Promotion of Energy Conservation Activities in Factories (Electricity)

Kokichi TAKEDA
Energy Conservation Center, Japan
In Lao PDR
October, 2006

1. Promotion of "Energy Conservation Activity"

2. Viewpoint of Power-saving

3. Methods of power-saving of major electric facilities

4. Power-saving Examples of Cement Process in Japan

1. Promotion of “Energy Conservation Activity”

1.1 Significance of “ Energy Conservation ”

“ Energy Conservation Activity ”
has contributed to “ Cost Down of each factory ”
moreover, Improvement of “ Cost ” and “SEC”
(“SEC” is Specific Energy Consumption and defined as energy conservation divided by production)

&

“ Energy Conservation Activity ”
has contributed to “ Reduction of the global warming ”

- Estimation in oil：0.252 [kL／MWh]
- Estimation in CO_2：0.555 [t-CO_2／MWh]

1.2 Control of Energy Conservation

① Establish organization control

- Management has to keep consciousness of employees.
- All staffs have to be involved in the project.

② Set the goal

Criteria of goal setting : operation, inspection, maintenance, and budget

③ Grasp the circumstances

Setup of measuring and recording devices

④ Perform

Performance of energy conservation
1. Small group activity
2. day-to-day business of staff
3. General development

⑤ Make an improvement plan

⑥ Implement revised plans

⑦ Assess the results

Repeat PDCA cycle of energy management

1.3 3 steps for Promotion of Energy Conservation

1st step: Reinforce energy management and increase efficiency of operations

- Low cost
- To avoid wastefulness
- To optimize use of existing equipment
- To make all staff involved
- To avoid unscheduled stop of operations

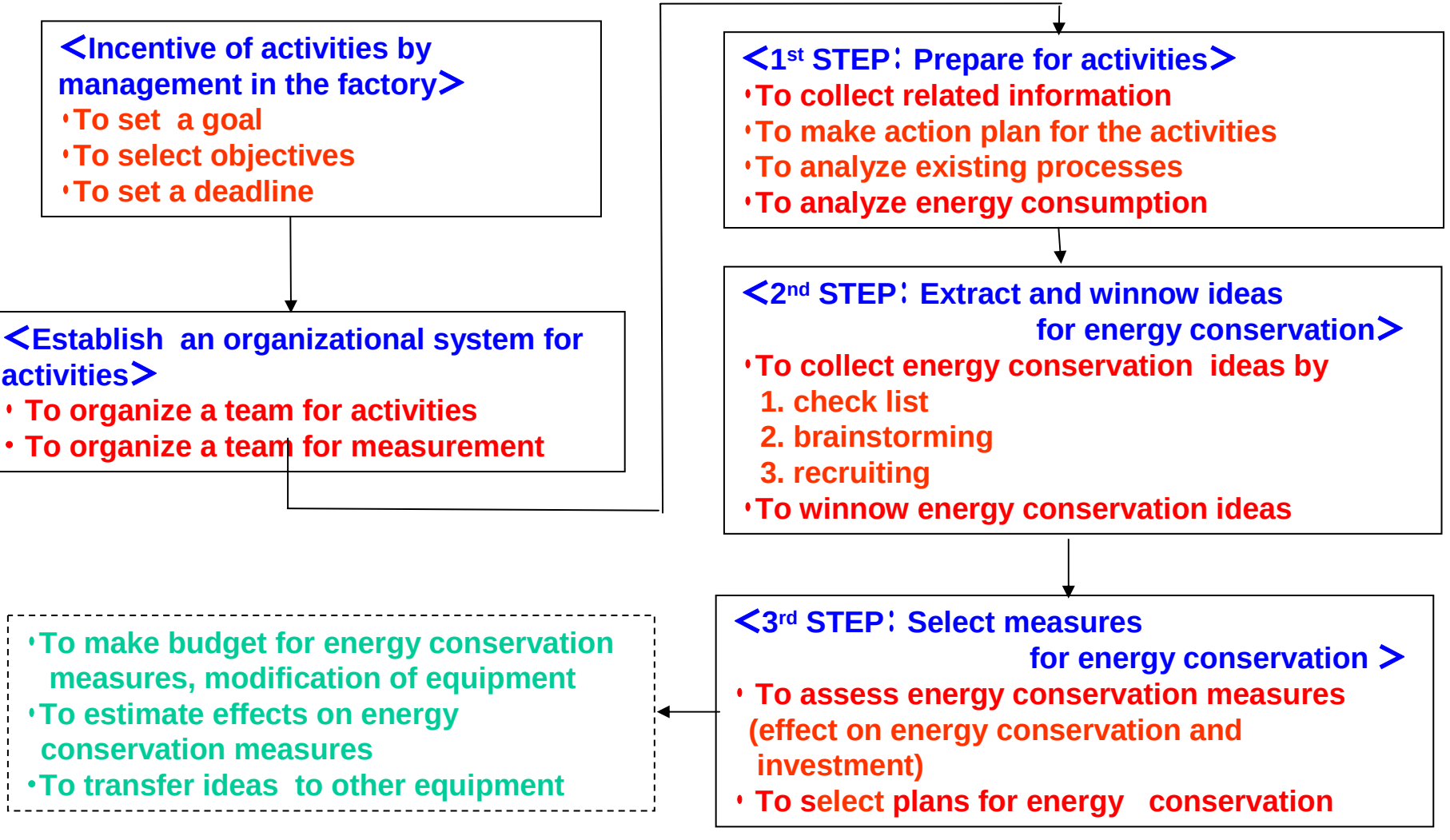
2nd step: Modify and/or add equipment

- Medium cost
- Modification and/or addition of equipment (It will be ineffective if main facilities are renewed or replaced)
- Introduction of energy-saving devices

3rd step: Introduce new processes and high efficiency equipment

- High cost
- Long-term investment
- It is necessary to develop and introduce new processes.

1.4 Work Flow of Energy Conservation Activity in Factory



1.5 Energy Audit

To fill out questionnaire about situations of energy conservation in a factory

Brief Audit

Hearing from staffs in a factory

Inspection of a factory

- **Identification of basic problems in a factory**
- **Proposal for overcoming (probability, latency and directions)**

Detailed Audit

Cooperation with specialists in energy conservation

Investigation in detail: understanding of present situation, making guideline, and assessment of results

- **Identification of quantitative issues on energy usage**
- **Proposal of definite guidelines (effect of investment for equipment and control)**

1. Promotion of
"Energy Conservation Activity"

2. Viewpoint of Power-saving

3. Methods of power-saving
of major electric facilities

4. Power-saving Examples
of Cement Process in Japan

. Viewpoint of Power-saving

2.1 Distribution of electricity : efficiency of facilities

Receiving, transforming and electric power distributing equipment (**transformer, cable** and others)

< 95～97% >

pump, fan･blower **< 60～85% >**

valve, damper **<20～100% >**

(efficiency changes with valve/damper opening)

