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Achieving Decarbonization and Employee Well-Being in Urban Business Districts: The Nihonbashi Initiative

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ABSTRACT

In recent years, Japanese companies and municipalities have increasingly recognized the importance of urban decarbonization. Urban areas, with their concentration of businesses, must consider not only decarbonization but also the well-being of the people working there. It is particularly important for business leaders to balance decarbonization efforts with employee well-being.

This project aims to create scenarios that achieve both decarbonization and well-being in Nihonbashi, a central business district in Tokyo.

The main focus is on long-term forecasting and management of energy demand using integrated simulation technology with an urban digital twin and developing scenarios that contribute to improving the overall well-being of employees.

Project activities include predicting and visualizing hourly energy demand for buildings within the area and assessing the effects of various decarbonization options. One decarbonization option involves implementing a system to transmit locally generated renewable energy to Nihonbashi and validating it with predictive models. By collaborating with building owners to advance energy management, the project has identified the potential to achieve approximately 10% energy savings.

In addition, the project will also work to improve employee well-being by implementing a chatbot program that will educate employees about their company's decarbonization activities and encourage behavior change to increase their sense of contribution.

The project aims to enhance sustainable urban development and comfort in the office area and is an important step in a larger decarbonization initiative that will be implemented in partnership with building owners in the Nihonbashi area.

Ultimately, the project aims to improve energy efficiency and overall community well-being and serve as a model for future urban sustainability.

Keywords: Urban decarbonization, Well-being, Urban digital twin, AEMS, electricity consignment

1. INTRODUCTION

As climate change countermeasures become a global issue, efforts to optimize and decarbonize the thermal environment in the office environments of Japanese companies are an urgent priority. According to a report by the Ministry of Economy, Trade and Industry, Japan's business sector (office buildings, etc.) accounts for approximately 17% of the country's CO2 emissions, and there is a strong need to reduce these emissions. In addition, deterioration of existing air conditioning systems has led to issues of reduced comfort for employees due to uneven indoor temperatures and increased energy consumption.

On the other hand, according to the Small and Medium Enterprise Agency (2023), a lack of manpower and know-how is a barrier for Small and Medium-sized Enterprises to promote decarbonization. Low employee involvement in decarbonization activities is identified as a common problem among many Japanese companies.

To address these issues, the optimization of air conditioning systems and wellbeing measures, as well as the introduction of chatbots, are expected to promote employee engagement in decarbonization activities.

2. MATERIAL AND METHODS

The objective of this study is to combine the optimization of HVAC systems with the improvement of wellbeing, as well as to increase employees' awareness of the need to participate in decarbonization activities and change their behavior using a decarbonization

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educational chatbot. Specifically, the following three objectives will be set.

・ Improve energy efficiency: optimising air conditioning systems effectively to reduce energy consumption and lower carbon dioxide emissions

・ Improve wellbeing: Reduce employee stress and improve concentration and productivity through optimal temperature control

・ Use of chatbots: Provide employees with information on decarbonization activities to raise awareness and encourage them to take action to reduce daily energy consumption.

2.1 Data collection and analysis

Collect real-time data on temperature, humidity, CO2 concentration, etc. in the office using environmental sensors; utilize BEM to visualize the temperature distribution in each area and identify hot and cold spots.

2.2 Implementation of wellbeing measures

The aim is to reduce employee stress and improve productivity by providing a comfortable temperature environment. Periodic surveys would be conducted to control temperatures to reflect employee opinions, and coordinate with our health promotion program.

2.3 Introduction of chatbots

Through a chatbot, the system provides information on decarbonization, up-to-date environmental data, and energy consumption tips. It suggests daily energy saving actions to employees, asks employees to input the results of their actions, and provides positive feedback on the results.

2.4 Evaluation of results

Quantitatively assess the impact of energy consumption reductions. Monitor changes in wellbeing indicators (stress levels, satisfaction, productivity, etc.) to measure the impact of improvements.[1] Analyse the long-term impact of environmental improvements on business performance and employee health. Chatbot usage and employee feedback would be analysed to evaluate the effectiveness of our efforts.

2.5 Office layout diagram

Figure 1 shows the 3D layout of an office in BEM, visualizing the placement and structure of each zone. Each zone in the diagram is separated by walls and partitions, with Zone 8 being the &F area used as the main.

