The sustainable energy service company (ESCO) experience at DIC Corporation

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Abstract

An ink manufacturing company in Japan is focused on reducing its energy consumption and CO_2 emissions. This paper describes energy supply systems that have been applied to actual plants in recent years. We have planned and installed new sustainable systems that combine heat and power (CHP) facilities driven by biomass fuel with large-scale wind power facilities. In our biomass boiler and steam turbine system, the boiler produces high-pressure steam to drive the extraction and condensing steam turbine. The steam turbine generates power (electricity) and heat (process steam) simultaneously. The ratio of heat and power can be controlled according to factory energy demand. We have also built a wind power plant capable of generating total power of 4 MW. An ink factory consumes all the power internally generated by the wind power plant, except that exceeding factory demand. In this way, we plan to reduce the CO_2 emission rate. These facilities will be able to reduce our previous use of fossil fuels by 65%, and consequently reduce CO_2 emissions by 75%. This paper also introduces the content of our project, subsequent effects and evaluation results.

Keywords: energy saving, CO_2 emission, energy service company, biomass, wind turbine.

1 Introduction

Effective February 2005, the Kyoto Protocol dictates that measures designed to reduce greenhouse gas emissions will be implemented over a five-year period from 2008 to 2012.

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Since Japanese manufacturing industries have already devoted considerable efforts to practicing energy-saving measures designed to curtail their energy usage, an approach based on a new perspective is being sought to speed up the pace of energy savings.

Toward achieving the goal of drastically reducing carbon dioxide (CO_2) emissions, a conversion from fossil fuels to sources of carbon-free energy or those of lower CO_2 emissions would prove useful in exhibiting the heightening effectiveness of such sustainable sources of energy as wind power, solar energy and biomass.

This paper provides a summary insight into ongoing approaches to saving energy consumption at DIC Corporation and its Energy Service Company (ESCO) business through sustainable sources of energy.

2 Efforts made to date at the DIC Kashima Plant

DIC is a fine chemicals manufacturer extensively involved in four sectors of business including printing materials, based on printing inks and organic pigment inks. The manufacturer has publicly committed itself to a management policy of environmental preservation and operational safety in the form of a Responsible Care (RC) program, a voluntary management activity that implements measures related to the environment, safety and health in pursuit of further reducing environmental pollution, minimizing environmental impact and saving energy.

With organic inks, base inks and other inks as its principal line of products, the Kashima Plant is the largest energy consumer among all the plants of DIC Corporation, consuming about 20,000 kL of energy a year in crude equivalents.

The environmentally-conscious, energy-saving activities undertaken at the Kashima Plant to date include installing woodchip boilers fueled by waste materials in 1985 and setting up a gas turbine co-generation system in 1997, thereby enabling the plant to achieve about a 40% savings on its electric contract demand over a five-year period from 2001 to 2005, and cutting its annual energy operating cost by about 120 million yen [1].

3 Introduction of ESCO for the purpose of reconstructing energy supply systems

The Kashima Plant has explored various ways to achieve further cuts in energy usage and a drastic reduction in CO_2 emissions.

It has therefore decided to install a combined heat and power (CHP) system and wind turbine generators (run by the Hitachi Group as an ESCO operator) in an effort to proceed further with an eco-friendly energy reconstruction scheme.

Installing such systems entails such a huge amount of investment that it will be implemented on an ESCO contract basis. Leveraging the ESCO business offers the following benefits:

(1) Assuring a constant rate of energy savings at all times;

(2) Eliminating the need for capital investment on DIC's part, with the ESCO operator providing the funding necessary to finance facility procurement; and
(3) Off-balance sheet treatment of energy-saving facilities.

Still another benefit is utilizing the operational experience accumulated by Kashima Plant operators for more than 20 years to operate and maintain biomass-fueled boilers.

4 Overview of the sustainable energy ESCO business

4.1 Overview of the ESCO business

Table 1 summarizes the ESCO business under discussion [2].

Because the contract concluded between DIC and an ESCO operator is signed on a shared-saving ESCO basis, all facilities needed to achieve energy savings are procured and owned by the ESCO operator. The ESCO operator also operates and maintains these facilities, and assumes responsibility for the successful functionality of all equipment during the contract period. DIC, on the other hand, assumes responsibility for procuring biomass fuels. Since all sets of facilities are scheduled to be commissioned into service in April 2009, the ESCO contract package will be started from now on.

Table 1: Overview of ESCO business.

1. Contract method	Shared savings (investment costs borne by the ESCO operator)
2. Contract period	15 years
3. Installed facilities	(a) Woody biomass-fueled boiler: 30 t/h x 1 set (b) Extraction-condensing turbine generator: 4,000 kW x 1 set (c) Auxiliary boilers (for backup): 5.5 t/h x 6 sets, 2 t/h x 1 set (d) Wind turbine generator: 2,300 kW x 2 sets
4. Facility and contract startup times	(a) Biomass boiler and turbine generator facility: Commissioned into service in April 2008 (b) Wind turbine generator facility: To be commissioned into service in April 2009 (scheduled) (c) ESCO contract: At the beginning of 1st April 2009 (scheduled)

Figure 1 shows a general flowsheet of the ESCO facilities.

