Overview and EE&C of Steel Industry in Japan

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1. Recent status of Energy Conservation in Mini Mill Industry in Japan

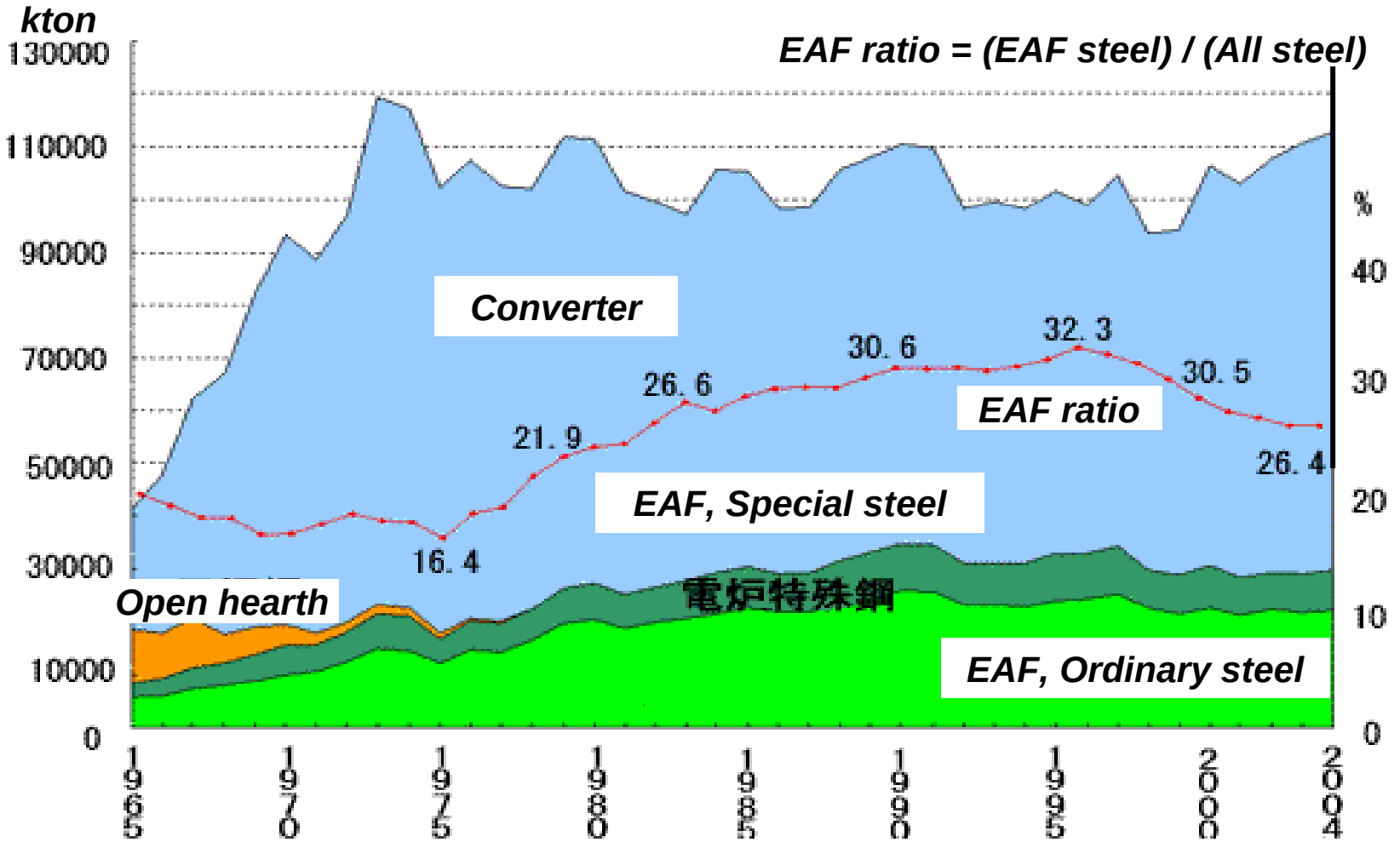
2. EE & C Activities in EAF

3. EE & C Activities in CC

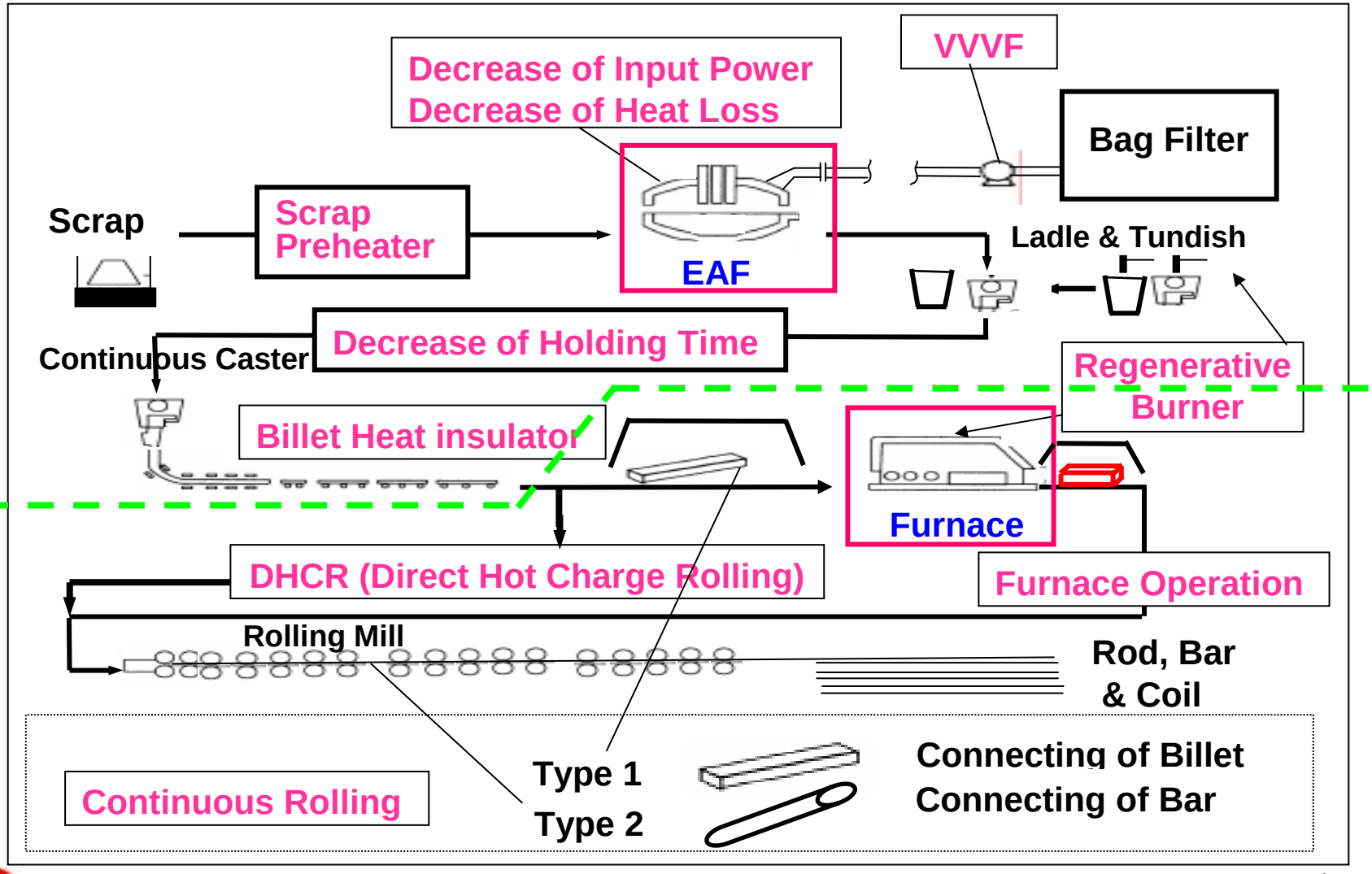
4. Energy Conservation in Rolling Mill Process

