October 29, 2003

10. Technologies for Energy Efficiency & Conservation

省エネルギー技術

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Energy Efficiency and Conservation

for Central and Eastern European Countries, 2003

Technologies
for Energy Efficiency and Conservation

- Methodology Including Energy Management -

October 29, 2003
at JICA / TIC, Japan

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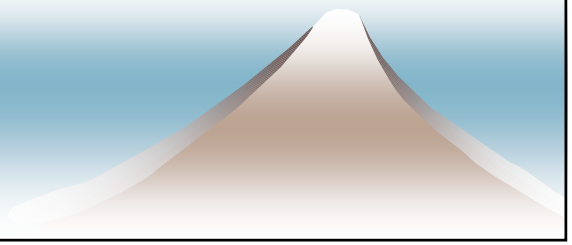
http://www.eccj.or.jp

Contents

1. Energy Management

- Energy Management
- Essential Aspects
- Measure
- Effect
- Education



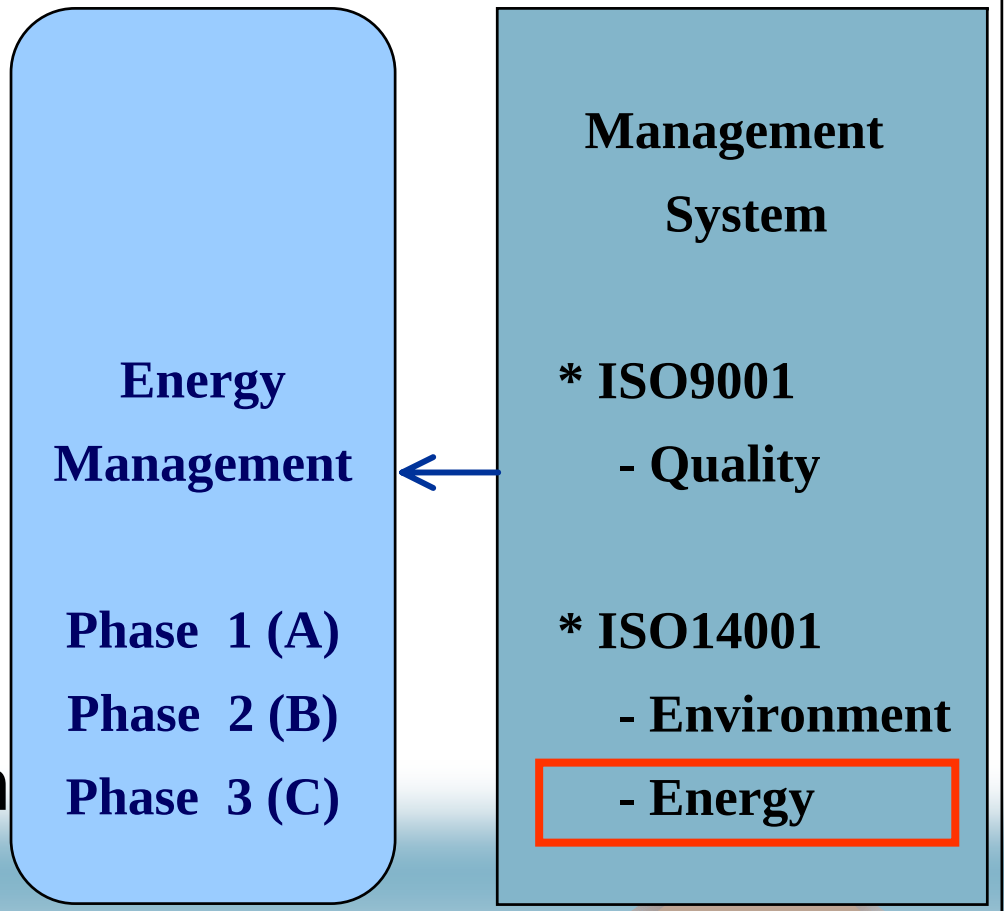
Energy Management

- Energy Saving(or Conservation)
  - **Energy Efficiency**

(by Machine, System)

    - Machine Efficiency
    - Energy Recovery
    - Control System
  - **Energy Conservation**

(by Human)



The Essential Aspects of Energy Management

- **Phase 1 : Improved Operation**

  (A) Without Investment

- **Phase 2 : Equipment Improvement**

  (B) Small Investment

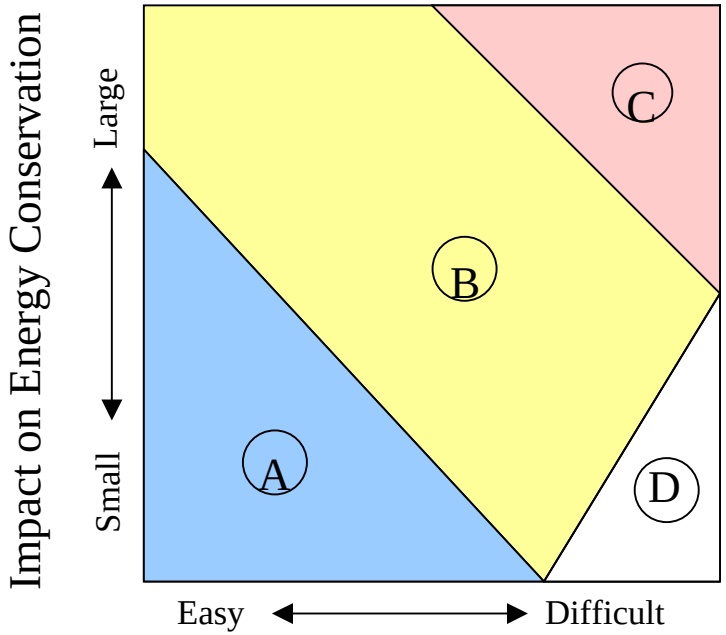
- **Phase 3 : Dramatic Improvement**

  (Strategy, Innovation)

  (C) Large Investment

Measure of Management

Category of Measure



Technology and Economic Conditions

Measure and Implementation

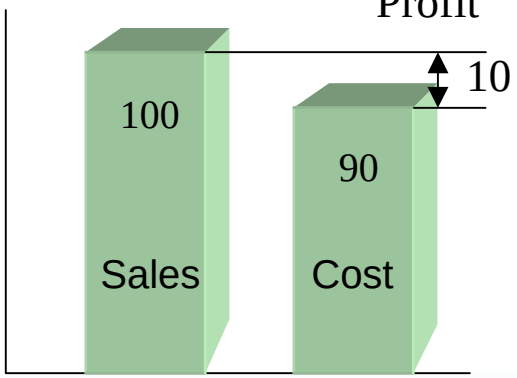
	Small-group Circle	Manager Group	Director Project team
A	◎	○	
B	○	◎	○
C		○	◎
D	×		

- A Without Investment
- B Small Investment
- C Large Investment
- D Not Consider

Schematic Concept of Conservation

" Energy Conservation = Company Management Itself "

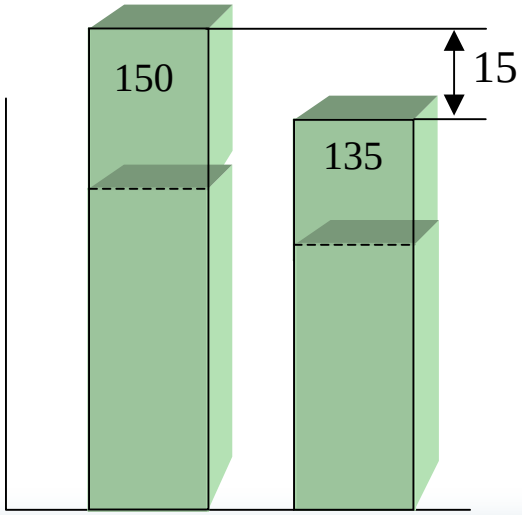
Profit 10%



Base

Profit 15%

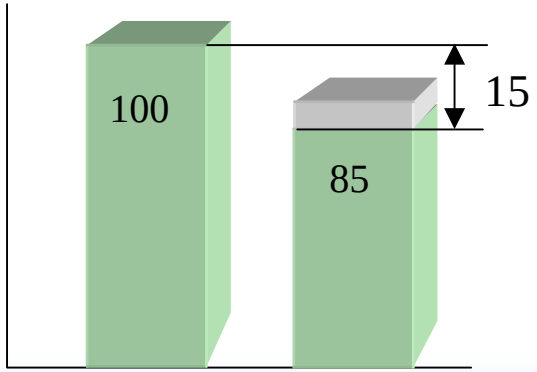
Very Difficult



Sales up 50%

Profit 15%

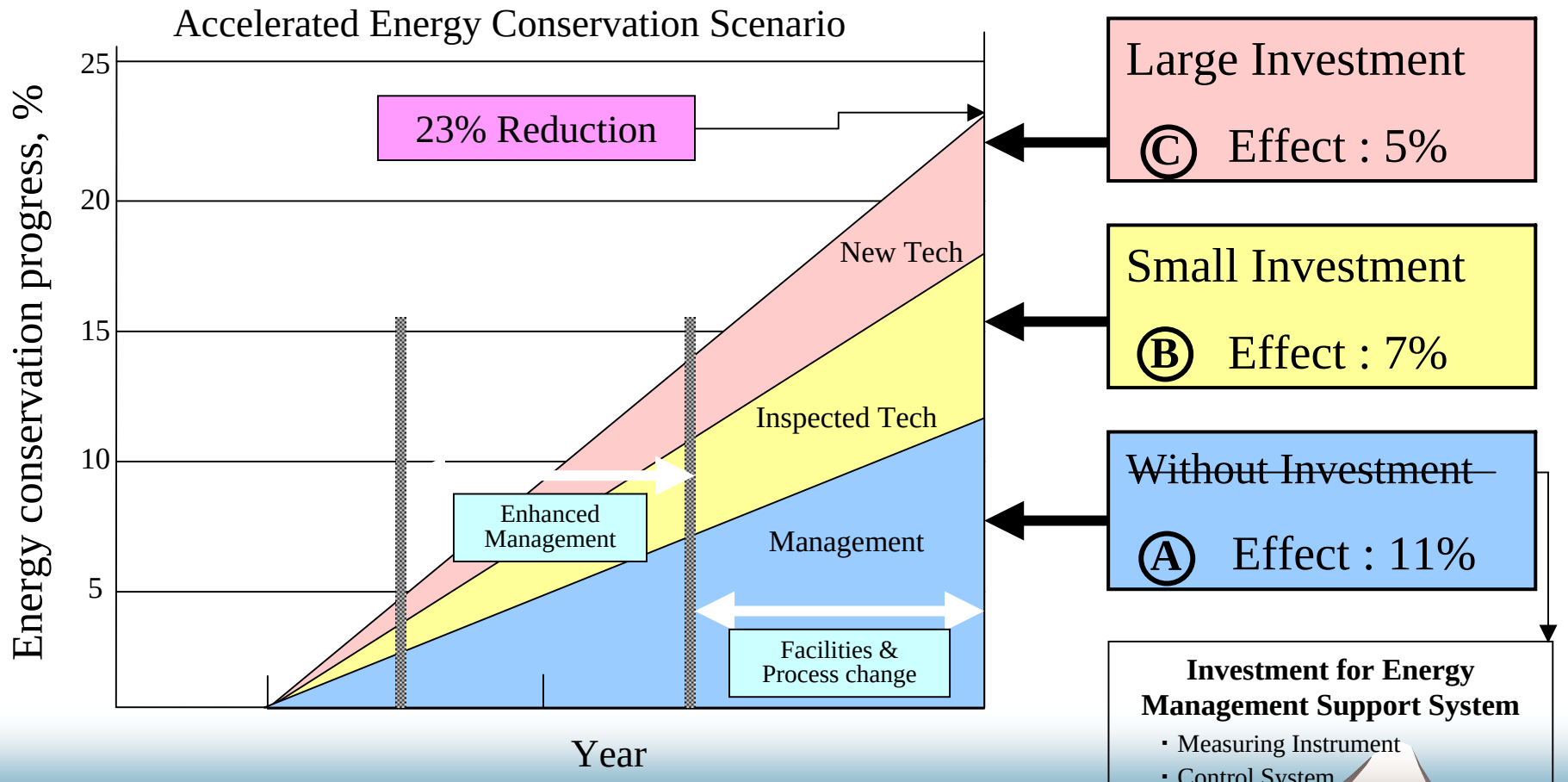
Rather Acceptable!



Conservation 5%

Effect of Energy Conservation

" Energy Management is most profitable "



<an example of audit>

Education of Energy Conservation

Expert Person : Self Promotion

(Designated Person)

Case of Japan (≈Case of Germany)

< Education >

· Knowledge (Policy, Technology, Management)

· Audit (Measure, Inspection, Proposal)

· Implement (Management, Small Invest, Large Invest)

< Target >

Ability to promote independently

- Person
- Organization
- Policy

Expert Company : Out- Sourcing

(Energy Service Company)

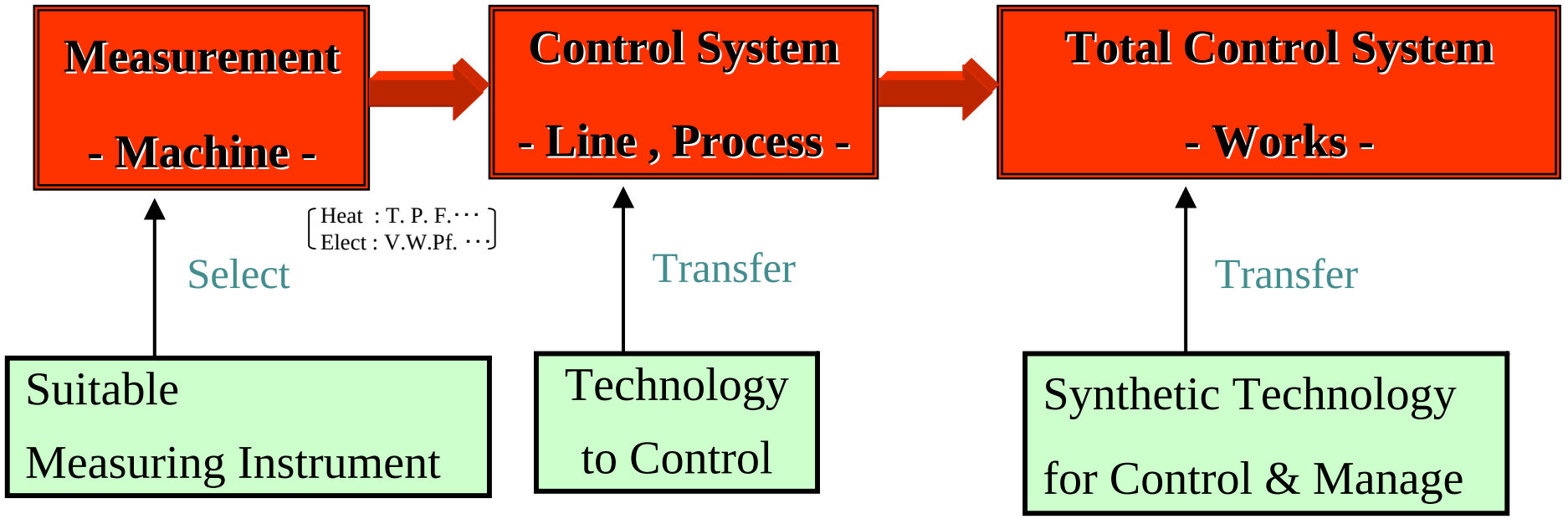
Case of U.S.A. and others

2. Measurement

- Measurement and Management
- Example of Measure for Industrial Furnace
- Example of Measurement Instruments

Measurement (1)

" Energy Conservation : More than 10% "



Now : A little Expensive

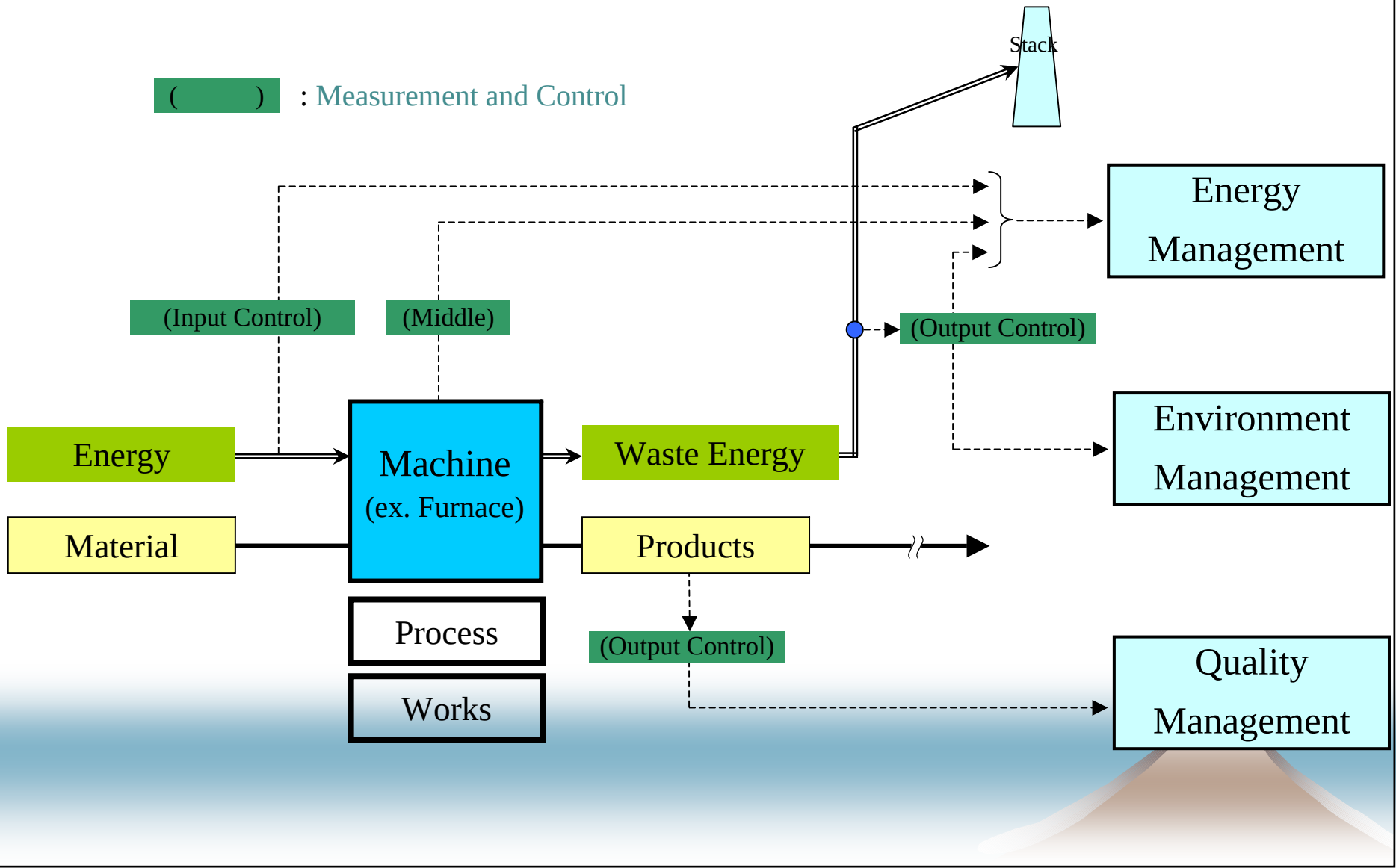
Future : Not Expensive (to be developed)

Past : Very Expensive

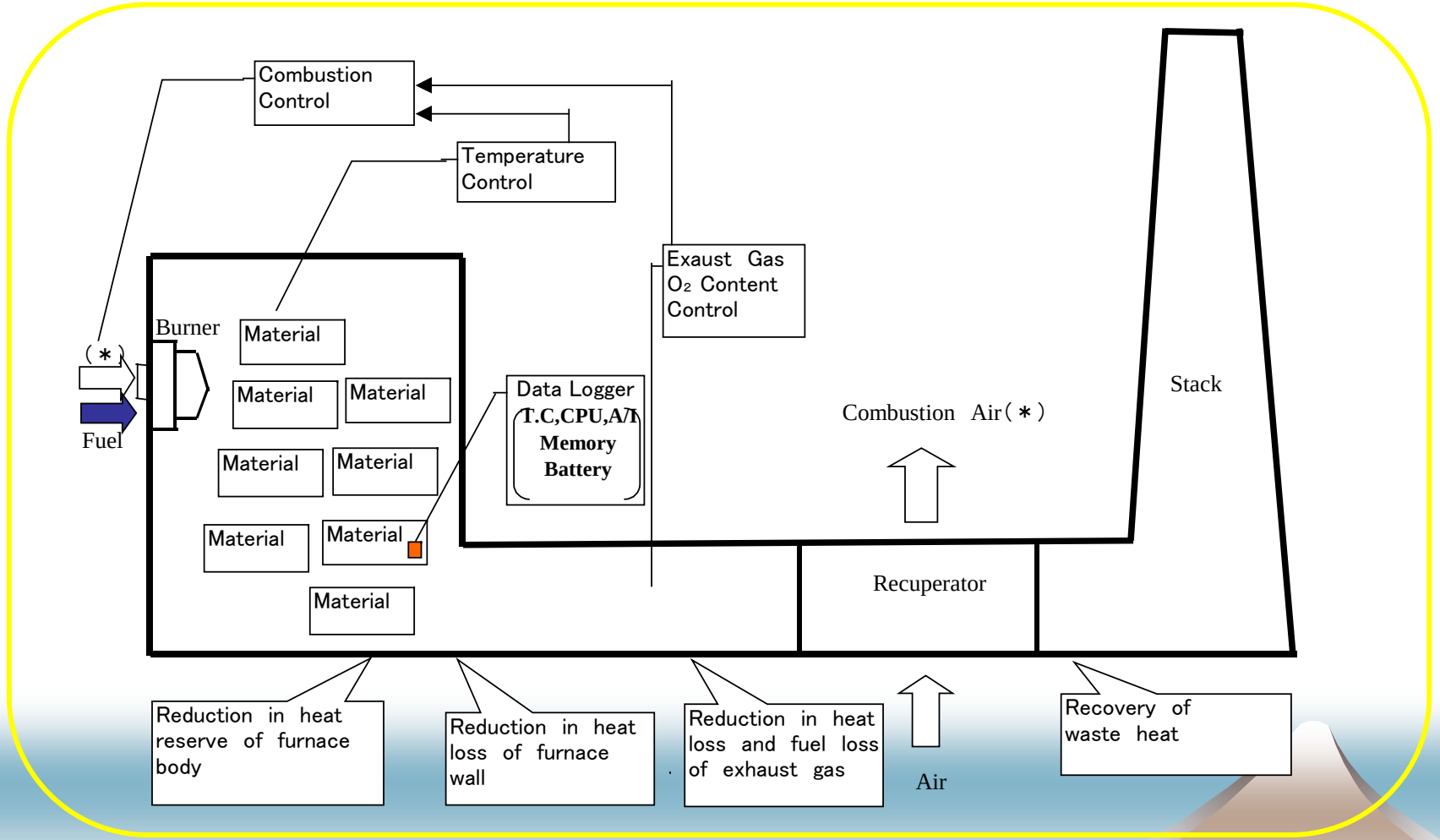
Now : Not Expensive

Measurement (2)

"From Measurement, Energy Management is Superior Conception "

