data Display (Graf)

2.7.3 Measurement Data Processing

While some measuring instruments are used for spot measurements, others have main bodies that come with memory functions, and yet other types are capable of outputting signals to recorder.

(l) Instruments used for spot measurements

In order to prevent omissions in measurements, record the measurement data on a dedicated recording form or by other means devised for such purpose.

Pressure gauge（bourdon tube）(P-1 ~ P-4)
Glass thermometer (T-1)
Thermo-hygrometer (T-2)
Surface thermometer ('I'-8)
SC meter (W-1)
pH meter (W-2)
Oxygen analyzer (spot) (G-3)
Low voltage detector (E-1)
Tester (E-2)
Clip-on AC power meter (E-4)
Tachometer (TM-1)
Lux meter (L-1)

(2) Instruments with main bodies that have memory functions

If the instrument has a built-in floppy disk unit, use a dedicated analysis software to analyze its data, and if it has a memory function, call up the data and then organize it.

- Radiation pyrometer (T-9, T10)
  Number of memory points: 100
- Infrared thermovideo (T-12)
  Number of memory points: 30 images/1 disk (3.5 inch FD 2HD)
  Use its dedicated analysis software to analyze.
- Steam trap checker (S-1)
  Number of memory points: 800
  After transmitting the data to a personal computer using an RS232C, analyze it with a dedicated software.
- Clamp-on power meter (Li-3)
  Analyze the recorded data after reading it in from the main body
  as numerical data using Microsoft EXCEL's accessory FllD Unit

(3) Instnunents that output analog signals

Measurement data from each measuring instrument is output in analog signals, and then stored on the floppy disk of a recorder with built-in memory. Data in the floppy disk is converted to a table and graph by reading it in with a spreadsheet software (Microsoft EXCEL).

- Digital low pressure indicator (P-5)	output : DC 1-5V
- Steam pressure transmitter (P-6)	output : DC 4-20mA
- Sheathed thermocouple (T-3 - T-7)	
- Suction pyrometer (T-11)	output : DC 1-5V
- Ultrasonic flowmeter (F-1)	output : DC 1-5V
- Vortex flowmeter (F-2)	output : DC 4-20mA
- Hot wire anemometer (F-3)	output : DC 0-1 V
- Oxygen analyzer (continuous) G-2)	output : DC 0-1 V
- Transducer (E-5 - E-9)	output : DC 0-1V, 0-1.1mA
- CO, CO_2 meter(EC-1)	output : DC 0-1V
- Pitot type flowmeter (EC-2)	output : DC 1-5V

} to Hyprid recorder or data logger

2.8 Audit Report

The measurement data is analyzed firstly; then the improvement measures are decided referring to the guideline. Finally audit is finished. Table 2.8-1 shows the example of audit.

The check items include these contents related to the factory to be diagnosed from "check items of the factory energy audit" in Table 2.2.2-1.

Table 2.8-1 An Example of Audit Report

JICA / The Study on Energy Conservation and Efficiency Improvement in Republic of Indonesia

The Report of Factory Energy Audit
Of
XXXX Company
In
Republic of Indonesia

November 2007

Japan International Cooperation Agency (JICA)

1. Outline of the factory

a. Factory name: XXX Company
b. Location:
Tel Fax
c. The contents of business
Sub-sector :
Main product of the factory:
Capital: -
Annual shipment amount: -
The number of employees of the factory: - Persons
d. Main person in charge at the energy audit: (Mr. Ms.)

2. Outline of energy audit

a. Person engaged in energy audit
b. Energy auditing date:
c. Request items on energy audit (main items): Fill the request items of the factory from the questionnaire

3. Energy audit results

(1) Improvement proposal items and the expected effect after improvement measure implementation

No.	Observation list Classification No.	Improvement items (Itemized corresponding to an appending observation list)	Expected effects		
			Kind of Energy	The amount of energy conservation (kL/y, kWh/y etc.)	Amount of energy saving (Rp/y)
1					
2					
3					
4					
Total of expected results			Fuel (total) (A)		
			Electric power (total) (B)		
Energy conservation rate of the whole factory			Fuel (total) (A/D*100)		
			Electric power (total) (B/C*100)		

(2) The amount of the annual energy consumption, the energy cost ratio, and energy intensity of the whole factory in 2006

a. The Amount of annual energy consumption

Amount of electric power C= MWh (Purchased electric power E= (1000kWh)

Amount of all fuel consumption D= kL (Diesel oil equivalent of fuel: kL =)

Details (before conversion) Heavy oil ( ): kL City gas: m3

Kerosene: kL L P G: ton

Light oil: kL

b. Energy cost ratio (Energy cost per annual shipment amount F=)

Annual production capacity (P) = ton

Annual electric power charge (G): Rupiah Power cost ratio: % (G/F x 100)

Annual fuel cost (H): Rupiah Fuel cost ratio: % (H/F x 100)

c. Energy intensity (Energy consumption per annual shipment amount etc.)

Electric power intensity per production (E / P) = kWh/ton

Fuel intensity per production (D / P) = L/ton

(3) Remarks

a. Plant operation hour

Annual operation days: days

Daily operation hours: hours, shifts

b. Energy price

Diesel oil: Rupiah/liter

Electric power: Rupiah/kWh

Factory energy conservation audit
Observation list (Detailed explanation of improvement and expected effects are indicated in attached sheet)

1. General management items

No.	Check items and contents	Evaluation (note 1)	The present condition and problems	Measures for improvement
	General Management Items			
	1. Energy Management Organization - Maintenance of an organization, capacity building - Adjustment with environmental management - Energy conservation target, investment budget - Medium and long term plan - Use of governmental incentive system - Energy conservation activity			
	2. Implementation of Measurement and Record - Installation and operation of measuring instrument, - Maintenance and inspection of measuring instrument - Implementation of periodical measurement and record			
	3. Maintenance Management of Equipment - Periodical inspection, daily inspection - Repairing of leakage (water, air and steam) - Heat insulation - Cleaning of equipment (filter and strainer)			

No.	Check items and contents	Evaluation (note 1)	The present condition and problems	Measures for improvement
	4. Energy consumption management - Daily report record - Daily consumption, daily load curve - Monthly consumption, Consumption graph comparing with previous year			
	5. Energy intensity management of Main Products - Energy intensity per shipment amount - Energy intensity per Production amount			
	6. Environmental management - Implementation of CO_2 emission reduction measure - Practical use of Life Cycle Assessment (LCA): Purchasing → manufacture → use → disposal and recycling - Waste processing (measure for loss in quantity, separating and recycling) - Waste water treatment			
ISO 14001 acquisition situation		Acquisition on (year month day), Plan of acquisition on (year month),		

(Notes 1) Evaluation column sign A: Excellent B: Very good C: Good D: It is necessary to do more effort. E: It is necessary to do hard.

Energy conservation audit of a factory　Observation list (Example)

2. Boiler, Industrial Furnace, Steam System, Heat Exchanger, Waste Heat, Waste Water, etc.

	A check item and contents	The present condition and problems	The measure against improvement, and the expected effect per year (kL, kWh, 1000 Rp)	
	Boiler and Industrial Furnace			
	1. Combustion Control - Excess air ratio, exhaust gas control - Burner, fuel, ventilation system - Combustion control unit - Regenerative type combustion system - Fuel conversion			
	2. Heat Insulation, and Heat Dissipation Prevention - Temperature of outside surface, of furnace wall and duct - Heat insulation and insulation material (thermal storage loss) - Opening seal and inside pressure of furnace			
	3. Exhaust Gas Temperature Control and Exhaust Heat Recovery - Exhaust gas temperature - Heat recovery (Supply water and air preheating) - Exhaust gas circulation			

4) Tenter m/c

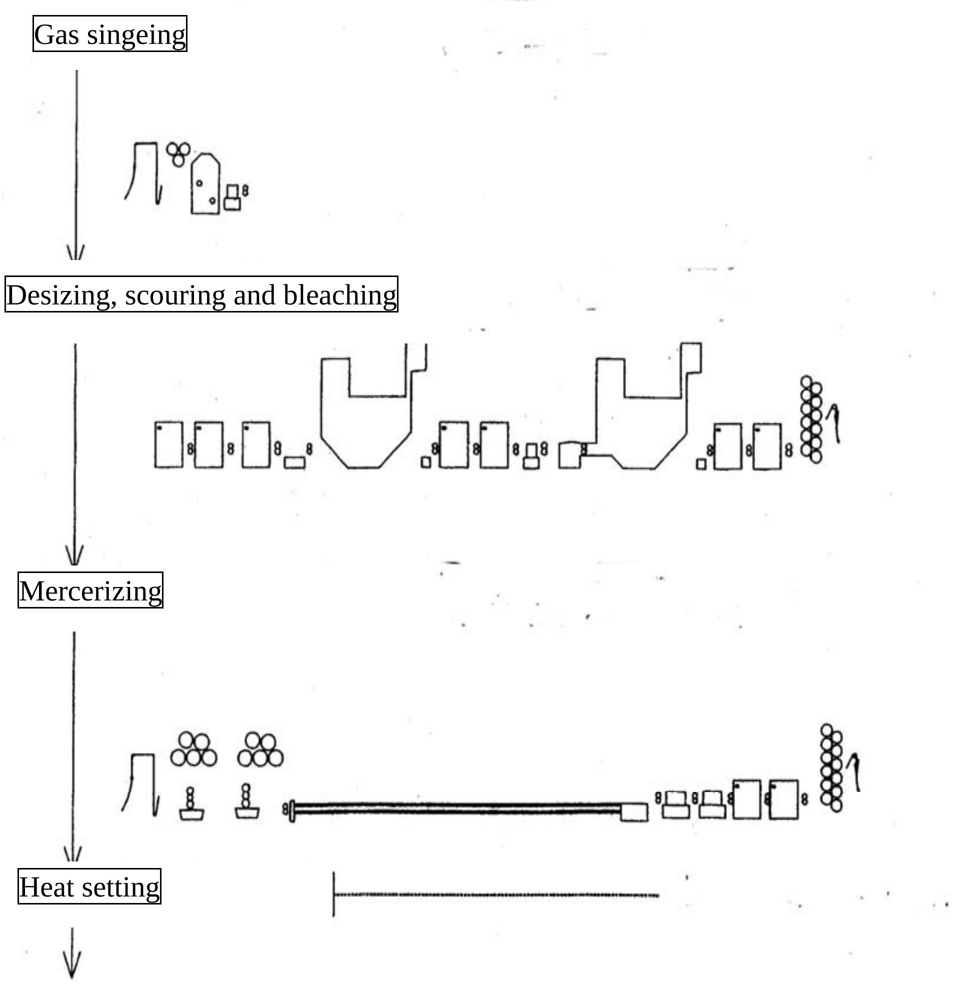
The equipment adjusts the width of the nozzle according to the width of the fabric (Figure 3.3.2-28). Besides the exclusion of loss in the width, through let the hot wind blowing nozzle approach the fabric, the dry ability is improved.

5) Calculation of the energy conservation effect for the feasible technologies at replacement or new establishment

In the year 2025 which is the decrease target year of energy elasticity rate, the following calculation is based on the assumption that the new equipments including that is shown in chapter 3.3.2 (3) have been spread. Besides including the inverters in all equipments, the energy conservation potential is described.

By including the general energy conservation equipments, such as co-generation, boiler, pumps, and compressors, etc., much energy conservation is expected.

Energy conservation potential by investing in new continuous dyeing process of cotton and blended fabric (1/2)



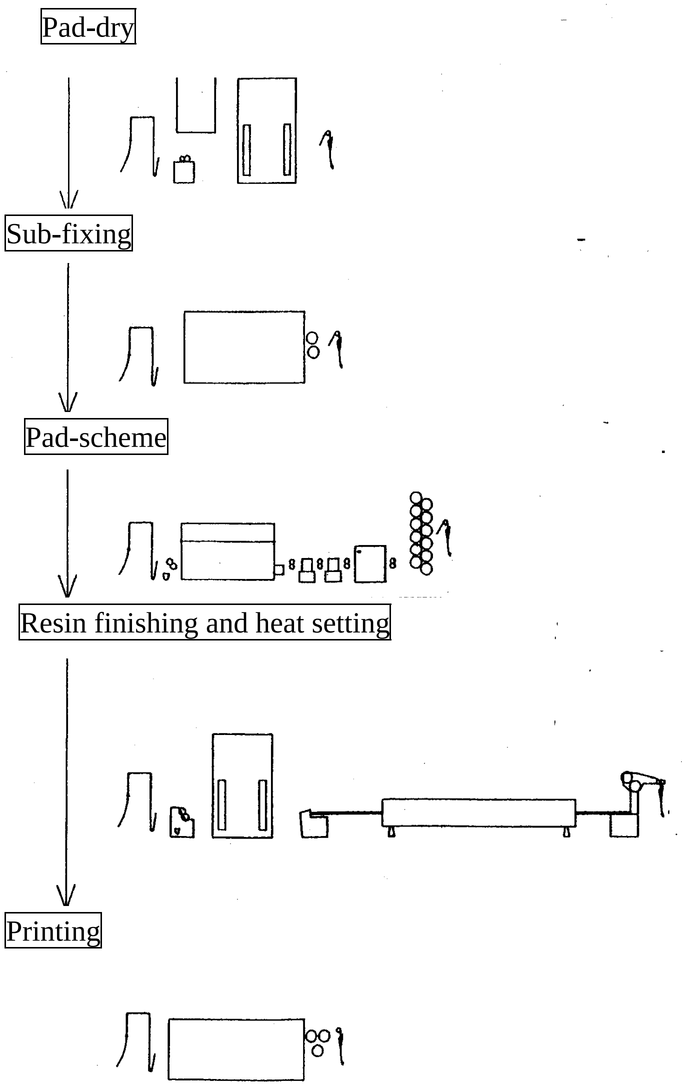
Scouring and bleaching	Water (ton/hr)	Steam (t・hr)	Electricity kWh	Energy saving ratio
Past device	61.0	5.0	115.0	Per time
New device	35.0	3.0	125.0	36.55％

1. High efficient washing device
2. Monitor for flow volume of washing device and inputted steam volume
3. Installation of over drying prevention device
4. Heat recovery device

Mercerize	Water (ton/hr)	Steam (t・hr)	Electricity kWh	Energy saving ratio
Past device	24.0	2.6	145	Per time
New device	10.0	1.5	159	34.4％

1. High efficient washing equipment
2. Monitor for flow volume of washing device and inputted steam volume
3. Installation of over drying prevention device
4. Automatic device for control of chemicals solution density
5. Heat recovery device

Energy conservation potential by investing in new continuous dyeing process of cotton and blended fabric (2/2)



Pad-Dryer	Water (ton/hr)	Gas (Mcal)	Electricity kWh	Energy saving ratio
Past device	1.9	542	6.0	Per time
New device	0.9	345	6.3	44.8%

