Pacific Northwest
NATIONAL LABORATORY

Session 3: Market Delivery Barriers & Opportunities

ORNL Manufactured Housing Workshop

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U.S. DEPARTMENT of ENERGY | Office of Critical Minerals and Energy Innovation

BATTELLE

Project Overview

What We Did

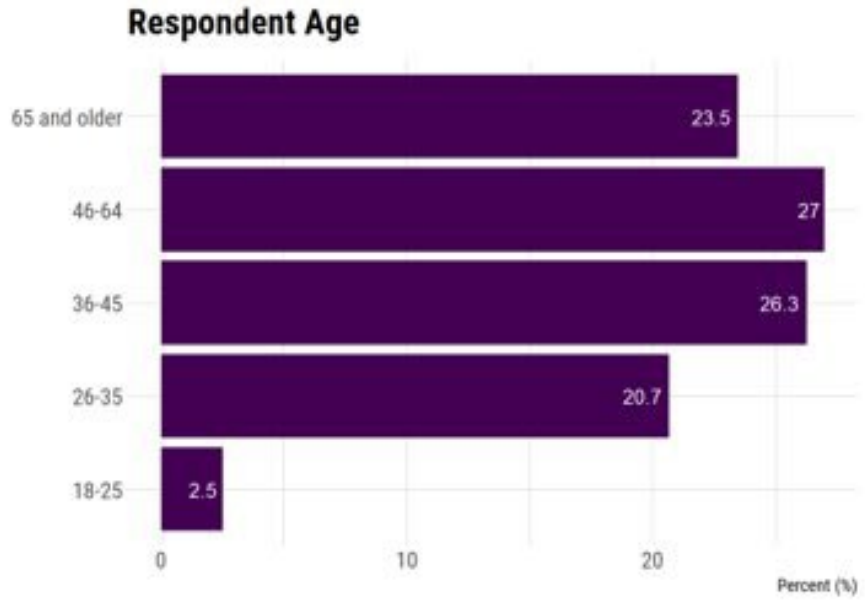
We collected data from a national sample of manufactured housing (MH) residents:

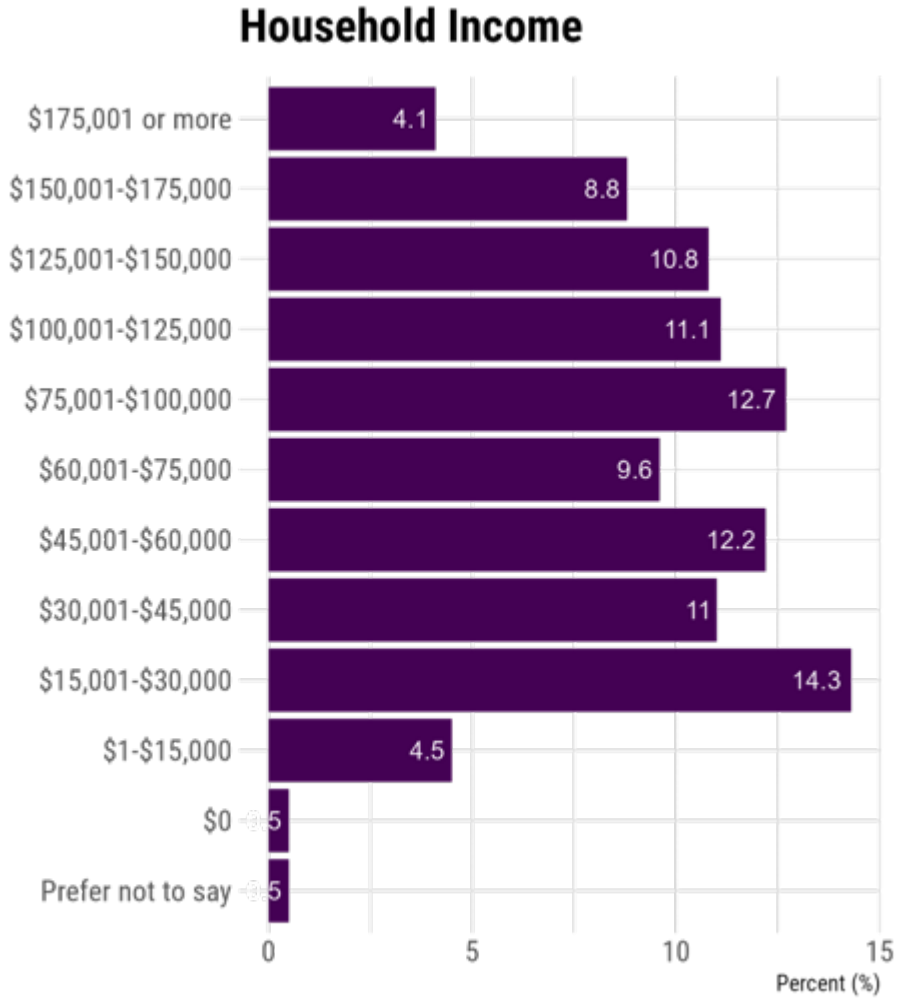
- National Sample: A randomly sampled set of 2,017 U.S. residents in 49 states who were randomly sampled through Ovation data consulting services
- Advisory Committee: A panel of experts who helped us pilot and develop the survey. They recruited 38 manufactured home resident respondents amongst themselves and their trusted contacts, known as the advisory committee sample. We used this sample for level-setting and providing additional insights into the national sample.