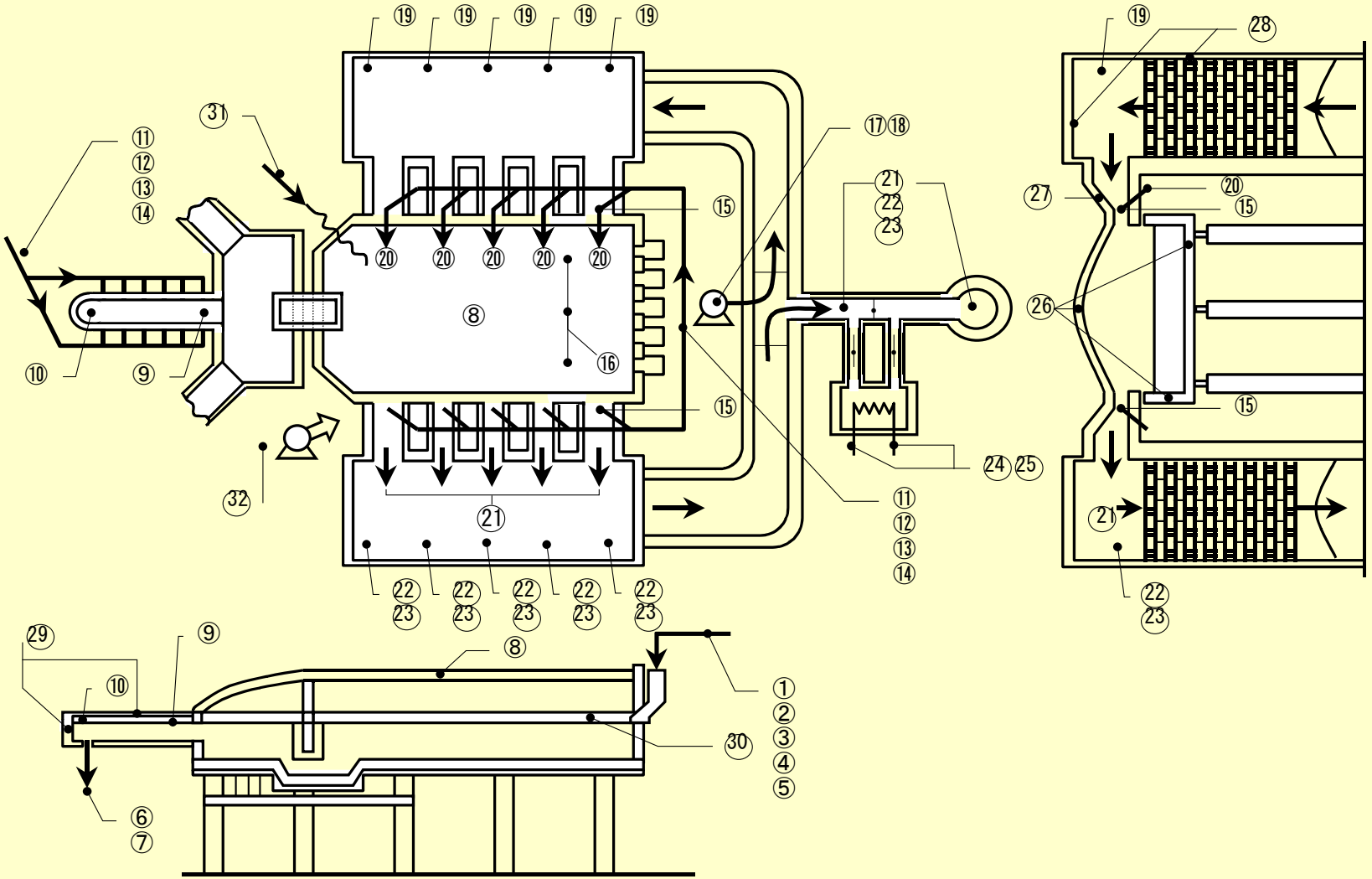


Measure for in Industrial Furnace



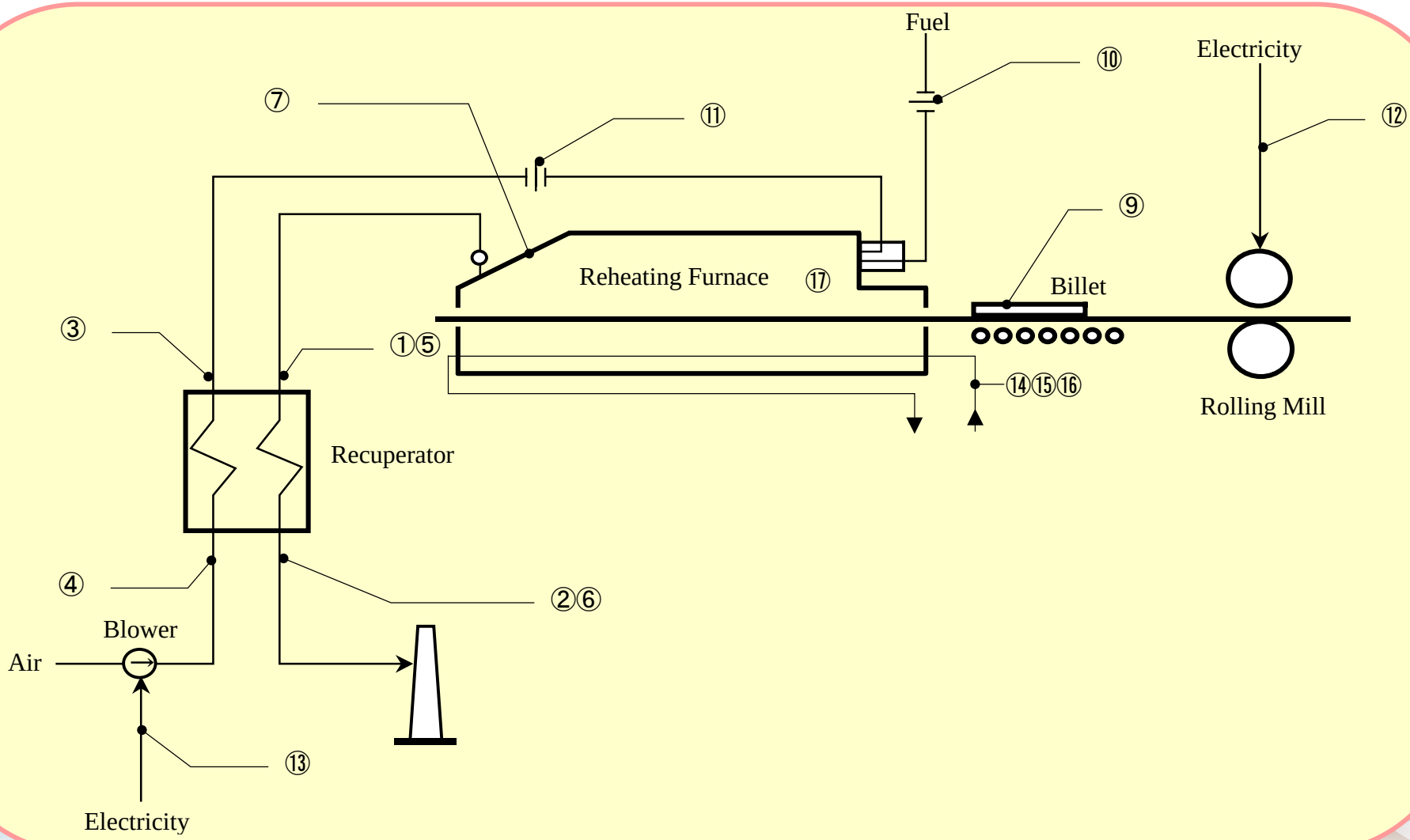
Measuring Points of Dissolution Furnace

(Number : Measuring point)



Measuring Points of Rolling Mill & Reheating Furnace

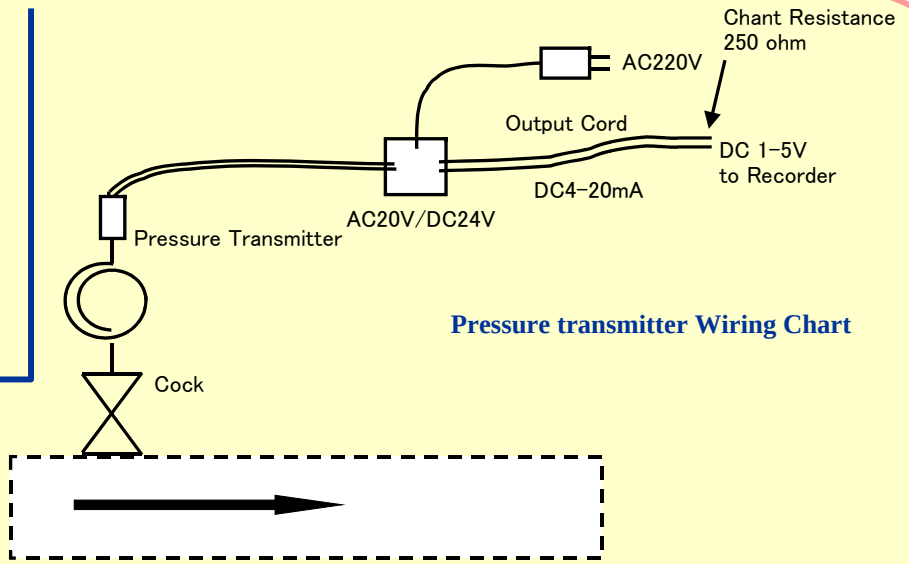
(Number : Measuring point)



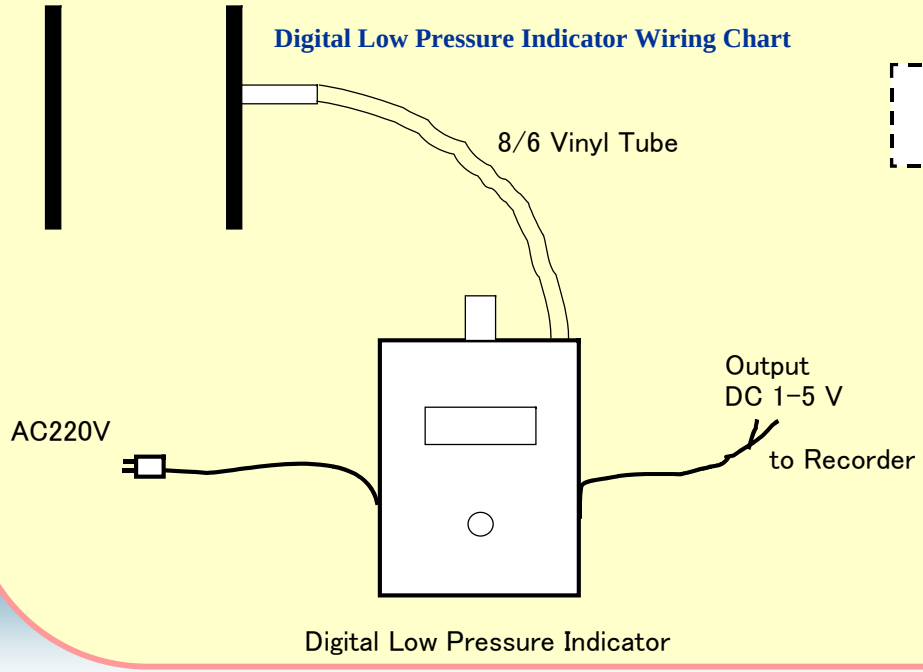
< Example 1 >

Wiring Chart of Measuring Instrument

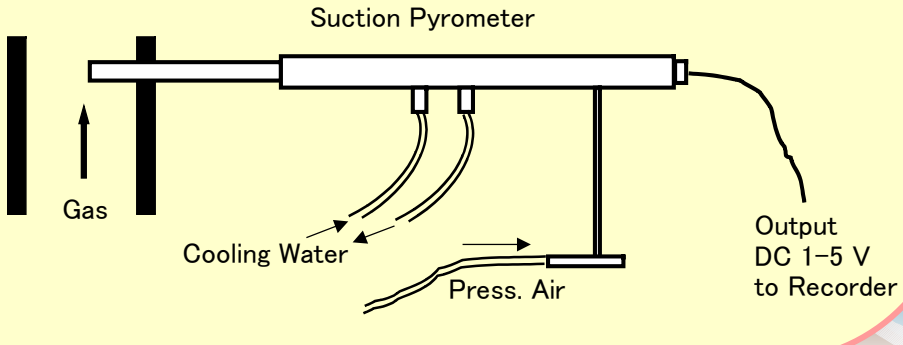
Pressure transmitter Wiring Chart



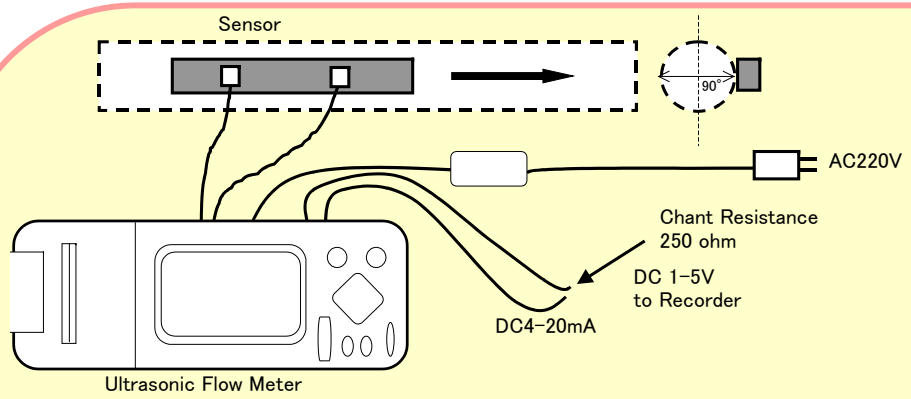
Digital Low Pressure Indicator Wiring Chart



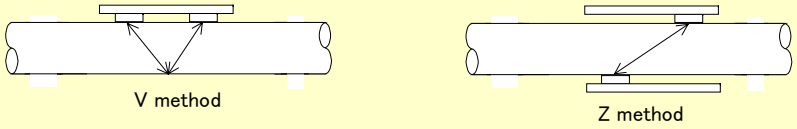
Suction Pyrometer Wiring Chart

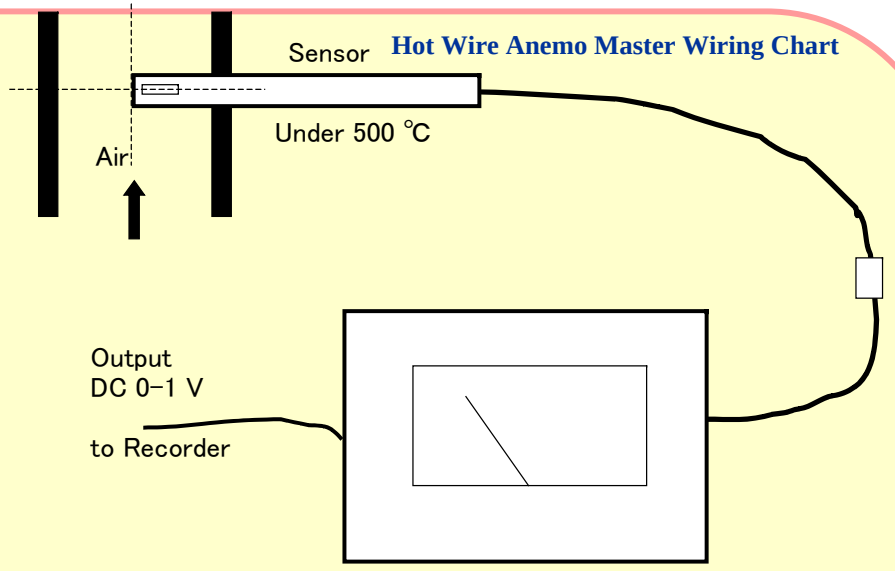


< Example 2 >



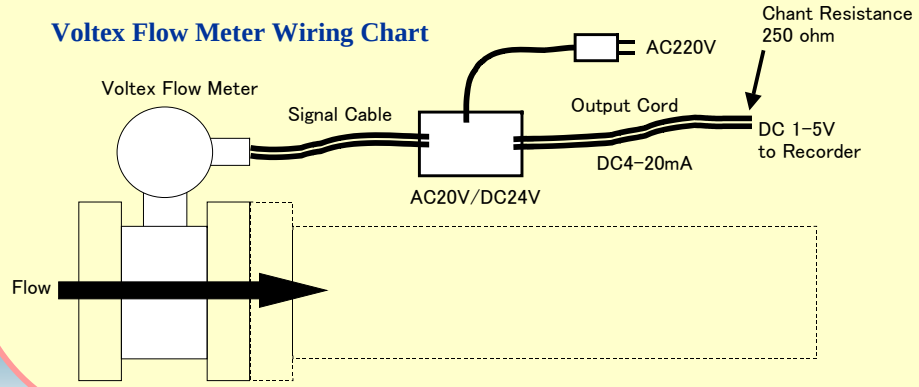
Ultrasonic Flow Meter Wiring Chart

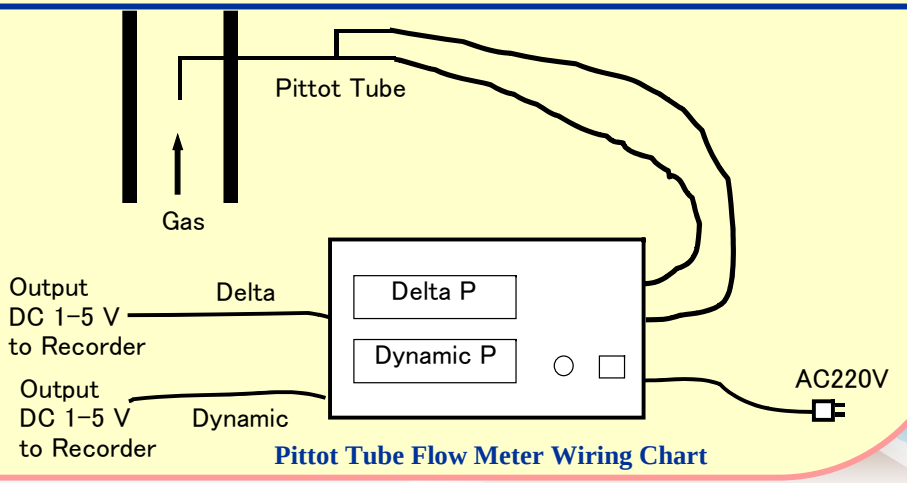




Hot Wire Anemo Master Wiring Chart

Voltex Flow Meter Wiring Chart



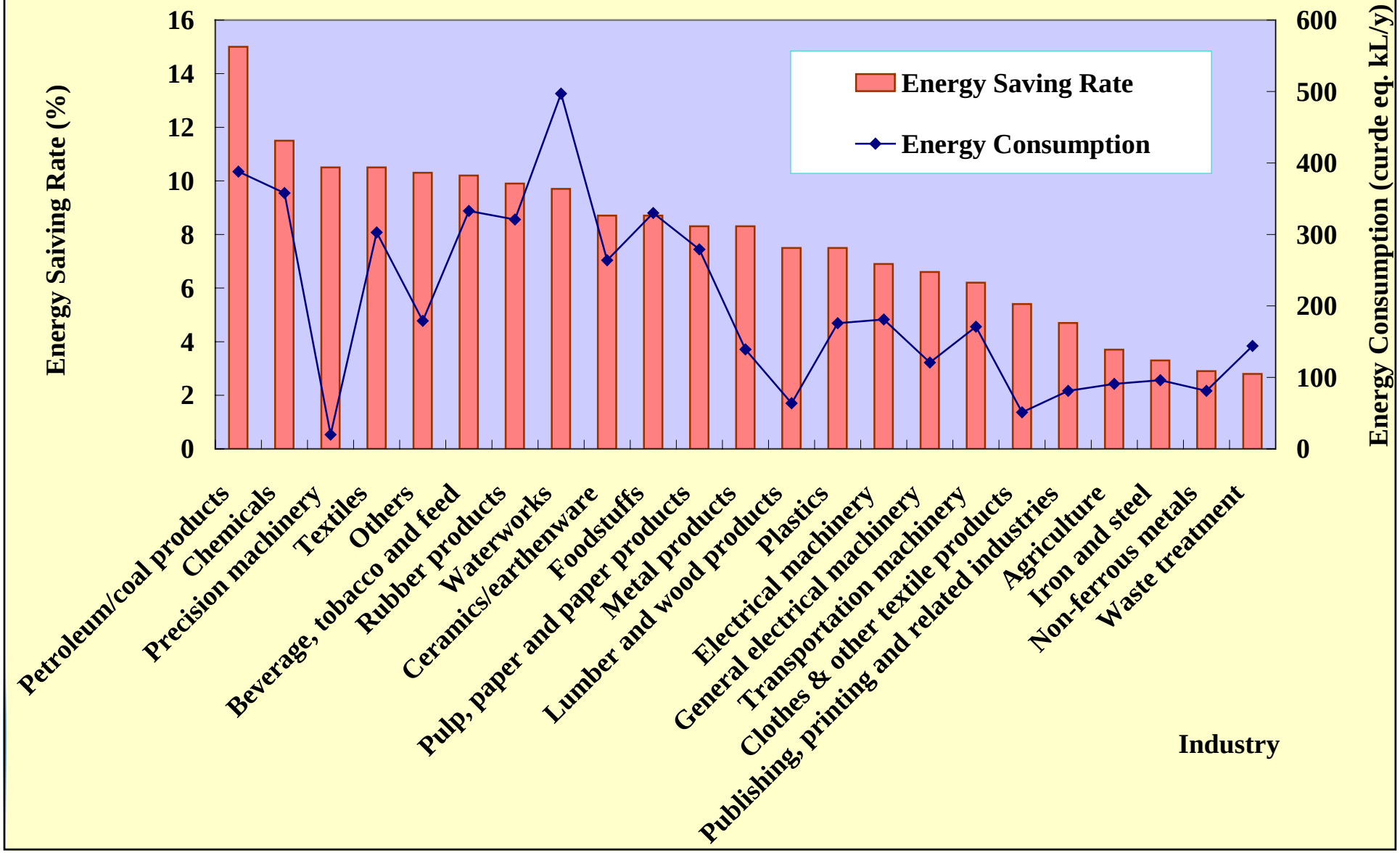


Pittot Tube Flow Meter Wiring Chart

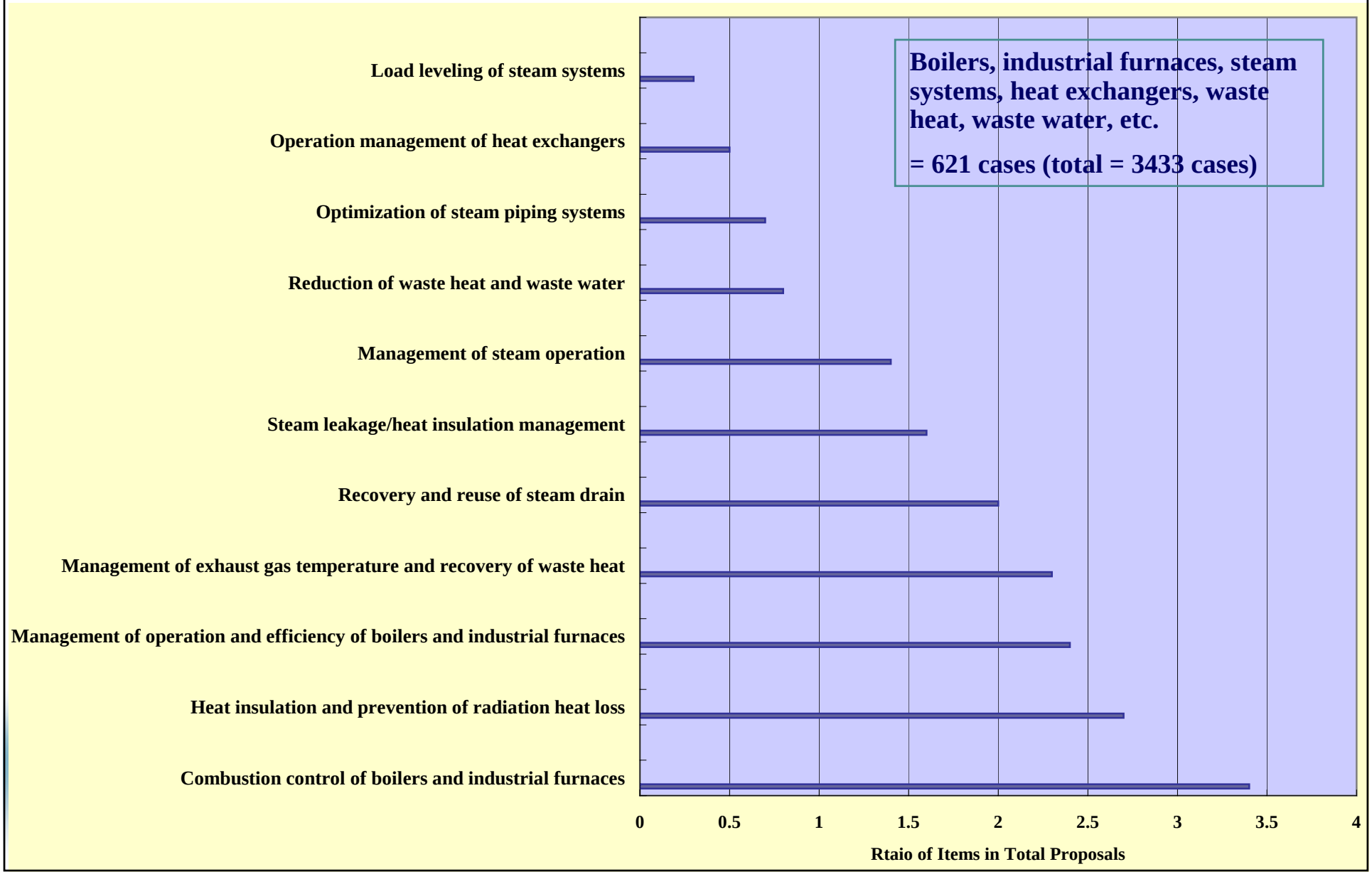
3. Energy Audit

- <Survey Result>
- Number of Audit
- Energy Saving Potential
- Items of Energy Management
- Practical Way of Energy Management (Example in the field of Thermal Energy)

