2009 Prize of Director General of Agency for Natural Resources and Energy

Local Public Hospital Challenges Energy-saving Activity

Kasugai Municipal Hospital

◎ Concept

We give first priority to the software-type measure based on thorough energy-saving tuning and then consider customizing or renewing equipment to introduce.

◎ Outline of Theme

This hospital opened in August 1951 and moved into the new building in November 1998. In the wake of enforcement of the amended Energy Conservation Law, the hospital became the type 1 energy management factory in July 2006 and launched the Energy-saving Committee next year to promote energy-saving activities. The hospital building is designed to exert lots of energy-saving performance. For example, the variable water volume (VWV) method and the variable dumper (VAV) are adopted for air conditioning, the digital communication (DDC) is used for control, and high-frequency lamp (Hf) and high-efficiency motor are in use for electricity. Thus, it seemed there are few things left to be improved in terms of energy conservation. However, as a result of thorough energy-saving tuning by analysis of sheet data, we managed to implement 40 or more of energy-saving measures, primarily software-type ones to be done without cost. We were able to prove that not only big hospitals with relatively sufficient number of staff, but local public hospitals with limited number of staff can achieve effective energy conservation by accumulating small energy conservation efforts.

◎ Implementation Period of the said Example

- Project planning period: April 2005－continuing
- Measures implementation period: April 2006－continuing
- Measure effects verification period: June 2007－continuing

◎ Outline of the Business Establishment

- Type: General hospital
- Address: Kasugai City, Aichi Prefecture
- Number of staff: Approx. 1,200 (including temps)
- Number of outpatient: Approx. 1,500/day
- Number of beds: 556 (general 550, infection 6)
- Type 1 energy management factory

◎ Outline of Target Facilities

Premise area: 140,200 m^2

Floor area: 47,951 m^2

Number of buildings: 2

Electricity facility

- Electricity reception method: Main wire, spare wire method
- Electricity reception voltage: 6,600 V
- Contracted power: 1,530 kW
- Power generator: 280 kW x 2 units

Heating facility

- Steam boiler: 6 ton x 2 units
- Cool/warm water generator: 600 USRT x 2 units
- Absorption chiller: 200 USRT x 2 units
- Air-cooling chiller: 80 USRT x 2 units

1. Progress of Activities

(1) Implementation Structure

Fig. 1 shows this hospital's energy-saving management organization.

Energy-saving Measure Committee is called twice a year to draw up middle-long term plans based on Energy Conservation Law and decide yearly energy-saving measures. Also, in addition to the committee members, an energy manager is assigned by each department to let all employees know the decisions made by the Committee. Nippon Kucho Service Co., Ltd., a facility management vendor, attends the Committee as an observer to provide technical support.

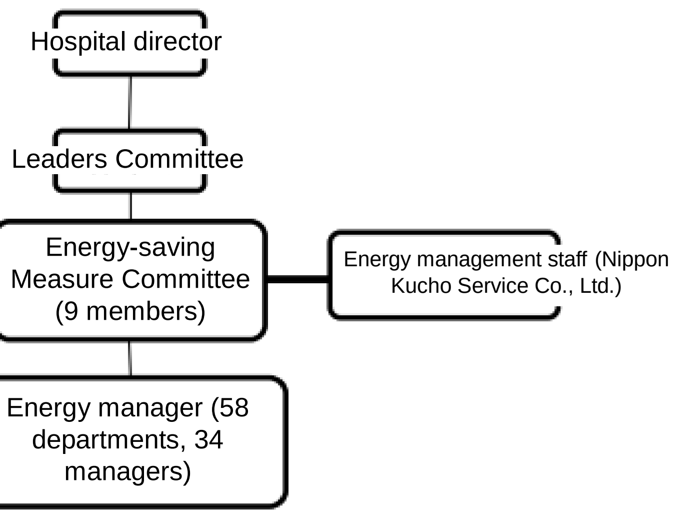


Fig. 1 Energy-saving Management Organization Chart

(2) Activity of Energy-saving Measure Committee

In June, Energy-saving Measure Committee is convened to approve middle-long term plans, periodical reports and yearly energy-saving measures. After the approval, each measure is to be implemented in a year by the staff under the supervision of an energy manager. In

March, the Committee is convened a second time to disclose a yearly report and the next year's energy-saving measures. Then, PDCA cycle is executed in a way the temporarily adopted energy-saving measure is to be validated by the time the Committee is held next time and to be approved by the Committee, which is convened next June.

