Effects of Energy-saving Facilities on Cost and Environmental Load Reduction of Sewage Systems

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ABSTRACT

Using the LCA method, we estimated the annualized life cycle CO_2 (ALC-CO_2) of sewage systems (pipe systems, wastewater treatment plants, and pump stations) in the Lake Biwa basin. Based on this estimate, we analyzed the effect of energy-saving facilities and new energy systems, such as photovoltaic systems, a fuel cell power plant running on anaerobic digester gas (ADG), and wind power systems, on the cost and environmental load reduction of the sewage systems.

OBJECTIVE

Sewage systems emit large amounts of greenhouse gases (GHGs) during the water-purifying lifecycle. Advanced technologies for reducing GHGs, include new energy systems, such as photovoltaic and wind power systems. This study estimated the environmental load of the sewage systems in the Lake Biwa basin using the LCA method, and analyzed the effect of new energy systems on costs and environmental load reductions.

LIFE CYCLE INVENTORY

The targets of this inventory were four major sewage treatment plants and associated pipe systems and pump stations in the Lake Biwa basin. The targeted life cycle stages included both the initial and operational stages.

The initial CO_2 emissions from plants and pump stations were calculated using an input-output table. The initial CO_2 emissions from pipes were calculated using basic units based on pipe length and caliber. The operational CO_2 emissions from plants and pumps were calculated from actual performance records.

Figure 1 shows the annualized CO_2 emissions for the lifecycle of the sewage systems. Sewage treatment plants occupy 59.0% of the total emissions (its operational stage occupies 79.3%). Due to this estimation, considerable CO_2 reduction in the operational stage of sewage treatment plants should be effective for the global warming prevention on sewage systems.

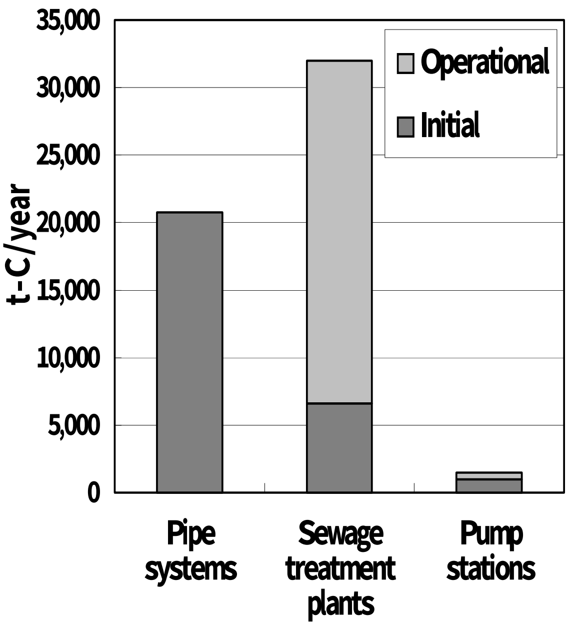

Fig. 1: CO_2 emissions from sewage systems

GREEN HOUSE GAS EMISSIONS

In addition to CO_2 emissions, the amounts of GHGs other than CO_2 from the four sewage treatment plants were estimated. The targeted GHGs were CO_2, CH_4, and N_2O. CH_4, and N_2O were converted to CO_2 emissions using global warming potential (GWP), and the net GHG emissions from the plants are shown in **Fig. 2**.

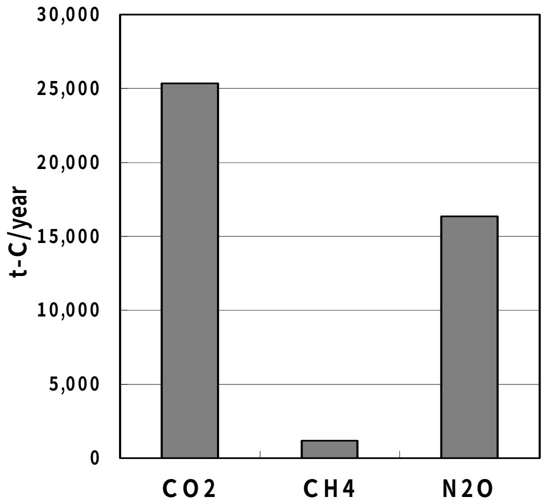

Fig. 2: GHG Emissions (Conversion to CO_2)

