2007 Prize of Director General of Agency for Natural Resources and Energy

Reduction of Energy Consumption by Innovation of Energy Supply System

Tonami Plant, Semiconductor Company, Matsushita Electric Industrial Co., Ltd.
Team Eco

◎ **Keywords: Rationalization of heating, cooling, and heat transfer (air-conditioning equipment, hot water installations, etc.)**

◎ Outline of Theme

This plant is an energy intensive plant that manufactures semiconductors by 24 hour operation through the year. Therefore, we introduced cogeneration system that uses LPG as fuel for high efficiency energy use and for avoiding the impact of production facilities by prevention of instantaneous voltage drop or power outage due to thunderbolt etc. from the beginning of the factory construction. However, we had problems such as increase of air-conditioning cost due to recent energy price change and energy loss during winter season when air-conditioning load decreases. Therefore, we innovated the energy supply system to significantly reduce energy consumption while maintaining stable supply of power.

◎ Implementation Period for the said Example

October, 2003 - March, 2007

- Planning period — October, 2003 - July, 2004, total 10 months
- Implementation period — August, 2004 - May, 2006, total 22 months
- Effect verification period — June, 2006 - June, 2007, total 12 months

◎ Outline of the Business Establishment

- Produced items: Semiconductors (S-LSI, A-LSI, CCD, etc.)
- Number of employees: 683
- Type1 designated energy management factory

◎ Overview of Target Facilities

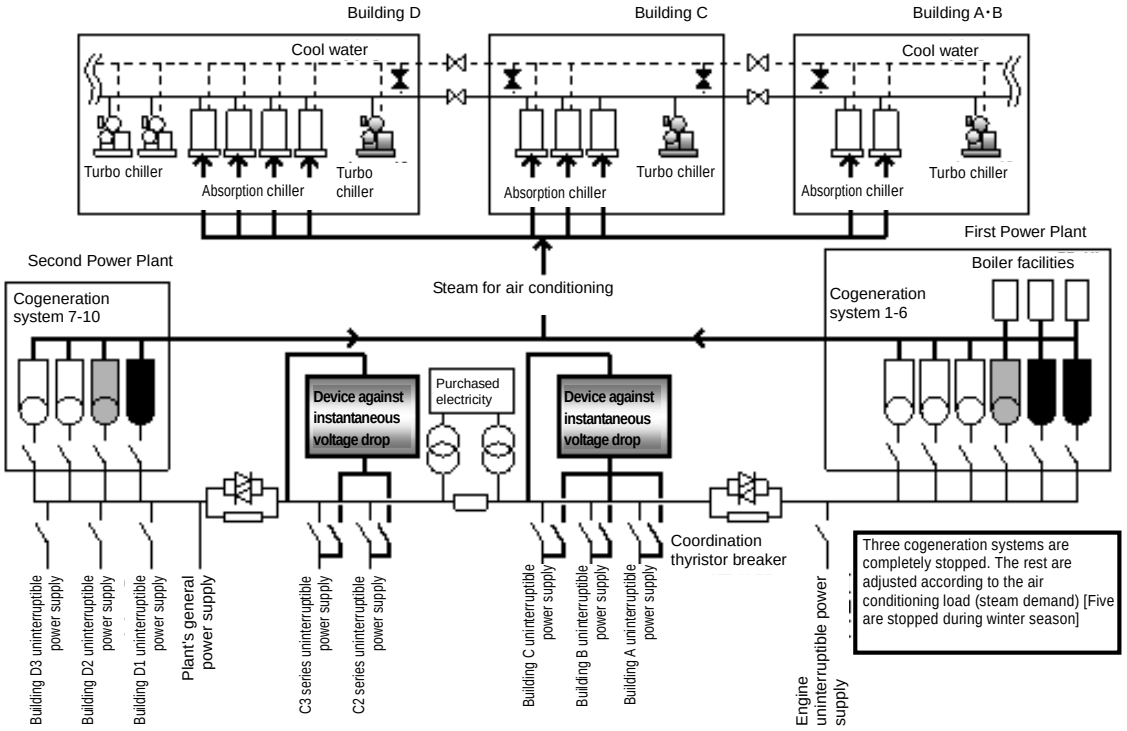

Fig. 1 System diagram

1. Reasons for Theme Selection

This plant manufactures semiconductors by 24 hour operation through the year. As it is located in Hokuriku area, where thunderbolt frequently occurs, we gradually introduced 10 units of cogeneration system equipment along with development of the plant for high efficiency energy use and protection of the production facilities from instantaneous voltage drop or power outage due to thunderbolt etc.

