Republic of Serbia
Ministry of Infrastructure and Energy of the Republic of Serbia

The Study for Introduction of Energy Management System in Energy Consumption Sectors in the Republic of Serbia

FINAL REPORT

Appendix

June 2011

Japan International Cooperation Agency (JICA)

Tokyo Electric Power Company (TEPCO)

Table of Contents

Appendix 1

Questionnaire of Energy Assessment by Local Consultants

Original Questionnaire

Questionnaires

Section 1. Basic Information

Name of Company / Factory / Institution	
Ownership	Public Private Privatized （in ）
Capital	
Address	
Respondent	Department : Name :
	TEL: FAX: E-mail address :

Industrial or Commercial Sector	1. Industrial Sector 2. Commercial Sector

Outline of Factory/ Building	Kind of Industry/ Building	1. Metal 2. Cement 3. Refinery 4. Food 5. Others ( )
		1. Office 2. Governmental 3. Hospital 4. Hotel 5. School 6. Others ( )
	Main Products and Production (in case of industry)	Products Amount
	Amount of Production per year	
	Number of Employees	
	Operation Days per year	
	Operation Hours per day	

Note: fill in only the related colums

Energy Consumption per year	Kinds	Unit	Amount	
	1. Electriciy	kWh		
	2. Natural Gas	Sm^3		
	3. LPG	kg		
	4. Heavy Fuel Oil (Mazut)	kL		
	5. Steam/Hot Water etc. which is supplied from outside	GJ		
	6. Others			

Note: fill in only the colums of fuels and heat which you consume.

Section 2. Data Availabirily if Energy Management System is introduced

Energy Data

1. Are monthly data of energy consumption amount of each kind of energy available?

   a. Yes b. No

   c. some Yes, others No; available energy ( )

2. If no, What kinds of amount data are avialable?

   a. yearly amount b. quaterly amount c. yearly expenses d. quarterly expenses

3. How are they obtained?

   a. automatic measurement b. manual measurement c. by bills

   d. others

4. Are they recorded?

   a. Yes (amount and expenses) b. Yes (only expenses) c. Yes (only amount) d. No

5. Are there any person in charge of the record?

   a. Yes b. No

Equipment

1. Is it possible to identify equipment/systems which in total consume more than 80% of total energy consumption?

   a. easily Yes b. with some help, Yes c. perhaps, No

2. If yes, are their specifications available?

   a. easily Yes b. with some work, Yes c. perhaps, difficult

Factor which well describes your business

1. Do you think of good factors which describe your business and strongly relate to energy consumption?

   a. amount of production b. amount of sales c. total floor area d. others

Operational Manual

1. Are the operation manuals available, which defines appropriate conditions such as temperatures and pressures and intervals of measurement /record?

   a. Yes b. only for production lines and not for facilities such as air-conditioning

   c. No

2. If you have to prepare such manuals, namely Management Standards in EMS, a sample is attached, what kind of help do you need?

Section 3. Capacity/Possibility to deal with Energy Management System (Awareness & Activities)

General

1. Do you already conduct activities to promote energy efficiency?
   a. Yes; detail:
   b. No
2. Do you have a plan for energy efficiency?
   a. Yes; detail:
   b. No

Energy Audit/Assessment

1. Have you ever had energy audits/assessment?
   a. Yes; detail:
   b. No
2. Have you retrofitted equipment/systems for energy efficiency?
   a. Yes b. No
   1. If Yes, how many times? And by outside auditor or internal engineers?
   2. If Yes, what was the suggestion of the audits?
   4. Did you adopt the proposals for energy efficiency?
      a. If No, what are the reasons not to?
   5. Were there any financial support such as grants?

Personnel

1. Is there a responsible person for energy efficeincy?
   a. Yes b. No
   1. If Yes, what kind of position of the responsible person?
2. Is there a team for energy efficiency?
   a. Yes b. No
   1. If Yes, how many people are in the team? And what kind of people?
3. Are there any candidates for energy managers or do you think of such a person?
   a. Yes b. No
   1. If Yes, what kind of backgrounds and qualifications they have?

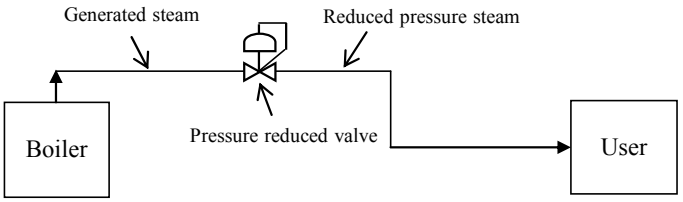
Will

1. Do you want to promote energy efficiency?
   a. Yes b. No
   1. If Yes, what are the reasons? (multiple answers are allowed)
      a. global warming issue b. energy security c. energy expenses
      d. others ( )

Section4. Tecnological Level of Sites and Possible Technogoly for improvement

Steam Boiler and Pipe Line

1 How much is generated steam pressure, and if the steam pressure is reduced by pressure reducing valve, how much is reduced steam pressure?



2 Are there measurement nozzle for O2% checking on exhaust gas duct?

3 Do you check O2% in exhaust gas periodically?
If you do, is O2% adjusted when required and what is the adjusted range?

4 Do you check steam traps periodically on the actions?

Hot Water Boiler

1 How many degrees are the supply and return temperature?

2 Do you check O2% in exhaust gas periodically?
If you do, is O2% adjusted if required and what is the adjusted range?

Air Compressor

1 How much pressure is generated compressed air?

2 How many air compressors are operated in normal condition?

3 How is the compressed air pressure controlled?

4 Do you check leaking compressed air periodically?

Chiller

1 How many degrees do you set the supply temperature of chilled water?

2 Is the cooling water temperature is managed considering the efficiency of chillers?
Note: In genral, it is prefarable to keep the temperature as low as possible within the practical range for the high efficient operation.

Air-Conditioning System

1 Is the system controlled from the center?

2 Does the system have VAV or VWV?

3 Do you use heat recovery system?

Cooling

1 How much temperature did you set for room temperature this summer?

2 Did you change the above temperature compared to the last year?
If you did, what are the reasons?

Heating

1 How much temperature did you set for room temperature this summer?

2 Did you change the above temperature compared to the last year?

3 If you did, what are the reasons?

Equipment/System

1 Do you adopt any EE&C measures for air-conditioning system?
   a. shorten operateion time
   b. regularly clean filters of air-conditioning system
   c. change to more efficienct equipment
   d. introduce efficient air-conditioning system
   e. any other measures?

Lighting

1 Do you adopt any EE&C measures for lighting? (muptiple answers are allowed)
   a. Do you switch off lights when unnecessary?
   b. Do you switch off lights of the office during lunch time?
   c. Do you decide not to use some lighting equipment?
   d. Have you changed lighting fixture to more efficient ones such as Bulb type FLR/ Hf lights/ HID lights/ LED lights
   e. Do you have a thermo sensor for lighting?
   f. Any other measures for energy efficiency?
2 Have you invested to improve EE&C?
3 If not, what are the reasons for not investing lighting for EE&C?
   a. lack of confidence for payback
   b. too much personnel cost
   c. too much initial cost
   d. lack of finance for investment

Section 5. Detailed Data:Equipment

Requested Document for EE&C Audit

1) Site layout drawing
2) Flow diagram of steam system
3) Flow diagram of hot water system
4) Flow diagram of compressed air system
5) Design data sheet of every steam boiler
6) Design data sheet of every hot water boiler
7) Design data sheet of every air compressor
8) Design data sheet of every chiller
9) Single line diagram of power supply system

Equipment

Main Production Facilities	Name and Main Specifications	

Utility Facilities	Steam Boiler		1		2		3		4
	Evaporation (Rated)	t/h							
	Steam Press. (Rated)	MPaG							
	Kind of Fuel								
	Hot Water Boiler		1		2		3		4
	Capacity (Rated)	MJ/h							
	Kind of Fuel								
	Air Compressor		1		2		3		4
	Type								
	Air Volume (Rated)	Nm3/h							
	Discharge Press. (Rated)	MPaG							
	Input Power (Rated)	kW							
	Chiller		1		2		3		4
	Type								
	Capacity (Rated)	MJ/h							
	Input Power (Rated)	kW							
	Receiving Power Transformer		1		2		3		4
	1ry and 2ry Voltage		/		/		/		/
	Capacity	kVA							
	Installed Year								
	Independent Generator		1				2		
	Type / Kind of Fuel		/				/		
	Generated Power (Rated)								
	Normal use or Emergency use								
Air Conditioners	Heating								
	Heating Floor Area	m2							
	Heat Source								
	Cooling								
	Cooling Floor Area	m2							
	Cooking Source								
Lighting	Type of Lamps		Incandiscent	Fluorescent	Fluorescent (HF)	HID			
	Number of Lamps								
	Ave. Consumed Power per each	W							
Other Equipment Consuming a Large Quantity of Utilities(Pump, Blower, etc.), and the Specifications									

Note: fill in only the colums of equipment which you possess.

Section 6. Detailed Data: Energy

Monthly Energy Consumption of the Latest Year

Year/Month		Purchased Elecricity		Generated Power	Natural Gas	LPG	Heavy Fuel Oil (Mazut)	Coal		Water		Production	
		Peak in every month	Cumulative							Potable Water	Well or River Water	Shipment Amount	Sales Amount
Year	Month	kW	kWh	kWh	Sm3	kg	kL	ton		m3	m3	Ton, Number, etc.	RSD
	Total												

Note: fill in only the colums of equipment which you consume.

Typical Properties of Fuels

Natural Gas	Net Heating Value :	KJ/Sm3				
LPG	Net Heating Value :	KJ/kg				
Heavy Oil	Net Heating Value :	KJ/L	Density :	kg/L	Sulfur Content :	wt%
Coal	Net Heating Value :	KJ/kg	Source :			

Note: fill in only the colums of equipment which you consume.

Unit Prices of Fuels and Water

Natural Gas	RSD/Sm3
LPG	RSD/kg
Heavy Fuel Oil (Mazut)	RSD/L
Coal	RSD/kg
Water	RSD/ton

Tariff of Electricity

(Demand Charge/Energy Charge/etc.)

Note: fill in only the colums of equipment which you consume.

Appendix 2

Training Materials in Pilot Implementation of Energy Management System

TQM Training Program

1

Basic Management Training for Energy Manager

November 2009

2

Self-Introduction

1. Your name.
2. Your job.
3. Your expectations for this training.

* Within 1 minute.

3

1. Definition of "management"

All actions whereby various management resources, including people, goods, money, information, technology, time etc, are used effectively, efficiently, economically, and continuously to materialize the objectives and attain the goals of the organization.

4

2. Group Discussion

1. What are the objectives and goals of your organization?

2.What kind of management resources do you have?

3.What is the most serious problem or issue you are facing?

5

MANAGEMENT TRAINING ACTION PLAN SHEET

1.What is the most serious issue you are facing in your workplace ?

2.Your action plan.

Theme
Action plan

3.Review

Your action	Till when	Expected goal

6

3.Necessity of Energy Conservation Activities

Outside factors	Inside factors

7

4. TQM (Total Quality Management)

(1) Dimensions of "Quality"

Q: Quality
C: Cost
D: Delivery
P: Productivity
M: Moral
S: Safety
E: Environment

8

4. TQM (Total Quality Management)

(2) Purpose of the Quality Management

1. To Increase Customer Satisfaction
2. To Reduce Cost
3. To Stimulate Employees

- ISO: What to do
- TQM: How to do

9

4. TQM (Total Quality Management)

(3) Key words of TQM activities

-View point of Problem Solving-

Market-in

Fact control

Emphasis on process

Priority orientation

PDCA cycle

10

5. Human Resources

o Unique Points

・The more we use them , the more refined they become and higher their resource value becomes.
>>>>Training our members

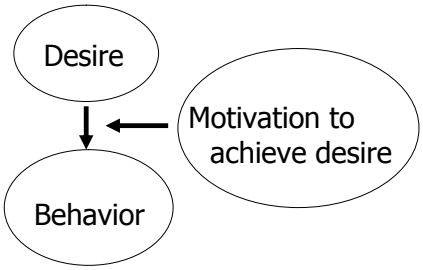
・Their desires and abilities are drawn out to the maximum. >>>Motivating our members

11

6. Situational Leadership

12

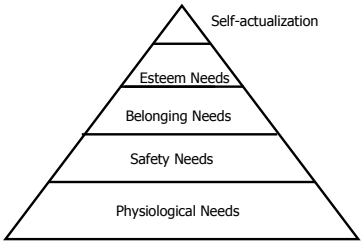
7. Motivation



13

7-1. Motivation Theory 1

"Hierarchy of Needs" by Maslow



14

7-2. Motivation Theory 2

" 2 Factor Hygiene and Motivation " by Herzberg

o Hygiene Factors
- Company policies and administration
- Supervision
- Salary, status and security

o Motivating Factors
- Achievement
- Recognition for achievement
- Interest in the work
- Responsibility for enlarged
- Growth and advancement to higher level tasks

15

8. Communication

① Motivating members
② Good human relation based on the good communication
③ Communication in the workplace
- Greeting
- Exchanging Information
- Sympathizing

16

9. Problem Solving

(1)What is the problem?

- Problems refer to any difference between the ideal situation and the real situation.

Goal — Ideal situation (Goals, Plans, Demands)

Gap (Difference)= Problem

Real situation — Present situation (Present results)

17

9. Problem Solving

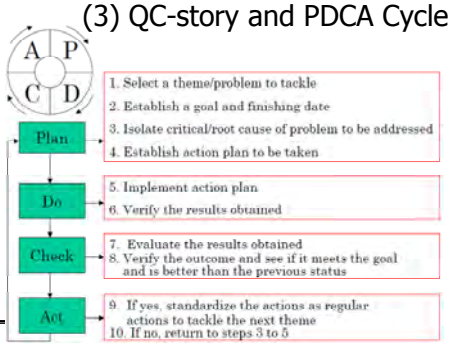
(2) Flow of the QC-story

Step1. Theme selection
Step2. Comprehension of present situation and setting target
Step3. Action plan scheduling
Step4. Analysis of factors
Step5. counter-measure study and implementation
Step6. Evaluation of the result
Step7. Standardization and settlement of control

18

9. Problem Solving

(3) QC-story and PDCA Cycle



19

9. Problem Solving

(4) QC 7 Tools

1. check Sheet
2. Pareto Diagram
3. Cause and Effect Diagram
4. Histogram
5. Graph/Chart
6. Scatter Diagram
7. Control Chart

20

9. Problem Solving

(5) QC 7 Management Tools

1. Affinity Diagram
2. Relations Diagram
3. Matrix Diagram
4. Tree Diagram
5. PDPC
6. Arrow Diagram
7. Matrix Data Analysis

Training Material for Trainers

1

Training of Trainers

November 2009

2

Self-Introduction

1. Your name.
2. Your job.
3. Your expectations for this training.

* Within 1 minute.

3

1. Group Discussion

1. Your Experiences
2. Your Expected Abilities

4

2. Making a Training Plan (1)

1. Clarifying the Aims and Objectives
2. Clarifying the Targets
3. Clarifying the Goals
4. Grasping the Real Situations of the Target

5

2. Making a Training Plan (2)

5. Making a Scenario to achieve the Goal
6. Grasping the Restrictions
7. Making a Training Program
8. Making an Implementation Plan
9. Collecting Participants

6

2. Making a Training Plan (3)

10. Preparing the Training
11. Implementing the Training
12. Evaluating the Training

* Grasping the Needs

7

3. Training Method (1)

1. Lecture
2. Group Discussion
3. Case Study (Case Method)
4. Role Playing

8

3. Training Method (2)

5. Practice/Experiment
6. Test
7. Questionnaires (Evaluation)

9

4. Instruction Skills

1. Speech
2. Asking and Answering Questions
3. Writing on a board
4. Attitude, Outfits, etc.

10

5. TQM (Total Quality Management)

(1) Dimensions of "Quality"

Q: Quality
C: Cost
D: Delivery
P: Productivity
M: Moral
S: Safety
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11

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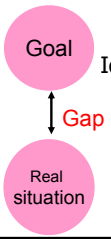
12

5. TQM (Total Quality Management)

(3) Problem Solving – What is the problem?

- Problems refer to any difference between the ideal situation and the real situation.



