2008 Prize of the Chairman of ECCJ

Energy Conservation Activities of Renesas Technology Corp., Saijo Factory

Renesas Technology Corp., Saijo Factory
Production Engineering Division, Power Engineering Section

◎ **Keywords: Rationalization of heating, cooling and heat transfer (Heating equipment, etc.)**
Waste heat recovery and usage
Rationalization in conversion of electricity into motive power and heat, etc. (Electric power application equipment, electric heating equipment, etc.)

◎ Outline of Theme

This factory is a main factory of our company manufacturing semi conductors. It is consuming a great deal of electricity and fuel to maintain the cleanness and the constant temperature and humidity of the clean room. In this case study, we could reduce the usage of the fuel as much as 51% from the level of fiscal year 2004 and the usage of the electricity for the chillers as much as 38% from the level of fiscal year 2003 by using waste heat of the chiller cooling water, introducing high-efficiency chillers and using ESCO business scheme, etc.

◎ Implementation Period of the Said Example

April 2004 – March 2008 (Continuously planned and implemented)

● Project Planning Period	April 2004 – February 2008	Total of 47 months
● Measures Implementation Period	May 2004 – February 2008	Total of 46 months
● Measures Effect Verification Period	June 2004 – March 2008	Total of 46 months

◎ Outline of the Business Establishment

- Items Produced　Semi conductor integrated circuits
- No. of Employees　Approx. 1,400 (Including those of cooperative companies)

- Type 1 designated energy management factory

◎ Process Flow of Target Facility

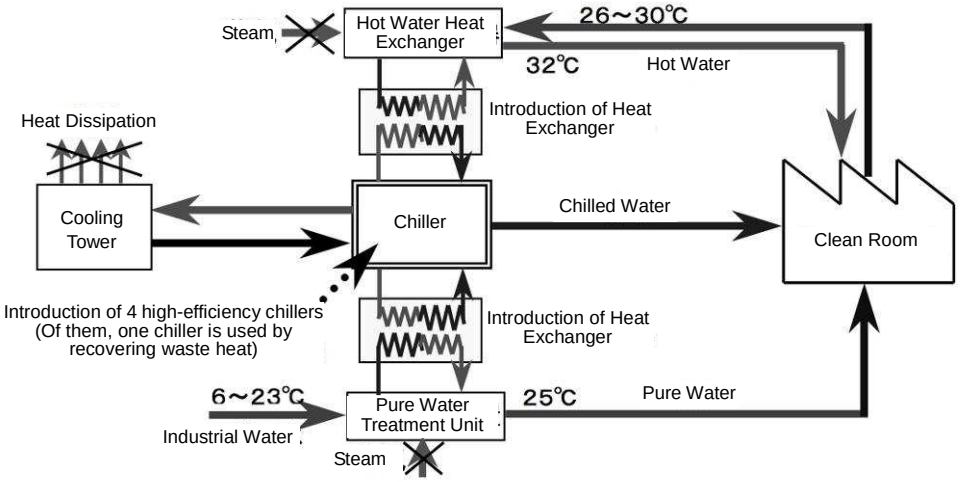


Fig. 1 Approximate Flow of Chillers and Waste Heat Recovery System

1. Reasons for Theme Selection

Of the energy used in the power and manufacturing processes (Fiscal year 2003), the power process used to account for 61%. In case of electricity especially, the operational efficiency of the chillers was bad because they were old, and the steam used by the air conditioner and the pure water equipment used to share the most of the fuel, so we implemented energy conservation measures aiming to reduce the energy of the power process, through introducing high-efficiency chillers, recovering waste heat of the chiller and using ESCO business scheme.

2. Progress of Activities

(1) Implementation Structure

As the energy management organization chart of Fig. 2 shows, under the initiative of the power engineering section and the power operation management division, we did activities for reducing the amount of electricity and fuel used by the power process. When introducing high-efficiency chillers and building the waste heat recovery system, we actively used ESCO business scheme.

