

Abstract

[Research Title]

Development of National and Local Governments' Carbon Management System for Building Sector

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Japan is implementing measures to reduce greenhouse gas emissions in 2030 by 46% compared with 2013 levels. Although progress management is conducted annually, the lack of a detailed factor analysis means that it is unclear whether progress is on track. Our research group is developing a system to estimate emission reductions and we have made specific proposals that should enable national and local governments to more effectively manage carbon emissions in the residential and commercial sectors.

For the residential sector, we conducted estimations using total residential end-use energy simulation (TREES) and compared these to the latest statistical emissions data. When the impact of weather was eliminated, it became evident that the improvement in housing performance and the introduction of high-efficiency air conditioners significantly contributed to these reductions. However, since fiscal year 2021, the reduction target for secondary energy consumption has not been met. Further enhancement and promotion of the measures are necessary to achieve the 2030 target. The efficiency of the current measures was evaluated by analyzing the relationship between marginal abatement costs and CO₂ reduction. We also proposed four additional scenarios and estimated their energy-saving effects up to 2050. Supplementary measures that could effectively help achieve the targets were also identified.

For commercial building stocks, this study developed a building stock energy modeling framework that integrates top-down building stock decomposition, including building systems and energy conservation measures, and bottom-up physics-based energy demand quantification using reference building models that represent building stock segments. The developed model effectively captured the contributions made by these technologies and their short-term dynamics. Although there were significant errors in estimating some building subsectors and end uses, the model predicted changes in the aggregated energy

consumption with acceptable accuracy. The Japanese 2030 emission reduction target cannot be achieved with the current technology deployment trends; however, this shortfall can be addressed by applying additional measures.

At the basic municipality level, there are no high-precision statistics, such as comprehensive energy statistics, that can be used by the national government. However, survey data on smart meters and regional electricity contracts are powerful tools that provide input conditions tailored to the characteristics of each municipality. The digital twin model, which combines these data with the simulation model developed in this project, is an effective tool that could be used by municipalities to efficiently manage and reduce greenhouse gas emissions.

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