5. Transition of Total Energy Intensity (Crude oil equivalent) - Example -

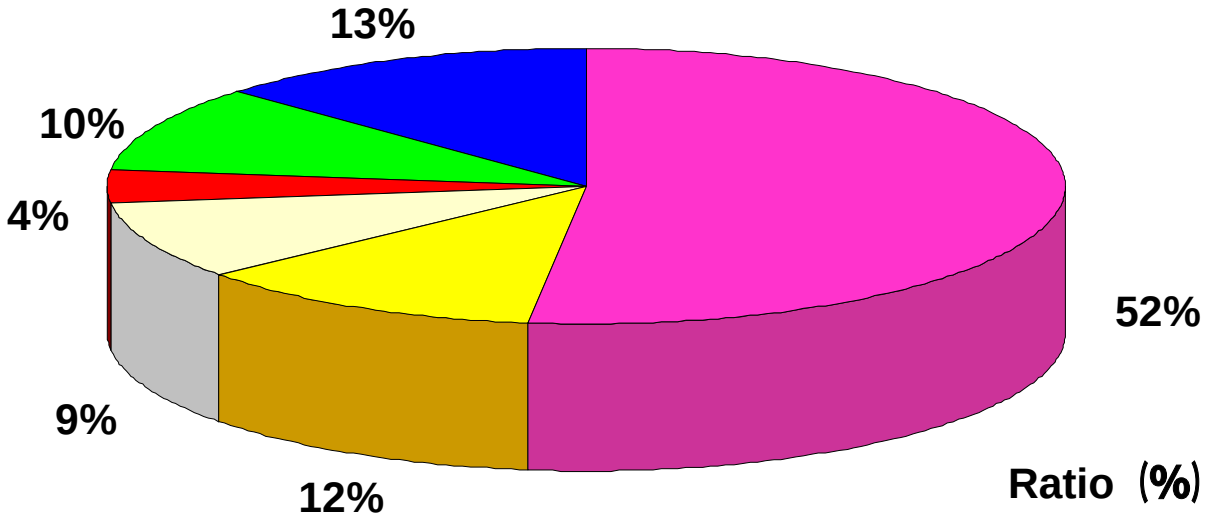
(1) Trend of Crude Steel Production, Operation Status in Japan



(2) Energy Saving Technologies in Mini Mill Process



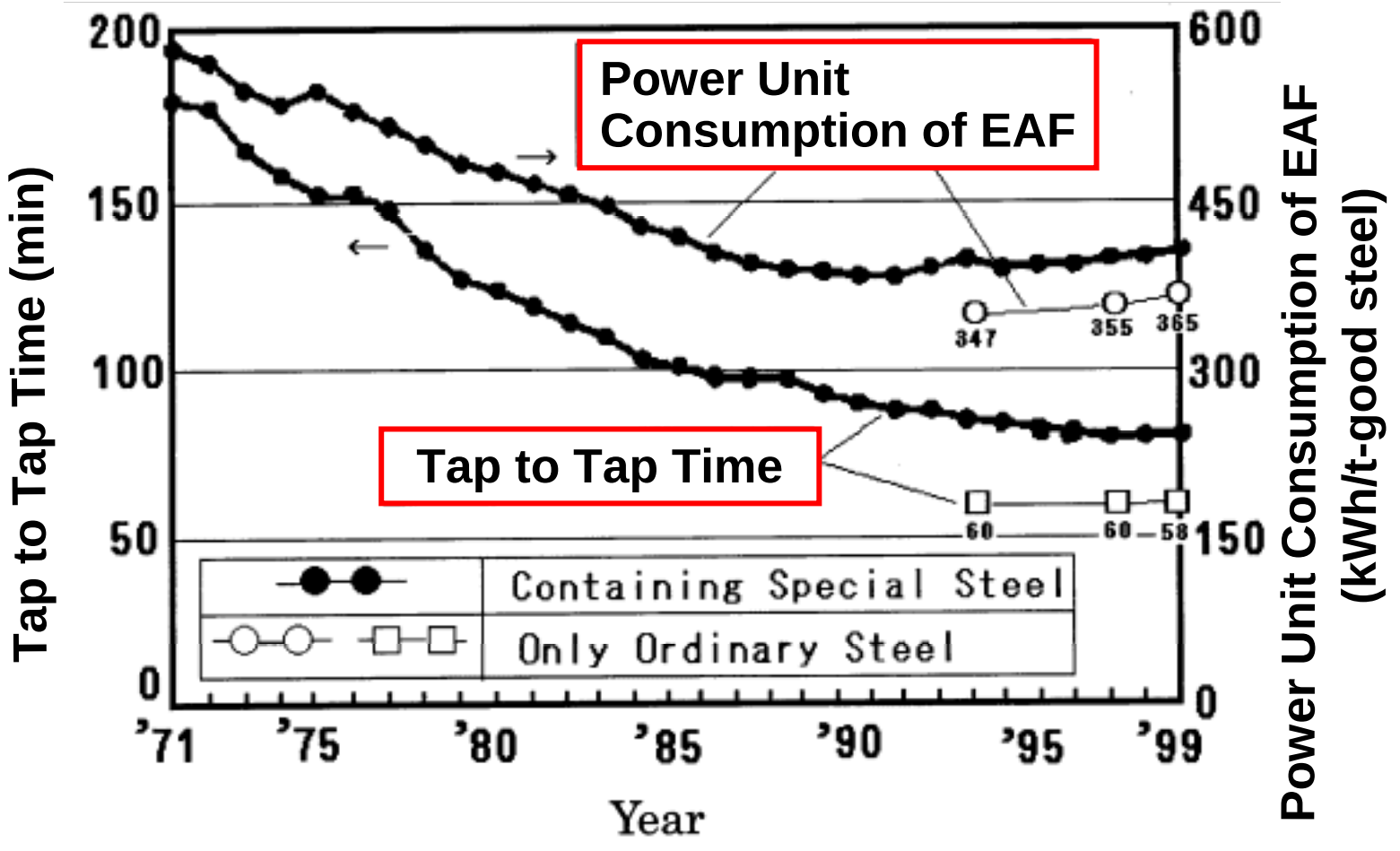
(3) Energy Use in Mini Mill Factory
(Products: Steel Bars for Concrete Reinforcement)



(1) Transition of Technical Development (EAF-CC)

Period	Introduction of new Technologies	Tap-Tap Time (min)	Power Consum. (kWh/t)	Oxygen m^3N/t	Oil L/t
~ 1976	Traditional operation method	176	560	10	--
1976~ 1978	LF installation Burners on wall Furnace water cooling	147	497	12	3.2
1979~ 1980	Wider water cool area High power factor operation Carbon injection	110	390	20	2.8
1981~ 1984	SPH installation Oxygen rich operation (PSA) New casting machine	95	345	28	2.3
1985~	EBT installation Installation of more wall burners	85	325	32	1.8
1988~ 2000	Bottom stirring DC furnace (More than 20 f'ces) Aluminum arm, Slag detector Powder casting or nozzle casting Large tundish, EMS Mist cooling	63	Hot metal operation Night time operation Utilization of waste materials		
2001~ 2006	Ecoarc (Shaft furnace and continuous operation)		200		

(2) Trend in Operation Indices of EAF



(3) Energy Conservation Activities in EAF Process

1) Energy conservation in EAF shop

(EAF: Electric Arc Furnace (AC, DC))

a) Increase of input energy

- **Enrichment of O_2**

According to above countermeasure

- ***Increase of Oil (Burner), Carbon, Low cost alloys (Aluminum ash, Bundle made from Can, etc.)***

b) Increase of efficiency in input energy

- **Power**

  Common (DC, AC):

  ○ ***VVVF control of electrode lifting***

  Introduction of Inverter control system

  ○ ***Foaming slag control in refining stage, etc.***

  AC：Al-arm, Reactor (in case of enough capacity of power station and high voltage operation), etc

- **Other**

  Post combustion (Shaft furnace), Supersonic lance, etc.

c) Decrease of output energy

- ***Increase of Heat size***
- ***Decrease of Tap to Tap time and waiting time***

  of the time after tapping (from tapping to the start of scrap charge)
- ***Decrease of heat loss by slag***