What We Found

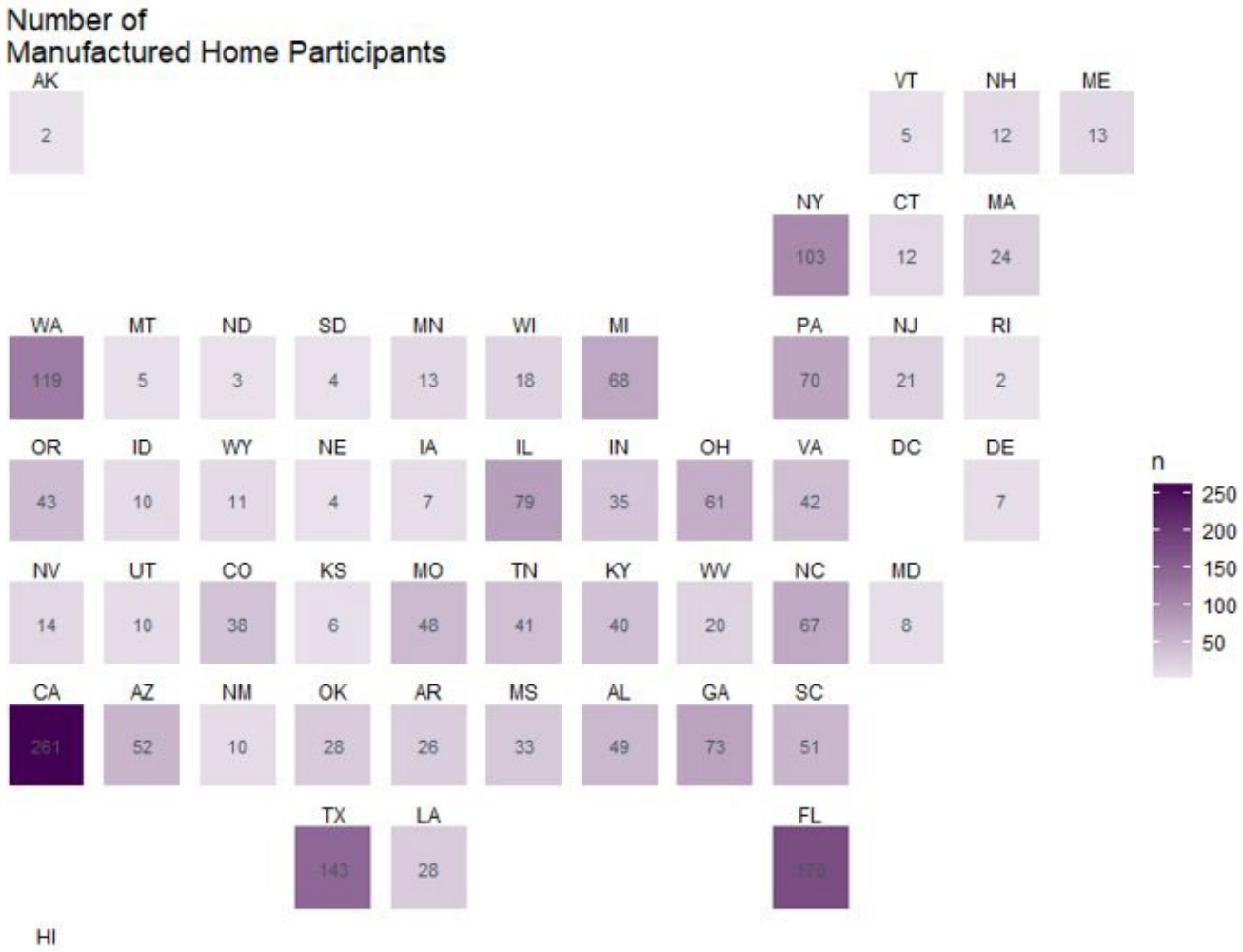
- Observed key differences in tastes, preferences, and decision-making for MH residents in urban, rural, suburban locations
- MH residents who self-identified as having trouble paying energy bills had higher energy costs overall and were more likely to utilize stopgap HVAC measures

MH Respondent Characteristics





Respondents by State



Highest sample sizes from:

- California: 261
- Florida: 178
- Texas: 143
- Washington: 119
- New York: 103

No respondents from:

- District of Columbia
- Hawaii

When were respondents' homes built?