13

5. TQM (Total Quality Management)

(4) Key words of TQM activities

-View point of Problem Solving-

- Market-in
- Fact control
- Emphasis on process
- Priority orientation
- PDCA cycle

14

5. TQM (Total Quality Management)

(5) Flow of the QC-story

Step1. Theme selection
Step2. Comprehension of present situation and setting target
Step3. Action plan scheduling
Step4. Analysis of factors
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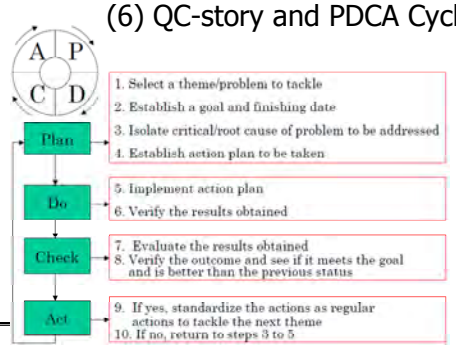
Step6. Evaluation of the result
Step7. Standardization and settlement of control

15

5. TQM (Total Quality Management)

(6) QC-story and PDCA Cycle



16

5. TQM (Total Quality Management)

(7) QC 7 Tools

1. check Sheet
2. Pareto Diagram
3. Cause and Effect Diagram
4. Histogram
5. Graph/Chart
6. Scatter Diagram
7. Control Chart

17

5. TQM (Total Quality Management)

(8) QC 7 Management Tools

1. Affinity Diagram
2. Relations Diagram
3. Matrix Diagram
4. Tree Diagram
5. PDPC
6. Arrow Diagram
7. Matrix Data Analysis

18

6.Action Plan

1. Your strong points as an Instructor
2. Your weak points as an Instructor
3. 3 points which you want to improve
4. An action plan to achieve the goal
5. Your evaluation method

Training Materials for Factory and Building

1

How to promote Energy efficiency on Building

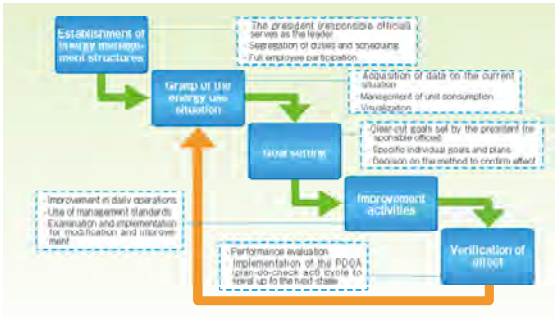
JICA Study Team
Yoshiharu IKEUCHI

2

Contents

3

1. Procedure of Energy Conservation Activities



Source from ECCJ

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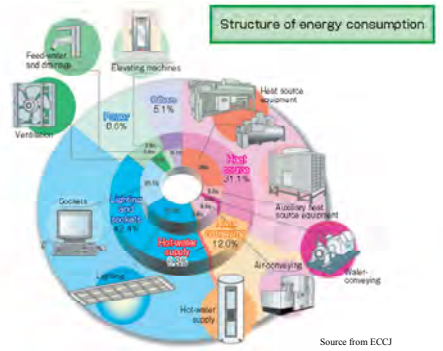
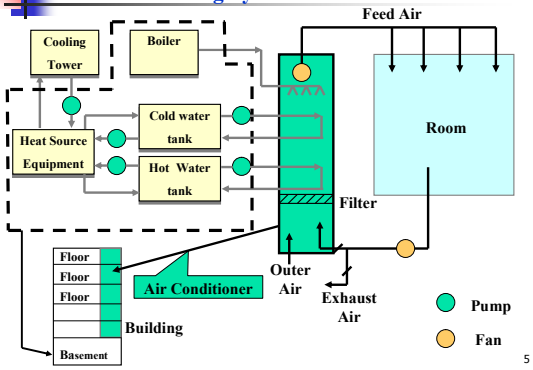
Structure of energy consumption



Source from ECCJ

5

Air Conditioning System



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Energy consuming equipment

Energy consuming equipment

Heat source and heat-conveying equipment, air-conditioning and ventilation equipment, hot-water supply and water-feed and drainage equipment, freezing and refrigeration and kitchen equipment, power receiving and transforming equipment, lighting and electrical equipment

supply

Demand

Air

machines

Major energy loss

Wastefulness
- Air-conditioning and lighting turned on in the unoccupied rooms and during the unoccupied hours
- Water left running

Defective operation and maintenance management
- Excess capacity operation
- Treatment of outside air at the start-up operation of air-conditioning
- Clogging of the filter

Insufficient utilization of natural conditions
- Nonuse of outer air cooling equipment
- Lighting control in the area near the window

Heat flow
- Heat loss from piping and duct
- Resistive loss from piping and duct

Efficiency of facility and equipment
- Refrigerators, air-conditioning equipment, air blowers, boilers, and pumps

Energy conversion
- Electricity → heat, light, and power
- Heat → electricity
- Design process

Overdesign, and non-optimum design
- Abolition of energy conservation systems
- Adoption of inefficient equipment

Source from ECCJ

7

Classification table of energy consumption item & equipment

Source from ECCJ

Classification of energy consumption		Main energy consumption equipment
Item	Particulars	
Heat Source	Heat Source	Refrigerating equipment, water cooler/heaters, Boiler
	Auxiliary Facility	Pump, Cooling Tower, 1st stage pump
Heat Conveyance	Water Conveyance	2nd stage pump,
	Air Conveyance	Air conditioning equipment, Fan coil unit,
Hot water supply	Heat Source	Boiler, electric water heater, pump
Lighting & Sockets	Lighting	Lighting equipment
	Sockets	OA machines
Power	Ventilation	Fan for parking facilities
	Feed-water & Drainage	Lifting pump
	Elevating machines	Elevator, Escalator
Others	Others	Transformer s and kitchen equipment

7

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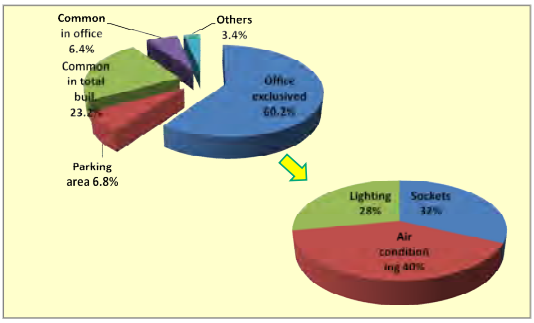
Energy consumption in each section on general building



Source from ECCJ

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9

Promotion of Energy Conservation Measures 1. General management items

Source from ECCJ

1.Energy management system	**•Establishment of the organization and employee education** **•Establishment of the management standards** •Targets of energy conservation and investment budget •Status of implementation of energy conservation
2. Measurement & recording	•Installation of measuring instruments and the status of operation •Implementation of periodical measurements and recording •Status of the maintenance and inspection of measuring instruments •Status of the introduction of measuring and control systems
3. Energy consumption management	**•Status of recording of the daily reports •Monthly consumption** •Daily consumption and daily load curve •Graphs for comparison with the data for the previous year
4. Equipment maintenance management	•Periodical inspection and daily check •Management of system performance •Management of equipment performance •Cleaning of equipment (fi lters and strainers)
5. Management of energy intensity	**•Energy intensity (MJ/m2 per year) •Unit consumption by building** **•Specific energy cost (yen/m2 per year) •Unit consumption by destination**
6. PDCA management cycle	•Status of exercise of the PDCA management •Status of implementation of continuous improvements ("kaizen")

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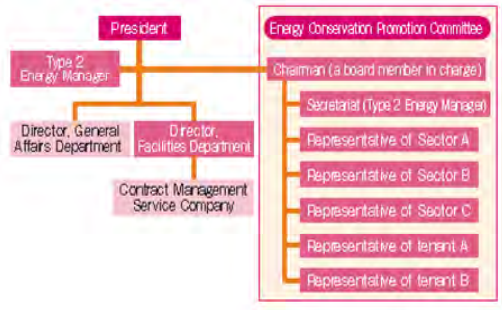

Source from ECCJ

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11

Example of management standard (Boiler)

●**Management or criteria**

NO	Item	Content	Remark
1	Air ratio	> 1.3	
2	Pressure, volume, temperature	0.85-0.90 Mpa 8.0-8.5 ton/h 290 – 300C	
3	Flue gas temperature	>200 C	
4	Drain recovery	< 80%	

●**Measurement and record**

Fuel consumption, flue gas temp., O_2 content of flue gas, Pressure, volume and temperature of steam

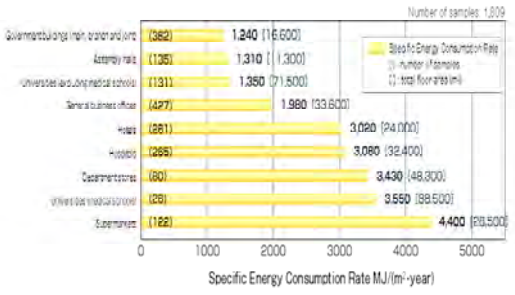
●**Maintenance and inspection**

Combustion equipment, removing soot, ACC system, heat transfer area, leakage of steam

11

12

Energy intensity on various types of building



Source from ECCJ

12

13

Calculation of energy intensity of building

Type of building : General office building

Total floor area : 40,000 m²

Annual energy consumption
Electricity : 6,000 MWh
Hot water : 100,000 ton(80 ℃)
N.G : 115,000 Nm³

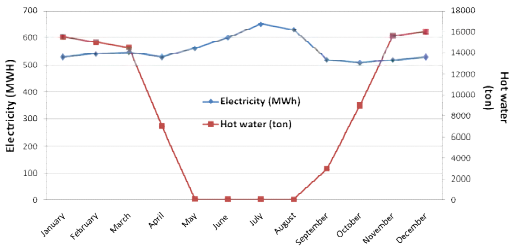
● **Energy consumption(one year)**
Electricity = 6,000 x 10³ kWh x 9.76MJ/kWh = 58,560 x 10³ MJ
Hot water = 100,000 ton x 335 MJ/ton = 33,500 x 10³ MJ
NG = 115,000 Nm3 x 43,500 MJ/1000Nm3 = 5,000 x 10³ MJ

● **Energy intensity = (58,560 + 33,500 + 5,000) x 10³ MJ/ 40,000 m²**
= 2,426 MJ/ m². year

13

14

Monthly energy consumption

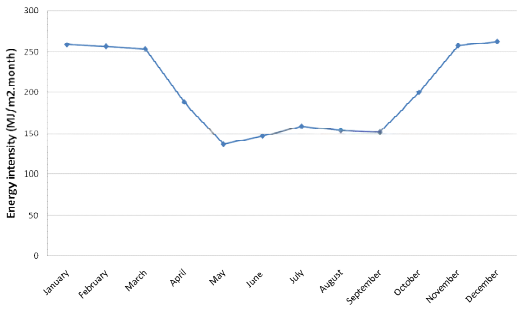


Total floor area: 40,000m²

14

15

Monthly energy intensity



15

16

2. Heat source and heat con-conveying equipment

1.Performance management of combustion equipment	**•Management of air ratio and exhaust gas •Combustion control devices** •Burners, fuel, and draft system •Fuel conversion (boilers, generators, etc.)
2. Performance management of refrigerating equipment	**•Coefficient of performance (COP)** •Descaling of heat exchangers •Setting of chilled water outlet temperature •Temperature efficiency of heat exchangers •Setting of cooling water temperature
3. Operation and efficiency management	•Load factor and start-up/shutdown status •Steam pressure •Quantity control •Water quality management and blow control •Heat efficiency, heat balance, and heat distribution
4. Operation management of auxiliary equipment	•Operation control of cooling towers **•Operation control of pumps (water volume and lift)** •Water quality management (electric conductivity) •Improvement of routing

Source from ECCJ

16

17

Continued

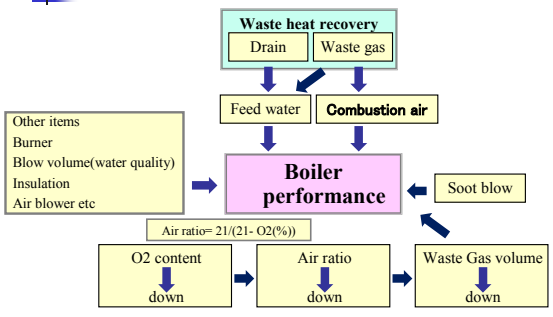
5. Operation management of heat-conveying equipment	•Quantity control of pumps and fans •Flow rate and pressure **•Revolution control of pumps and fans** •Improvement of routing (open or closed) •Status of valve opening and closing (automatic valves, header bypass valves, etc.)
6. Exhaust gas temperature and exhaust heat recovery	•Management of exhaust gas temperature •Heat recovery (HP, CGS, etc.)
7. Steam leak and heat retention management	**•Piping system** •Loading equipment
8. Management of heat storage tank	•Heat storage efficiency •Improvement of conveying route •Heat storage and heat release time

Source from ECCJ

17

18

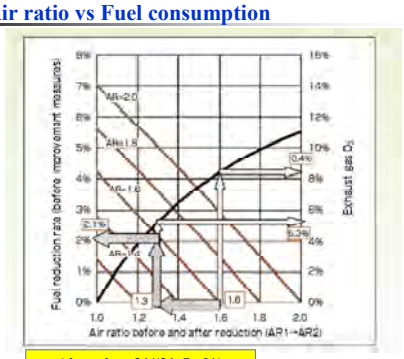
Boiler performance



18

19

Air ratio vs Fuel consumption



Air ratio = $21/(21-O_2\ \%)$

Source from ECCJ

19

20

Valves insulated with covers (Example 1)

Problems with the current operation

In a large hospital (total floor area: 60,000 m2), steam piping valves, which are not insulated, so cause great heat loss from the surface.

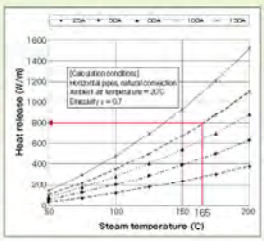
Improvement measures

Heat loss was prevented by putting insulating covers with a hook and loop fastener on steam valves. They can be quickly attached to and removed from intricately-shaped valves.

Source from ECCJ

20

21



Source from ECCJ

21

22

Effect estimation

Source from ECCJ

■ **Preconditions of estimation**

Steam pressure/temperature (saturated): 0.7 MPa･165℃
Specifications and number of steam valves: 100A flanged type spherical valve, 100 units
Bare valve heat loss: 100A bare steam pipe heat loss (see the Chart 2) x straight pipe length equivalent to the valve surface area
= 800 W/m x 1.27 m/unit = 1.0 kW/unit
Heat insulating efficiency (= heat loss reduction after heat retention ÷ bare pipe heat loss): 85%
Boiler efficiency: 70% (including operation efficiency)
Operating hours: 12 h/day x 365 day/year = 4,380 h/year
Calorific value of gas (13A): 45.0 MJ/m3
Average gas unit price: 70 yen/m3

■ **Effect estimation**

Heat loss reduction = 1.0 kW/unit x 100 units x 0.85 x 4,380 h/year x 3.6 MJ/kWh = 1,340,280 MJ/year
Gas reduction = 1,340,280 MJ/year ÷ (45.0 MJ/m3 x 0.7)
= 42,549 m3/year

22

23

COP（Coefficient of Performance)

COP = Capacity of cooling/ heating of equipment (kW)
÷Energy consumption for cooling/heating of equipment (kW)

Absorption refrigerating equipment(Gas type)：1.2～1.5
Heat pump (Gas type)：1.2～1.4
Heat pump (Electricity type) :
Centrifugal water chiller : 6.4（100%load） Max 11.4

Detail calculation method of COP is described in JIS(Japan Industrial Standards)

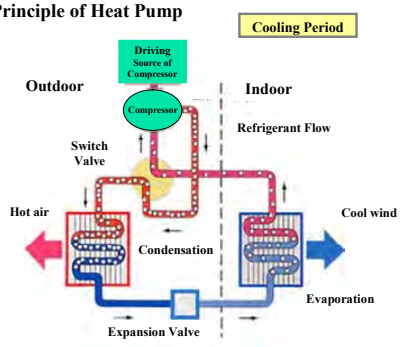
It is very important to compare COP value of usual operating and design one.

23

24

Electric Heat Pump, Gas Heat Pump and Co-generation Machine

● Principle of Heat Pump



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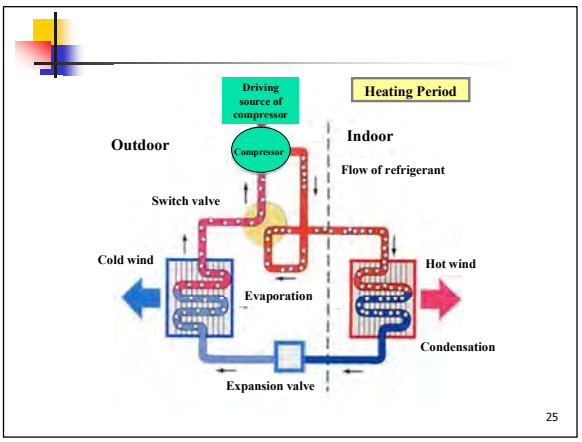
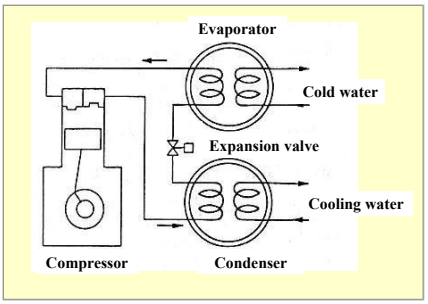


26

Structure of compressed type refrigerating equipment



Source from ECCJ

26

27

Electricity consumption of pump & blower

Blower;

$$P\,(kw) = \frac{Q \times H}{6{,}120 \times E_f}$$

Pump;

$$P\,(kw) = \frac{Q \times H \times D_e}{6{,}120 \times E_f}$$

Symbol	Item	Dimension	
		Pump	Blower
Q	Flow Volume	m^3/min	m^3/min
H	Discharge pressure	m(kg/cm^2=10m)	mmAq
E_f	Efficiency	—	—
D_e	Density	Kg/m^3	—

$Q = k_1 N$, $H = k_2 N^2$, $P = k_3 N^3$

N=Rotation speed

27

28

Use of inverter for chilled water pumps (Example 2)

Problems with the current operation

In a big hotel (total floor area: 36,000 m2), three secondary chilled water pumps are running under multiple unit control systems in response to air-conditioning load.