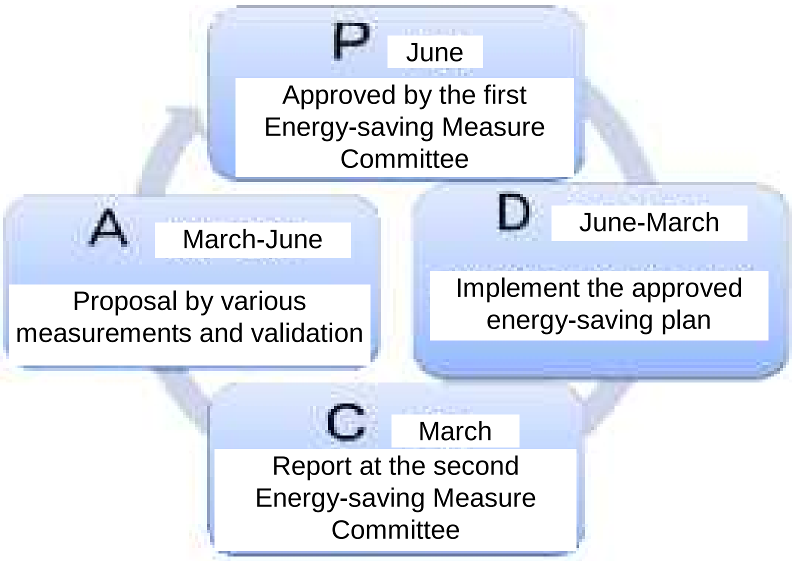


Fig. 2 Flow of Yearly Energy-saving Activity

(3) Activity of Energy Manager

Initially, an energy manager was patrolling departments he is responsible for and making a report once a month. After one and half years passed, as the patrol effect was fully confirmed, they changed to energy-saving patrols. Dividing the hospital into nine equally segmented areas, they patrol one area once a month and all areas in one year. They not only confirm the status by patrol but address each staff as shown in Photo 1 to enlighten the staff on energy conservation.

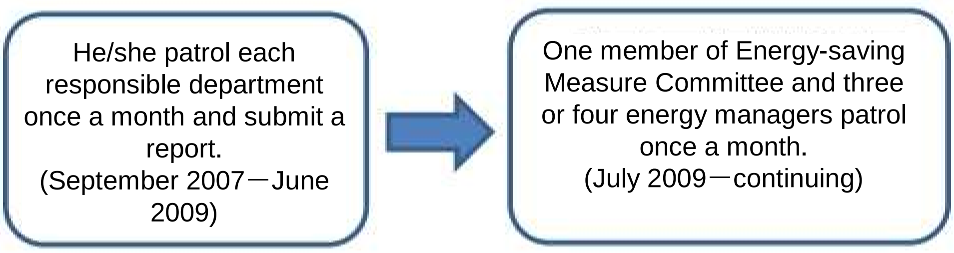


Fig. 3 Activity contents of energy manager

Also, energy managers attend a study meeting once a year to increase their knowledge level and passion. Photo 2 shows how they are studying with a material of DVD for measures against global warming.

Photo 1 Energy-saving patrol

Photo 2 Study meeting of energy managers

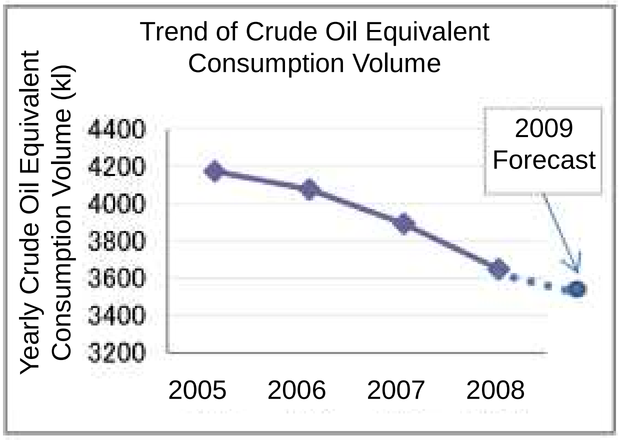
2. Contents of Energy-saving Measures

(1) Effects of energy-saving

For these three years, we achieved the reduction of 526 kL of crude oil equivalent (See Fig. 4). The reduction rate is 12.6 %. Its breakdown is as follows:

- Electricity: 70,000 kWh reduced
- City gas: 425,000 m^3 reduced
- Water: 21,000 m^3 reduced

The total reduction is equivalent to 30 million yen or more. The accumulation of small efforts led to a major achievement. In terms of CO^2, the reduction is 938 tons. As for the intensity, we reached 2,950 MJ/m^2/year, which is lower than the initial target of 3,000 MJ/m^2/year (See Fig. 5). According to the pamphlet provided by the Energy Conservation Center, Japan the average value for a public hospital of this class is some 3,600 MJ/m^2/year, which proves our energy-saving activity is very successful.



