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Demographic Information Incorporated Household Energy Consumption Analysis

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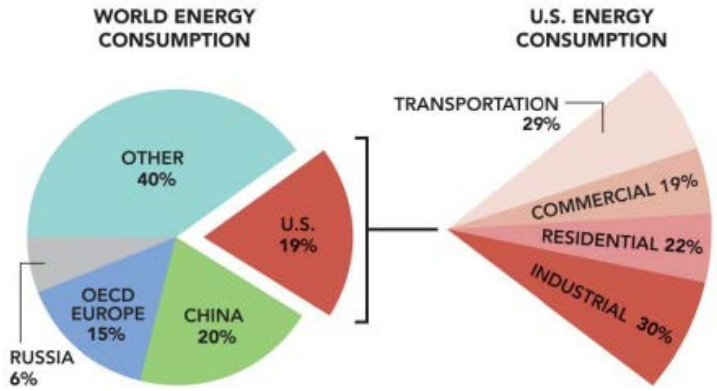
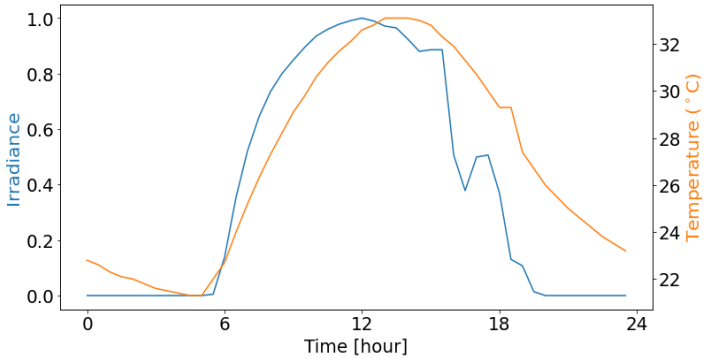
Background

- Residential buildings have great potential to participate in demand response in distribution system operation
- Developed a load model to generate synthetic load profiles based on time use survey data and weather data
- Energy consumption patterns are compared based on different groups



Data Introduction

- Current Population Survey Data (CPS)
  - CPS dataset is a monthly survey of approximately 60,000 U.S. households conducted by the U.S. Census Bureau for the Bureau of Labor Statistics
  - Include the employment status of the civilian population 16 years and over by age, employment status, and marital status.
- American Time Use Survey Data (ATUS)
  - ATUS data set measures the amount of time people spend doing various activities, including working, leisure, childcare, and household activities
- National Solar Radiation Database (NSRDB)
  - Solar radiation and temperature data