However, the rated flow is applied to all pumps.

Improvement measures

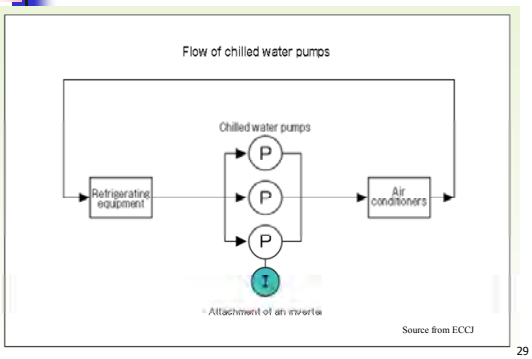
Power consumption was reduced by attaching an inverter to one of the three chilled water pumps, and controlling the flow volume.

Source from ECCJ

28

29

Flow of chilled water pumps



Source from ECCJ

29

30

Effect estimation

■ Preconditions of estimation

Secondary chilled water pump capacity: 55kW x 3 units, secondary hot water pump capacity: 15 kW x 1 unit

Operating hours:

(Chilled water pumps) March-June, October-November (12h/day): 2,160 h

July-September (22h/day): 1,980 h; Total 4,140 h/year

☆Average pump flow volume after attachment of an inverter: estimated to be 70% of the current volume

☆ Total pressure difference in the vicinity of the pump after attachment of an inverter: estimated to be 90% of the current value

☆ Inverter efficiency: 0.95

☆ Average electricity unit price: 18 yen/kWh

■ Effect estimation

Reduced power consumption = 55 kW x 4,140 h/year x (1 - 0.7 x 0.9 ÷ 0.95) = 76,699 kWh/year

Source from ECCJ

30

31

Rated efficiency on high efficiency mortar

出力 kW	2P		4P		6P	
	50HZ	60HZ	50HZ	60HZ	50HZ	60HZ
0.2	73.8	75.3	72.6	75.4	—	—
0.4	78	79.4	77.5	80	74.6	78
0.75	81.8	82.4	81.4	83.2	80	82
1.5	84.4	84.8	84.4	85.8	83.5	85
2.2	86.5	86.3	86.6	87.6	85.8	86.8
3.7	88	87.8	88.4	89.2	87.4	88
5.5	89.3	89	89.8	90.3	88.8	89.3
7.5	90.4	90	90.8	91.4	89.8	90.3
11	91.2	90.8	91.6	91.8	90.8	91.2
15	91.8	91.5	92.2	92.2	91.6	91.8
18.5	92.4	92	92.6	92.6	92.2	92.4
22	92.9	92.3	93	92.8	92.7	92.8
30	93.3	92.6	93.3	93	93	93
37	93.5	92.8	93.5	93.2	–	–

Source from ECCJ

32

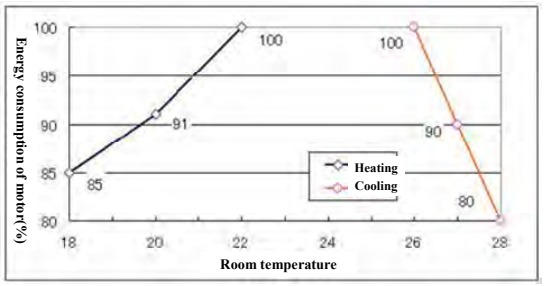
3. Air-conditioning and ventilation equipment

1. Operation management of air-conditioning	・**Optimization of preset temperature and humidity** ・**Control of external air intake volume** ・Suitability of humidifying zone and method ・Review of operating hours ・Suitability of reheating ・Switching off of air-conditioning in unoccupied rooms ・Uneven temperature distribution ・Keeping outside air from entering ・Warm-up operation ・Management of indoor condition (CO2, etc
2. Management of air-conditioning efficiency	・Confinement of air-conditioning compartment ・Night purge ・**Utilization of outside air (outdoor air cooling)** ・Sprinkling of water on the rooftop and outdoor condensing unit ・Setting of dew-point control ・Accuracy of automatic control ・Prevention of mixing loss
3. Introduction of energy conservation equipment	・Control of heat-conveying speed (VAV and VWV) ・Installation of total heat exchangers ・Local cooling and exhaust ・Planting on the rooftop, etc. ・**Outer air inlet control system (Control by CO2 content)**
4. Management of ventilation equipment	・Optimization of air change rate ・Local ventilation ・Review of operating hours ・Ventilation control of parking facilities (Control by CO2 concentration) ・Switching off of ventilation in unoccupied rooms ・**Speed control of air blowers and exhaust fans (VAV and VWV)** ・Management of operating temperature (electric room, machine room, and CVCF room)

Source from ECCJ

33

Room temperature vs Energy consumption

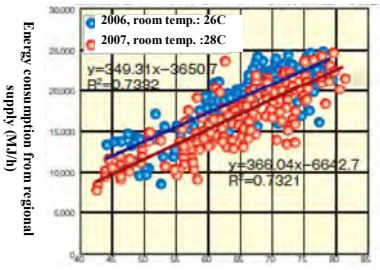


Source from ECCJ

34

Energy conservation by changing room temperature from 26 C to 28 C (Example 3)

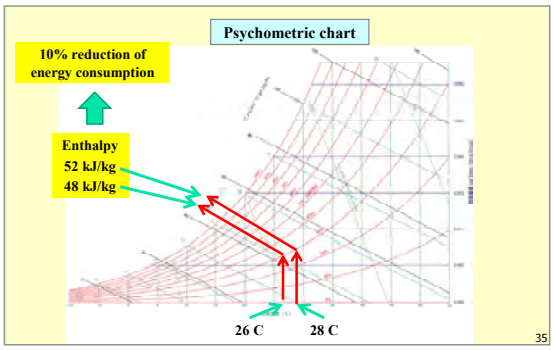
11 % reduction of energy consumption



Source from ECCJ

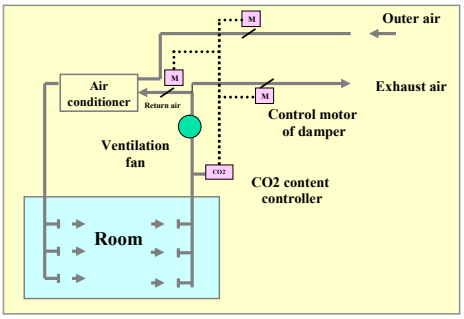
35

Comparison of enthalpy between 26C and 28C



36

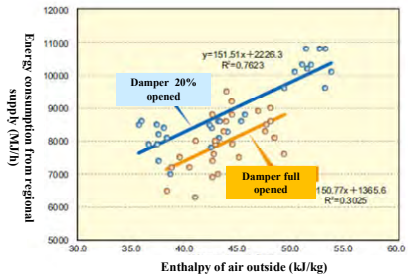
Control of taking in outer air



Source from ECCJ

37

Utilization of outer air during spring and autumn seasons (Example 4)



From 20% damper opened to full open

10 % reduction of energy consumption

Source from ECCJ

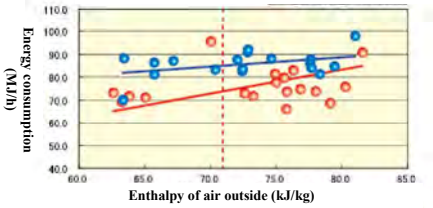
37

38

Reduction of outer air during summer season (Example5)

Outer air : from 2,373m3/h to 1,819 m3/h (23% reduction)

Energy consumption is reduced by 12%



Source from ECCJ

38

39

4.Heat-water supply, feed-water and drainage, freezing and refrigeration, kitchen equipment

1.Management of hot water supply equipment	・Hot-water supply temperature ・Scheduled control for holidays and nighttime ・Improvement in hot-water supply efficiency (descaling, etc.) ・Utilization of waste heat ・Shutting off of supply except in winter season ・Utilization of solar heat
2. Management of water-feed and drainage equipment	・Hot-water supply temperature ・Scheduled control for holidays and nighttime ・Improvement in hot-water supply efficiency (descaling, etc.) ・Utilization of waste heat ・Shutting off of supply except in winter season ・Utilization of solar heat
3. Management of freezing and refrigeration and kitchen equipment	・Management of heat retention ・Management of heat insulation and defrosting ・Management of door opening and closing ・Showcase management ・Management of kitchen equipment (cooking equipment, tableware dryer, dishwasher, etc.) ・Enhancement of efficiency

Source from ECCJ

39

40

Water-saving by automatic faucets (Example6)

Problems with the current operation

In a public facility (total floor area: 30,000 m2), valve-type cold and hot water faucets for wash basins in toilets induce excessive water consumption.

Improvement measures

Valve-type water faucets were changed to automatic faucets in order to reduce the amount of water from the tap and prevent the wasteful consumption of water (hot water). Also, users were encouraged to cooperate with" water-saving" by posters..

Source from ECCJ

40

41

<Basic function of automatic faucets>

(1) Infrared is emitted to hands, and beam reflected from hands is received.

(2) The reflected beam is detected as hands and water comes out.

Source from ECCJ

41

42

Effect estimation

■**Preconditions of estimation**

Number of users: (business days) employees: 1,600 person/day; visitors: 400 persons/day
(holidays) employees: 100 person/day
Number of days: (business days) 244 days/year, (holidays) 121days/year
Frequency of wash basin use: (employees) 4 times/person-day, (citizens) 1 time/person-day
Water consumption: (valve-type) 2.0 L/use, (automatic) 0.8 L/use
Average water and sewage unit price: 780 yen/m3
Annual number of users:
Total number of employees: 1,600 persons/day x 244 days/year + 100 persons/day x 121 days/year = 402,500 persons/year
Total number of visitors: 400 persons/day x 244 days/year = 97,600 persons/year
Annual frequency of wash basin use: 402,500 persons/year x 4 times/persons + 97,600 persons/year + 1 time/person = 1,707,600 times/year

■ **Effect estimation**

Annual amount of water saving = (2.0 - 0.8) L/use x 1,707,600 times/year = 2,049 m3/year

Source from ECCJ

42

43

5. Power receiving and transforming, lighting, and electrical equipment

1. Management of the power receiving and transforming equipment	・Voltage adjustments ・Consumption management ・Power factor management ・Utilization of night power ・Transformer capacity ・Power factor improvement control ・Demand factor, and load adjustments ・Demand control ・Cutting-off of unnecessary transformers ・Low-loss transformers ・Optimization of demand ・Quantity control of transformers
2. Operation management of lighting equipment	・Optimum illumination control ・Management of outdoor light **・ Switching off of the light during the time of day when no lighting is necessary (utilization of daylight, etc.)** ・Switching off of nighttime guide light ・Cleaning and replacement of lighting fixtures **・Adoption of high-efficiency lamps** ・Lamp fitting mounting position and circuit segmentation **・Adoption of high-efficiency apparatuses** ・Dimming and switching-off of the light with automatic light controller **・Inverter stabilizer** ・Local lighting ・Task and ambient lighting ・Adoption of energy-saving bulbs ・On-off lighting control ・Improvement in light output ratio (reflectivity) ・Natural lighting system
3. Management of OA equipment	・Reduction in standby power requirement **・Introduction of energy saving models** ・Power-off when not in service
4. Management of vending machine	**・Introduction of energy-saving equipment** ・Time control

Source from ECCJ

44

Life of various kind of lamp

Kind of lamp	Life(Hr)
LED	40,000
Hf fluorescence	12,000
Mercury lamp	6,000
Halogen lamp	4,000
Incandescent lamp	1,000

45

Installation of inverters for fluorescent chokes (Example 7)

Problems with the current operation

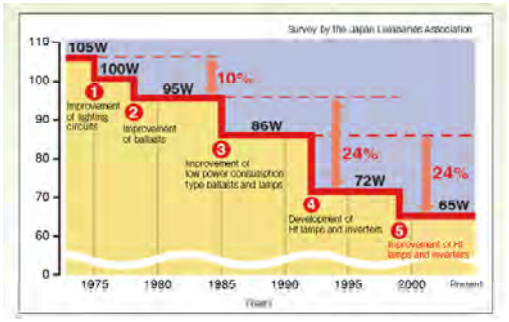
In a store, copper-iron fluorescent chokes, which were installed twenty years ago, are inefficient in lighting power consumption.

Improvement measures

Copper-iron fluorescent chokes were replaced with Hf inverter chokes with less power consumption.
[Measures at the time of upgrading equipment]

Source from ECCJ

46



Source from ECCJ

47

Effect estimation

Source from ECCJ

■ **Preconditions of estimation**
Number of units: 100
Power consumption: Power consumption of lighting equipment has been decreased while producing the same light output.
Lighting equipment installed in the current situation: 86 W/unit at the point of 1. shown in the above chart
Lighting equipment installed after improvement: 65 W/unit at the point of 5. shown in the above chart
Lighting hours: 12 h/day x 365 days/year = 4,380 h/year
Average electricity unit price: 18 yen/kWh

■ **Effect estimation**
Electric power in the current situation = 86 W/unit x 100 units x 4,380 h/year
= 37,668 kWh/year
Electric power after improvement = 65 W/unit x 100 units x 4,380 h/year
=28,500 kWh/year
Electric power reduction = 37,668 kWh/year - 28,500 kWh/year
= 9,168 kWh/year

48

LED Lighting

Energy conservation and long life

■**Energy conservation : Comparison of energy consumption under same luminous intensity**

Incandescent lamp	54.0w
fluorescence	12.0w
LED	6.9w

87% down

■ **Long life : Lighting period (10 h/day)**

Incandescent lamp	1500Hr
fluorescence	8,000Hr
LED	40,000Hr

27 times

from Panasonic catalog

49

Figures of LED Lamp

Energy conservation Electricity fee 90% reduction	Long life 40,000 hrs

1. Mercury isn't included
2. Brighten quickly
3. Bug not drawn
4. 90 % reduction of CO^2
5. Strong against frequency of ON.OFF
6. Low UV, low infrared ray

49

50

Use of high-intensity guidance light (Example 8)

Problems with the current operation

In a business office, fluorescent tube guidance lights (single 20W lamp) are installed.
There is room for improvement, including replacement by high-intensity guidance lights with less power consumption..

Improvement measures

Fluorescent tube guidance lights were replaced by high-intensity guidance lights (cold cathode fluorescent lamps).

Source from ECCJ

50

51

Source from ECCJ

51

52

Effect estimation

■Preconditions of estimation
Current situation:
Fluorescent tube guidance lights (single 20W lamp) Installed lights: 20 units;
Power consumption: 23 W/unit (including ballasts)
After improvement:
High-intensity guidance lights (cold cathode fluorescent lamps) Installed lights: 20 units; Power consumption: 6 W/unit
Lighting hours: 24 h/day x 365 days/year = 8,760 h/year
Average electricity unit price: 18 yen/kWh

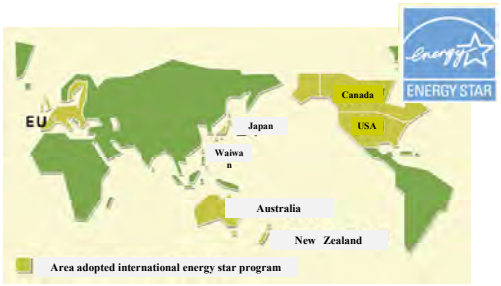
■Effect estimation
Electric power in the current situation = 23 W/unit x 20 units x 8,760 h/year
= 4,030 kWh/year
Electric power after improvement = 6 W/unit x 20 units x 8,760 h/year
= 1,050 kWh/year
Electric power reduction = 4,030 kWh/year - 1,050 kWh/year
= 2,980 kWh/year

Source from ECCJ

52

53

International Energy Star Program



53

54

Subjected equipment

54

55

Criteria of International energy star program

Electricity consumption during operating period, sleeping period and off period is adopted as a subject of standard on "International Energy Star Program"

Adopted equipment automatically shifts to sleeping and off mode, while condition of equipment keeps no operation.

