2007 Prize of Director General of Regional Bureau of Economy, Trade and Industry

Introduction of Biogas Co-firing type Natural Gas Cogeneration System

Tonegawa Brewery, Suntory Limited
Engineering Division
Facility Technology Group

◎ **Keywords: Use of Recovered Waste Heat and Rationalization for Conversion of Heat to Power (Cogeneration Facility)**

◎ Outline of Theme

Suntory is aiming to develop manufacturing plants (eco-factories), in harmony with the global environment, by promoting activities for conserving energy and reducing carbon dioxide emissions. The targets are to reduce the carbon dioxide emissions in 1990 by 57% by the year 2008. This is a report on the implementation of a cogeneration system, as one of the energy conservation activities being conducted at our manufacturing plant.

◎ Implementation period for the Said Example

July 2004 through November 2006

- Period for formulation of plan: July 2004 - July 2005 Total of 12 months.
- Period for implementation of action: July 2005 – Nov. 2005 Total of 5 months.
- Period for verifying effectiveness of action: Dec. 2005 – Nov. 2006 Total of 12 months.

◎ Outline of the Business Establishment

- Production items: Beer, sparkling wine, liqueur (sparkling-type) [1] and other alcoholic beverages [1].
- Number of employees: 305 persons (including personnel of subcontractors) (as of April 1, 2007).
- Type 1 Designated Energy Management Factory