Load Model

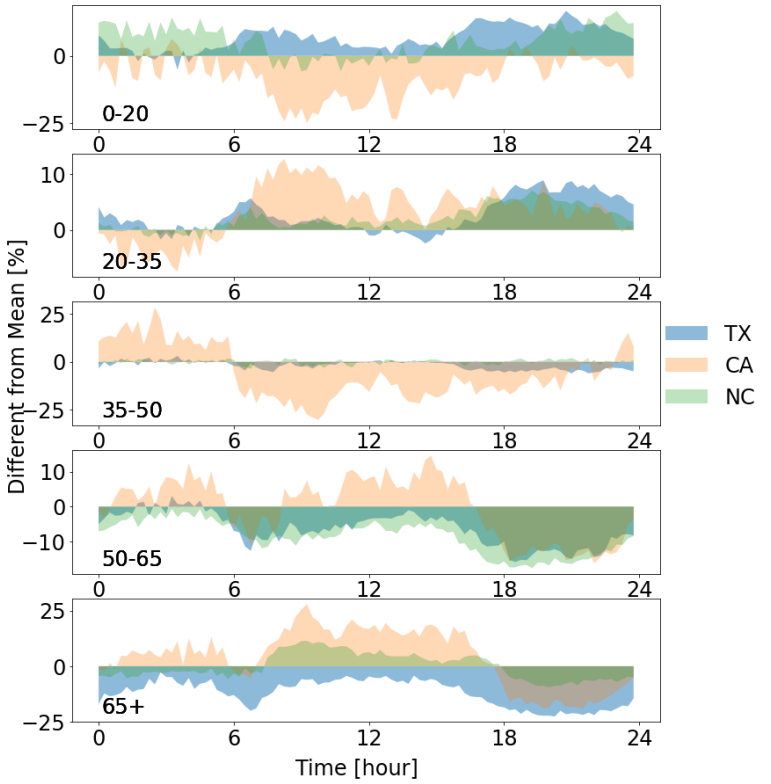
- Temperature-based loads: ETP model

$$T_i^{t+1} = T_a^{t+1} + Q_{hvac}R_{hvac} - (T_a^{t+1} + Q_{hvac}R_{hvac} - T_i^t)e^{\frac{\Delta t}{R_{hvac}C_{hvac}}}$$

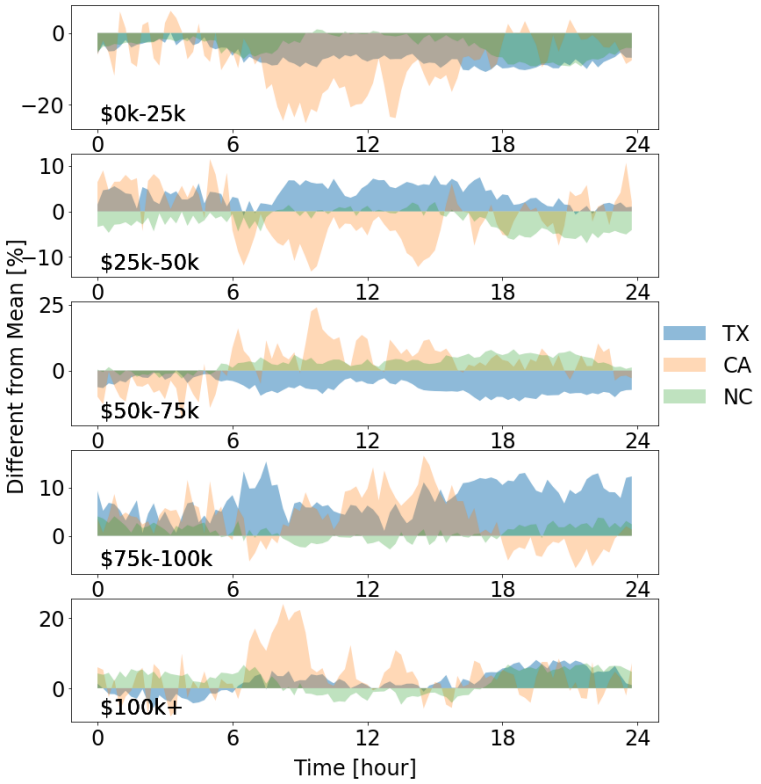
- Activity-based loads:
  - Lighting: agent-based modeling method
  - Laundry/dishwasher: based on ATUS data
- Other loads:
  - Power conversion factors are considered based on activity state