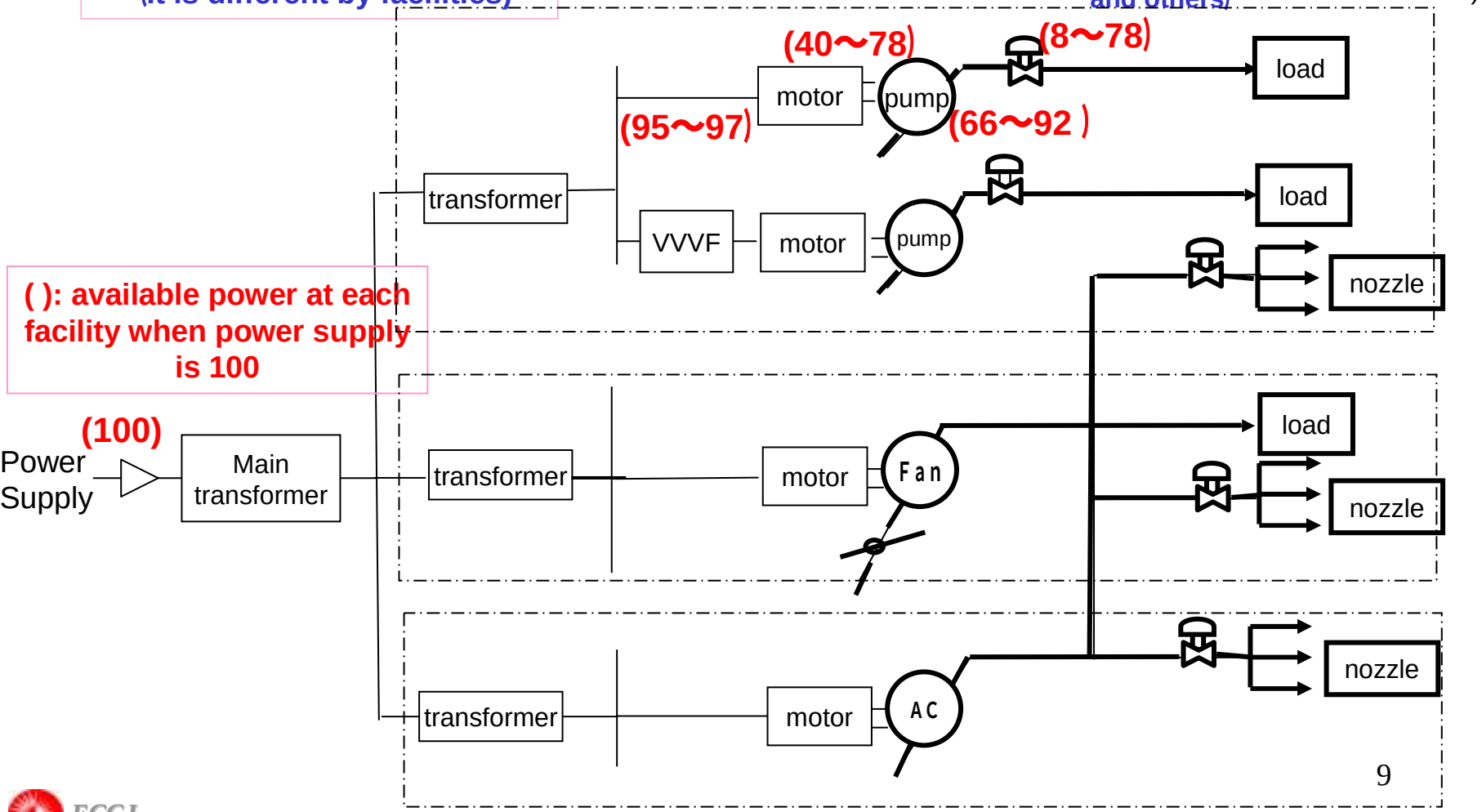
Motor, VVVF, and others **< 70～95% >**

Piping, duct **(-α) : piping loss and others)**

Excessive supply(Q (efficiency change with load factor)

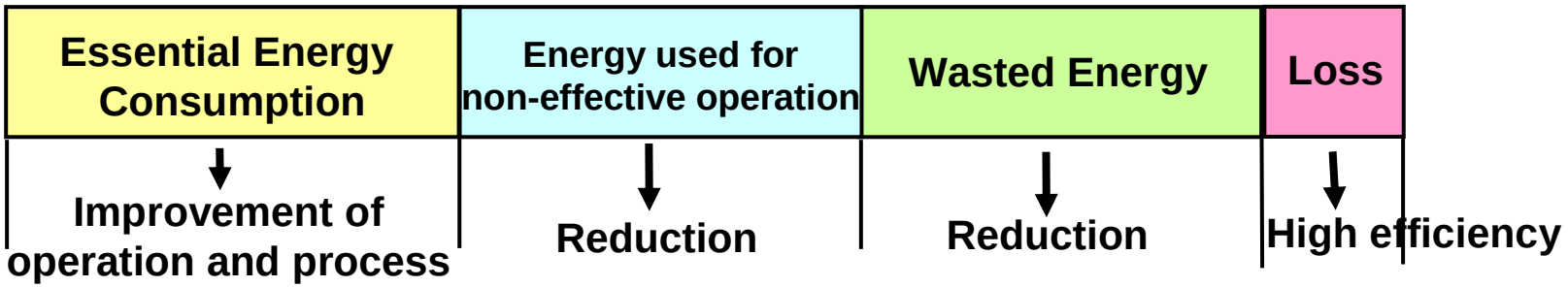
< > : efficiency of facilities (It is different by facilities)

( ): available power at each facility when power supply is 100



☆ Selection of Equipment which are Subject to Energy Audit from a Viewpoint of Consumption and Efficiency

★Categorization of Power Consumption (or related power losses)



★Point of Selection of equipment for Energy Conservation

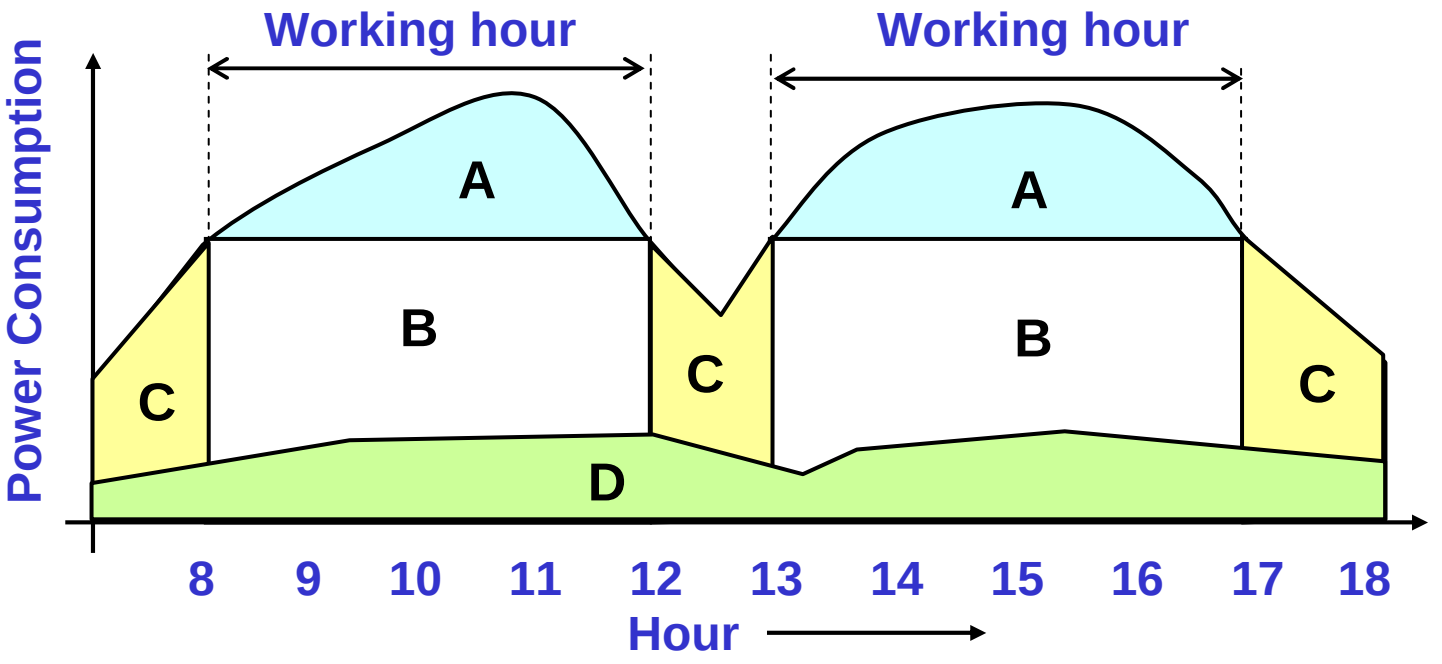
① Equipment (electric motor, transformer, etc) is subject to be audited only when they are established or renewed.

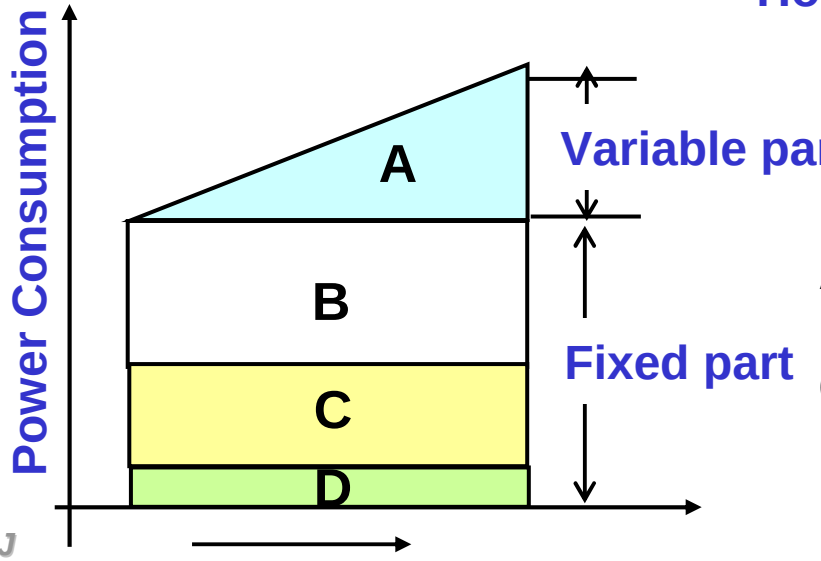
It is difficult to renew electric motor, transformer, and cables except for lighting facility for energy conservation, because these equipment contribute too little to operating efficiency and are too expensive to increase efficiency.