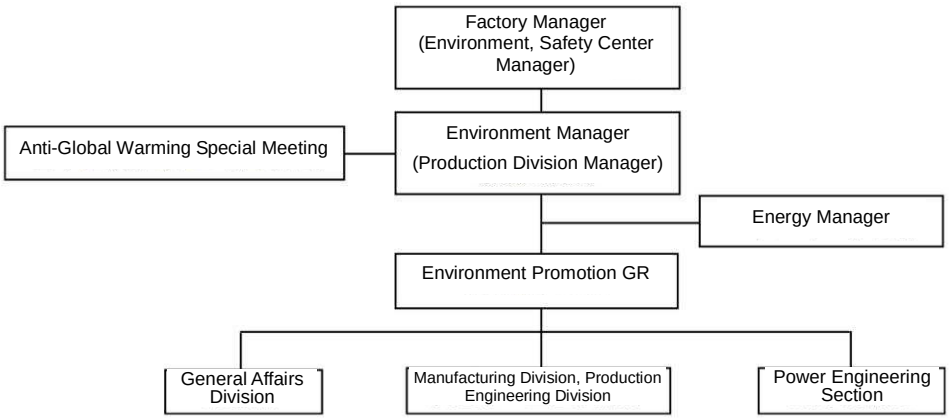


Fig. 2 Energy Management Organization Chart

(2) Understanding of Current Situation

This factory uses electricity/kerosene as its primary energy. Fig. 3 shows the breakdown of energy used in fiscal year 2003, showing that the electricity accounted for 92% of the total energy. As regards the use of energy in each process, the power process accounted for 61% of the total (Fig. 4).

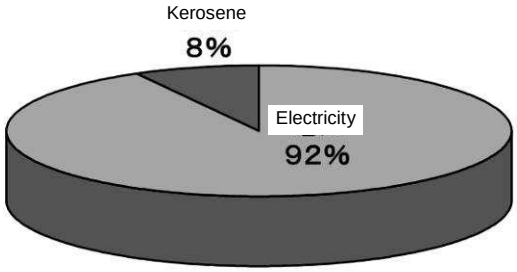


Fig. 3 Ratio of Energy Use (FY2003)

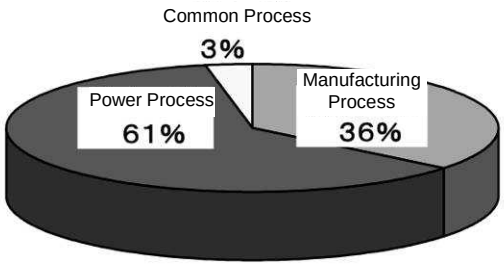


Fig. 4 Ratio of Energy Use by Process (FY2003)

(3) Analysis of Current Situation

1) Ratio of kerosene (steam) use by process

In the ratio of kerosene (steam) use by process in fiscal year 2004 (Fig. 5), the air conditioning accounted for 54% and the pure water accounted for 40%. In case of the air conditioning, the use of steam which went to the hot water heat exchanger in SA building accounted for 80% of the air conditioning total (Fig. 6), and in case of the pure water equipment, the steam for heating the primary pure water accounted for as much as 94% of the pure water total (Fig. 7).

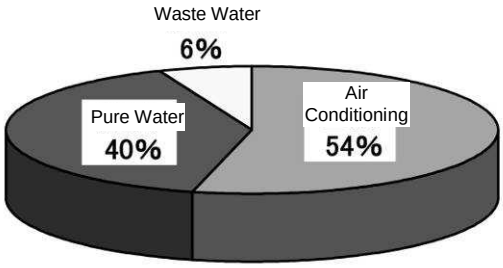


Fig. 5 Ratio of Kerosene (steam) Use by Process (FY2004)