However, we had a problem of increased cost of driving power due to recent skyrocketing crude oil prices, so we worked on innovation of the energy supply system to reduce fuel consumption and environmental load.

2. Understanding and Analysis of Current Situation

[1] Energy consumption and CO2 emission are increasing every year with deployment of the plant, and in 2004, when this activity is planed, consumption was 2.5 times and emission was 2.4 times compared of those in 1996 (Fig. 2).

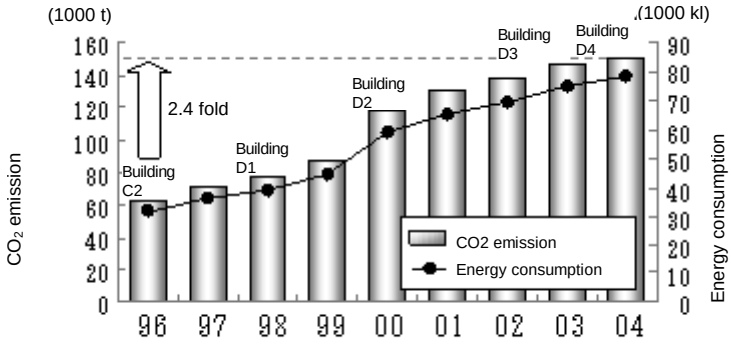

Fig. 2 Trend of energy consumption and CO2 emission

[2] LPG for steam generation accounts for 35% of the consumed energy in 2004 (Fig. 3), 66% of which is used for absorption type chillers (23% of the total energy) (Fig. 4).

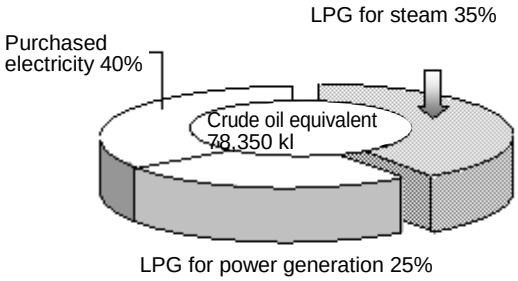

Fig. 3 Classification of consumed energy

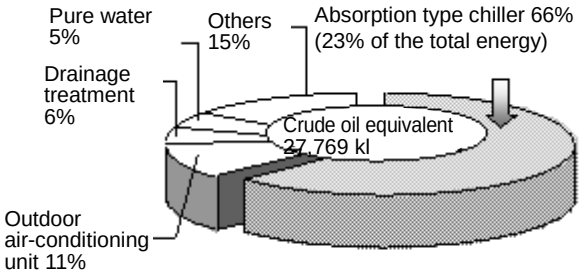

Fig. 4 Breakdown of usage of LPG for steam

[3] Comparing the energy unit prices when the plant was constructed and now, unit price of electricity decreased ▲ 35%. The unit price of LPG increased △98% almost double. (Fig. 5)

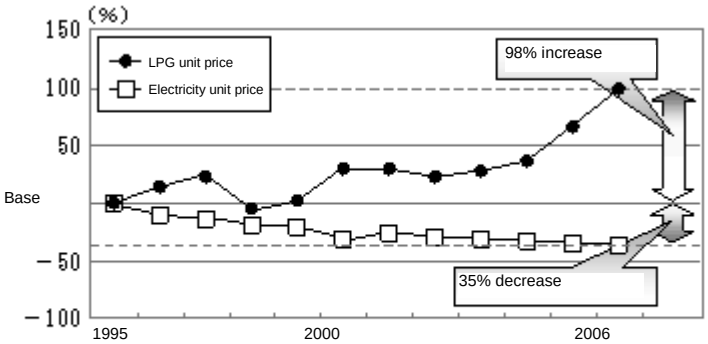

Fig. 5 Trend of unit prices of energy

[4] The load of power generation to protect manufacturing equipment is constant except the peak season in summer, so in winter, when air-conditioning load

decreases, steam loss occurs. (Fig. 6)