Major HUD Code Changes

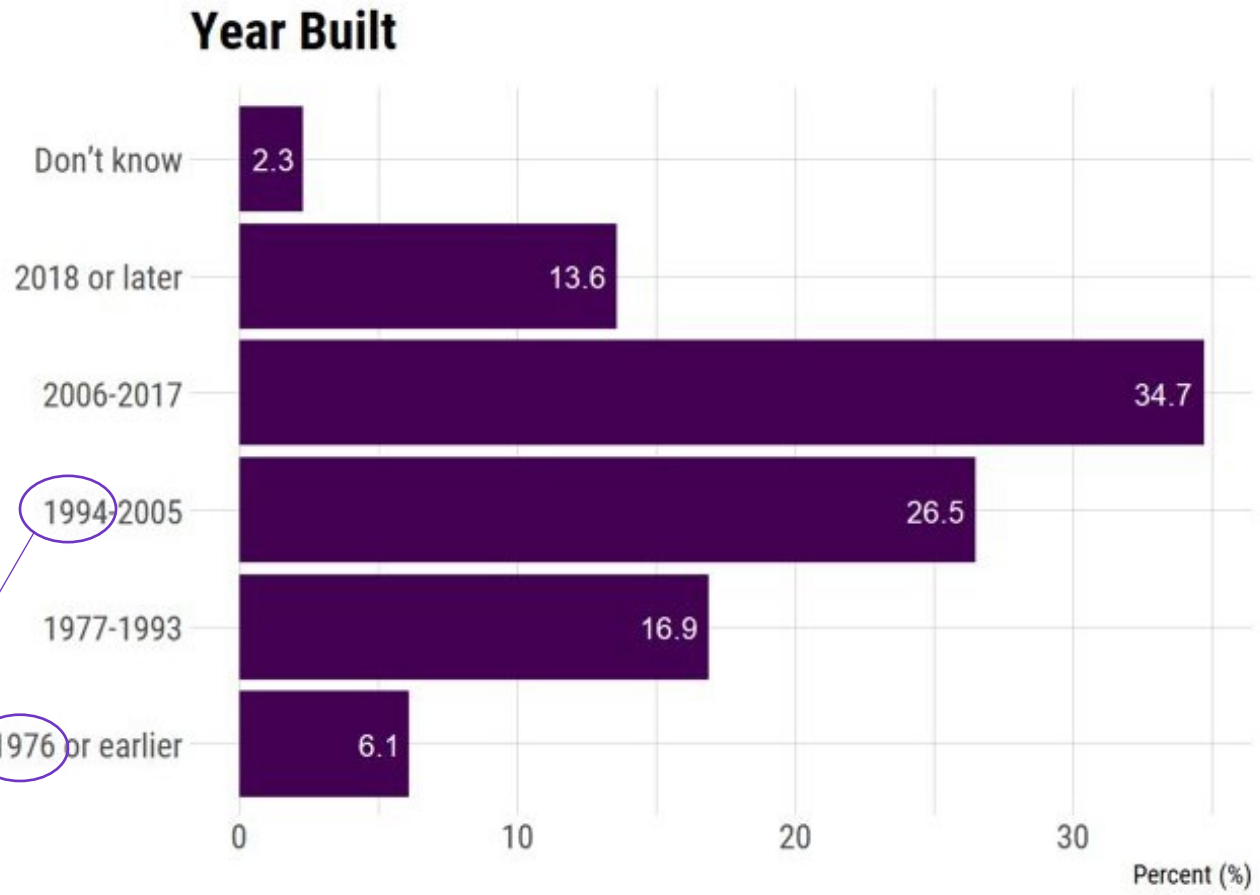
1976: First HUD Code implemented; all new manufactured homes must comply.

1993: Energy conservation requirements strengthened (thermal performance and ventilation).

2005: Major revisions based on MHCC recommendations (fire safety, roof load, design, thermal protection).