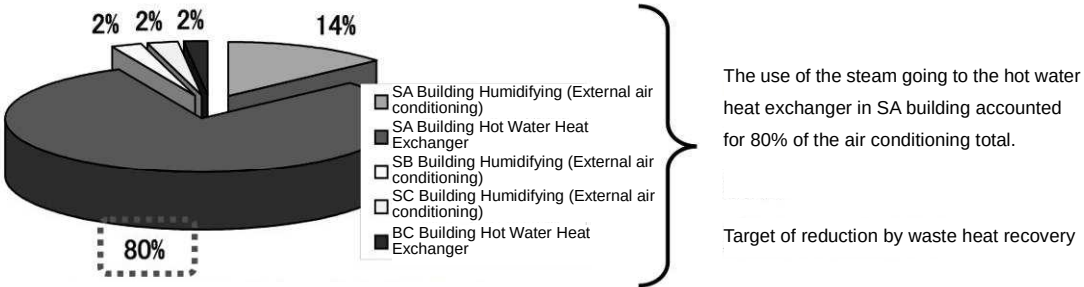


Fig. 6 Ratio of Steam Use by Each Air Conditioning

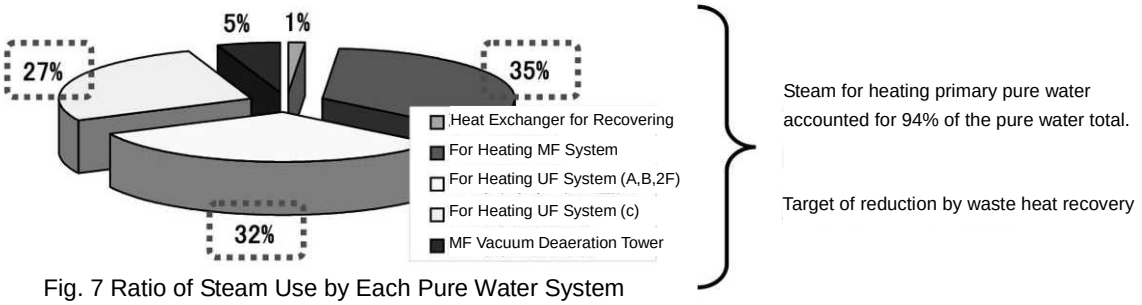


Fig. 7 Ratio of Steam Use by Each Pure Water System

2) Ratio of electricity use by chillers

In the ratio of electricity use by process in fiscal year 2003, chiller equipment accounted for 31% of the total (Fig. 8).

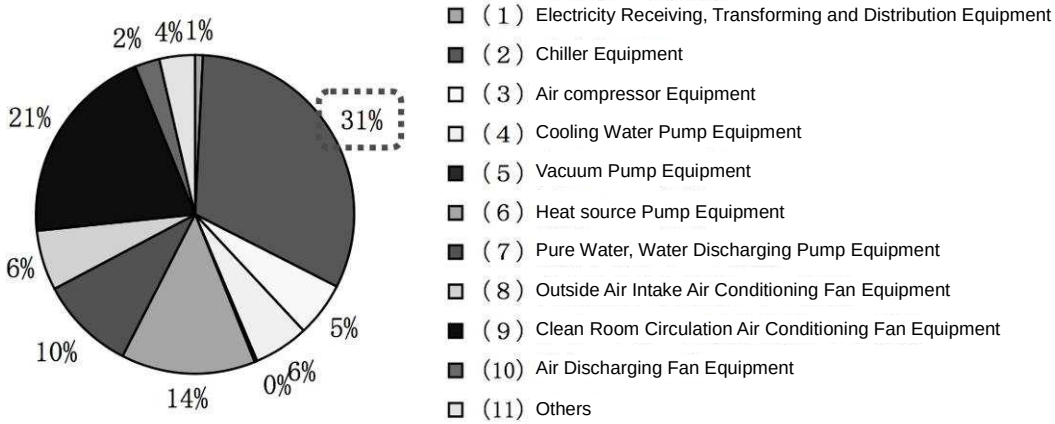


Fig. 8 Ratio of Electricity Use by Power Process

(4) Target Settings

The targets for reducing the use of kerosene and electricity of the chiller were set as shown in Fig. 9 and Fig. 10 below.