1. Exhaust control with humidity sensor
2. Over drying prevention mechanism
3. Automatic control of temperature of dryer

Used as heat set

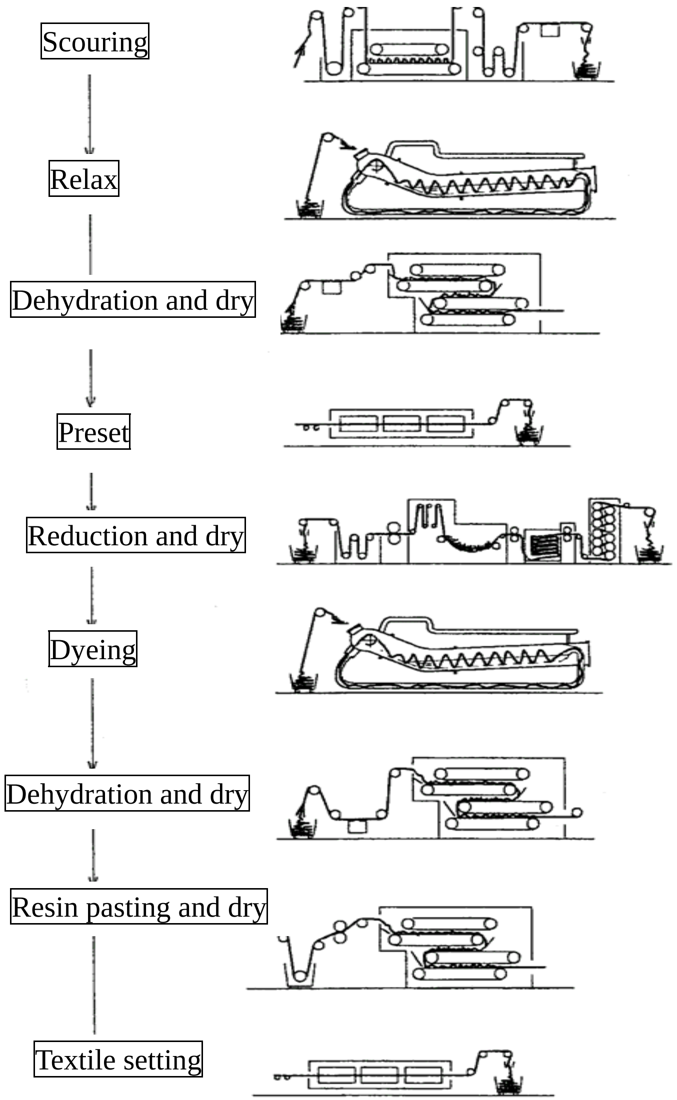
Pad-Steamer	Water (ton/hr)	Steam (t/hr)	Electricity kWh	Energy saving ratio
Past device	16.6	3.24	31.2	Per time
New device	8.5	2.07	26.2	35.8%

Used as finishing dryer

Tenter m/c	Water (ton/hr)	Gas (Mcal)	Electricity kWh	Energy saving ratio
Past device	1.50	400	91	Per time
New device	1.35	243	66	36.3%

Tenter m/c	Water (ton/hr)	Gas (Mcal)	Steam (t/hr)	Electricity kWh	Energy saving ratio
Past device	1.5	1085	0.637	152	Per time
New device	1.35	751	0.446	110	34.6%

Energy conservation potential by investing in new dyeing process of 100% polyester fabric（1/2）



Relaxation process
1. The trough structure for steady run of fabric and low water ratio
2. Setting of optimal processing time for the numerical control of computers
3. Total heat recovery

Dehydration, opening and dry process
1. Improvement of dehydration ability by using vacuum dehydration device
2. Decrease in thermal capacity by the compact of equipments
3. Uniformity of heat distribution by the compact of equipments
4. Reduce of heat loss by the compact of equipments

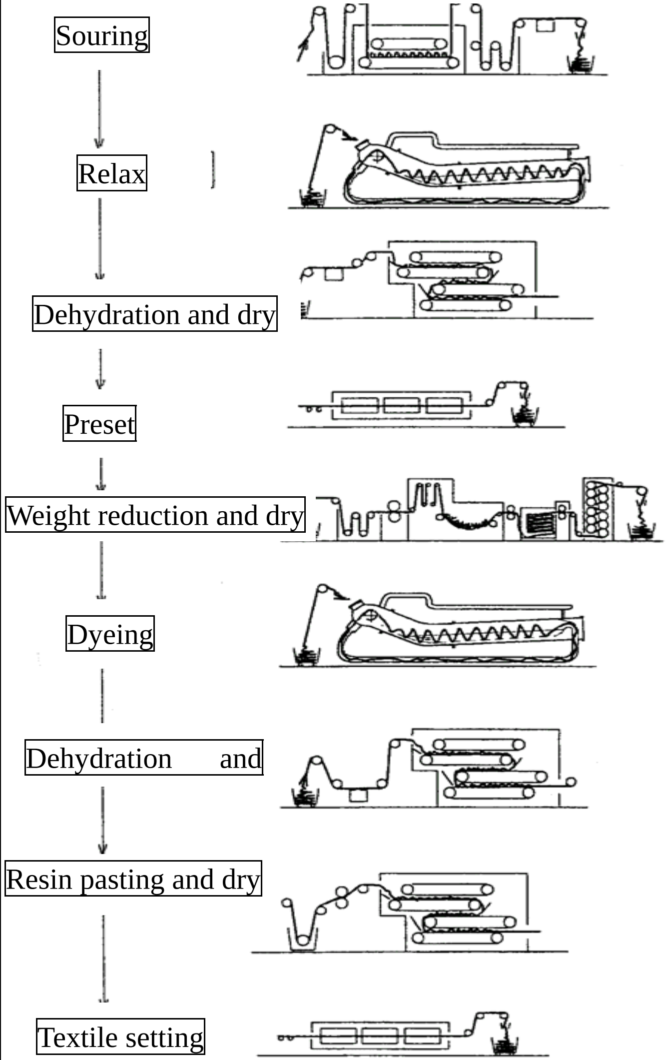
Preset process
1. Improvement of thermal efficient with width-follow hot air nozzle
2. Relative rise of wind speed of width-follow hot air nozzle
3. Heat recovery with heat recovery device
4. High rate operation with automatic filter

Weight reduction and dry process
1. Energy conservation based on continuous weight reduction
2. Control of water supply
3. Control of temperature

Dyeing process
1. The tank structure for steady run of fabric and low water ratio
2. Setting of optimal processing time for the numerical control of computers
3. Heat recovery system (High temperature drain system)

Finish set process
1. Improvement of thermal efficient with width-follow hot air nozzle
2. Relative rise of wind speed of width-follow hot air nozzle
3. Heat recovery with heat recovery device
4. High rate operation with automatic filter

Energy conservation potential by investing in new dyeing process of 100% polyesterfabric（2/2）



Relaxation	Water (ton/hr)	Steam（ton)	Electricity kWh	Energy saving ratio
Past device	42.3	2.34	121	Per Batch
New device	22.5	0.55	141	63.5%

Dehydration and drying	Water (ton/hr)	Steam（t/hr)	Electricity kWh	Energy saving ratio
Past device	0	0.95	75.5	Per time
New device	0	0.35	09.7	45.2%

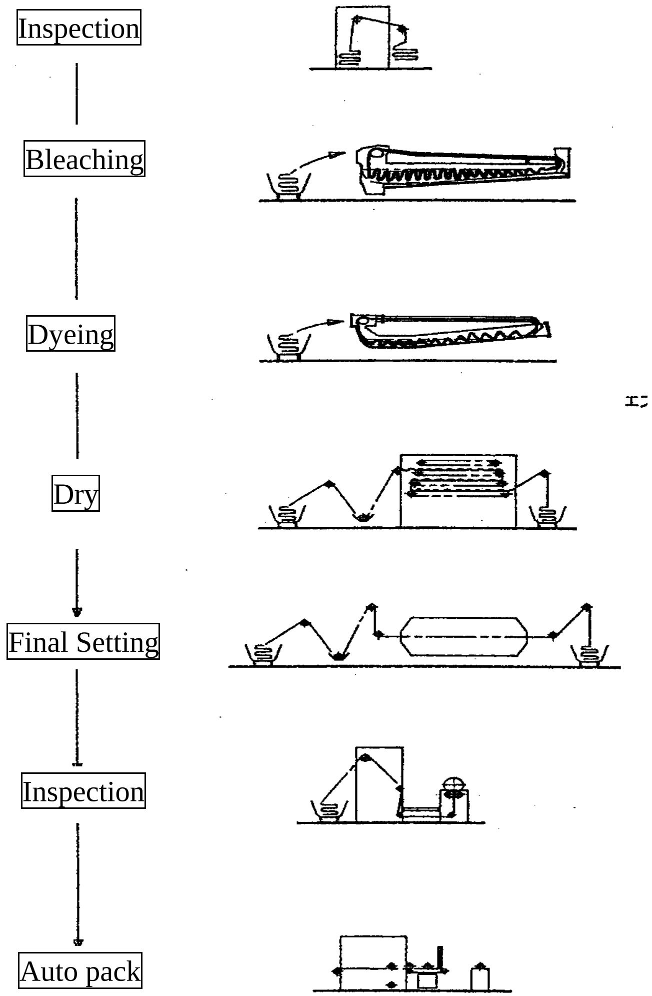
Preset	Water (ton/hr)	Gas（Mcal)	Electricity kWh	Energy saving ratio
Past device	0	390	62.3	Per time
New device	0	220	70.4	28.6%

Weight reduction and dry	Water (ton/hr)	Steam（ton)	Electricity kWh	Energy saving ratio
Past device	50	6.3	2.0	Per Batch
New device	4.5	2.2	48.1	62.3%

Dyeing	Water (ton/hr)	Steam（ton)	Electricity kWh	Energy saving ratio
Past device	53.8	2.34	423	Per Batch
New device	28.8	0.65	282	57.9%

Finishing set	Water (ton/hr)	Gas（Mcal)	Electricity kWh	Energy saving ratio
Past device	0	400	81	Per time
New device	0	280	91	28.0%

Energy conservation potential by investing in new dyeing process of cotton and blended knitted Fabrics (1/2)



Bleaching and dyeing process

1. Machine structure for low water ratio
2. Standardization of heat recovery system
3. Setting of optimal processing time for the numerical control of computers
4. Securing of yield by inputting chemicals automatically

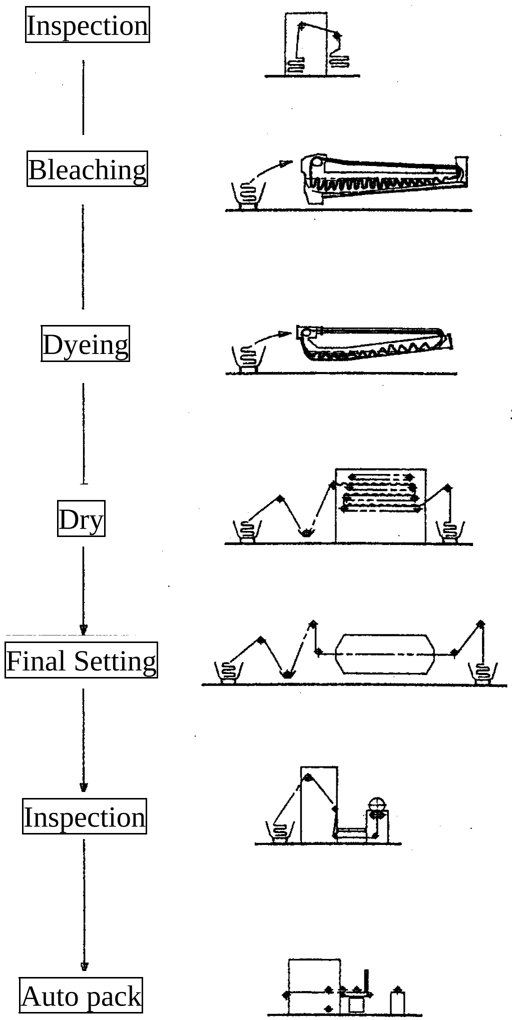
Dry process

1. Decrease in thermal capacity by the compact of equipments
2. Decrease of heat loss accompanying compact
3. Installation of automatic filter
4. Automatic control of fabric moisture
5. Monitoring of exhaust humidity and adjustment of exhaust

Final Setting

1. Strengthen of heat insulation board
2. Installation of automatic filter
3. Heat recovery filter
4. Interlock of fan motor
5. Monitoring of exhaust humidity and adjustment of exhaust

Energy conservation potential by investing in new dyeing process of cotton and blended knitted Fabric (2/2)



Bleaching	Water (ton/hr)	Steam（ton)	Electricity (kWh)	Energy saving ratio
Past device	15.8	1.3	84.2	Per Batch
New device	22.1	0.69	22.1	51.0%

Dyeing (cotton)	Water (ton/hr)	Steam（ton)	Electricity (kWh)	Energy saving ratio
Past device	10.5	0.79	30.6	Per Batch
New device	5.6	0.34	21.4	53.0%

Dyeing(T/C)	Water (ton/hr)	Steam（ton)	Electricity (kWh)	Energy saving ratio
Past device	17.3	1.24	80.5	Per Batch
New device	9.2	0.53	52.5	54.0%

Dry	Water (ton/hr)	Steam（ton/hr)	Electricity (kWh)	Energy saving ratio
Past device	0	0.92	68.0	Per time
New device	0	0.56	60.0	33.8%

Finishing (Set)	Water (ton/hr)	Gas（Mcal)	Electricity (kWh)	Energy saving ratio
Past device	0	500	60.0	Per time
New device	0	320	65.0	32.5%

3.4 Guideline for Energy Efficiency Improvement and Conservation for Commercial Buildings

3.4.1 Basic Items

To grasp energy conservation measures and energy conservation potential, energy conservation audit is carried out. In energy audit, the effective energy conservation measures and the calculation of potential are done by an investigation of the management & operation situation of energy consumption facilities and a measurement, etc.

(1) The Situation of the Energy Management

To promote energy conservation, it is necessary to implement energy management and improve efficiency as described as follows. In energy audit, it is necessary to confirm the enforcement level for the following contents.

(a) Target oriented management by PDCA cycle

(b) Energy consumption and intensity management

(c) Maintenance management of facilities

(d) Facilities functions management (for efficient operation)

(e) Operation management of facilities

(f) LCC(Life Cycle Cost) management of the facilities

Contents and effect of the energy management is shown in Table 3.4.1-1.

Table 3.4.1-1 Outline of Energy Management

Items	Contents	Measures / Effect
1) Energy management system	・ Establish organization and employee education ・ Setting of Energy conservation target and budget ・ Setting of the management standard ・ Grasping present situation of energy conservation	・ Establishing an organization including TOP management, employee, tenant and facilities managers and enforcing PDCA. ・ Reinforcement of enlightenment and guidance to a resident.
2) Situation of a measurement and record	・ Preparation of the drawing and documents of the building ・ Installation of measuring instruments, operation, maintenance ・ Enforcement of a measurement and record	・ The measurement and analysis with detailed range according to different facilities and sectors as detailed as possible

Items	Contents	Measures / Effect
3) Energy consumption management	・ Daily record situation ・ Daily and monthly consumption ・ The power balance ・ Annual comparison graph	・ Analyzing the measurement data by trend and graph. Energy intensity and CO_2
4) Maintenance of the machinery	・ Periodic inspection and daily check ・ Machinery and system performance management (COP) ・ Machinery cleaning（Filter, Strainer etc.)	・ The adoption of the high maintenance such as preventive and predictive maintenance is examined ・ Adjustment on the performance management with maintenance company are desirable.
5) Energy intensity management	・ Heat intensity (MJ/m^2・Y) ・ Electricity intensity (kWh/m^2・Y) ・ CO_2 intensity ($t\text{-}CO_2/m^2$・Y)	・ The information as described in left column for different area and facilities is obtained as detailed as possible.
6) Management system	・ The adoption of the BEMS system	・ Introduction of optimizing control by LCC

Though it is possible to improve the energy management by introducing automation systems such as BEMS, BAS, the introduction rate of these systems in Indonesia is still low and most management is done by human resources Therefore, to reduce the energy consumption, it is necessary to establish an organization structure, set the energy reduction targeted value, then select and implement energy reduction measures, and finally measure and the evaluate the effect. To increase the energy reduction effectively, every section's participation should be completed in the building.

The concept of Life Cycle Cost

The life cycle cost (LCC) is a method to evaluate economy by considering all investment such as energy expense and maintenance expense (a life cycle cost) in its life period from the building stage to broken stage. Generally the initial cost is not more than about 20% of the total (life cycle) cost.

In order to reduce the equipment cost at the construction stage, the energy conservation facilities for air-conditioning are usually not installed. The initial cost of useful energy conservation equipments can be recovered within several years, so it is very important to make the owner understood the financial benefit by energy conservation.

(2) The Energy Consumption Characteristic of the Building

A building is finished through the stages of plan, design, and construction. And, it is possible to elaborate the peculiar energy consumption characteristics at both stages of plan and design.

In designing stage, capacities of various kinds of facilities, machines and a devices in the building have been decided to the value more than the demanded maximum load. At the stage of the final inspection by the owner before the building completion, there exist no real load, and the capacity of equipment is set at designed one. Therefore, the capacity of equipment is lager than the real load, so it is not efficient to operate under this designed condition.