Results - 1

- 100 load profiles are generated for Texas, California, and North Carolina

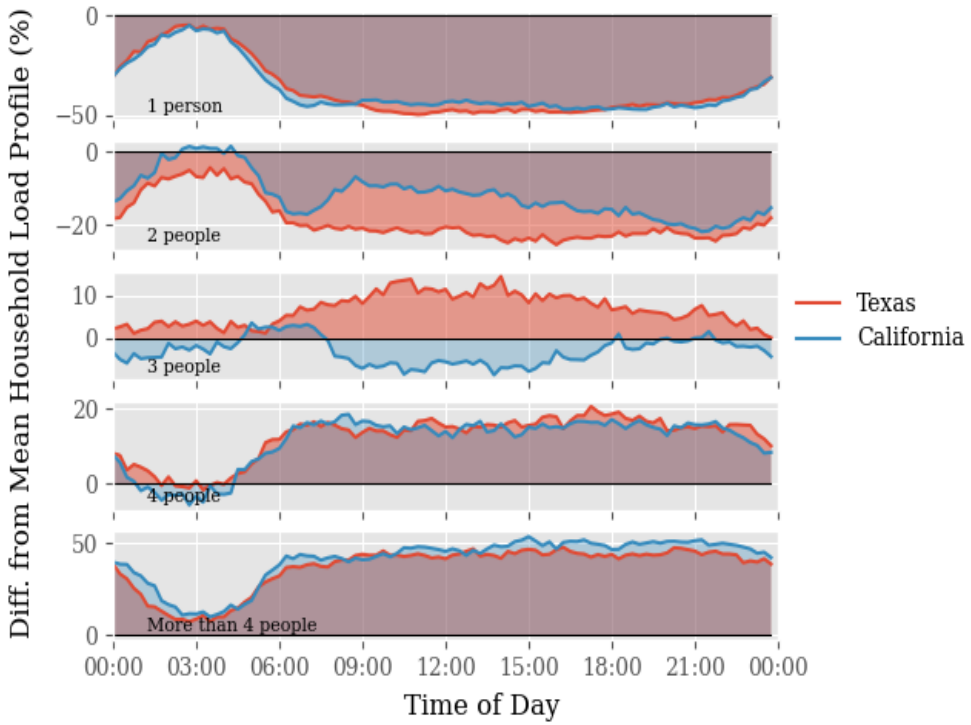


Difference in mean household load profile by age group

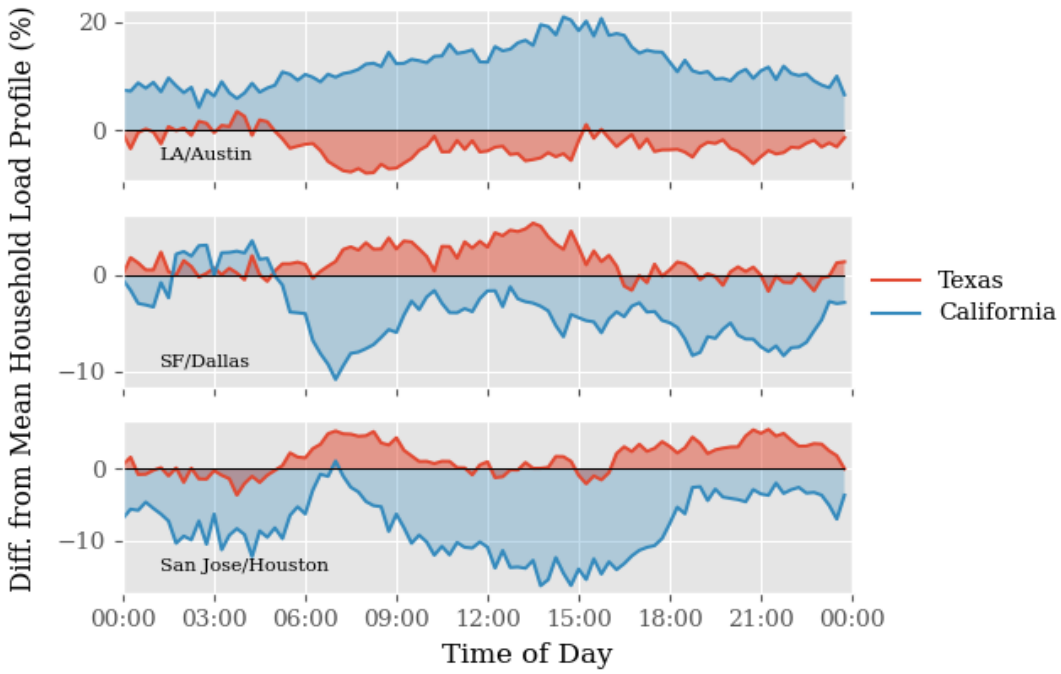


Difference in mean household load profile by income group

Results - 2



Difference in mean household load profile by occupant number group



Difference in mean household load profile by city

Future Work

- Validate the proposed load modeling method with actual data
- Generate the load profiles for more representative states
- Analyze the load profiles by more groups, such as average occupation status and occupation category

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