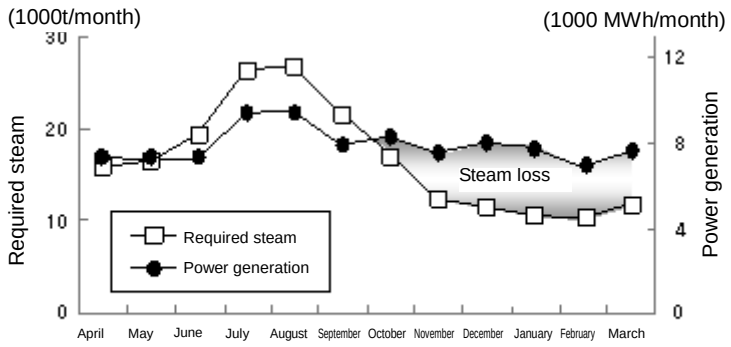

Fig. 6 Power generation and required steam

[5] Among 14 absorption chillers, there are 5 absorption type chillers whose refrigeration performance is decreased 10% or more due to aging of equipment.

[6] Each plant building has separate cool water line, and chillers are operated excessively as the entire plant. (Although there are backup pipes, they are not used for normal operation because they are for emergencies) The current cogeneration system is operated according to the electricity demand and absorption chillers are operated so that the generated exhaust heat (steam) is not wasted. Therefore, we expect that innovation of energy supply system that consists of cogeneration system using LPG as fuel and absorption chillers whose COP is low and with loss due to performance degradation will be effective.

3. Progress of Activities

(1) Implementation Structure

As a part of energy conservation activities in the plant, we started a joint project by manufacturing department and outworkers around the environment and facility technology team and worked in two stages (Table -1).

Table-1 Activity plan

Item	FY 2003		FY 2004		FY 2005		FY 2006		FY 2007
	First semester	Second semester	First semester	Second semester	First semester	Second semester	First semester	Second semester	First semester
Project kick off	☆								
Understand and analyze the current status	■								
Discuss measures	■	■			■				
Enforce measures			step 1			step 2			
Verify effects					■		■	■	

(2) Target Settings

1) Energy conservation: -3% compared to the previous year

4,650kl after two years (Fig. 7)

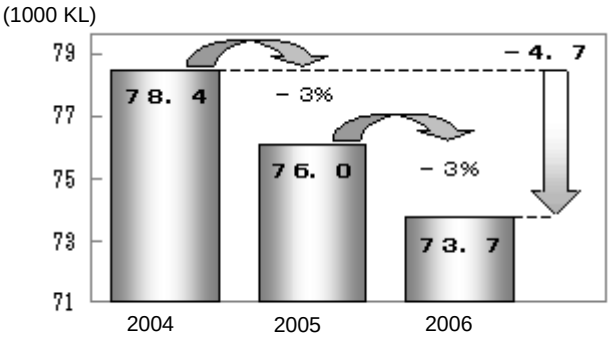

Fig. 7 Energy reduction volume [target value]

2) CO2 reduction volume: -7% compared to the previous year

20,400 t-CO2/ after two years

3) To build a beneficial system that is not affected by the change of crude oil price (LPG unit price)

4) Period to recover investment: within one year

(3) Problem Points and their Investigation

Problems and issues to be reviewed to innovate the current energy supply system (Fig.-8) that is mainly composed of cogeneration system using LPG are as follows:

1) Measures against instantaneous voltage drop (to ensure uninterruptible power source)

- Review specification of a equipment to protect manufacturing facilities form instantaneous voltage drop due to sunderbolt etc.

2) Measures against loss of steam during winter and curb peak consumption of power during summer

- Review the number of operation equipments of cogeneration system all year round.

3) Measures against cool water producing cost

- Review introducing high efficiency inverter turbo chillers
- Review appropriate number of operated chillers