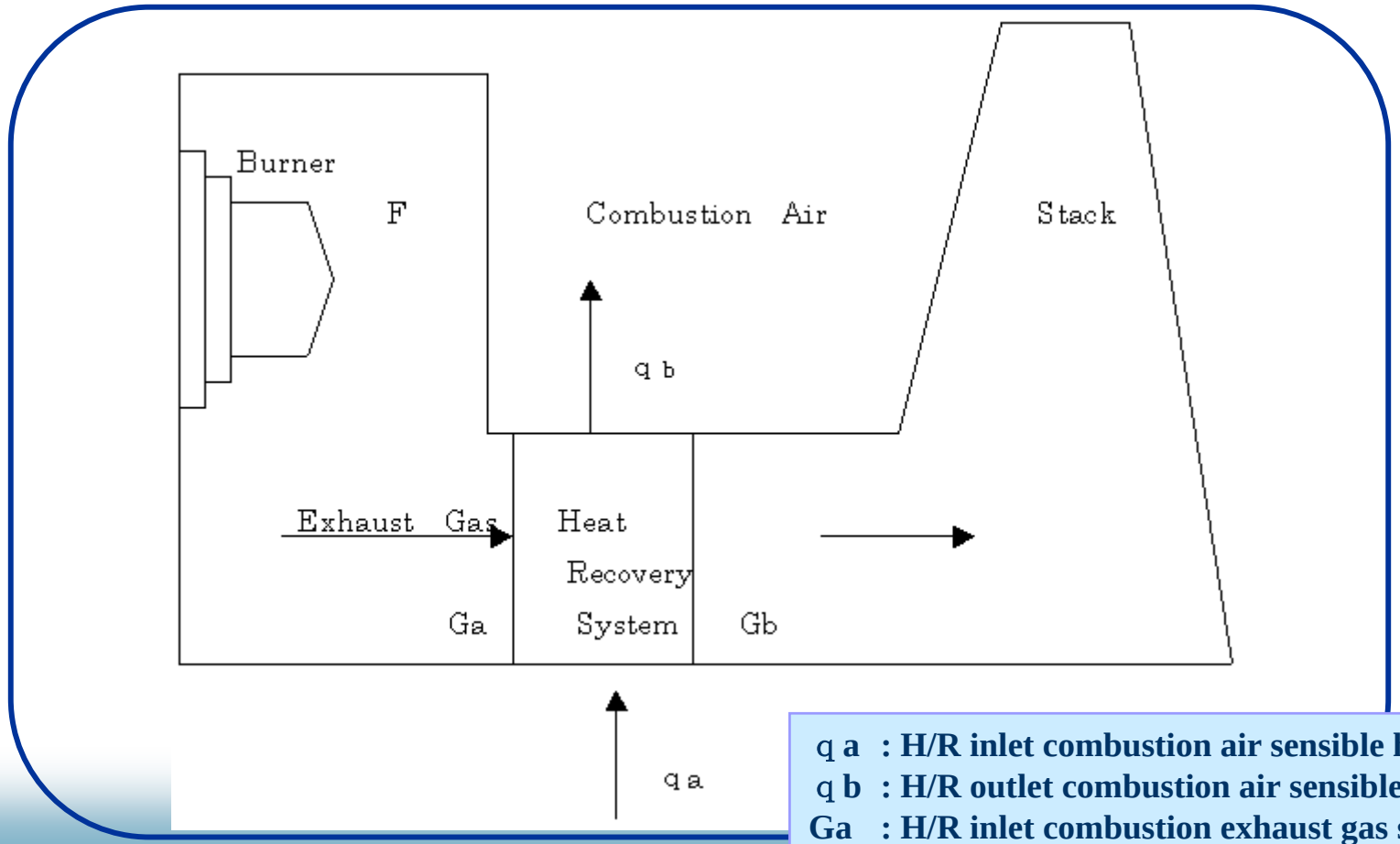
Energy Saving Potential in Industry (Survey 1999 by ECCJ)



Items of Proposals for Energy Management (for Furnaces, boilers)



Waste Heat Recovery



q a : H/R inlet combustion air sensible heat
q b : H/R outlet combustion air sensible heat
Ga : H/R inlet combustion exhaust gas sensible heat
Gb : H/R outlet combustion exhaust gas sensible heat
F : Fuel heat value

Practical Management Introduction

1. **The standard of rationalization of energy use**
   1) **Air Ratio**
   2) **Outer Wall Temperature of Furnace Wall**
   3) **Recovery Rate of Waste Heat**

2. **Example /** **Industrial Furnace (Combustion)**

The Air Ratio of Combustion

Air ratio (m) = Actual Air／Theoretical Air (Volume)

Air ratio＝21／(21-O2) (%)

・Excess Air : The increase in exhaust gas heat loss

Increase in NOx → Environmental aggravation

Increase in oxidation loss → Yield aggravation

•Insufficient Air : The increase in non-combustion fuel loss

Generating of CO & Soot → Environmental aggravation

Inner pressure of furnace : High → Blow off of a flame

→ Opening heat loss

Low → Increase in invasion air

→ Increase in waste gas heat loss

Rationalization of Combustion of Fuel
(Guideline)

Standard & Target air ratio for Industrial furnace

Type of Metallic Furnace	Gaseous Fuel		Liquid Fuel	
	Coetaneous		Intermittent	Continuous
Dissolution Furnace	Intermittent 1.40	1.25	1.35	1.30
For Casting (Target)	1.05～1.20	1.05～1.25	1.05～1.25	1.05～1.30
Billet Heating	—	1.20	—	1.25
Furnace (Target)	1.05～1.15 —		—	1.05～1.20
Heating Furnace	1.35	1.25	1.35	1.25
(Target)	1.05～1.20	1.05～1.30	1.05～1.20	1.05～1.30

External Surface Temperature / PDCA

Management	Control standard of furnace wall temperature Establishment & reconstruction
Measure Record	Temperature of furnace wall & inner furnace, work environment Observation (Leak of combustion gas and red heat / Distortion of Furnace Body)
Maintenance Check	Scheduled repair of Furnace wall
Execution Construction	Improvement of heat insulation (selection of proper insulator)

Prevention of Heat Loss by Radiation,Heat Transfer, etc.
(Guideline)

Standard and Target of external surface temperature

Inner Temp.(℃)	Ceiling	Side wall	Bottom touched to the outer space
1,300 ≦ t	140	120	180
	120	**110**	**160**
1,100 ≦ t ＜1,300	125	110	145
	110	**100**	**135**
900 ≦ t ＜1,100	110	95	120
	100	**90**	**110**
t ＜ 900	90	80	100
	80	**70**	**90**

(1) Combustion process

- To improve the excess air ratio
- To recover the exhaust heat to use for air heater or recovery boiler or preheat of material to be heated in the process.
- Replace the burners to re-generative burners

Recovery Use of Waste Heat

Combustion Exhaust Gas

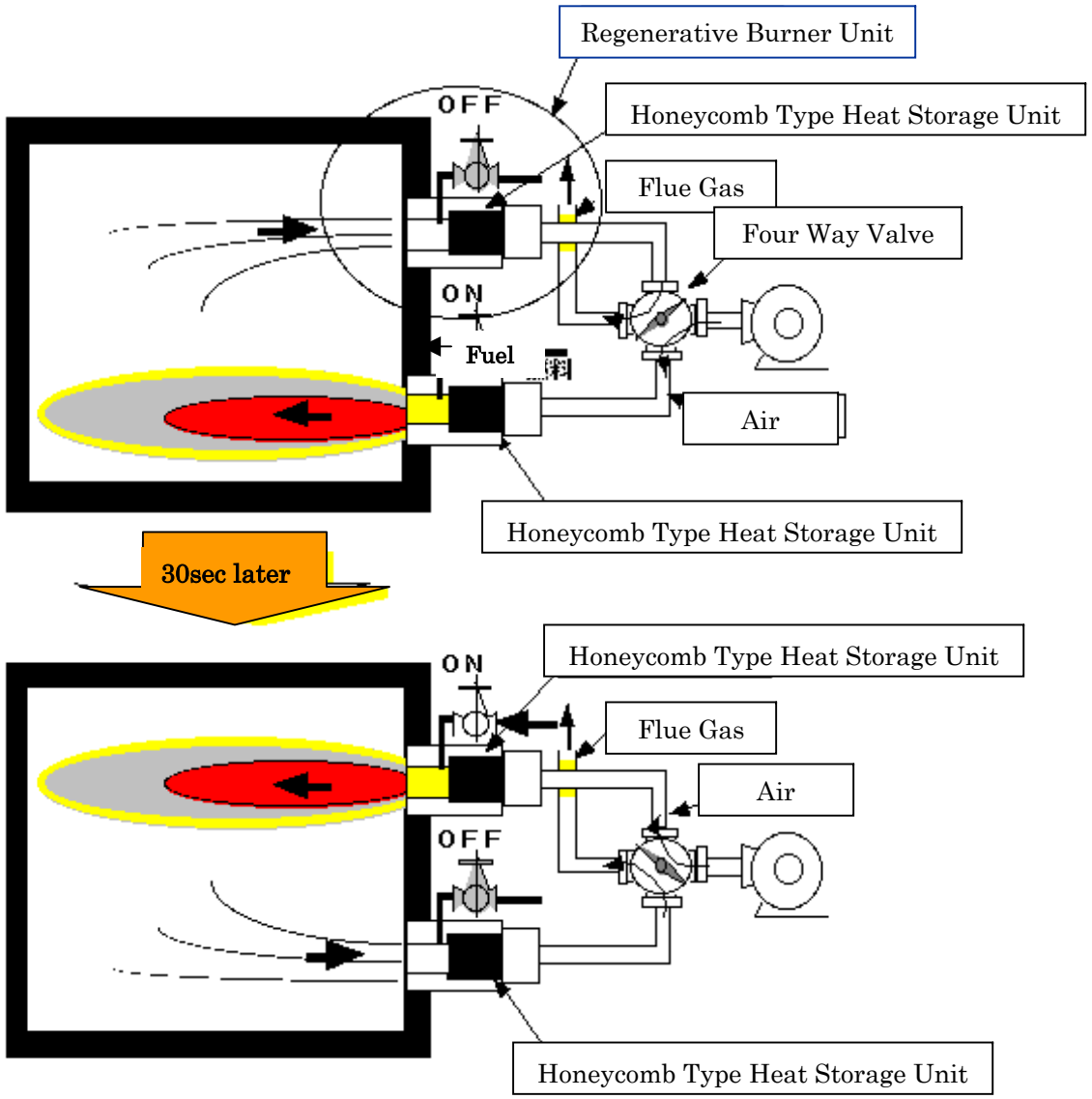
Combustion Air Preheating → Recuperator
Recuperative Burner
Regenerative Burner

Water supply Preheating

Waste heat Recovery Boiler

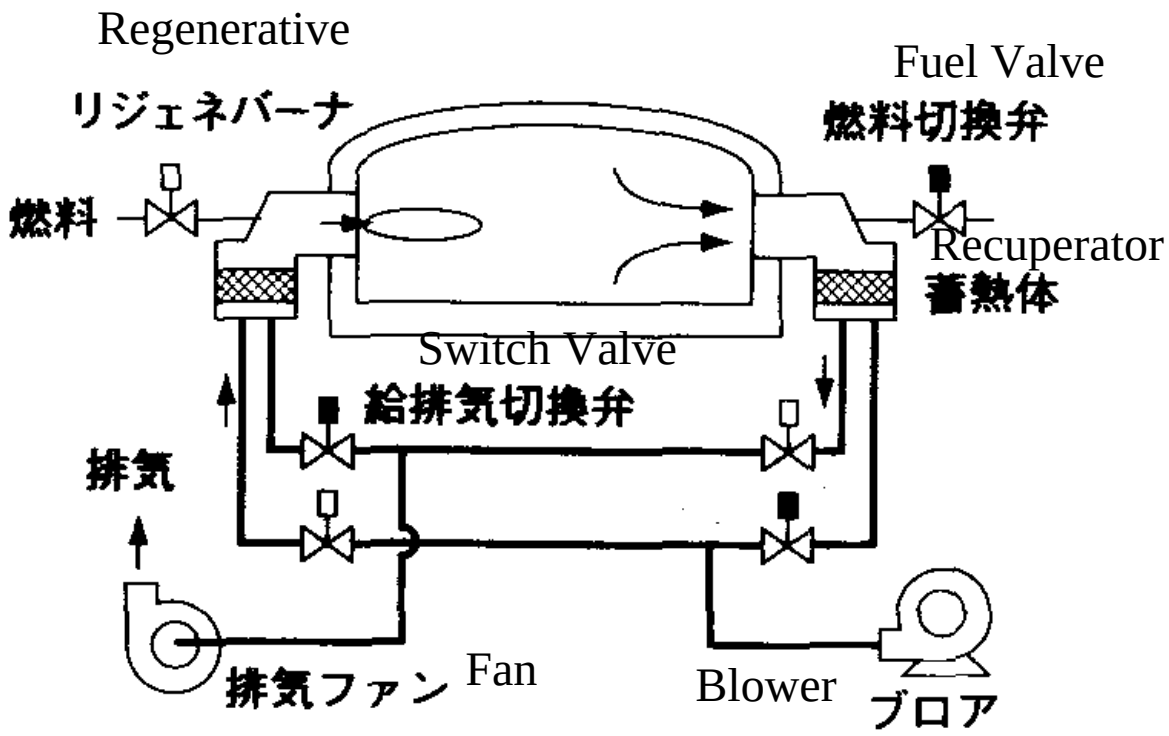
Raw Material Preheating

Fuel Preheating



Re-generative Burner System

High Performance Industrial Furnace

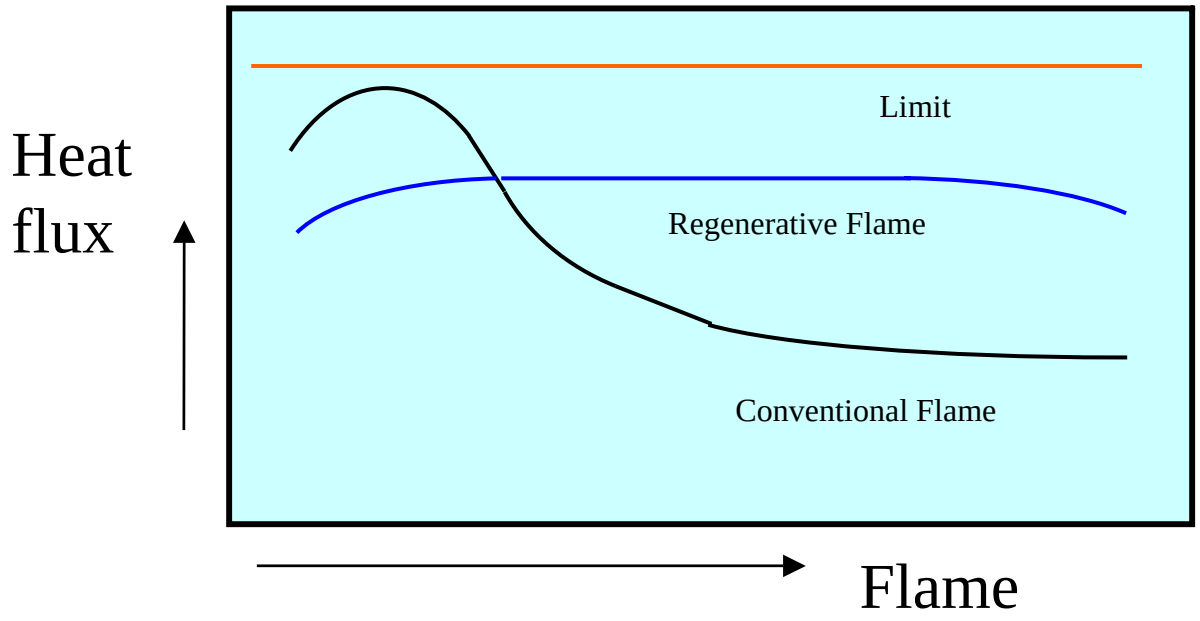


Regenerative Burner System

図－１　リジェネバーナシステム

(HiTAC)

