Diba Malekpour Koupaei¹, Farzad Hashemi², Vinciane Tabard-Fortecoëf³ and Ulrike Passe¹

¹ Iowa State University

² Penn State University

³ INSA Lyon

Representing Low-Income Households in Building Energy Modelling Tools

PROBLEM STATEMENT

In urban areas, low-income households experience a high energy burden and need to allocate a disproportionate share of their income to energy expenditures due to energy inefficiencies in their homes.

Thus, in the recent years improving the low-income housing stock and providing the residents with resources and/or incentives that would present a venue for a more sustainable future has been emphasized and promoted.

However, all parties involved in this process suffer from a lack of reliable data that is specific to low-income households and their unique characteristics.

DESCRIPTION OF THE TECHNIQUE

Building energy performance modelling tools provide a basis for informative decision making. However, such tools need occupancy related data to count for the effect of presence and activities of users on energy consumption and this need becomes challenging when little to no data is available for representing unique populations like low-income households.

Accordingly, in this study population-specific data collected via a mail survey is used to refine the results of a Markov-chain probabilistic occupancy prediction model based on the American Time-Use Survey (ATUS).

An overview of the proposed technique

This following question in the survey specifically addressed occupancy patterns:

“In an average week:

a. What percent of your Monday-Friday daytime hours is spent at home?

b. What percent of your Monday-Friday evening hours is spent at home?

c. What percent of your weekend daytime hours is spent at home?

d. What percent of your weekend evening hours is spent at home?”

This energy use survey was sent to about 1000 household addresses in three adjoining low-income neighborhoods (i.e., Capitol East, Capitol Park, and MLK Jr Park) in the Des Moines metropolitan area.

CASE STUDY

Median household incomes in the selected neighborhoods (2012-16)

Survey results were clustered into six representative groups and using the proposed technique, the following occupancy profiles were generated:

24-Hour occupancy presence schedules

Our findings verify that unique populations present behavioral patterns that do not necessarily agree with standard generic profiles. This suggests that the use of standard schedules (ASHRAE 90.1) would result in a wide gap between buildings' energy consumption predictions and actual performance.

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