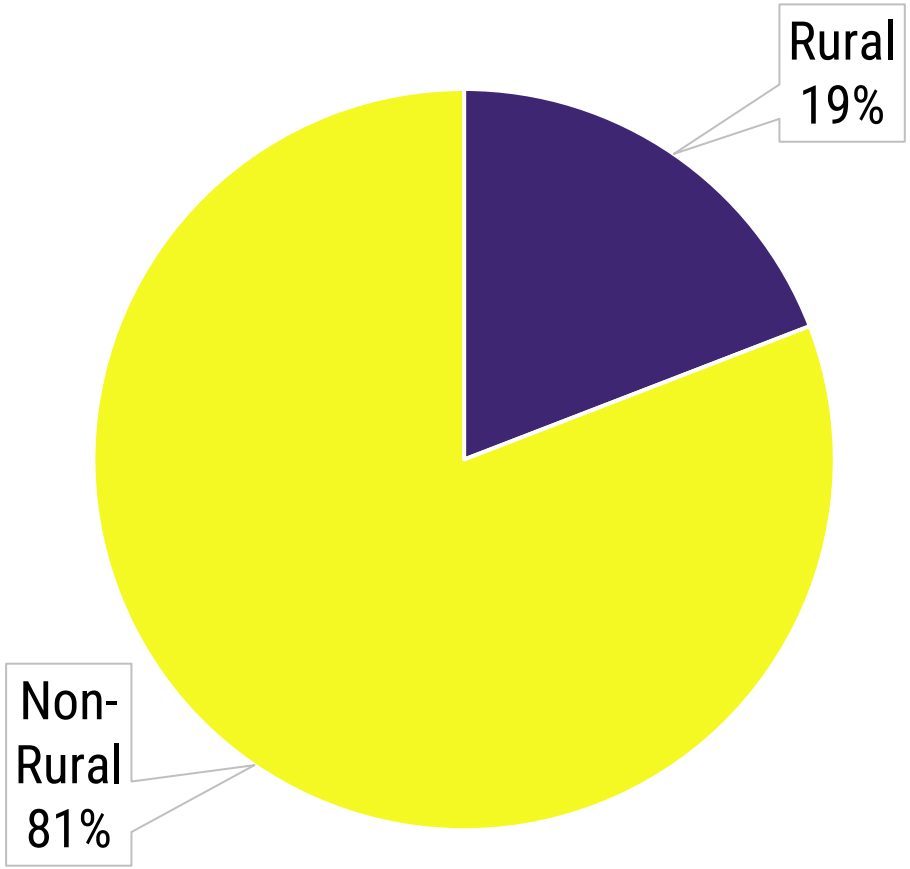
The Manufactured Housing Improvement Act

National Manufactured Housing Construction and Safety Standards Act

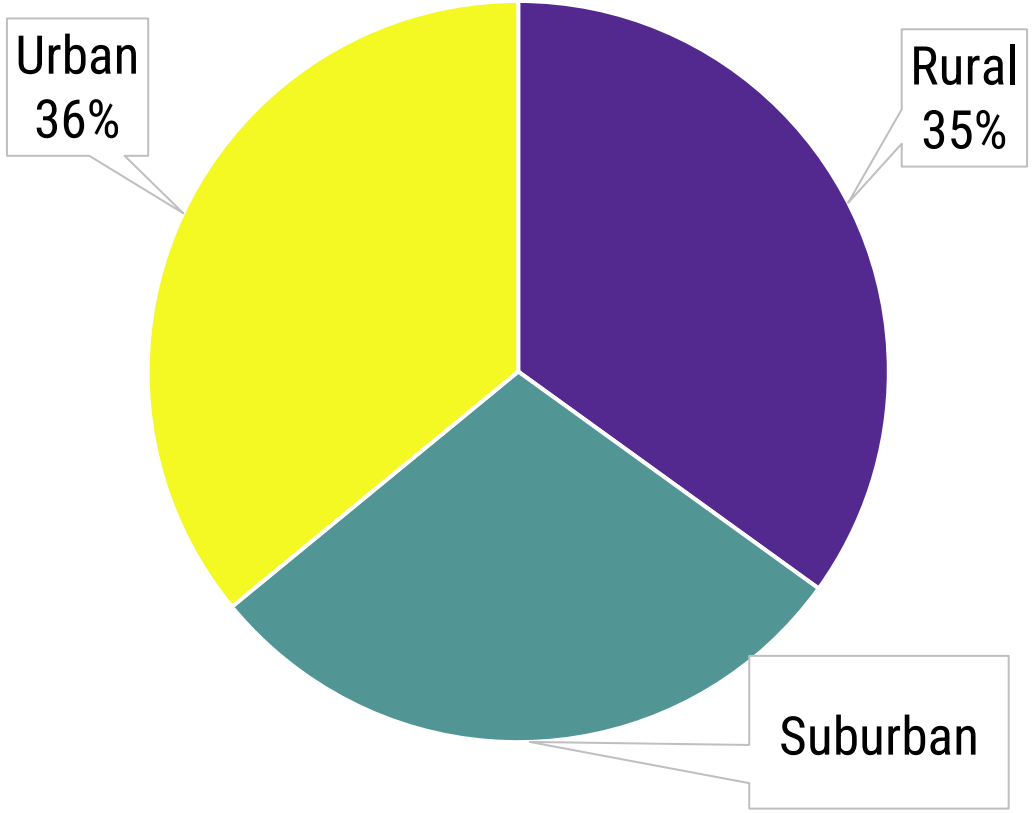


Where do MH respondents live?