◎ Process Flow of Target Facility

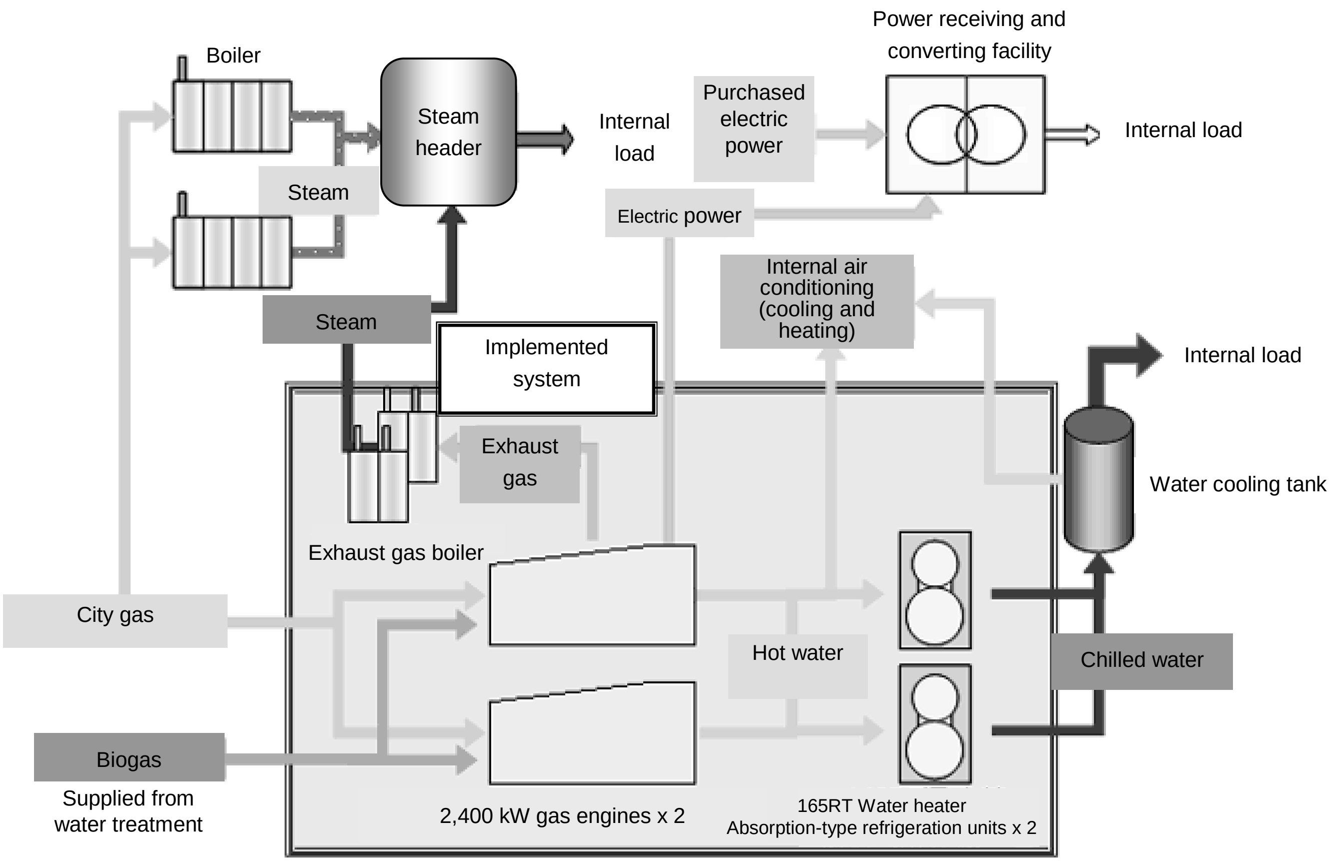

Figure 1: Process of intended facility (newly implemented facility)

1. Reasons for Theme Selection

The Tonegawa Brewery was established in 1982 as the third beer brewery of the company and it has been serving in important role as the key manufacturing plant in our company, catering to demand in Eastern Japan.

This beer brewery aims to become an "Eco-brewery" (a beer brewery in harmony with the environment) and energy conservation and a reduction in carbon dioxide emissions are important activity issues. Action is taken with the priorities according to the perspectives of environmental changes, viabilities, effectiveness of the investments and quality issues from among those included in the medium-term plan for reducing the specific unit of carbon dioxide emissions.

This theme aims to further conserve energy and to reduce carbon dioxide gas emissions by implementing a biogas co-combustion type natural gas cogeneration system.

2. Understanding and Analysis of Current Situation

(1) Understanding of Current Situation

Recently, activities relating to issues focused on losses have been developed to conserve energy and reduce carbon dioxide emissions at this beer brewery. The conversion of fuel for boilers, the implementation of degassing facilities and the creation of a framework for controlling losses due to air leaks can be cited as examples of action that yielded successful results. While such activities have been continually implemented and proved to bring about successful results, the targets were not reached. In order to attain the targets, it would be necessary to further conserve energy and reduction in the carbon dioxide emissions, thus the energy supply system for the entire beer brewery needed to be reviewed.

(2) Analysis of Current Situation

A large amount of heat is required for the manufacturing processes of beer, with characteristic extreme temperature fluctuations taking place as well. As indicated in the beer manufacturing process, shown in Fig.2, a large amount of heat is used in the preparation process for warming the malt and water in the pot, while cooling, which requires electric power, plays the main role in the subsequent processes of fermentation, storage and filtration. The heat load and electric power load of this beer manufacturing process fluctuates when production continues, since it is a batch process and the manufacturing lead time is extremely long. Furthermore, there are periods when hardly any heat loads exist and only electric power loads for cooling exist during the production that involves no preparation process.
Therefore, there were not only concerns regarding electric power but also the stable recovery of exhaust heat had been an issue for promoting the assurance of energy conservation.