  Hot recycle of slag, Control of scrap's dust, etc.
- ***Scrap preheating***

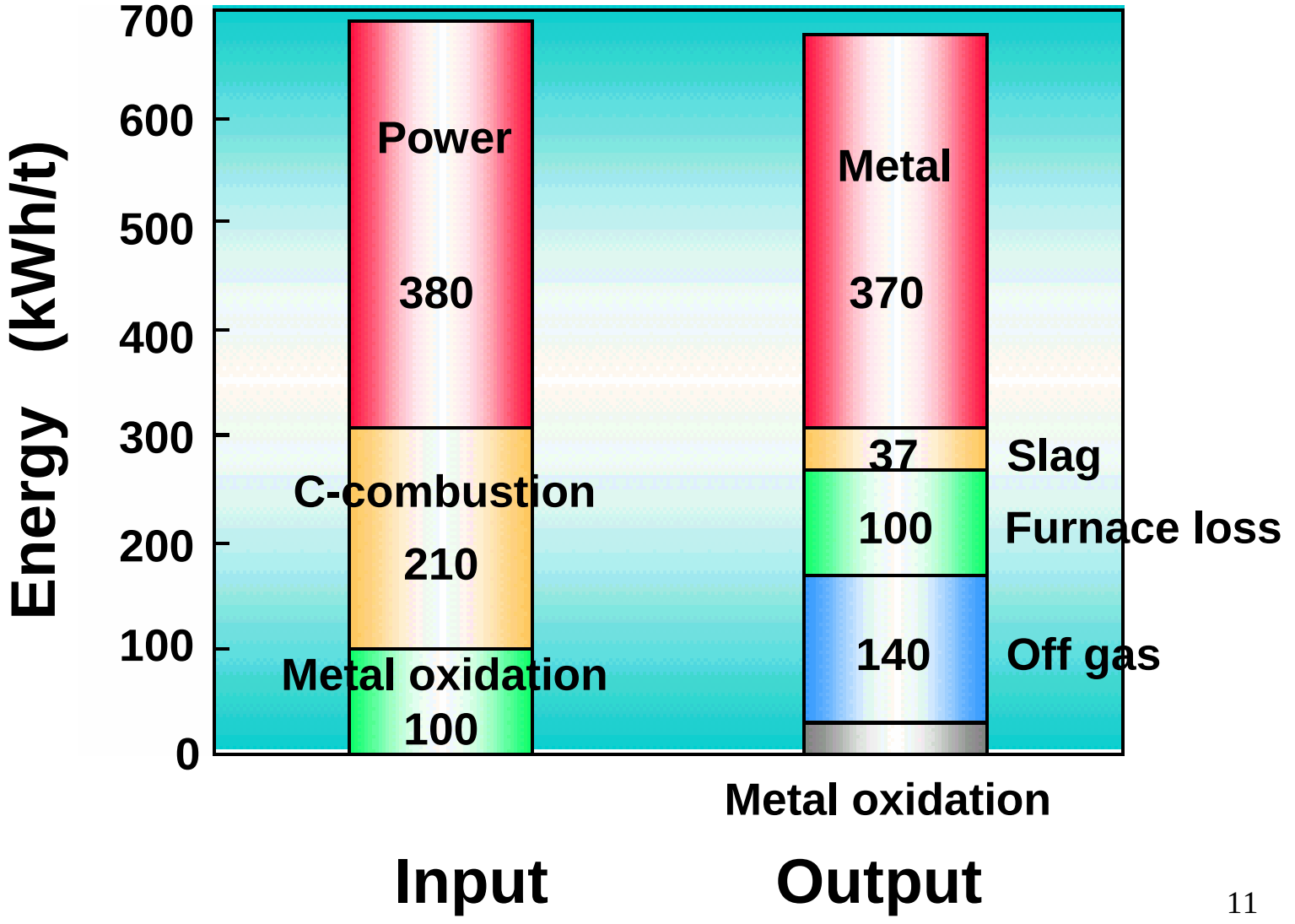
  Shaft furnace with decreasing technology of dioxin

2) Others

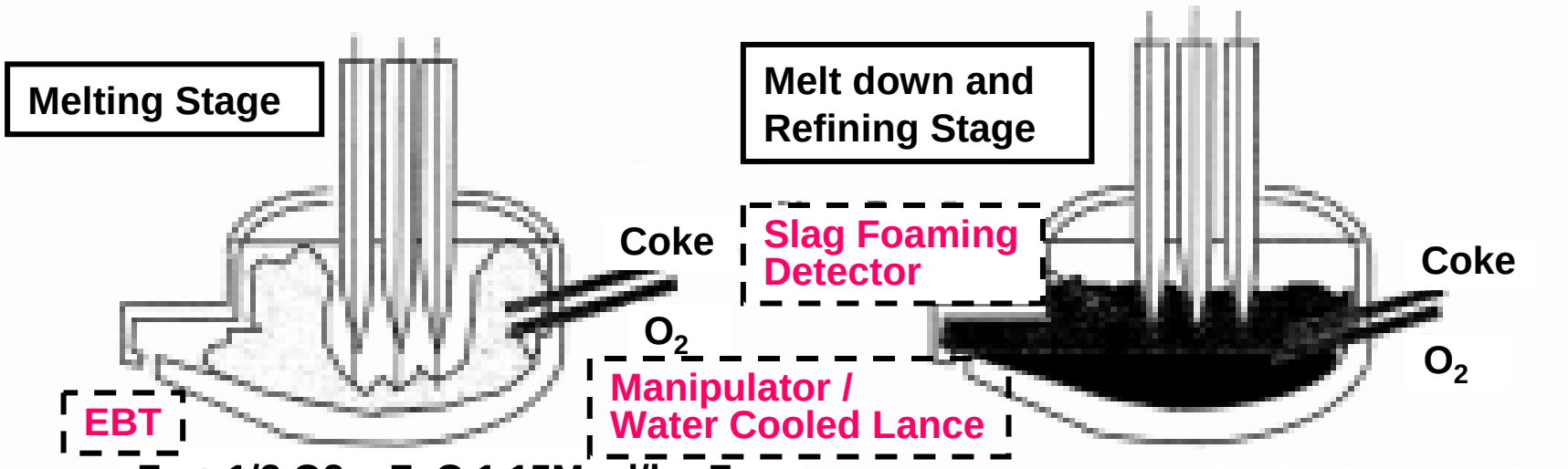
- **Power saving in auxiliaries**

  VVVF control of dust collecting fan motor, etc.

(4) Energy Balance-1



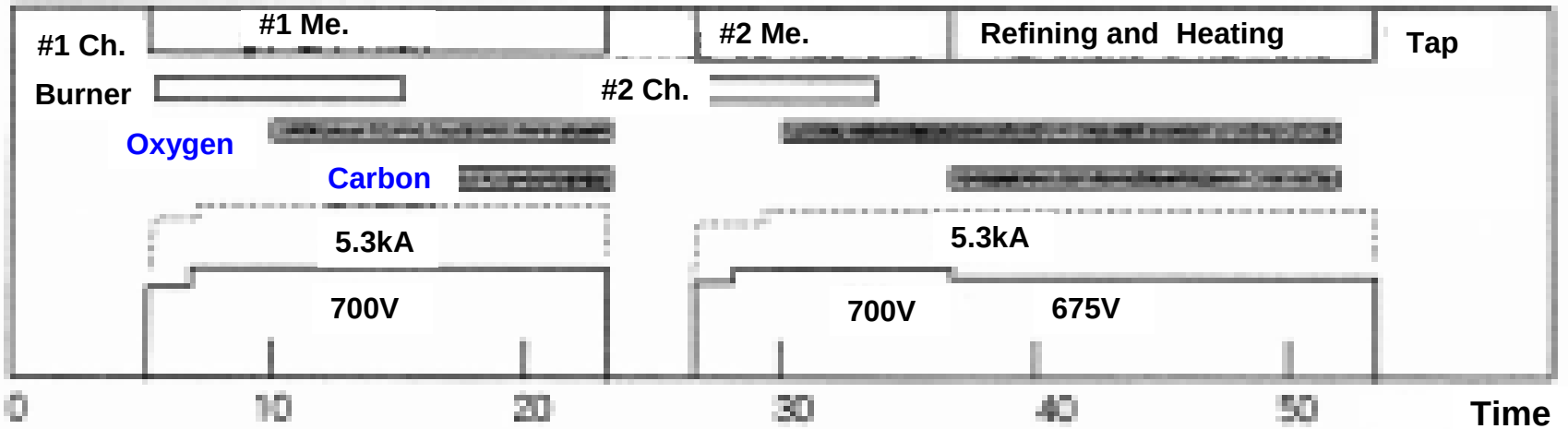
(5) Enriched Oxygen Operation (Example)