USDA Economic Research Service Definition applied to MH Survey Data

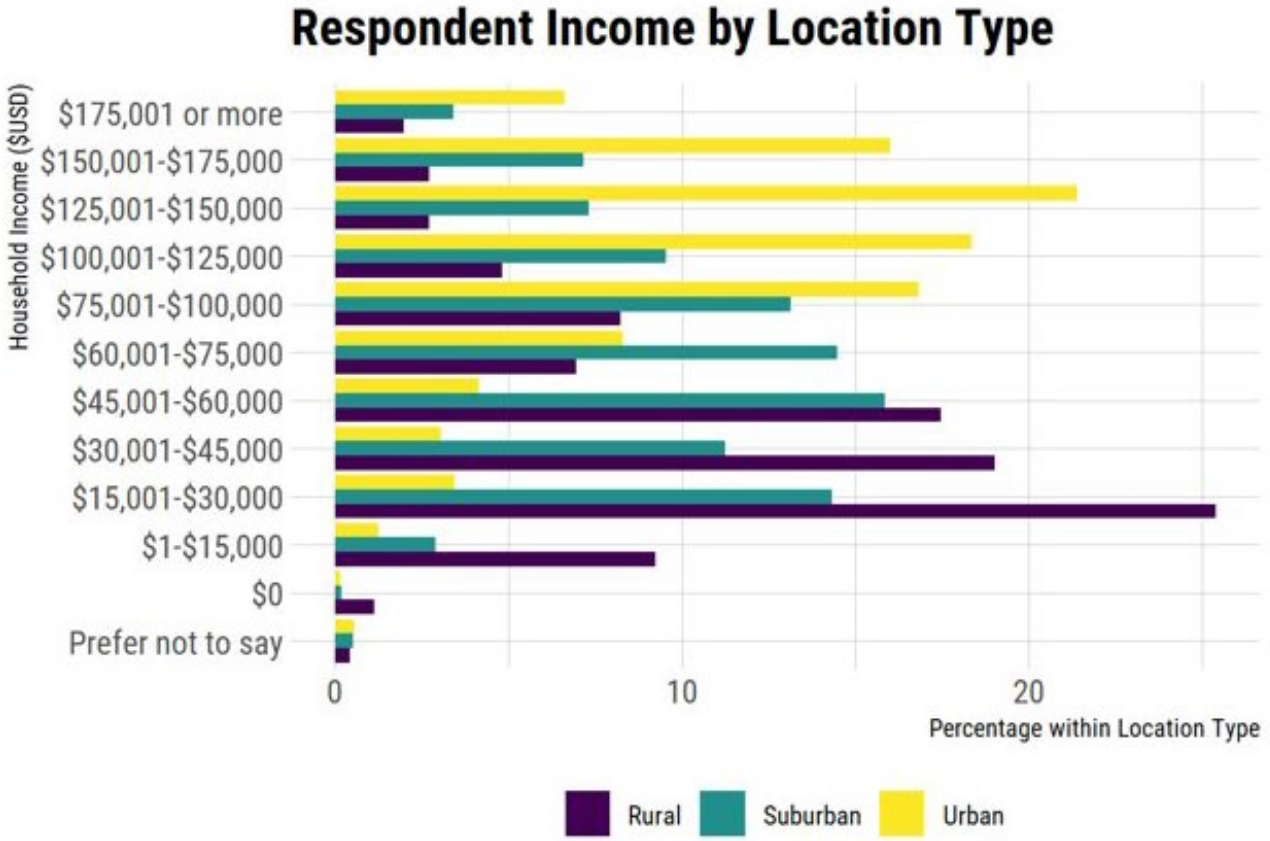


Self-Classification from MH Survey Data

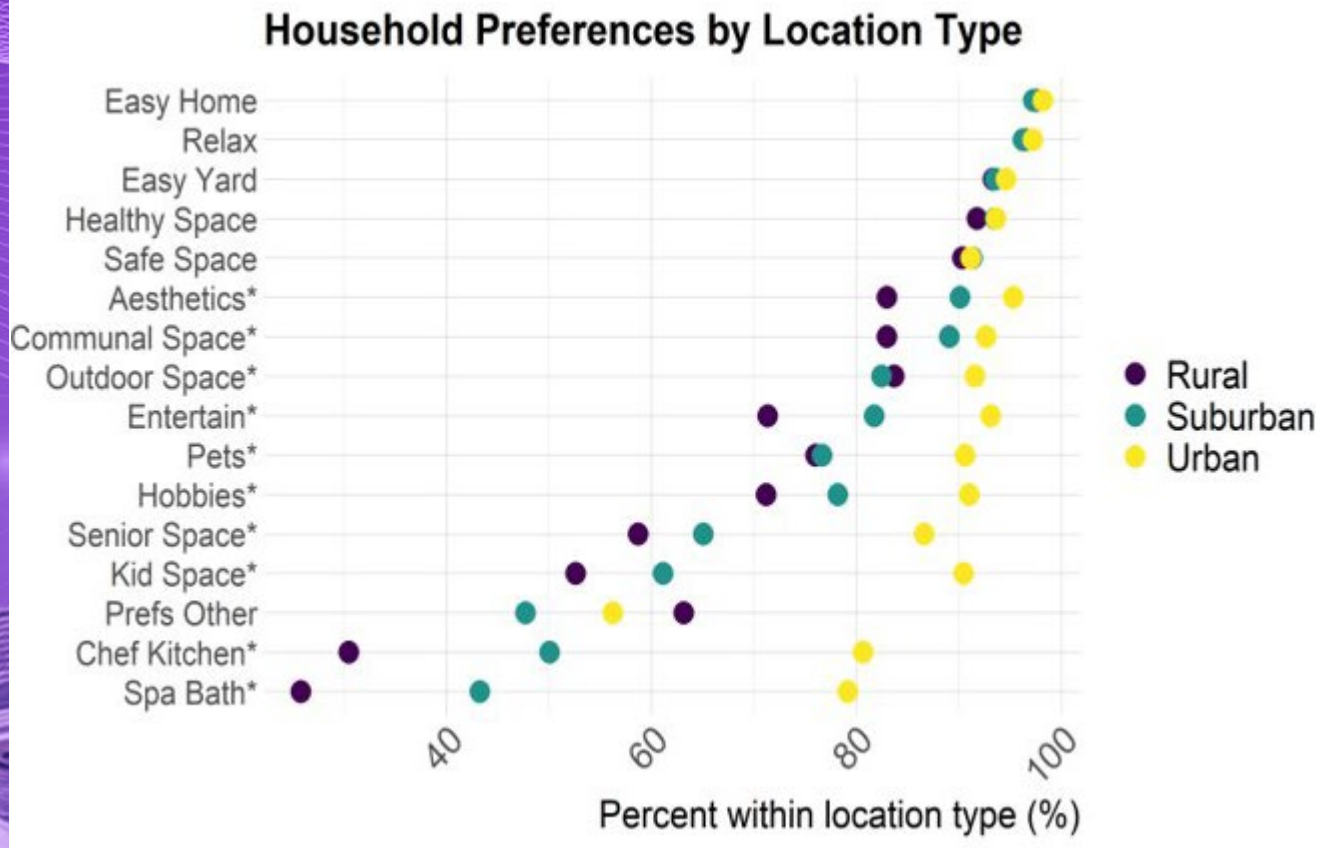


What household income patterns can be observed by location type?

- **Urban** MH respondent household incomes are generally **higher**
- **Rural** MH respondent incomes are generally **lower**
- **Suburban** MH respondent incomes generally **in the middle** of the two



Do respondents have different household preferences based on location type?



Percent shows those who responded that the preference was 'important' or 'somewhat important'