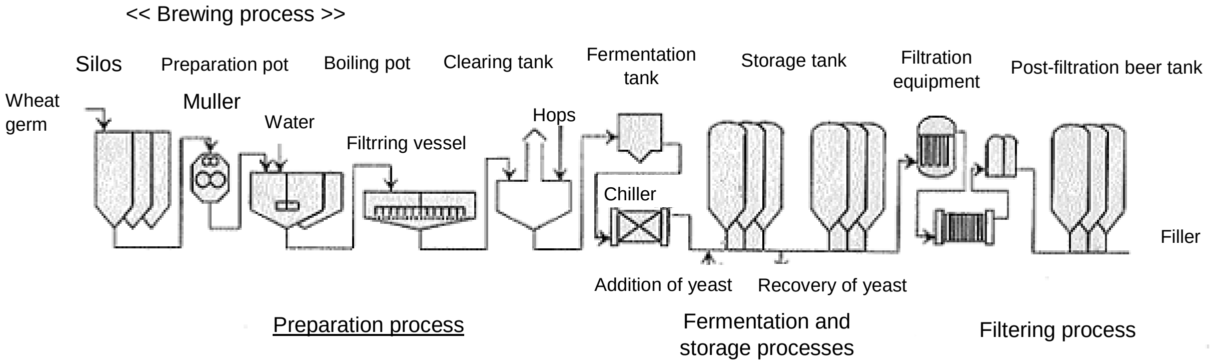

Figure 2: Summary of beer manufacturing process

3. Progress of activities

(1) Implementation Structure

In the factory, energy conservation plans are formulated primarily by the Qualified Person for Energy Management of Type 1 Designated Factories, approaches to establish frameworks for control primarily are treated by the Energy Management Committee, comprised of the representatives of individual corporate organizations at this beer brewery, and strategies for achieving the targets of individual corporate organizations are implemented by the Environmental Conservation Promotion Secretariat. Among all such activities this theme deals primarily with the Engineering Division.