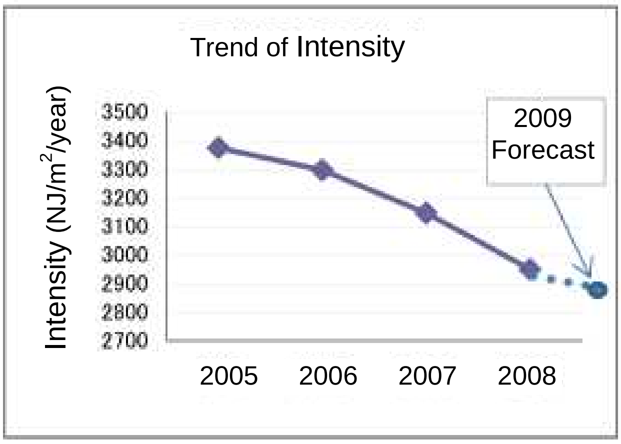


Fig. 4 Trend of Crude Oil Equivalent Consumption Volume　Fig. 5 Trend of Intensity

Each measure is summarized in Table 1. We implemented 42 measures in all. There are 28 software-type measures and 14 hardware-type measures that require monetary investment. Though software-type measures are generally seen, we crafted them to be the measures best fit for operations of this hospital's facilities by continuing validations. The hardware-type measures that require monetary investment are often seen in other institutions as well except for the introduction of energy-saving flat belt. We improved those measures as well to make them the best fit for this hospital's facilities by continuing validations.

Contents of measure	Reduction (kL)	Note
1. Review of air-con 2nd pump pressure	51.45	Pressure changed
2. Review of basement parking lot exhaust fan CO control	1.96	Program changed
3. Operation review of ward air-con, exhaust wind machine	22.53	Use pole number convert motor
4. Introduction of energy-saving V belt	1.97	Air-con, send/exhaust wind
5. Lighting schedule change	17.84	Review each part
6. Room TV changed to LCD-type	5.56	520 units changed
7. Operation review of co-gene hot water supply pump	6.24	One unit alternating use from 2 units
8. Schedule review of external water sprinkling	1.67	Water 10,000 m^3 reduced
9. Operation review of basement trench fan in winter, middle-term	21.73	4 units stopped
10. Operation change of heating equipment	75.43	Water 3,600 m^3 reduced
11. Thermal insulation construction for hot water supply, steam tubes	19.34	Middle-long term planning
12. Temperature review of electricity room	-	Change 26 to 28℃
13. Review of co-gene operation	33.94	Alternating run at night
14. Review of surgery room air-conditioning	21.62	Run if necessary
15. Update facility refrigerators to inverter type	1.52	Middle-long term planning
16. Attach stickers to each switch (1,500 stickers)	-	Air-con, electricity, elevator
17. Optimize cooling water volume of linac machine	0.34	Water 5,000m^3 reduced
18. Thermal insulation construction for steam boiler	39.04	Complete thermal insulation of boiler

19. Stop supply/exhaust fans of heat machine room in winter	5.40	No ventilation due to thermal insulation effect
20. Stop exhaust fans by digitalizing developer	0.72	Developer replaced
21. Steam supply time change for autoclave	-	Supply stop at night
22. Thermal insulation construction for steam/hot water tubes	12.20	Further thermal insulation
23. Repair construction for hot water supply pre-heat tank	12.80	Middle-long term planning
24. Each toilet lighting human sensor left time change	0.45	Left time from 15 to 5 min.
25. Review of indirect lighting in dayroom of middle ward	1.95	24 h lamps removed
26. Review of lighting of ward 6th floor west (Ophthalmology)	0.86	Partial change
27. Automatic light by EE sensor to external lamps	1.13	Lighting time optimized
28. Change air-con of machine room to external air in winter	0.12	Air-con operation change
29. Remove panel lighting from vending machines	2.36	No lighting inside hospital
30. Review of lighting at rehabilitation ward corridor	0.25	All lamps off on holidays
31. Change air-con time for basement changing room	5.92	Operation change by removing odor
32. Change boiler pressure in winter (700 kPa→600 kPa)	0.46	Boiler pressure reviewed
33. Review external lamp lighting at night	0.28	Unnecessary lamps off
34. Operation change in surgery dept. clean supply air-con	4.30	Unnecessary fans stopped
35. Lighting review of central hall on holidays	2.37	Operation reviewed on holidays
36. Operation change of 4-tube type air-con	0.22	Hot water cut in summer
37. Air-conditioning ventilation volume change of rehabilitation water treatment room	1.50	Ventilation volume fit for status
38. Heat retention construction for hot water piping	3.00	Thorough thermal insulation of hot water piping
39. Operation review by repairing basement trench drain tubes	3.60	Middle-long term planning
40. Introduction of energy-saving flat belt	2.40	Middle-long term planning
41. Further change in co-gene operation method	14.40	Improved operation by software update
42. Operation change by adding more lighting switches at staff cafeteria	1.40	Now operable at hand
Total	**400.27**	**Reduction volume that can be validated**

Table 1 Implementation Record of Energy-saving Activities

(* Colored fields mean they are software-type measures with no cost.)

(2) Software-type measures

(a) Operation change of heating equipment

[10. Operation change of heating equipment] is a case that produced the greatest effect. This is a popular method. In this case, the heating equipment being operated by the program of the heating controller was changed in the order of COP to manual operation by permanent staff (See Fig. 6). At the same time, they analyzed the sheet data and crafted an operation manual for the heating equipment depending on the load as a standard manual for manual operation. The manual states that the operation should be done after deciding on the combination of heating equipment that works for each load. The effect was seen in the

operational state of the direct-heating cool/warm water generator (600 USRT).
Highly efficient operation has always been possible (See Fig. 7).