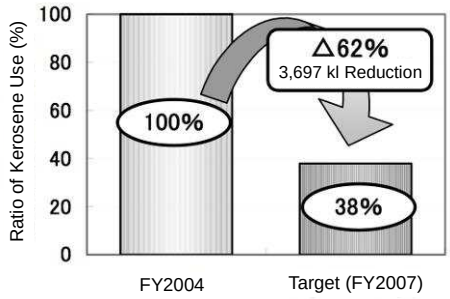


Fig. 9 Target for Reducing Kerosene Amount Used

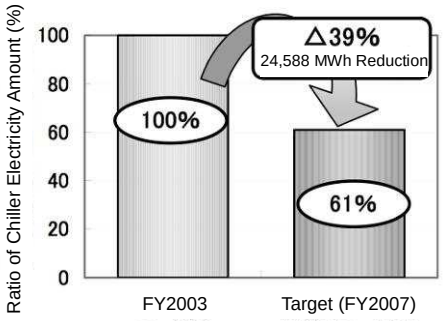


Fig. 10 Target for Reducing Chiller Electricity Amount

(5) Problem Points and Their Investigation

1) Problem points

[1] Since already existing chillers were old, it was difficult to operate them safely and to recover and use their waste heat.

[2] As the cooling tower was an open type, the cooling water was contaminated by scales or foreign substances sticking to the filling materials, making the heat exchanger for recovering waste heat easily clogged.

[3] In the pure water waste heat recovery, it was necessary to study the method to prevent from affecting the pure water quality or stopping the equipment.

[4] For the rated operation, there was a problem in the number of units necessary + α operation (as redundant chilling capacity, the capacity of the cooling water bypass was wasted).

2) Investigation of problem points

[1] To get rid of old chillers and introduce high-efficiency chillers. To recover waste heat of the air conditioning and pure water equipment with one of the chillers renewed (constant speed machine).

[2] To renew the cooling tower filling material and install a booster pump + an automatic reverse washing filter to the cooling water line of the waste heat recovering heat exchanger to make the flow faster and prevent the heat exchanger from being clogged.

[3] To make the specifications which can heat the water of the raw water tank and filtering water tank which are near the inlet side of the industrial water.

[4] To introduce chillers and chiller water pumps both equipped with INV to cope with the change of the load.

(6) Details of Measures

Table 1 shows main energy conservation measures. Of them, we describe 4 case studies in detail as the improvement made for equipment.

No.	Measures	Implementation Time	Energy Amount Reduced	CO_2 Amount Reduced
1	Introduction of chiller monitoring system (asking a lot of people to meticulously start and stop chillers).	May, 2004	5,174 (MWh/year)	2,872
②	Reduction of electricity by introducing 2 constant speed machines of high-efficiency chillers (2,000USRt).	June, December, 2005	10,303 (MWh/year)	5,718
③	Reduction of kerosene by using chiller's waste heat (for hot water humidification of air conditioning).	November, 2005	2,250 (kL/year)	5,599
4	Reduction of electricity by introducing INV to RO high pressure pumps of pure water yard.	April, 2006	890 (MWh/year)	494
5	Reduction of exhaust air amount (reduction of electricity) by introducing gas sensors interlocked with motor dampers.	December, 2006 -	1,630 (MWh/year)	905
⑥	Reduction of kerosene by using chiller's waste heat (for hot water humidification of air conditioning).	March, 2007	1,896 (kL/year)	4,718
⑦	Reduction of electricity by introducing 2 high-efficiency chillers (12,000USRt, 2,000USRt).	April, 2007	15,415 (MWh/year)	8,555
8	Reduction of electricity by changing the position of air outlet of external air conditioning to under the floor and by reviewing the temperature of air introduced.	April, 2007	5,130 (MWh/year)	2,847
9	Stopping of hot water pumps and reduction of electricity by having back-up of the hot water supply (SA -> BC building system).	April, 2007	2,915 (MWh/year)	1,618
10	Operational improvement of circulation liquid unit (stopping of chillers, reduction of heater electricity).	May, 2007	408 (MWh/year)	226
Total		Electricity	41,865 (MWh/year)	33,551
		Kerosene	4,146 (kL/year)	(t-CO_2/year)