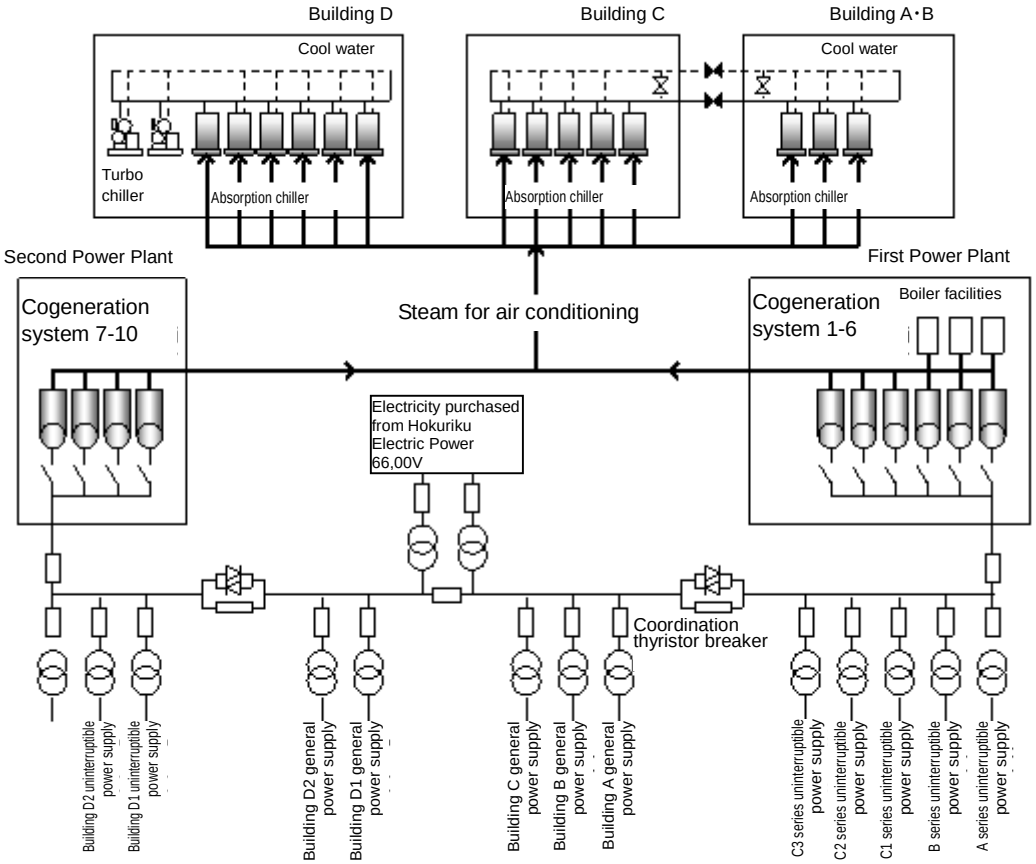

Fig. 8 Power and heat source diagram [before activity]

4. Details of Measures

(1) Measures for power system

1) In Step 1, a device against instantaneous voltage drop for buying electricity was introduced and a part of the plant's uninterruptible power supply system (UPS) was switched to it. As a result, two units of cogeneration system were completely stopped (Measure implemented in FY 2004). In Step 2, after verifying the effect of Step 1, another device against instantaneous voltage drop was introduced and another unit of cogeneration system was completely stopped (Measure implemented in FY 2005).

[Specifications of the equipment against instantaneous voltage drop]
Switching UPS by semiconductor switch: Capacity 4500 KVA
(3 minutes' guarantee, efficiency 98% or higher, DIP time 1.0 msec or less)

2) By introduction of equipment against instantaneous voltage drop, operation condition of cogeneration system changes from electric demand to steam demand, so the number of operated cogeneration system was controlled according to the air conditioning load for curbing peak consumption of power during summer and suppressing loss of steam during winter. (Fig. 9)

- Summer (June to September): Operate seven units
- Winter (November to February): Operate five units