55

56

Example of note book computer
Unified type of CPU: Memory: 8Gb, 1HDD
TEC electricity consumption : < 41.6 kWh

TEC: Typical electricity consumption

Example of work station
Max. electricity consumption 180W, 2HDD installed
TEC electricity consumption : < 53.2 W
Standard value = 0.28 x (180 + (2 x 5)) =53.2 W
Where; 5 HDD installed

Example of small size server type

Electricity consumption during off period: < 2.0 W
Electricity consumption during Idle period : < 50.0 W

56

57

Criteria of computer

Grouping	Criteria of electricity consumption	Automatically shift to sleeping mode
Desk top. Note book	Conceptual standard annual electricity consumption considering idle period, sleeping period and off period (kWh)	After equipment isn't using, >15 minutes (Display) >30 minutes (Computer) But concerned small size server type and thin client type, computer itself is not adopted
Work station	Conceptual standard electricity consumption considering idle period, sleeping period and off period (W)	
Small size server. Thin client	Electricity consumption of idle period and off period. (W)	

57

58

OA equipment vs Electricity consumption

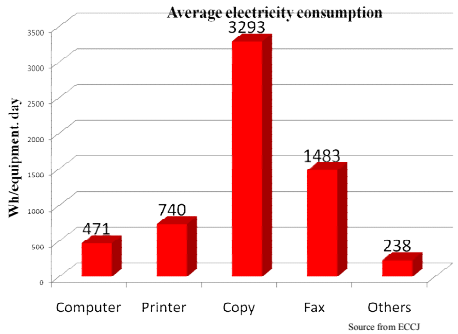
	Electricity consumption			Shift time (minutes)
	Operating(W)	Idling(W)	Sleeping(W)	
Computer	58	34	15	< 30
Display	85	85	15	
Scanner	50	16	12	
Fax	430	120	15	< 5
Printer	430	65	20	< 30
Copy	1,100	180	120	< 15
Complex	1400	120	204	< 15

From: International energy star program

58

59

Average Electricity Consumption in Japanese Offices



Source from ECCJ

59

60

6. Elevating machines and buildings

Source from ECCJ

1. Operation management of elevating machines	•Control in the number of units in operation •Reduction in the number of floors at which the elevator stops •Management of operation schedule by time of day •Adoption of inverter control •Reduction of mechanical loss at power transmission parts
2. Operation management of escalators	•Management of operation schedule by time zone •Adoption of human motion sensors
3. Energy conservation in buildings	•Thermal insulation properties of a structure •Blocking off solar radiation on the roof •Thermal insulation and airtight windows •Air flow windows •Shielding of intrusion of external air •Rooftop gardening •Blocking off solar radiation on the window •Green government building plans

7. Load leveling

1. Measures for load leveling	•Review of the operation forms (operation time, operating rate, load factor, etc.) • Adoption of equipment to meet the purpose (ice thermal storage system, gas-fired absorption chiller/heater, etc.)
2. Cogeneration	• Operation management (power generation efficiency, waste heat recovery, total efficiency, etc.) •Seasonal load variation •Rate of utilization and heat-to-power ratio •Equipment model, capacity, and fuel
3. Renewable energy	•Fuel cell •Solar heat •Geothermal power generation •Wind-power generation

60

61

Automatic operation of escalators Example(9)

Problems with the current operation

At a private railway station in the suburbs, all escalators are used exclusively for ascent except during rush hour, and empty escalators also keep going up most of the time.

Improvement measures

During off-hours, it was arranged that escalators automatically start operation for ascent only by detecting passengers with "photoelectric posts" (human motion sensors) installed just before escalators on the platform floor, and stop operation if they are left without passengers for a certain time. During morning and evening rush hours, they are used exclusively for descent according to the manual as before.

Source from ECCJ

61

62

Source from ECCJ

62

63

Effect estimation

■ **Preconditions of estimation**

Power for escalators: 11 kW/unit x 2 units (each one on No. 1 and 2 platforms,
H = 6.7 m) = 22 kW
Automatic operating hours: 9.25 h/day (9:00-16:00 and 22:00-24:15)
Annual automatic operating hours: 9.25 h/day x 365 day/year
= 3,376.25 h/year
Escalator electric-load factor: 50% (The same level should be maintained before and after improvement).
Operating hour reduction rate by automatic operation: 70%
Average electricity unit price: 18 yen/kWh

■ **Effect estimation**

Electric power reduction = 22 kW x 0.5 x 3,376.25 h/year x 0.7
= 25,997 kWh/ye

Source from ECCJ

63

64

Reduction of solar radiation load through window glass (Example 10)

Problems with the current operation

An assembly hall (total floor area: 13,000 m3) has a heavy solar radiation load from window glass of the south wall in the cooling period. Although blinds are attached to windows, they are not used effectively.

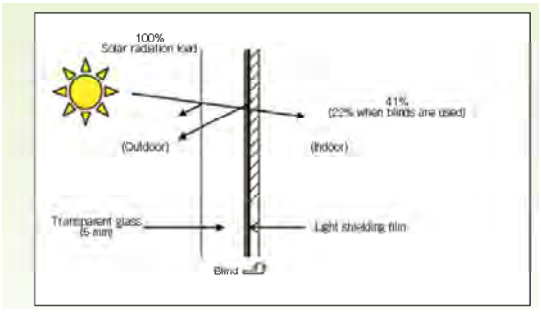
Improvement measures

Light shielding films were put on window glass in combination with blinds, aiming for reduction of solar radiation load.
[Measures at the time of renewal of building]

Source from ECCJ

64

65



Source from ECCJ

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Effect estimation

Source from ECCJ

■**Preconditions of estimation**

South wall window glass area: 1,000 m2
Solar radiation shading coefficient: (glass) 0.97, (glass + light shielding film) 0.41(glass + blind) 0.53, (glass + blind + light shielding film) 0.22
Blind usage rate (both in current situation and after improvement): 50%
South wall solar radiation (Wh/(m2･day)): (June) 2,006 (July) 2,042 (August) 2,479 (September) 3,344 (based on regional data from the Meteorological Agency)
Days in the cooling period x sunshine rate = sunshine days: (June) 22 days x 0.29 = 6.38 days; (July) 20 days x 0.45 = 9.0 days; (August) 23 days x 0.49 = 11.27 days; (September) 20 days x 0.35 = 7.0 days
Electric compression refrigerating machine COP: 3.5
Average electricity unit price: 18 yen/kWh

■**Effect estimation**

Solar radiation heat input
: (2,006 x 6.38 + 2,042 x 9.0 + 2,479 x 11.27 + 3,344 x 7.0)Wh/m2 x 1,000 m2
= 82,523 kWh
Insulation transmission heat reduction after improvement
: 82,523 kWh x [(0.97 - 0.41) x 0.5 + (0.53 - 0.22) x 0.5] = 35,898 kWh
Heat source electric power reduction = 35,898 kWh/year ÷ 3.5 = 10,257 Wh/year

66

67

High efficiency transformer

Phase	kVA	50 HZ No-load loss Wi (W)	50 HZ Load loss WC (W)	50 HZ Total loss Wt (W)	60 HZ No-load loss Wi (W)	60 HZ Load-load loss Wi (W)	60 HZ Total loss Wt (W)
One phase	50	35	600	635	30	720	750
	75	45	1,050	1,095	45	1,000	1,045
	100	50	1,400	1,450	50	1,350	1,400
	150	80	2,000	2,080	80	2,000	2,080
	200	100	2,550	2,650	100	2,550	2,650
	300	140	2,040	2,180	170	2,035	2,205
	500	160	4,235	4,395	175	4,000	4,175
Three phase	50	60	900	960	55	880	935
	75	70	1,280	1,350	70	1,285	1,355
	100	85	1,640	1,725	85	1,640	1,725
	150	105	2,365	2,470	105	2,365	2,470
	200	120	3,000	3,120	120	3,000	3,120
	300	160	1,790	1,950	220	1,470	1,690
	500	220	3,250	3,470	265	2,720	2,985

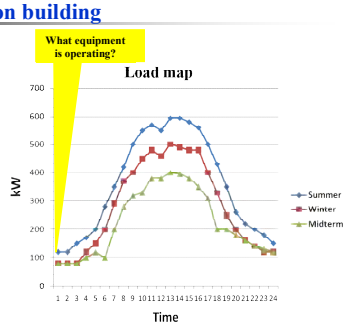
From Hitach catalog

67

68

Load map on building

Time	Summer	Winter	Midterm
1	120	80	80
2	120	80	80
3	150	80	80
4	170	120	100
5	200	150	120
6	280	200	100
7	350	290	200
8	420	370	280
9	500	400	320
10	550	450	330
11	570	480	380
12	550	460	380
13	594	500	400
14	594	490	395
15	580	480	380
16	560	480	350
17	500	400	310
18	430	330	200
19	350	250	200
20	260	200	180
21	220	160	160
22	200	140	140
23	180	120	130
24	150	120	120

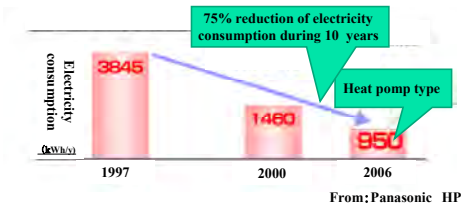


Source from ECCJ

68

69

Energy efficiency typed vender



From: Panasonic HP

69

70

A Big Thank You!!

70

1

How to Promote Energy Efficiency On Factory

JICA Study Team

Yoshiharu IKEUCHI

2

Contents

Slide No.

3

1. Procedure of promoting energy efficiency

4

Energy Efficiency Benefits

Industry	Nation	Globe
* Reduced energy bills * Increased competitiveness * Increased productivity * Improved quality * Increased profits	* Reduced energy imports * Conservation of limited resources * Improved energy security	* Reduced GHG and other emissions * Maintains a sustainable environment

5

The key points for promoting energy conservation

1. Roles of Top Manager

(1) Top down decisions & Strong determinations

(Concrete target, period of energy efficiency activities, amount of investment and standard of ROI)

(2) Top managers always have to

have the awareness and enthusiasm of energy efficiency,

know the status of energy efficiency results and

take the lead in promoting energy efficiency

6

The key points for promoting energy conservation

2. Having the organization or person in charge of energy efficiency activity.

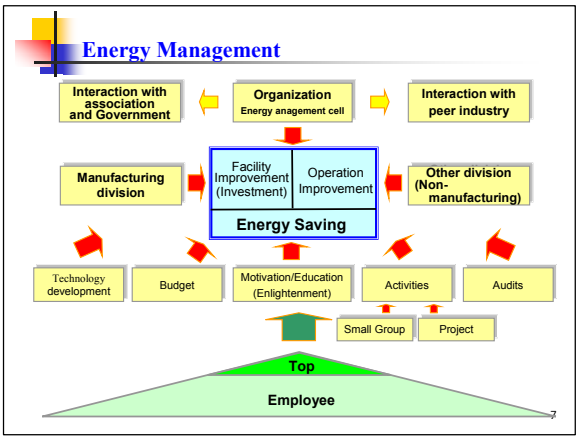
(1) The organization or he has to have an awareness for promoting energy efficiency activity

(2) The organization or he is given the power and responsibility for promoting energy efficiency activity by top manager.

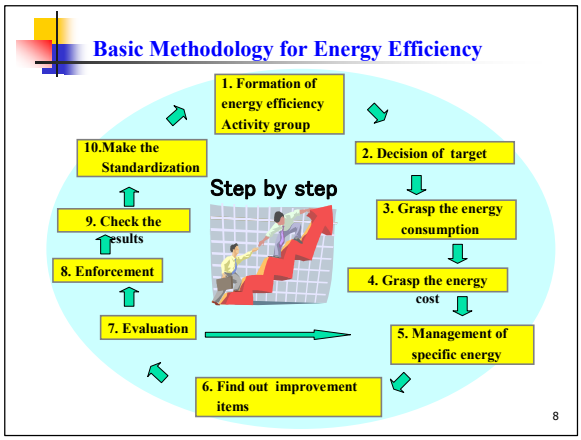
3. Energy efficiency activities by all employees

4. Study of peer company's energy efficiency activities

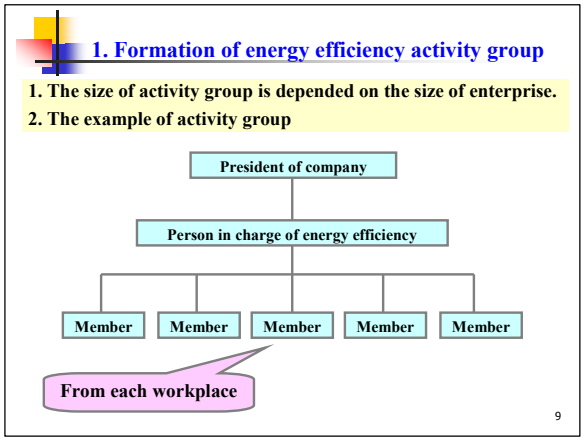
7


Energy Management
Interaction with association and Government
Organization
Energy anagement cell
Interaction with peer industry
Manufacturing division
Facility Improvement (Investment)
Operation Improvement
Other division (Non-manufacturing)
Energy Saving
Technology development
Budget
Motivation/Education (Enlightenment)
Activities
Audits
Small Group
Project
Top
Employee
7

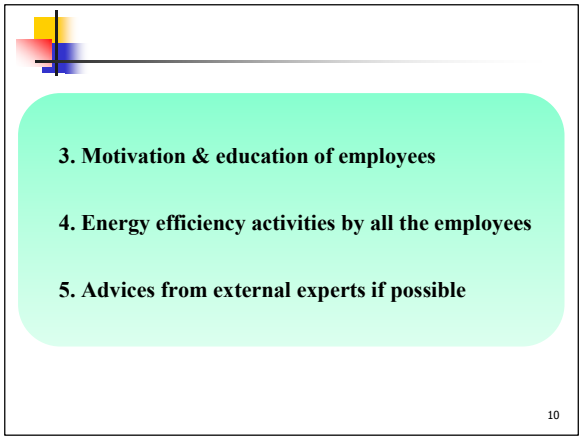
8


Basic Methodology for Energy Efficiency
1. Formation of energy efficiency Activity group
2. Decision of target
3. Grasp the energy consumption
4. Grasp the energy cost
5. Management of specific energy
6. Find out improvement items
7. Evaluation
8. Enforcement
9. Check the results
10.Make the Standardization
Step by step
8

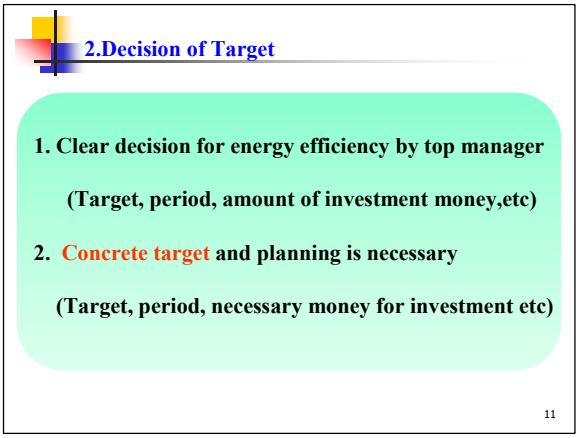
9


1. Formation of energy efficiency activity group
1. The size of activity group is depended on the size of enterprise.
2. The example of activity group
President of company
Person in charge of energy efficiency
Member
Member
Member
Member
Member
From each workplace
9

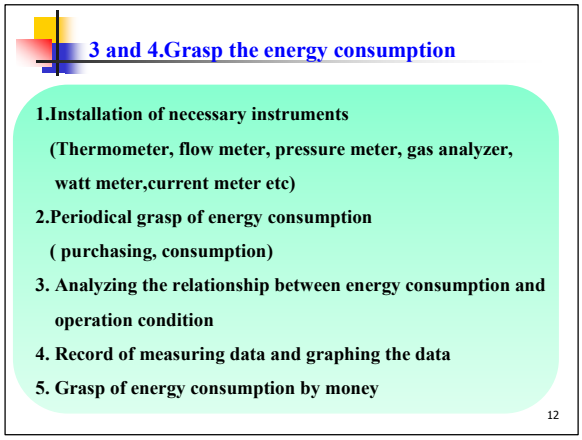
10


3. Motivation & education of employees
4. Energy efficiency activities by all the employees
5. Advices from external experts if possible
10

11

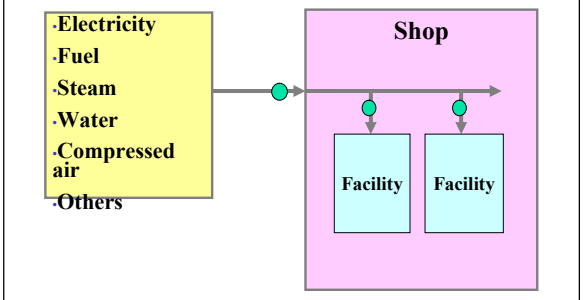

2.Decision of Target
1. Clear decision for energy efficiency by top manager
(Target, period, amount of investment money,etc)
2. Concrete target and planning is necessary
(Target, period, necessary money for investment etc)
11

12


3 and 4.Grasp the energy consumption
1.Installation of necessary instruments
(Thermometer, flow meter, pressure meter, gas analyzer, watt meter,current meter etc)
2.Periodical grasp of energy consumption
(purchasing, consumption)
3. Analyzing the relationship between energy consumption and operation condition
4. Record of measuring data and graphing the data
5. Grasp of energy consumption by money
12

13

Energy Flow Diagram & Instrumentation



13

14

Energy Equipment Book

Manege't No	Installed Place	Producer	Model	Flow (m3/hr)	Capacity (Kw)	Head (m)	Voltage (V)	Current (A)	Installed year
A-01	Boiler	Ebara	FS2F6	60	10	50	400	15	1989

14

15

5. Management of specific energy consumption

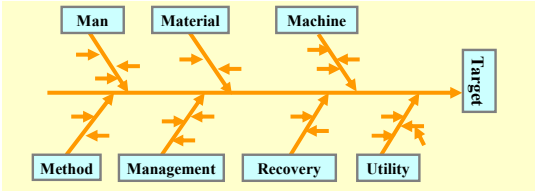
1. Management of specific energy consumption
2. Energy consumption & amount of manufacturing products
3. Specific energy consumption is showed by energy consumption/products(Kcal/ton, Kcal/kg,Kwh/ton)