Priority of heating controller (Summer)
1. Direct-heating cool/warm water generator (600 USRT)
2. Direct-heating cool/warm water generator (600 USRT)
3. Steam-heating absorbing chiller (200 USRT)
4. Steam-heating absorbing chiller (200 USRT)
5. Air-cooling heat pump chiller (80 USRT)
6. Air-cooling heat pump chiller (80 USRT)

Priority in the order of COP (From high to low) (Summer)
1. Air-cooling heat pump chiller (80 USRT)
2. Air-cooling heat pump chiller (80 USRT)
3. Direct-heating cool/warm water generator (600 USRT)
4. Direct-heating cool/warm water generator (600 USRT)
5. Steam-heating absorbing chiller (200 USRT)
6. Steam-heating absorbing chiller (200 USRT)

Fig. 6 Change in Heating Source Priority (Summer)

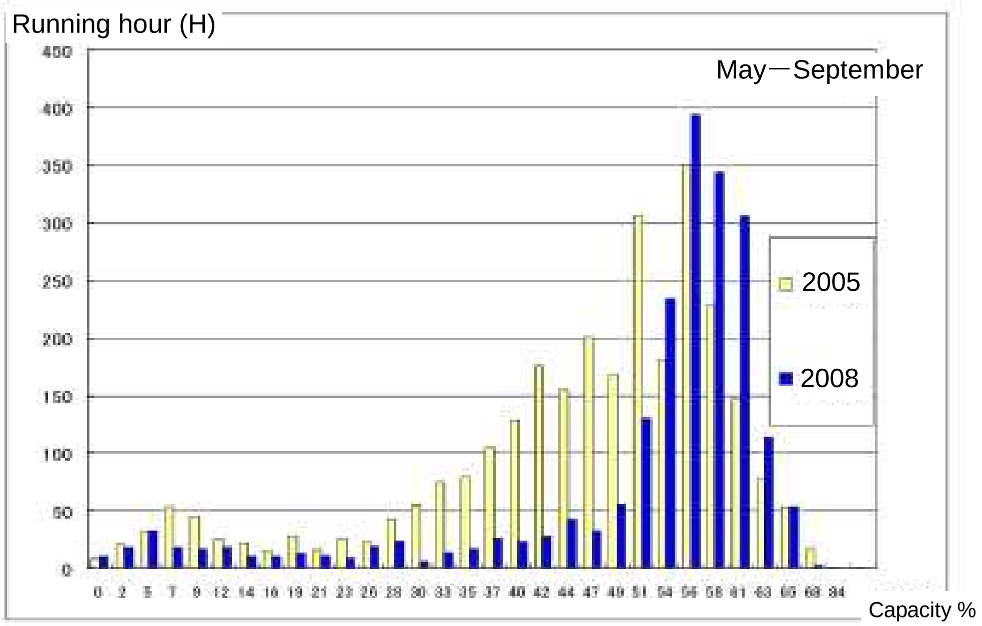


Fig. 7 Running State of Direct-heating cool/warm water generator

As a result of the operational change, the operating time of the air-cooling heat pump chiller that was infrequently used has greatly increased, and conversely the operating time of the steam-heating absorbing chiller has decreased. This has made it possible to greatly reduce energy consumption. At the same time, they reviewed the operation in winter (See Fig. 8).

Priority of heating controller (Winter)
1. Steam-heating absorbing chiller (200 USRT) 2. Steam-heating absorbing chiller (200 USRT)

→

Priority in the order of COP (From high to low) (Winter)
1. Air-cooling heat pump chiller (80 USRT) 2. Air-cooling heat pump chiller (80 USRT) 3. Steam-heating absorbing chiller (200 USRT) 4. Steam-heating absorbing chiller (200 USRT)

Fig. 8 Change in Heating Source Priority (Winter)

In the past, the air-cooling heat pump chiller was used as a heat source in winter. However, their investigation shows it can be used as a heat and cooling source until the outdoor temperature drops to minus 10℃. Fortunately, days when the outdoor temperature drops to minus 10℃ are zero in Kasugai City, Aichi Prefecture. Therefore, they dared to use it as a heat and cooling source even in winter. After two winter seasons, the equipment worked without going down at all. This has made it possible to greatly slash the cooling load, contributing to the reduction of 4,000 GJ a year (See Fig. 9). This reduction is equivalent to some 55 kL of crude oil.

Steam-heating absorbing chiller COP 1.16	Cooling load 4,000 GJ →	Air-cooling heat pump chiller COP 3.0

Fig. 9 Transfer of Cooling Load

Thus, they succeeded in the reduction of 75.43 kL as long as the assessment is possible. Also, as a result of validation of the measure for more than two years, since steam-heating absorbing chillers as the heat and cooling source in winter are now being used infrequently, they reviewed the pressure setting for the boilers. They changed the pressure setting from 700 kPa to 600 kPa where an autoclave is needed at minimum.
This change has contributed to a reduction of 0.46 kL (assumed).

