# Strategy for Introducing Sewage Sludge Energy Utilization Systems at Sewage Treatment Plants in Major Cities in Japan: Technology Introduction Scenario

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## INTRODUCTION

In recent years, an advanced energy recovery system is designed in the field where energy conversion technology of dewatered sludge is implemented in sewage treatment plant (STP). One approach is solid fuel conversion systems (dry granulation, low temperature carbonization), and biogas can be used for drying sludge on the condition that a STP has digestion tanks. On the other hand, measures to convert conventional high-temperature incineration without any energy recovery equipment to incineration with waste heat power generation equipment have already been renewed in some STPs: Seibu Sewage Center in Sapporo City, and so on. In this study, we model the material and energy balance of STPs in 14 large cities with a population of 1 million or more: Sapporo, Sendai, Saitama, Chiba, Tokyo's wards, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu, and Fukuoka. Furthermore, based on the renewal time of existing incinerators at STPs in each city, we developed the design support tool to create two renewal scenarios towards 2030 and embodied roadmaps for reducing greenhouse gas (GHG) emissions.

## MATERIALS AND METHODS

### Analysis method of material balance and energy balance

The target technologies are three conventional ones: high-temperature incineration without power generation equipment, melting, incineration in a cement industry's kiln; and three energy conversion ones: incineration with power generation equipment, dry granulation, and low temperature carbonization. In analyzing the energy balance, the actual value was applied for two parameters refer to the 2015 Sewerage Statistics (JSWA, 2017): One is the organic matter content in solid matter of concentrated sludge at each STP; and the other is the decomposition rate of organic matter in the digestion process of STPs with a digestion tank. The auxiliary fuel (fossil fuel) consumption for dewatered sludge conversion treatment is estimated by using the heat balance analysis model constructed in this study.

### Technology introduction scenario

In this study, the renewal plan of sludge treatment process in large cities' STPs was set as two scenarios.

Scenario A is "Distribution of resource recovery route" scenario. The properties of sludge treated in the dewatered sludge conversion process are diversified, and many STPs select both energy conversion technologies: incineration with power generation equipment and solid fuel conversion. The contractors for solid fuel use or final disposal can be decentralized. Scenario B is "minimization of external fuel" scenario. Depending on the installation characteristics of the digestion tank and the properties of dewatered sludge in each city, priority is given to technology that reduces consumptions of external fuel. STPs without digestion tank tend to select incineration with power generation equipment for direct (not digested) dewatered sludge, and STPs with digestion tank do solid fuel conversion by using biogas for drying.

## RESULTS AND DISCUSSION

### Scenario application

The characteristics of the Scenario A were shown by using Simpson's diversity index. On the other hand, the characteristics of the Scenario B are shown in the light of fossil fuels' consumption used for the treatment and energy conversion of dewatered sludge. In 2030, natural gas consumption in Scenario A is 6,388 GJ/d, whereas, Scenario B has achieved no external fuel consumption.

### GHG emissions

Figure 1 shows the analysis results of GHG emissions in all cities. In Scenario A and Scenario B, GHG emissions will decrease as the sludge treatment facility is renewed. As of 2030, Scenario A reduced GHG emissions by 2,192 t-$CO_2$eq/d (130%) and Scenario B reduced 1,987 t-$CO_2$eq/d (117%) compared to 2015. However, comparing the two scenarios, Scenario A shows lower GHG emissions. Because coal has a high GHG emission factor, solid fuel produced in cities that have adopted sludge solid fuel technology can replace coal, and the GHG reduction effect will be greater.

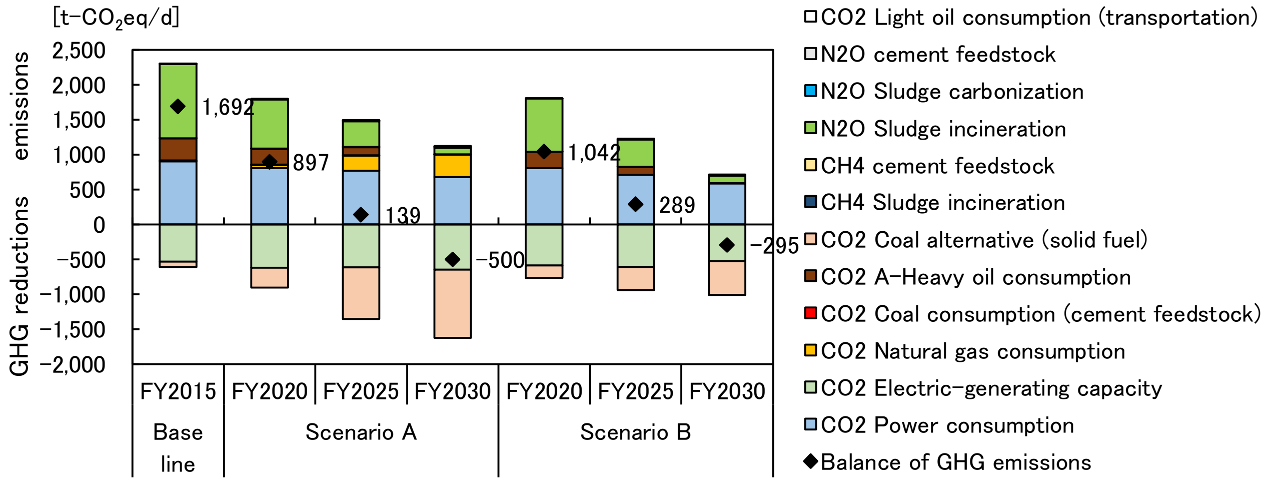


**Figure 1 Estimated results of GHG emissions**

## CONCLUSION

As of FY2030, there is no significant difference in the results of GHG emissions between two scenarios, and there is a definite effect of reducing GHG emissions. Scenario A shows excellent results in GHG emissions, and has achieved decentralized treatment routes as a countermeasure treatment method in the event of a disaster. Scenario B shows excellent results in primary energy consumptions and realizes a sludge treatment system that does not depend on auxiliary fuel in all large cities.

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## REFERENCES

Japan Sewage Works Association (JSWA), 2015 Sewerage Statistics, 2017.