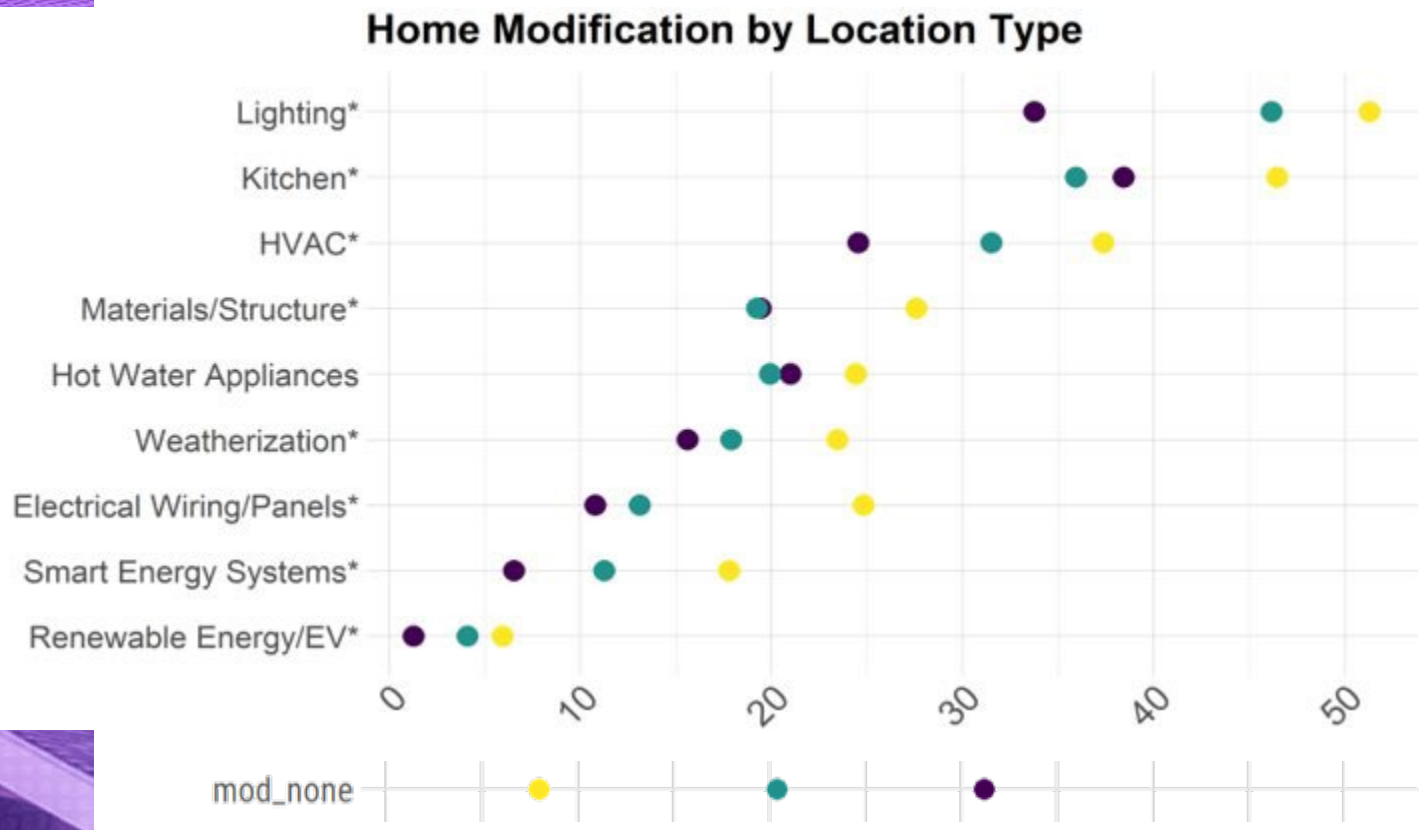
*indicates statistical significance (p <= 0.05)

The **rural** MH respondents have fewer consistent preferences overall, value safety, relaxation, and community

The **urban** MH respondents value many of the preferences simultaneously, including spaces for kids, seniors, and specialty spaces (e.g., chef's kitchen and home office)

The **suburban** MH respondents generally land between the two others

Do respondents make different home modifications by location type?

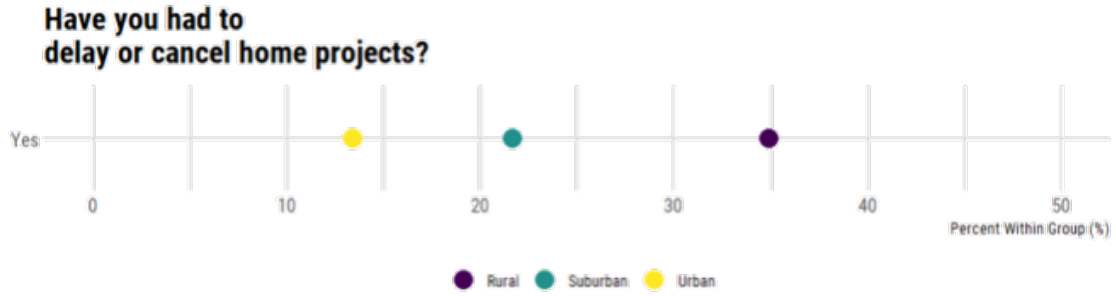


Rural MH respondents have fewer modifications overall, with around one-third of participants reporting no modification