(b) Review of co-generation operation

Next, they reviewed the co-generation operation as the case that may produce a major effect. Two units of gas-powered co-generation (output:280 kW each) are installed in this hospital. Heat is recovered in the form of steam and warm water. Since those units were installed, we have been running two of them 24 hours a day.
By installing a data logger to collect the accumulated data and the hidden data of warm

water that cannot be grasped by the central monitoring, they gathered and validated the data to fully visualize the heat use of co-generation. Then, it turned out that the heat use at night is problematic.

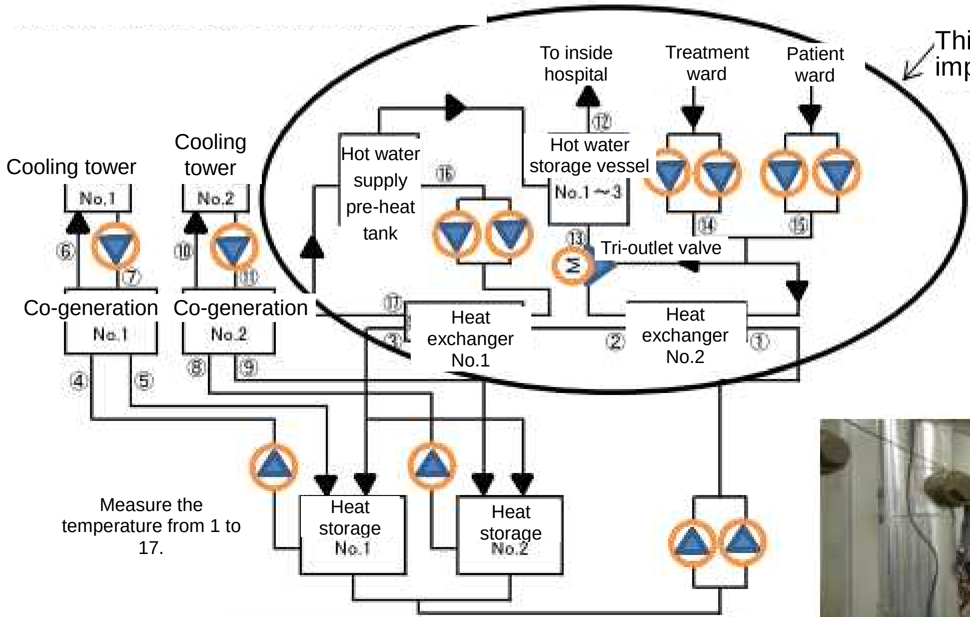


Fig. 10 Schematic chart of co-generation hot water supply piping

Photo-3. Thermocouple data logger

Since it became clear that the improvement of this part may lead to some energy conservation, they received the approval from Energy Conservation Measure Committee to change the operation method from August 2007. By running one unit of co-generation at night when the demand for heat is low, they managed to increase the operation efficiency of co-generation. This led to the reduction of 19.80 kL.

Furthermore, when they validated the data and compared the efficiency, they found a new theme. As shown in Fig. 11, though the efficiency improves in winter, the effect is flimsy in summer.

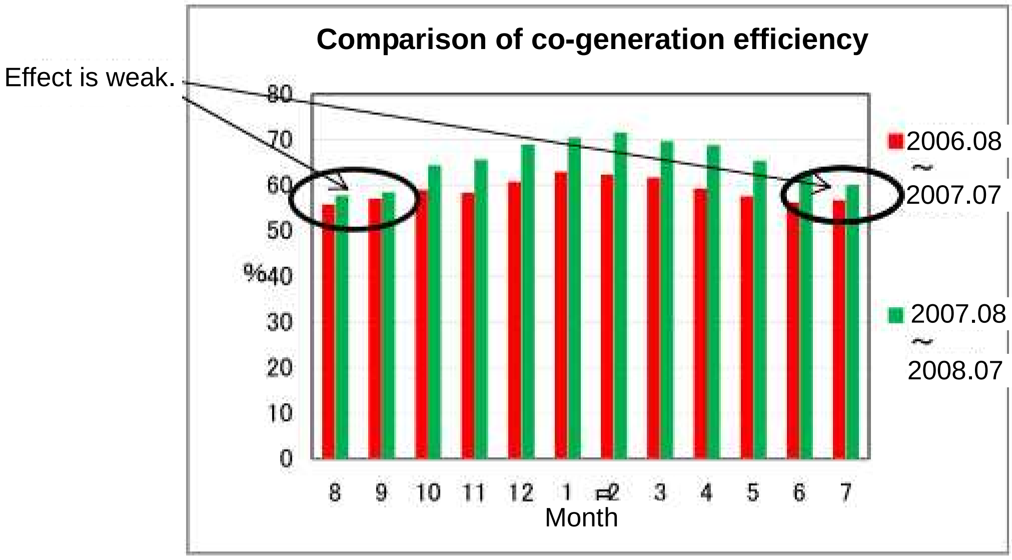


Fig. 11 Comparison of co-generation efficiency

As the next measure, they decided to halt one generator in the evenings in summer from August 2009. Their validation revealed a reduction of 9.6 kL was achieved in summer alone. Efficiency increased further by 2% (See Fig. 12).