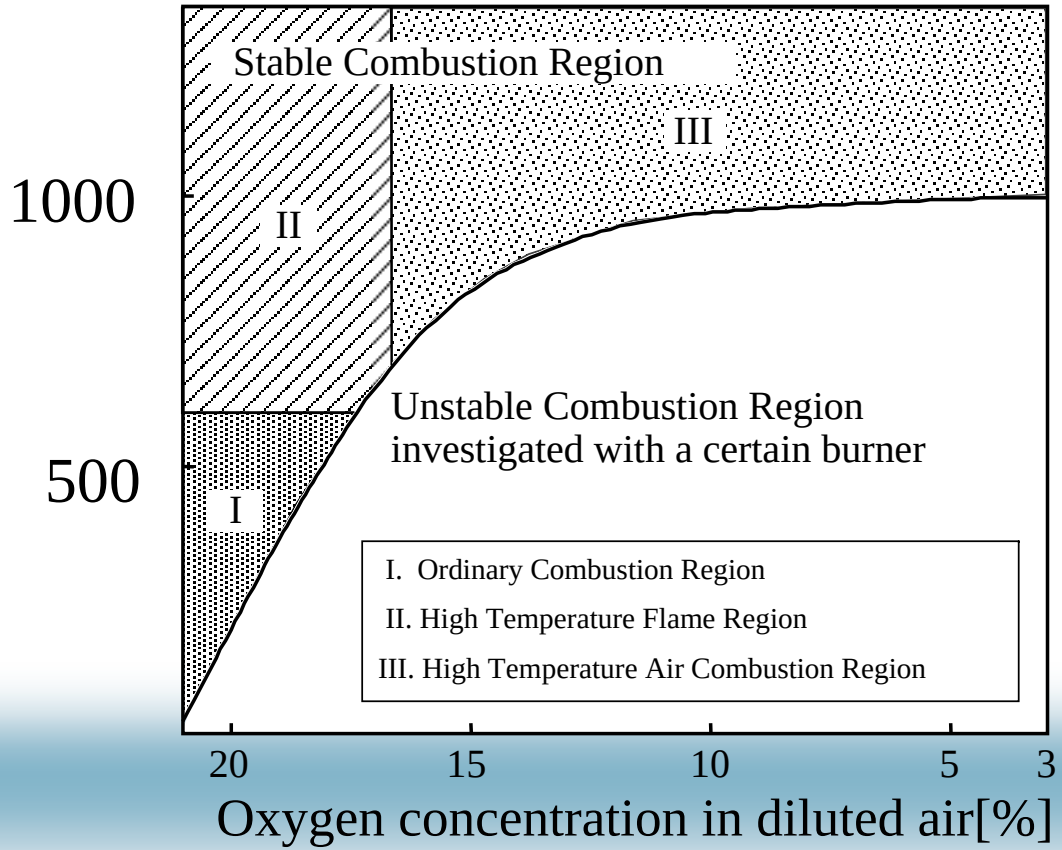
High Performance Industrial Furnace



Concept of High Temperature Air Combustion

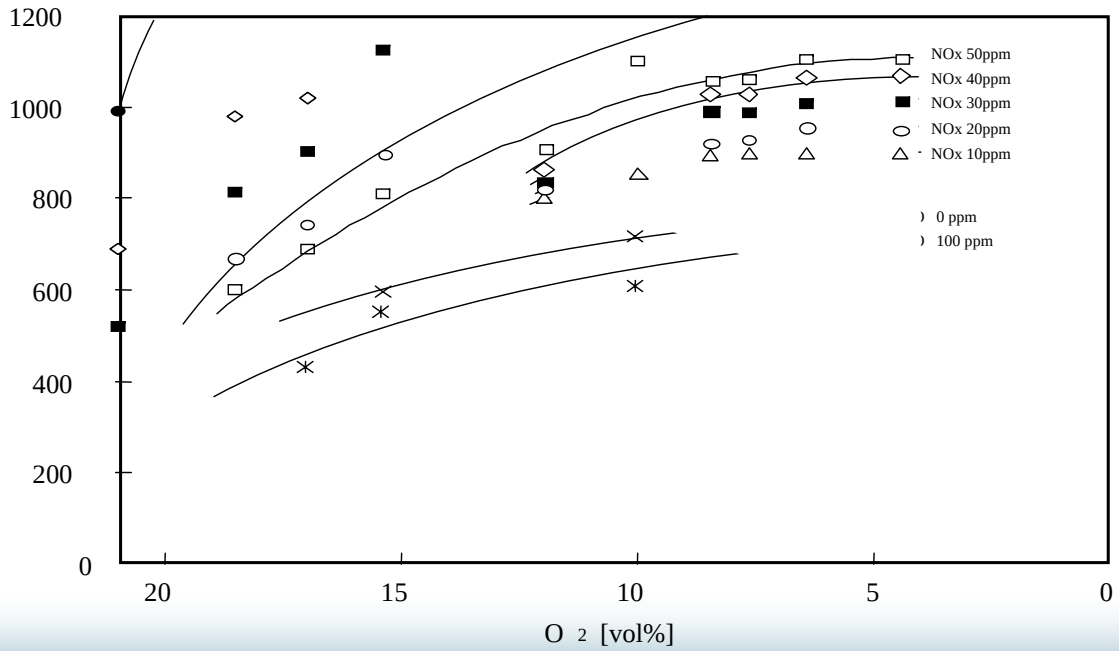
High Performance Industrial Furnace

Concept of High Temperature Air Combustion- Combustion Stability



High Performance Industrial Furnace

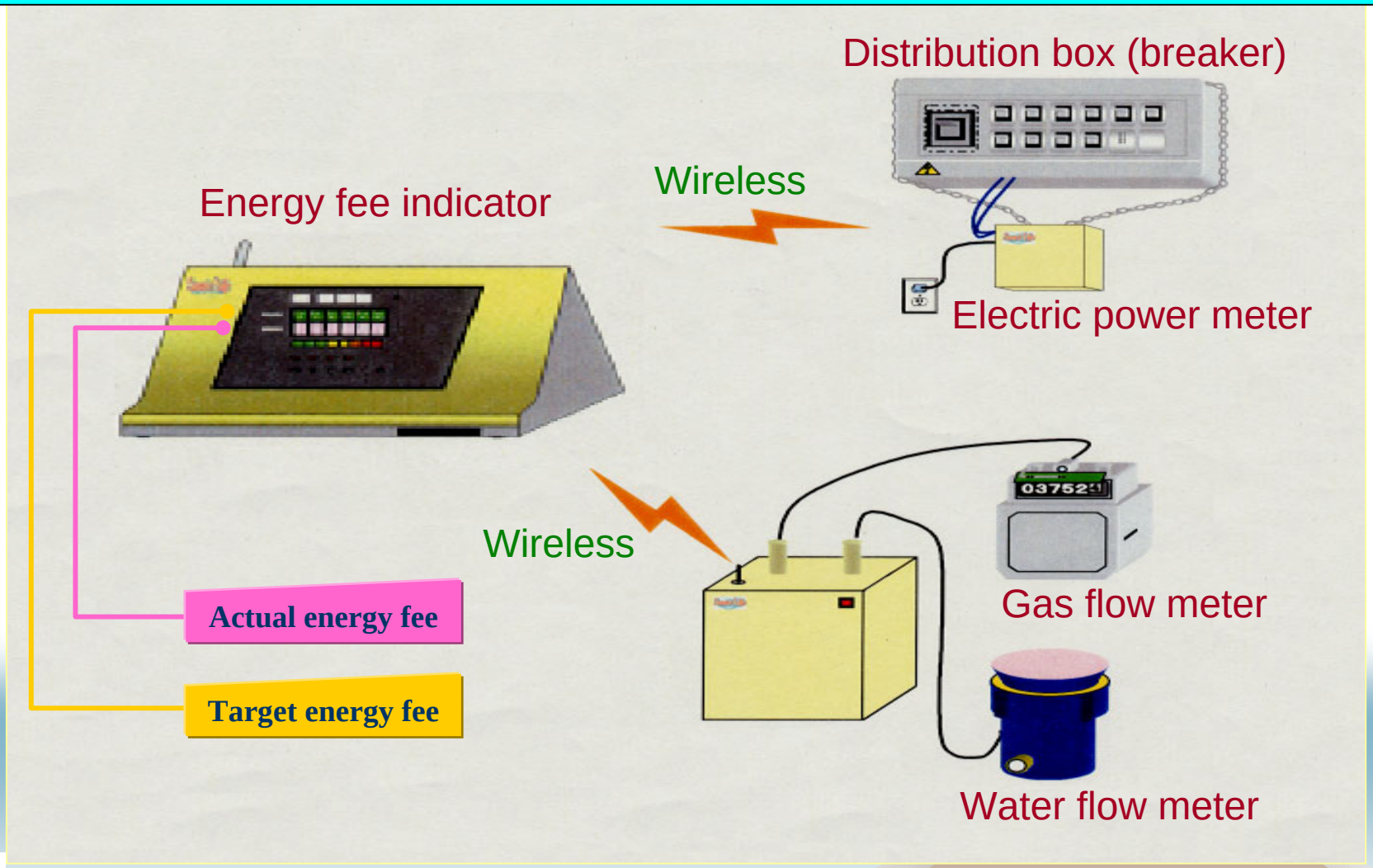
Measured NOx and CO emission affected by Diluted Air Temperature and O_2 concentration



4. Management System

- Energy ‘Navi’
- Overview of Management System
- System Development

Outline of Energy Fee Indication System ("Energy Conservation Navi")

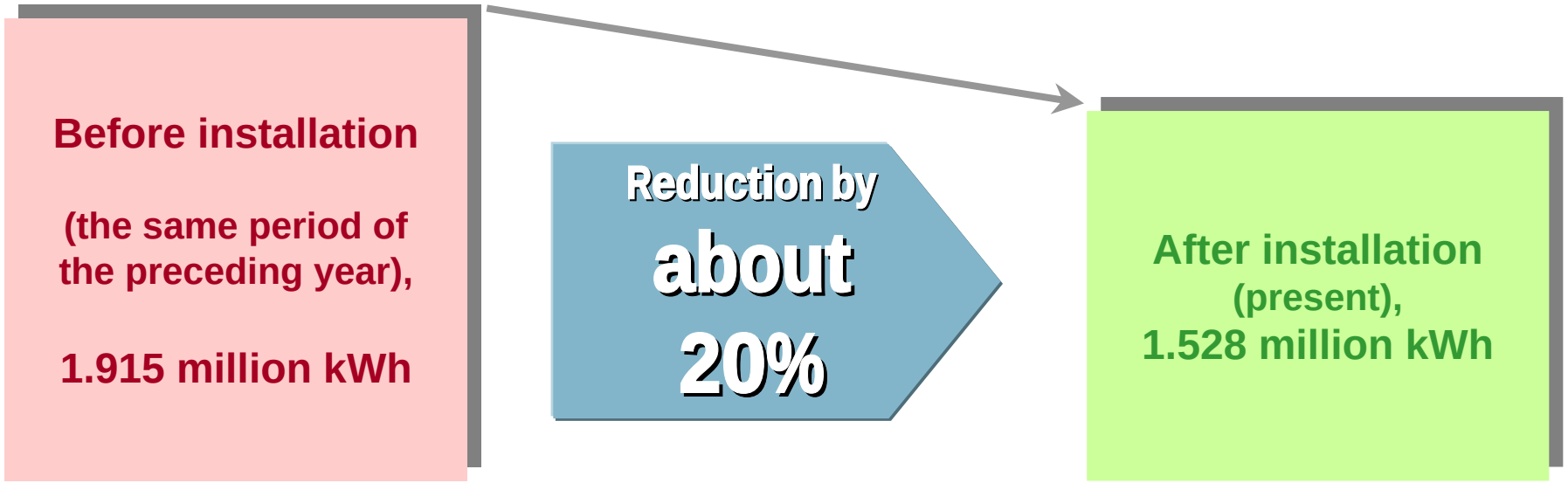


ECCJ

Effect of “Energy Conservation Navi”

Visual Effect

20% of energy saving can be attained by nature by seeing “Navi” frequently.



“Energy Conservation Navi” have been installed since November 1998 at monitors' houses. As of March 1999, Energy Conservation Navi” were installed at 800 houses across the nation.

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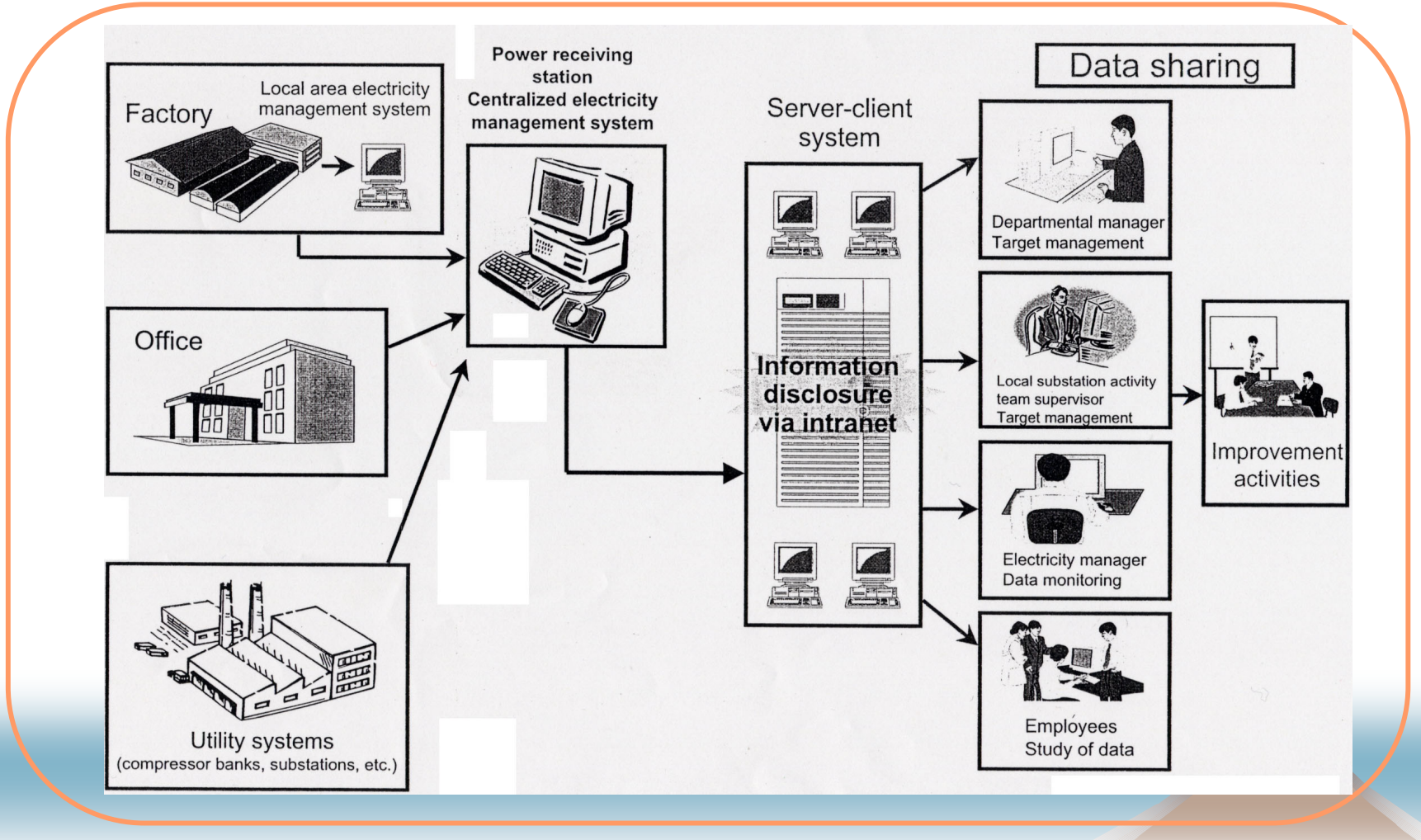
(example) Overview of Electricity Management System



Development of Energy Saving Control Technology for IT:

Energy Savings of 8 to 20% in Households, Office Buildings, and Factories

1.Objective

Electrical devices used in households, office buildings, shops, and factories

2.Main development items (target: 2002)

Using network:

- System that controls the entire loss of electricity minimal
- Information transmission interface that can be integrated into devices
- Compact and highly efficient inverter used in factories

3.Provisional calculations of energy savings upon completion of the development

Households : 20%

Office buildings and shops : 14%

Factories : 8%

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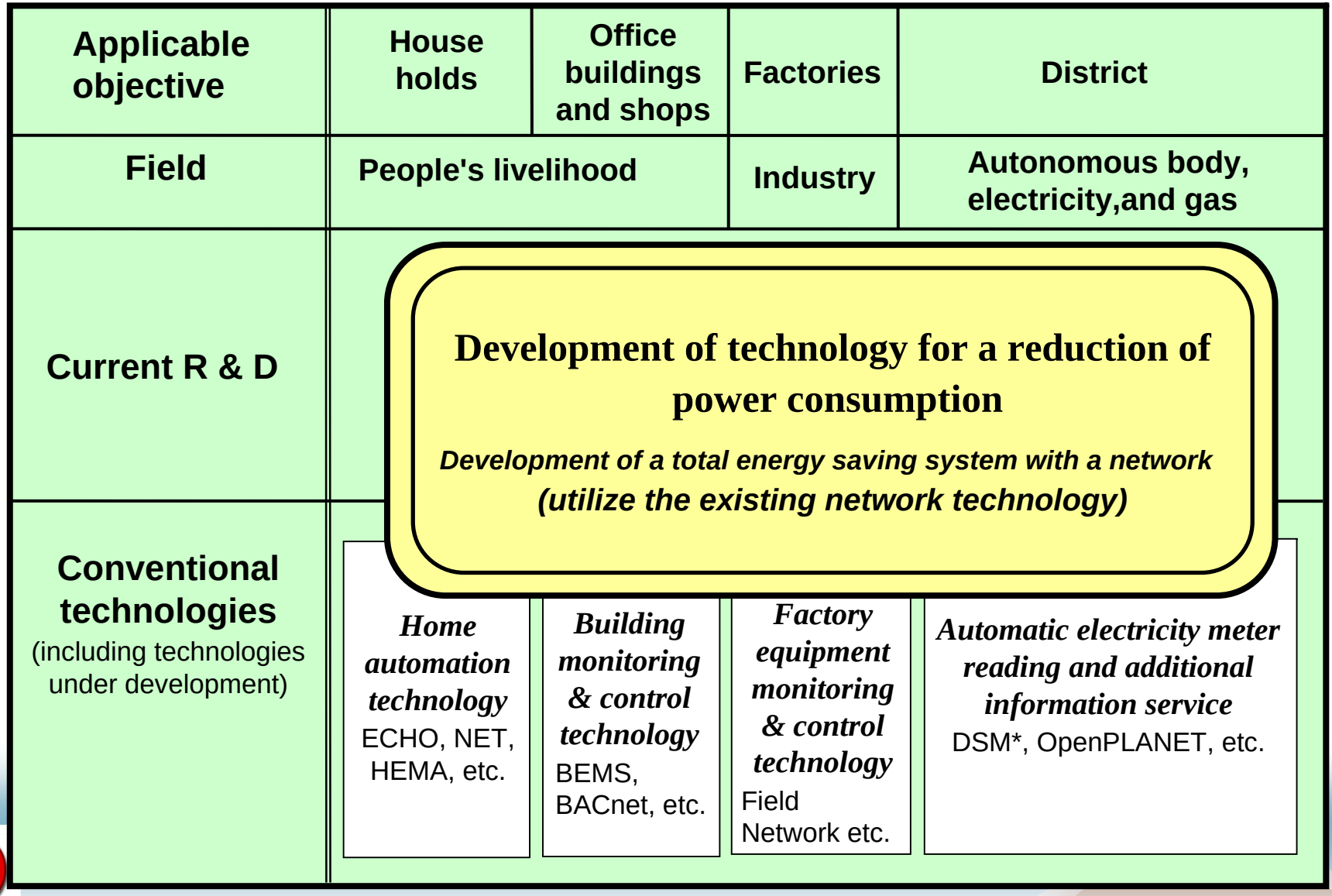
Figure 3: Relationship between Current R&D and Conventional Technologies



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* DSM : Demand Side Management

5. Methodology (Way of Thinking)

- General Energy Management Items
- Promotion Method for Energy Conservation
- Bentimark Activity
- Cleaner Production
- Strategy of NEDO
- International Cooperation Method

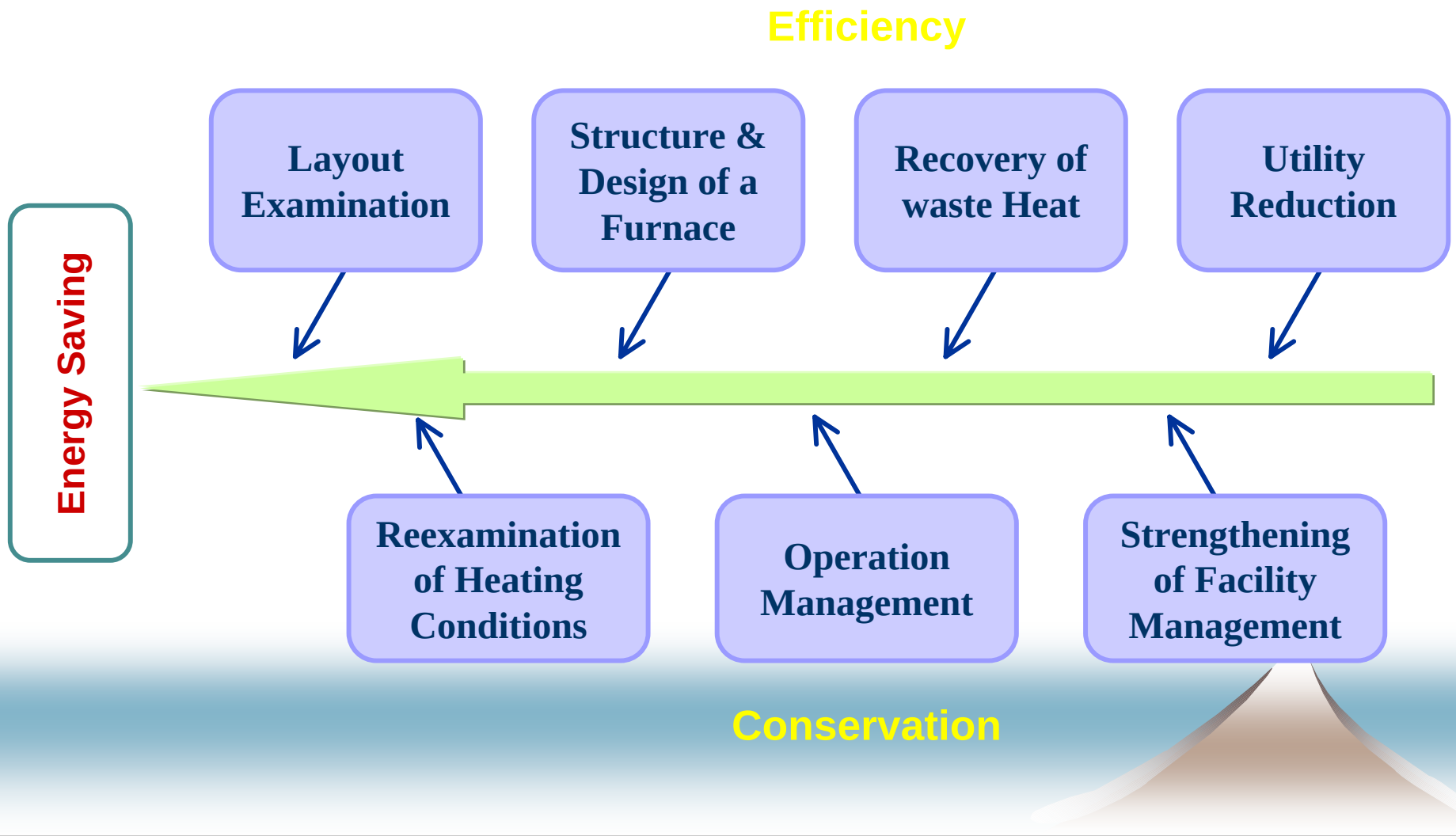
General Energy Management Items

- **Management System**
  - Organization System (CPU)
- **Measurement & Recording**
  - Energy Consumption
    - Daily, Monthly, On Real Time
  - Energy Intensity
    - Products, Consumption Rate
- **Maintenance & Management**
  - Equipment's, Insulation, Cleaning ...
- **Environmental Management**
  - CO2 Reduction, Waste Treatment ...