The ESCO facilities are organized into the following two systems:

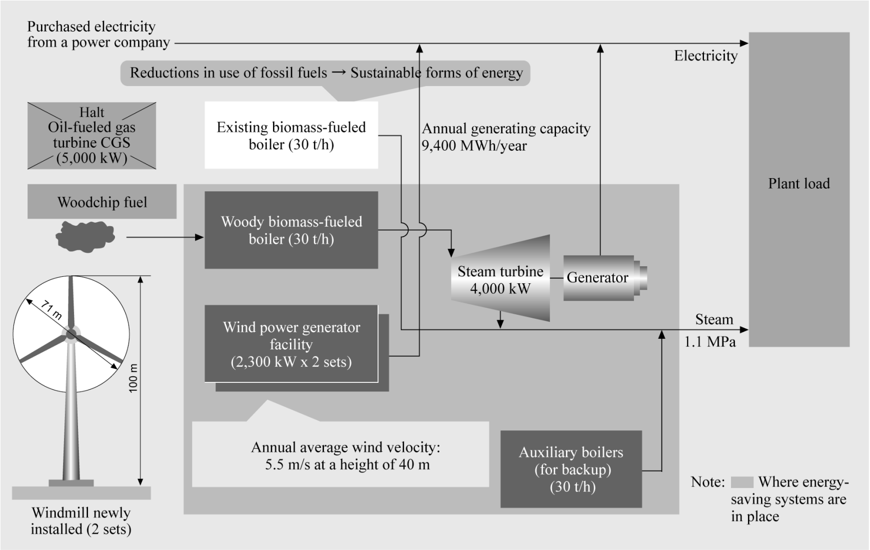
(1) Facility which generates steam and electricity by biomass, in which a biomass fuel is combusted at high temperature to generate steam energy in a boiler, from which electricity is recovered in a turbine.

(2) Wind turbine generator facility that recovers wind energy as electricity.

Any lacking portion of energy supplied from these facilities is met by purchasing electricity from a power company or producing steam energy by running an auxiliary boilers.

These ESCO facilities offer such significant energy-saving effects that Hitachi and DIC have been granted jointly the following two types of subsidies for operators:

(1) Biomass generator facility: Energy Use Rationalization Subsidy (New Energy and Industrial Technology Development Organization)
(2) Wind turbine generator facility: Supportive Measures applicable to the Promotion of ESCO Projects (Agency for Natural Resources and Energy)



Abbreviation
CGS: Co-generation system

Figure 1: General flowsheet of ESCO facilities.

Figure 2 shows the expected energy consumption rate, CO_2 emission rate, and their reductions for a one-year period.

Plans call for annual energy usage at the Kashima Plant to be cut from its year 2006 level of 20,000 kL by 11,220 kL (to 8,780 kL), and CO_2 emissions from 39,300 tons by 30,500 tons (to 8,800 tons).

4.2 Woody biomass generator facility

The plant requires large volumes of electricity and steam to operate its production equipments. These energy demands fluctuate widely on a seasonal, daily and hourly basis. The required steam pressure used at the plant is at a medium pressure (of 1.1 MPa (G)). This value must be maintained at all times.