To adjust the excessive facilities capacity to match the actual load leads to energy and cost reduction. And it is necessary to perform adjustment at least once a year periodically, because the actual load demand changes according to the use of the building and climatic condition.

The energy consumption of a building is reduced largely by this adjustment and finally it becomes stable at a minimum value. However, with time passing the deterioration of the machinery and an increase of tenant changes, and again energy consumption begins to increase, then it becomes necessary to enhance the maintenance and/or conduct an additional to keep the consumption level.

(3) Audit of the Facilities Capacity Adjustment

To reduce the energy consumption in buildings, at first, it is necessary to confirm whether the facilities are operated with high efficiency catching up the fluctuation of the actual load. The audit is done by analyzing the records of diary operation. The running situation of equipments in some day with the worst weather condition or the maximum annual energy consumption should be investigated and analyzed.

Take an example of air-conditioning system; it should be checked that whether the temperature difference between the inlet and outlet temperature of cool water of air-conditioning at the hottest day is almost equal to that of designed.

When the temperature difference deviates from the design value, it should be adjusted and matched with a designed value by changing the water flow of cool water circulation pump. That is to say, when an actual temperature difference is smaller than the designed value, the extra water is circulated and extra energy is supplied. The water flow of pump condition should be checked by reading the actual current value to meet the necessary water volume which is indicated by the characteristic curve of the pump.

It is important to confirm the fact whether the facilities are running with high efficiency following the fluctuation of the actual partial load, because usually the facilities are operated with a partial load throughout one year.. The audit is done by analyzing these records of running situation.

As for some day, when the load is 80%, 60%, 40% and 20% of annul maximum energy consumption, the running situation should be compared with the one with maximum energy consumption and the room of efficiency improvement will be analyzed.

In recent years, many buildings install the inverter systems which can follow partial load automatically to adjust the facilities running condition. In this case, it is necessary to adjust the automatic system based on the analysis of the record of the running situation. However, in old buildings, most of equipments only can be operated at the peak load, in such case, it is necessary to adjust by hand the medium flow to meet the partial load running.

To promote the reduction of energy consumption in buildings, it becomes a precondition to make the facilities installed in the buildings run with high running efficiently. Therefore, in daily running and maintenance, it is necessary to monitor the running situation whether it runs with high efficiency for partial load.

To grasp appropriate running situation of the facilities, effective measurement points and items are shown in Table 3.4.1-2.

Table 3.4.1-2 Measurement Points and Items for Each Facility

Machinery name	**Main part of machinery**				**Machinery inlet**		**Machinery outlet**			**Others**			
	Voltage	Electric current	Itgrating watt-hour	Integrating running time	Temperature	Pressure	Temperature	Pressure	Integrating flow	Integrating flow	Hygrometer	CO_2 concentration	Running rotational speed
Chiller	○	○	◎	○									
Air-conditioner					◎		◎						
Condenser					◎		◎						
Cooling tower	○	○	○		○		○						
Cold water (supply header)					◎	○							
Cold water return header)							◎	○					
Heat exchanger (primary wate)r					◎	○	◎	○					
Heat exchanger (secondary water)					◎	○	◎	○					
Cooling water pump	○	○	◎										
Cold water pump	○	○	◎										
Cold water circulation pump	○	○	◎										
PAC air conditioner condensation machine	○	○			◎		◎						

Machinery name	Main part of machinery				Machinery inlet		Machinery outlet			Others			
	Voltage	Electric current	Itgrating watt-hour	Integrating running time	Temperature	Pressure	Temperature	Pressure	Integrating flow	Integrating flow	Hygrometer	CO_2 concentration	Running rotational speed
Cold water coil					◎		◎		○				
Air washer					◎	◎							
around conditioner	○	○	○		◎	○	◎	○	○				
around fan coil													
Fan	○	○	○									○	
Filter						○		○					
Heat exchanger	○	○	○		○		○				○		
Supply water piping										○			
Water supply piping										○			
Elevator	○	○	○										
Escalator	○	○	○										
Power for each floor lighting			◎										
Power for consent			◎										

(4) Energy Intensity

Energy intensity management is prescribed as an evaluation standard of the energy consumption by Energy Conservation Law in Japan. Energy intensity is defined as energy conservation amount divided by unit production amount such as raw materials, power and labor which is necessary to produce an industrial products.

The energy intensity is calculated by (energy consumption/ production), and it is said that consumption efficiency is high when this value is low. The energy consumption in numerator is a total amount, which is calculated by converting respectively the use amount of fuel like oil and gas, steam and electricity into the thermal energy, J (Joule). And finally, they are converted into the calorific equivalent value of the crude oil. Though the product amount in denominator is generally set as the following unit such as kg, ton, kl, m^3, m^2. And it is necessary to choose a parameter which is little influenced by external factors (like market). When the numerator is the thermal energy, the value is called as energy intensity; and when it is electricity consumption or CO_2 emission, the value is called as electricity intensity or CO_2 emission intensity. In commercial buildings, it is popular that the floor area is used as a denominator of intensity calculation. The energy conservation status can be clarified by energy intensity. And it is easy to compare with the other similar buildings by using this intensity.

Detailed examination with energy intensity on different facilities, different sectors and different location can lead the effect of energy conservation further.

Draft conversion value of representative fuel in Indonesia is shown in Table 3.4.1-3.

Table 3.4.1-3 Conversion Value

Conversion		Calorie	CO_2	Note
Crude oil	(m^3)	38.51(GJ)	2.65 kg- CO_2/ℓ	4.1868kJ=1kcal 0.33 ℓ/kWh
LNG	(m^3)	37.23(GJ)	2.56 kg-CO_2/ℓ	
LPG	(m^3)	25.53(GJ)	1.76 kg- CO_2/ℓ	
Heavy oil	(m^3)	41.73(GJ)	2.87 kg- CO_2/ℓ	
Diesel oil	(m^3)	38.68(GJ)	2.66 kg- CO_2/ℓ	
Kerosene	(m^3)	34.80(GJ)	2.39 kg- CO_2/ℓ	
Electricity	(kWh)	11.63(MJ) ＝2,778(kcal)	0.7623 (kg- CO_2/kWh)	
Electric contract charge (Example)＝29,500 (RP/kVA/month]				
Charge according to use (Example)=439 Rp /kWh				

3.4.2 The Checkpoint of the Energy Conservation Audit

Buildings are generally classified as four large categories: 1) the buildings user, 2) the operator of buildings and equipment 3) the maintenance manage of buildings and equipment, 4) the facility management of buildings and equipment. The basic item requested for each category is different respectively to achieve the energy reduction target.

1) For the building user, the waste is requested to be excluded thoroughly.

2) For the operator of buildings and equipment, the equipments are requested to be operated with high running efficiency.
3) For the maintenance manager of buildings and equipment, the function of individual equipment is requested to be secured.
4) For the facility management of a buildings and equipment, the investment with good energy conservation effect is requested by considering the balance between the investment to reduce energy and the return.

For the above-mentioned four categories of building, the contents should be considered respectively for different sectors and the energy conservation measures with good energy reduction measures. The potential energy conservation countermeasures are shown in Table 3.4.2-1~Table 3.4.2-4

Table 3.4.2-1 Energy Conservation Countermeasures Taken by the Users of a Building

Item	Energy conservation countermeasures	Energy conservation effect
1) The usage of the room	(a) Rooms with the same usage or the related function to be arranged in same floor or adjacent floor.	Utilization frequency of the elevator to be reduced
	(b) Rooms with similar heat load characteristic to be supplied the air by same air-conditioner	Prevention of over-cooling and environmental preservation
2) Arrangement of heat generating equipments	(a) Computers and related equipments to be arranged in the same space.	Environment improvement, reduce the air-conditioning load by installing the heat exhausting equipments
	(b) OA machinery such as a copier and the PC to be arranged in the same space and exhaust heat.	
3) Limitation of the work time and place	(a) Equipments to be stopped at once on holiday	Reduce the energy of lighting and the air conditioning
	(b) Limitation of a place for over-time work and the time of over time.	
4) The obstacle removal of the air conditioning	(a) Remove goods in the inlet and outlet of air-conditioner so not to disturb circulation of the air conditioner.	Improve the running efficiency of the air conditioner.
	(b) A partitioning wall to be moved to not disturb circulation of the air-conditioner and more lighting	
5) The guidance to the user of works style	(a) Adjust the clothes according to individual difference.	Improve running efficiency of the air conditioner and reduce the sensible temperature with the individual difference
	(b) Make a group, change the air-conditioner and install the assistance air-conditioner for the duties which need special air-conditioner environment condition being different from common air-conditioner	
6) Effective use of the lighting	(a) The business space to be settled respectively according to necessary luminance standard	Reduce the lighting energy and heat load of air conditioning.
	(b) Optimization arrangement of work desk to be able to use maximally the existing lighting	
	(c) Work space which needs high illuminance to be arranged near the window.	

Item	Energy conservation countermeasures	Energy conservation effect
	(d) Work space to be arranged to make the sunlight easy to shoot	
	(e) Lighting to be turned off when the room is not used or the sunlight is good	
7) The operation of the window shade	(a) Window shades to be closed when there is sunlight	Reduce the heat load of air conditioning. and the load about 1/4 of all loads are influenced by the sunlight
	(b) Window shades to be opened to emit the heat from indoor to outdoors at night.	
8) Open and close of the door	(a) The door in stair hall to be always closed	Reduce heat load of air conditioning.
	(b) The door in outdoors or in the place without air-conditioning to be closed	

Table 3.4.2-2 Energy Conservation Taken by the Operator of a Building

Items	Energy conservation countermeasures	Energy conservation effect
1) Reduce fresh air	(a) Fresh air not to be input at pre-cooling	Useless energy not to be consumed
	(b) The adjustment of fresh air ・ Fresh air to be adjusted to match the numbers of the staff in indoors (Japan; Minimum 20m^3/ per person every hour) ・ Fresh air opening and shutting control according to CO_2 density controller	Reduction of the fresh air load
2) Change the indoor temperature and humidity setting	(a) Change the living room thermostat setting	Improve energy conservation about 10% when setting temperature 1 degree UP of the air conditioner (Japanese METI advice;28^{0}C)
	(b) The temperature and humidity setting in the passage space such as corridor and hall being higher than that in the living room	
	(c) Temperature and humidity setting indoor to be change according to the outdoor temperature ・ Setting value to be higher according to the rise of the outdoor temperature	
	(d) Change the living room humidity starter setting ・ Dehumidify when the indoor humidity being more than 70% ・ Set a high dew point when a dew point control being introduced.	Reduction of the air conditioning load. Reduction of load is about 17% when dew point arise from 10℃to 12℃.
	(e) Review indoor temperature and humidity requested by the computer	Reduction of the air conditioning load Reduction of the air conditioning latent heat load
	(f) Reheat with the purpose of dehumidification not to be done excluding the room be requested	Reduction of the air conditioning latent heat load
	(g) Reheat not to be done and control room temperature by the volume of air when indoor latent heat load being decreased	Reduction of re-heat energy and the air transportation power （Change from CAV to VAV）

Items	Energy conservation countermeasures	Energy conservation effect
3) Prevention of indoor excessive cooling	(a) Adjust the temperature of the cool water circulated in air-conditioner and fan coil unit according to the change of the load(Raise at low load）	Useless energy not to be consumed, at the same time, indoor environment to be improved
	(b) Adjustment of the outlet air volume ・ Adjust supply air volume to match the indoor load ・ Close the fan of the fan-coil unit and it is used as convector when the indoor load being little	
	(c) Adjust the air volume to prevent indoor over cooling	
	(d) Perform manual regulating when the facilities of automatic control being insufficient	
4) Adjust the start and stop time of the device and shorten the pre-cooling time	(a) Adjust the start and stop time by weekday, weekend day and seasons.	Useless energy not to be consumed
	(b) Regulate the pre-cooling time according the temperature difference between the outdoor air and the indoor	
	(c) Reduce the fresh air volume in one hour after air conditioner starting and before air conditioner closing	Decrease of the fresh air load
	(d) Running with the temperature be set in the hour when the room is started to be used	Reduction of the driving energy
	(e) Chiller to be stopped and pump and supply fan operated only in the one hour before the cooling end	
	(f) Shorten the running time of supply fan to be used in machine room and parking.	
5) Reduce the air supply volume	(a) Regulation of the supply and discharge air volume for machine room and parking. ・ Necessary minimum air volume setting ・ Pulley- down of the fan to be introduced for the surplus control of air volume	Reduction of the running power Power of fan is in proportion to the cube of the supply air volume, therefore, reduction of 10% air volume to cut down 27% power consumption
6) Control of air-conditioning running	(a) Air-conditioning in unnecessary room to be closed	Useless energy to be not consumed
	(b) Work with air-conditioning to be selected and local air-conditioning to be adopted	Reduce the running energy
	(c) Air-conditioning control for the over-time work	Reduce the running energy
7) High efficiency running of the	(a) Group management of chiller running ・ Reduce the running unit at partial load	Improve overall efficiency Improve COP

Items	Energy conservation countermeasures	Energy conservation effect
chiller plant	(b) Adjust the outlet temperature setting of cold water in the chiller ・ Change the outlet temperature setting of cold water with the outdoor temperature (Energy conservation can be obtained by increase the value) ・ Change the inlet temperature control of cold water	
	(c) Adjust the temperature setting of cooling water ・ The setting value of cooling water temperature control is below until the permissible temperature of a chiller	Improve COP
8) Combustion Equipment	(a) Optimization of air ratio and combustion temperature	Improvement of the burning efficiency
9) Running management of water supply and drainage and sanitary equipments	(a) Reduce and limit the hot water supply time and range	
	(b) Stop the forced circulation pump when a little hot water supply being need	
	(c) Lower the hot water supply temperature according the use	
	(d) Insert a water saving ring in the port of the flashbulb	Water saving
10) The management of the lighting equipments	(a) Turn off the lighting not to be used	Useless energy to be not consumed
	(b) Turn off the lighting of the window	Reduce the lighting electricity Reduce the air conditioner load
	(c) Turn off surplus lighting of the work space	
	(d) Shortening and limit the lighting time before work starting ・ Lighting per every work floor for the cleaning work in the morning.	
11) Management of power facilities	(a) Turn off the lighting and fan in the elevator when being not used	Power saving
	(b) Automatic door of the entrance to be operated by hand when the outdoor temperature being low	Reduce the running power
	(c) Reduce the operating of elevator and escalator when users being few (utilization rate to be about 50%)	
	(d) Reduce the number of the stop of elevator	
12) The operating management of electric facilities	(a) Balance three-phase circuit load	Reduction of the transformation loss
	(b) Reduce the running unit or switch off with low load, when an interception switch device of the transformer being not used	

Table 3.4.2-3 Energy Conservation Countermeasures by the Maintenance Manager of a Building

Items	Energy conservation countermeasures	Energy conservation effect
1) Maintenance and cleaning of equipments	(a) Cleaning of the air conditioner, a filter of a fan coil	Improvement of heat exchange efficiency
	(b) Cleaning of the condenser and evaporator of a chiller	Improvement of heat exchange efficiency
	(c) Cleaning of a lighting equipment and exchanging old lamps	Improvement of lighting efficiency
2) Check of automatic control device	(a) Precision check of sensors	Improvement of control precision
	(b) Operation checks such as an automatic valve, a damper	
	(c) Check of control machinery of a chiller plant	
3) Strengthening the monitor device	(a) Grasp the consumption situation of the energy and indoor environmental situation by adding the meter and measuring instruments	Improvement of the energy consumption efficiency
	(b) Check and review of the management items.	
4) Repair and exchange of the device	(a) Repair the part with performance deterioration, machinery and the device due to corrosion and abrasion	Improvement of the machinery efficiency
	(b) Change when performance being not restored even be reviewed	
5) Other	(a) Improve the lighting efficiency by cleaning indoor wall surface	Improvement of the lighting effect

