Summary

It is well understood that conservation of energy in the civilian sector, especially in the office and commercial buildings in the Tokyo metropolitan area, is one of the key issues towards the low carbon society. The distributed energy technologies including CGS and photovoltaics are expected to meet the increasing air-conditioning demands.

Recently, the concept of the net Zero Energy Building (ZEB) and related technologies have been proposed. Unused thermal sources such as rivers and underground heat are being revisited thanks to the progresses in heat pump (HP) technologies. Since the economic and environmental contributions of these new energy technologies and new energy sources have yet to be clarified, the quantitative evaluation of these factors is a major topic at present.

Based on these trends, the present study developed an energy flow model, on a unit building basis, and used simulations to quantitatively evaluate the effects of the contribution from these new technologies and as-yet-unused heat sources. We looked at three commercial and office buildings in the Tokyo area, and firstly evaluated the energy demand for room cooling, room heating, hot-water supply and general electricity. We then developed an energy technology flow model including new energy technologies such as DC-inverter controlled heat-pumps which have almost constant COP in the low capacity utilization duration. Utilization of the unused thermal energy of rivers and the underground heat provided high COP, reaching around 5-6, while the COP of ambient based conventional equipment was 4-5. Our model formulated the COP as a function of capacity utilization rates using non-linear optimization. As a net Zero Energy Building technology, we also included double-skin walls for heat insulation.

The simulation results showed that the utilization of underground heat reduced the total cost by 10% and that all new technologies including ZEB could reduce total cost by 7.7% and CO_2 emission by 8.5%.

The study indicated that the contribution of new energy sources as well as new energy facilities is substantial and that investigating demand and heat availability on a micro level, and a detailed breakdown of the additional influence of climate conditions, along with energy saving through collaboration with EV and ICT application are key to realizing the maximum potential of these technologies.