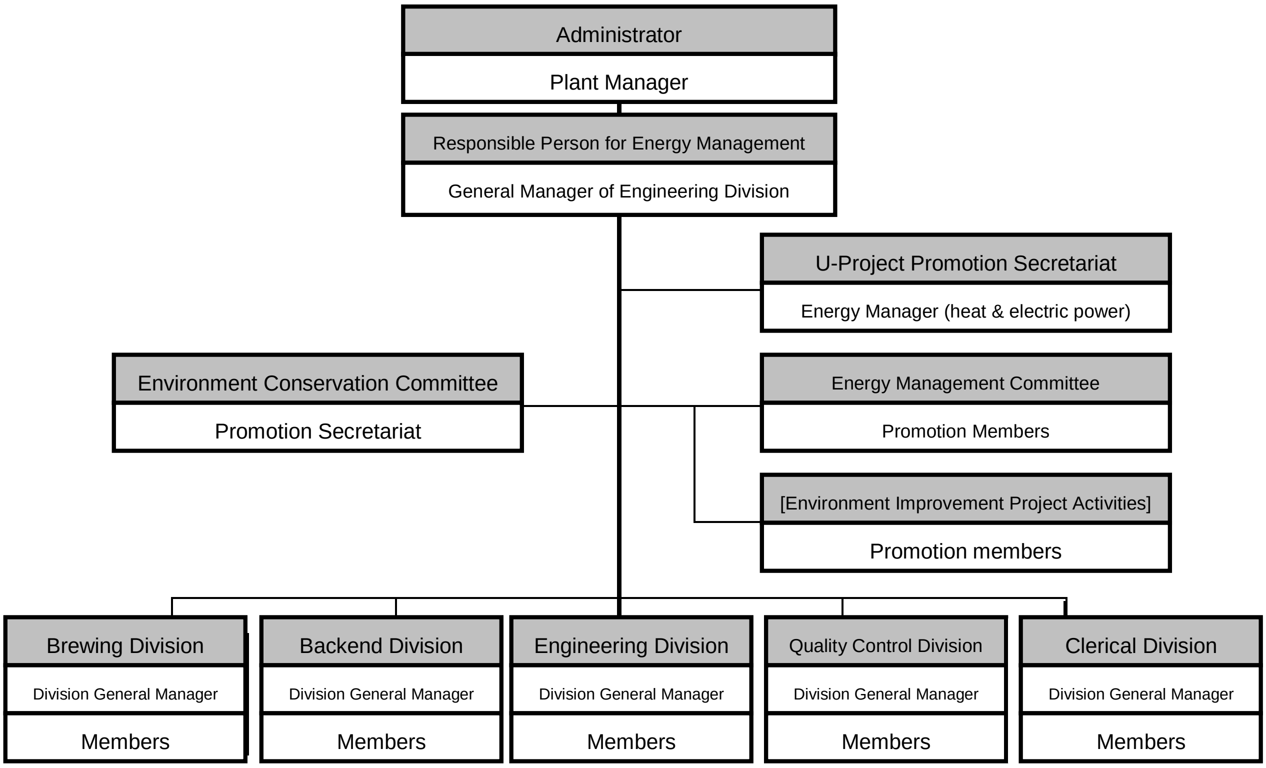

Figure 3: Organization for promoting Energy conservation activity

(2) Target Settings

- Amount of energy conservation: 2,585 kiloliters.
- Amount of carbon dioxide emission reduction: 12,509 tons of carbon dioxide (calculated from emission coefficient for thermal power generation).
- Rate of energy conservation: 16%.

(3) Problem Points and their Investigation

The following are the two main problems related to the implementation of the cogeneration system:

[1] Selection of cogeneration system suitable for the load of the beer brewery.

[2] Reduction of implementation costs and establishment of economic viability.

The details are individually described below:

[1] Selection of cogeneration system suitable for the load of the beer brewery

(A) Selecting a cogeneration system

Representative cogeneration systems are gas engine type and gas turbine type.
The characteristics of these systems are shown in Fig.4.:

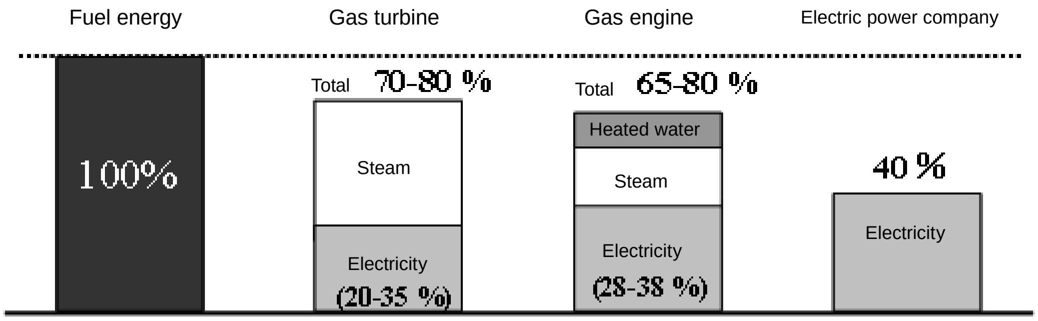

Figure 4: Comparison of energy efficiency for cogeneration systems

[Gas turbine]

- Superior overall efficiency.
- Necessity to recover energy from large amounts of steam.

[Gas engine]

- Superior power generating efficiency.
- DSS operations (suspension of daily operations) are possible.
- Use of biogas as fuel is possible.

In general the overall efficiency of gas turbines is superior to that of gas engines. When highly efficient operations are intended with a cogeneration system, however, it is necessary for all exhausted heat (steam & hot water) to be recovered. An optimum system that responds to the operating status of the beer brewery must be selected, as well as energy consumption, since a large amount of heat is required in the manufacturing processes of beer, with extreme characteristic temperature fluctuations taking place as well.

(B) Recovery of heat

Figure 5 shows the steam loads and steam recovery patterns using a gas engine over a one month period during the summer and winter seasons, respectively. Extreme characteristic fluctuations in the steam loads of the beer brewery are evident in the figure.
Almost the entire amount of steam can be recovered through the implementation of a gas engine, however, when a gas turbine of an equivalent class is implemented, it results in the generation of steam in large quantities, making it impossible to recovery the total amount of

steam generated by the cogeneration system. A gas engine was adopted for the purpose of conducting highly efficient heat recovery.