Table 3.4.2-4 Energy Conservation Plan by Operating Manager of a Building

Items	Energy conservation countermeasures	Energy conservation effect
1) Reconstructed of building	(a) Reinforcement of heat insulation for the exterior wall ・ Change of an insulation sash ・ Install an insulation panel outside of exterior wall ・ Introduction of double-sash or the pair glass ・ Remodel of insulation forms for roof and floor	Reduction of the building energy load
	(b) Prevention of the sunlight ・ Improve reflectance by changing the color of roof and exterior wall ・ Change reflection forms or introduce the absorption windowpane ・ Stick a heat reflection film on a windowpane ・ Installation of louver and eaves ・ Installation of window shade and the curtain ・ Installation of roof sprinkling and storage water facilities ・ Sunlight reduction by the planting	Reduction of the building energy load

Items	Energy conservation countermeasures	Energy conservation effect
	(c) Prevention of the draft ・ Install a air curtain or the revolving door in the building entrance ・ Install an air curtain and a flexible transparent curtain in the import entrance of the delivery space	Reduce the air load by preventing the inflow of outdoor air
2) Repair of air conditioning and ventilation facilities	(a) Install air curtain	Reduce the air load to prevent the entrance of the fresh air
	(b) Install local exhaust system in the area where large heat generating	Reduction of the air conditioner load
	(c) Hood with heat exhaust to be installed as lower as possible to emit little heat to surroundings	Reduction of the exhaust power,
	(d) Install smoking zone to exhaust the cigarette smoke.	Reduction of the air conditioning load
	(e) Ventilation facilities like rest room to be operated only in use time	Environmental improvement and reduction of the fresh air load
	(f) Ventilation facilities in the parking to be automatically controlled by using a CO_2 monitor	Reduction of the exhaust power
3) The repair of chiller facilities	(a) Change into high efficiency chiller facilities	Running power of the chillers facilities being expected to reduce 20-30%
	(b) Repair of the chiller facilities operating control system ・ Running capacity control to be able to run always at high efficiency point according to the load change load	System efficiency being expected to improve 20-30%
4) Repair of cold water circulating system and air supply system	(a) Automatically control to be installed to make the flow of cooling water and cooling air in cold water circulating system and air supply system match with the thermal load	Reduction of cold water circulating power and the ventilation power
	(b) Cooling water flow and air supply volume to be reduced by using as large as possible temperature difference of cold water and air supply	
	(c) Change into high efficiency pumps and blowers	
	(d) Reinforcement of heat insulation for the piping and the duct	Reduction of the heat loss
	(e) Change opening cold water circulating system into closing water route	Reduction of the cold water circulating power
5) Change air conditioning method	(a) Subdivide air conditioning zone	Environmental improvement and energy conservation
	(b) Change all air system into water-air system or refrigerant-air system	The improvement of the system efficiency
	(c) Change re-heating system into variable air system	
	(d) Introduce a quantity of fresh air control system	Reduction of the fresh air load
	(e) Install all heat exchangers	Reduction of the fresh air load

Items	Energy conservation countermeasures	Energy conservation effect
6) Repair of water supply and drainage and sanitary equipments	(a) Water saving method introduction ・ Change into water saving type appliance Introduction of automatic washing method of the toilet	Water saving Water saving and convenience improvement
	(b) Efficient utilization of the water ・ Introduction of rainwater use facilities ・ Introduction of gray water facilities	Water saving Water saving
	(c) Hot water supply system improvement ・ Change central method into local method ・ Insulation reinforcement of hot water supply	Improvement of hot water supply energy efficiency Reduction of hot water supply energy loss
7) Repair of lighting equipments	(a) Prevention of the surplus lighting ・ Introduction of the lighting control	Reduction of the lighting electricity
	(b) The limit of the lighting range ・ Individual switch installation for each lighting equipment ・ Subdivision of the lighting wiring circuit ・ Introduction of automatically light controller with the timer ・ Introduction of the task ambient method	
	(c) Change into high efficiency lamp (CFL, Hf, T8)	Improvement 30-45% of the lighting efficiency
	(d) Change into high efficiency appliance and install a reflector	
8) Repair of elevator facilities	(a) Introduction of the inverter	Reduction of the operating power
	(b) Introduction of the group management control	
9) Repair of electric facilities	(a) Introduction of power factor improvement control system	

3.4.3 Energy Efficiency Improvement Countermeasures in the Commercial Building

(1) Energy Intensity by Building use and Potential Energy Conservation Measures

Table 3.4.3-1 shows the electricity intensity data obtained by The World Bank based on 65 buildings in Indonesian. Figure 3.4.3-1~Figure 3.4.3-4 show potential energy conservation measures for various use of buildings.

Table 3.4.3-1 Example of Electric Power Intensity by Usage

	(kWh/y)	Conversion value (MJ)	Japanese (MJ)
Hotel	198.2	2305.1	2,810
Office	203.4	2365.5	2,000
Shopping Mall	228.9	2662.1	2,830 (Department Store)
Hospital	249.9	2906.3	3,060
Government office Building	(158.7)	(1845.7)	1,560
Computer Building	(614.2)	(7,143.1)	5,590
The average for all sectors	216.2	2514.4	

( ); Estimate : It is a value estimated referring to the value of Japan

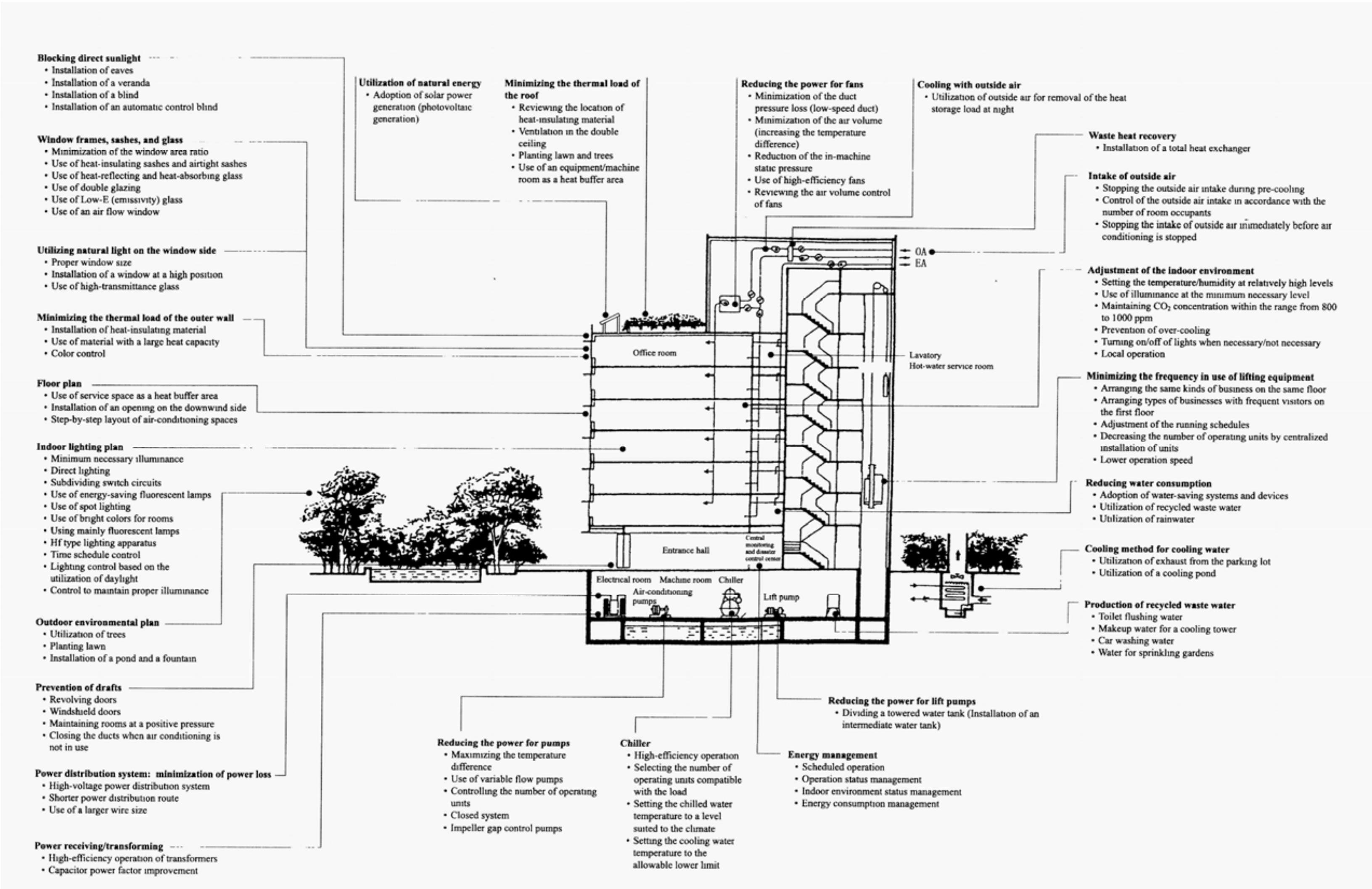


Figure 3.4.3-1 Guidelines for Energy Conservation Measures for Office Buildings The source; ECCJ

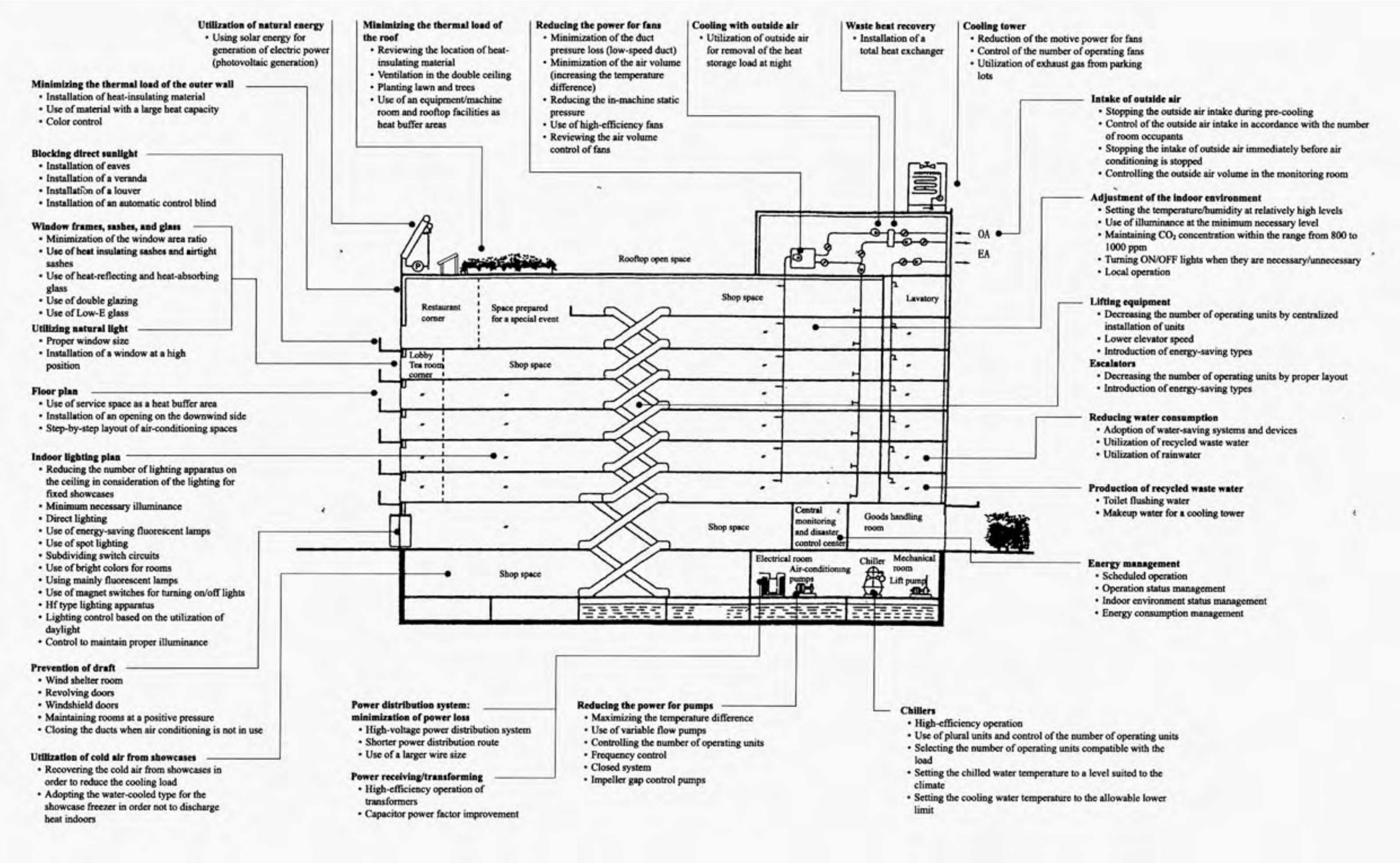


Figure 3.4.3-2 Guidelines for Energy Conservation Measures for Large Retail Shops The source; ECCJ

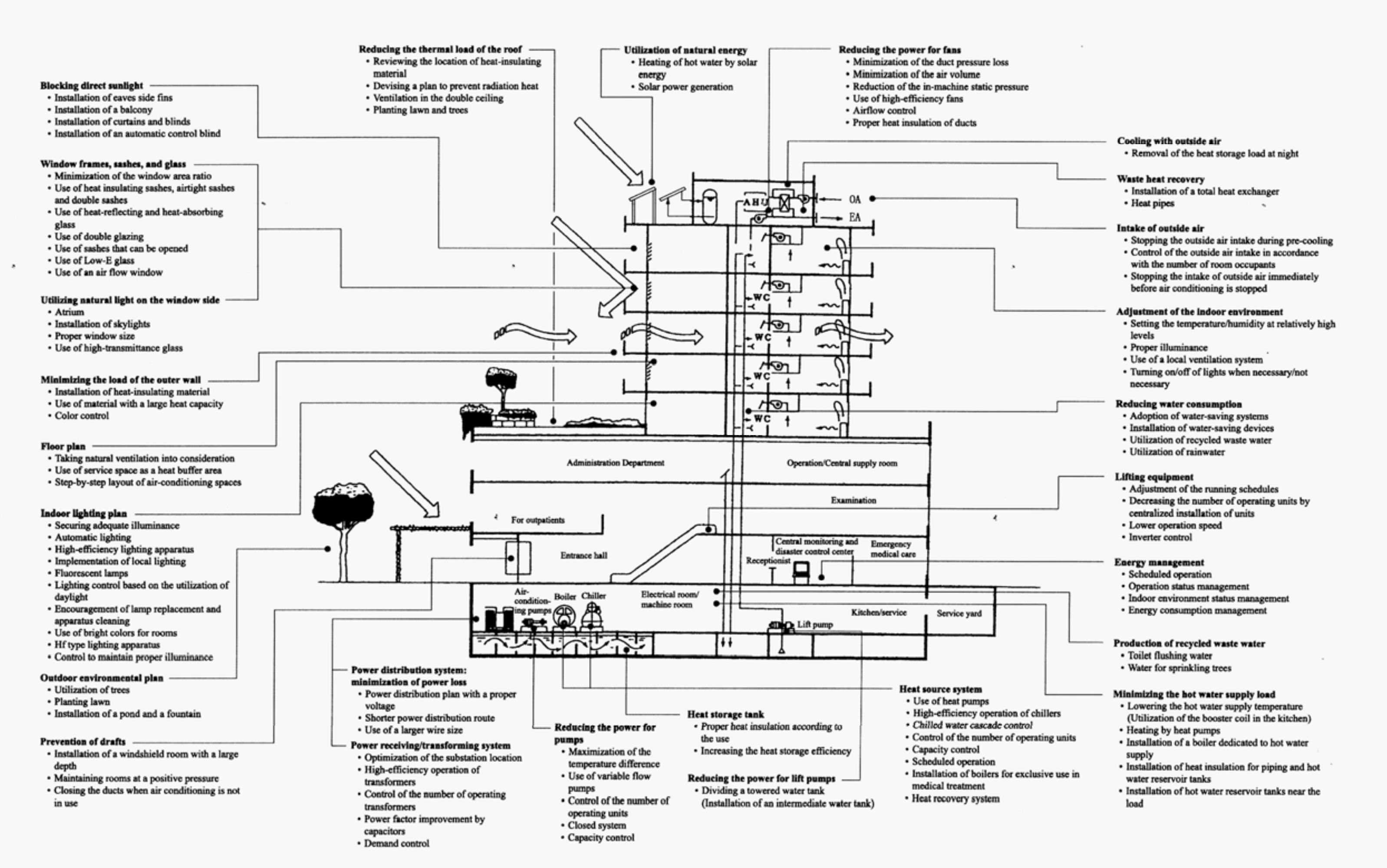


Figure 3.4.3-3 Guidelines for Energy Conservation Measures for Hospitals Buildings The source; ECCJ