Table 1 Example of Energy Conservation Measures during FY2004 to FY2007

1) Reduction of electricity by introducing high-efficiency chillers (Table 1, item (2) and (7))

We removed old 6 units of 1,000USRt screw chillers + 2 units of 600USRt turbo chillers and renewed them to 3 units of 2,000USRt turbo chillers (2 constant speed machines and 1 INV machine) + 1 unit of 1,200USRt (INV machine). And by implementing the improvements 1 and 2 shown in Fig. 11 below, we could cut redundant chilling capacity and improve the chiller's performance. As a result, we could reduce the chiller's electricity by 25,718

MWh/year in total. It was a great deal of energy we saved (as regards the introduction of INV chillers, we used ESCO business scheme).

* 1,200USRt (INV machine) was introduced to the chiller system in BC building after removing 2 units of 600USRt turbo chillers.

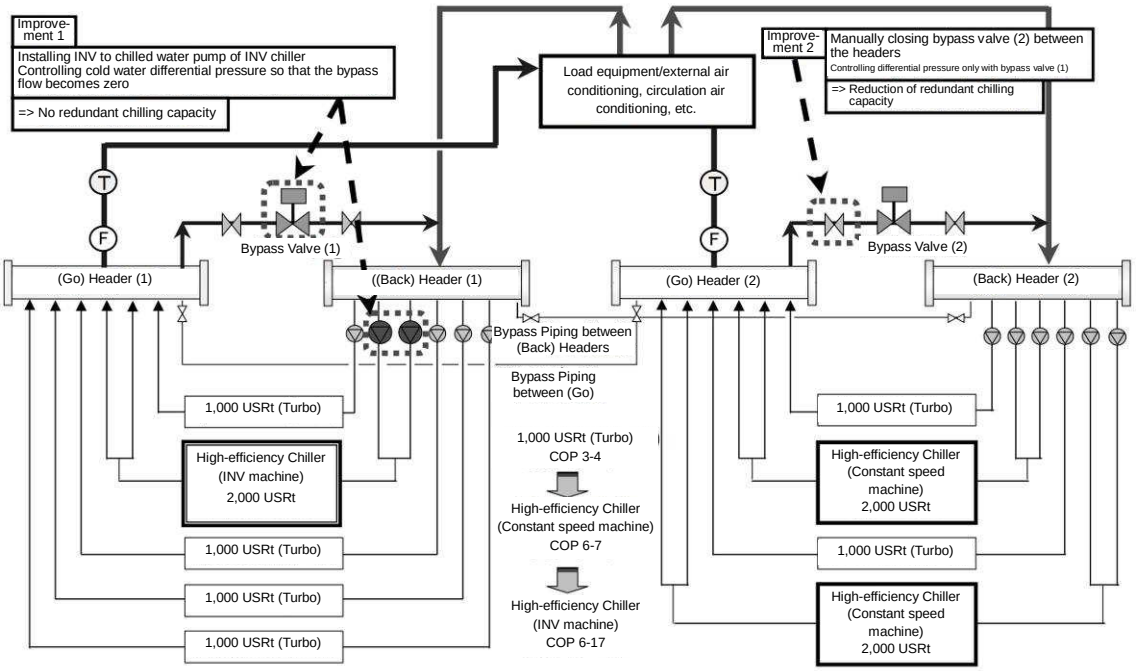


Fig. 11 Chiller System Schematic (SA Building System)