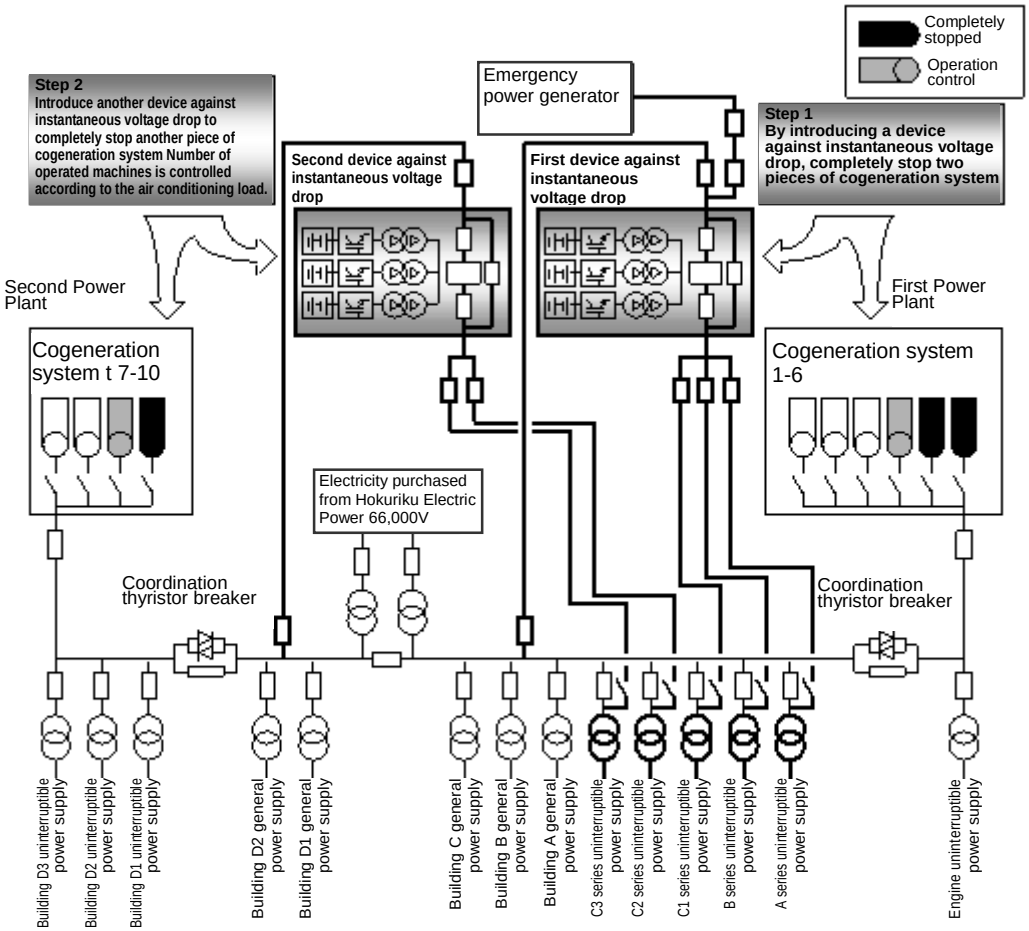

Fig. 9 Power diagram [after activity]

(2) Measures for heat sources system

3) In Step 1, one of the absorption type chillers (900 USRt) introduced to utilize exhaust heat (steam), which showed notable performance degradation, was replaced with high efficiency inverter turbo chiller (1200 USRt) and steam consumption reduced about 4 t/h (measure implemented in 2004). In Step 2, 4 units of the absorption type chillers (900

USRt) introduced to utilize exhaust heat (steam), which showed notable performance degradation, was replaced with one high efficiency inverter turbo chiller (1200 USRt) and steam consumption reduced about16 t/h (measure implemented in 2005). The high efficiency inverter turbo chiller is used all year round as the base chiller and cool water piping of plant buildings are connected with each other, which enabled to reduce the number of operated absorption chillers and reduce cost of cool water production. (Fig. 10)

[Introduced heat source facilities]

- High efficiency inverter turbo chiller
- Inverter controlled cooling tower
- Inverter activated cooling water pump
- Inverter control cooling water pump