15

16

6.Find out Improvement of Ideas

1. Brainstorming
2. Fish bone



3. Check list
4. Others

16

17

Checking points for energy saving

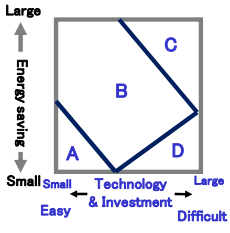
Step	Aiming points	Examples
Stop-1	Stop of waste energy	No load operation, no operation during interval,reexamine the worming up time,no light on during nobody is
Decrease	Temp., flow volume, pressure,contract of electricity	Pressure of air and steam、heating temp., water volume,blow air volume、
Maintain	Maintenance of equipment	Air leak, steam leak, insulation material, lights
Stop-2	Stop the equipment that are not necessary	Shorten the supplying line,
Divide	Divide the route depending on using objects	Divide the light circuit, Independence of one of compressed air line
Recover	Recovery of waste heat	Recover of drain、utilize the waste heat gas
Change	Production method 、process、kinds of energy、Adopt the high efficiency equipment	Electricity→fuel gas, air condition, illumination, hydraulic pressure → electricity,co-generation,

Investment: Large

17

18

Objects vs Activity

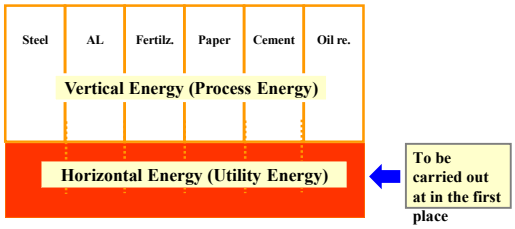


	Small Group Activity	Project Team Activity
A	●	
B	●	●
C		●
D	Not to be done	

18

19

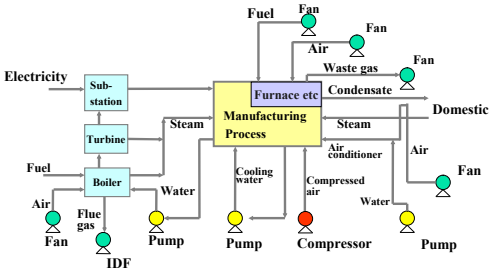
Process Energy vs Utility Energy



19

20

Utility System



20

21

Work on the improvement items from ideas

Pick up good ideas through the evaluation filter

Difficulty / Effect	Small	Middle	Big
Small	B	C	CC
Middle	A	B	C
Big	AA	A	B

After above check, cost and time should be examined

21

22

7.Evaluation

1. Operation improvement (Non investment)
2. ROI(Return on Investment)

$$\text{ROI (year)} = \frac{\text{Facility cost (\$)}}{\text{Profit (\$/y)} - (\text{Facility cost x Interest) (\$/y)}}$$

Company Rule	
ROI is less than 3 years	Enforcement
ROI is between 3 to 5 years	Discuss again
ROI is more than 5 years	Rejection

3.Timing and period of enforcement should be examined

22

23

8.Enforcement

1. The earlier , the better
2. Settle on the enforcement plan
   (1) Decision of starting date
   (2) Decision of person in charge (5W 2H)
   (3) Recognition of top manager
   (4) Cooperation with other job sites

23

24

9.Check the Results

Actual profit

1.Management graph

* Compare the present specific energy consumption with before enforcement

2. Heat balance and Energy balance of facility

Human Effect

1. Growth of team members

Leader → Team work, Solution ability,

Members → Method, Awareness, Own ability, Cooperation

24

25

10.Make the Standardization

1. Make the standards to be easy understood
2. Check the standards to be obeyed
3. Periodical check of effects

   (Using the management graph)

25

26

Example of Standard

Standard Name	Standards of operation			Specifications
Facility name	NO 1 Oil boiler	Number of boiler	1	Evaporation: 47 ton /h, Pressure: 16 kg/cm2, Temp.: 220 C

Implementation standard		Measurement & record		
Item	Standard	Item	Record	Frequency
1. Consumption unit	Fuel consumption	1) Fuel consumption 2) Evaporation volume 3) Energy consumption unit	Management note	Daily
2. Air ratio	O2 control (keep less than 4 %)	1) Fuel consumption 2) Flue gas temp. of outlet boiler 3) O2 % of flue gas 4) Flue gas temp. of outlet recup. 5) Air temp. of outlet recup. 6) Furnace pressure	Chart	Continuous record
3. Furnace pressure	10.0 mmAq			
4. Heat recovery	Management of outlet temp. of flue gas			
5. Water quality	PH: 11.2-11.4, Cl ion: 300-600 ppm Conductivity:	Depend on JIS	Management note	Once/ day
6. Insulation	Ceiling: 90 C Side: 80 C	1) Surface temp. of boiler 2) Atmosphere temp. around boiler 3) Inside temp. when above items are measured	Report	
7. Heat balance		Depend on JIS	Report	Once /1 year

26

27

2. Technology of energy efficiency for utility equipment / facility

(1) Industry Furnace

(2) Boiler

(3) Pump and Blower

(4) Compressor

27

28

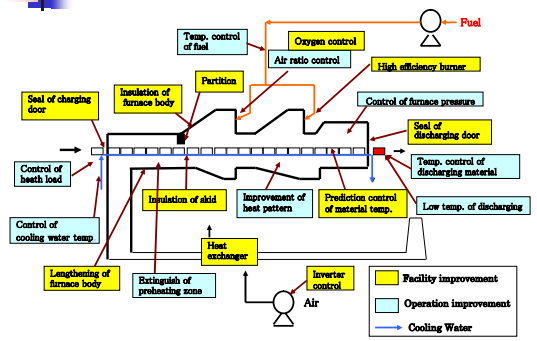
(1) Industry Furnace

(Reheating Furnace)

28

29

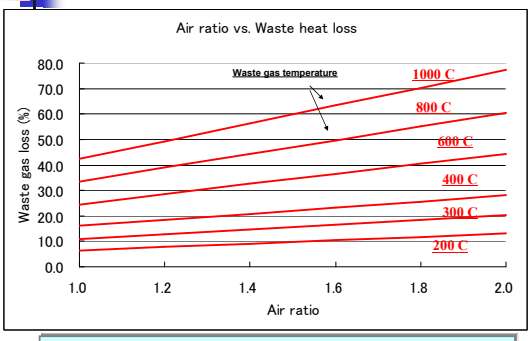
Reheating Furnace / Energy Saving Technology on Reheating Furnace



29

30

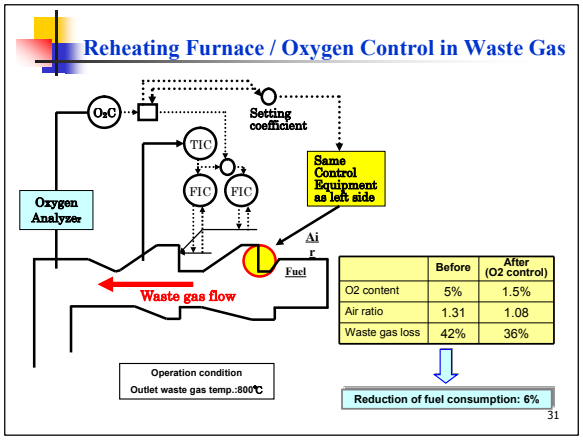
Reheating Furnace / Air ratio vs. Waste heat loss



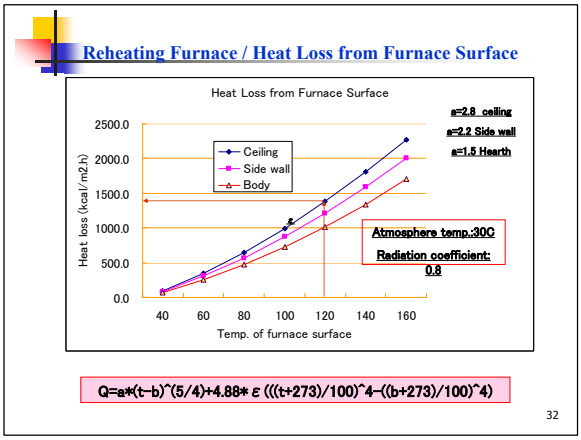
Air ratio (m) = 21%/(21% - O2 %) O2% is oxygen content in waste gas

30

31



32



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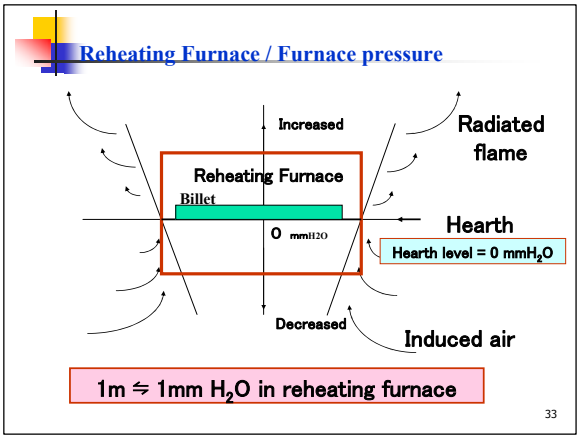

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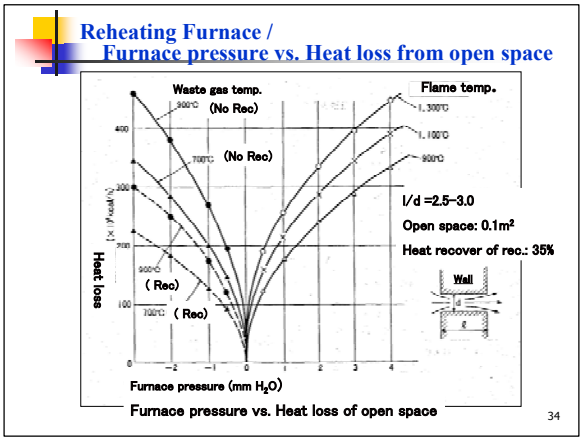

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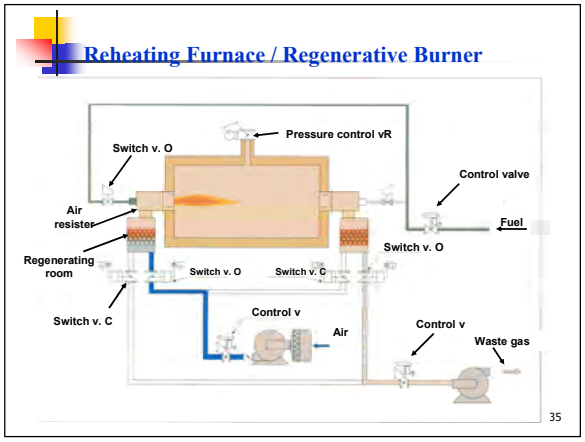
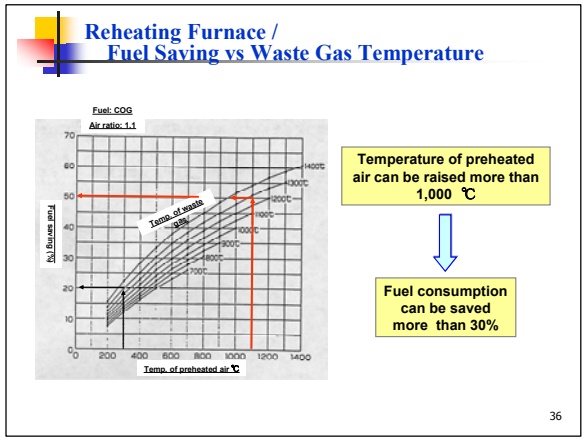


36

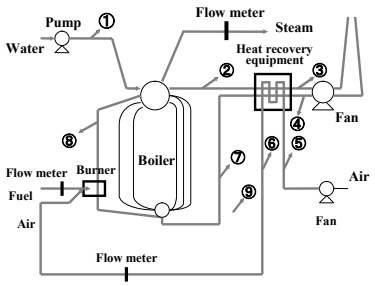


37

(2) Energy Efficiency of Boiler

37

38



38

39

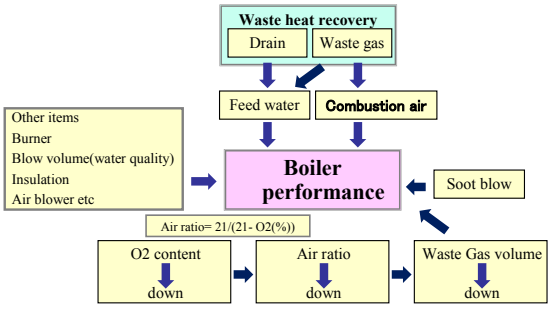
Measuring points for Audit

① Water flow.....Ultrasonic flow meter
② Gas content(inlet of recuperator).. CO, CO_2, O_2 analyzer
Gas temp.(inlet of recuperator).....K type thermocouple
③Gas temp. (outlet of recuperator)
.....K type thermocouple
Gas content(outlet of recuperator)... O_2 analyzer
④Pressure(Static & Dynamic).....Pitot
⑤Air temp. (inlet of recuperater)....K type thermocouple
⑥Air temp. (outlet of recuperator)
.....K type thermocouple
⑦⑧Surface temp.....Surface thermometer
⑨Atmosphere temp.....K type Thermocouple

39

40

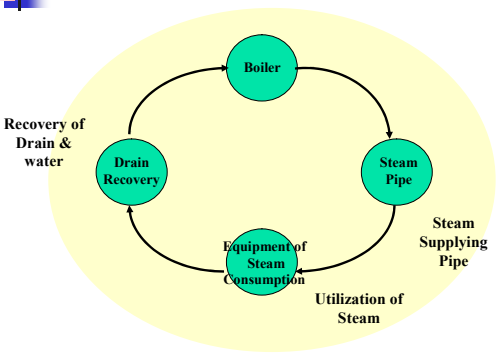
Boiler performance



40

41

Heat Cycle of Steam Utilization in Factory



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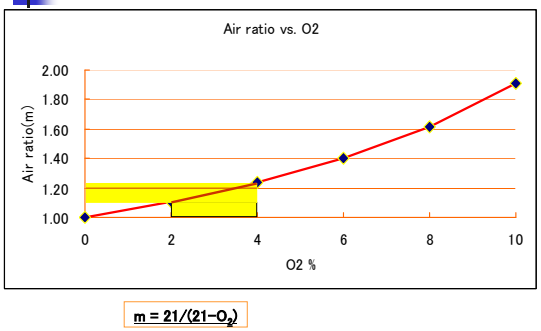
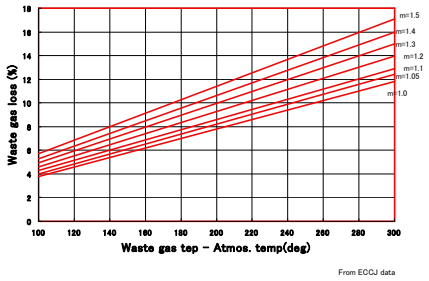


$m = 21/(21-O_2)$

42

43

Waste gas loss vs Gas temp. & Air ratio

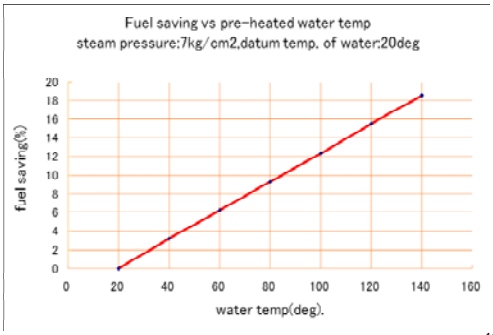


From ECCJ data

43

44

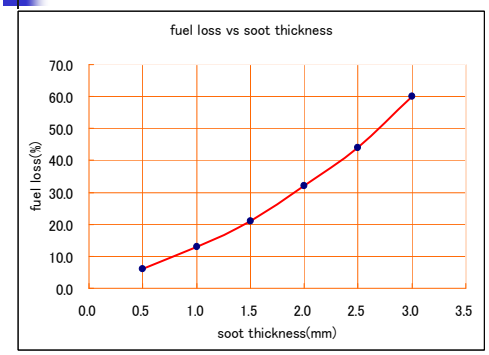
Fuel saving vs pre-heated water temp steam pressure:7kg/cm2,datum temp. of water:20deg



44

45

Fuel loss vs soot thickness



45

46

Steam leak from small hole

Steam leak volume; G kg/hr

G = K' x P

P; Absolute pressure of steam(kg/cm²)

K'; Coefficient

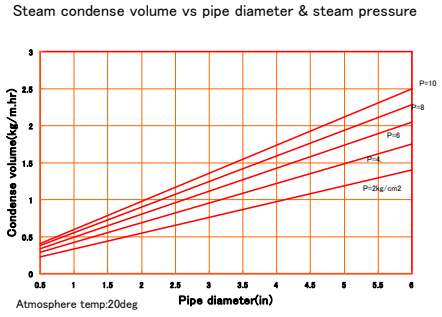
Diameter Of small hole(mm)	1.6	2.0	2.5	3.0	4.0	5.0
K'	0.62	0.97	1.5	2.2	3.9	6.0

From ECCJ data

46

47

Steam condense volume vs pipe diameter & steam pressure



From ECCJ data

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48

Insulation effect is very big

Insulated with 65mm material (CaSiO4)

100mm pipe with 10kg/cm2 steam

Heat loss

905kcal/m.hr(bare pipe)