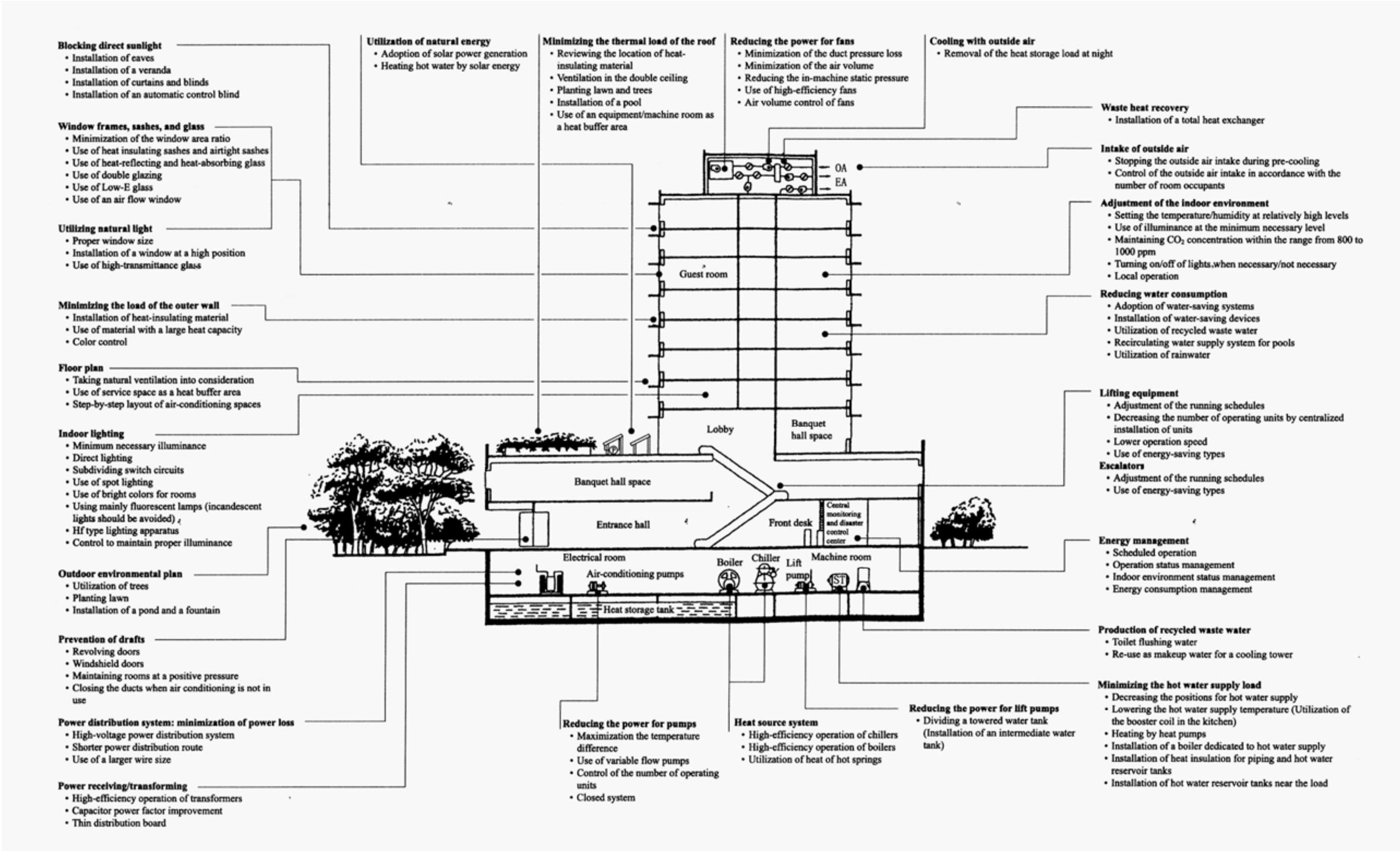


Figure 3.4.3-4 Guidelines for Energy Conservation Measures for Hotels Buildings The source; ECCJ

(2) Energy Conservation Measures for Various Usage of the Commercial Building

The need for the commercial building is changing year by year. It is necessary to achieve the energy conservation by improving and maintaining the environment and function of the building. In 2007 JICA investigation, based on the on-site energy auditing result and experiences in Japan, these energy conservation measures by each sub-sector in commercial buildings are described as follows.

1) Energy conservation for the office building (office)

The characteristics of the office building are that energy conservation can be achieved by the cooperation of the tenant and following the change of lifestyle. One typical feature is increase in cooling load. In our on-site surveys, cooling load was consumed about 50% of total energy consumption. Lighting load is the second biggest. We should focus on these two major loads firstly. Useful countermeasures are mentioned bellow:

a) Change the indoor temperature setting level (without additional investment)
In general, the air-conditioning energy decreases by 10% when the indoor air-conditioning setting temperature is raised at 1 degree.

b) The illumination of the window side in daytime is wasteful
An unnecessary illumination should be turned off by installation of daylight sensor or change of electricity distribution line to lighting fixtures.

c) Reduction of intake fresh air volume can achieve cooling load reduction.
The cooling load reduction can be achieved by intake stop during air-conditioning start-up time and the intake control with CO_2 sensor etc.

2) Energy conservation for the shopping center

Shopping center’s energy intensity is comparatively high. Especially, energy consumption on air-conditioning and illumination makes about 70 % of the whole consumption. The useful countermeasures are as follows:

a) Improvement of the condition of illumination environment
The tenant shop should be showed up, so it is necessary to enlarge the illuminance difference between the common area and the tenant area relatively.

Shopping center’s energy saving can be achieved by switching the common area lighting operation into three patterns a day.

For instance, in the morning energy conservation mode can be applied. The common area can be lightened by daylight in the afternoon and tenant area is lightened a little bit blighter than the common area. And at night time normal mode can be applied.

b) Decrease of distribution power line loss
In general, the shopping center is huge, so the distribution power system is complex and hard to be measured by the equipment. Therefore it is necessary to start with the maintenance of the distribution power system first of all.

c) Installation of BAS system
The measurement and the control by the BAS (Building automation system) are useful to get data for EE&C automatically.

d) Countermeasure to reduce the entrance cooling load and utilizing daylight are useful.
In a store, the lighting electricity is very large because of the large area ratio, high lighting and large share of incandescent electric lamp. In addition, air conditioning load is large for fresh air invasion from exit and entrance.

A wind screen room in exit and entrance should be established, and the daylight use in exit and entrance and near the window should be examined.

e) The number of customer fluctuates by time zone.
To meet the fluctuation of energy load, the automatic operation device (patterns) should be installed

3) Energy conservation for the hospital

In the hospital the energy consumption pattern is different by each department. Moreover, in general, buildings and equipments scatter in wide area, so the reduction of the transportation loss through the piping and wiring should be focused.

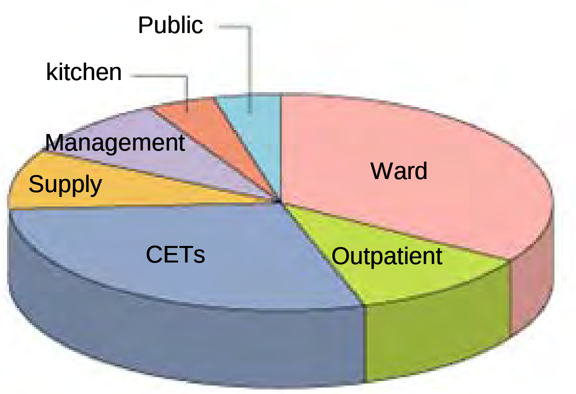


Figure 3.4.3-5 An Energy Consumption by Each Department

a) The hospital consumes of a lot of energy
A lot of steam and hot water is consumed; the amount of consumption of heat is large. It is necessary to consider the efficiency securing of the combustion equipment (The fuel is saved thorough the management of the air ratio of the steam boiler), measures of the steam leakage, and the heat loss prevention from the piping system, etc.

b) Hospital's energy consumption at nighttime is large as well as the hotel.
The energy consumption of central medical care section is large. There is a feature that the standby power is large and the power consumption at nighttime is not so small. (The power supply to highly developed medical equipment cannot be stopped at

nighttime).

c) The buildings are scattered in the large area.
The wire loss increases because of scattered electric power cable. It is necessary to consider the electric wire size and the arrangement of the power factor capacitor.

4） Energy conservation for the hotel

The hotel’s specified feature is 24 hours operation.

It has the wide entrance for customer's convenience and a big heat loss through it. The temperature of air-conditioning is set considerably low in Indonesia.

Expected potential technologies are as follows;

a) Air-conditioning stop in vacant rooms and a diligent turning off. "The first step of energy conservation is exclusion of uselessness".
b) The lighting pattern should be changed according to the usage pattern of the rooms.
c) Turning off the display illumination at preparation for banquet hall
The illumination of a specific place such as banquet halls is classified into the display illuminations such as chandeliers and the general illumination to keep the luminance of the room. As for the display illumination such as chandeliers, the amount of the electric power consumption is large compared with the general illumination.

The point of energy conservation is that only a general illumination is lit at the preparation time and the display illumination should not be turned on then. This measure is popular in Japanese hotel.

d) Use of daylight
e) Stop air-conditioning when guest room is cleaned
When the indoor air-conditioning machine (fan coil etc.) in the guest room stops, centralized air-conditioning is still operated. Therefore, the room does not become a very bad working environment, even if fan coil stops during cleaning time. Moreover, as for the illumination, opening the curtain and the use of daylight should be recommended. And only light in the bathroom should be turned on, (Making the manual).

f) Review of air-conditioning operation time
g) Making the manual on energy conservation management of each department
It should be recommended to make the energy conservation manual and post it on the wall.

This helps the employees aware the energy conservation under common recognition.

h) Propriety at operating time of kitchen ventilation fan
The impact of exhausted fan is large, because the volume of treated conditioned-air is quite large. So the point of this energy conservation is how to shorten the time of the fan operation as much as possible.

i) Raise the temperature setting of fresh air cooling machine properly
Most hotels drive the fresh air cooling machine for 24 hours a year. Running and temperature setting of the outdoor equipments have great influence on the energy consumption of air-conditioning. Temperature setting of the outdoor equipments without super-cooling (cooling temperature of outdoor air) is the key point of energy conservation.

j) Replacing the incandescent lamp to CFL
As for the hotel, the lighting time of the illumination of a common area is quite long because it has been operating for 24 hours. The energy conservation can be achieved by changing from the incandescent lamp to CFL.

k) Air-conditioning management of banquet hall
The banquet hall is applied for a various use, such as marriage, meeting, and the conferences. Effective operation pattern of cooling should be examined.

3.4.4 Energy Conservation for Air Conditioner Energy Conservation for E

(1) Energy Conservation Measures for Air-conditioning

The share of the energy consumption items investigated by JICA for various building is shown in the following figure. Commonly, air-conditioning demand is the largest. It is over 1/2 of the whole demand of the buildings. The lighting demand is the second largest value following air-conditioning in the office and the shopping center. On the other hand, hot water supply is large in hotel and hospital. Therefore, these loads are the dominant object of the energy conservation measures firstly.

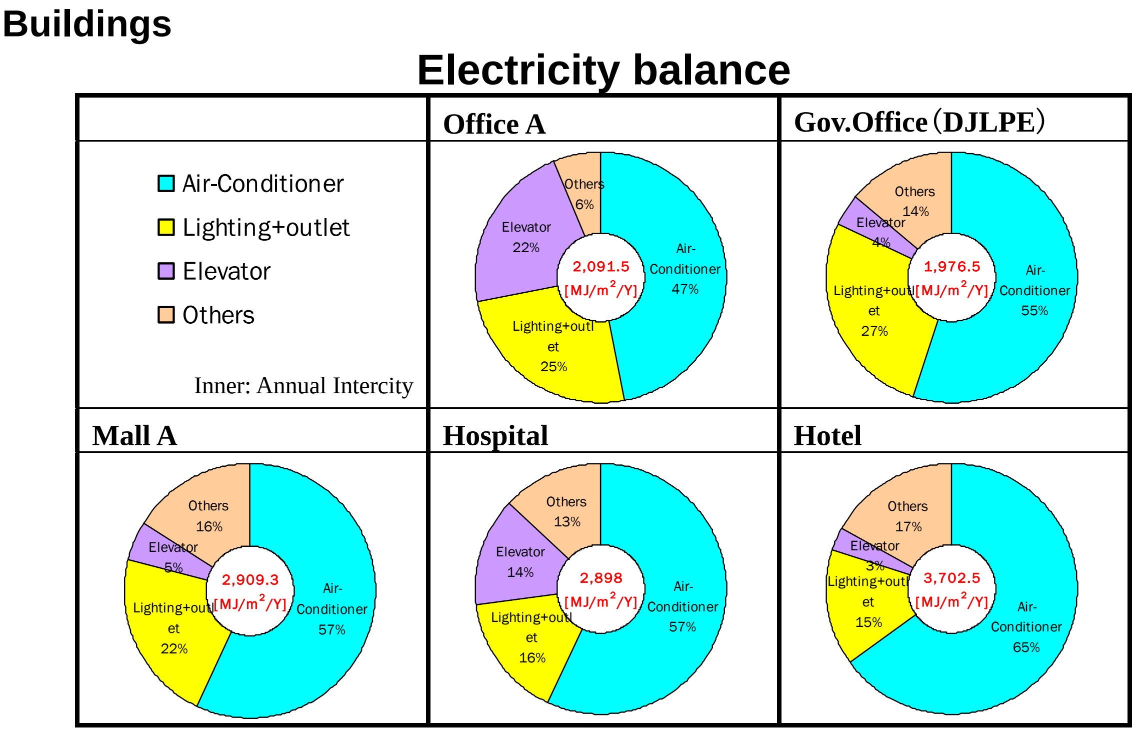


Figure 3.4.4-1 Break down of Electricity Consumption in Commercial Buildings

1) Rationalization of temperature setting level

Generally, the air-conditioning energy decreased by 10% when the indoor air-conditioning setting temperature is raised at 1 degree. If assuming that air-conditioning consumed 50% of the annual total energy, the annual energy conservation effect by raising 1°C temperature will achieve 5% (＝50% × 10%） of total energy consumption.

2) Rationalization of intake fresh air volume

The outside fresh air should be introduced into indoor in order to keep cleanness of indoor air building air-conditioning system in general. According to the Building Standard Law of Japan, The fresh air volume is at least $20m^3$/h per person to keep less than 1,000 ppm indoor CO_2 density. The fresh air load is about 20% - 30% of total cooling load. If the fresh air volume is decreased within the range which the Indoor Environmental Protection Standard can be satisfied, the fresh air cooling load decreases and save energy consumption. The energy conservation measures for fresh air control includes adjusting the reasonable opening level of the fresh air damper, the damper shutting when pre-cool fresh air and automatically controlling of damper by CO_2 sensor etc.

3) Decrease of invasion heat from window glass

The solar radiation heat load of external structure is about 1/4 of total cooling load in summer. The window glass load (invasion heat of window = directly sunshine radiation heat and heat conduction of glass) is about 75%. Therefore, it is effective to decrease the window invasion heat in order to reduce the external structure load. Countermeasures of decreasing invasion heat are described as follows.

a) Application of multilayer glass
The heat transfer coefficient of window glass will becomes small by using double and triple glasses, and then the invasion heat can be lowered considerably.