Items of Thinking

- **Stop : Stop Unnecessary Energy**
- **Repair : Repair Equipment Defect**
- **Turn off : Intermittent**
- **Reduce : Reduce Dresser, Temperature**
- **Recover : Recover Waste Energy**
- **Replace : Energy Source, Equipment Work Procedure**

The Characteristic Factor for Energy Saving



Promotion Method for Energy Conservation

Establish

Setting a target

Grasp the current Energy use

Management of energy intensity

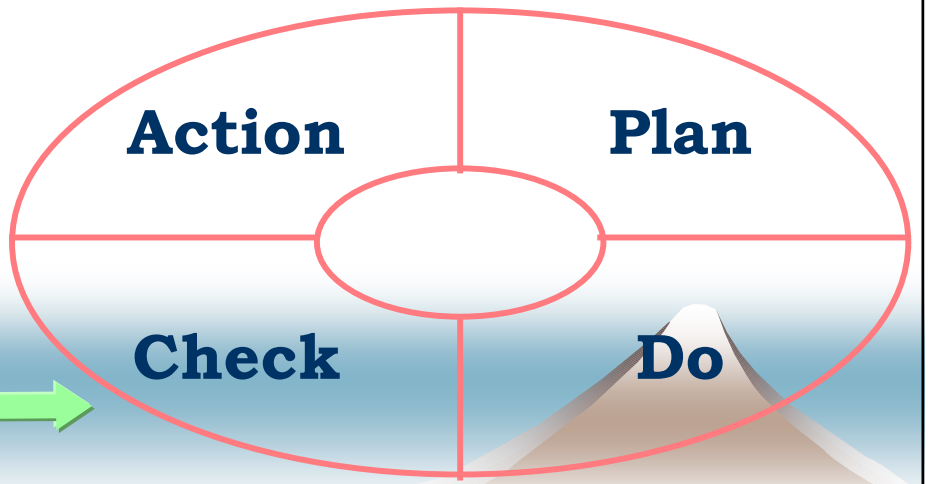
Planning improvement measures

Implementation & Improvement

Very Important

Bench Mark Activities

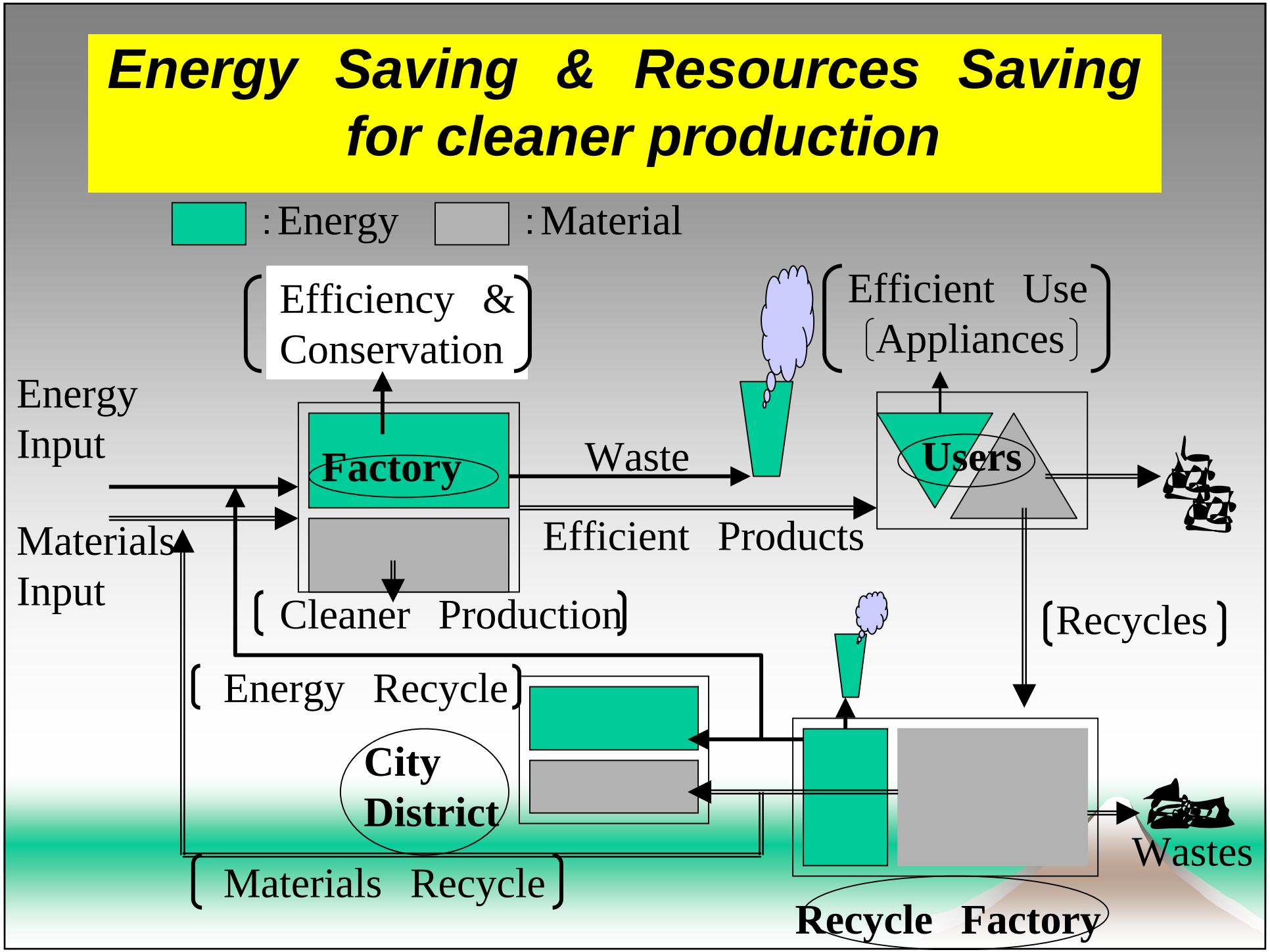
Get information from other industries, countries



Bench Marking of Energy Consumption Unit in Japan

Concept of Bench Marking

- Bench Mark： Target with range
  Best Target Data ,Target Process
- Bench Mark Data：Actual Best Data for establishing Target
- Bench Mark Activity：Activity Story in order to achieving Best Target
- Best Practice: Best Story
- Success Story：Successful Case of Implementation to achieve Best Target


Energy Saving & Resources Saving for cleaner production
: Energy
: Material
Efficiency & Conservation
Efficient Use (Appliances)
Energy Input
Materials Input
Factory
Waste
Users
Efficient Products
Cleaner Production
Recycles
Energy Recycle
City District
Materials Recycle
Wastes
Recycle Factory

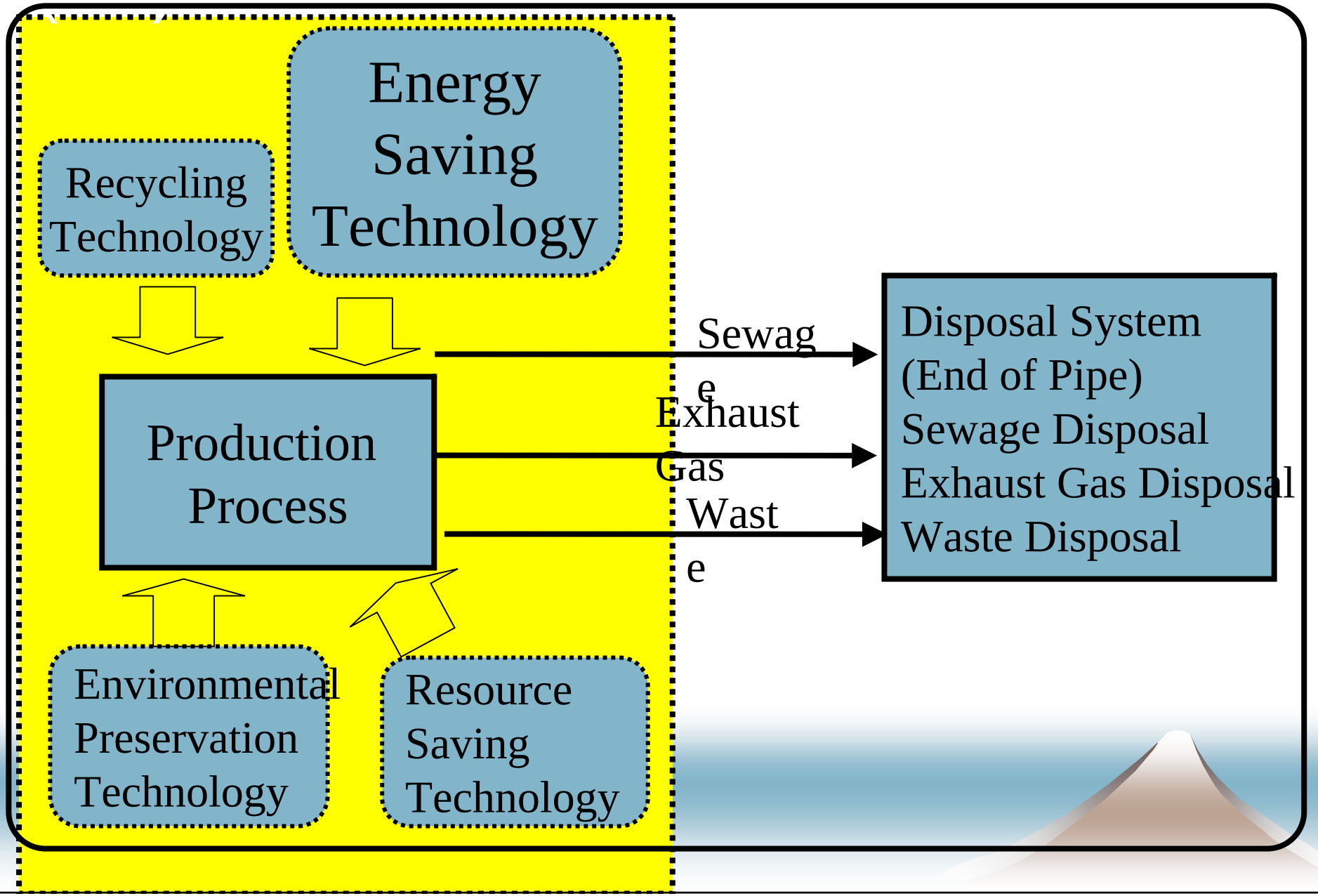
Concepts of Cleaner Production (1)

- Technologies of Air Pollution, Water Pollution and Water Treatment were called *End of Pipe .* Technology Because they disposed of pollutants at outlet.

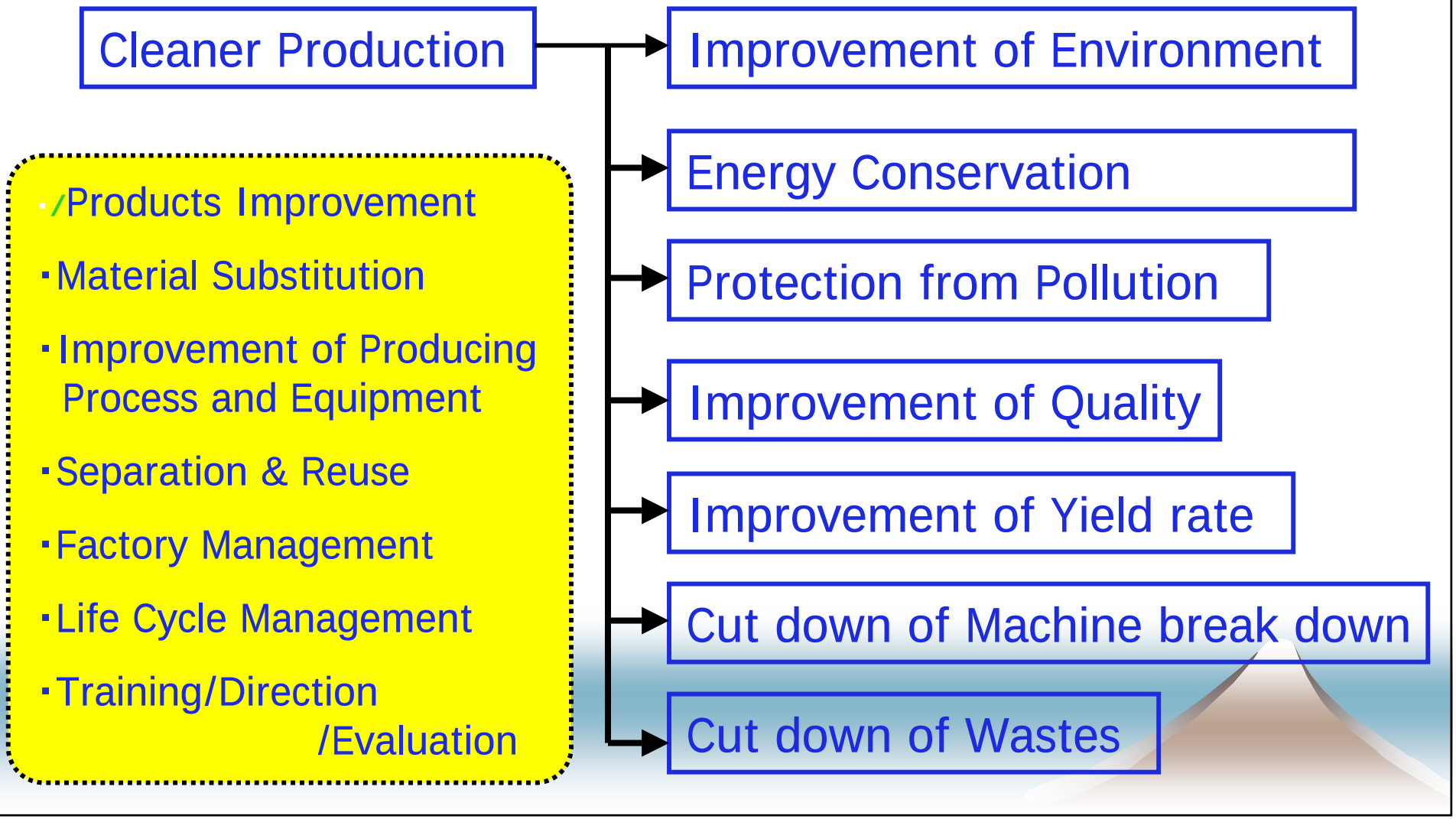
  (Against that, in Agenda 21 adopted by “United Nations Conference on Environment and Development (*Global Summit*) ” in 1992, “Cleaner Production (CP)” was suggested to progress.)

- CP includes not only the conventional technologies for each measure (*Hard Technology*), but the technologies by manageable methods (*Soft Technology*), based on the idea of reducing the environmental burden in every process from extracting of raw materials to disposal of products and reuse.

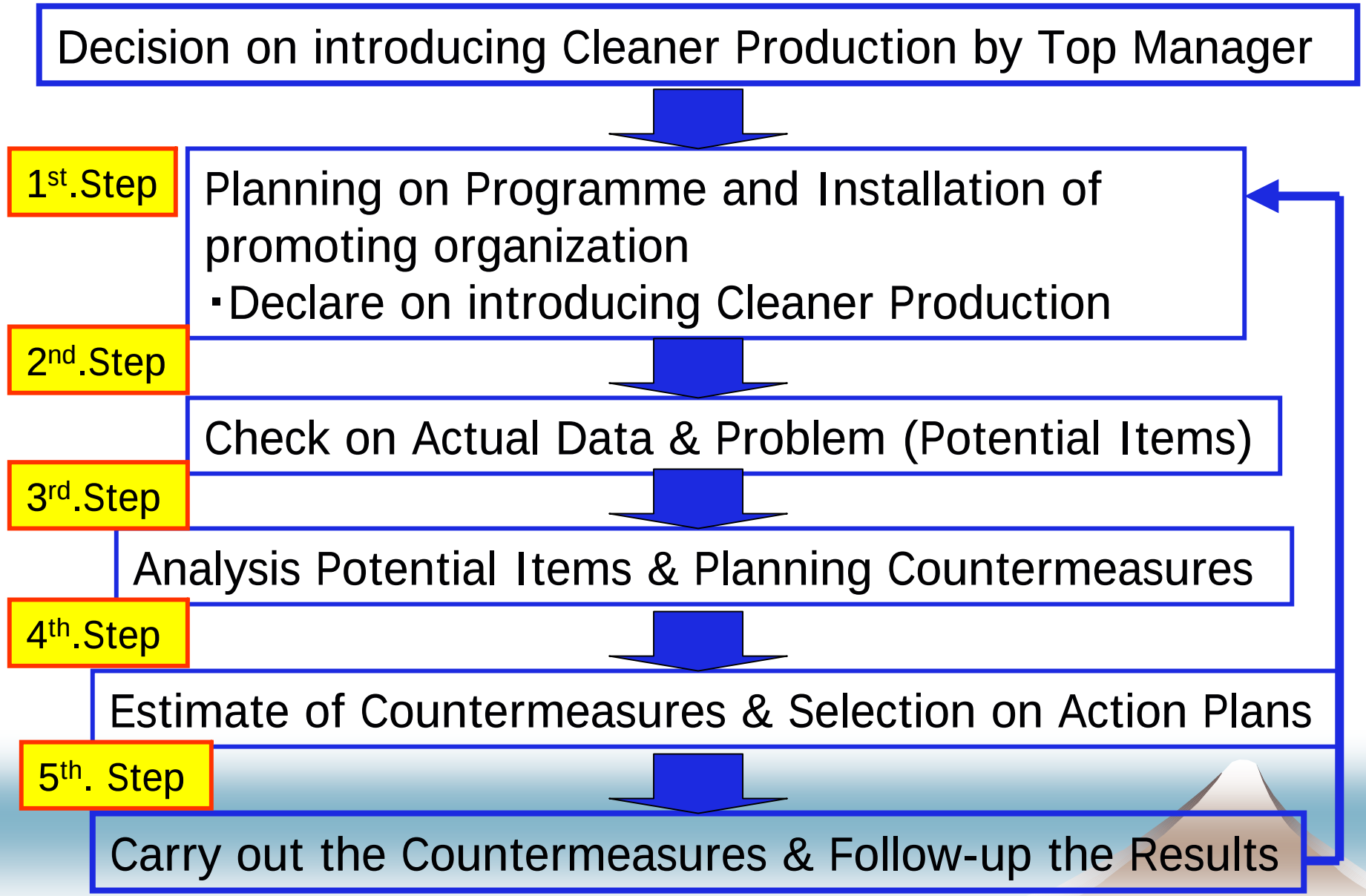
Concept of Cleaner Production (CP)



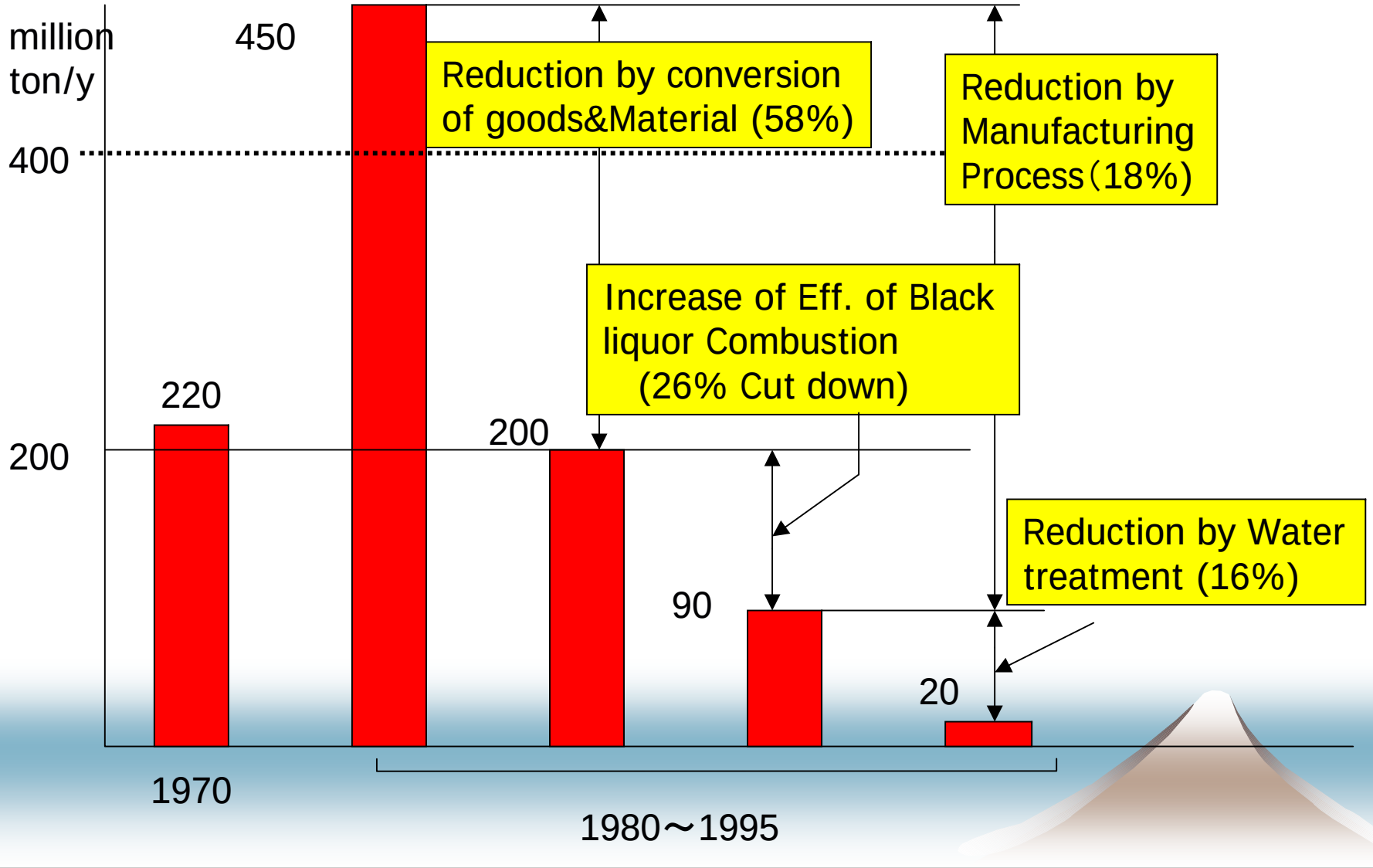
Objects of Cleaner Production



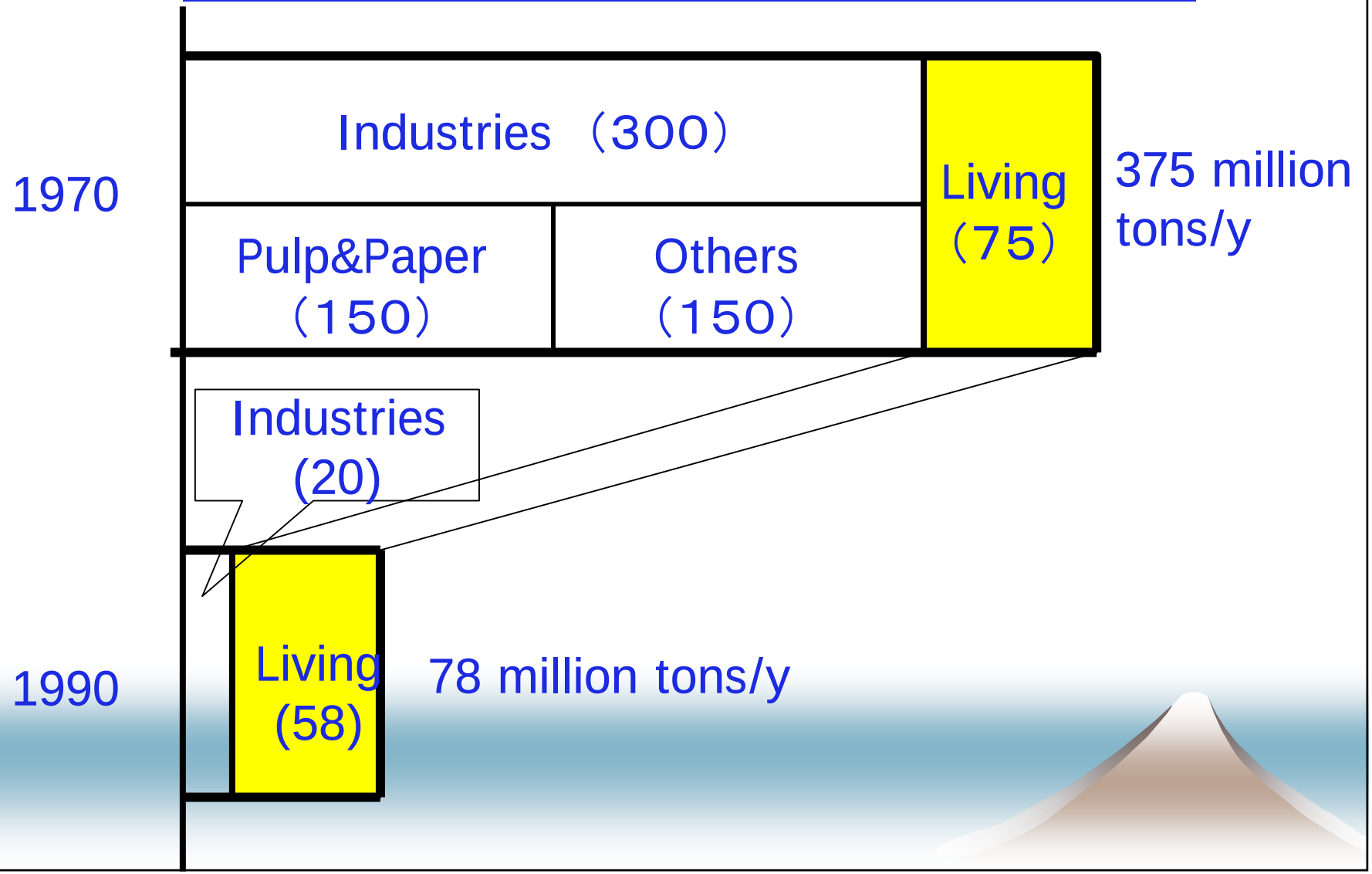
Promoting Procedure on Programme of "CP"