$Fe + 1/2\ O2 = FeO\ 1.15Mcal/kg\text{-}Fe$

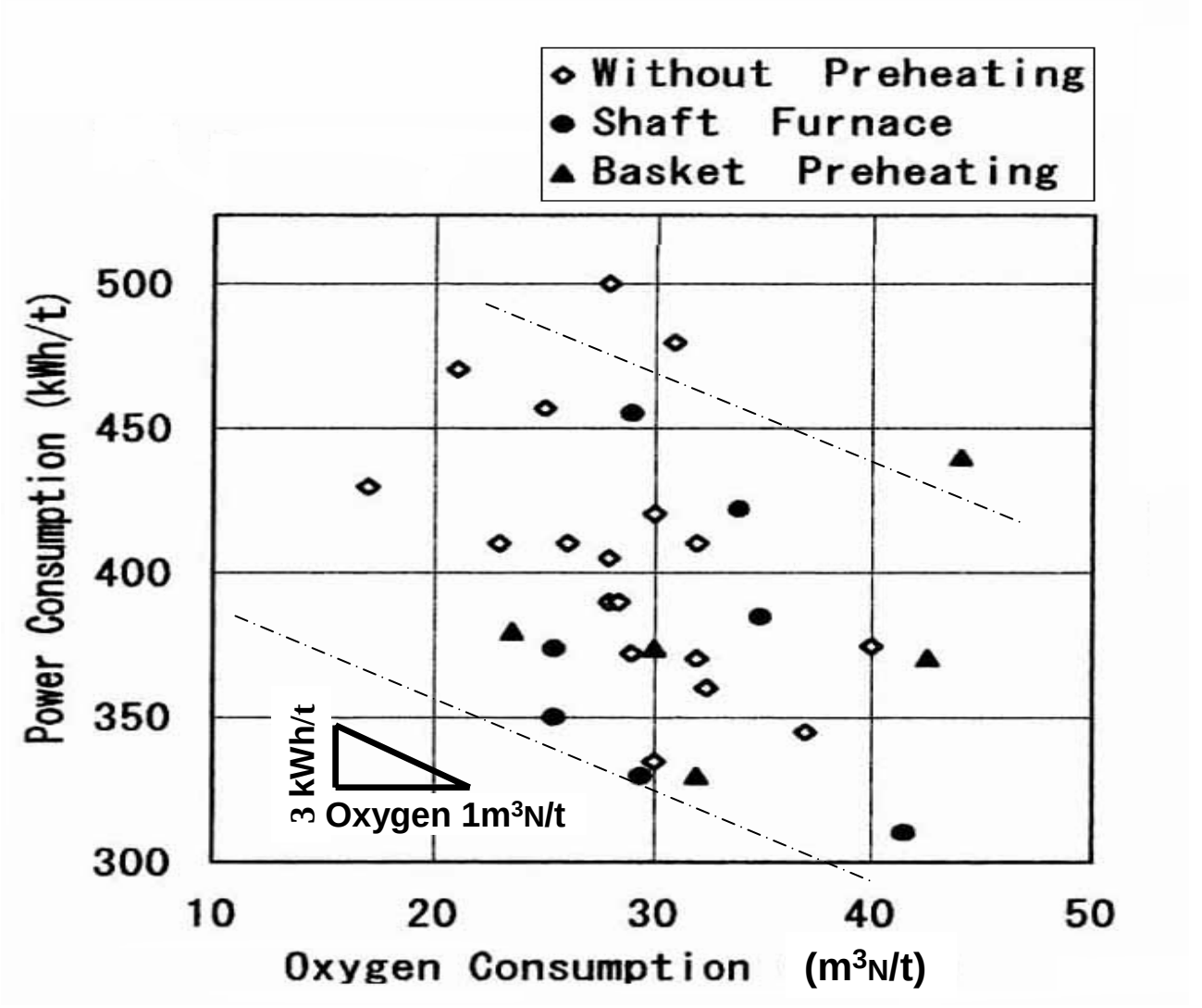
$C + 1/2\ O2 = CO\ \ 2.2Mcal/kg\text{-}C$

$FeO + C = Fe + CO - 0.68Mcal/kg\text{-}Fe$

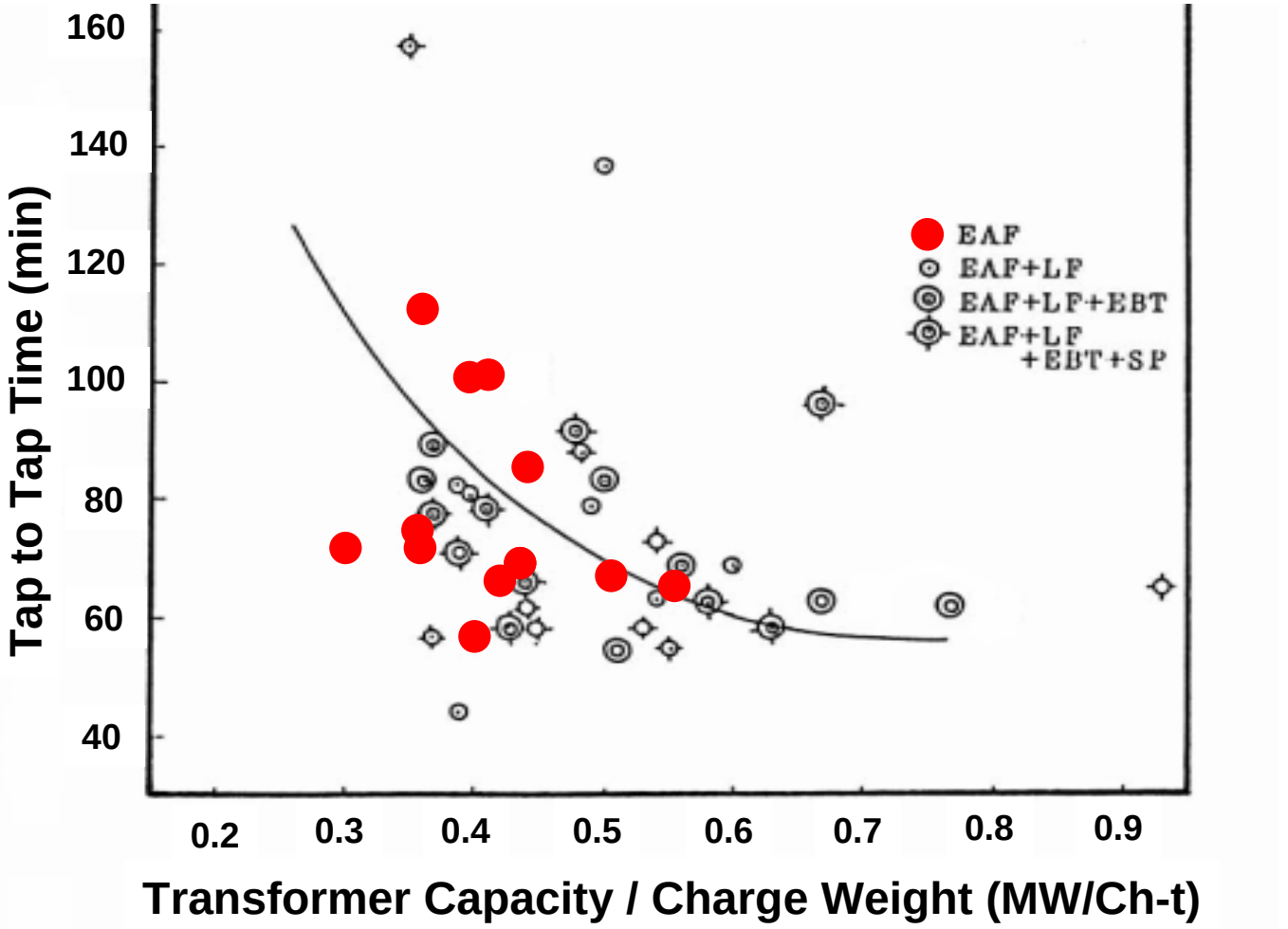


ECCJ

(6) Influence of Oxygen and Reheat on Power Consumption



(7) Relation between Transformer Capacity and Tap to Tap Time of EAF

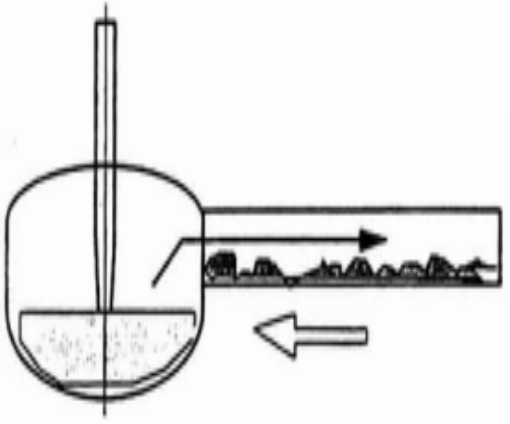


(8) Scrap Preheater

Several Types of Recent Scrap Preheater

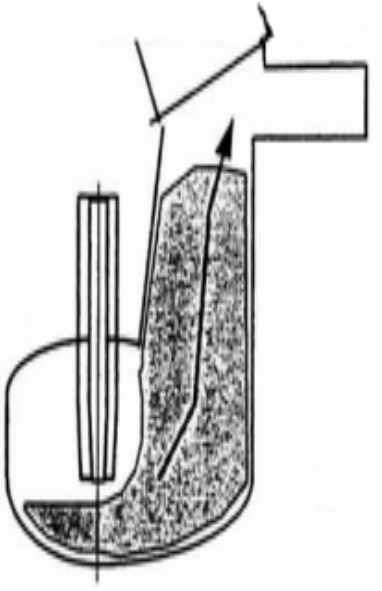
Consteel

Effect: 45kWh/t
(Reported value)