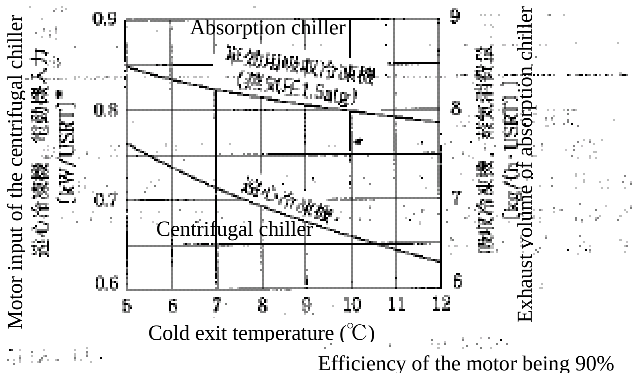
b) Using of blind and curtains
The directly sunshine radiation can be intercepted and about 15% - 20% invasion heat can be reduced by using blind and curtains in the window with sunshine. Moreover, it will gain large effect by setting the blind in the outside of the window.

4) Effective operation of chiller

The temperature control of chillers can be done as follows considering the season characteristic and partial load characteristic.

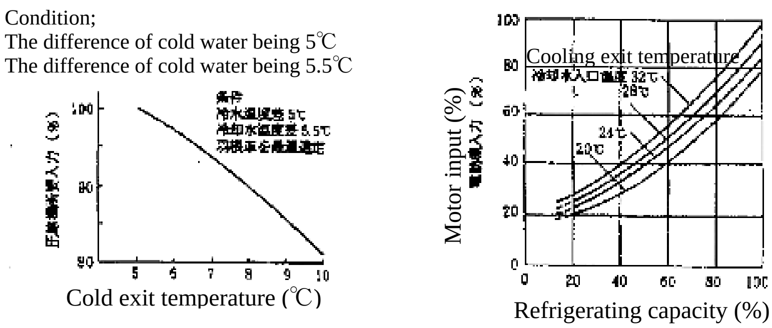
a) The cold water temperature is controlled by controlling the exit water temperature.
b) The temperature of cooling water is lowered as much as possible.

The necessary input decreases by raising the exit cold water temperature in chiller (Figure 3.4.4-2). However, it doesn't decrease at all loads because raising the exit cold water temperature decreases the air-conditioning ability. Therefore, the energy conservation can be obtained by raising the exit cold water temperature in the low load operation period. As shown in Figure 3.4.4-3 and Figure 3.4.4-4, the energy conservation operation can be achieved by the efficiency improvement of the centrifugal chiller and the absorption chiller with the lower cooling water temperature.



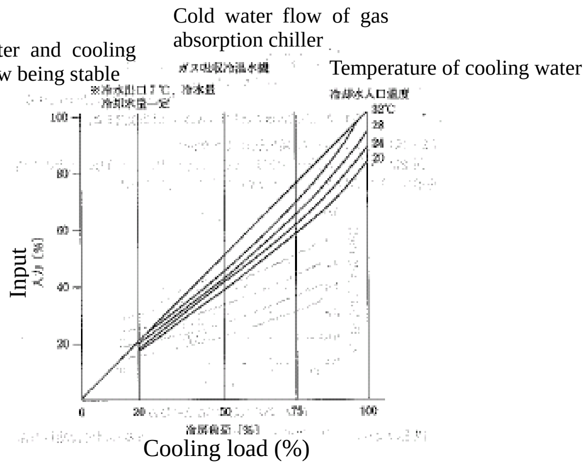
Source: ECCJ energy conservation pocketbook 2007

Figure 3.4.4-2 The Relationship between the Exit Cold Water Temperature and the Electric Motor Input of Chiller.



Source: Air harmony sanitary engineering handbook

Figure 3.4.4-3 The Relationship between the Cooling Water Temperature and the Electric Motor Input of centrifugal Chiller



Source: ECCJ energy conservation pocketbook 2007

Figure 3.4.4-4 The Relationship between the Cooling Water Temperature and the Electric Motor Input of Absorption Chiller

5) Temperature adjustment of cold water and cooling water

In the cold water type, the input energy of the turbo chiller is mainly influenced by the evaporation temperature and the condensation temperature of the refrigerator. That is to say; it is influenced by the exit cold water temperature. Therefore, raising the chiller exit cold water temperature or the evaporation temperature of the refrigerator as much as possible within the range being the thermal and humidity condition permitted at the air-conditioning space leads to the efficiency improvement of the chiller. On the other hand, in the same air-conditioning load, it needs to increase the number of coil rows and the flux of the air-conditioning equipment when the cold water temperature and the evaporation temperature are raised. That causes the increase of the pump power conflicting with the effect of energy conservation of chiller, so it is necessary to examine the relationship between both sides enough. By the way, according to the trial calculation of a certain building where the efficiency of the chiller power occupying all power for air-conditioning is high, about 3% of total energy consumption can be saved by improving the supply water temperature from 5°C to 8°C.

Moreover, energy conservation from the condensation temperature decrease needs to lower the cooling water temperature in the cooling tower, which causes the raise of the cooling tower blower power similarly. Therefore, in the chiller system, it is necessary to attempt energy conservation from the view of entire system, considering not only the main equipment but also the cooling tower and other attached equipments

6) Chiller multi-unit control

As we know, the annual average load ratio of a chiller is about 40% - 50% generally. The load ratio with the highest COP of centrifugal chiller is about 75%. Considering the annual load ratio, the number of the chiller that can make the chiller operated with the maximum efficiency as much as possible need to be decided. For example, if introducing two chillers with same capacity, 50% load is set as the control point. 50% load is set as the operation boundary if two chillers with same capacity are set up, then only one chiller should be operated in the lower load and both two chillers should be operated in the higher load. The comprehensive efficiency can be improved by using such chiller multi-unit control. As a result, it obtains energy conservation compared with the case that only one chiller is running with two times capacity.

The number of centrifugal chiller is controlled by the input electricity value. The reason is that the input electricity value is the best parameter to show clearly the operation condition of chiller compared with the heat amount control method.

Compared with the method that operates small number of chillers as much as possible by using proportion control measuring the exit cold water temperature of chiller, it is advisable to start additional chiller considering the criteria of not only the electric current value but also the temperature of exit cold water temperature plus 2.0°C.

Moreover, in the load decreasing condition, the operation number of chillers should be decreased according to the entrance cold water temperature besides the electric current value. It is preferable that the operation rotate of the plural number chiller should be arranged to average the annual operation time of chillers.

7) Cleaning of heat exchanger tube

After a long time operation of the turbo chiller, the screw attachment on the cooling water tube (heat transfer tube) causes the increase of the electricity consumption and operation trouble. In order to decrease the electricity consumption, keep steady operation condition and extend equipment operating life, the periodic condensation tube cleaning with chemicals is very important.

8) Water quality management

The chiller breakdown caused by the water entering into equipment is the most serious trouble in chiller troubles. The water infiltrating into refrigerator will lead to refrigerator resolution, inside rust of equipment and dielectric breakdown of electric motor and so on. The restoration of those troubles need lots of time and cost. One reason that cause inside water infiltration of equipment is the corrosion due to water pollution. The standard value of water quality management is generally adopt the standard improved by the Japan Refrigeration and Air Conditioning Industry Association

In water quality management, the regular pursuit is very important, especially, the water concentrate of the opening cooling water should be attended. In this case, by the chemical injection treatment for the water, the concentration rate can be raised up to about eight times by operating the blow device work with monitoring the conductivity and PH value. The replenishment water amount for the cooling water can be greatly decreased by this measurement. The concrete management includes concentrate management and the chemicals density management.

9) Air tightness maintenance management

In the turbo chiller, the air tightness maintenance is important. The air tightness deteriorate causes air invades into equipment inside, and then the extra electricity is consumed with the rise of condensing pressure. After a long time stop, air invasion in equipment inside causes the failure operation because of the trip of high pressure in condensation. Moreover, the corrosion by acid in the invasion air or the refrigerant resolution caused by the moisture happens. There is a constant relationship between pressure and condensation (saturation) temperatures of the refrigerator. So the air invasion can be checked by measuring the refrigerator pressure. It is supposed that the air leakage happened if the temperature difference between saturation temperatures under measured pressure and refrigerator condensation temperature is over 1.5°C, then it is necessary to make investigation.

There also has another method to check air leak, such as air tightness test and vacuum test. As the air tightness test, the inside equipment is pressurized with chokedamp, and then the leakage respect is investigated with the gas leakage container. As about the vacuum test, the pressure in equipment inside is made less than 99.991kPa (750 mm Hg) by using the vacuum pump, then the air leak can be judged by checking the vacuum condition.

10) Load cutting from the source

The number of office apparatuses, such as computer and copier, is increasing recently, that causes the electrical outlet load increases from $10W/m^2$ - $40W/m^2$. Because the rejection heat from these office apparatuses becomes cooling load, it needs to be discharged locally outside before it diffuses into indoor.

11) Zero energy band control

Regarding the existing indoor temperature control system, the air-conditioning system start operation when a little temperature increase over 26°C setting temperature. By setting band (for example 2-3°C), the air-conditioning system operation can be mitigated. No air-conditioning when the room temperature is in this range. The range where energy is not used is called zero energy bands.

12) Utilization of the exhaust heat

The amount of low temperature exhaust heat (called as city exhaust heat and unutilized heat) from resident, city and factory is very rich, but it is difficult to be utilized because of the low temperature. It is individually used for supplying hot water heating by using heat pump to recover the air-conditioning exhaust heat. There is also the report that about 20% electricity consumption amount has been decreased by the district heating and cooling system using river water. Moreover, by using the double glass window in the building opening area, the air-conditioned exhausted air flows between double glasses, then is used to mitigate the influence from outside (Ventilation window).

(2) Evaluation index of air-conditioning equipment

Several evaluation indexes that evaluate the air-conditioning equipment and the energy consumption condition are defined. These indexes are shown in Table 3.4.4-1. These indexes are to be checked periodically whether they are in the normal value or not.

Table 3.4.4-1 Energy Consumption Evaluation Indexes in Air-conditioning

<table>
<tr><th colspan="2">Evaluation method</th><th>Basic expression</th><th>period</th><th>Denominator</th><th>Numerator</th><th>Example</th></tr>
<tr><td colspan="2" rowspan="2">Evaluation of Energy Intensity</td><td rowspan="2">$\frac{\text{Period Energy (or load)}}{\text{Scale}}$</td><td>Month, season, period, Year</td><td>Total floor area;
Equivalent total floor area;
Air-conditioning area;
Capacity;
Air-conditioning Capacity;</td><td>Air-conditioning load;
Secondary energy;
Primary energy;
Energy resource;</td><td>Annual primary energy consumption amount for total floor area;
Basic energy consumption unit;
Energy budget;
(MJ/m^2•Year)
(GJ/m^2•Year)</td></tr>
<tr><td>Hour</td><td>Floor area;
External surface area
Capacity;</td><td>Heat transfer amount;
Air-conditioning amount;</td><td>External structure integrated heat transfer rate
($kcal/m^2$• h •°C)
(W/m^2•°C)</td></tr>
<tr><td rowspan="2">Efficiency Evaluation</td><td>Efficiency</td><td>$\eta = \frac{\text{Output Energy}}{\text{Input Energy}}$</td><td rowspan="2">Hour, Month, Season, Period, Year</td><td>Secondary energy;
Primary energy;</td><td>Air-conditioning load;
Secondary energy</td><td>Period boiler efficiency
$\eta = \frac{\text{Winter Output (load) Sum}}{\text{Winter Energy Input Amount}}$</td></tr>
<tr><td>Coefficient</td><td>$COP = \frac{\text{Output Energy}}{\text{Input Energy}}$</td><td>Secondary energy;
Primary energy
Energy resource</td><td>Air-conditioning load;
Room load (Removal heat amount),
air-conditioning unit (coil) load;
(actual);
air-conditioning unit (coil) load;
(Assume)
Heat source load</td><td>Heat source energy Co-efficiency
$COP_{HS-n} = \frac{\text{Heat Source Output}}{\text{Energy Input Amount}}$</td></tr>
</table>

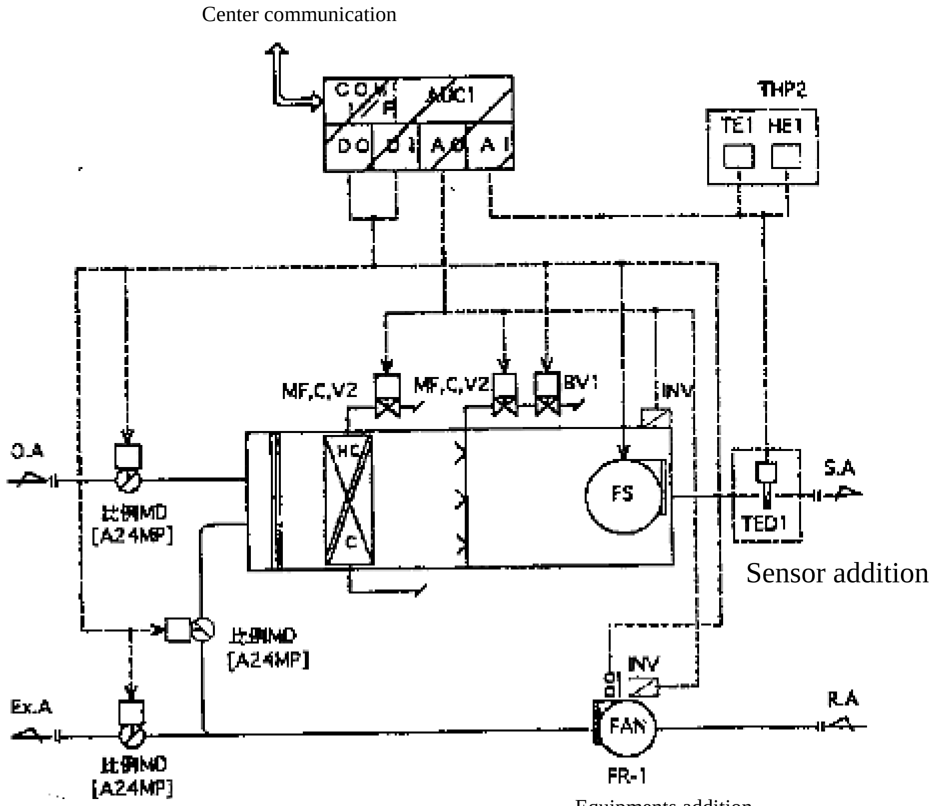
3.4.5 Energy Conservation for Transportation Equipment

(1) Control of Ventilation Transportation System

1) Control of ventilation volume

In an air-conditioning system with fixed volume, the fan power can be reduced by controlling the rotational speed with installing the inverter device in the fan in following conditions. 1) There is surplus capacity of cooling to maintain indoor thermal environment. 2) There is surplus amount of the introduction fresh air.

Generally, the air volume (motor rotational speed) is decided by the temperature, and sometimes, the CO_2 density is applied to adjust it. Moreover, it is necessary to set the lowest rotational speed limitation to protect floating dust increase due to the decrease of the air change rate and the indoor temperature unbalance due to the decrease of the indoor air velocity (Figure 3.4.5-1).