Reduction trend of COD of Pulp&Paper industry



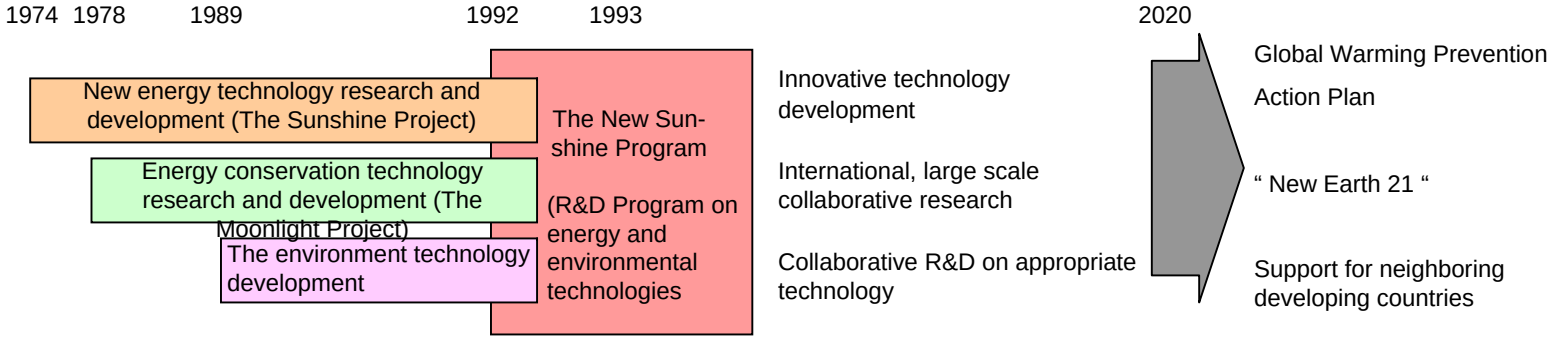
Discharge Load of BOD (Japan)



Strategy of NEDO for Environment & Energy Efficient Technology

(NEDO : New Energy and Industrial Technology Development Organization)

1. New Sunshine Program (New Technology Development)



2. Energy Efficiency Oriented International Cooperation

International Cooperation Center

- FS & Model Project
- Database Project
- Technology Transfer

3. Environment Oriented Technology

Environment Technology Development Office

- FS & Environment Technology Project
- Technology Transfer

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6. Energy Saving Technology

- Common (many industries)
- Process (example of Iron & Steel,Ceramic, Pulp & Paper, Power Generation)
- Power Plant, Cascade Utilization
- HiTAC (High Temperature air Combustion Technology)

Classification of Energy Saving Technology

1. Process Technology :

(1) Common Technology

(2) Process Technology

Production Equipment

Auxiliary Machinery & Equipment

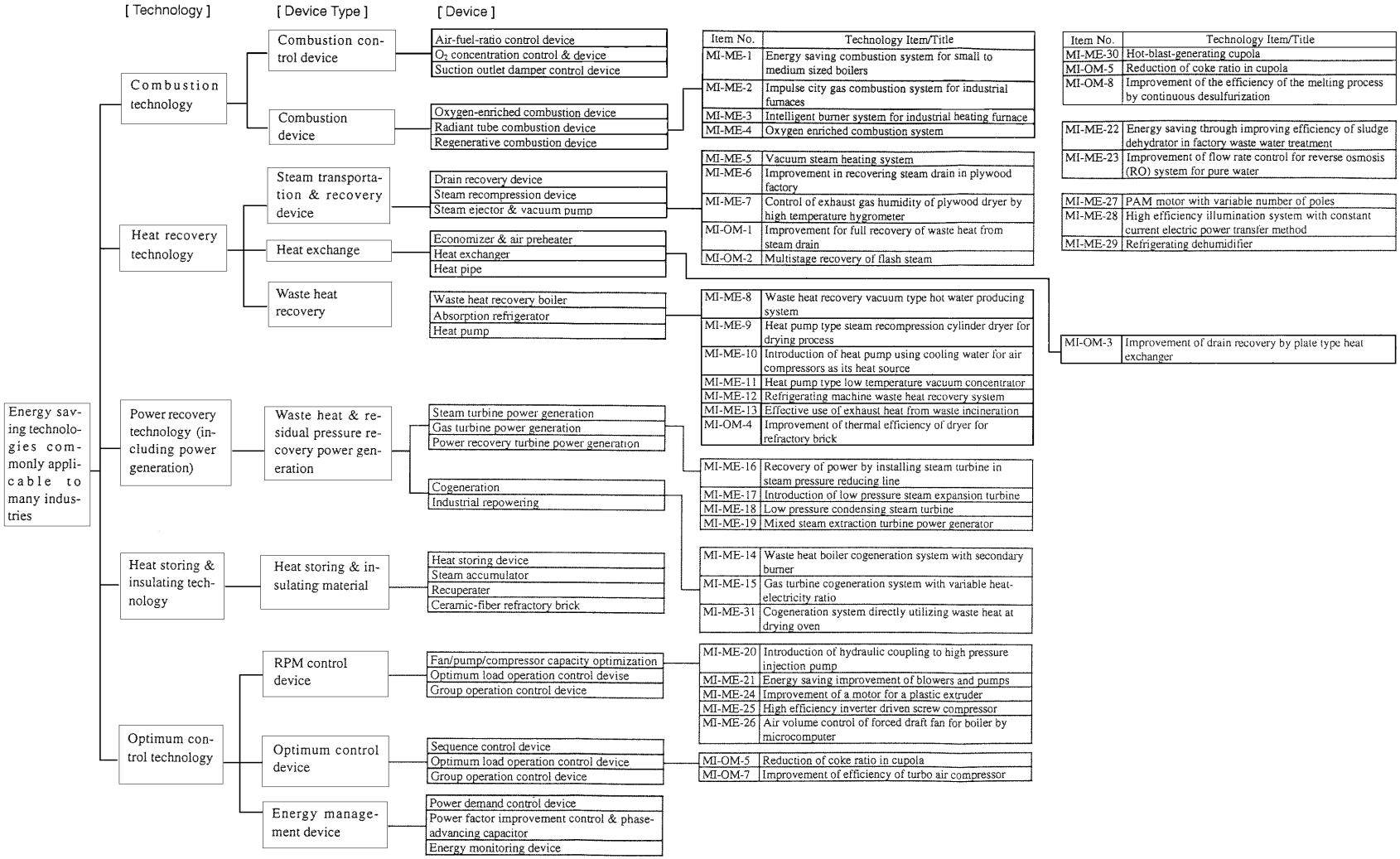
Operation & Management

2. Energy Manager System:

Heat:Thermal Conservation Technology

Electricity :Electrical Conservation Technology

Flow diagram of energy saving technologies applicable to many industries



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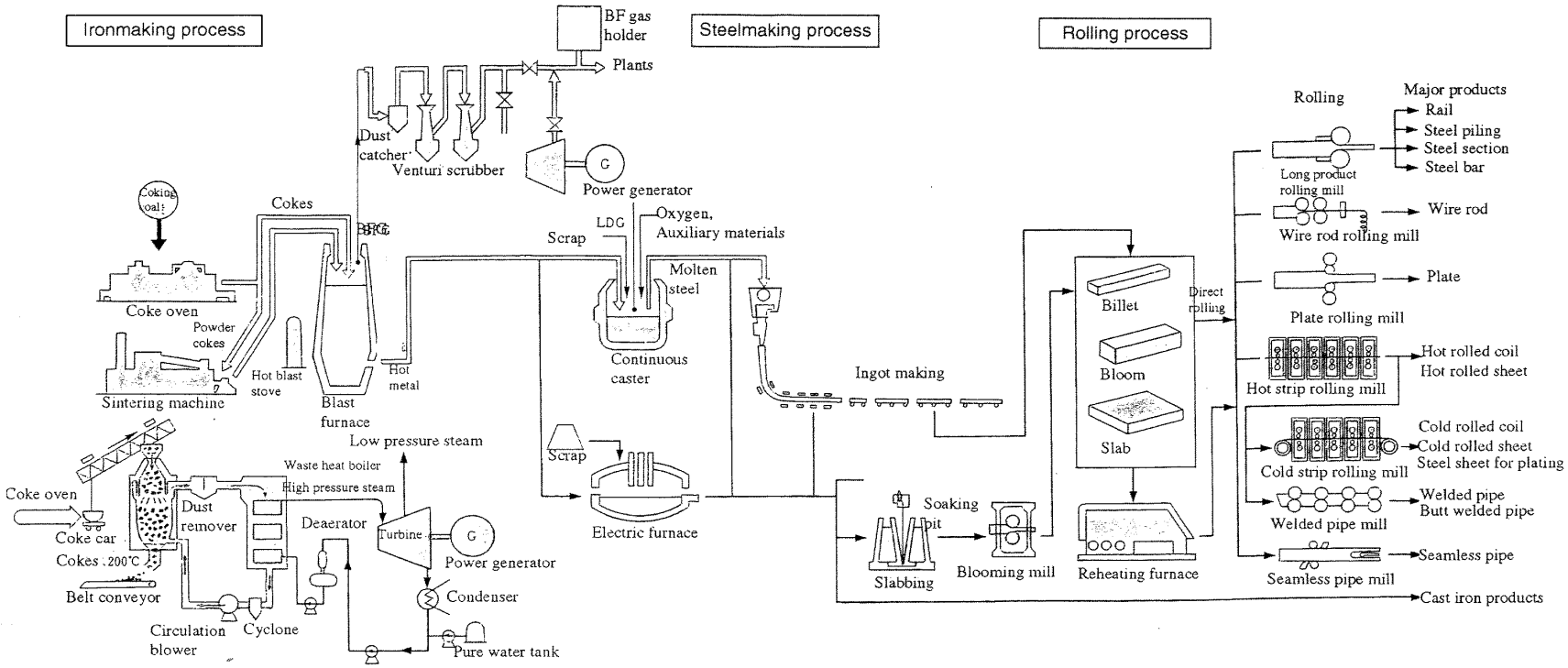
Iron & Steel : Production Process and Energy Saving Technology



Item No.	Technology Item/Title
IS-PE-1	Improvement in segregated charging of sintering materials
IS-ME-1	Coal drying and moisture control equipment for coke oven
IS-ME-2	Coke dry quenching
IS-ME-3	Exhaust heat recovery system for sintered ore cooling equipment
IS-ME-4	Sensible heat recovery from main exhaust gas of sintering machine
IS-OM-1	Automatic combustion control of coke oven
IS-OM-2	Blast furnace operation control system
IS-OM-3	Blast furnace hot blast valve control system
IS-OM-4	Blast furnace burden distribution control

Item No.	Technology Item/Title
IS-PE-2	Pulverized coal injection for blast furnace
IS-PE-3	BF top-pressure recovery turbine

Item No.	Technology Item/Title
IS-PE-4	DC arc furnace with water cooled furnace wall
IS-PE-5	Continuous casting machine
IS-PE-10	High frequency melting furnace
IS-PE-11	Channel induction furnace for cast iron melting
IS-PE-12	Ferroalloy furnace for effective energy utilization
IS-ME-5	Hot stove exhaust heat recovery equipment
IS-ME-6	BOF exhaust gas recovery device (including sealed BOF)
IS-ME-7	BOF gas sensible heat recovery apparatus
IS-ME-8	Raw material preheater for electric arc furnace
IS-ME-9	Heating furnace with regenerative burners
IS-ME-10	Ladle heating apparatus with regenerative burners
IS-OM-5	Energy saving operation of electric arc furnace

Item No.	Technology Item/Title
IS-PE-6	Hot charging and direct rolling mill
IS-PE-11	Channel induction furnace for cast iron melting
IS-PE-12	Ferroalloy furnace for effective energy utilization
IS-ME-9	Heating furnace with regenerative burners
IS-ME-11	High performance heating furnace
IS-ME-12	Recovery of sensible heat from skid cooling water in heating furnace
IS-ME-13	Descaling pump (conversion to plunger pump)
IS-OM-6	Operation improvement of heat treatment furnace

Item No.	Technology Item/Title
IS-PE-7	Continuous annealing line
IS-PE-8	Convection heating type heat treatment furnace for wire rod coil
IS-PE-9	Low temperature forge welded pipe production method

IS-ME-14	High efficiency gas separation apparatus
IS-OM-7	Centralized energy management (Energy center)

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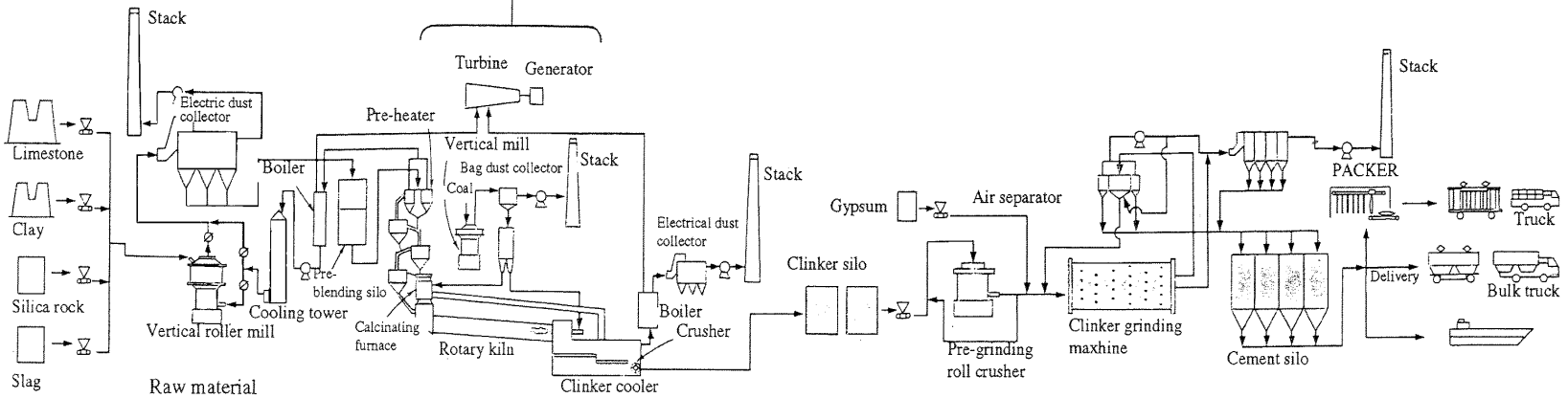
Ceramic (Cement) : Production Process and Energy Saving Technology

Item No.	Technology Item/Title
YC-ME-5	Cement production process: Medium-to-low-temperature flue gas power plant



Item No.	Technology Item/Title
YC-PE-2	Cement clinker burning process: Adoption of suspension preheater (SP)
YC-PE-3	NSP-type cement calcining furnace
YC-ME-2	Cement burning process: Modification of a conventional suspension preheater to a five-stage cyclone suspension preheater
YC-ME-3	Clinker burning process: Small-pressure-drop suspension preheater
YC-ME-4	Burning of used tires as substitute fuel for cement kiln

Item No.	Technology Item/Title
YC-PE-5	Cement production finishing section: Introduction of pre-grinding roll crusher in the finishing section (Roller press)
YC-PE-6	Cement production finishing section: Introduction of clinker pre-grinding roll crusher (Pre-grinder)
YC-PE-7	Adoption of a high-efficiency separator in the finishing process

Item No.	Technology Item/Title
YG-PE-1	Introduction of electric furnace instead of crucible furnace for melting glass
YC-ME-1	Rock crushing process: Adoption of external rock transfer system to the roller mill crusher

Item No.	Technology Item/Title
YC-PE-8	Cement clinker burning process: Adoption of high-efficiency quenching cooler

Item No.	Technology Item/Title
YC-PE-4	Cement clinker burning process: Adoption of vertical roller mill for coal crushing

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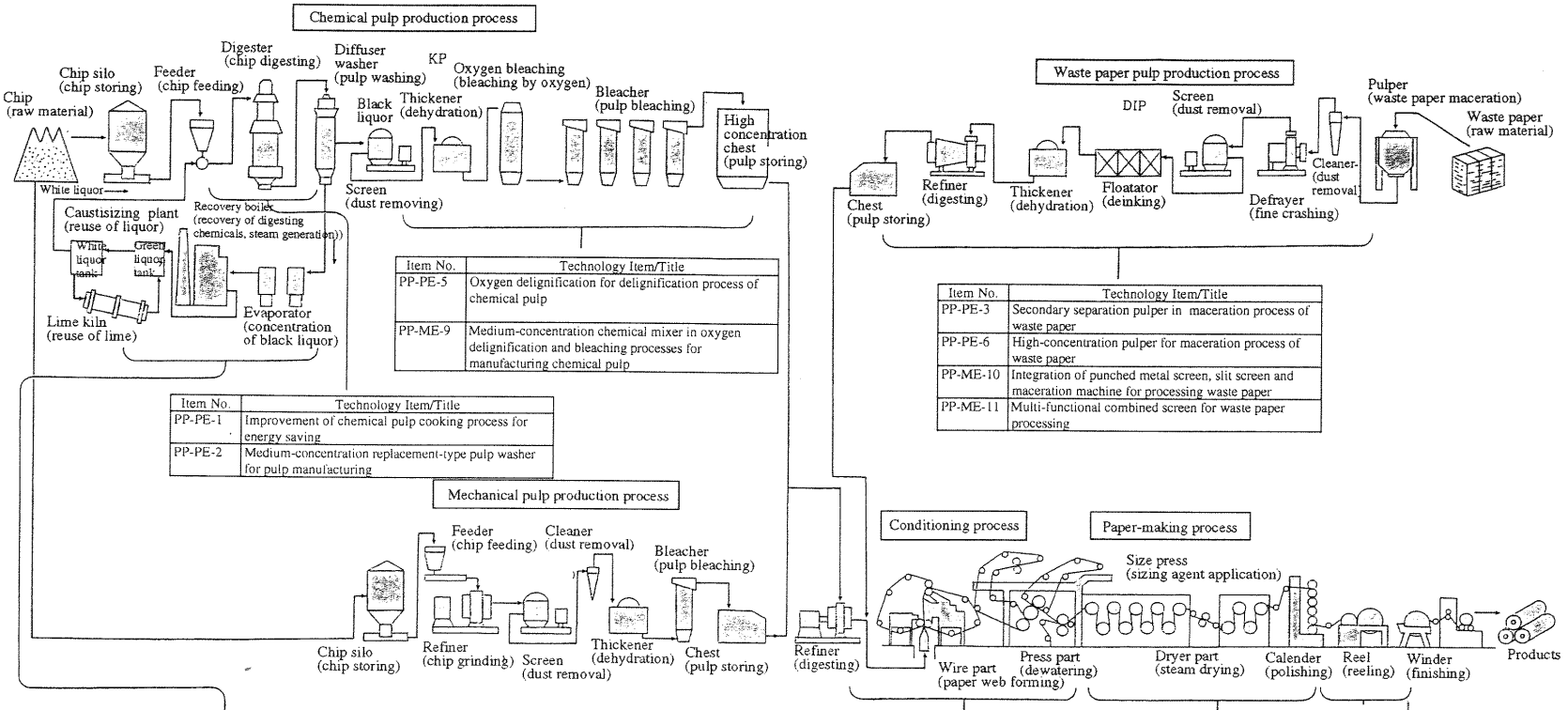
Pulp & Paper : Production Process and Energy Saving Technology



Item No.	Technology Item/Title
PP-PE-5	Oxygen delignification for delignification process of chemical pulp
PP-ME-9	Medium-concentration chemical mixer in oxygen delignification and bleaching processes for manufacturing chemical pulp

Item No.	Technology Item/Title
PP-PE-3	Secondary separation pulper in maceration process of waste paper
PP-PE-6	High-concentration pulper for maceration process of waste paper
PP-ME-10	Integration of punched metal screen, slit screen and maceration machine for processing waste paper
PP-ME-11	Multi-functional combined screen for waste paper processing

Item No.	Technology Item/Title
PP-PE-1	Improvement of chemical pulp cooking process for energy saving
PP-PE-2	Medium-concentration replacement-type pulp washer for pulp manufacturing

Item No.	Technology Item/Title
PP-ME-1	High-temperature odorless Heat Recovery Boiler
PP-ME -2	Plate-type multi-effect liquid-film evaporator for condensing black liquor of chemical pulp

Item No.	Technology Item/Title
PP-PE-4	High-concentration size press
PP-ME-6	High efficiency dehydrator for dryer of paper-making machine
PP-ME-12	Energy saving in crown controlling roll
PP-ME-13	High-temperature soft calender for paper making

Item No.	Technology Item/Title
PP-ME-3	Dryer with dryer bars installed inside for paper-making machine
PP-ME-4	Installation of steam-recompression heat pump on paper-making dryer
PP-OM-1	Improvement of dryer part hood to closed type
PP-OM -2	Energy saving of vacuum pump for paper-making machine

Item No.	Technology Item/Title
PP-ME-7	Heat recovery by sludge incinerator
PP-ME-8	Re-powering system and gas turbine waste heat boiler

Item No.	Technology Item/Title
PP-ME-5	Heat recovery from thermo-mechanical pulp (TMP) in mechanical pulp manufacturing process
PP-OM-3	Energy efficient production process of thermo-mechanical pulp (TMP)

Item No.	Technology Item/Title
PP-ME-14	AC driving of paper-making machine and winder system
PP-ME-15	Rotation control of equipment in paper-making process

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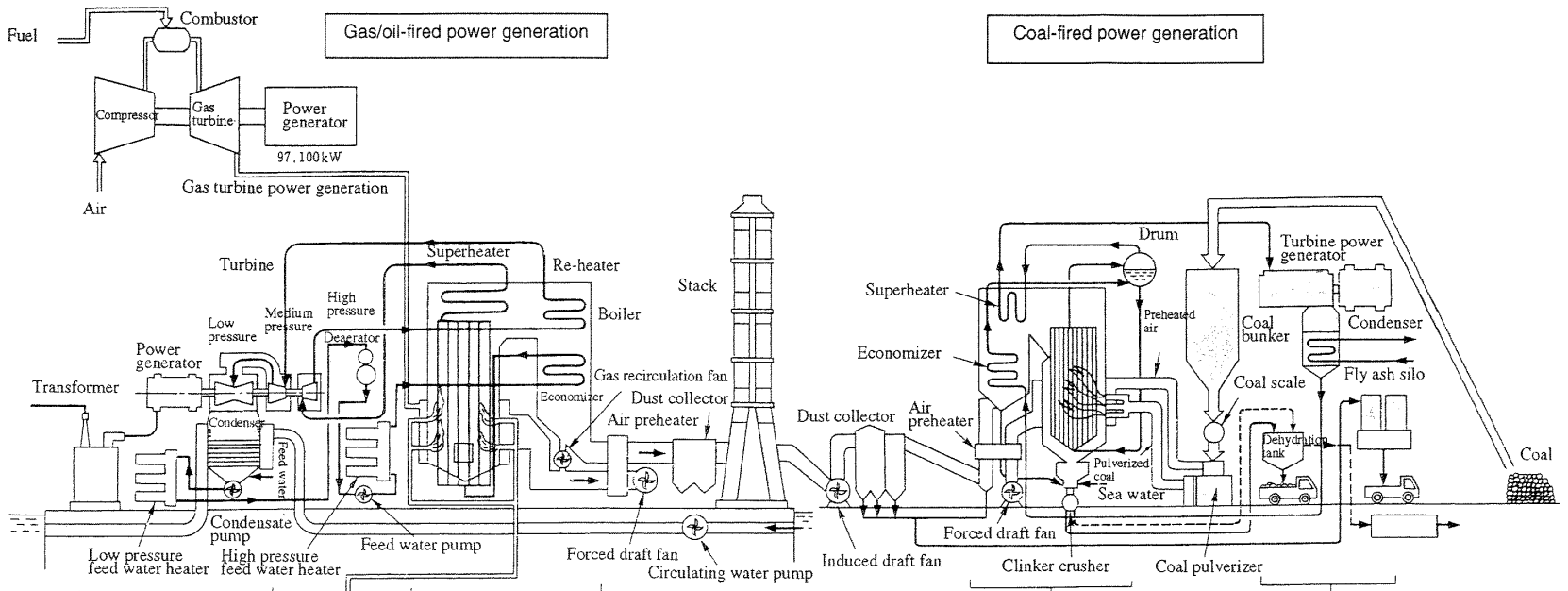
Electricity Generation : Power Generation and Energy Saving Technology



