

Optimal Technology Choice of Residential Hot Water Supply Equipment Based on Load Survey Data

Background

Natural refrigerant heat pump hot water supply system (CO₂-HP) and micro gas engine cogeneration system (GE-CGS) are in the early stages of penetration in the residential sector. These two hot water supply systems are competitive technologies because they have been developed for the same market. Hot water supply demand has one third of residential energy demand in Japan. Cost effectiveness of the technology for customer depends on load profile of electricity demand and hot water demand and energy efficiency of equipments.

Objectives

We identify economical and technological conditions of the future hot water supply systems based on monitored load data.

Principal Results

We developed the cost minimization model that chose electricity rate menu and equipment for residential hot water supply. With average load profile obtained by actual load survey in Sapporo area and Tokyo Metropolitan area, the following findings were obtained.

- (1) Under the current electricity and city gas tariffs and the price of each equipment, CO₂-HP is more economical than GE-CGS both in Sapporo area and Tokyo Metropolitan area.
- (2) GE-CGS is economical according to sensitivity analysis of rated COP of CO₂-HP when the COP of CO₂-HP is less than 2.8 in summer in Sapporo area and 4 in summer in Tokyo Metropolitan area as shown in Fig.1.
- (3) GE-CGS is operated at rated output by daily start and stop operation between 8:00 and 22:00, and excess hot water produced between 8:00-17:00 is stored in a tank. Daily hot water consumption is larger than total daily supply from the gas engine cogeneration system in Tokyo Metropolitan area and hot water is supplied supplementary from gas boiler between 20:00 and 1:00.
- (4) The optimal capacity of the GE-CGS should be determined based on electricity demand not on hot water demand from a viewpoint of cost minimization.

Future Developments

We will analyze effect for technology choice by actual efficiency of system on several metrological conditions. Furthermore, we will analyze effect for technology choice by characteristics of area and lifestyle of customers based on actual load survey analysis

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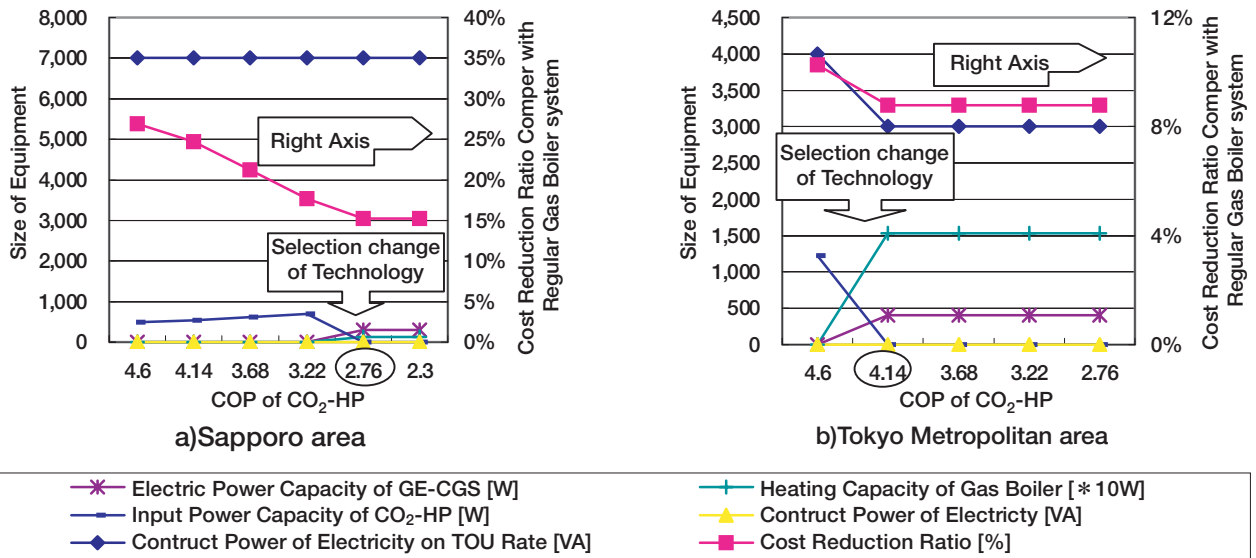


Fig.1 Sensitivity of COP of CO₂ Heat Pump Water Heater on Optimal Capacity

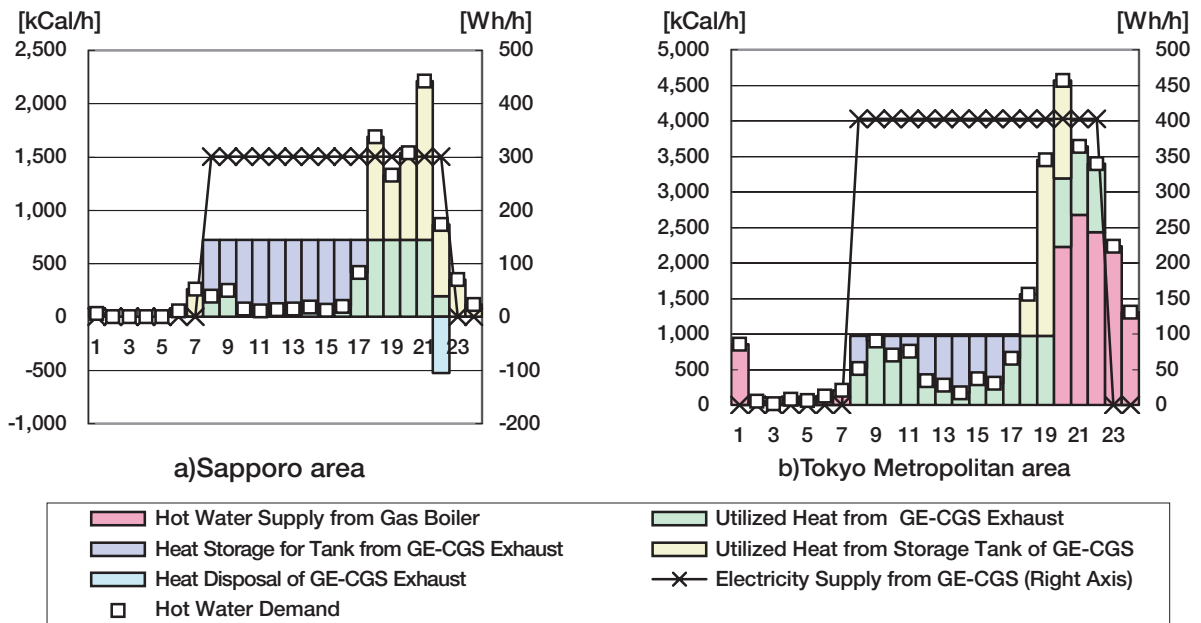


Fig.2 Optimal Operation of GE-CGS