2) (For heating hot water of air conditioning) Reduction of kerosene amount used by using waste heat of chillers (Table 1, Item (3))

There was a problem of increase of the pressure loss and decrease of the flow rate caused by the contamination of the cooling water and addition of the heat exchangers. We tried to solve the problem by using ESCO business scheme and by installing an automatic reverse washing filter and a booster pump in front of the waste heat recovery heat exchanger. One of the renewed chillers (constant speed machine) was used as a chiller for recovering the waste heat. Using the waste heat of cooling water whose temperature is 33 to 35℃, we could reduce the steam amount used for the hot water heat exchanger as shown in Fig. 12. The reduction effect is shown in Table 2.

Reduction of Kerosene Usage Reduction of CO_2 Emission	Increase of Electricity, Increase of CO_2 Emission		CO_2 Emission
	Pump Electricity	Chiller Electricity Increased	Increase/Decrease
2,250 (kL/year) 5,599 (t-CO_2/year)	540 (MWh/year) 300 (t-CO_2/year)	328 (MWh/year) 182 (t-CO_2/year)	5,117 (t-CO_2/year) Decreased

Table 2 Improvement Effect

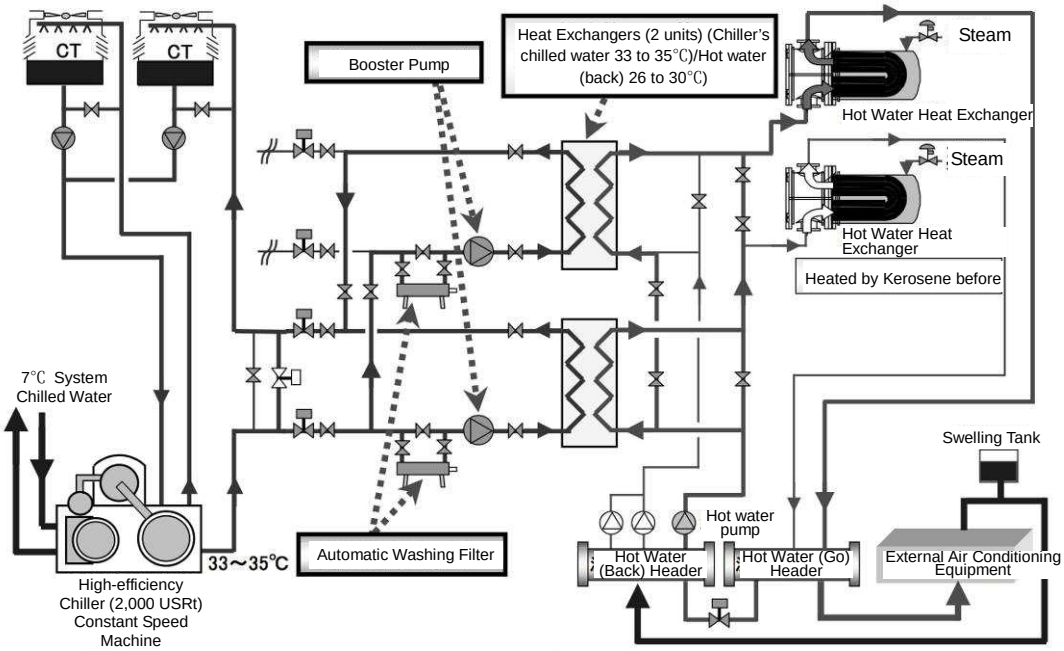
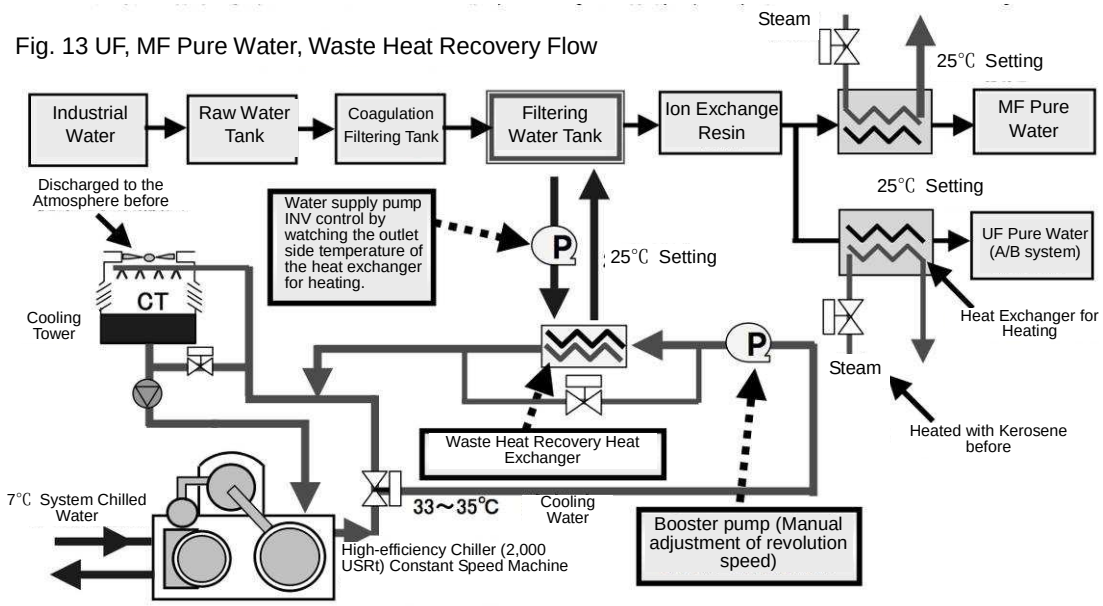


