The Impact of Household Members' Time-Use Patterns on Residential Carbon Emissions in China's Electricity Sector

Qi Zeng[1], Yuko Kanamori[2]

1, Tokyo Institute of Technology; 2, National Institute for Environmental Studies (NIES)

Email: zeng.qi@nies.go.jp

Introduction

- Global climate change is a major environmental threat, making it crucial to reduce carbon emissions across all sectors, including residential electricity use in China. The household sector is a major contributor to overall carbon emissions, with different household members contributing variably based on their daily routines. Understanding these time-use patterns is crucial for developing targeted mitigation strategies within the Chinese context.
- Time-use data is essential for linking daily activities to carbon footprints. Studies indicate that in China, working individuals tend to have higher evening energy peaks, while homemakers exhibit more consistent energy usage throughout the day. Activities such as cooking, cleaning, and entertainment are significant energy consumers, especially when high-energy appliances like ovens and microwaves are involved.
- By analyzing the time-use patterns of household members and their impact on energy demand, this research aims to provide insights into how residential energy consumption in China can be optimized to reduce carbon emissions within the electricity sector.

Objectives

- **Evaluate the Impact of Household Size on Peak Electricity Demand:** Quantify how different household sizes (e.g., 2-person households, 4-person households, 6-person households) affect the timing and magnitude of peak electricity demand.
- **Analyze the Impact of Household Member Compositions on Peak Electricity Demand:** Systematically assess how different household member compositions (occupation types) influence the timing and intensity of peak electricity demand.
- **Explore how the interaction of household size and member composition collectively affects the timing and magnitude of peak electricity demand.**

Study Site

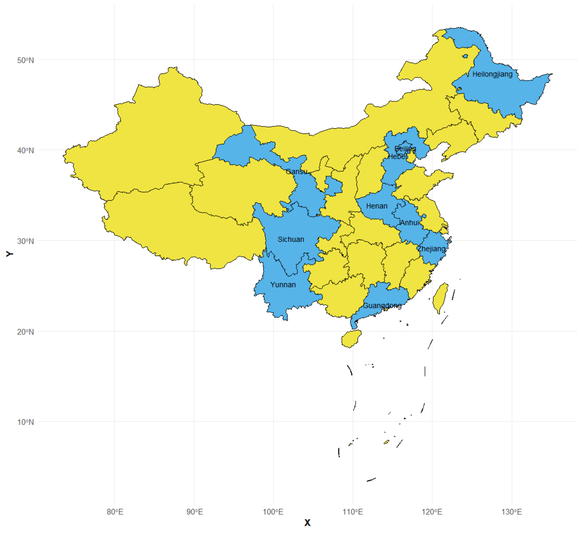
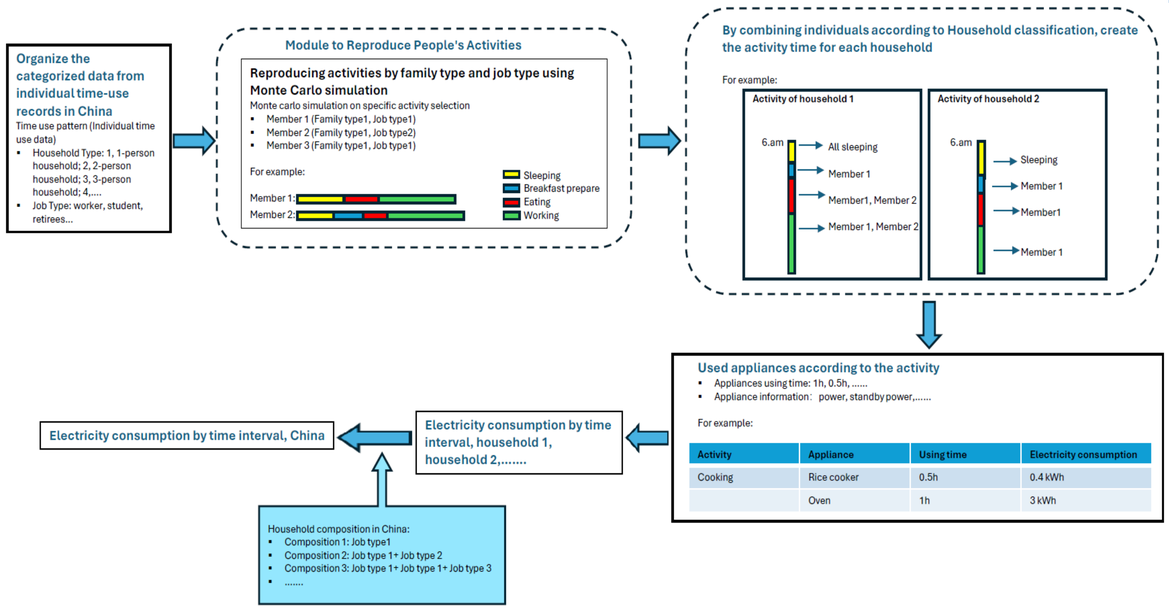