Item No.	Technology Item/Title
EG-PE-1	High efficiency steam turbine blade
EG-PE-2	Supercritical pressure power generation
EG-PE-3	Combined gas and steam turbine power generation
EG-PE-4	Waste heat recovery power generation
EG-ME-4	Removal method of scale from inside condenser tubes
EG-ME-5	Air cooler for gas turbine combustion air

Item No.	Technology Item/Title
EG-ME-1	Rotating regenerative air preheater automatic seal gap controller
EG-ME-2	Carbon-sealed regenerative air preheater for boiler
EG-ME-3	Separate type heat pipe heat exchanger
EG-ME-6	Large sized boiler soot blower
EG-ME-9	Rotation speed control of large boiler blower and exhauster through wet type multi-plate speed reducer

Item No.	Technology Item/Title
EG-OM-1	Low-pressure operation of natural circulation boiler
EG-OM-2	Operation method of increased temperature of main steam at boiler outlet
EG-OM-3	Gas recirculating steam temperature control system
EG-OM-4	Reduction of starting-up time of cold plant

Item No.	Technology Item/Title
EG-PE-5	Fluidized bed combustion coal fired boiler

Item No.	Technology Item/Title
EG-PE-6	Pressurized fluidized bed composite coal fired power plant (PFBC)

Item No.	Technology Item/Title
EG-ME-7	Repowering combined cycle system of exhaust repeat combustion type
EG-ME-8	Industrial repowering system

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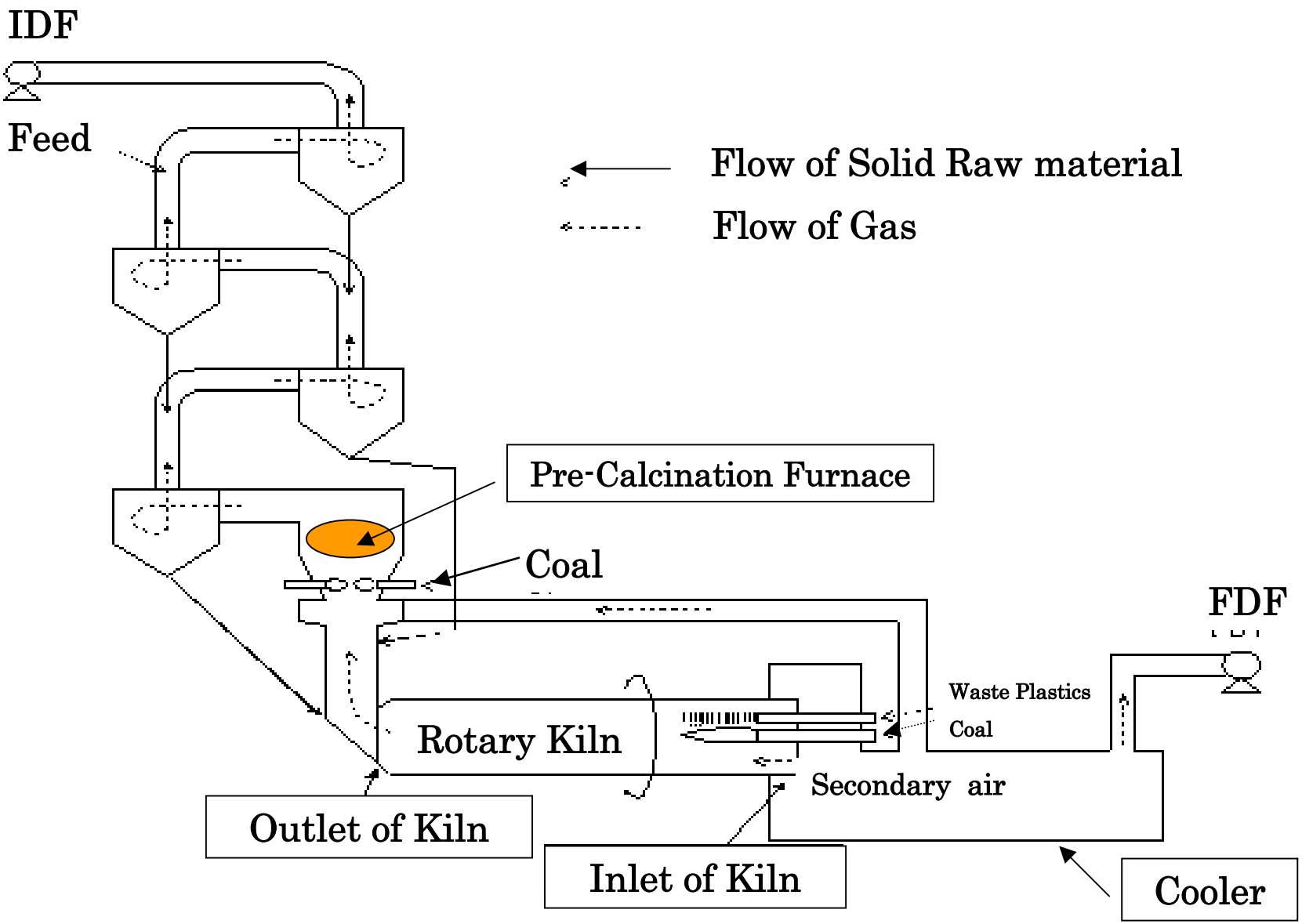
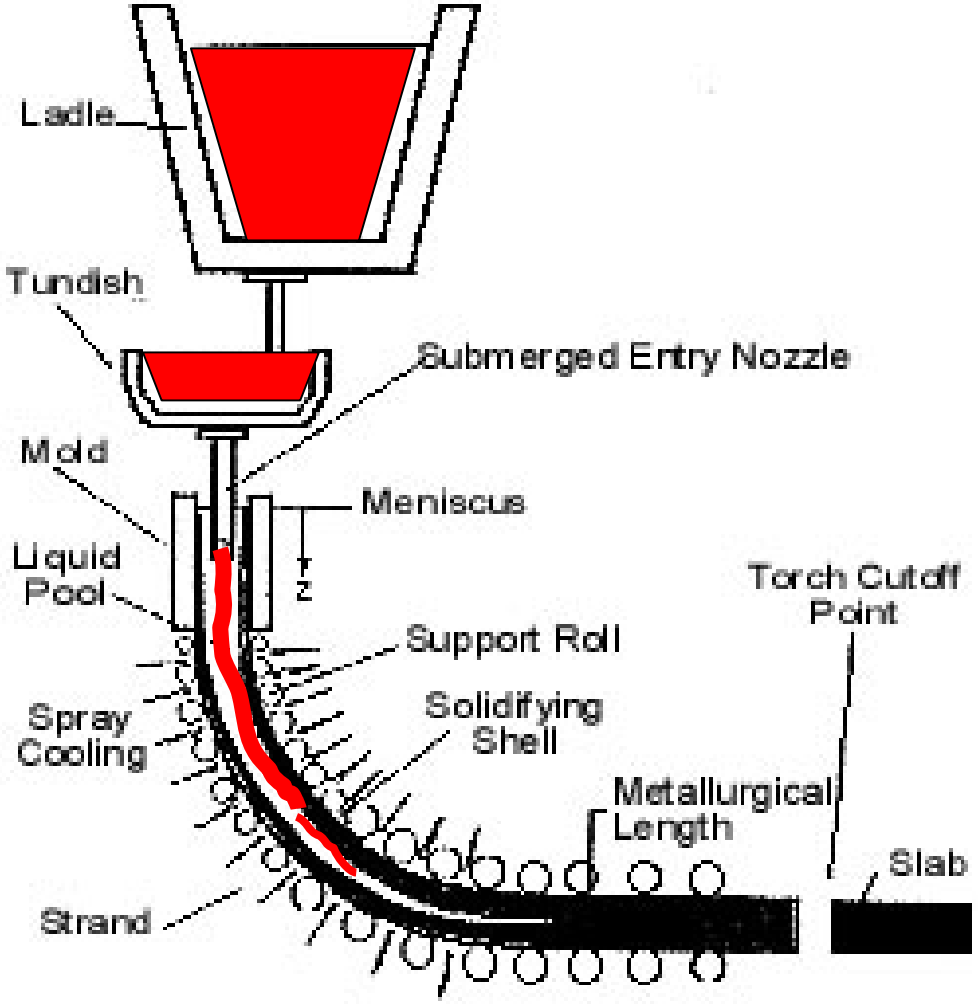
Effect of Measures and Dissemination Rate of Typical Equipment for Energy Conservation

Industry	Decrease of Energy Intensity (94/73)	Typical Energy Conservation Equipment	Dissemination Rate as of 1998
Iron &Steel	29 %	Continuous caster (CC)	100 %
		Blast furnace top gas pressure recovery equipment (TRT)	100 %
		Coke dry quenching equipment (CDQ)	91 %
Petrochemical	58 %	High-efficiency naphtha cracking reactor	100 %
		High efficiency compressor	100 %
		Gas turbine	100 %
Cement	65 %	SP, NSP kiln (Heat recovery)	100 %
Paper & Pulp	61 %	Continuous digester	100 %

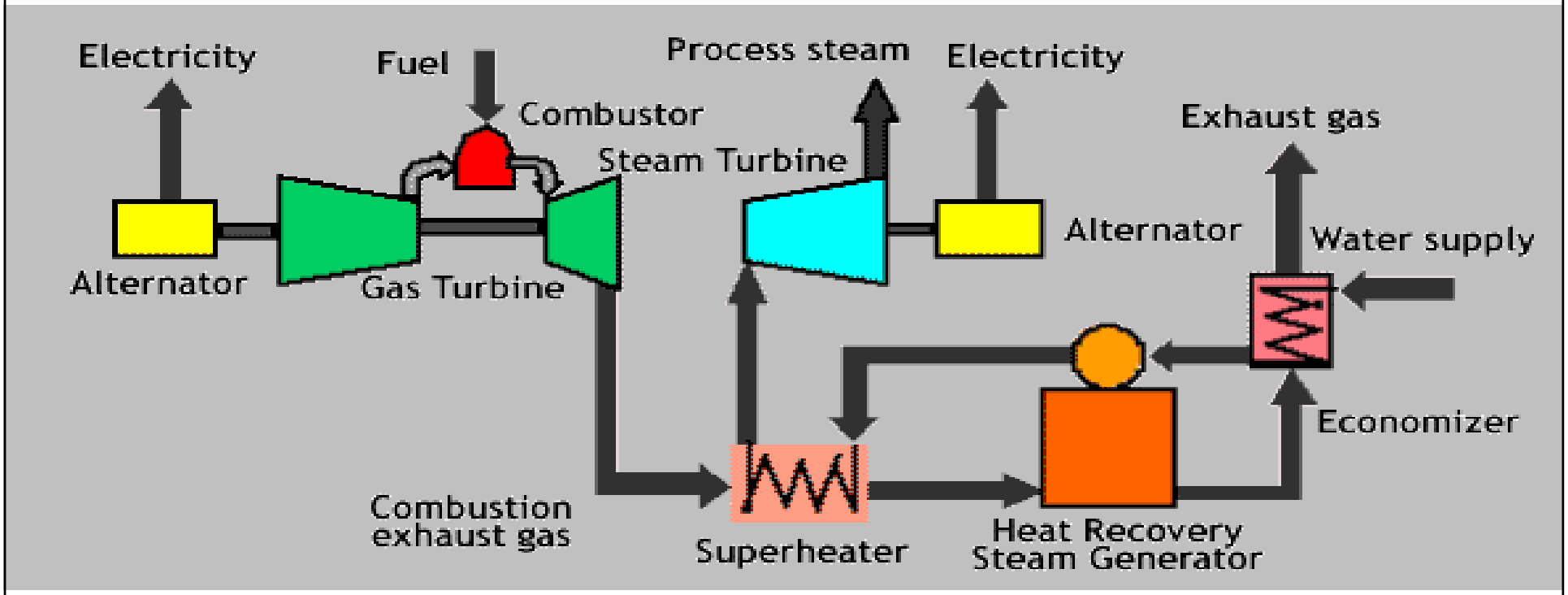
Source : ECCJ



New type Cement Kiln

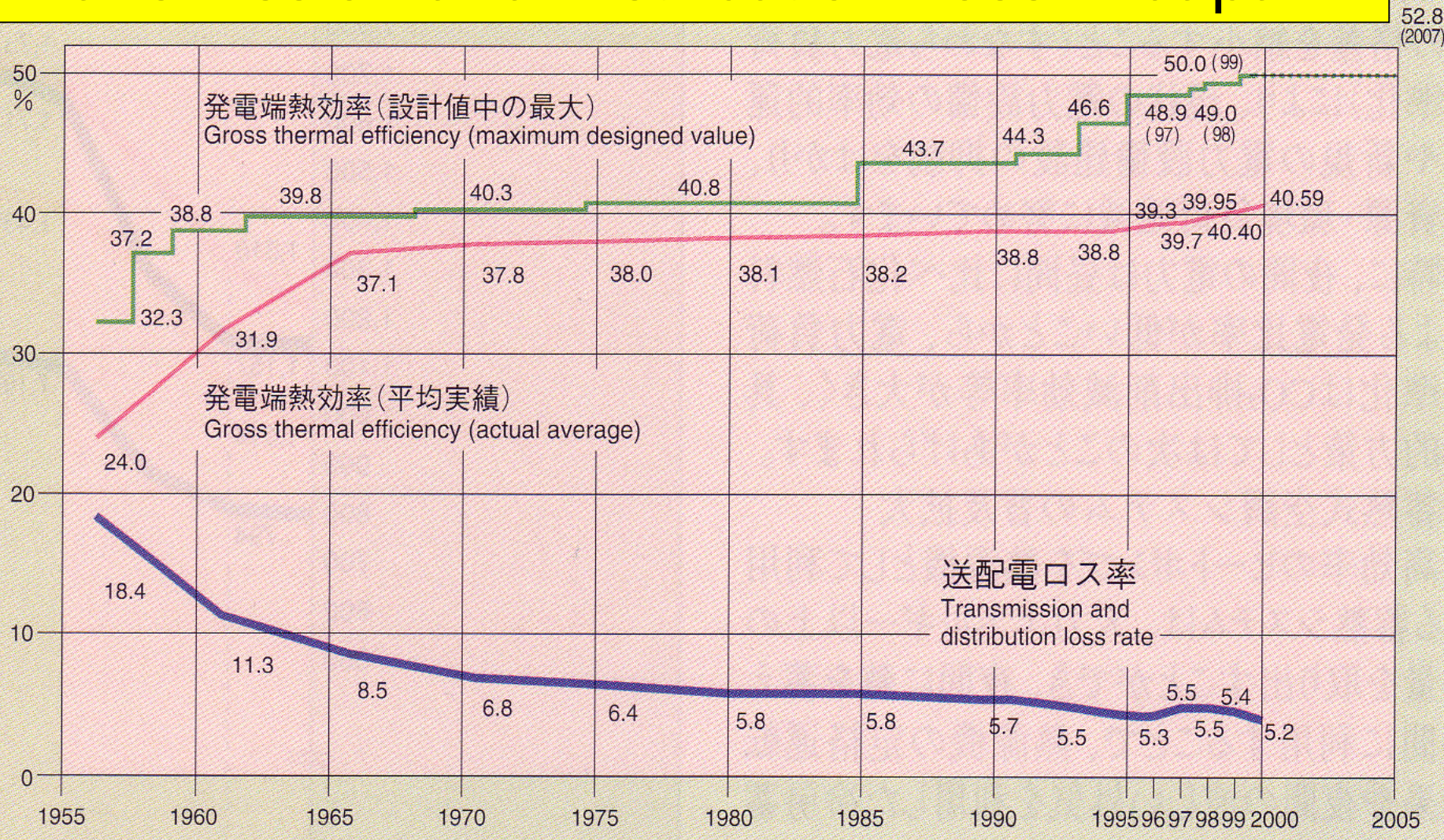


Continuous caster (CC)



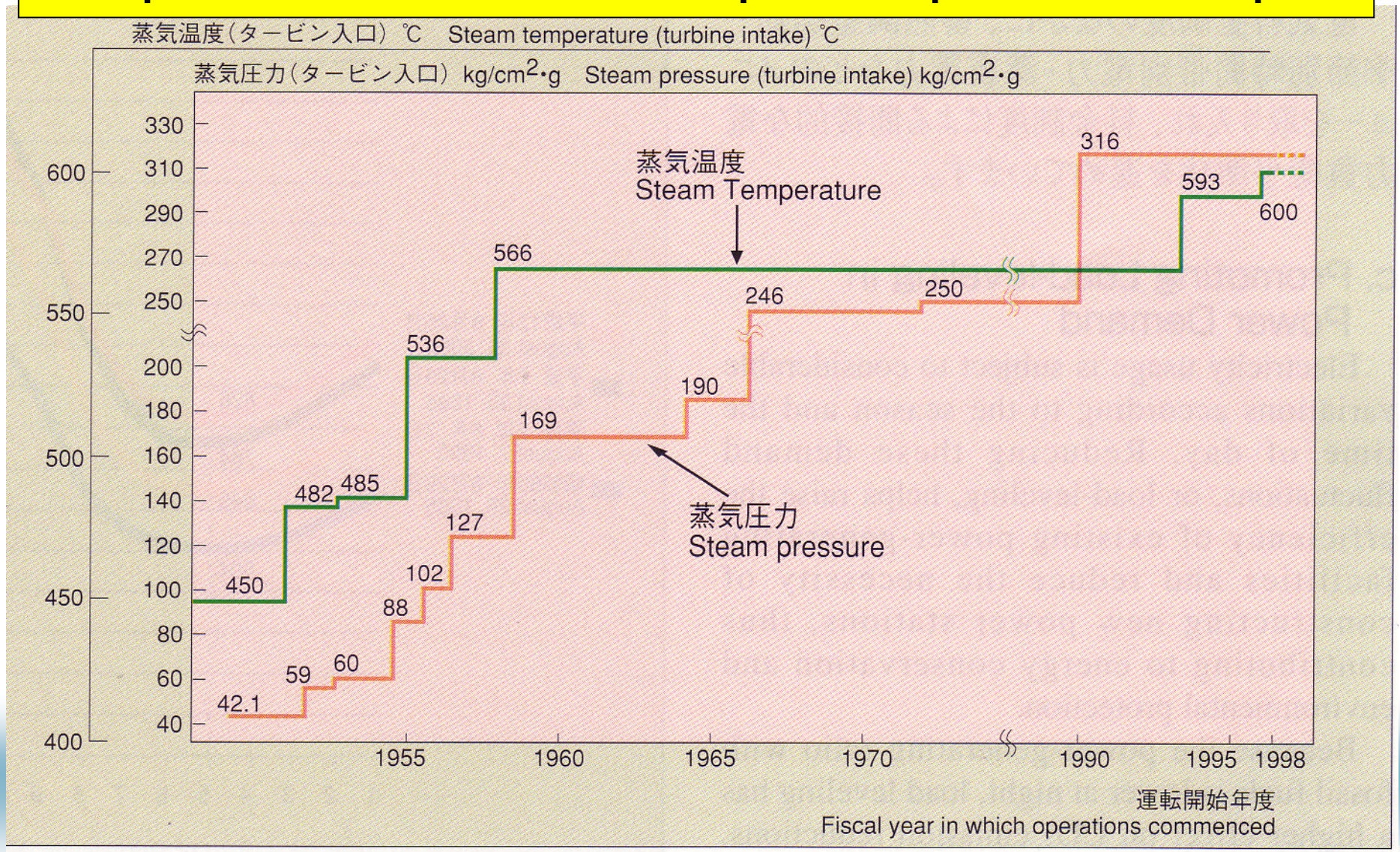
Combined cycle power generation

Trends of Gross Thermal Efficiency (HHV)and Transmission and Distribution Loss in Japan