Fig. 12 Schematic of Air Conditioning Waste Heat Recovery System

3) (For pure water raw water heating) Reduction of kerosene amount used by using waste heat of chillers (Table 1, Item (6))

Using ESCO business scheme, we tried to reduce the steam used by heating heat exchanger as shown in Fig. 13, using cooling water's waste heat coming from outlet of the chiller (33 to 35℃). In order to heat the water in the filtering tank without affecting the quality of pure water or stopping the production of pure water, we installed one each of heat exchanger and water supply pump at the cooling water side and the pure water side. As regards the UF pure water (C system), we also installed the heat exchanger and the water supply pump to heat the water of the raw water tank. The reduction effect is shown in Table 3.

Fig. 13 UF, MF Pure Water, Waste Heat Recovery Flow



Reduction of Kerosene Reduction of CO_2 Emission	Increase of Electricity, Increase of CO_2 Emission		CO_2 Emission Increase/Decrease
	Pump Electricity	Chiller Increased Electricity	
1,896 (kL/year) 4,718 (t-CO_2/year)	781 (MWh/year) 433 (t-CO_2/year)	Included in the air conditioning waste heat recovery	4,285 (t-CO_2/year) Reduction

Table 3 Improvement effect

(7) Effects Achieved after Implementing Measures

1) Reduction effect of chiller electricity

The effects obtained by renewing the chillers and by implementing further energy conservation measures are shown in Fig. 14. Although we were slightly short of the original target (increase of production load + influence of outside air load), we could reduce the chiller electricity by 24,247 MWh/year from the level of fiscal year 2003.