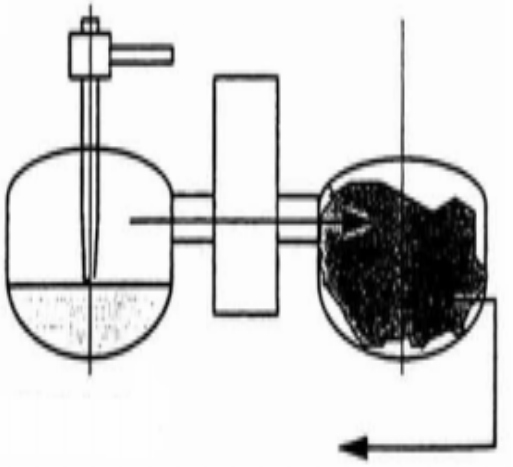
Shaft Furnace

Effect: 70kWh/t
(Reported value)



Twin Shell Furnace

Effect: 30kWh/t
(Reported value)



(9) Effect of VVVF
(Example of Power saving calculation)

(80t furnace)

	Without VVVF	With VVVF
Blower Motor of Direct Dust Collector (970kW)	970・0.85・(min/60) = 960kWh/ch.	970・0.85・[1・11/60 + 0.85^3・10/60 + 0.75^3・49/60] = 520kWh/ch.
Power Consumption	960/80 = 12kWh/t	520/80 = 6.5kWh/t
Difference	5.5kWh/t	

Operation rate: 100%　85%　75%
1 charge = 70 min: 11 + 10 + 49 min

(10) *Energy Control System*

Standardized Operation and Reduction of Production Cost in EAF

Melting Control

- Power control
- Melting profile calculation
- Raw/Submaterial feed control
- Additional scrap charging & meltdown determination

Refining Control

- Slag foaming guidance
- Thermal model calculation
- Metallurgical model calculation

Data Management

- Statistical data analysis
- Operation tracking and reporting (Electricity & fuel: daily & monthly report)

Other Functions

- Trend graph of kWh/t
- Correlation between kWh & oxygen
- Etc.

(1) EE&C Activities in CC

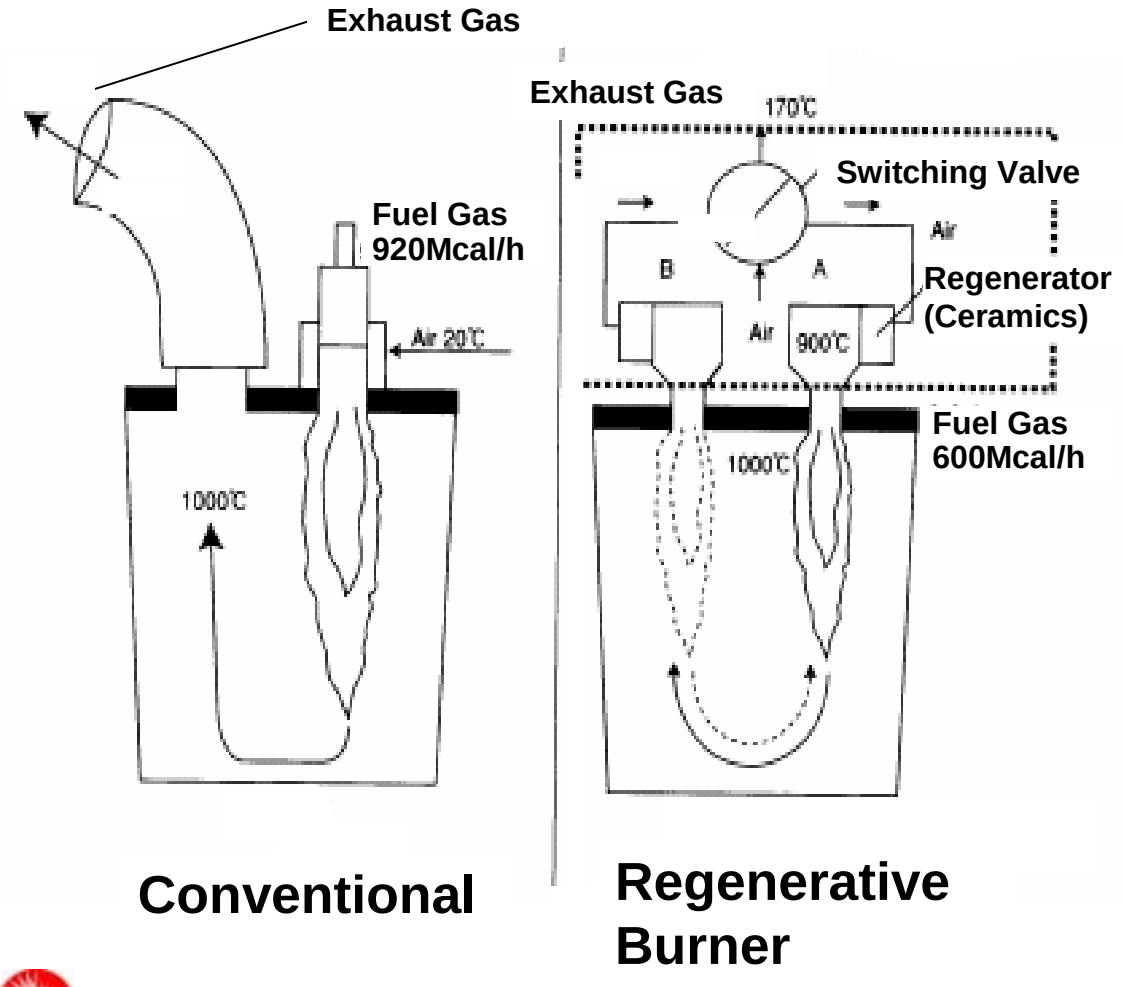
(1) Energy conservation in Ladle and CC

- **Regenerative burner for ladle & tundish**
- **Matching of the productivity between EAF and CC (Continuous Casting)**

(2) Energy conservation after CC

- **Billet heat insulating equipment**
- **DHCR (Direct Hot Charge Rolling), etc.**
- **Matching of the productivity between CC and Rolling Mill**

(2) Regenerative Burner for Ladle
(Same System for CC Tundish)



Effect:

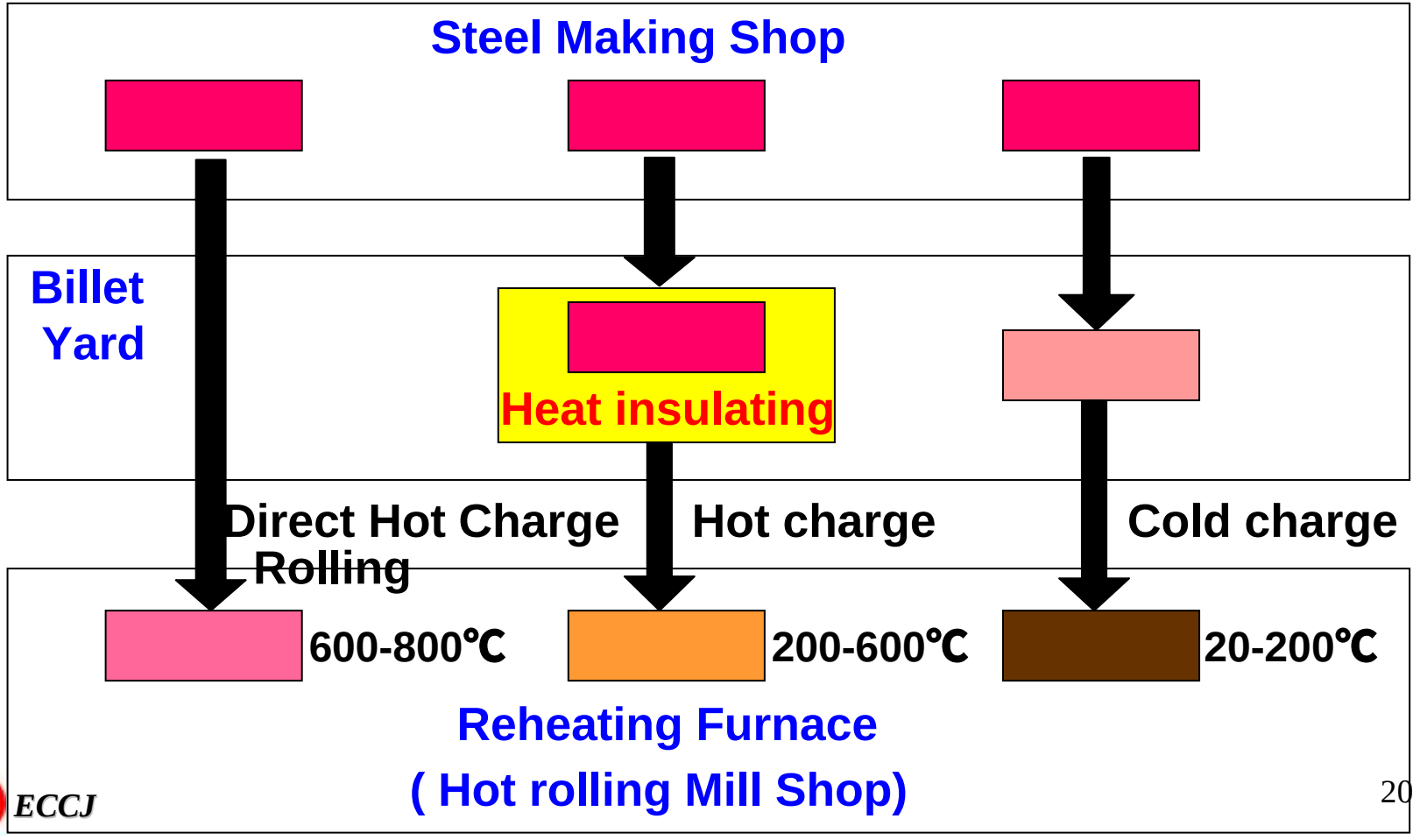
Fuel Reduction Ratio
= 51%

[Condition]

- **Ladle Capacity: 100 t**
- **Heating Period: 10 hours**

(3) Billet heat insulating equipment

This equipment maintain the billet temperature in hot at waiting to the reheating furnace.



(1) Transition of Technical Development (Rolling Mill)

Period	Introduction of new Technologies	Power Consum. (kWh/t)	Oil L/t
1995~	Regenerative burner		Oil reduction: 20~29%
2001~	DHCR (Direct Ht Charge rolling), and subsidiary furnace (Heat keeping furnace)		Oil reduction: 52%
2001~	Endless rolling		
2002~	Hot eddy current inspection		

(2) Energy Conservation Measures in Rolling Mill Factory

(1) Matching of the productivity between CC and Mill

(2) DHCR (Direct Hot Charge Rolling), etc.

(3) Reheating furnace:

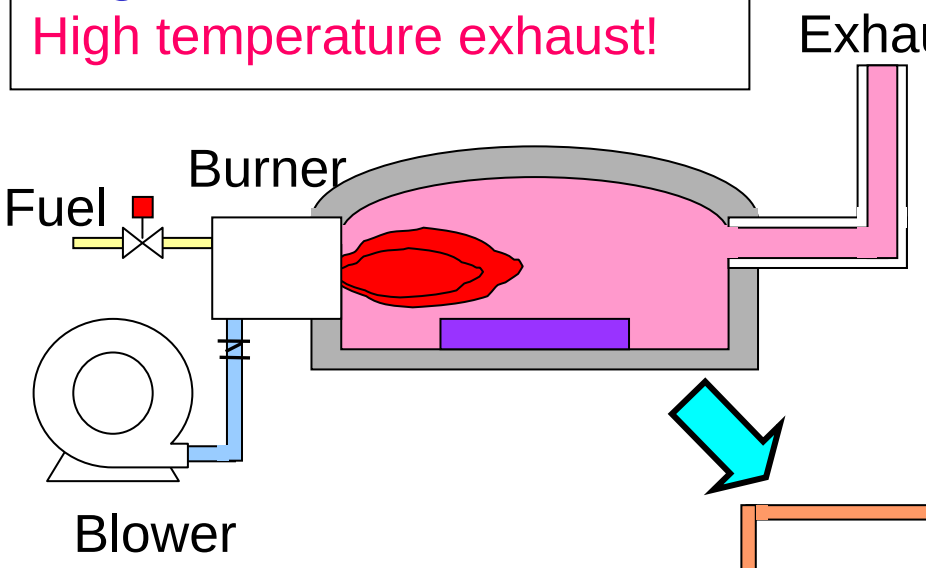
Application of regenerative burner system

(4) Energy saving of fluid machinery:

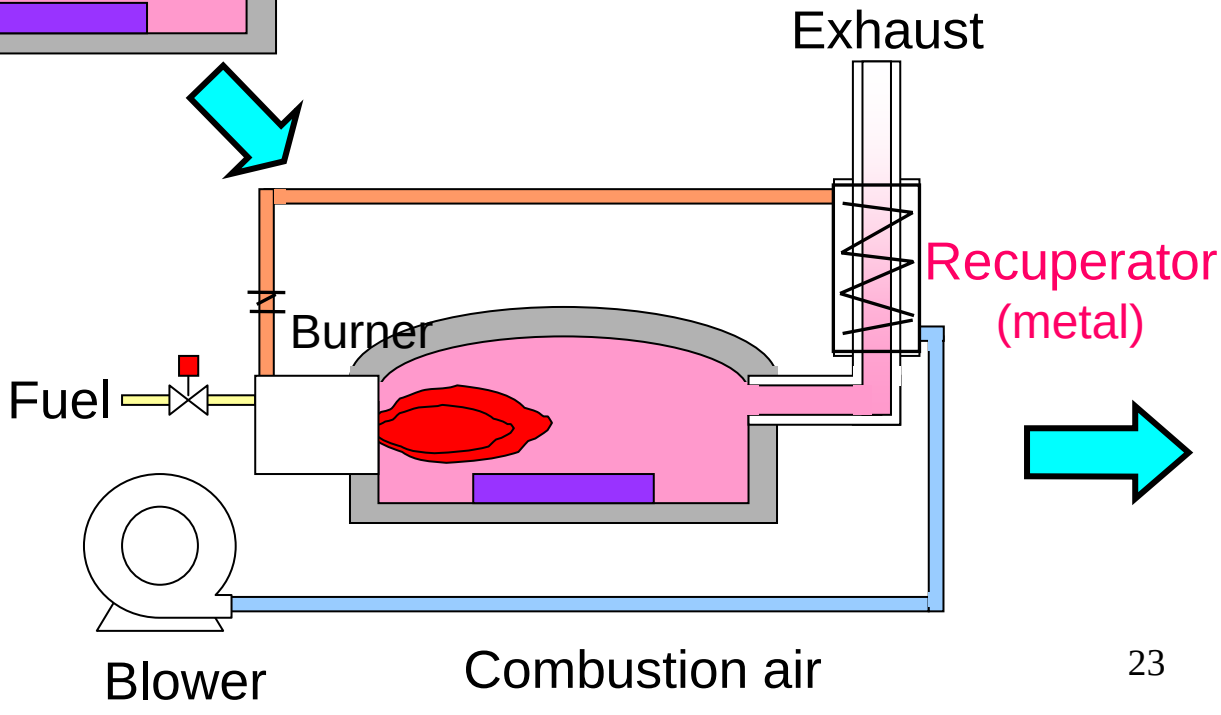
Pump, Fan, Air Compressor, etc.

(3) Application of Regenerative Burner

Regular Industrial Furnace
High temperature exhaust!