Controlling items
1. Air supply temperature control (present indoor temperature control)
2. Volume control by indoor temperature.
3. Load reset control
4. Inverter control

Equipments addition
. Inverter addition
. Air supply temperature sensor addition
. Change of control software for air-conditioner
. Measurement meter addition of power, electricity

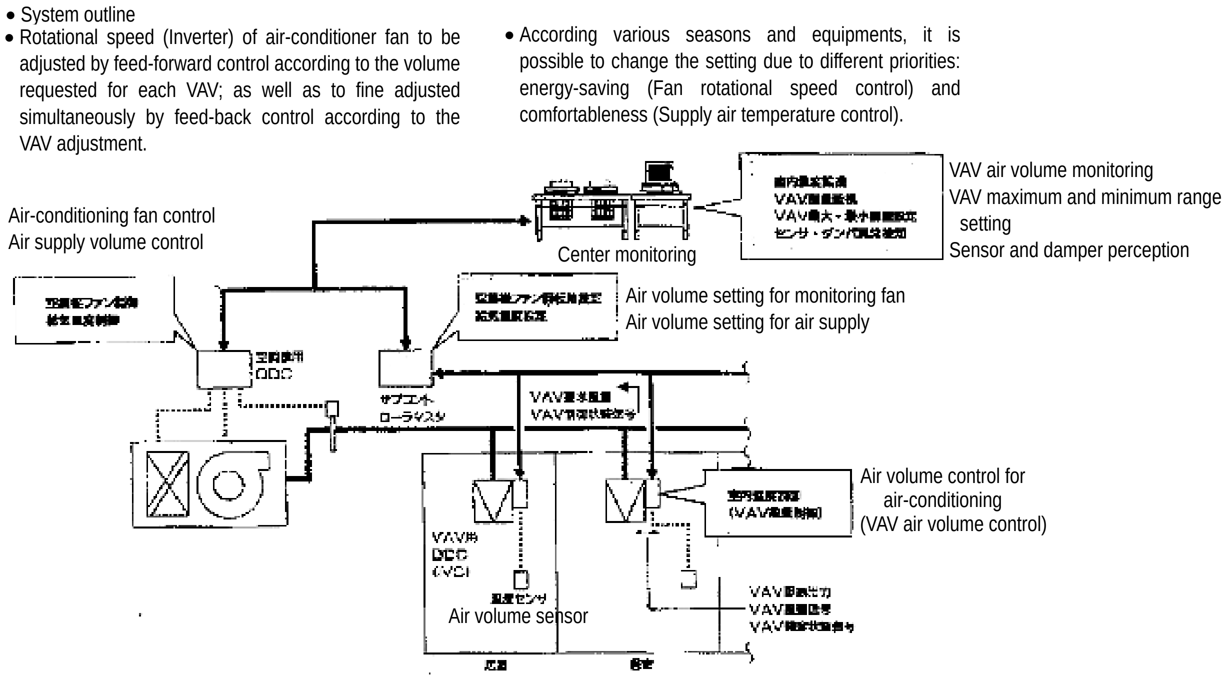
Source : Building Energy Comprehensive Management Technique
The Building Energy Manager's Association of Japan 2000

Figure 3.4.5-1 Example of Inverter Control

2) VAV control

VAV system is a system that controls air-conditioning load by executing respectively the temperature control for each VAV unit. Each VAV unit keeps the indoor temperature constant by controlling the supply air volume. On the other hand, although it is making efforts to prevent air deficiency of the supply air to maintain indoor temperature for each VAV unit by cool air-conditioning system, the supply air temperature and the necessary supply air volume influence mutually. Although the VAV opening degree is controlled by the temperature sensor in VAV unit, it is necessary to introduce enough outside fresh air amounts to maintain indoor air quality because the necessary supply air volume does not depend on the indoor air-conditioning load.

The optimization air supply temperature and volume is requested in the air-conditioning control. Figure 3.4.5.1-2 is a control example. In this example, it executes the optimization air volume control with minimum pressure drop by the following control method: feed-forward control with request air volume in each VAV unit and feed-forward control for minute adjustment with signal of VAV opening degrees. Moreover, in the condition that the energy conservation control by changing the supply water temperature is used together in the heat source side, it is necessary to make individual control because the energy conservation due to water supply temperature change and the energy conservation due to transportation power influence mutually.



Source：「Building Energy Comprehensive Management Technique」
The Building Energy Manager's Association of Japan 2000

Figure 3.4.5-2 VAV Control

3) Other energy conservation management of ventilation equipment

- Decrease of ventilation transportation power
  The ventilation should be stopped when it is unnecessary in the lavatory, hot water making room, storehouse and the equipment room, etc.
- Maintenance of ventilation equipment
  Checking and maintaining of the fan belt.
- Decrease of ventilation load
  Decreasing the ventilation load via outside air introduce volume decrease by introducing the smoking limitation, smoking room and the air cleaner device.
- Ventilation control of parking lot
  The ventilation control at a lower load is done by schedule or CO_2 sensor.
- Replace of large amount ventilation
  Decreasing the ventilation amount by setting cooling equipment when there need large amount ventilation to removal internal heat generation in the electricity transfer room and the equipment room, etc.
- Temperature control of equipment room ventilation

Ventilation to be controlled by the temperature sensor in the space the ventilation is not necessary below a constant temperature like the equipment room.

- Decreasing ventilation volume by limited locally exhausts
  Decreasing the outside fresh air intake by locally exhaust for the air polluters like combustor and copier.
- Change of kitchen exhaust hood
  Decreasing the ventilation load by changing the kitchen exhaust hood into the type integrated with air supply.

4) Utilization of the natural ventilation

It is possible to decrease energy consumption for air-conditioning by the utilization of the natural ventilation in the buildings and factories. At night, the remaining heat indoor is discharged by the air ventilate from open part (window and ventilation louver).

(2) Control of the water transportation system

1) Control of the water supply pressure

The cool water secondary pump in heat source system should always supply the clod water to each air-conditioning unit and fan-coil with certain pressure.

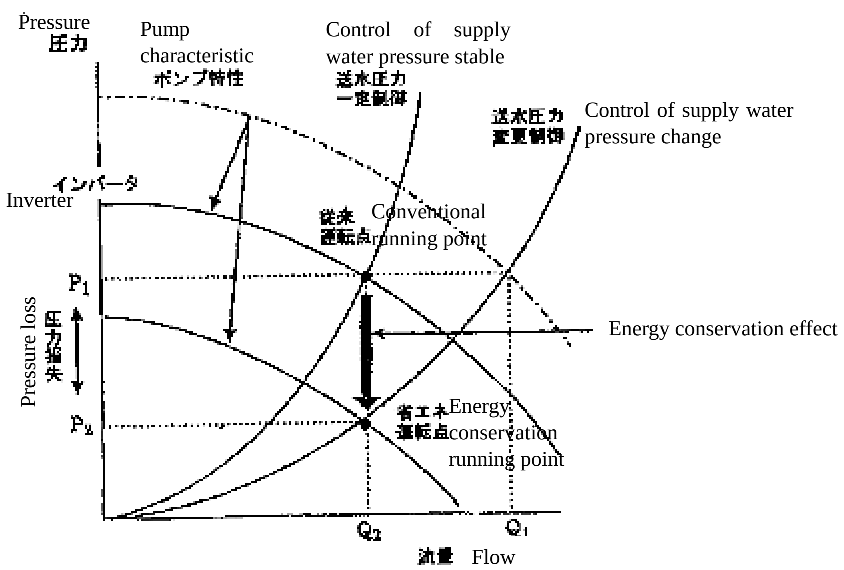


Figure 3.4.5-3 Energy Conservation of Water Supply Pressure Control

This water supply pressure is set to the value that can supply enough water at the maximum load. Therefore, in the partial load condition, the pressure balance of the entire system is kept by the pressure drop due to the control of valve. The pump is controlled by the lowest pressure that can supply enough necessary water to each air-conditioning system, and then it can gain energy conservation because the pump is running at the low rotational speed. (Figure 3.4.5-3)

The instrumentation system is a system that collects and grasps the measured data, such as valve opening degree, supply air temperature and indoor temperature, indicating each air-conditioning unit load condition, and then judge the water deficiency, finally, the deficiency information is transferred to the center equipment. In the center equipment, the best water supply pressure value of the entire system is decided based on transferred deficiency information from each air-conditioning system, and then the decided pressure value is sent to the controller of the pressure control loop.

2) Secure efficiency of fluid machinery and piping

- Secure highly efficiency of pump
- Prevention of water leak from a pump and pipe system
- Secure insulation effect of pipe to prevent heat loss and condensation. Especially, in the cool water pipe, the insulation effect extremely down is happened frequency because the surface condensation.
- Recovery from the flux decrease that is occurred because of the foreign thing and friction in the pump impeller.

3) Controllability of pump flux

- Examination on the appropriate of the pressure setting point which is set to control rotational speed (speed control).
- Examination on the possibility of rotational speed control adoption in the flux change
- Examination on the conversion that changing the constant flux amount system (changing the two-way valve operation into three-way valve operation) into the flux change system.
- Realization of the appropriate pump number division and the operation time leveling
- Check on energy characteristic of variable speed motor

4) Flux adjustment and load control possibility

- In the super large flux condition, the energy consumption is obstructed by the rotational speed decreasing or the valve and damper narrow down.
- Size adjustment of control valve and control damper. The excessive size damages the controllability and easily cause the energy waste in load side.

5) Use temperature difference

- The possibility to expand the temperatures difference (supply and return) should be examined. (It is necessary to analyze the heat exchanger characteristic.）
- Seasonal re-setting of the heat transfer medium temperature（improvement of the heat source COP）

- Density increasing of heat transfer medium, for example, the ice slurry transportation and so on.(using in the condition that the indoor load increases）

3.4.6 Equipment of Control System

(1) BEMS (Building Energy)

The building management automation becomes popular by the development of the computer in the factory automation (FA) and the office automation (OA). BEMS which controls efficiency and manages building energy will be developed as a system in the 21st century.

1) Outline of BEMS

BEMS is a system that optimizes and minimized the building energy consumption by using the energy consumption and indoor environment data. It aims to achieve the best environment with minimum energy.

In detail, it is composed of measurement device, controller, monitoring instrument, data storage, data analysis, etc. The related management systems are summarized in Table 3.4.6-1.

Table 3.4.6-1 BEMS concept

Function	Monitor	BA	BMS	EMS	BEMS
Monitor and display	○	○	○	○	○
Control		○	○	○	○
Measurement		○	○	○	○
Building management			○		○
Energy management				○	○
Energy optimization					○

2) BEMS function

As shown in Figure 3.4.6-1, the BEMS is an integrated composition, and its function is listed as follows.

a) Monitor and display
- Abnormality and breakdown（Including remote supervision）
- Start and stop operations
- Operation state display

b) Control
- Automation of equipment (for FA、OA equipment)
- Equipment operation by digital switchboard
- Securing of amenity environment

c) Building management
- Decrease of LCC
- Maintenance expense decrease and comfortable environment improvement

- Extension of maintenance interval
- Control of the operation number of equipment and operation time
- Enhancement of building security function

d) Energy management

- Energy efficiency management and control.
- Operation control by the data of the temperature, humidity, heat amount and electricity amount.

e) Energy optimization

- The most comfortable environment achievement with minimum energy consumption.
- Optimization management of heat load fluctuation by using COP energy management.
- Optimization management of the entire system.
- Energy conservation, cost reduction and CO_2 reduction plan

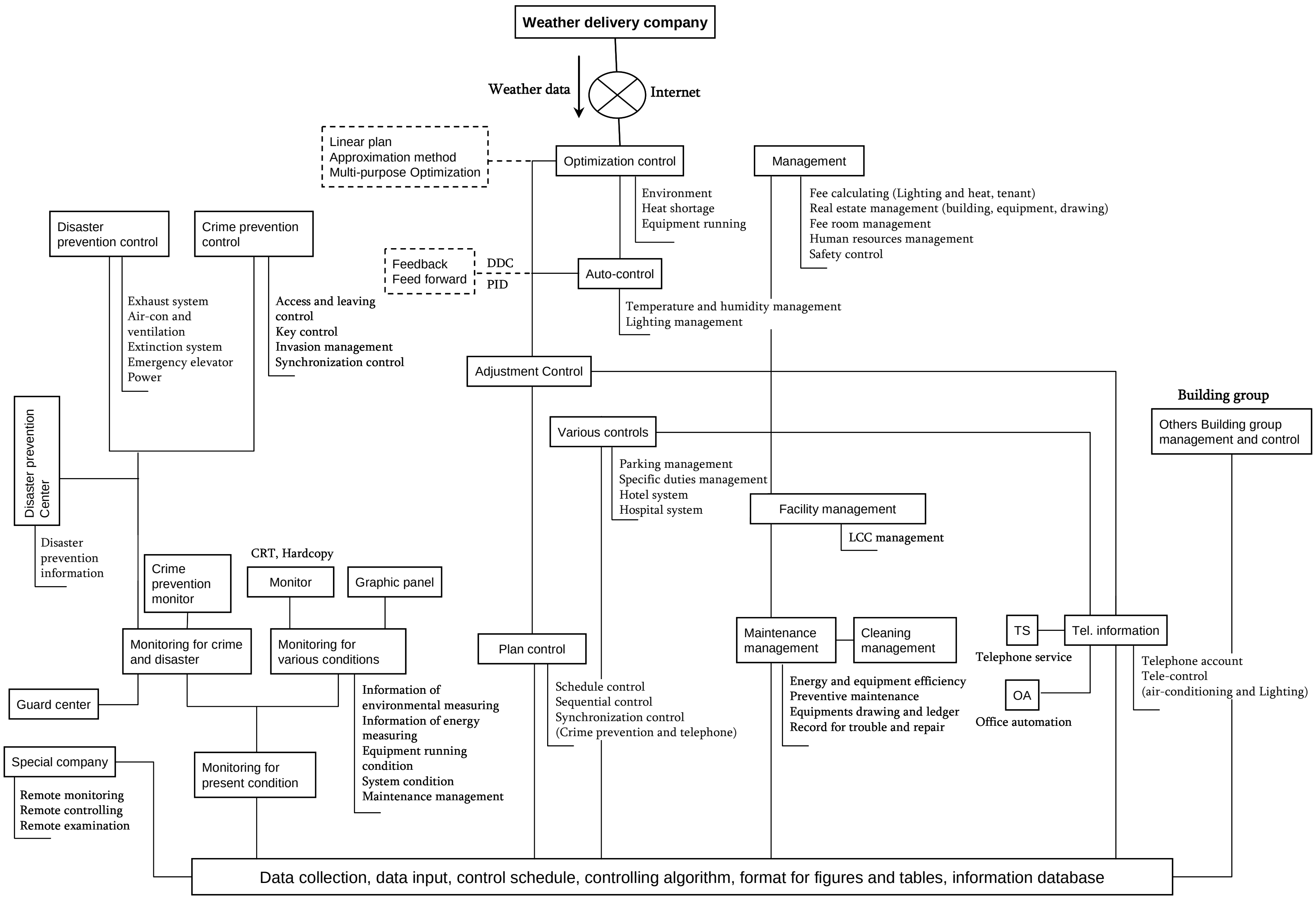


Figure 3.4.6-1 The Integrated BEMS Composition

3.4.7 Lighting equipment

(1) Inverter Type Hf Fluorescent Lamp and Automatic Control

The electronic ballast used for inverter type fluorescent lamp has become popular replacing the magnetic ballast used for the traditional fluorescent lamp. The lighting device which changes the power-frequency into high-frequency has the following merits: less and economical electricity consumption, no uneven light, small size and lightweight and so on.

1) Merits of inverter lighting (electronic ballast)

a) Efficiency improvement of lamp----- The total luminous flux improves more than 20% by using the more than 40kHz high-frequency lighting.
b) Reduce of ballast loss----- The ballast using high-frequency can miniaturize and then decrease loss.
c) It is adaptable to widely condition----- The inverter lighting can be used in all of voltage range from 100-254 V voltage (Phase voltage: 3φ440V).
d) Small size and lightweight----- Because the ballast and capacitor can be miniaturized and lightened, it is possible to miniaturize and lighted the total lighting device. Easy to implementation and variety of design.
e) Easy control on illuminance ----- The light amount (illuminance) of the fluorescent lamp can be easily adjusted according to daylight amount, using the following adjustment method: Light adjustment controller that can continuously adjust the light amount and lighting control system that combining the illuminance sensors or time switches and so on.
f) Three kinds of fluorescent lamps can be used----- The electronic ballast can be applied for the Hf lighting (T8), the rapid magnetic ballast fluorescence lamps (FLR), the glow magnetic ballast fluorescence lamps (FL).