② Main target is motor-powered equipment for energy conservation.

Energy conservation may be expected by avoiding wastefulness and improving efficiency of motor-powered equipment (pump, fan, blower, air-compressor, etc) because these equipment represent a large portion of energy consumption.

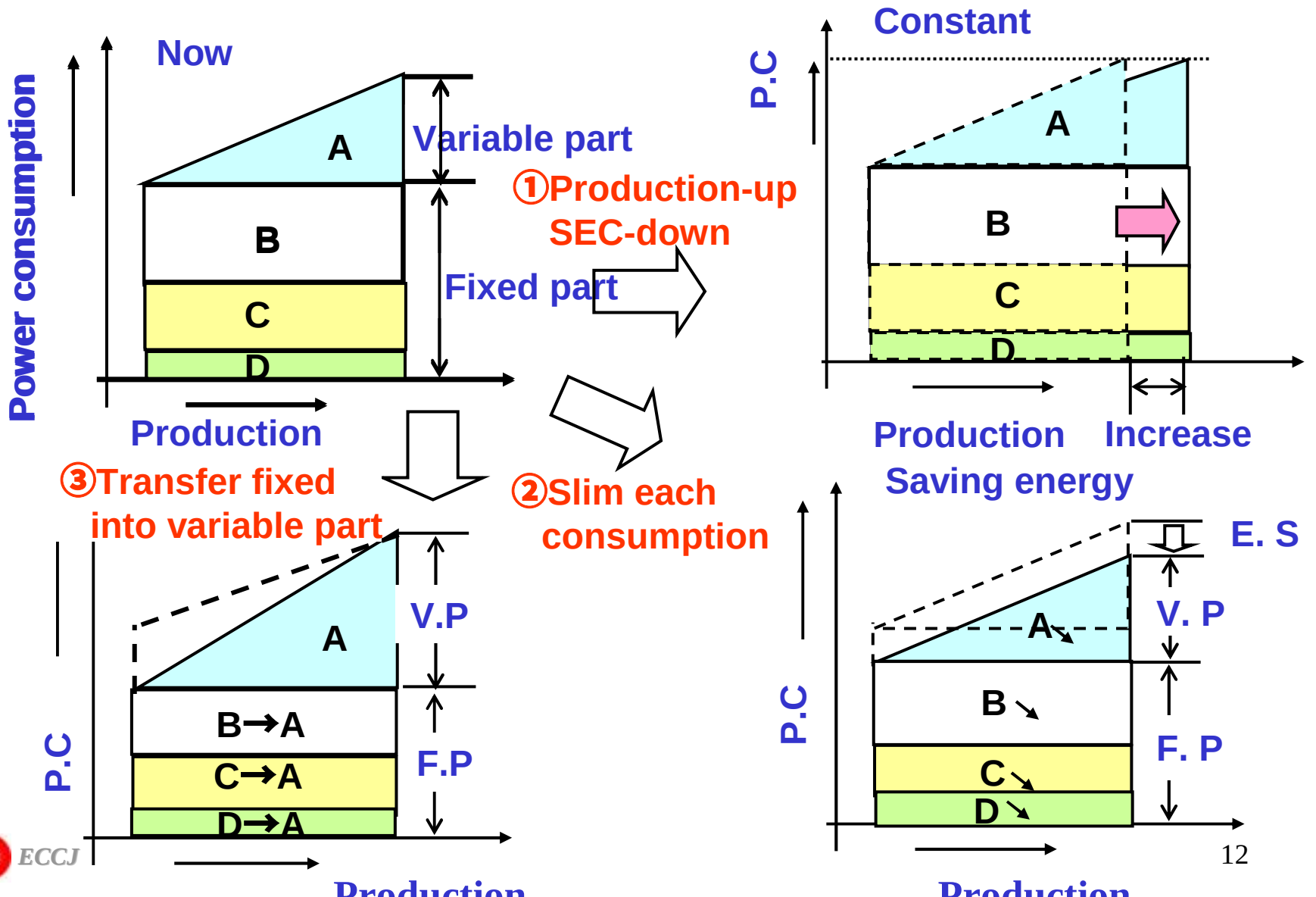
2.2 Breakdown of Energy Consumption by its Usage





A: to be proportional to production
B: to keep product plants
C: to start up or shut down lines
D: to keep utility plants

☆ 3 Viewpoints of Energy Conservation Activity



☆ Viewpoint of Energy Conservation Activity for Reducing Fixed Part of " B, C and D "

① Is a machine paused during a resting period in intermittent operation?

- To pause a coupling of product lines
- To make an automatic ON or OFF

② Is a capacity of equipment too large against requirement?

- To introduce an inverter for pressure regulation in place of valve and damper
- To scale down a capacity

③ Is a fluctuation of workloads properly regulated?

- Automatic control of workloads
- Variable flow control

④ Are inspection and maintenance definitely carried out?

- Guideline on leakage prevention of air and water
- Prevention of pressure loss with cleaning filters etc
- Inspection with regular dismantlement of devices

Awareness in operators and maintenance staff on energy conservation is of primary importance.

1. Promotion of
“Energy Conservation Activity”

2. Viewpoint of Power-saving

3. Methods of power-saving of major electric facilities

4. Power-saving Examples of Cement Process in Japan

3. Methods of power-saving of major electric facilities

3.1 Pumps, Fans, and Blowers

Viewpoint of power-saving	Examples regarding methods of power-saving
a) Reduction of flow rate	Anti-leak measure of air and water, prevention of excessive use, etc
b) Reduction of pressure	Reduction of operating pressure, Reduction of pressure loss (filter, etc)
c) Reduction of excessive specification (reduction to reasonable level)	・To replace to small capacity or machine of less pressure loss ・To change impeller, to cut down impeller diameter, and to decrease stages of rotor impeller ・To change a rotating speed (pole change or pulley, inverter)
d) Addition of variable flow control and multi-unit control	・ Addition of multi-unit control system ・ Selection of big and/or small machines ・ Addition of variable flow control (pole change, pulley, fluid coupling, vane control, inverter)
e) Replace to high efficiency machine	・ To replace to high efficiency machine
f) Pause at a resting time in intermittent load	・ To replace to motor of high frequency start type ・ Addition of soft starter with inverter ・ Addition of fluid coupling

☆ Multi-unit Control in Pumps and Blowers

Figure shown below is a comparison of pump efficiency (100%, 80%, or 50% of capacity).