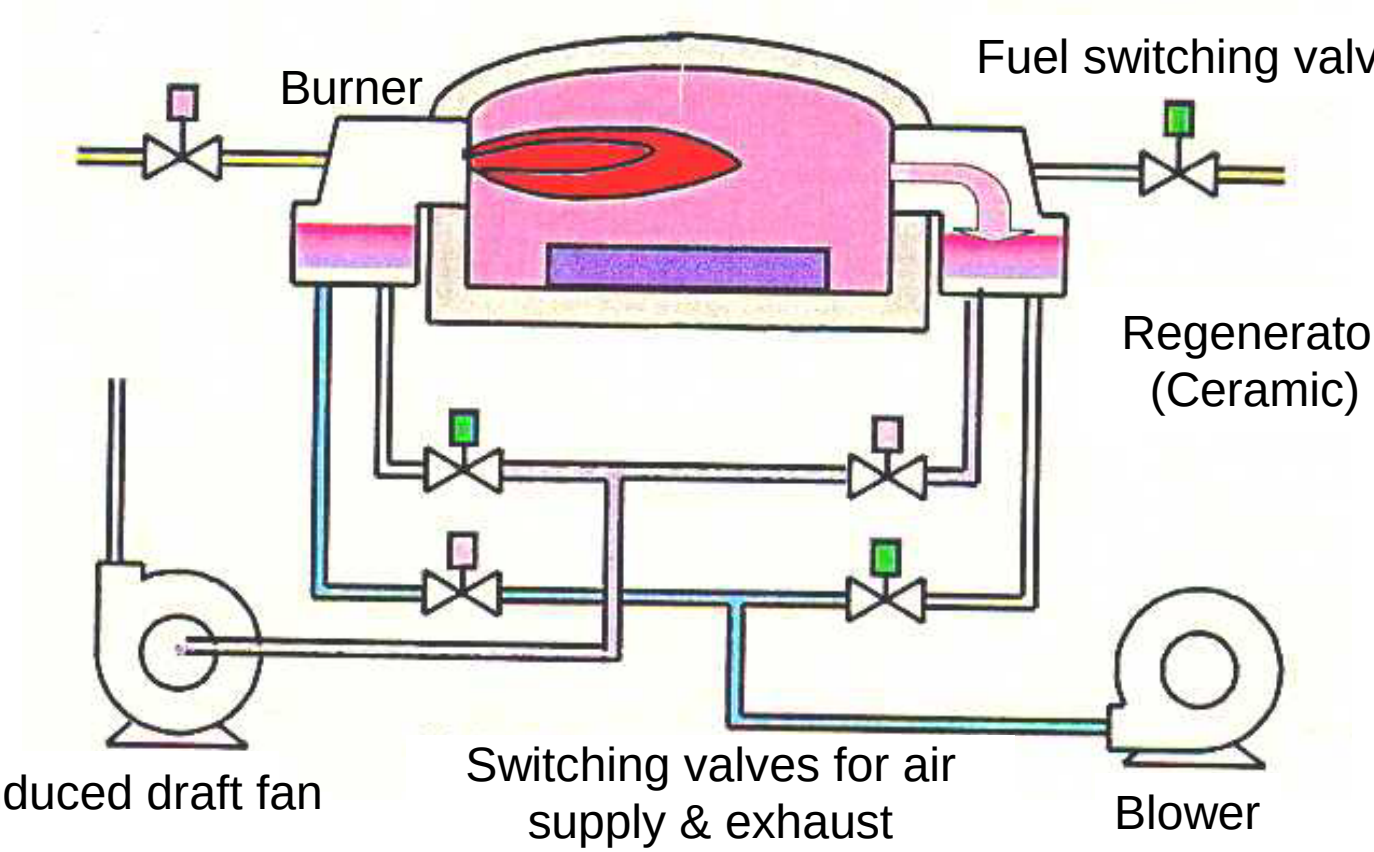


High-performance
Industrial Furnace (1)
Metal type heat exchanger



High-performance Industrial Furnace

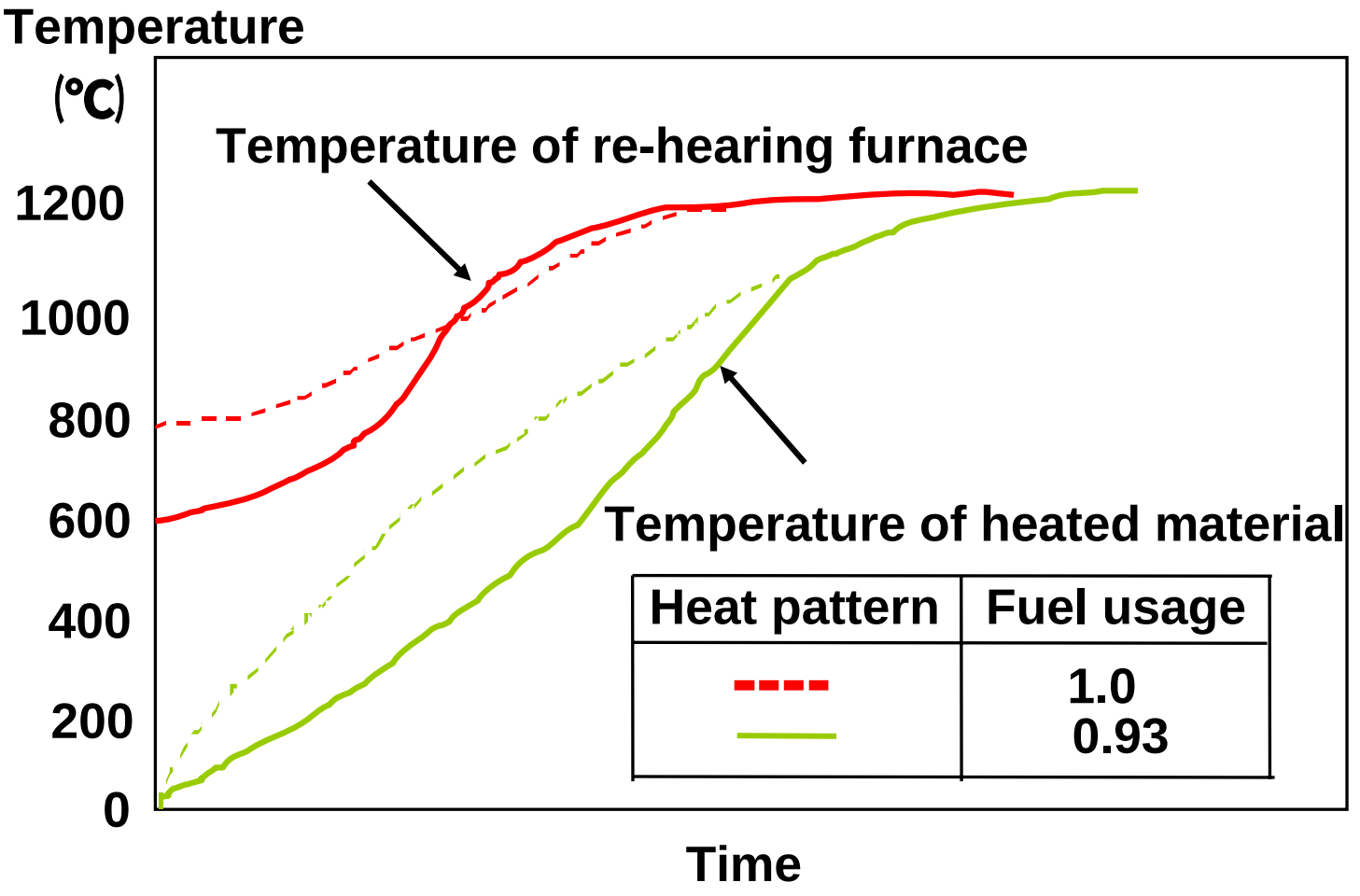
Alignment of a pair of burners with a built-in ceramic storage heat exchanger, combustion and exhausting in turn, temperature preheated of combustion air



Merit of Regenerative Burner in Furnace

- **Energy – saving**
  - ◆ **Effect of high temperature combustion air over 1,000℃ (Reduction of fuel = - 20%)**
- **Uniform heating**
  - ◆ **Effect of the stirring of waste gas by cyclic combustion**
- **Compact equipment**
  - ◆ **Shortening of the furnace length by installing burners along the full length of the furnace**