2) Automatic dimmer system

a) Outline of the system----- Hf fluorescent lamp can achieve big energy conservation compared with the old model lamp, and the lighting control is also possible. The launching luminous flux of Hf fluorescent lamp can be changed arbitrarily by the dimmer control.
Because the electricity consumption is proportion to the luminous flux, the energy can be saved by decreasing excessive illuminance.

b) Light adjustment control
In order to secure the setting brightness, the light adjustment is done by the following signals: signal from illuminance sensor and human sensor installed in light adjustment devices, specified time input signal from timer and signal from wireless remote control and so on. There is a case that 50% electricity consumption is reduced by the HF fluorescent lamp and dimmer. (Refer to Figure 3.4.7-1).

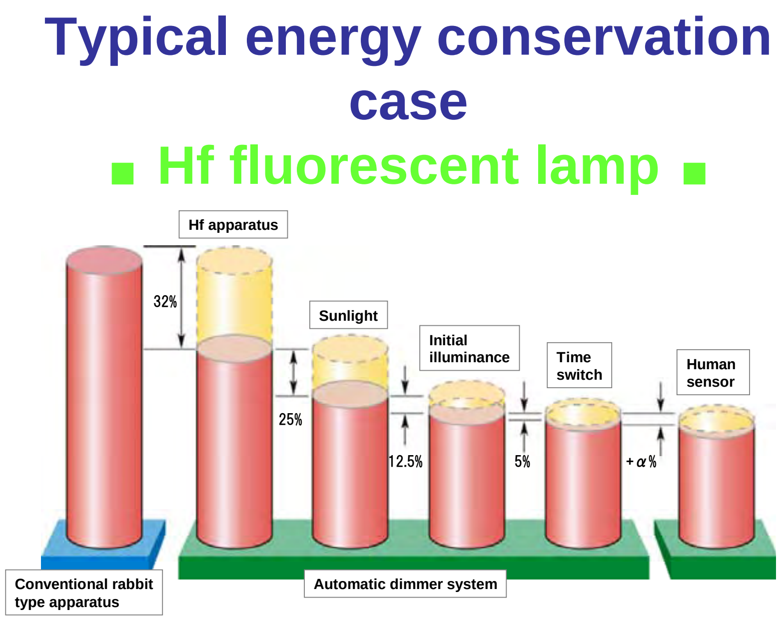


Figure 3.4.7-1 Effect of Energy Conservation by Mode

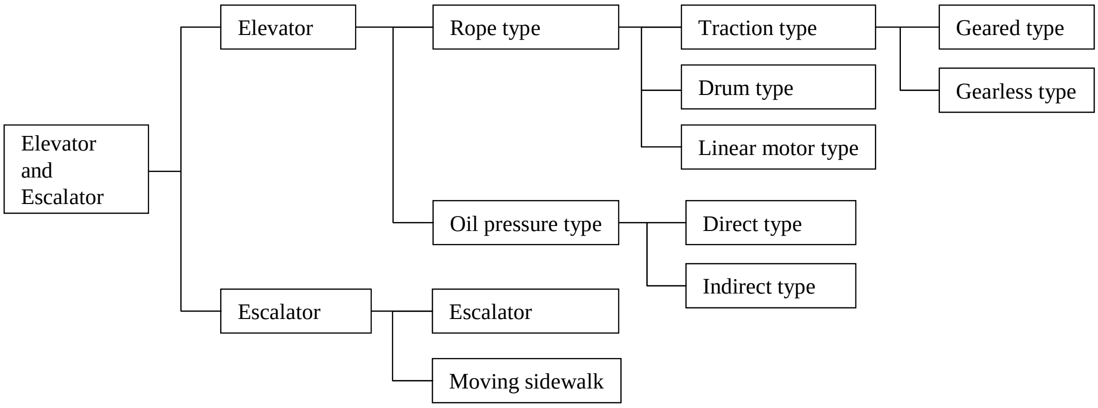
(2) High Efficiency Fluorescent Lamp and Reflector

Although it is not still spread in Indonesia, the adoption of High efficiency fluorescent lamp (T8,Hf) and the addition of the specular reflector have about 10% and 45% energy conservation potential, respectively. These are spreading in other countries, and can] be introduced in Indonesia soon, because they need comparatively small investment.

3.4.8 Elevator and Escalator

(1) Classification of Elevator and Escalator

Figure 3.4.8-1 shows the elevator and escalator classification according to the driving system. Elevator is divided roughly into the rope type elevator and the oil pressure type elevator pushed up by oil pressure. The rope type elevator includes the most spread traction type, drum type that winds rope up to net car and linear motor type that driven the basket through rope by the impellent generated by the linear motor setting in the counterweight side. The escalator is divided into two types. One is the structural escalator that always maintains the stile horizontal. The other is the structural moving sidewalk that doesn't install high difference between stiles.



Source : Energy conservation of office building by equipment operation management
The Building Energy Manager's Association of Japan {H8}

Figure 3.4.8-1 Elevator and Escalator Classification According to the Drive System

(2) Elevator

1) Control technology transition and energy conservation

Generally, the elevator is classified into medium- and low-speed elevator (less than 105m/Minute) and high-speed elevator (more than 120m/minute) according to the speed. Table 3.4.8-1 shows the transition of the rope type elevator from the view of control technology.

Table 3.4.8-1 Control technology transition of the rope type elevator

<table>
<tr><td colspan="2">year
Rated speed(m/min)</td><td colspan="4">1,900 71 75 85 2,000
100</td></tr>
<tr><td rowspan="3">medium- and low-speed elevator</td><td>Less than 30</td><td>AC one step speed (with cogwheel decelerator)</td><td colspan="2">AC return control (with cogwheel decelerator)</td><td>Inverter control (with cogwheel decelerator, none electric resurrection)</td></tr>
<tr><td>45 - 60</td><td>AC two step speed (with cogwheel decelerator)</td><td colspan="2"></td><td></td></tr>
<tr><td>90 - 105</td><td>Ward Leonard Control (with cogwheel decelerator)</td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="3">high-speed elevator</td><td>120 - 150</td><td rowspan="3" colspan="2">Ward Leonard Control (none cogwheel decelerator)</td><td rowspan="3">Thyristor Leonard Control (none cogwheel decelerator)</td><td rowspan="2">Inverter control (with/none cogwheel decelerator, with electric resurrection)</td></tr>
<tr><td>180 - 240</td></tr>
<tr><td>More than 300</td><td>Inverter control (none cogwheel decelerator, with electric resurrection)</td></tr>
</table>

Source :「Energy conservation of office building by equipment operation management」 The Building Energy Manager's Association of Japan {H8.3}

2) Power saving by inverter control

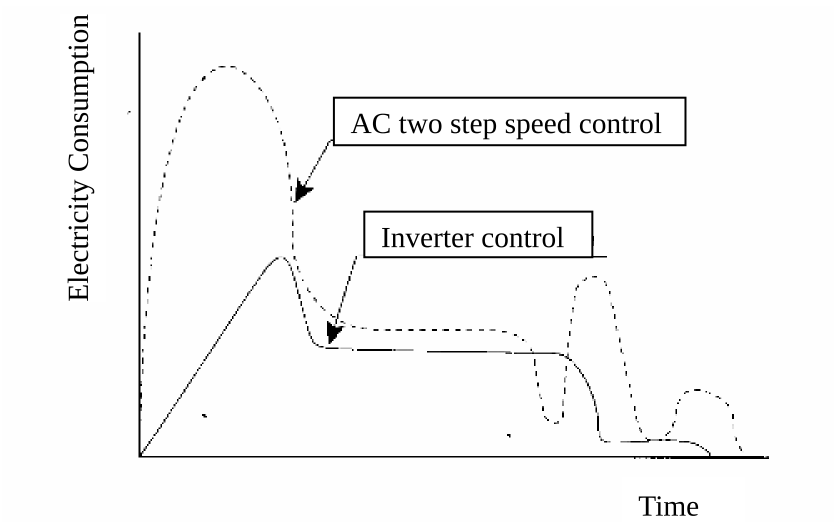
The improvement of electricity utilization efficiency is remarkable because of the technology advancement in elevator. The energy conservation technology also has been introduced into the rope type and oil pressure type elevator. Especially, the practical use of the inverter control method makes it possible to remarkable decrease electricity consumption in each drive method. Therefore, it is expected that the electricity consumption is decreased greatly by changing the existing control method to inverter control method in elevator.

Table 3.4.8-2 shows the electricity consumption decrease ratio duo to inverter control compared with existing control method. Figure 3.4.8-2 is the electricity consumption comparison.

Table 3.4.8-2 Electricity Consumption Decrease Ratio by Inverter Control

Drive type	Existing control		Inverter control
Rope type	Middle- and low-speed	AC one step speed control	50－60％
		AC two step speed control	
		AC return control	40－50％
	High-speed	Ward Leonard Control	30－40％
		Thyristor Leonard Control	5－10％
Oil pressure type	Electromagnetic valve flux control		40－50％
	LM control (Landing time Minimizing)		More than 15％

(Source :「Energy conservation of office building by equipment operation management」 The Building Energy Manager's Association of Japan {H8.3})



Source : (Energy conservation of office building by equipment operation management) The Building Energy Manager's Association of Japan {H8.3}

Figure 3.4.8-2 Electricity Consumption Pattern of Inverter Control

3) Calculation method of electricity consumption for elevator

The electricity consumption for elevator can be calculated from the main design items by using the expressions listed in Table 3.4.8-3 with the electric motor output. The value of motor output P is a little bit smaller than that of the rated output of the installed motor. The electricity consumption of each control method is calculated based on the P value disregarding the difference between P value and the rated output value.

Table 3.4.8-3 Rough Calculation Method of Electricity Consumption

Rough calculation method of electricity consumption
Output of electric motor
P = L*V*F / 6,120η
F：unbalance rate of hanging weight（Normal: 0.5）
η：Elevator comprehensive efficiency
・Winch without cogwheel decelerator : 0.7~0.75
・Winch with warm cogwheel decelerator : 0.5~0.6

P: Output of electric motor(kW)
L: Rated live load｛kg｝
V: Rated speed (ｍ/minute)

Item	Control type	Roughly calculation expression
Middle- and low-speed	AC return control (Microcomputer type)	W＝0.36 * N / 2000 * P * T
	Inverter control (none resurrection)	W＝0.18 * N / 2000 * P * T
High-speed	Ward Leonard Control	W＝(0.1 + 0.26 * N / 2000) * Ｐ * Ｔ
	Thyristor Leonard Control	W＝0.26 * N / 2000 * Ｐ * Ｔ
	Inverter control (with resurrection)	W＝0.24 * N / 2000 * Ｐ * Ｔ

W : Daily electricity consumption amount（kWh /day）
N : Daily start number for ten hours
P（kW）: Motor input（Calculating value according the above data）
T : Running time of elevator per day (hr / day)

Note1: "N/2,000" in the expression is a value that a little higher than the value calculated by dividing the results of ten hours standard elevator in one day.
Note2: The electric motor efficiency (output/input) has been considered into the roughly calculation.
Energy conservation of office building by equipment operation management（H8.3）
The Building Energy Manager's Association of Japan
Source: Building Energy Comprehensive Management Technique)The Building Energy Manager's Association of Japan 2000

4) Energy management of elevator

a) Microcomputer control
In the past, the operation control part in the elevator control board was composed of electromagnetic relay. But now, it is composed of microcomputer. By using the microcomputer control, not only improvement of the operation performance, machine efficiency and long lifetime for elevator, but also 5% electricity saving can be achieved.

b) Inverter control
By adopting the inverter control, the crystal of the power electronics, the electricity consumption can be decreased by 50% compared with the AC two step speed control as shown in Figure 3.4.8-2. Moreover, by using the inverter control, it can realize the

improvement of riding comfort and running time shortening as well as the improvement of arrival floor performance with the high effective control.

c) Automatic turning off of lighting
The lighting automatic turning off is a mechanism that lighting is automatically turned off after a fixed time with no user, and it is lightened again when new calling comes. This device can save energy on holiday, night and un-busy time on weekday when few users exist. However, the lifetime of bulb becomes shortened, it is not suitable to apply this device in the conditions where calling comes so frequently.

d) Promotion to use stairs
The sections with a lot of traffic in-between floors should be located on the neighboring floor, such as upper and lower floor, and use the stairs should be promoted as much as possible.

e) Group management for operation improvement
If the operation of the elevator is driven independently in a building where two or more elevator is installed, the operation loss happens easily by one user's pushing two or more hall buttons. Energy conservation by changing the independent management into group management, it can reduce operation loss and improve operation efficiency of elevators. In addition, the service can be improved, such as shortening waiting time, due to the reduction of the delay operation and operation loss.

(3) Escalator

1) Energy management of escalator

a) Addition of automatic operation device
In recently years, the automatic operation type is increasing quickly in urban traffic such as the railway station. The automatic operation type stops the operation with no passenger by detecting passenger’s boarding with photoelectric device.

Figure 3.4.8-3 shows the concept of the automatic operation of an escalator.

It is the method that eliminates empty operation with no passenger by using the photoelectric device or the infrared sensor to check the existence of a passenger. In the station where fluctuation of passengers is quite big, about 20%-30% energy conservation effect can be expected compared with a continuous operation.

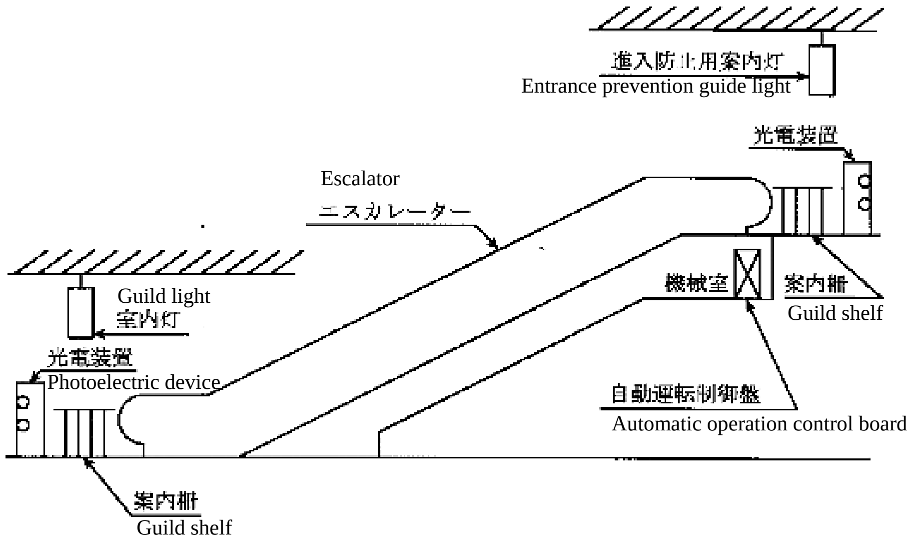


Figure 3.4.8-3 The Automatic Operation Control of Escalator

Source：(Energy conservation of office building by equipment operation management) The Building Energy Manager's Association of Japan

b) Addition of electricity saving operation device

In the department and shopping center, lots of escalators are installed to form smooth human flow. In these cases the automatic operation method is not suitable, because the human flow is psychologically obstructed due to intermittent operation. Therefore, an automatic Y-Δ switch electricity saving device is mainly introduced in the escalator to achieve the electricity saving. The electricity saving effect is less than that of the automatic operation method.

Automatic Y-Δ switch device is an electricity saving device that the stator winding, Y connection and the Δ connection, of the induction motor switching automatically according to the load. This device can achieve energy conservation by simply control that keeps continuous operation of escalator and does not need incidental equipment.

(4) Practical affairs of energy management for elevator and escalator

The energy consumption of the elevator is multifarious due to the various traffic demands of individual buildings and it is impossible to set a general reference value. Therefore, the energy reduction target is set based on the actual condition on operation and management of elevator in the building by analyzing the measurement or calculated energy consumption value. The key point on energy conservation of elevator is reducing the frequency of start and operation. The operation time can be shortened by the decrease of the frequency of start.

However, the service quality down should not be aware by passengers. For example, in the bank with multi elevators, the waiting time is extended because the enforcement of the partial operation, and then the business loss due to the extended waiting time is far exceeding energy conservation effect. It is necessary to pay attention on the adjustment with the operation management.