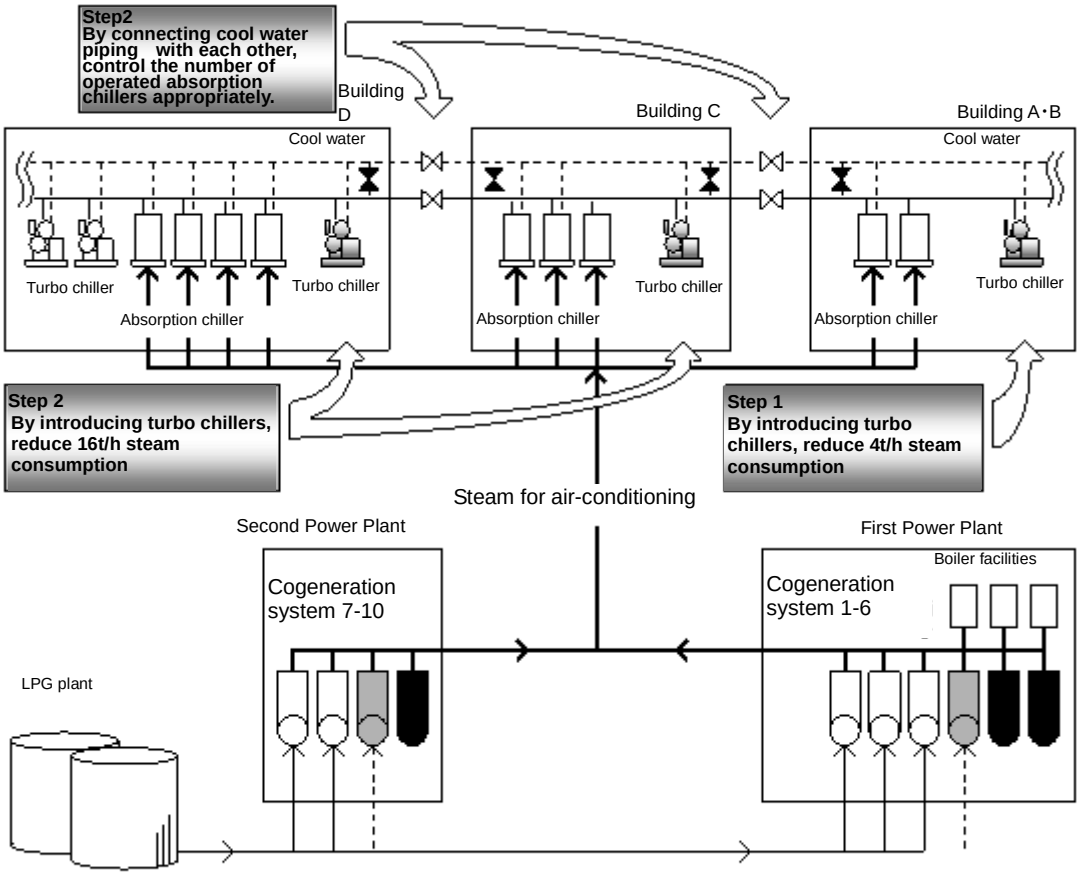

Fig. 10 Heat source diagram [after activity]

5. Effects Achieved After Implementing Measures

[1] Energy reduction : 6,710 kl (Fig. 11)

- power increment : 42,147,000 kWh
- LPG reduction : 13,785 t

[2] Reduction of CO2emission : 26,584 t-CO2

[3] Monetary amount of energy conservation effect: 439.0 million yen

[4] Investment : 283.9 million yen

[5] Years payback: 0.65 years

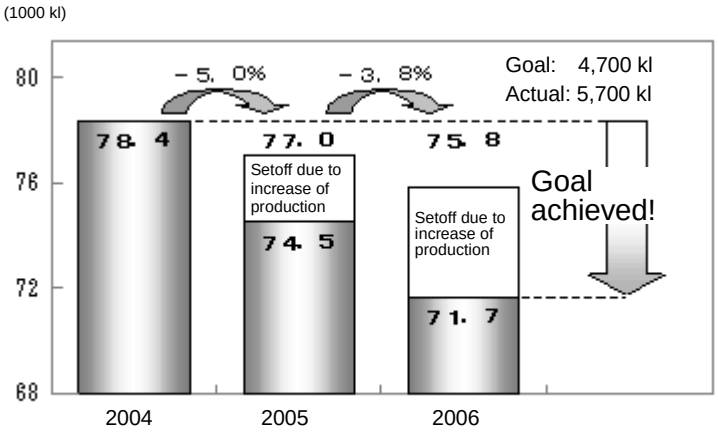

Fig. 11 Energy reduction volume [actual record]

6. Summary

[1] By introducing equipment against instantaneous voltage drop and inverter turbo chillers, the energy source for air conditioning was changed from LPG to electricity. By suppressing energy loss by operating appropriate number of absorption chillers, the upward trend of fuel consumption and CO2 emission was staved off. As a result, reduction beyond expectation was achieved.

[2] Because of the high LPG price and suppressing initial investment by lease contract of introduced equipment, we could achieve a significant management advantage.

[3] We realized a system that can ensure a profit even when the LPG price declines by 30% compared to 2004.

7. Future Plans

[1] We would like to continue verification of effects, and while identifying performance degradation due to aging of existing equipment, we aim for more highly efficient system operation.

[2] We would like to further decrease steam consumption for air conditioning and promote to change energy source of air conditioning to electricity.