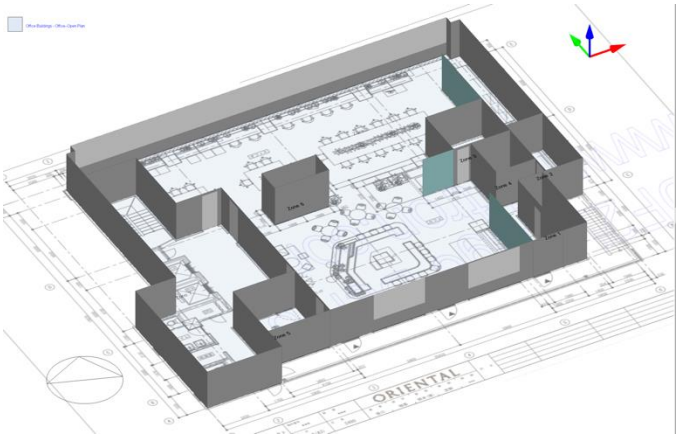

Fig. 1 Office layout diagram

2.6 Daylight factor distribution

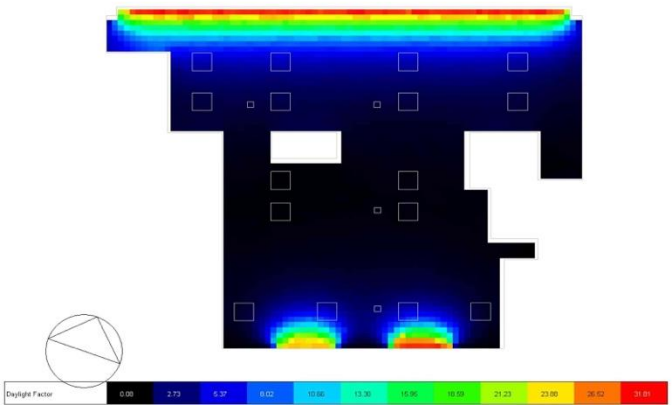

Fig. 2 Office daylight factor

Figure 2 shows the distribution of Daylight Factor in the office. The Daylight Factor is a measure of the distribution and intensity of natural light, and the colour coding in the figure indicates the Daylight Factor value. The values are particularly high near the north and south windows, where temperatures are also relatively high.

2.7 Improving energy efficiency

Based on these analyses, following changes could be made to reduce energy consumption in &F area.

1. Lower air conditioning temperatures only in some areas and raise the overall average.
2. Change operating hours to 8:00-19:00 instead of 9:00-18:00

From Figure 3 and Figure 4, changes for energy efficiency were done and shown following results.
Total site energy:

- Before: 11,119.78 kWh
- After: 9,958.60 kWh
- Change: 1,161.18 kWh reduction (approx. 10.4%)

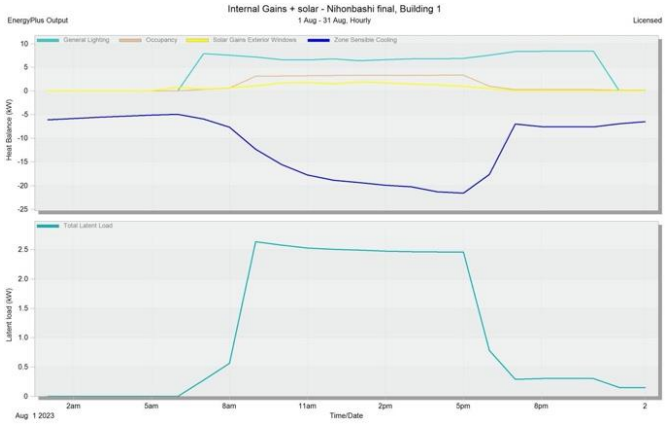

Fig. 3 Energy performance before modification

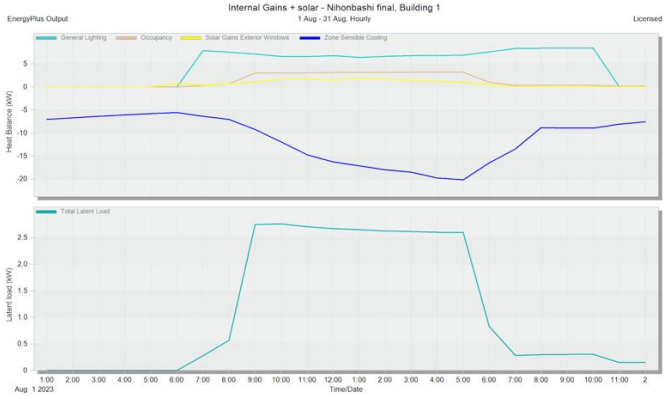

Fig. 4 Energy performance after modification

For zone sensible cooling, as indicated by the blue line indicates the amount of heat removal due to cooling. Total cooling load is reduced after changes made, and the overall energy efficiency is improved. Shown by the blue line, lowest cooling load occurs at night, and the higher during the peak daytime hours. It is especially high between 2:00 and 5:00 PM.

Before the change, the cooling load is high and energy consumption is high, especially during daytime peak hours. After the change, we can see that the zone sensory cooling load has decreased through daytime and overall energy efficiency has improved.

3. CONCLUSIONS

The objective of this study is to create scenarios that achieve both decarbonization and well-being in Nihonbashi, a central business district in Tokyo.

The main focus is on long-term forecasting and management of energy demand using integrated simulation technology with an urban digital twin and developing scenarios that contribute to improving the overall well-being of employees.

In cooperation with Urban Digital Twin, we have used integrated simulation technology to develop scenarios that contribute to the long-term forecasting and management of energy demand and overall employee wellbeing and have identified energy savings of around 10%.

Future work will also aim to improve chatbots to effectively promote decarbonisation behaviours and improve wellbeing in behaviour change.

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