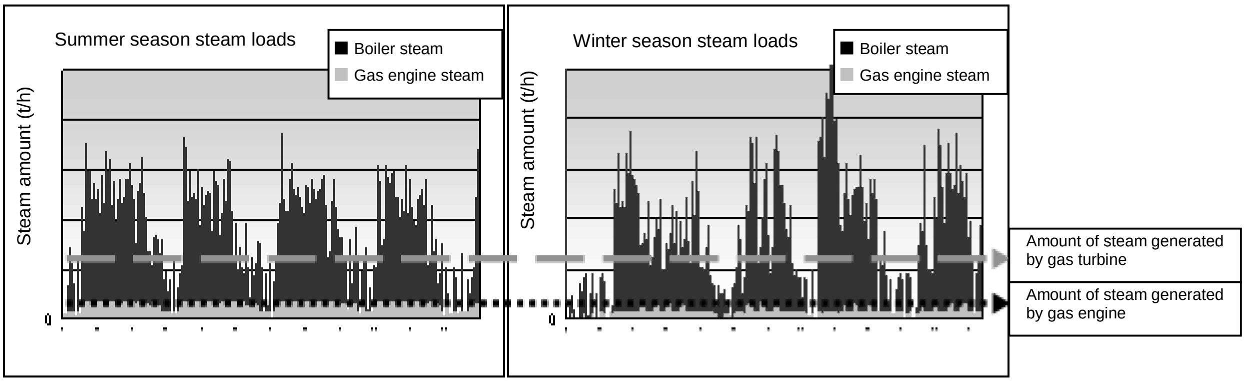

Figure 5: Steam loads and recovery from cogeneration systems

(C) Electric power generating capacity

Figure 6 shows the electric power loads and electric power generation patterns using a gas engine over a one month period during the summer and winter seasons, respectively.

Through the installation of two gas engine units, maximized benefits (combination of continuous operations and DSS) of energy conservation effects and long run operation were targeted by following the load fluctuations caused from the deference between business days and holidays in seasons respectively, along with energy conservation effects and operations for many hours.

The specific operating methods are as follows:

Summer season: Operation of two gas electric power generator units.

Winter season: Continuous operation of gas generator No. 1 and intermittent operation of gas generator No. 2, operating only daytime of during production.

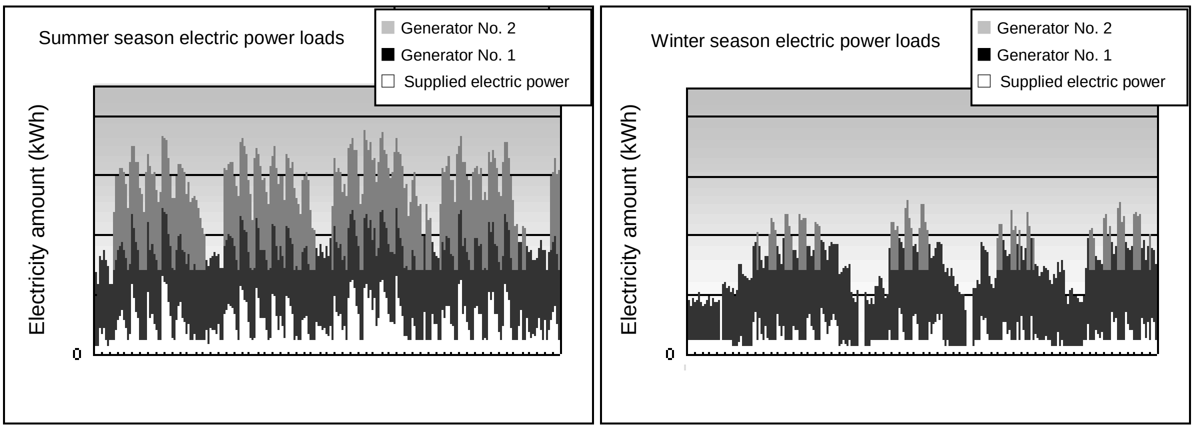

Figure 6: Electric power loads and electric power generation patterns for respective seasons

(D) Co-combustion of biogas

Since gas engines were adopted, it has been possible to use a mixture of city gas and biogas generated from industrial effluent. Therefore the excessive amount of biogas from the existing boilers has been able to become usable effectively; it is possible to reduce the amount of fuel used at the beer brewery when this facility is implemented.