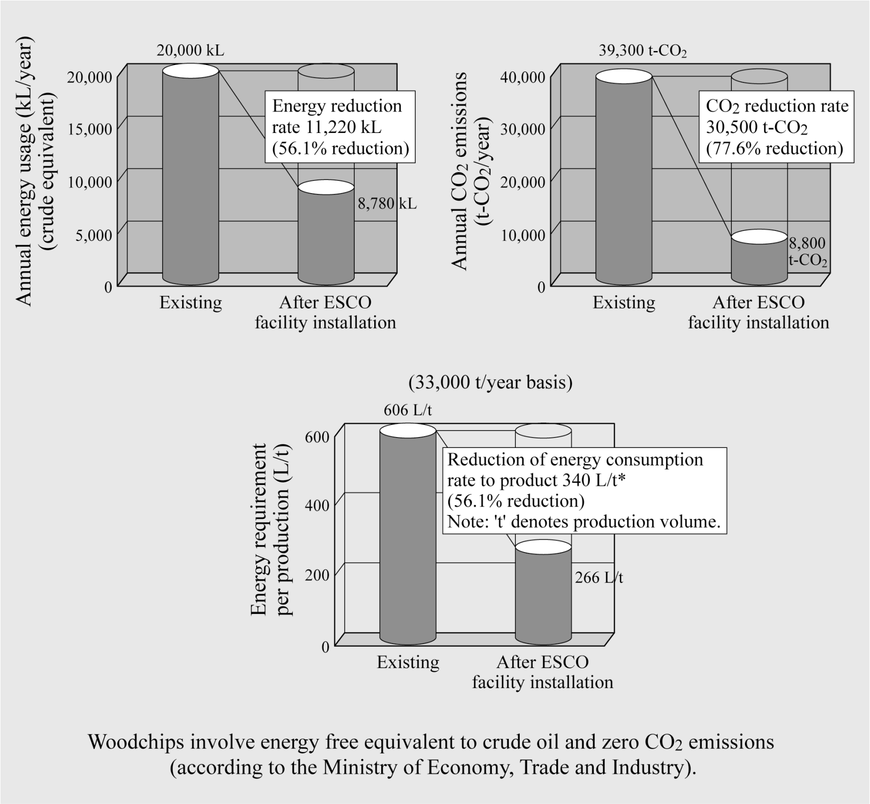


Figure 2: Expected energy consumption rate, CO_2 emission rate, and their reductions (compared between existing and new ESCO facilities).

To enhance the efficiency with which energy is recovered from biomass fuels, the following design enhancements have been factored into the steam usage system:

(1) Higher-enthalpy steam recovered from waste heat
Steam requirements for the biomass-fueled boilers have been enhanced to a higher pressure (of 6.08 MPa (G)) and higher temperature (of 683 K) to increase the amount of power recovered by the steam turbine. Steam of higher enthalpy is able to efficiently produce heat and electricity.

(2) Combined heat and power (CHP) generation by a steam turbine generator facility
Electricity is recovered by a back-pressure turbine to enable the effective utilization of energy from high to medium pressures. Should the steam demand be lower than the amount of steam generated from the boiler, excess steam is generated. In such a case, a condensing steam turbine is used to recover electricity from excess steam energy as it generated.
An extraction-condensing turbine generator facility is planned in order to meet both requirements.

This system feeds steam to meet the heating demand, with any excess proportion of steam being dedicated to generating electric power (free from CO_2 emissions) in order to make effective fuel derived from biomass.

Woody biomass fuels that vary in terms of heating value and shape would require enhancing the reliable supply of fuel (woodchips) to ensure stable and consistent system operation.

To achieve the projected increase in the volume of woody biomass fuel procurement from 40,000 tons to 60,000 tons a year, more procurement sources are needed, and entail a specifically designed fuel supply system. Based on past experience, the following two improvement measures have been incorporated into the fuel supply system:

(1) The previously manual night-time fuel charging system has been automated through the use of a hoist crane.
    This method significantly lessens operator workload at night.
(2) The sharp-angled (75-degree), chain-driven flight conveyor previously used in the fuel charging system often impeded successful travel as it developed problems, such as a cut chain or deformed flight. As a solution, loading over a belt conveyor gradually angled at 45 degrees has been introduced to alleviate such problems.

Figure 3: Woody biomass-fueled steam and generator facility commissioned into service at the DIC Kashima Plant.

Figure 3 shows an overview of the newly installed woody biomass-fueled steam and generator facility commissioned into service in April 2008. The facility has since been successfully running as of March 2009.

4.3 Wind turbine generator system

Conveniently located along on the Pacific coast, the Kashima area is such an appropriate location in terms of wind conditions (e.g., wind intensity, occurrence probability) that wind turbine generator facilities have already been constructed in this area, mainly for the purpose of selling the electricity generated to power companies.

Power producers who sell electricity generated by wind turbines to a power company are called “independent power producers (IPPs).” In contrast, all electricity generated by the generator facility at the DIC Kashima Plant is dedicated to its internal consumption in order to enhance energy saving effects, thereby marking the first time in Japan where the total amount of electricity generated by a total 4 MW-class large wind turbine generator facility is consumed in-house.

It is generally known that the higher above ground level, the better the wind conditions.

This wind turbine generator facility has an elevated hub height of 64 m to generate more wind power, and also features a diameter of 71 m to produce as much as 2,300 kW of generated power.

Two sets of the wind turbine generator facility capable of generating 2,300 kW are currently planned. As of February 2009, both were in the final

Figure 4: Overview of the wind turbine generator facility (2,300 kW class x 2 sets).

stage of construction. Figure 4 shows an overview of the wind turbine generator facility nearing completion.

5 Conclusions

This paper has introduced an example of an energy restructuring ESCO business that makes positive use of sustainable forms of energy free from carbon dioxide emissions.

While the market for fossil fuels has fluctuated erratically in recent years amid the perceived peaking of crude oil supply and a rapidly developing world recession, sustainable forms of energy are predicted to gain accelerating popularity in response to these situations. Sustainable forms of energy are subject to certain uncertainties, however, such as wind conditions, heating value and shape, thereby demanding handling experience essentially and expertise to put them to positive use.

We would like to take advantage of the experience gained from operating these and other systems, and also promote their ongoing popularity by releasing relevant information.

References

[1] Ishimaru: Energy Saving Effort in Practice at a Fine Chemicals Plant, The Institute of Electrical Engineers of Japan, General Industry Workshop Literature (February 2008) (in Japanese).

[2] Yunoue et al.: Carbon Dioxide Gas Reduction Using Renewable Energy, Hitachi Hyoron, 89, 3, pp. 294-297 (March 2007) (in Japanese).