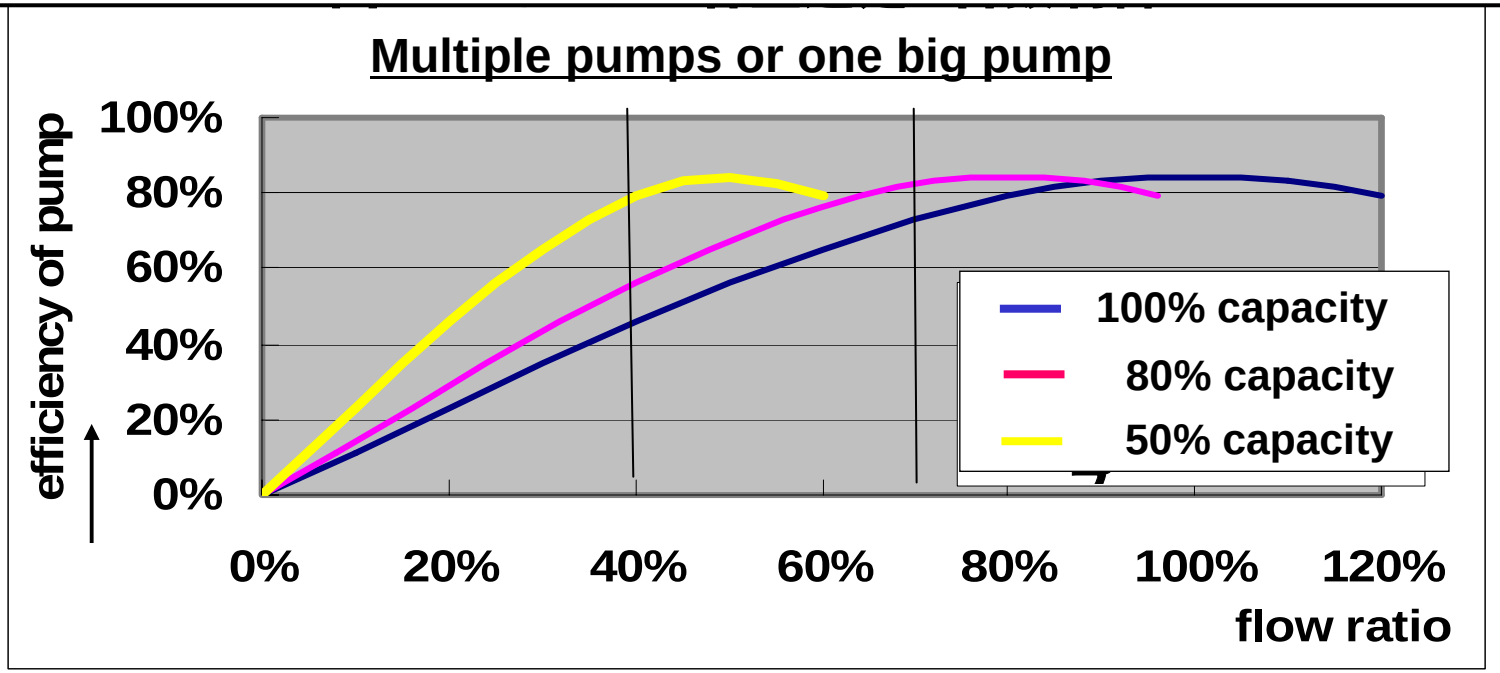
(1)Selection of properly-sized pump

Efficiency of pump with 80% capacity is about 10% better than that of a pump with 100% capacity operated at 70% load.

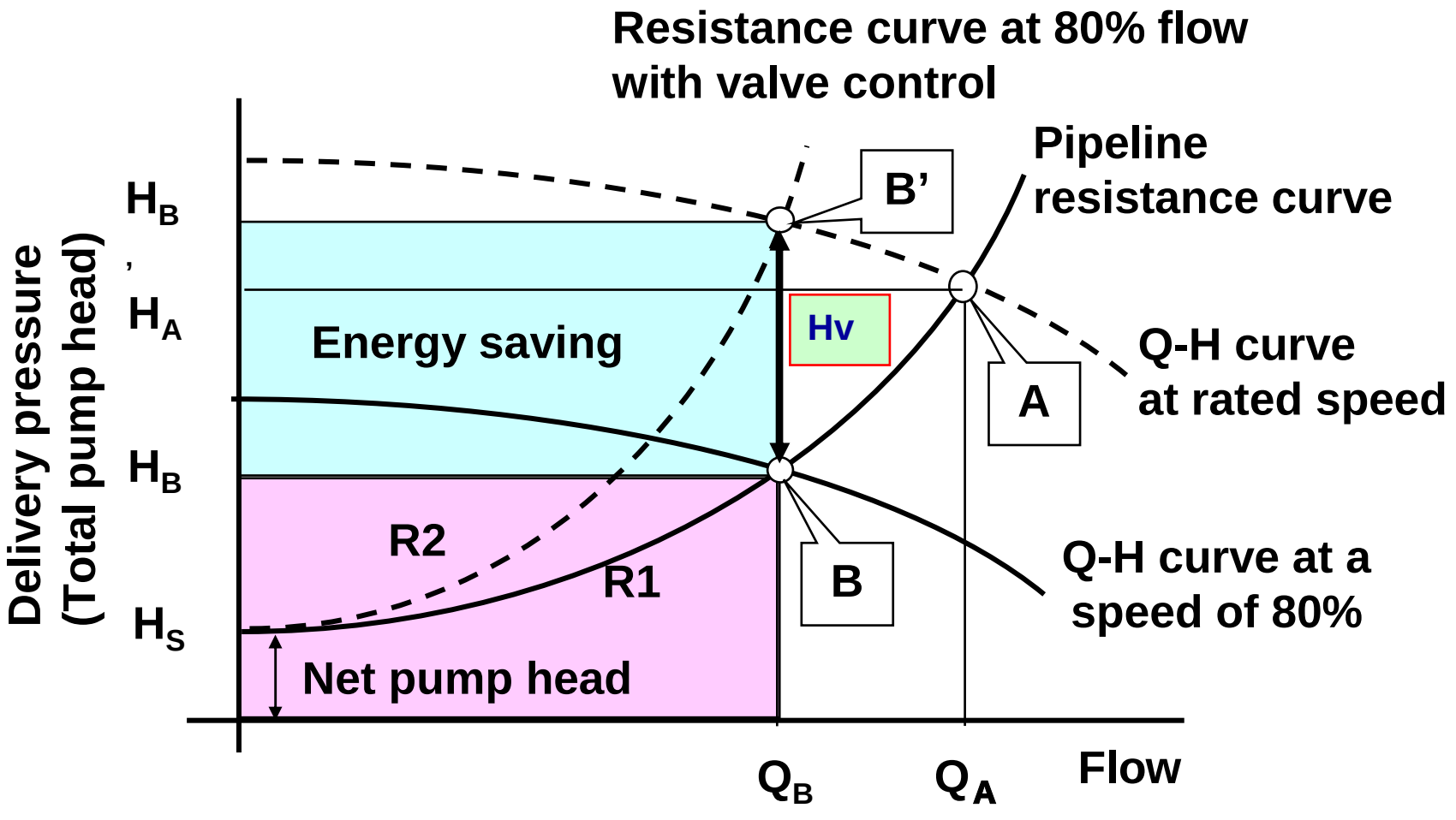
(2)Multi-unit control in pumps

Efficiency of pump with 50% capacity is about 35% better than that of a pump with 100% capacity operated at 40% load.

Introduction of multiple small pumps instead of one big pump, and control of a number of operating pumps, so called multi-unit control, lead to energy conservation.



☆ Power-saving by Speed Control (1)



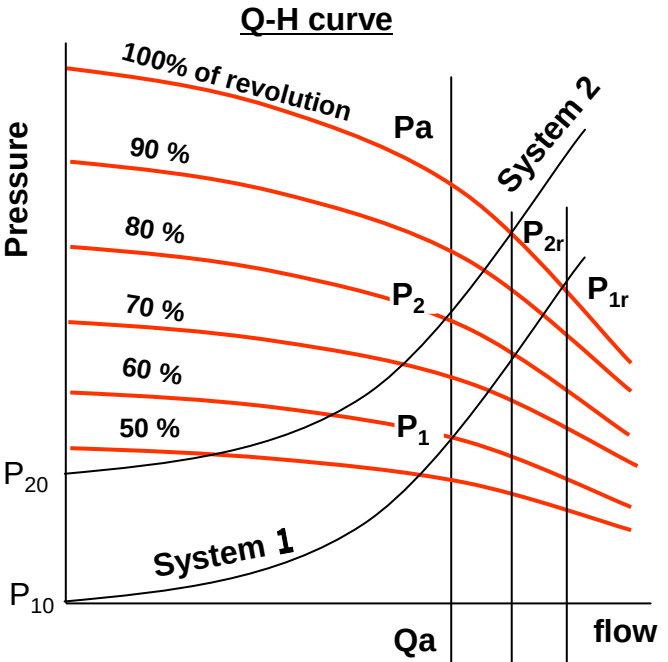
☆ Power-saving by Speed Control (2)

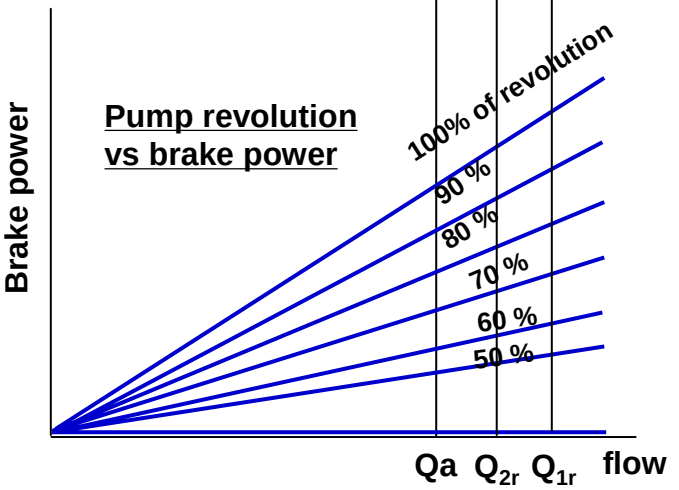
System1：
When static pressure of recipient is the same as that of supplier, loss of pressure in piping is compensated by pump.