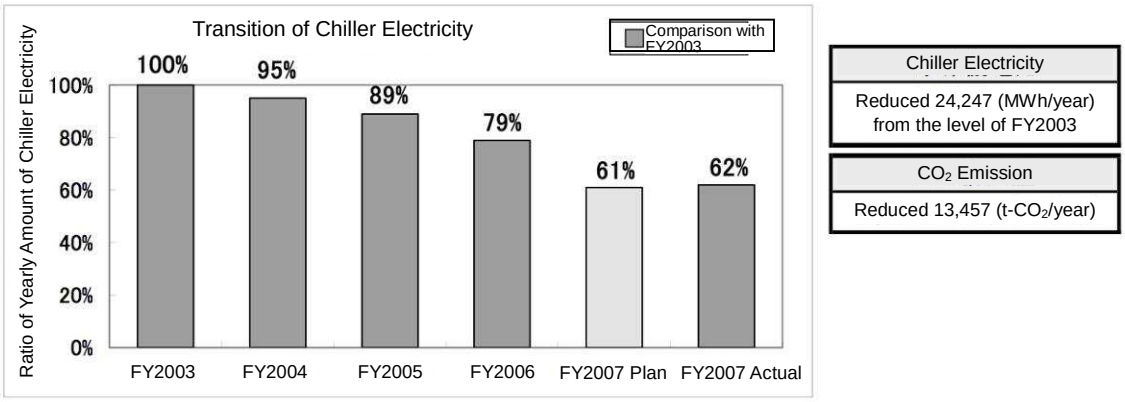


Fig. 14 Reduction Effect of Chiller Electricity (FY2003 to FY2007)

2) Reduction effect of kerosene amount used

The effects obtained by using chiller waste heat to heat the air conditioning and pure water are shown in Fig. 15. Although we were slightly short of the original target (increase of production load + influence of outside air load), we could reduce the kerosene amount used by 3,090 kL/year from the level of fiscal year 2004, which was the reduction of 49% from the level of fiscal year 2004.

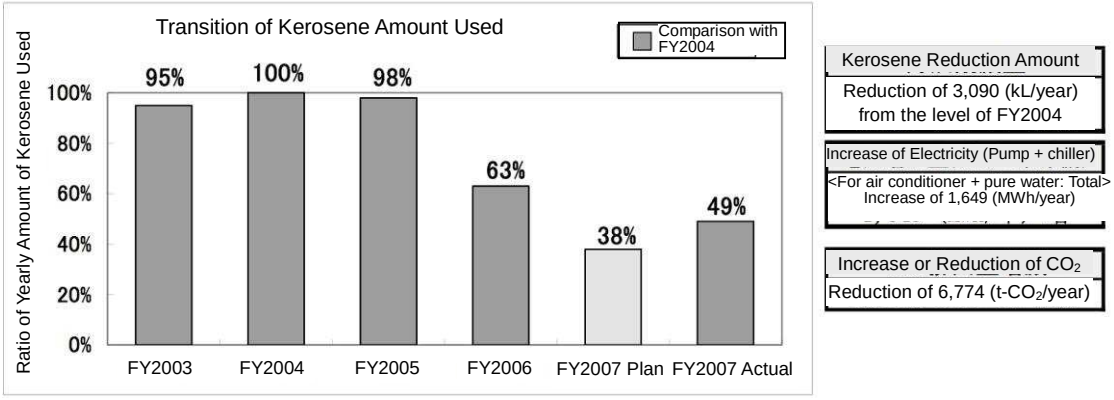


Fig. 15 Reduction Effect of Kerosene Amount Used (FY2003 to FY2007)

3. Summary

By using the waste heat of the chiller cooling water, introducing high-efficiency chillers and using ESCO business scheme, we could reduce the use of fuel as much as 51% compared with fiscal year 2004 and the chiller electricity as much as 38% compared with fiscal year 2003. We also could reduce the share of the energy used by the power process in the power

and production processes from 61% in fiscal year 2003 to 53% in fiscal year 2007 (8% reduction).

4. Future Plans

We will continue the energy conservation activities throughout the factory by having people concerned share the information through the regular meeting held once a week.