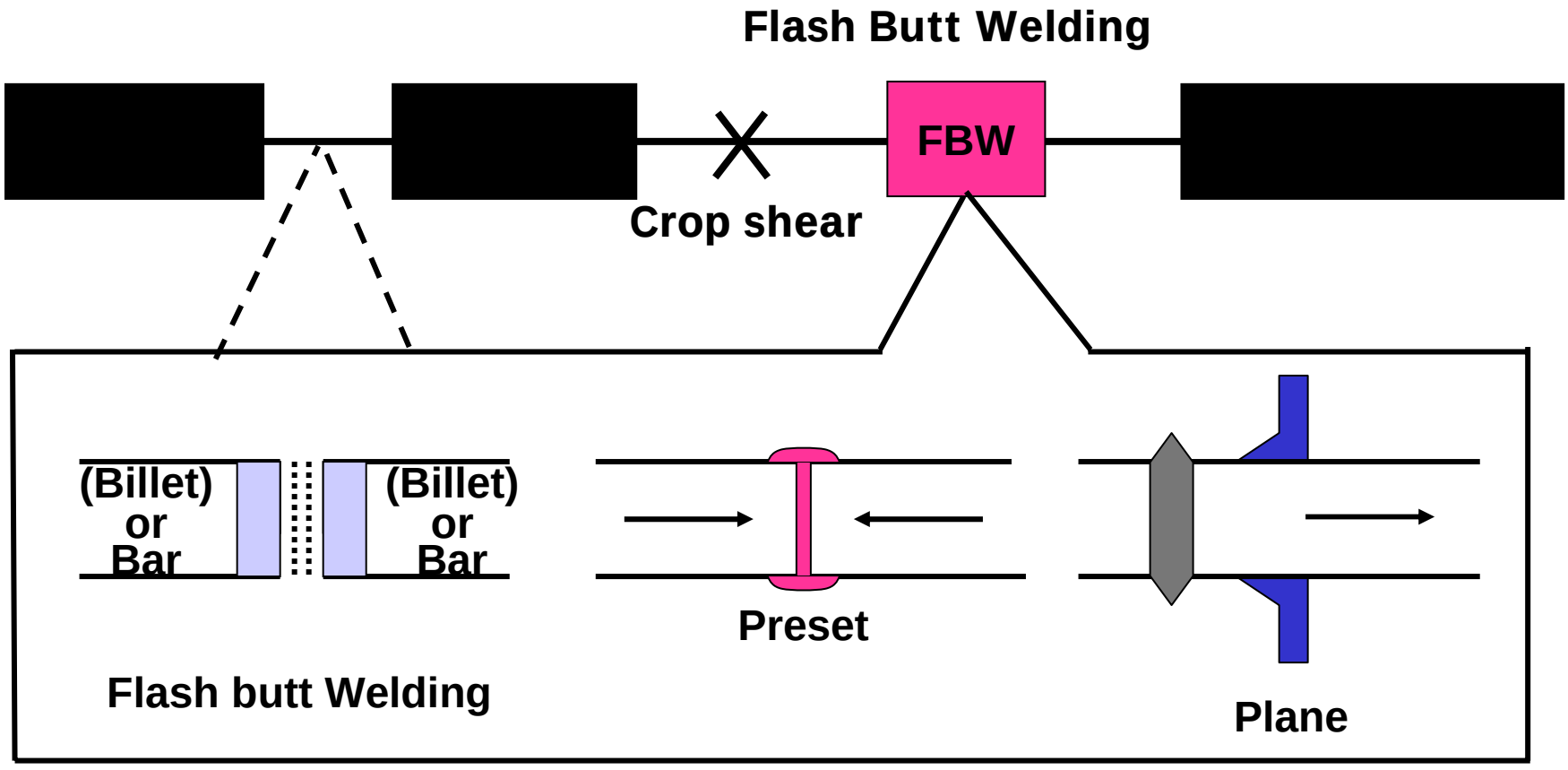
(4) Effect of Heat Pattern Change in Re-hearing Furnace



(5) Endless Bar Rolling System

- **Loss reduction by eliminating of cutting off at both ends of bars**
- **Reduction of the idle time before feeding each new billet and the factors for rolling errors**
- **Drastic reduction in products of wrong dimension or insufficient length**
- **Reduction in energy cost 3%**

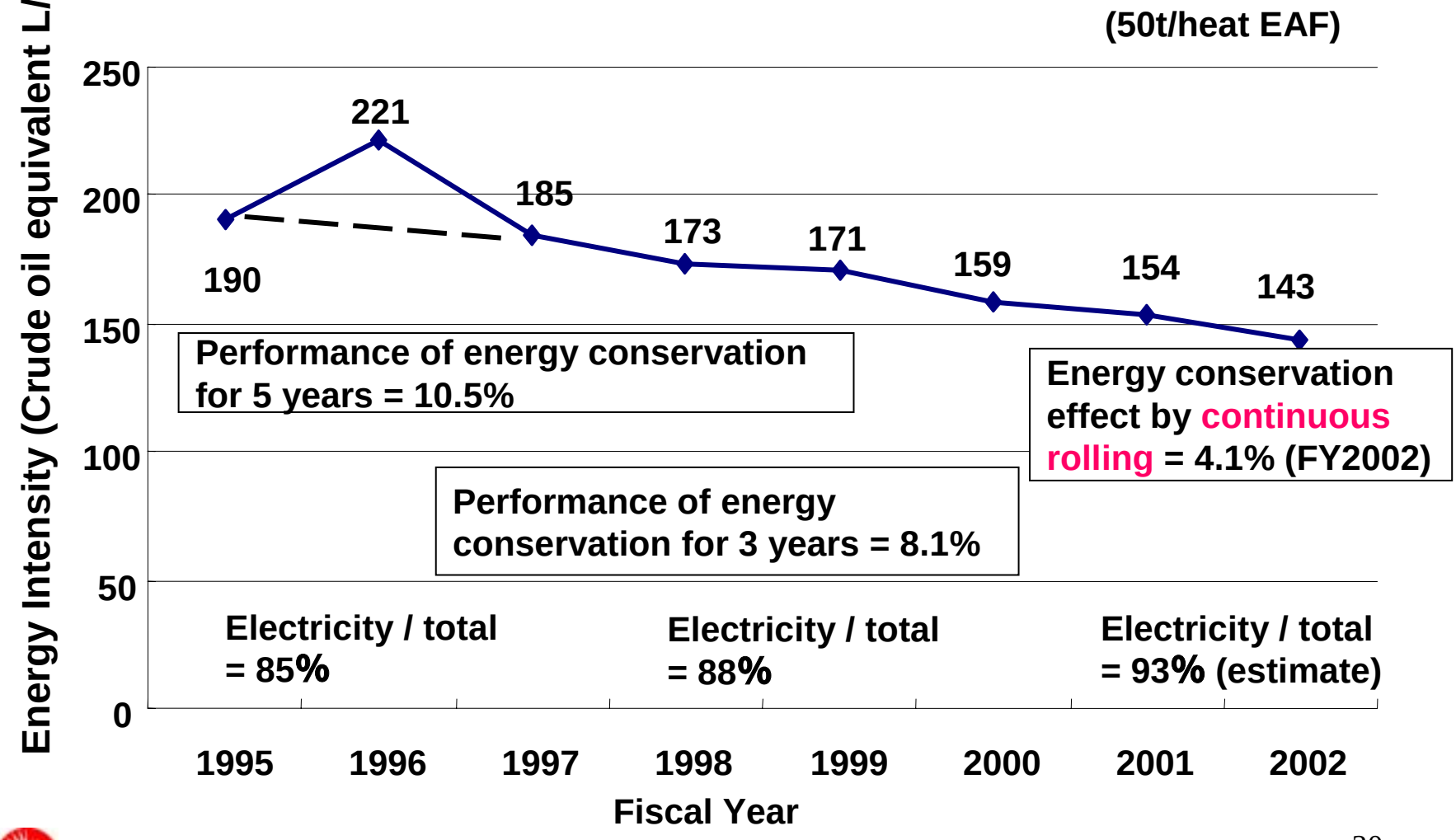
Endless Bar Rolling - Welding



(6) Energy Conservation System

- **Accumulation and analysis of the energy consumption data**
- **Control and management of energy consumption & intensity**
- **Application of existing system examples**
  Energy monitor and analysis system
  - **Local devices**

(1) Transition of Total Energy Intensity (Crude oil equivalent) - Example -




Thank You