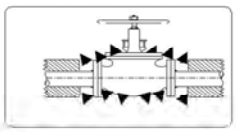
63kcak/m.hr(insulated)

48

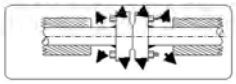
49

Heat loss from bare valve and flange

Items	Equivalent length
10k Ball Valve	1.1−1.3m
10 K flange	0.3 − 0.4m



10K Ball valve

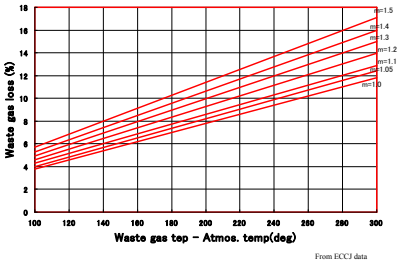


10 K flange

49

50

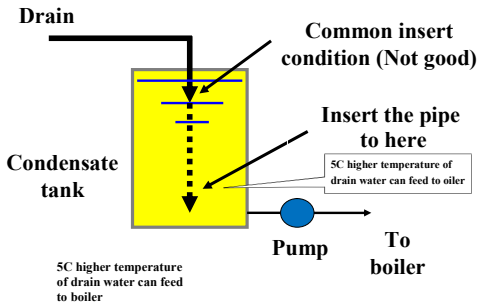
Waste gas loss vs Gas temp. & Air ratio



50

51

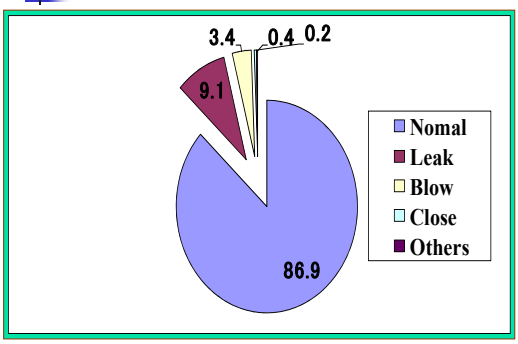
Condensate tank



51

52

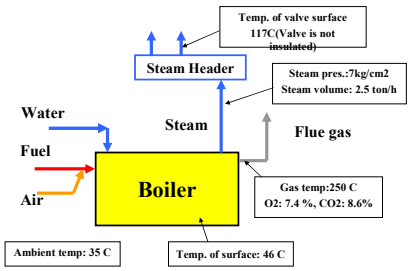
Ordinal Steam trap condition



52

53

Example of boiler audits



53

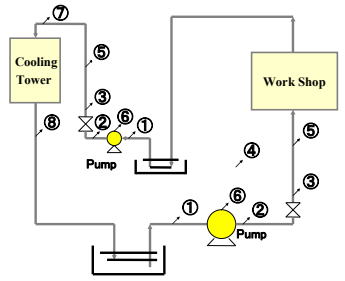
54

(3) Energy Efficiency of Pump & Boiler

54

55

Water Supply System



55

56

Measuring Points

Measuring points for pump audit

① Pressure of inlet pump.... Vacuum gauge
② Pressure of outlet pump....Pressure gauge
③ Pressure of after valve.....Pressure gauge
④ Atmospheric pressure..... .Barometer
⑤ Water flow..... .Ultrasonic flow meter
⑥ Voltage,currency,power.....Clamp-on meter
⑦ Temp. of inlet cooling tower
⑧ Temp. of outlet cooling tower
.....Thermocouple

56

57

Electricity consumption of pump & blower

Blower;

$$P\,(kw) = \frac{Q \times H}{6{,}120 \times E_f}$$

Pump;

$$P\,(kw) = \frac{Q \times H \times D_e}{6{,}120 \times E_f}$$

Symbol	Item	Dimension	
		Pump	Blower
Q	Flow Volume	m^3/min	m^3/min
H	Discharge pressure	m(kg/cm^2=10m)	mmAq
E_f	Efficiency	—	—
D_e	Density	Kg/m^3	—

$Q = k_1 N, \quad H = k_2 N^2,$
$P = k_3 N^3$

N=Rotation speed

57

58

Improvement Items

1. Reexamination of Numbers of operation pumps
2. Reexamination of Q and H
   Small Pump or Impeller Cut
3. High Efficiency Pump
4. Rotation Control（Inverter control)

58

59

Improvement measures for pump & fan

Installed capacity > Required capacity

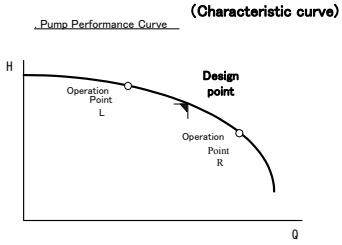
Pump & fan
1. Inverter control(rotation speed control)
2. Impeller cut
3. High efficiency motor
4. Numbers control
5. Damper control(fan)
6. Enforcement of operation control

59

60

Pump Performance Curve

(Characteristic curve)



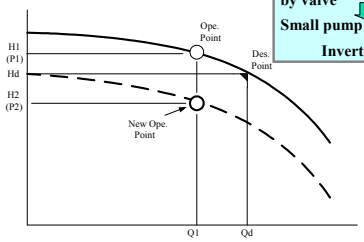
We can suggest energy saving ideas when the gap between the operation point and the design point is observed.

60

61

Energy Saving Ideas(No.1)

Energy Saving Ideas (No. 1)



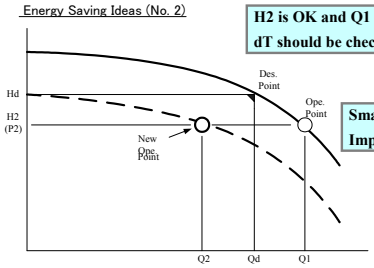
Q1 is OK and H1 is closed by valve
Small pump or Impeller cut
Inverter control

61

62

Energy Saving Ideas(No.2)

Energy Saving Ideas (No. 2)



H2 is OK and Q1 is overflow.
dT should be checked

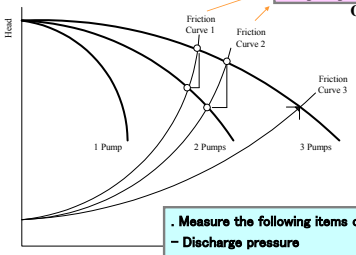
Small or Impeller cut

62

63

Pumps in Parallel Operation

Pumps in Parallel Operation



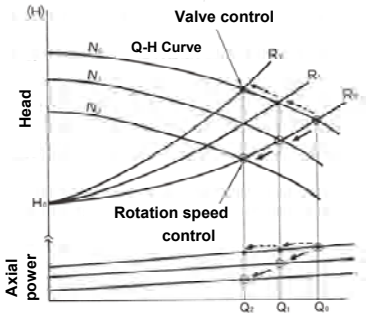
2 pump operation is OK

. Measure the following items of the each pump.
- Discharge pressure
- Openness of the discharge valve
- Pressure after the discharge valve
- Motor ammeter

63

64

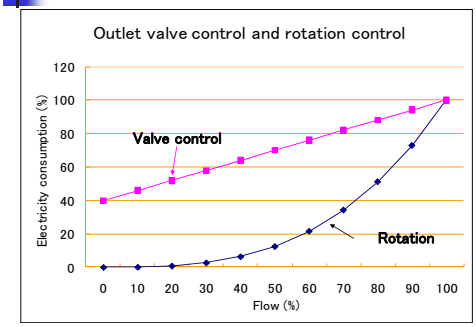
Valve control vs. Rotation control



64

65

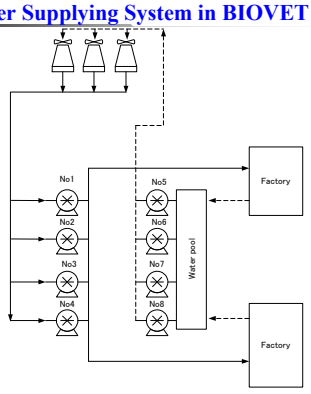
Outlet valve control and rotation control



65

66

Water Supplying System in BIOVET



66

67

Audit Data

NO	Model	Data	Flow	Head	Power (kW)	Voltage (V)	Currency (A)	Power factor	Rotation r.p.m
1	300D 70	Rated	1080	48m	250	380	440	88 %	1480
		Audit	-	5.1kg	-	-	280	-	-
2	300D 70	Rated	1080	48m	250	380	440	88 %	1480
		Audit	-	5.3kg	-	-	280	-	-
3	300D 70	Rated	1080	48 m	250	380	440	88 %	1480
		Audit	-		-	-		-	-
4	300D 70	Rated	1080	48 m	250	380	440	88 %	1480
		Audit	-	5.0kg	-	-	330	-	-
5	300D 70A	Rated	1008	24 m	110	380	180	88 %	970
		Audit	-	3.0kg	-	-	140	-	-
6	300D 70A	Rated	1008	24 m	110	380	180	88 %	970
		Audit	-		-	-		-	-
7	300D 70A	Rated	1008	24 m	110	380	180	88 %	970
		Audit	-	2.3kg	-	-	130	-	-
8	300D 70A	Rated	1008	24 m	110	380	180	88 %	970
		Audit	-	2.4kg	-	-	100	-	-

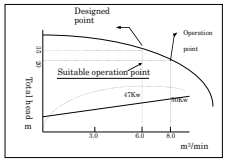
67

68

Example of Pump

Example (Pump)(1)

(1) Survey the present operation



<Designed point: 6.0 m³/min x35m x60Kw(47Kw:Axial power)
<Operation point:8.0 m³/min x20m x60Kw(50Kw:Axial power)
<Operation point is right side from designed point
<Try the test of
Decrease the flow volume until designed point
Confirm some trouble will happen or not(for equipment)
→If Ok → Decrease the flow volume more
Check again →Find out the suitable point

(2) Study of test data
Designed point is suitable in this case
It is possible to supply water ; Flow volume:6.0 m³/min Total head : 20 m

(3) Improvement
<Change the impeller(total head 35 m → 20m) → 47Kw →35Kw(-12Kw)
<Change the pump(Motor is changed) → 47Kw→ 26Kw(-21Kw)

(4) Conclusion Cut the impeller(because of better profit)
Expected profit:12kw x 8760 h/y x 0.9= 94608Kwh/y(2800$) (0.03$/kwh)

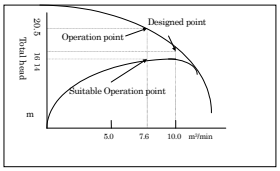
68

69

Example of Pump

Example (Pump)(2)

(1) Survey the present operation



<Designed point:10m3/min X 16m
<Operation point:7.6m3/min x 14m
Flow volume is measured by ultra sonic flow meter.
Head is measured by gauge(P2)

Valve is usually little close during operation

(2) Study of test data
Present operation point:
Flow volume:7.6m³/min Total head : 14m

(3) Improvement
<Change the impeller(head 21.5m → 14m)
37.5Kw → 25.5Kw
Expected profit (37.5-25.5)kw x 8760h/y x 0.9 =94608Kwh/y(2800$) <0.03$/Kwh>

69

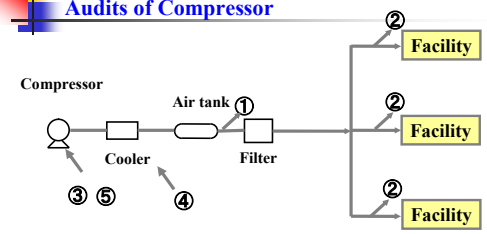
70

(4) Energy Efficiency of Compressor

70

71

Audits of Compressor



Measuring points
① Out let pressure of compressed air
② Inlet pressure of facilities
③ Time for on-load and un-load of compressor and each pressure
④ Temperature of Compressor room
⑤ Measuring of motor currency

71

72

Improvement measures for compressor

Compressor

1. Decrease the discharge pressure
2. Decrease the temp. & humidity of induced air
3. Adopt the high efficiency compressor
4. Adopt the parallel operation & numbers control operation
5. Survey the present operating condition

Supplying pipe lines

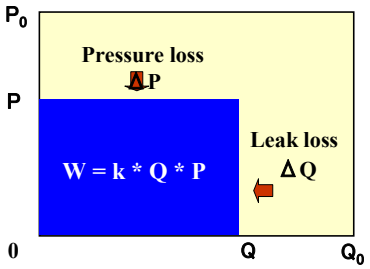
1. Prevent the leakage
2. Decrease the pipe line pressure loss
3. Periodical drain out
4. Periodical maintenance

72

73

Energy Efficiency of Compressor

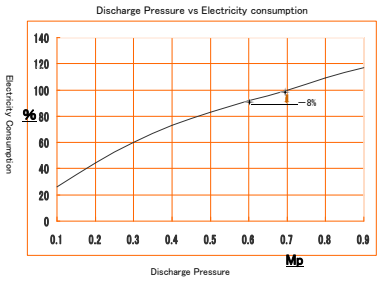
Power of compressor(W) = k * Q * P
Q: Supply volume, P: Supply pressure



73

74

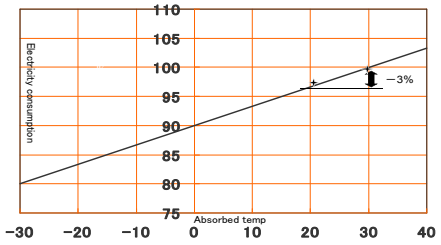
Discharge Pressure vs Electricity consumption



74

75

Absorbed temp vs Electricity consumption



75

76

Survey the present operating condition

Almost all installed capacity > Required capacity

1. Survey the present operating load of each compressor

2. Survey the time of on-load & un-load on each compressor

76

77

Compressor operation (Example1)

	On-load	Un-load	Remarks
No.1 (535 Kw, 7kg/cm2)	30 %	70 %	On:6.8k Un:7.4
No.2 (535 Kw, 7kg/cm2)	30 %	70 %	On:6.8k Un:7.4
No.3 (535 Kw, 7kg/cm2)	—	—	Stop

Stop one comp.:

77

78

Compressor operation (Example2)

High pressure

Model	On load	Un load	Volume	Remarks
35kg/cm²G 15kw	18% 33A, 10kw	82% 16A, 4.3kw	1.2m³/min	
35kg/cm²G 15kw	9% 88A, 24.4kw	91% 20A, 5kw	3.01m³/min	

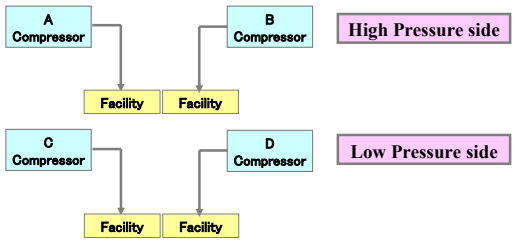
Low pressure

Model	On load	Un load	Volume	Remarks
7kg/cm²G 15kw	9% 32A, 9kw	91% 18A, 4..4kw	2.95m³/min	
7kg/cm²G 37kw	30% 138A, 40.6kw	70% 50A,13kw	7.37m³/min	

78

79

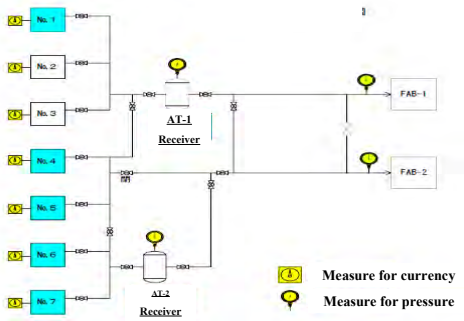
Flow Diagram of Compressed Air Pipe



79

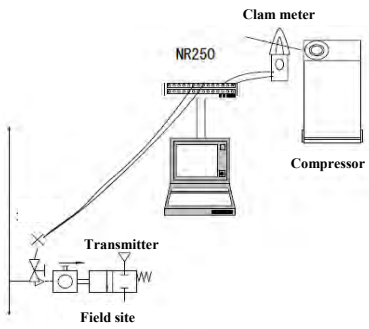
80

Measuring of currency and pressure (Example3)



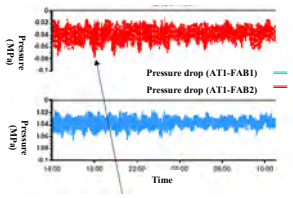
81

Measuring system



82

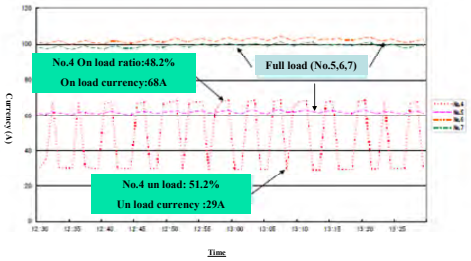
Pressure drop between AT1 and FAB1,2



Max drop :0.079 MPa

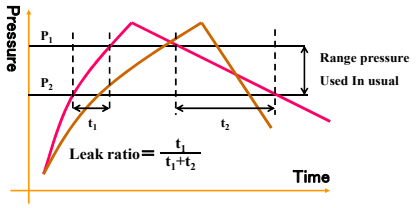
83

Currency and pressure of each compressor



84

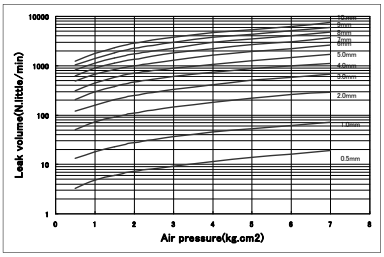
How to Check the leak of compressed air



84

85

Air pressure and hole diameter vs leak volume



Leak volume = 0.65 x graph data

From ECCJ data

85

86

A

BIG

THANK YOU !