(1) Pressure and flow reach P_{1r} and Q_{1r} at 100% of revolution without throttling valves.
(2) If valves are not throttled, flow cannot be decreased from Q_{1r} to Qa. However, if pressure is reduced to P_1 by valve throttling, flow will decrease to Qa.
(3) If pressure and flow decrease to P_1 and Qa by reducing revolution, it is more efficient to save energy than by valve throttling.
(4) Required brake power is shown in the figure as shown below.

System2：
When static pressure (P_{20}) of supplier is higher than that (P_{10}) of recipient, both a difference of pressure between supplier and recipient and a loss of pressure in piping are compensated by pump.

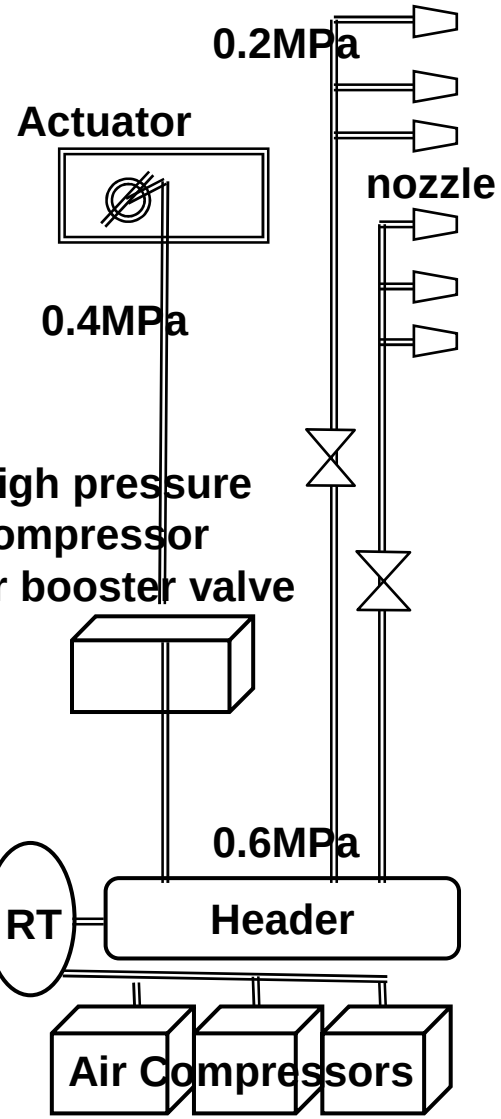
(1) Pressure and flow reach P_{2r} and Q_{2r} at 100% of revolution without throttling valves.
(2) Effect on energy saving is less than System1, because static pressure of recipient is higher than that of System1.





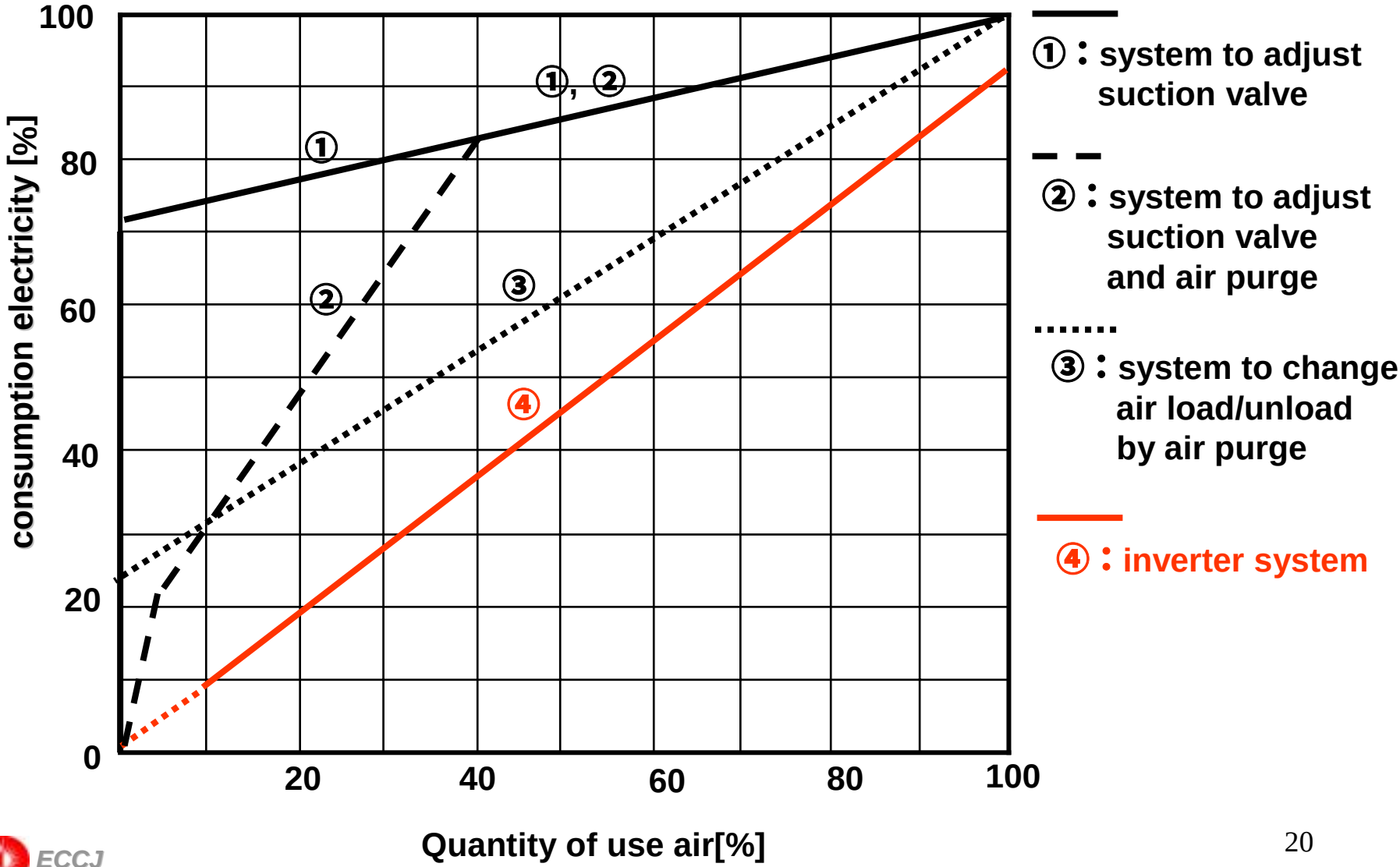
3.2 Air Compressor

Compressed air system>



Viewpoint of Power-saving	Examples regarding Methods of Power-saving
Review whether spec. is too large or not	•Optimization of spec. for user (on/off control, conversion to low pressure air by blower)
Reduction of air leak	•Measures of air leak •Detector for air leak (valve, flange, others)
Reduction of pressure loss Division by use pressure	•Reduction of pressure loss in piping and reducing valve •Addition of high pressure compressor or booster valve
Addition of high efficient control system that adapts to load fluctuation	•Control of multi-unit control •Addition of variable flow control (inverter, IGV, others) •Integration of compressors
Selection of high efficient machine	•Selection of inverter system •Small capacity, low pressure
Pause at a resting period	•Addition of automatic driving/pause function,