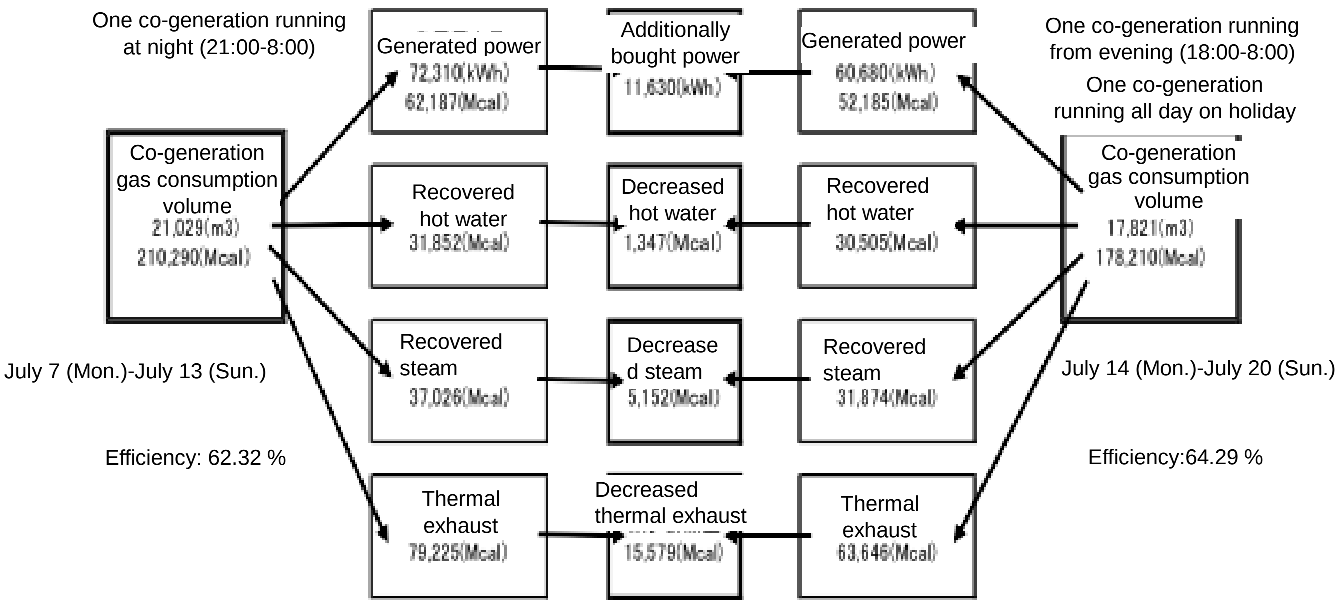


Fig. 12 Co-generation Operation Validation

In addition, they considered customizing the software of the central monitoring equipment for co-generation. When the central monitoring equipment was replaced in November 2009, we conveyed our request to the manufacturer and had the software customized for the co-generation of this hospital. Specifically, we had the feature added by which we can easily grasp the thermal storage state and which sounds an alarm when the temperature of the thermal storage vessel reaches a certain temperature. With this software upgrade, management by time has been changed to that by load status. We expect the efficiency for the middle term to improve. In the future, we aim to further improve efficiency and increase the running time by introducing the low temperature absorbing chiller.

(c) Energy-saving enlightenment education for staff

Energy-saving enlightenment education for the staff is considered to be the most important activity in implementing energy conservation. Fig. 1 shows the energy-saving organization in this hospital. To instill decisions made by the Committee in each department, a representative of each department is appointed as an energy manager and a study meeting is periodically held to enhance the knowledge and motivation of the energy managers. Also, to raise the awareness of all staff, an original energy-saving sticker was crafted and attached to the light switches, air-conditioning switches, and elevator buttons. As a matter of fact, the transportation frequency of the elevator dedicated to the staff decreased some 10%, proving that the energy-saving awareness of the staff is rising.

Photo 4 Elevator sticker


Photo 5 Air-con switch sticker

Photo 6 Lighting switch sticker

Effects of these activities are seen in many places. Air-conditioning in the operation room used to be run simultaneously for all equipment under a schedule. But now it is turned on or off by a nurse at the job site depending on the operation schedule. This has contributed to a reduction in the operation time of some 30% and a reduction of 21.62 kL.

