Energy demand modeling and decarbonization of residential and commercial building stock

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Researchmap https://researchmap.jp/read0140668?lang=en

Abstract

This study develops simulation models to estimate energy demand and carbon dioxide emissions for the Japanese residential and commercial building stocks. The developed models (1) quantify the demand of the building stock as the sum of the energy demand of individual households and commercial buildings, (2) simulate human activity in estimating the energy demand, and (3) use a building stock model that represents the heterogeneity of the stock composition and changes over time, which is designed to provide the analytical capabilities needed for the decarboniza-tion of the building stocks.

Background & Results

Decarbonizing the residential and commercial building stocks is an imperative to mitigate climate change. The Japanese government has set a goal of halving carbon dioxide emissions from 2013 levels by 2030 and achieving carbon neutrality by 2050. To realize this goal, it is necessary to introduce various technological measures, such as improving the energy efficiency of buildings, building systems, and energy-consuming appliances, electrifying the energy source for space heating, cooling, and water heating, and the use of renewable energy sources such as solar power generation. Lifestyle changes, including behavioral changes, have also been attracted attention. To achieve the carbon dioxide emission reduction targets, it is necessary to address the question, "when and to what extent will these measures need to be introduced?"

As a result of applying the developed method to the Japanese commercial building stock covering the offices, hotel, medical, retail, and school buildings, it was found that A) significant reductions in carbon dioxide emissions are achievable, B) the expected increase in electricity demand due to electrification for space heating, cooling, and water heating can be avoided by improving energy efficiency through the introduction of various energy conservation technologies, and C) the dissemination of energy efficiency measures is expected to reduce CO_2 emissions by 27 $MtCO_2$/year by 2030 and has a potential to reduce by 43 $MtCO_2$/year, compared to 148 $MtCO_2$/year in FY2013.

## Significance of the research and Future perspective

We are currently using the developed models to assess Japan's progress in reducing carbon dioxide emissions in the residential and commercial building stocks and to develop decarbonization scenarios for Japan that include behavioral and lifestyle changes. In addition to this, we are developing an agent-based human behavior simulation model that stochastically simulates people's time use and travel behavior, and estimating energy demand of electric vehicles based on the behavior simulation result to analyze changes in energy demand comprehensively.
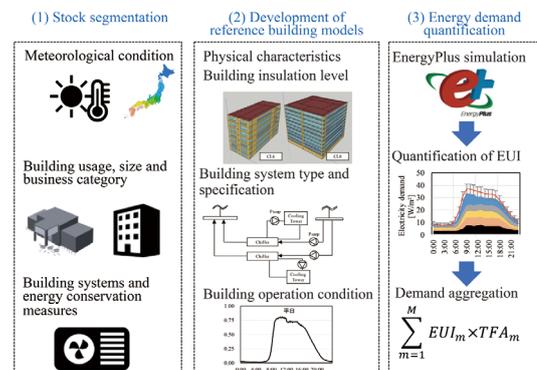
Energy demand quantification procedure for the Japanese commercial building stock
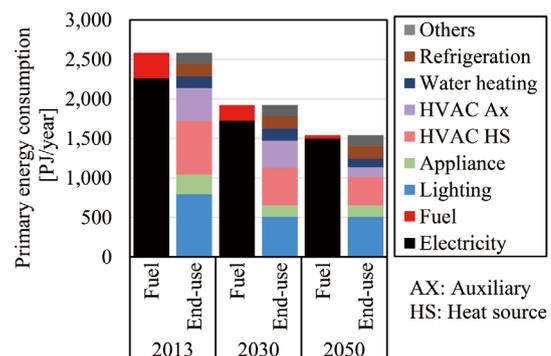
Estimated energy consumption for the Japanese commercial building stock
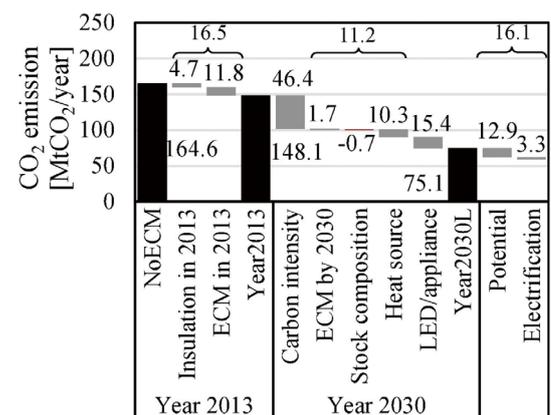
Contributions of factors providing reduction in CO_2 emissions. ECM: Energy conservation measures