86

1

How to Prepare a Medium - and Long-Term Plan

JICA Study Team

Yoshiharu IKEUCHI

2

Contents

3

1. Medium- and long term plan (1)

I Planning Period
FY - FY

Medium-and long-term means about 3-5 years

II Plan for EE&C and Expected Effects
"Hard" measures

Process/Facility	Plan	Expected Effects of EE&C (toe) in primary energy
pumps of hot/cold water system	ex. Add inverters for pumps	

This plan should be described mainly "hard" measures related to installing facility, equipment .

"Soft" measures

Process/Facility	Plan	Expected Effects of EE&C (toe) in primary energy

This plan should be described mainly "soft" measure related to operation improvement

4

Example of described plan for EE&C and expected effect

Hard measures

Process/facility	Plan	Expected effect of EE&C (toe) in primary energy
Boiler facility	Renewal of No2-No5 boilers(10t/h) (2011-2014) (1)Renewal to high efficiency boiler (15kL) (2)Improvement of air ratio by installation of O2 control system (32 kL)	47 kL
Compressor facility	Change from compressors(10 units) to blower one by one (2011- 2013)	15kL (61,000kWh)
Cooling system (Pump)	Renewal of circulation pumps(3 units, 30kW) (2012-2015) (1)Adoption of high efficiency motor(29,000kWh) (2)Adoption of inverter(121,000kWh)	38kL (150,000kWh)

Described in name of process or facility

Described in concrete name of installation facility

Described in toe

5

Soft measures (operation improvement)

Process/facility	Plan	Expected effect of EE&C (toe) in primary energy
Boiler facility	Improving air ratio of No5-7 boilers(10t/h) by using portable O2 analyzer (from 6% to 3%) (2011)	15kL
Lighting	Turn off lights while out seated (2011-2012)	7kL (28,000 kWh)
Air-conditioning system	(1) Change room temperature from 24C to 20C in winter season (2011-2012) (2) Taking in outer air during Spring & Fall seasons (2011)	8 kL (33,000kWh) 15kL (61,000 kWh)

6

2. Medium- and long term plan (2)

III Comparison to Plan of Previous Fiscal Year

Process	Deleted Contents of Measures	Reasons
Boiler facility	High efficiency boiler is adopted at No1 boiler in 2010	Enforced
Process	**Added Contents of Measures**	**Reasons**
Compressor facility	Change from compressors(10 units) to blower one by one (2011- 2013)	Adopted newly for 1% annual reduction of energy intensity

IV Other Issues on Planning

7

3. Let's try to prepare a medium- and long-term plan

A one factory is manufacturing some goods with three shift system.

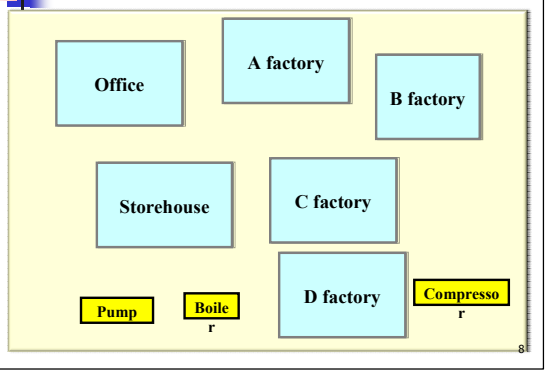
Annual energy consumption of energy facilities and operation conditions are shown as following sheets.

Then, would you try to prepare a medium- and long-term plan by yourselves?

7

8

3. (1) Layout of factory



8

9

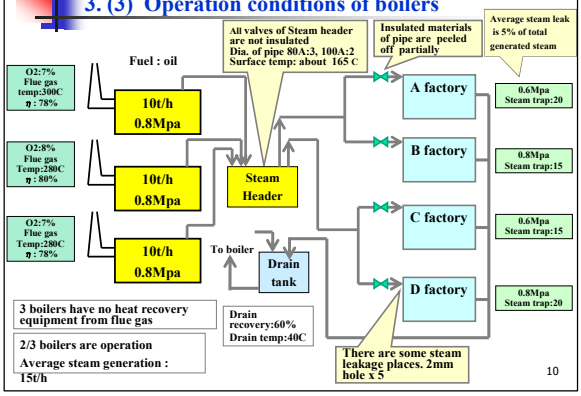
3. (2) Operation condition and annual energy consumption of Factory

1. Operation hours
   : factory :8,400 hours/ year, office: 2,000 hors/year
2. Annual energy consumption
   (1) Boiler : 10,000 KL
   (2) Compressor : 756,000 kWh
   (3) Pump: 420,000 kWh
   (4) Lighting: 600,000 kWh
   (5) Manufacturing machine : 1,200,000 kWh
   (6) Air conditioner : 400,000 kWh
   (7) Others : 300 kWh

9

10

3. (3) Operation conditions of boilers



10

11

Reference data and sheets for boiler

Energy efficiency on building; sheet No.19,21

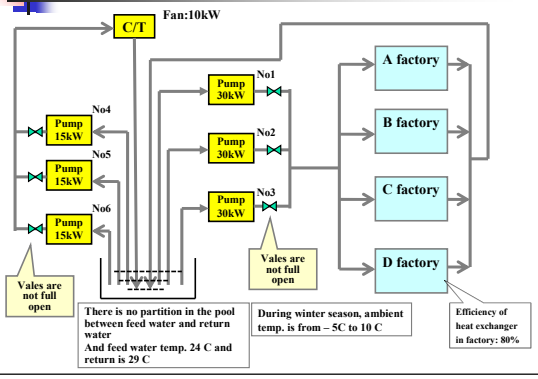
Energy efficiency on factory;
sheet No. 50,51,53,54,55,57,59,60

If you install the heat exchanger, its efficiency will be 90%
If you improve drain tank, temperature and recovery rate will be from 40C to 80C and from 60% to 80%.

11

12

3. (4) Operation Conditions of Pumps (1)



12

13

Operation Conditions of Pumps (2)

NO	Data	Flow (m3/h)	Head (m)	Power (kW)	Voltage (V)	Currency (A)	Power factor
1	Rated	154	50	30	400	55	0.8
	Operation	*109	5.2 kg	*22		40	
2	Rated	154	50	30	400	55	0.8
	Operation	*106	5.2 kg	*21.5		39	
3	Rated	154	50	30	400	55	0.8
	Operation	*102	5.3 kg	*21		38	
4	Rated	154	25	15	400	27	0.8
	Operation	*104	2.7kg	*11		20	
5	Rated	154	25	15	400	27	0.8
	Operation	*101	2.8 kg	*11		20	
6	Rated	154	25	15	400	27	0.8
	Operation	*101	2.8 kg	*11		20	

* : Necessary to calculate

$P = 3^{1/2} \times V \times I \times \cos\phi$ $P = (Q \times H)/(6.12 \times \eta)$

$\cos\phi$: Power factor, η : Efficiency of motor η :0.7

14

Reference data and sheets for Pump

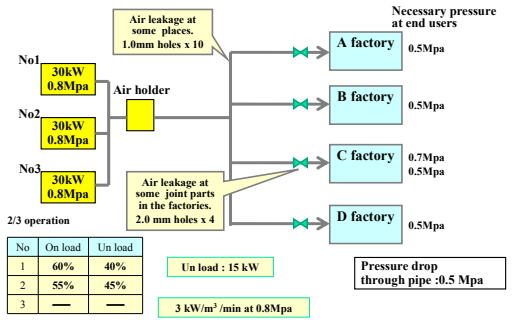
Energy efficiency on factory; sheet No. 71,73,75,76

If you install the separate partition, feed water temp. will decrease by 1 C

14

15

3. (5) Operation Conditions of Compressor



No	On load	Un load
1	60%	40%
2	55%	45%
3	—	—

Un load : 15 kW

Pressure drop through pipe :0.5 Mpa

3 kW/m³ /min at 0.8Mpa

15

16

Reference data and sheets for compressor

Energy efficiency on factory; sheet No. 83,84,86-92,94

16

17

3. (6) Operation Conditions of Lighting

Place	Lamp	Remarks
Office	Fluorescent lamp: 40Wx2 x200	
Storehouse	Mercury lamp: 400 W x 60 Fluorescent lamp: 40Wx2 x20	
A factory	Mercury lamp: 400 W x 20 Fluorescent lamp: 40Wx2 x100	
B factory	Mercury lamp: 400 W x 15 Fluorescent lamp: 40Wx2 x100	
C factory	Mercury lamp: 400 W x 25 Fluorescent lamp: 40Wx2 x150	
D factory	Mercury lamp: 400 W x 30 Fluorescent lamp: 40Wx2 x180	

Places where lightings are turned on while no persons are, are found here and there.
And fluorescent lamps are old type.

17

18

Reference data and sheets for lighting

Energy efficiency on building; sheet No. 45,46,47

Mercury lamp : Electricity consumption :427W
Ceramic metal halide lamp : Electricity consumption: 237 W
Both lamp are almost same bright.
Old type fluorescent lamp : 86 W (2units)
Hf type fluorescent lamp : 65 W (2units)

18


A
Big
Thank You!!
19

1

Example of Medium- and Long-Term Plan

JICA Study Team

Yoshiharu IKEUCHI

2

Contents

3

1. Boiler

Hard measures

Process/Facility	Plan	Expected effect of EE&C (toe) in primary energy
Boiler system	Renewal of 3 boilers (η : 90%) (2012-2015)	① 1,255 kL
Boiler system	Improvement air ratio by installing O_2 control system (2012-2014)	② 280 kL
Boiler system	Insulation of valve on steam header (2011)	③ 4 kL
Boiler system	Improvement of drain recovery (from 60% to 80%) (2011-2012)	④ 428 kL
Boiler system	Replace of new steam traps (2011-2014)	⑤ 566 kL
Boiler system	Repair the insulation materials of pipe (2011)	⑥

Soft measures

Boiler system	Repair the steam leakage (2011)	⑦ 33 kL
Boiler system	Repair the insert pipe to condensate tank(2011)	⑧ 69 kL

4

Calculation

① Average η of existing boilers ; (78+80+78)/3 = 78.7%
η of new installing boiler is 90%
Present annual oil consumption is 10,000 kL
So reduction of oil consumption: 10,000 kL x (1- 78.7/90)
= 1,255 kL

② Present average O_2 content in flue gas : (7+8+7)/3 = 7.3%
Installation of O_2 control system : O_2 content will be 3%
By sheet No17 of energy efficiency on building, approximately 2.8% reduction of oil consumption will be improved.
So, reduction of fuel: 10,000 kL x 0.028 = 280 kL

③ By sheet No.21(on building), heat losses from bare valves are
700W/m for 80A and 800W/m for100A.
Pipe length equivalent of ball valve :1.27m (see sheet No22)
Insulation efficiency is 85% (see sheet No.22)
Operation hour: 8,400 hours/y
Reduction of heat loss : 1/1.163 x 1.27 m x (700 W/m x 3 + 800W/m x 2)
x 8,400 h/y x 0.85 = 29 Gcal/y
Boiler efficiency: 78.7% . Reduction oil consumption : 29/0.787
= 37Gcal/y = 4 kL

5

Calculation

④ Drain recovery: from 60% to 80%
Drain temp.: from 40C to 80C
Total drain volume is 80% of total generation steam
Increasing recovery drain energy: 15 t/h x 0.8 x 8,400h/y x ((80 C x 0.8 - 40C x0.6))
x 1kcal/kg.C x 1000kg/t= 4,000Gcal/y =
= 428kL/y

⑤ 5% of total generated steam is leaked from bad quality steam traps.
Total leak steam through steam traps: 15t/h x 0.05 x 8,400 h/y = 6,300t/y
= 6,300 t/y x 660kcal/kg x 1,000 kg/t
= 4158 Gcal/y
Reduction of fuel consumption : 4158 Gcal/0.787 = 566 kL/y

⑥ Omit

⑦ By sheet No54 (on factory), leakage steam volume for 2mm hole:
0.97cm²/h x 9kg/cm² x 5 x 8,400 h/y = 367t/y = 367t/y x 660 kcal/kg x1000kg/t
= 242 Gcal/y
Transfer to oil volume : 242Gcal/y/0.787 =307Gcal/y =33kL/y

⑧ By sheet No 59 (on building) , 5 C higher hot water can feed to boiler by deep inserted pipe.
Reduction energy of boiler: 15t/h x 0.8 x 5C x 1000kcal/ton.C x8,400 h/y ÷ 0.787
= 640Gcal/y = 69 kL/y

6

2. Pump

Hard measures

Process/Facility	Plan	Expected effect of EE&C (toe) in primary energy
Cooling system	Install the inverter system (2013-2014)	① 57 kL (221,000 kWh)
Cooling system	Install the separate partition in water pool (2011)	② 18 kL (70,000 kWh)

Soft measures

Cooling system	Stop the each one pump of feed water to factory and of feed water to cooling tower(2011)	③ 16.4 kL (63,000 kWh)
Cooling system	Stop the fan of cooling tower during winter season (2011)	④ 7.4 kL 28,800 kWh)

7

Calculation

① Inverter efficiency: 0.95
Water flow is about 70% of rated one.
Total efficiency included with motor, pump and inverter: 0.65 (0.7 x 0.95)
Electricity reduction by inverter: 30 kW x 3 x 8400h/y x (1- (0.7)^3 /0.65)
=357,000kWh/y
Electricity reduction by present operation : (90- 22 – 21.5 -21) x 84,000h/y
=214,000kWh/y
Electricity reduction 143,000kWh/y
As same way, pumps for feed water to cooling tower
Electricity reduction : 78,000kWh/y
Total reduction221,000kWh/y = 57kL

② Present temperature difference between feed and return water: 5 C
If partition is installed, it becomes 6C
Efficiency of heat exchanger in each factory: 0.8
Therefore, necessary feed water will decrease by16.7%(1/6 x100%)
Electricity reduction is 16.7%
420,000 kWh x 0.167 = 70,000 kWh = 18 kL

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8

Calculation

③ Electricity consumption of two pumps operation : 60kW
Present electricity consumption : 22 + 21.5 + 21 = 64.5 kW
Reduction electricity consumption : 4.5 kW x 8,400 h/y = 37,800 kWh/y
= 9.7kL
As same way, pumps for feed water to cooling tower,
Reduction of electricity consumption ;25,200 kWh/y =6.5kL
Total reduction = 9.7kL + 6.5 kL = 16.4 kL

④ Winter season : 120days
Electricity reduction : 10kWh x 120 days/y x 24h/day = 28,800 kWh/y
= 7.4 kL

8

9

3. Compressor

Hard measures

Process/Facility	Plan	Expected effect of EE&C (toe) in primary energy
Compressor system	Install the inverter system (2012)	① 55kL (214,000 kWh)
Compressor system	Install the booster valve at C factory Or install the baby compressor at C factory (2011)	② 39 kL (151,000 kWh)

Soft measures

Compressor system	Repair the air leakage(2011)	③ 6 kL (23,000 kWh)

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10

Calculation

① One compressor works full time with full load.
Another one works 15% of full time.
Present electricity consumption: (60kW x 1.15 (115%) + 30kWh x 0.85) x
8,400 h/y = 794,000 kWh/y
After installation of inverter, electricity consumption:
60 kWh x 1.15 x 8,400 h/y= 580,000 kWh/y
Reduction of electricity consumption : 214,000 kWh/y = 55 kL/y

② Outlet pressure of compressor can be reduced by 0.25Mpa
Annual electricity consumption : 756,000 kWh
By sheet No.83(on factory), reduction of electricity consumption:
756,000 kWh/y x 8%/kg x 2.5 kg = 151,000 kWh/y = 39 kL/y

③ Air leak from 1mm hole: 90L/m= 5.4Nm^3/h (by sheet No.94)
Air leak from 2mm hole :125 L/m = 7.5Nm^3/h
By repairing leaking holes, reduction of compressed air consumption:
(5.4 x 10 + 7.5 x 4)m^3/h x 8,400 h/y x 0.65 = 459,000 m^3/y
Reduction of electricity consumption : 3 kW/m3/min x 459,000m3/y
= 23,000 kWh/y = 6 kL/y

10

11

4. Lighting

Hard measures

Process/Facility	Plan	Expected effect of EE&C (toe) in primary energy
Lighting	Replace the fluorescent lamps to Hf type (2011-2013)	① 27kL (105,400 kWh)
Lighting	Replace the mercury lamps to ceramic metal halide lamps (2012-2014)	② 62kL (239,400 kWh)

Soft measures

Lighting	Turn off lamps while nobody seated (2011)	③

11

12

Calculation

① Electricity consumption of present fluorescent lamp: 86 W (2units)
Electricity consumption of Hf fluorescent lamp : 65W (2units)
Reduction of electricity consumption in factory and storehouse:
(86 -65)W x 550 x 8,400 h/y = 97,000 kWh = 25kL
Reduction of electricity consumption in office:
(86 – 65) W x 200 x 2,000 h/y = 8,400 kWh/y = 2 kL
Total reduction of electricity consumption : 27 kL