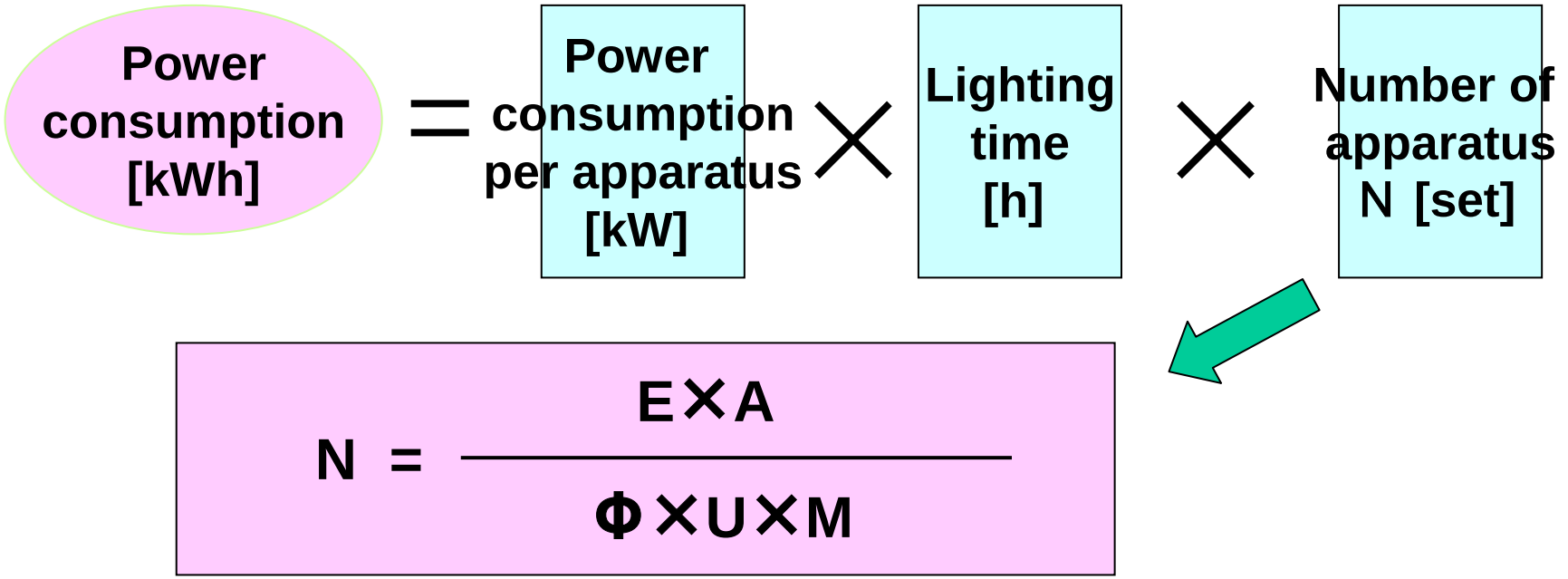
(Examples)
Comparison of electricity consumption of the compressor at variable capacity system



3.3 Lighting apparatus

Viewpoint of Power-saving	Examples regarding methods of power-saving
Choice of high efficiency light sources	Choice of high efficiency lamp such as sodium lamp Choice of Hf fluorescent lamp utilizing inverter Choice of low loss type stabilizer
Reduction of illumination	Adequacy of lighting standards in workshop Reduction of whole illumination and use of part illumination Dimming of lighting through proper lighting control
Reduction of illumination object	Review and reduction of place needing illumination
Choice of high efficiency lamps	Choice of high efficiency lamp, floodlight beams
Improvement of illumination rate	Consideration such as reflection efficiency to lighted location
Improvement of maintenance rate	Periodical cleaning of lamp Appropriate exchange of lamps
Reduction of lighting time	Close lights out Extinguishing of lighting through proper lighting control

Energy Consumption of Lighting Apparatus



$$N = \frac{E \times A}{\Phi \times U \times M}$$

N: Number of lighting apparatus installed

E: Average luminance on working place [LX]

Φ: Luminous flux per lighting apparatus [lm]

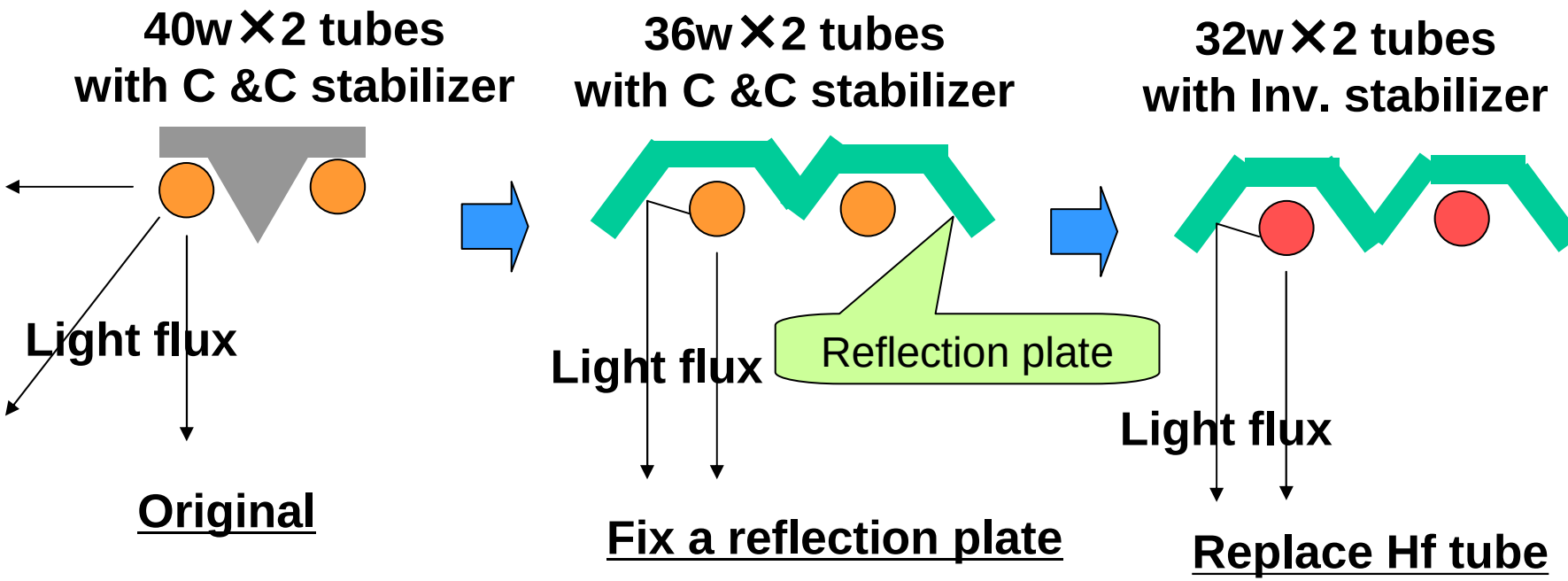
A: Room space [m^2]

U: Utilization factor

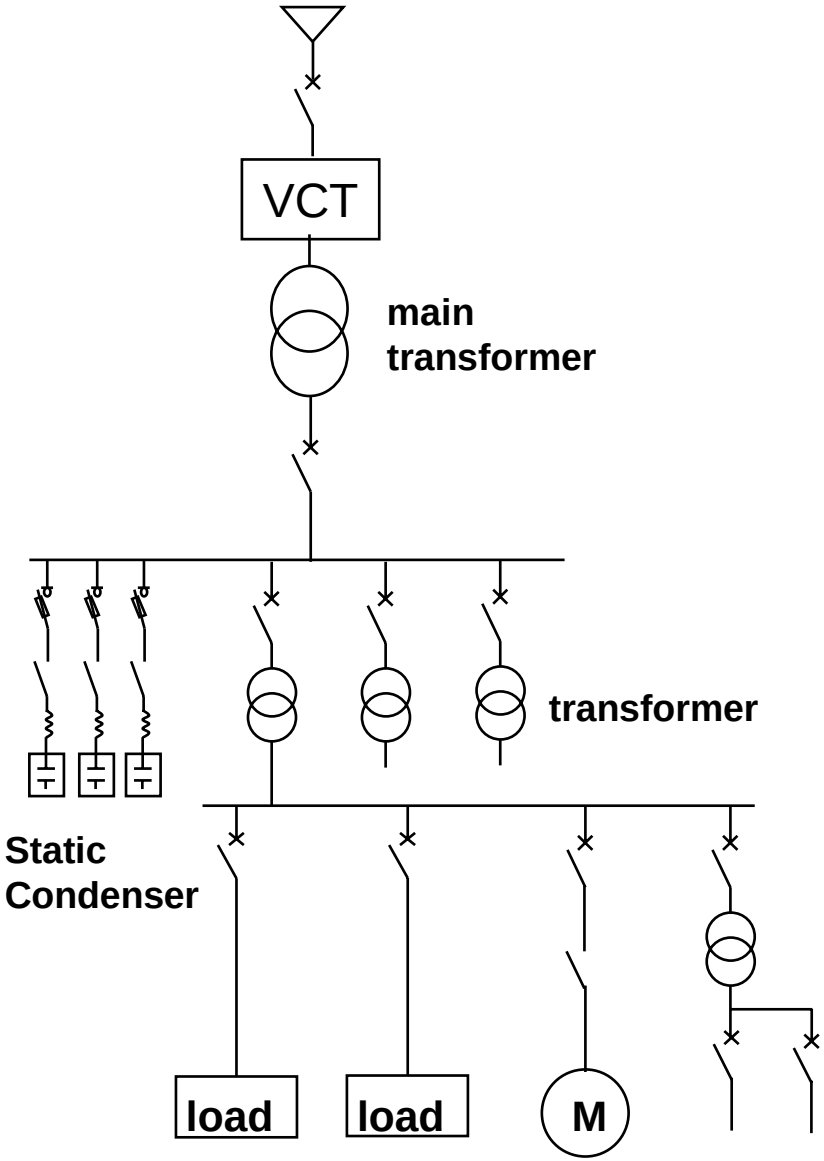
M: Maintenance factor

Lighting standards in workshop in JAPAN : JIS Z9110

Replace with more efficient light



3.5 Electric Power Distribution System



Viewpoint of power-saving	Examples regarding methods of power-saving
Selection of high efficiency apparatus	Selection of high efficiency transformer☆
Improvement of power factor	Addition of condenser for improvement of power factor ☆
	Selection of high power factor apparatus ☆
apparatus with pause at a resting time	Integration and halt of light-load transformers
	Pause of fans for transformers when transformers are loaded lightly and/or not heated