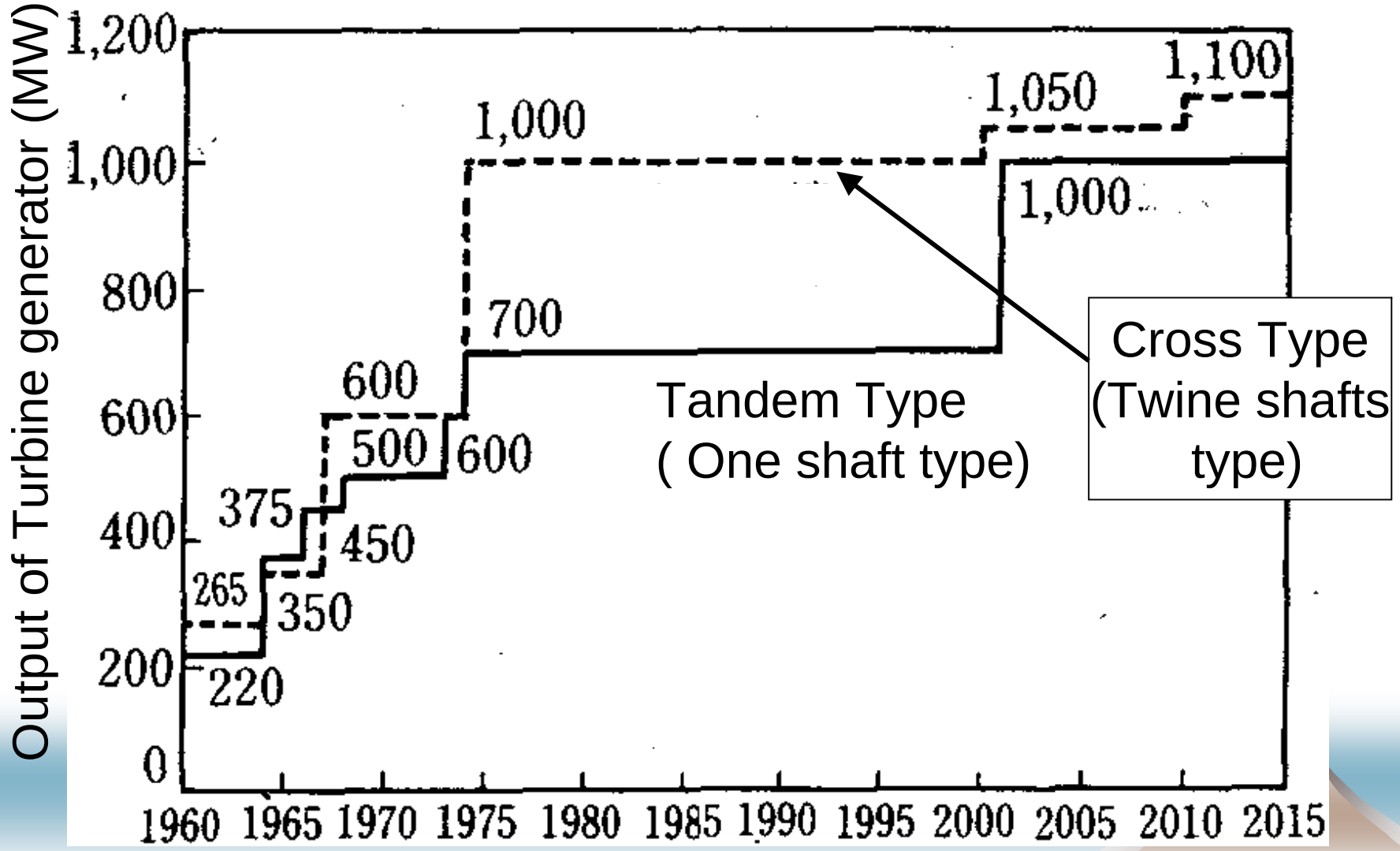


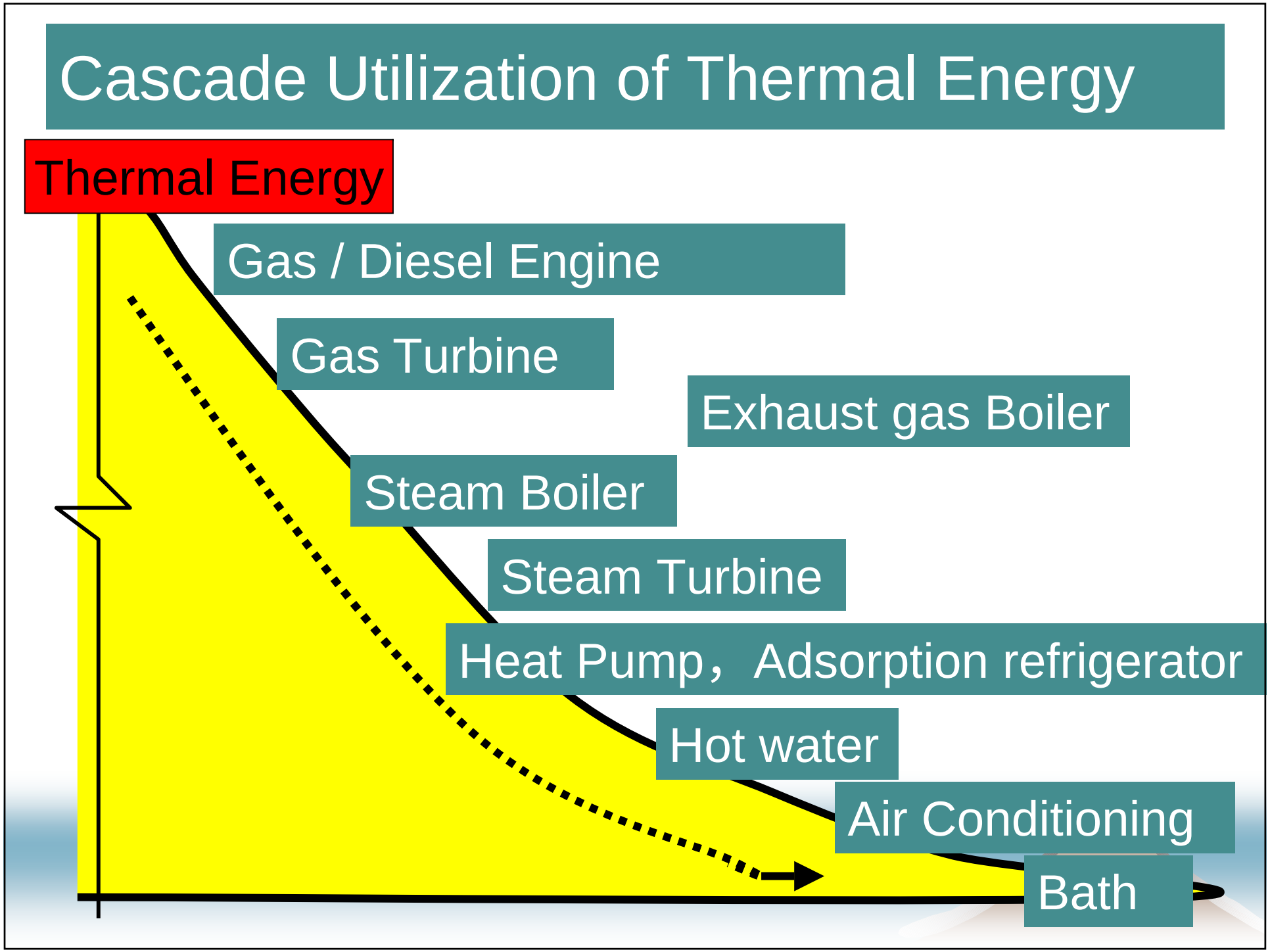
出典：電気事業便覧（平成13年版）他
Source: Japan Electric Utilities Handbook etc (2000)

Trends of Steam Pressure and Steam temperature on Thermal power plants in Japan



Trends of Development on Unit capacity of Thermal Power Plant in Japan

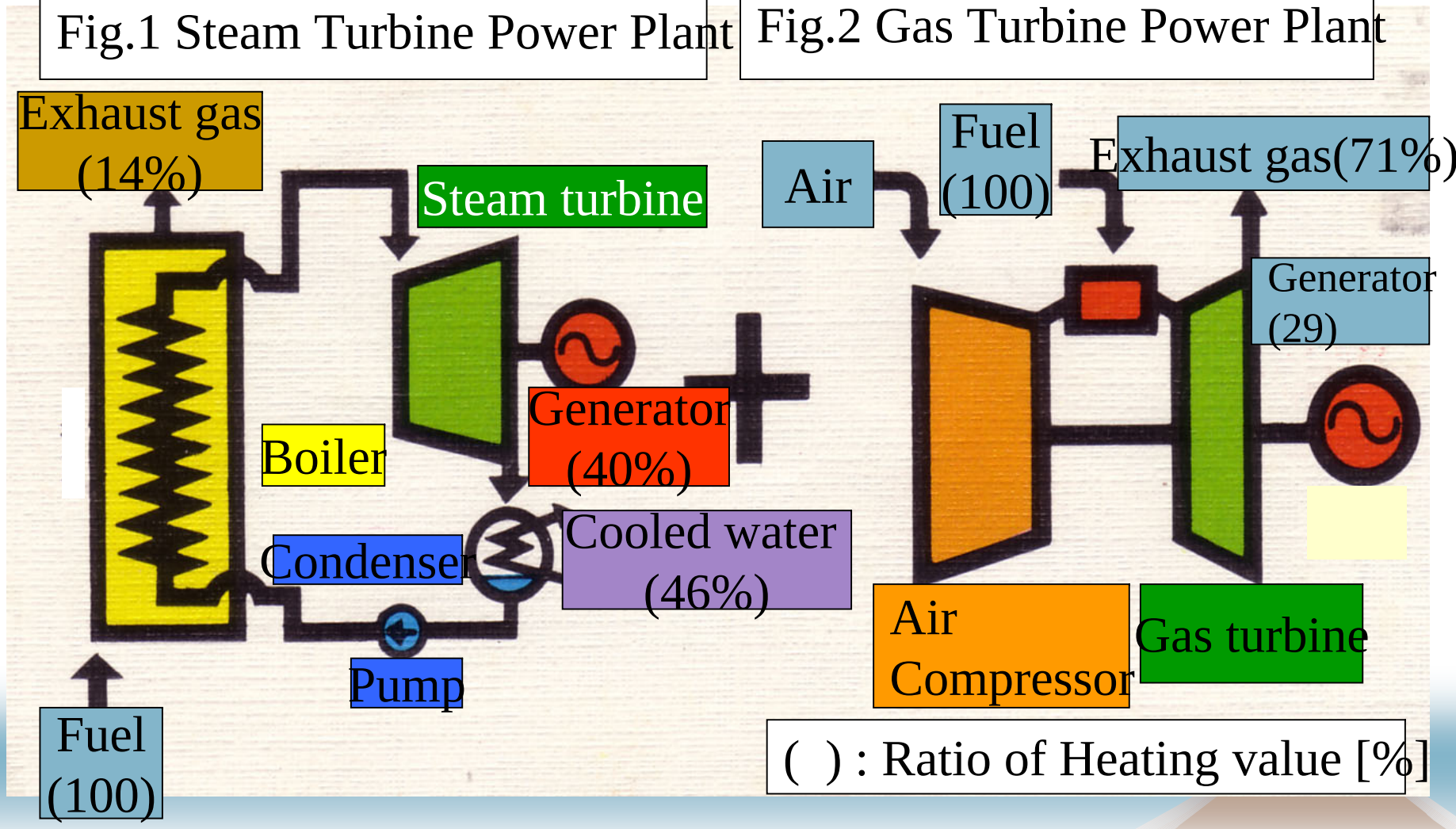



Cascade Utilization of Thermal Energy
Thermal Energy
Gas / Diesel Engine
Gas Turbine
Exhaust gas Boiler
Steam Boiler
Steam Turbine
Heat Pump，Adsorption refrigerator
Hot water
Air Conditioning
Bath

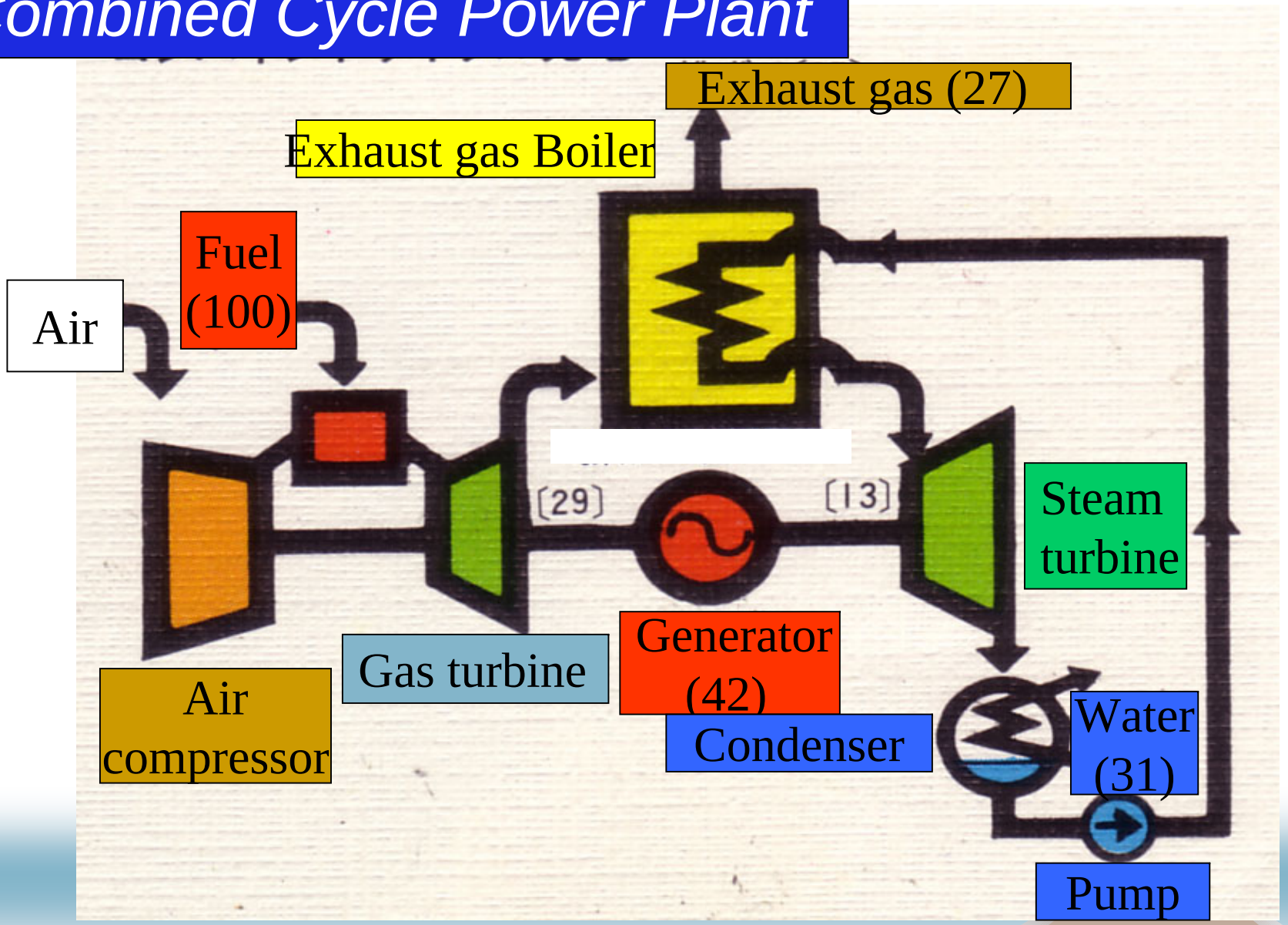
Example: Illustration of Combined Cycle Assembling

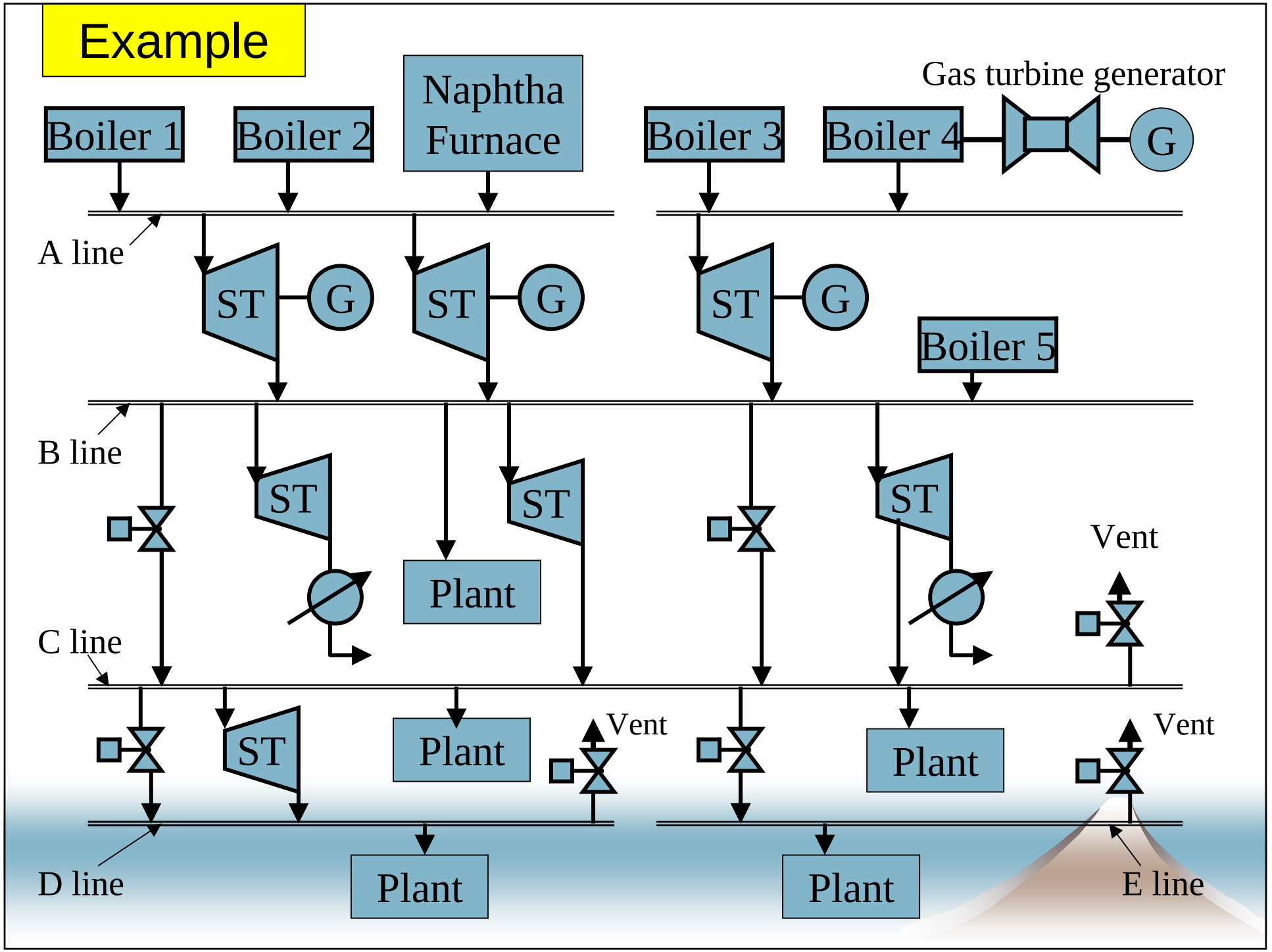
Fig.1 Steam Turbine Power Plant

Fig.2 Gas Turbine Power Plant

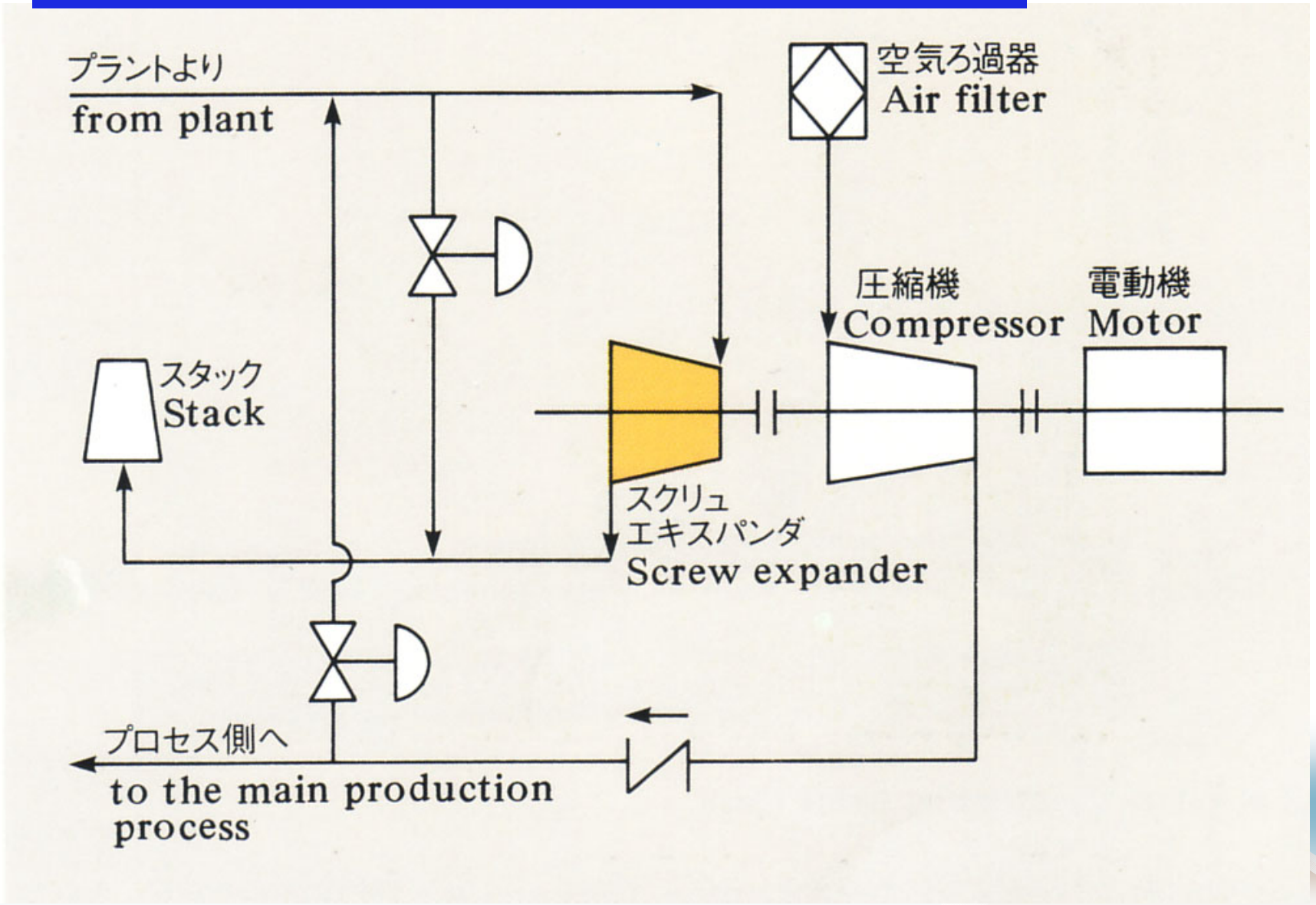


Combined Cycle Power Plant




Example
Boiler 1
Boiler 2
Naphtha Furnace
Boiler 3
Boiler 4
Gas turbine generator
G
A line
ST
G
ST
G
ST
G
Boiler 5
B line
ST
ST
ST
Plant
Vent
C line
ST
Plant
Vent
Plant
Vent
D line
Plant
Plant
E line

Example 2　Waste gas application



Conclusion

- **Energy Management**

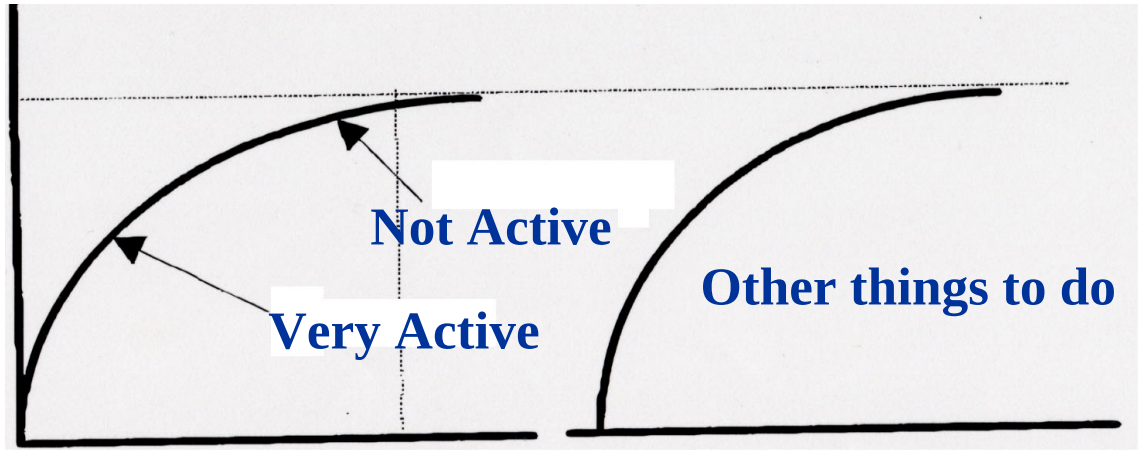
  Energy Saving should be Promoted Practically & Steadily

- **The Results will be**
  - **Improvement in Productivity**
  - **Cost Reduction**
  - **Life Keeping of Facilities**
  - **Environmentally Friendly, Waste Reduction**

Apply the Concept of Bolzmann's Principle to Activity - 1

Normal Effort : Level not Grows up Many things to do

S : Effect



W : Energy input (Effort)

Apply the Concept of Bolzmann's Principle to Activity - 2