② Electricity consumption of present mercury lamp: 427W
Electricity consumption of ceramic metal halide lamp : 237W
Reduction of electricity consumption:
(427 - 237)W x 150 x 8,400 h/y = 239,400 kWh = 62 kL

③ Omit

12

13

1

How to Prepare a Periodical Report

JICA Study Team

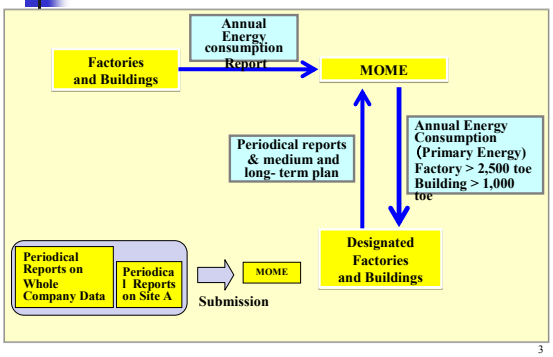
Yoshiharu IKEUCHI

2

Contents

3

1. Procedure to Submit Periodical Reports



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2. Items of Periodical Reports for Whole company and Site

Whole company	Site of company
EE&C Results Report (1) Energy consumption calculation Sheet for the company including RE and water (2) Energy consumption data of each site of the company (3) Calculation of energy intensity of the company (4) Historical trend of the energy intensity of the company (5) Reasons if numerical target is not achieved (6) Compliance check list for the company (7) Calculation of CO2 emission of the company	EE&C Results Report (1) Energy consumption calculation Sheet for the site including RE and water (2) Energy consuming equipment1 list and operation status (3) Calculation of energy intensity of the site (4) Historical trend of the energy intensity of the site (5) Reasons if numerical target is not achieved (6) Compliance check list for the site (7) Calculation of CO2 emission of the site

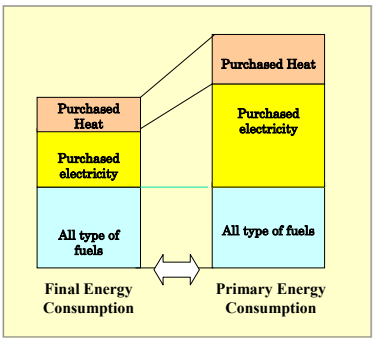
5

Table-1 Energy consumption calculation sheet for the site including RE and water

	Unit	(Fiscal year) Used energy A	Sold energy B	Net Total A-B	Final Energy (toe)	Primary Energy (toe)	Carbon Dioxide (tCO2)
Lignite raw	t			0	0	0	0
Lignite dried	t			0	0	0	0
Brown Coal	t			0	0	0	0
Hard Coal	t			0	0	0	0
Heating oil	m3			0	0	0	0
Heavy fuel oil	t			0	0	0	0
Kerosene	m3			0	0	0	0
Propane-Butane	m3			0	0	0	0
Natural gas	m3			0	0	0	0
Biogas	m3			0	0	0	0
Coke	t			0	0	0	0
Wood	m3			0	0	0	0
Wood waste	t			0	0	0	0
Biomass	t			0	0	0	0
				0			
Steam	kWh			0	0	0	0
Hot water	kWh			0	0	0	0
Technical steam	kWh			0	0	0	0
Geothermal water	kWh?			0	0	0	0
Sub-total							
EPS	kWh			0	0	0	0
Solar (PV)	kWh			0	0	0	0
Wind Power	kWh			0	0	0	0
Others	kWh			0	0	0	0
Sub-total					0	0	0
Total					0	0	0

6

Primary Energy vs Final Energy



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Net Energy Consumption in Factory and Building

①All type of fuel

②Grid electricity

③Heat from utility

Factory & Building

④Generation of renewable energy

⑤Stock

⑥Energy release

Fuel

Electricity

Heat

Net energy consumption = ①+ ②+ ③+ ④- ⑤- ⑥

But ,⑤(stock) = Final stock – beginning stock

7

8

List of designated factory/Building

Category of designation (Factory/Building)	Registered Number of Designated Factory/Building/Site	Name of Factory/Building	Address of Factory/Building	Energy Consumption (toe)	Business category No.	Name of business category

8

9

Converter table

		Unit	to Final Energy (kWh)	final to CO2: to Primary Energy (kWh)	final to CO2: to Carbon Dioxide (kWh to kgCO2)
Lignite raw		t	3,600	3,600	0.35
Lignite dried		t	4,500	4,500	0.35
Brown Coal		t	5,000	5,000	0.35
Hard Coal		t	6,000	6,000	0.35
Heating oil		m3	11,390	11,390	0.25
Heavy fuel oil		t	11,000	11,000	0.28
Kerocine		m3	11,000	11,000	0.25
Propane-Butane		m3	11,000	11,000	0.24
Natural gas		m3	9.26	9	0.20
Biogas		m3	9.00	9	0.20
Coke		t	7,000	7,000	0.35
Wood		m3	1,680	1,680	0.30
Wood waste		t	4,500	4,500	0.30
Biomass		t	3,500	3,500	0.30
Steam		kWh	1.00		0.40
Hot water		kWh	1.00		0.40
Technical steam		kWh	1.00		0.40
Geothermal water		kWh	1.00		0.00
Ordinary Supply	EPS	kWh	1.00		0.80
RE	Solar energy	kWh	1.00	1.00	0.00
	Wind Energy	kWh	1.00	1.00	0.00
Others					

9

10

Table-2 Energy consuming equipment list and operation status

	Name of facilities	Outline of facilities	Operational status	New installation, remodeling or dismantling
Facilities related to rational use of energy				
Major energy consuming facilities other than the above				

Facilities should be described within 30

Facilities related to rational use of energy mean facilities that are being more rational by installations and improvements of facilities

Facilities in this table should cover 80% of total energy consumption.

Facilities should be described within 30

10

11

Example of described sheet

	Name of facilities	Outline of facilities	Operational status	New installation, remodeling or dismantling
Facilities related to rationalise of energy				
Major energy consuming facilities other than the above				

Model , capacity and numbers of unit

Operating days a year and hours a day

Installed and remodeled date of years for past 3-5 years

Model , capacity and numbers of unit

Operating days a year and hours a day

11

12

Table-3 Production quantity and others

Fiscal Year	FY2010	Comparison to previous fiscal year(%)
Values closely related to energy consumption such as production quantity, gross floor space or others (Crude steel 1000 ton	2,500	104.5

Definite name of production quantity, for example crude steel (ton) in manufacturing factories and floor space (m^2) in building

Figures are described in 4 –digit number.. Round off to whole number

$$\frac{\text{Production quantity and other figure in this year}}{\text{Production quantity and other figure in previous year}} \times 100$$

Round off to one decimal place

12

13

Table-4 Calculation of energy intensity of the site

	FY 2010	Comparison to previous year(%)
Energy Consumption Unit = Quantity energy used (Primary energy in kWh) / Values closely related to energy consumption such as production quantity, gross floor space and other value.	1455	98.3

Quantity energy used: Converted to kWh of (A- (B+C)) in Table-1

Figures are described in 4 –digit number. Round off to whole number

Energy intensity in FY2010 / Energy intensity in FY2009 X 100
Round off to one decimal place

13

14

Table-5 Historical trend of the energy intensity of the site

	FY2006	FY2007	FY2008	FY2009	FY2010	Average change of energy intensity for 5 years
Energy intensity	1525	1510	1495	1480	1455	
Comparison to previous year (%)		99.0 ①	99.0 ②	99.0 ③	98.3 ④	98.8 ⑤

Figures are described in 4 –digit number In principal.

Round off to one decimal place

Average change of energy intensity for 5 years = (① x ② x ③ x ④)$^{1/4}$

14

15

Table-6 Reasons if numerical target is not achieved

Reasons for (A) a case where average change of unit energy consumption for the past five years did not improve by 1 % or more (The value of ⑤ in previous sheet is more than 99.0 %)

Reasons for (B) a case where unit energy consumption to the previous fiscal year did not improve. (The value of ④ in previous sheet is over 100%)

15

16

Example of reasons why average energy intensity for the past five years couldn't improve by 1 % or more

- Decline of product price. Fall of value added product. Reduction of amount money of shipment and sale.
- Reduction of production.
- Trouble of manufacturing facilities.
- Being too old for manufacturing facilities . Reduction of efficiency of facilities
- Change of production structure
- Correspondence for market need (high quality, high added value, small lot and many kinds of product)
- measures for environment (protection for pollution, measures for local environment)
- Measures for productivity improvement (Automation, robot)
- Measures for resource protection (Recycle of raw material, Recycling)
- Increasing air-conditioning for production (Clean room, constant temperature room)
- Change of climate (Heat wave, severe cold, water shortage)
- Increasing trial operation and trail piece
- Change of fuel structure (Fuel change, increasing waste fuel)

16

17

Evaluation criteria of rational energy use

NO	Contents
1.	Rationalization of combustion of Fuels
2. 2-1 2-2	Rationalization of heating and cooling as well as heat transfer. ●Heating units, etc ●Air-conditioning equipment and hot water supply system, etc.
3.	Recovery and utilization of waste heat.
4. 4-1 4-2	Rationalization of conversion of heat into power, etc. ●Exclusive generation system ●Cogeneration system
5. 5-1 5-2	Prevention of Energy loss due to emission, conduction, resistance, etc ●Prevention of heat loss due to radiation and conduction, etc ●Prevention of electricity loss due to resistance, etc
6. 6-1 6-2	Rationalization of conversion of electricity into power, heat, etc. ●Electric motor appliances and electric heating appliances, etc ●Lighting system, elevating machines, office appliances and consumer equipment

17

18

Table-7 Compliance check list for the site

Target item (facilities)	Operation control	Measurement /record	Maintenance /inspection	Measures for installation of new facilities
(1) Rationalization of combustion of fuel	Control of fuel combustion	Measurement /record for fuel combustion	Maintenance /inspection for combustion facilities	Measures for installation of new combustion facilities
Mark √ on the corresponding item	Status of establishing management standards	Status of establishing management standards regarding to Measurement /record	Status of establishing management standards regarding to Maintenance /inspection	☐ Take measures as standard criteria in installation of new facilities.
	☐ Already established	☐ Already established	☐ Already established	☐ Not to take measures as standard criteria in installation of new facilities
	☑ Being established (80%)	☐ Being established (%)	☐ Being established (%)	
	☐ To be established	☐ To be established	☐ To be established	☐ No installation of new facilities
Fill out achievement rate	Status of following items decided in Management standards	Status of following items of Measurement /record decided in Management standards	Status of following items of Maintenance /inspection decided in Management standards	
	☐ Enforced	☐ Enforced	☐ Enforced	
	☐ Partially enforced	☐ Partially enforced	☐ Partially enforced	
	☐ Not enforced	☐ Not enforced	☐ Not enforced	

18

19

Table-7 Compliance check list for the site (1)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(1)Rationalization of combustion of fuel	Status of establishing management standards for air ratio and others	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of combustion facilities
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80 %)	☐ Being established (%)	☐ Being established (%)	☐ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

Mark √ on the corresponding item

Fill out achievement rate

19

20

Table-7 Compliance check list for the site (2)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(2)Rationalization of heating, cooling and heart transfer (Heat consumption facility)	Status of establishing management standards for heating equipment and others	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of heating equipment and others
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable
	Status of establishing management standards for air-conditioning and hot water supply facility	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of air-conditioning and others
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80 %)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

20

21

Table-7 Compliance check list for the site (3)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(3) Waste heat recovery (Waste heat recovery facility)	Status of establishing management standards for waste heat recovery facility	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of waste heat recovery facility
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80 %)	☐ Being established (%)	☐ Being established (%)	☐ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

21

22

Table-7 Compliance check list for the site (4)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(4) Rationalization of converting heat to power and others (Power generation facility and cogeneration facility)	Status of establishing management standards for gas turbine of power generation facility and others	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of power generation facility and others
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable
	Status of establishing management standards for cogeneration facility	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of cogeneration facility
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

22

23

Table-7 Compliance check list for the site (5)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(5) Prevention of energy loss by radiation, conduction, resistance and others (Heat consumption facility, power receiving & transforming facility and distribution facility)	Status of establishing management standards for heat loss	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of heat consumption facility
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable
	Status of establishing management standards for power receiving & transforming facility and distribution facility	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of power receiving & transforming facility and distribution facility
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

23

24

Table-7 Compliance check list for the site (6)

Target item (facilities)	Status of establishing management standards	Status of observing measurement/record	Status of observing maintenance /inspection	Status of measures to betaken on new installation
(6) Rationalization of converting electricity to power and heat and others (Electricity utilizing facility)	Status of establishing management standards for applied electric power facility, electric heating facility, electrolysis facility and others	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of applied electric power facility and other
	☐ Already established	☑ Being established (%)	☑ Being established (%)	☐ Done
	☑ Being established (80 %)	☐ To be established	☐ To be established	☑ Not done
	☐ To be established			☐ Not applicable
	Status of establishing management standards for lighting facility and others	Status of measurement/record defined in management standards	Status of maintenance/inspection defined in management standards	Status of measures to be taken on new installation of lighting facility and others
	☐ Already established	☐ Already established	☐ Already established	☐ Done
	☑ Being established (80%)	☑ Being established (%)	☑ Being established (%)	☑ Not done
	☐ To be established	☐ To be established	☐ To be established	☐ Not applicable

24

1

A Way of Finding EE&C Potential

November 2009

1

2

Contents

1. Draw a Picture of Flow/System Diagram
2. Make a Table "Estimation of Consumed Energy and Money"
3. Make a "Matrix" and Check one by one
4. Evaluate the level of each possibility roughly and Make a table of them

2

3

- This activity should be done by a Team consisting of different section, not just by a specialist, such as energy manager.
- An example
  - A firm (chemical factory) tried this method
  - Operators, Engineers, Designers: 2,212 man/hour
  - Results
    - Possible EE&C theme: 608
      - Difficult A: 250, B 285, C:73
    - Conducted: 95
    - EE&C rate: 27.8%

3

4

1. Draw a Picture of Flow/System Diagram

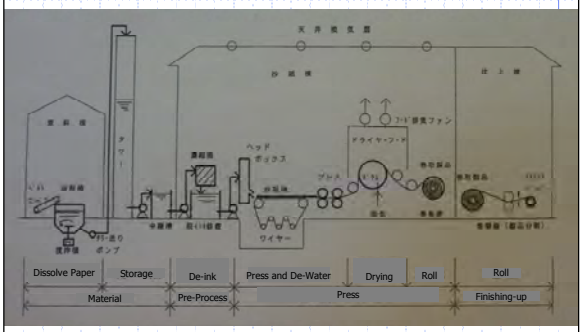
- Objective
  - To confirm the relationships between the equipment
- Together with the Picture,

1. Make a table with basic specifications of equipment and operation conditions
2. Check the conditions of the equipment
   If you already have data, also put them in.

4

5

- Sample: A Picture of System Diagram



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6

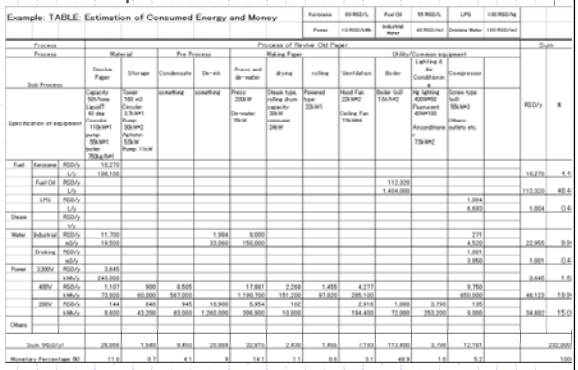
2. Make a Table "Estimation of Consumed Energy and Money"

- Objective
  - To grasp the situation, finding out which is the key equipment such as most energy and money consuming and relating various equipment
- Just estimate roughly, do not get into too much details
  - Capacity, Operation hours/schedule, Working rate, etc.
- Estimation in "Money" is important to keep it in mind

6

7

A Sample:


Example: TABLE: Estimation of Consumed Energy and Money

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3. Make a "Matrix" and Check

1. Make a Matrix for Heat (fuel, steam, water) and Electricity
2. Fill in the process and major equipment
3. Modify the columns according to the situation

- EE&C is defined here is, for example, energy/production.
- So, production efficiency, such as improving production rate, reducing failure, also contributes energy efficiency.

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		Finding Direction		Process				
				Equipment A	Equipment B			
UNIT	Kind	Change Service	Ex. Change to higher calorie fuel					
		Grade Change	Ex. Change to lower pressure					
	Logistics	Transport Change						
INPUT	Reduce Amount							
	Reduce Loss							

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4.Make a Table and "Check"

- Check each column on its possibility

1. Some possibility---------Mark in Green
2. See some problems-----Mark in Yellow
3. Idea of measures--------Mark in Red

- At the beginning, no need for considering the reality or possible measures, like brainstorming

10

11

4. Evaluate possibility and Make a Table

- Make a Table with possible parts
- Consider the measures

Address		Situation and Problems	What you want to do and its way	Energy	Calculation	Money to be saved
50	3	Motor has been on when not in operation, water operation is not necessary. 1 time/day, 1h/time	Check and stop water operation	power		
18	15	When checking, cold drought comes in and temperature decreases. It needs extra heating.	Shorten checking time and try to avoid the drought.			

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Thank you for your attention!

12