Figure 1. Data source region of China: Beijing, Hebei, Heilongjiang, Zhejiang, Anhui, Henan, Guangdong, Sichuan, Yunnan, Gansu

Framework & Data



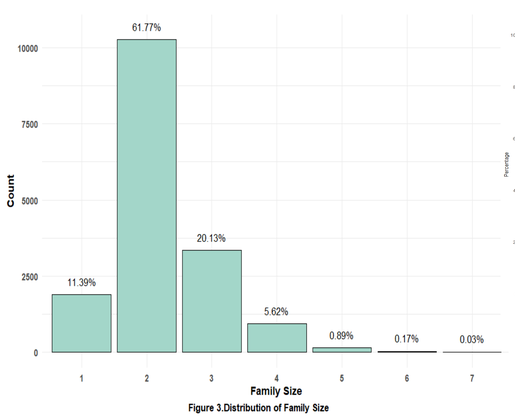


Figure 3.Distribution of Family Size

The bar chart illustrates the distribution of family sizes within the surveyed city, with family sizes ranging from one to seven members. Each bar represents the number of households, and the percentage labels on top of the bars indicate the proportion of each family size in the total population. Notably, two-person households dominate the distribution, accounting for 61.8% of the total. This suggests that in the surveyed city, smaller families, particularly two-person households, form the majority. (Figure 3)

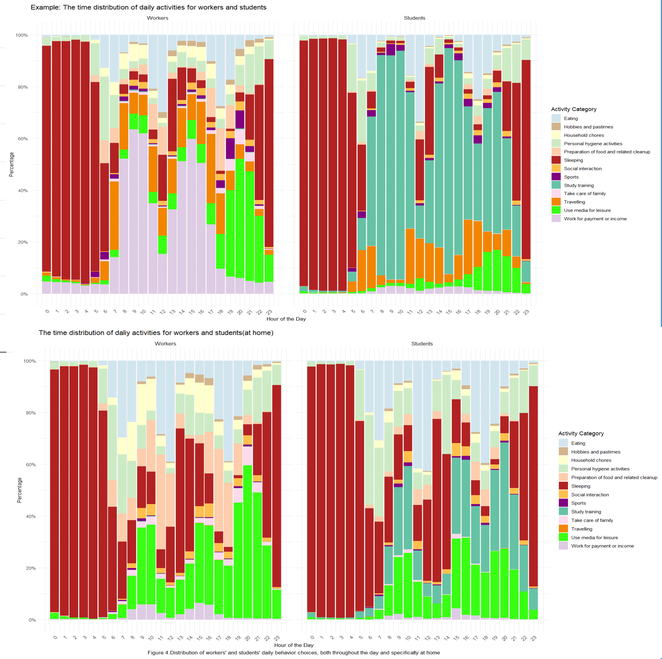


Figure 4.Distribution of workers' and students' daily behavior choices, both throughout the day and specifically at home

Figure 4 For example, workers' and students' activity choices throughout the day (top) and specifically at home (bottom), providing a basis for analyzing potential impacts on electricity usage.

Expected Results

Figure 5. Hypothetical Power Consumption Curves for Different Cases

Figure 5. Illustrates hypothetical power consumption curves for different household compositions and occupational statuses, derived from time-use patterns.

This research is expected to reveal how household size and member composition influence peak electricity demand. Larger households are anticipated to show higher peak consumption, particularly during key daily activities. Different occupational statuses may result in varied demand patterns, with working individuals likely causing morning and evening peaks. These insights could inform targeted energy efficiency measures and strategies to reduce carbon emissions in residential settings.

Future Work

1, Expanding Data Collection**: Future efforts will focus on collecting additional data related to household electricity usage, such as time-use patterns and appliance usage frequencies. This will enable further refinement and enhancement of the models to improve the accuracy of electricity demand predictions.

2, Incorporating Future Emerging Lifestyle Trends: The research will explore the impact of lifestyle changes, such as the increase in remote work and shifts in daily routines, on household electricity demand. This may include scenario analysis to assess how varying levels of remote work adoption affect peak demand.

3, Improving Models and Policy Development**: Building on the current research, future work will involve improving the models to better reflect real-world conditions. The insights gained will inform targeted energy efficiency policies tailored to different household compositions and work patterns, aiming to optimize electricity consumption and reduce carbon emissions.

4, Simulating Seasonal Variations**: To enhance model accuracy, future simulations will incorporate seasonal variations, considering how different times of the year affect household energy usage due to climate factors and changes in daily routines.

References

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