



# Energy management technology for smart building

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## Abstract

Most part of the social energy consumption is dominated by buildings, and energy saving of the buildings becomes crucial. Recently, buildings are often equipped with solar panels and batteries, and the energy management technology that manages the entire building, including various energy-consuming devices such as air conditioning and smart home appliances, is becoming more and more important. Prediction and optimization are key core technologies for reducing energy consumption without compromising residents' convenience and comfort. Our research group is developing comprehensive energy management technology based on such prediction and optimization. Especially, we are developing technology for predicting electricity prices and electricity demand using deep learning, and efficient optimization technology for many energy-consuming devices.

## Background & Results

Our energy management technologies enable not only energy saving, but also extracting demand-side flexibility. Our technologies contribute to the new energy services and expect to drive DX (Digital Transformation) in the energy sector.

## Significance of the research and Future perspective

Buildings are the foundation of our daily lives and consume a lot of energy every day. To reduce energy consumption in buildings without compromising the convenience and comfort of residents, it is necessary to properly operate energy-consuming devices such as air conditioning and smart home appliances, in addition to solar panels and storage batteries that have become popular in recent years. Especially, it is necessary to optimize the entire system by utilizing predictive information such as the amount of renewable energy generation by solar panels, residents' behavior patterns, and electricity prices.

Battery and energy-consuming equipment scheduling is an important challenge to minimizing energy consumption. Usually, energy-consuming equipment such as air conditioning and smart home appliances require hours to day planning period, while the granularity of the renewable energy generation and the battery behavior is seconds' order. The scheduling problem is quite complicated and hard to solve. In this research, we have developed a novel hierarchical scheduling method. The proposed method has reduced more than 48% in electricity costs in about 10 minutes of computation time over the baseline method.

Time-series forecasting of electricity demand and electricity prices is another important challenge, and deep learning is often used to tackle this. Normally, the time-series data of electricity demand and electricity prices contains noise, and it is known that the noise affects forecasting accuracy. In this research, we have researched the novel forecasting method of electricity price by combining frequency analysis and deep learning. Our method achieved the best

forecasting accuracy over the leading-edge method at that time.

Our research group has developed novel energy management technology based on such forecasting and optimization. We are also actively implementing our technology in building equipment such as air conditioning for industrial applications.

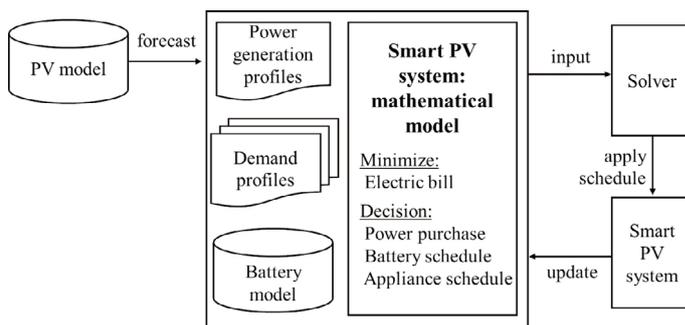


Fig. 1 Overview of proposed scheduling framework

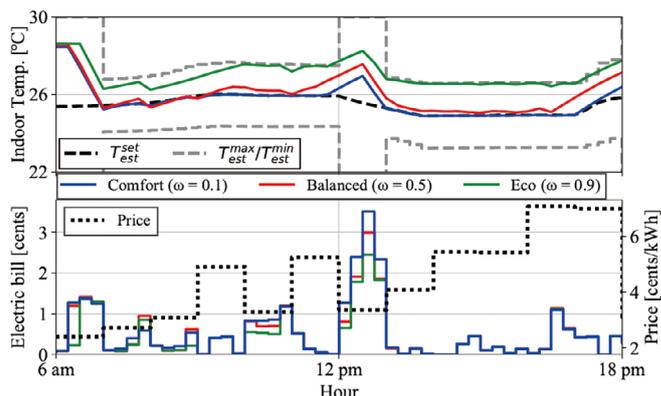


Fig. 2 Example of scheduling results of air conditioning considering thermal comfort

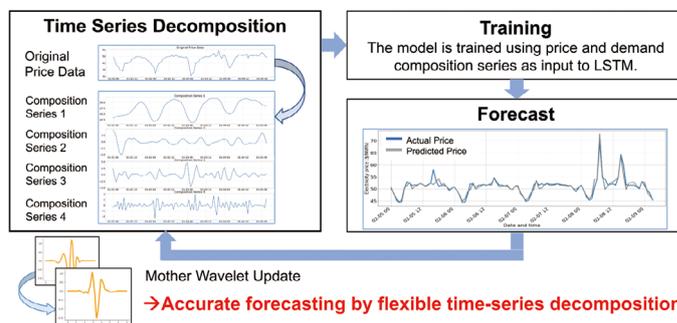


Fig. 3 Overview of electricity price forecasting based on frequency analysis and deep learning

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Treatise

Watari, Daichi; Taniguchi, Ittetsu; Goverde, Hans et al. Multi-time scale energy management framework for smart PV systems mixing fast and slow dynamics. Applied Energy. 2021, Volume 289, 116671, doi:10.1016/j.apenergy.2021.116671  
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Keyword smart building, energy management system, battery, smart appliance, solar energy