(3) Hardware-type measures

(a) Repair of piping for hot water supply preheating tank

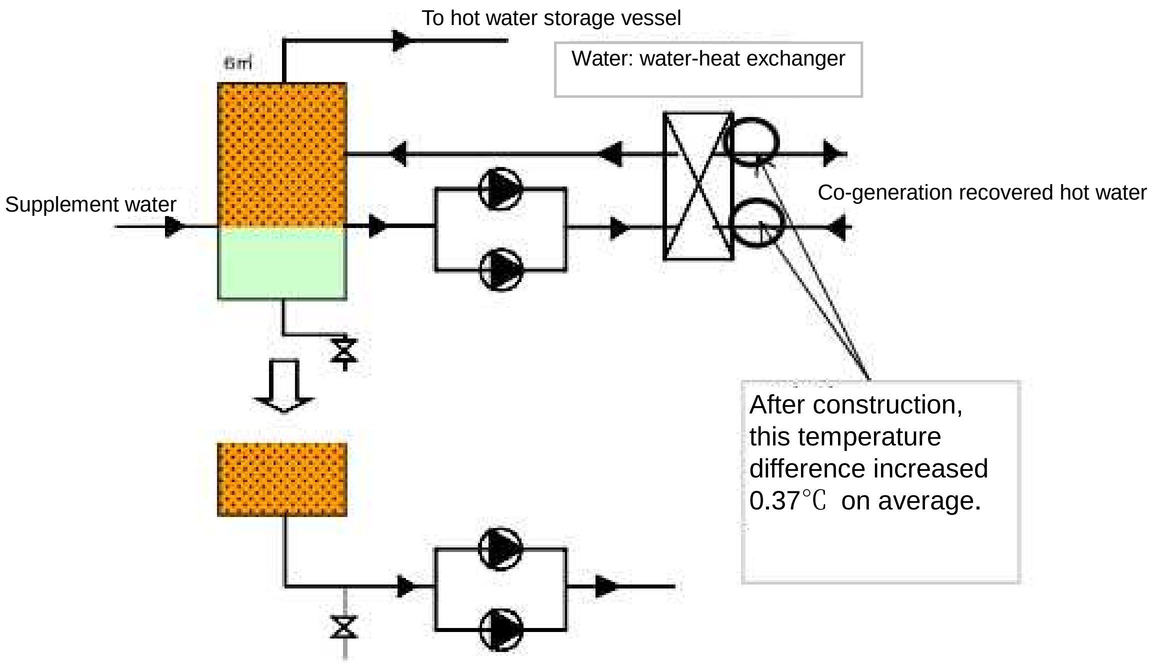


Fig. 13 Before and After Change in Piping for Hot Water Supply Pre-heating Tank

As shown in Fig. 13, by changing the piping, the stored heat from the hot water preheating tank has increased, and it is now possible to increase the heat exhaust recovery volume of the co-generation. The post-construction validation confirmed the in-coming and out-going temperature difference of the heat exchanger increased 0.37℃ on average, contributing to the energy reduction of 12.80 kL. However, as the temperature in the upper side of the tank may exceed 80℃, this cannot be applied to a hot water storage tank.

(b) Basement trench drain piping repair

Ten years have passed since this hospital was built, and water exhaust from the building is over to some extent. Therefore, we decided to completely halt the operation of four units of the trench system wind exhaust machines in the basement during the middle term and winter. As a result, we managed to reduce 3.98 kL of motor power and also achieved a load reduction of 17.7 kL in air conditioning by preventing under-floor cooling in winter and reducing radiation loss from the inside pits. In summer, since the air conditioning drain is discharged into the ditch of the basement trench, we were unable to halt the exhaust fans. To resolve this, construction of extending the drain piping was done. The piping extension to the water exhaust mass has made air exhaust unnecessary, enabling us to halt the exhaust fans in summer. Currently, due to the night purge in summer, fans are in operation only for three hours in the morning.

Photo-7 Before drain piping repair

Photo-8 After drain piping repair

Photo-9 Before drain piping repair

Photo-10 After drain piping repair

(c) Heat retention and thermal insulation construction

Next, the heat retention and thermal insulation construction is a case that produced a major effect (See Table 2). The thermal insulation construction has been done not only to valves and flanges of steam and hot water but also to all other possible places such as plate heat exchangers, boiler mirror plates and manholes (See Photo 11,12). Under the suggestion of Nippon Kucho Service that is always providing maintenance services, they found places where thermal insulation is not done, confirmed them with a thermal camera, and implemented construction four times in all.

Steam valve (150 A)	4 locations
Steam valve (100 A)	26 locations
Steam valve (65 A)	50 locations
Steam flange (50 A)	30 locations
Roller suspending metal (80 A)	70 locations
Around steam boiler	2 units
Hot water supply valve (150 A)	6 locations

Hot water supply valve (100 A)	8 locations
Hot water supply valve (50 A)	43 locations
Hot water supply flange (100 A)	114 locations
Hot water supply flange (50 A)	82 locations
Hot water supply silencer	3 units
Plate heat exchanger	4 units
Around hot water pump	4 units
Hot water flange, valve	53 locations

Table 2 List of construction places of heat retention and thermal insulation

Photo-11 After thermal insulation of boiler mirror plate

Photo-12 After thermal insulation of plate heat exchanger

As a result of the thermal insulation construction, energy conservation of at least 67.77 kL has been accomplished. In particular, the efficiency of the steam boiler has increased around 5% compared with the pre-insulation conditions. As a supplementary explanation to Fig. 14, the construction lasted from January 4 until February 12, 2008. As a result, the steam volume per cubic meter of city gas was slightly rising as the construction neared the end.