(E) Use of hot water

Through the use of exhaust heat and hot water from the cogeneration system as a heat source for space heating, it has not only been possible to reduce the consumption of fuel for boilers but also to use the heat source for operating absorption-type refrigeration units. The chilled water obtained in this manner was then supplied to the cooling process of the beer manufacturing process to significantly reduce the electric power consumption of the existing electric driven refrigeration unit.

[2] Reduced implementation costs and established economic viability

This project was adopted as one of a supplementary project of the "New Energy and Industrial Technology Development Organization" for FY2004. Furthermore, its economic viability was established through a reduction in the initial investment with the adoption of the ESCO business.

4. Details of Measures

A summary of the implemented facility is shown in Table 1 The system before and after implementation is described in Figure 7.

The whole electric power generated by the gas engine was used by the internal load of the facility, through electric grid. The co-combustion of natural gas and biogas generated by the effluent treatment facility was possible. Furthermore, steam recovered by a waste heat boiler was connected to the steam systems of the existing facility to be used for the beer manufacturing process, thereby reducing the amount of fuel used by the existing steam boilers. Through the use of the hot water recovered from the exhaust heat as a heat source for space heating, it was not only possible to reduce the consumption of fuel for the boilers but it also used the heat source for operating the absorption-type refrigeration units, thereby reducing the amount of electric power consumption for the existing refrigeration units.

Table 1: Summary of implemented facility

Gas engine	Type	Four cycle gas engine unit (a V-type, 20 cylinder engine)
	Fuel consumption rate	6,321 kWh (combustion using utility gas type 13A exclusively as fuel)
	Electric power generating efficiency	41.6% (combustion using utility gas type 13A exclusively as fuel)
	Output	2,430 kWh (2,480 kVA) x 2 units
	Voltage	6.600 V
Utility supplied gas boiler	Type	Multi-pipe flow -through boiler
	Evaporation rate	1.8 tons/hour・unit x 2
Hot water absorption-type refrigeration unit	Refrigerating capacity	165 RT/unit x 2