IMPLEMENTING ENERGY-SAVING FACILITIES

To reduce environmental loads from wastewater treatment plants, a case study was conducted to evaluate the effectiveness of implementing energy-saving facilities in terms of costs and environmental load reductions. The following three types of facility were considered:

a) Photo Voltaic Systems

If standard solar panels were set up on 50% of the area of the sedimentation ponds and aeration tanks, reductions of 2.4 to 5.1% of total electricity purchases and 1.3 to 2.7% of CO_2 emissions for the entire plant could be expected. Almost half of the cost should be covered by grants from national or local governments.

b) Fuel Cell Power Plant Running on Anaerobic Digester Gas (ADG)

This system consists of a 200-kW phosphoric acid fuel cell power plant and a gas pretreatment unit. When the transmission end efficiency is 38%, reductions of 12.6 to 50.9% of total electricity purchases and 8.2 to 48.7% of CO_2 emissions for the entire plant are expected.

c) Wind Power Systems

If standard 1500-kW systems were implemented at the Konan, Kosei, and Tohoku plants, and a standard 800-kW system were implemented at the Takashima plant, reductions of 9.0 to 88.0% of total electricity purchases and 0.1 to 0.9% of CO_2 emissions for the entire plant could be expected.

Figure 3 shows the total electricity balance for each wastewater treatment plant after implementing all of the energy-saving facilities. **Figure 4** shows the relationship between GHGs reduction and the costs of the implementations.

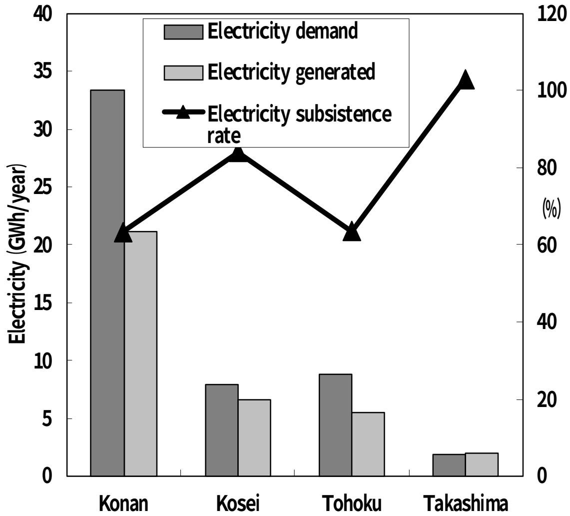

Fig. 3: Electricity Generated from energy-saving facilities and Electiricity subsistence rates

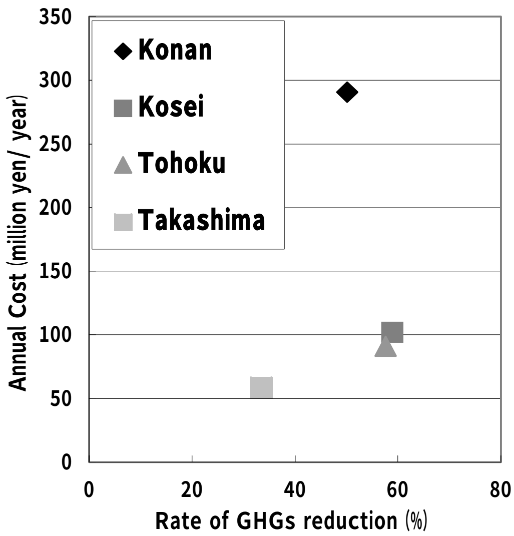

Fig. 4: Relationship between the rete of GHGs reduction and annual cost

CONCLUSION

This study demonstrated that implementing standard energy-saving facilities in sewage systems is effective for reducing the environmental load. It is clear that a higher electricity subsistence rate and GHGs reductions can be obtained at relatively low cost in quite small plants.

REFERENCE

[1] Japan Sewege Works Association, Introduction of Global Warming Prevention on Sewerage (1999)