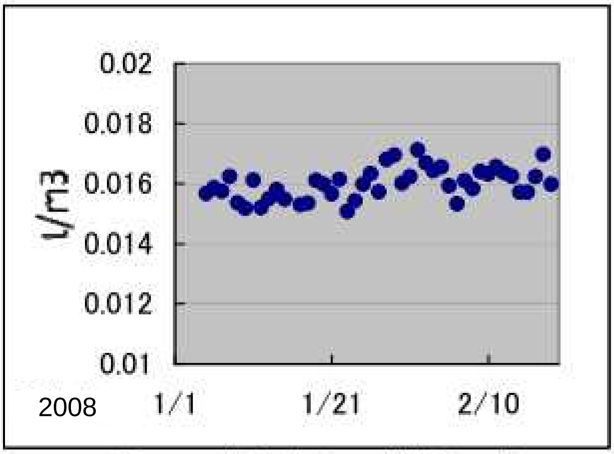


Fig. 14 Fuel cost of steam boiler (t/m^3)

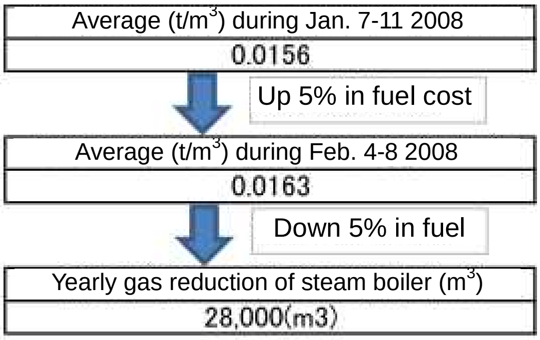


Fig. 15 Fuel reduction of steam boiler

To further visualize the thermal insulation effect, the pre- and post-heat retention conditions were confirmed by a thermo camera.

Photo-13 After thermal insulation of steam valve

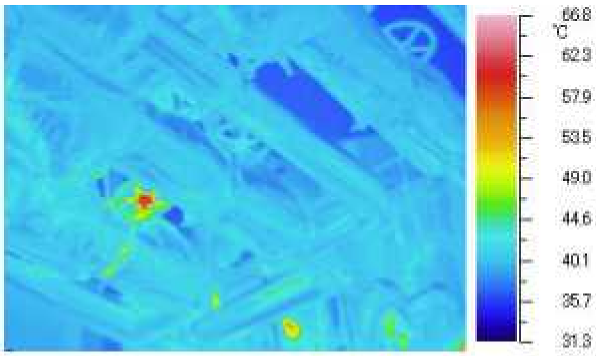


Photo-14 Conditions seen by a thermo camera after thermal insulation of steam tubing

In September 2009, the heat retention was extended to legs of steam boiler (See Photo 15,16).

Photo-15 Before thermal insulation of boiler legs

Photo-16 After thermal insulation of boiler legs

(d) Introduction of energy-saving flat belt

As an advanced measure, there is an introduction of energy-saving flat belt. Its targets are machines like air conditioner that are driven by a V-shape belt. This time, they challenged the attachment of an energy-saving flat belt by customizing the installed air conditioner. They thought the power conveyance efficiency would be improved by changing from the V-shape belt to the energy-saving flat belt, leading to energy conservation.

Photo-17 V-shape belt air-conditioner

Photo-18 Air-conditioner fitted with flat belt

Photo 18 shows the air conditioner fitted with flat belt. To attach a flat belt, it is necessary to install a conveyance device called tensioner between pulleys. Tensioner is a device to control a flat belt in a zigzag. With assistance from Bando Chemical Industry Ltd., which is a maker of belts, and Nippon Kucho Service, which is a hospital facility maintenance management vendor, they somehow managed to attach the belt. After the attachment of the belt, they confirmed fans and a motor retain the same rpm (revolutions per minute) as before the attachment, and they were successful in reducing the driving current by 6% as initially planned. After 2009 as well, we plan to introduce the belt.

(4) Summary

Though we have been conducting various energy-saving activities so far, the most important thing is how successively we do them. In this hospital, we launched Energy-saving Measure Committee, which is convened twice a year and built the mechanism to make PDCA cycle work itself. Thus, the successive energy conservation has become possible. Also, as a technical point, as this hospital outsources the energy management work and facility management work to Nippon Kucho Service Co., Ltd., the association with this vendor is very important. The staff of Nippon Kucho Service, who are very familiar with our facilities and operation methods, found many energy-saving points and proposed many energy-saving measures. From now on, we expect the hardware-type measures to increase. Though the aggressive investment is difficult to execute due to the hospital's financial issues, we intend to find the best investment along with the deterioration issue of the facilities and promote further energy conservation.