☆：Consider when facilities will be replaced or equipment will be newly installed

1. Promotion of
“Energy Conservation Activity”

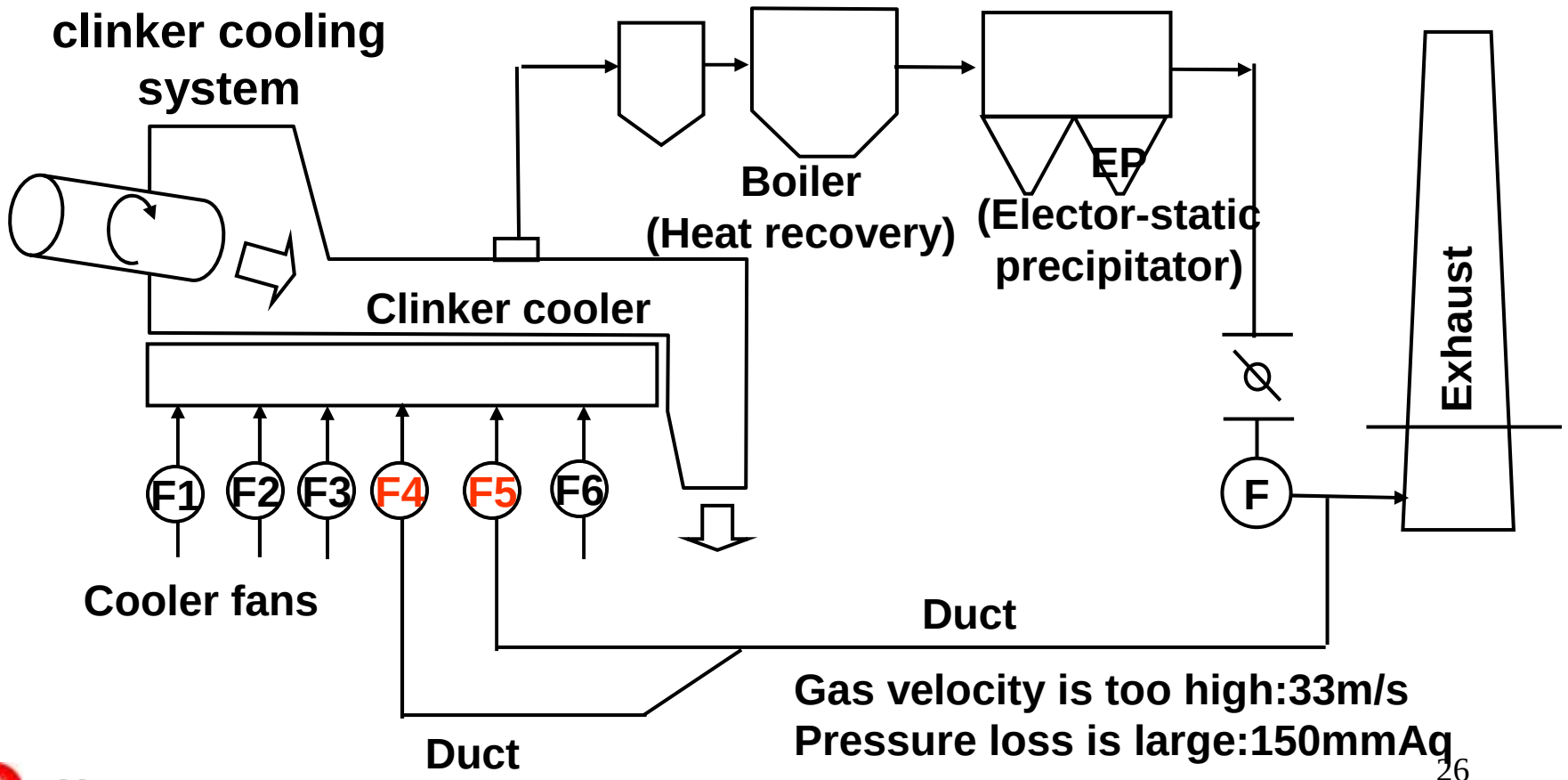
2. Viewpoint of Power-saving

3. Methods of power-saving
of major electric facilities

**4. Power-saving Examples
of Cement Process in Japan**

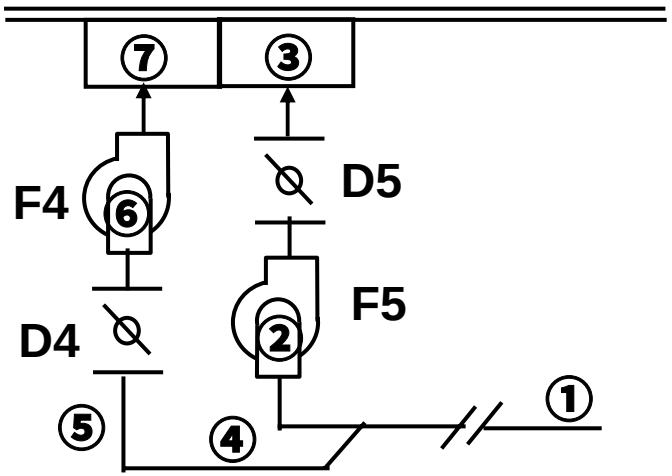
4．Power-saving Examples of Cement Process in Japan

4.1 Power saving on Clinker-cooling-Fan



Measurement Data

Clinker Cooler



Pressure (mmAq)

Position	Pressure
①	-122
②	-135
③	+260
④	-270
⑤	-280
⑥	-250
⑦	+430

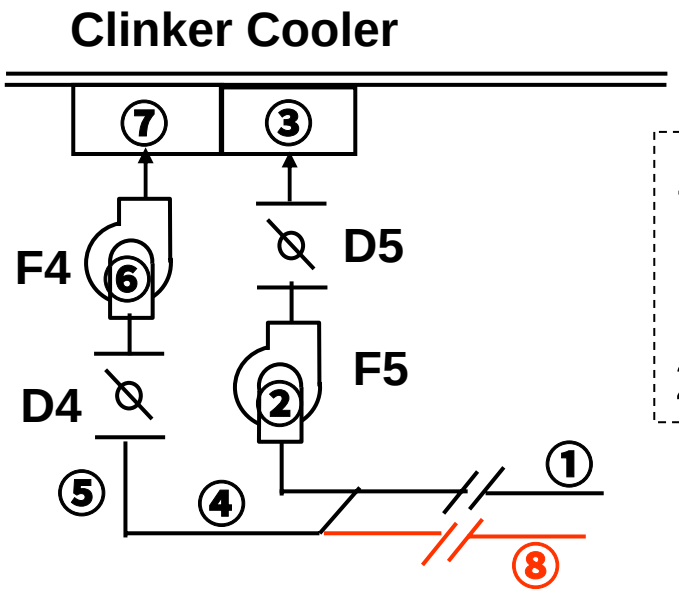
Gas Data at Position #1

Temperature(℃)	115
Velocity (m/s)	Around 33
Flow(m^3/min)	6,550

Fan data

	Flow (m^3/min)	Damper-opening
F4	3,750	78%
F5	2,800	100%

Improvement Measures



1. Place a new duct to reduce gas velocity
   Damper-opening:
   F4:55%, F5:45%
2. Fan-runner cutting

Runner Diameter (mm)

	Original	After cutting	Cut-ratio
F4	1,568	1,506	4.0%
F5	1,348	1,276	5.3%

Evaluation

1.Pressure (mmAq)