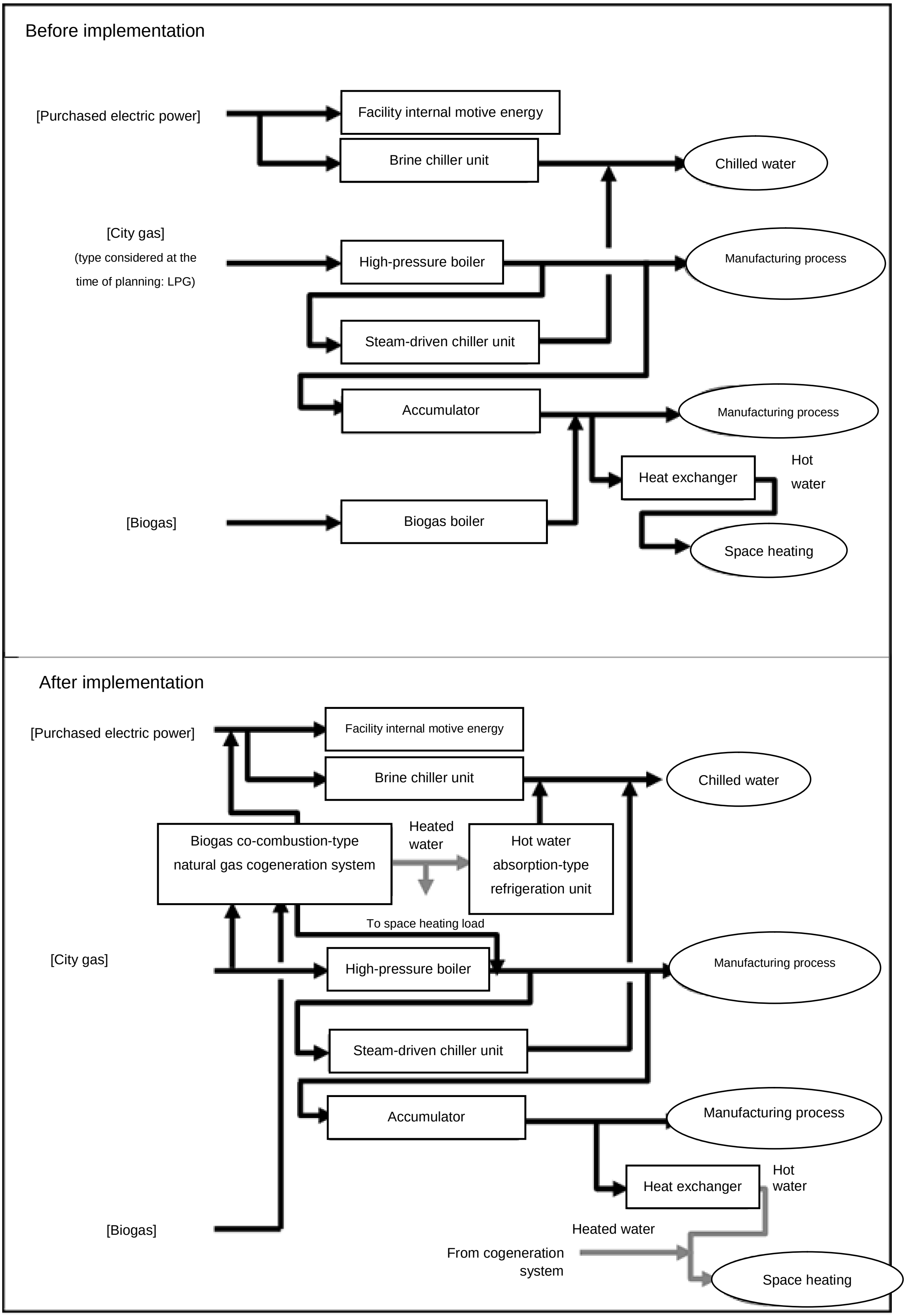

Figure 7: System before and after implementation

5. Effects achieved after Implementing Measures

(energy conservation in monetary amounts, energy conservation rate, energy conservation amount, specific unit, etc.)

- Amount of energy conservation: 2,461 kiloliters.
- Amount of carbon dioxide emission reduction: 12,110 tons of carbon dioxide (calculated from emission coefficient for thermal power generation).
- Rate of energy conservation: 15%.

6. Summary

The significant conservation of energy and a reduction in the emission of carbon dioxide were realized through the implementation of an optimum cogeneration system, through the consideration of ways to recover all exhaust heat (steam and hot water) and a required amount of electric power secured to meet extreme characteristic energy load fluctuations of the beer brewery. Furthermore, even more energy conservation has been made possible through the adoption of the biogas co-combustion-type cogeneration system, which is a new technology.

7. Future Plans

The “Comprehensive Energy Conservation Project with the Use of Recovered Exhaust Heat and Implementation of Highly Efficient Equipment at Tonegawa Brewery”, a supplementary project of the “New Energy and Industrial Technology Development Organization”, will be pursued in the future, in order to achieve the targeted specific unit of carbon dioxide emission.

Suntory Limited, furthermore, has been promoting “Water for Life, Suntory” as the corporate message since 2005. This overlap of Suntory’s traits with water which has flexible ductile, smooth, natural and pliable traits, go along with the refreshing vitality. Water, which is incorporated in this message, is considered to be a finite and precious resource, in addition to the global environment.

Further proactive efforts will be made with environmental activities in the future, aiming for a sustainable society in “Harmonious Coexistence with Nature”.