Position	Pressure
①	-122 to -60
②	-135 to -70
③	260 to +256

④	-270 to -97
⑤	-280 to -110
⑥	-250 to -203
⑦	430 to +388

⑧	-56

2.Gas flow

Position	Speed(m/s)	Flow(m^3/min)
①	33 to 18.0	3,565
⑧	17.5	3,104

3.Damper opening

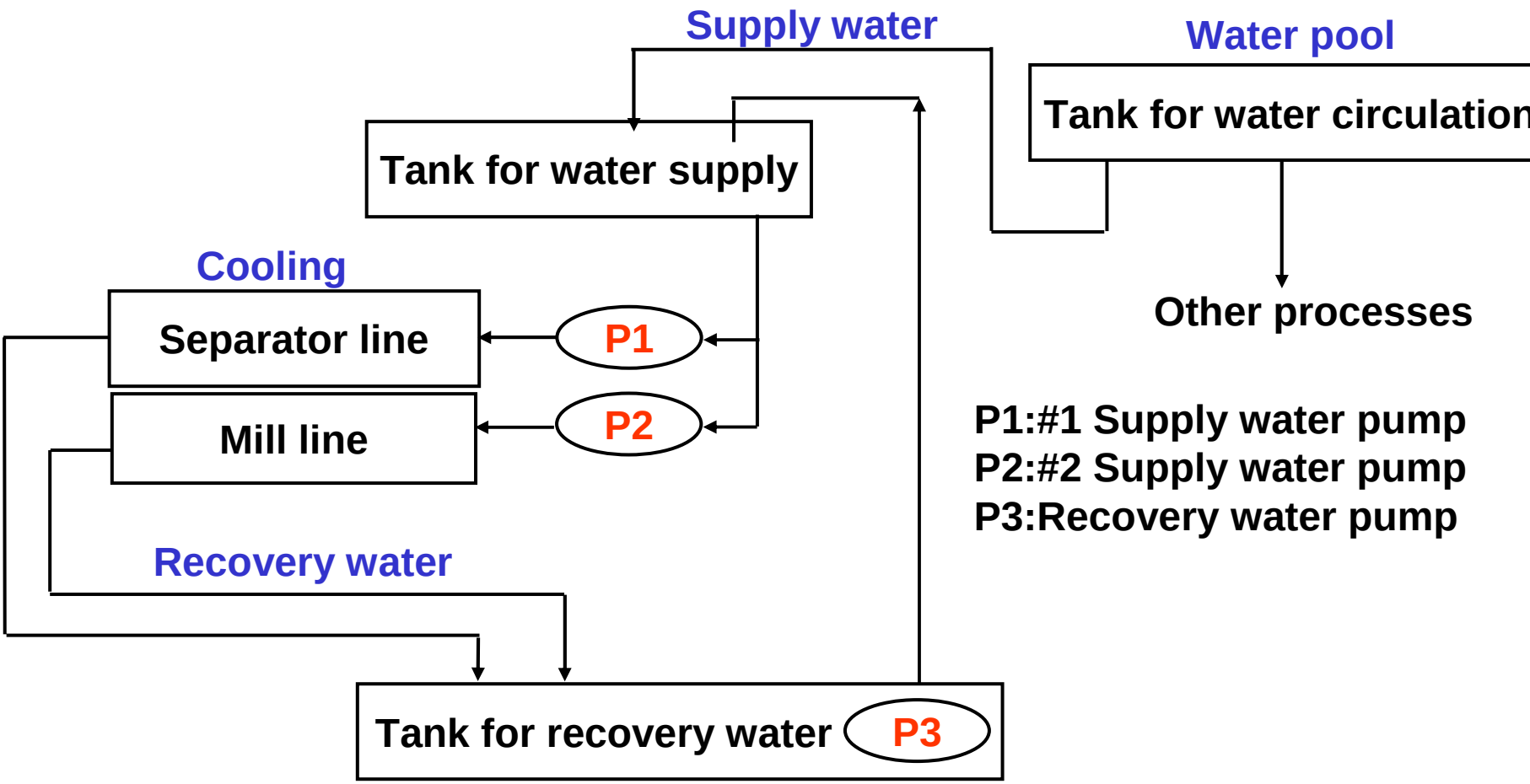
	Lay Duct	Runner-cut
F4	57%	80%
F5	45%	100%

4.Power consumption of Fans (kW)

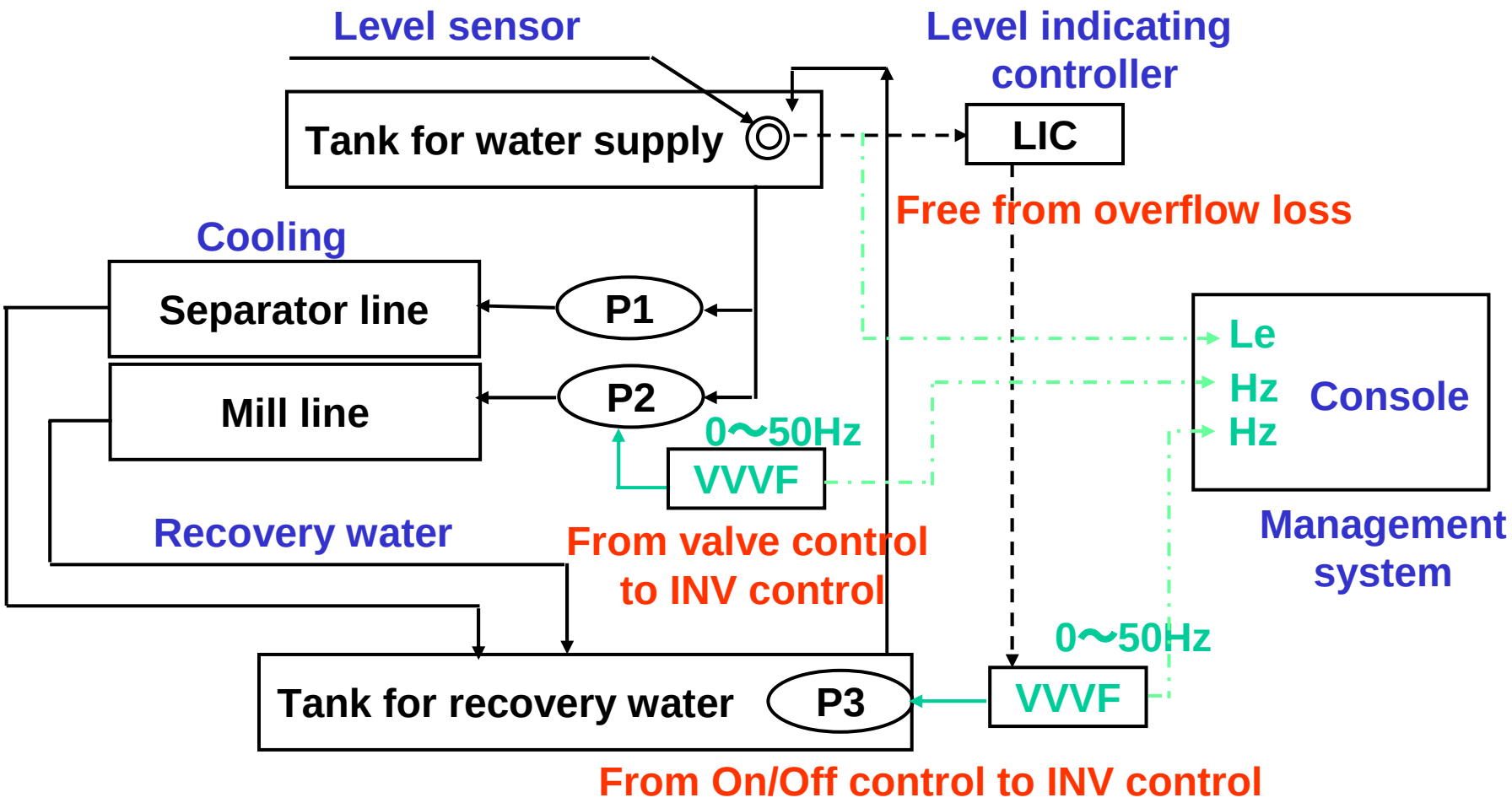
	Before	New duct	Runner-cut	Saving
F4	550	525	489	61
F5	254	267	205	49

4.2 Power-saving on Cooling Water System

Cooling water circulation in finishing section



Inverter control and Management system



Evaluation

1.Water Saving

Before	18t/h
After	10t/h
Saving	8t/h

2. Energy Saving

(kW)

	P1	P2	P3	total
Power Consumption	3.7	11	11	25.7
Saving	—	7	2	9.0

3. Conclusion

Saving Water is Saving Power

The End **Thank you!**