Urban MH respondents lead modifications in every category

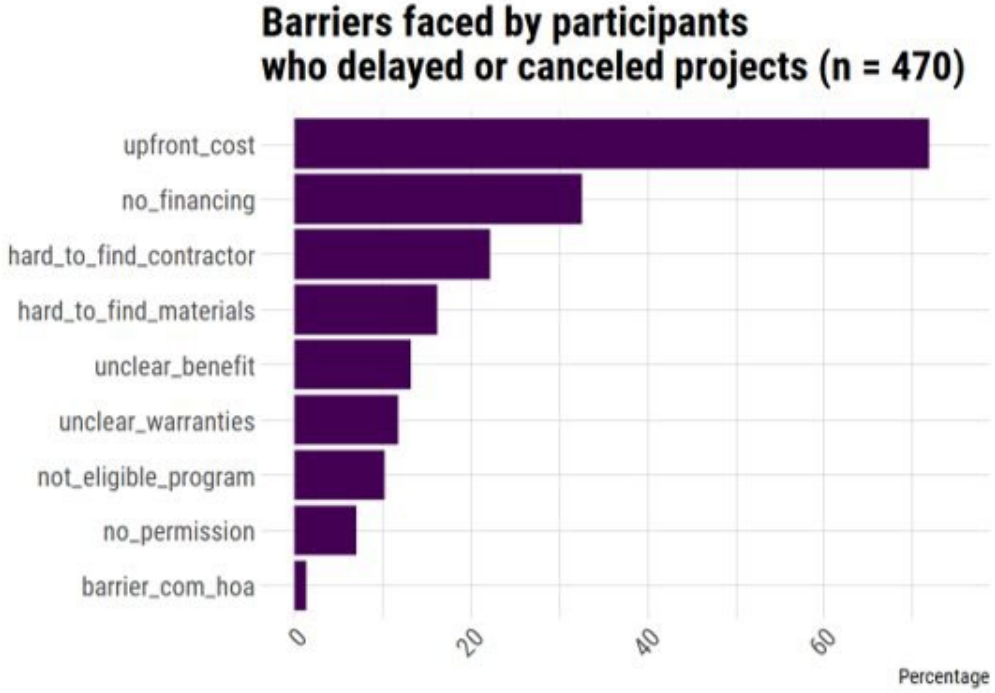
Suburban MH respondents vary

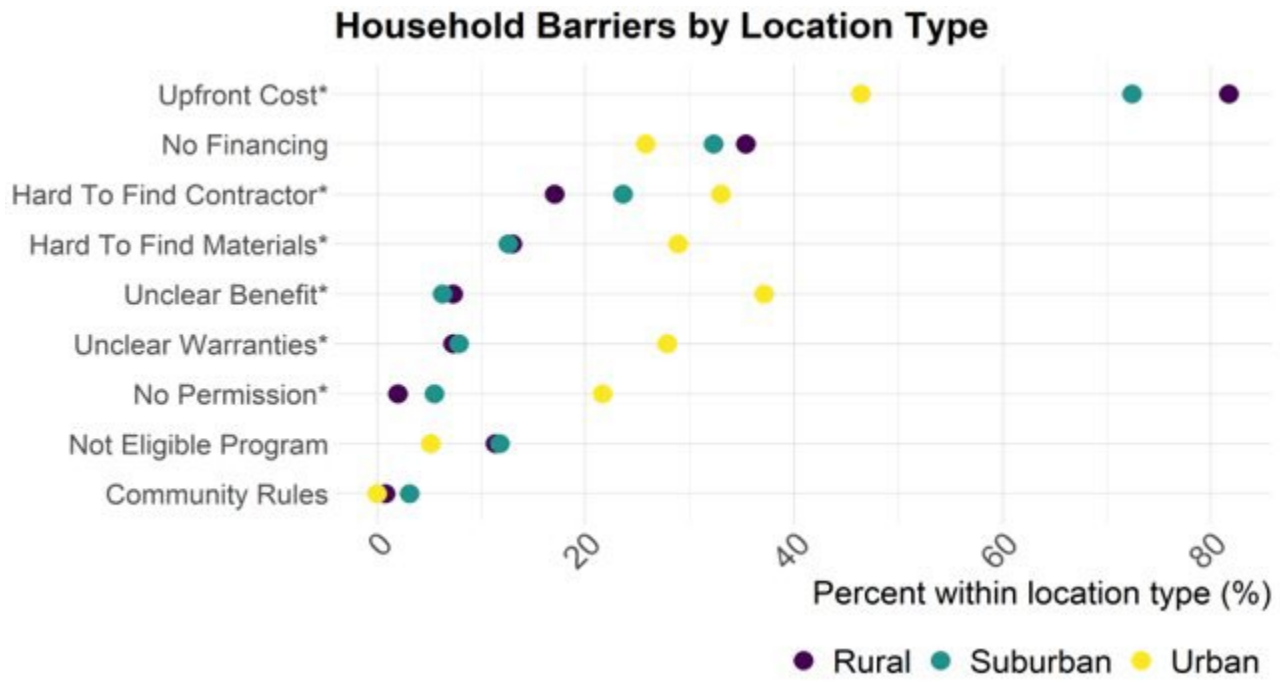
Do respondents face different barriers by location type?



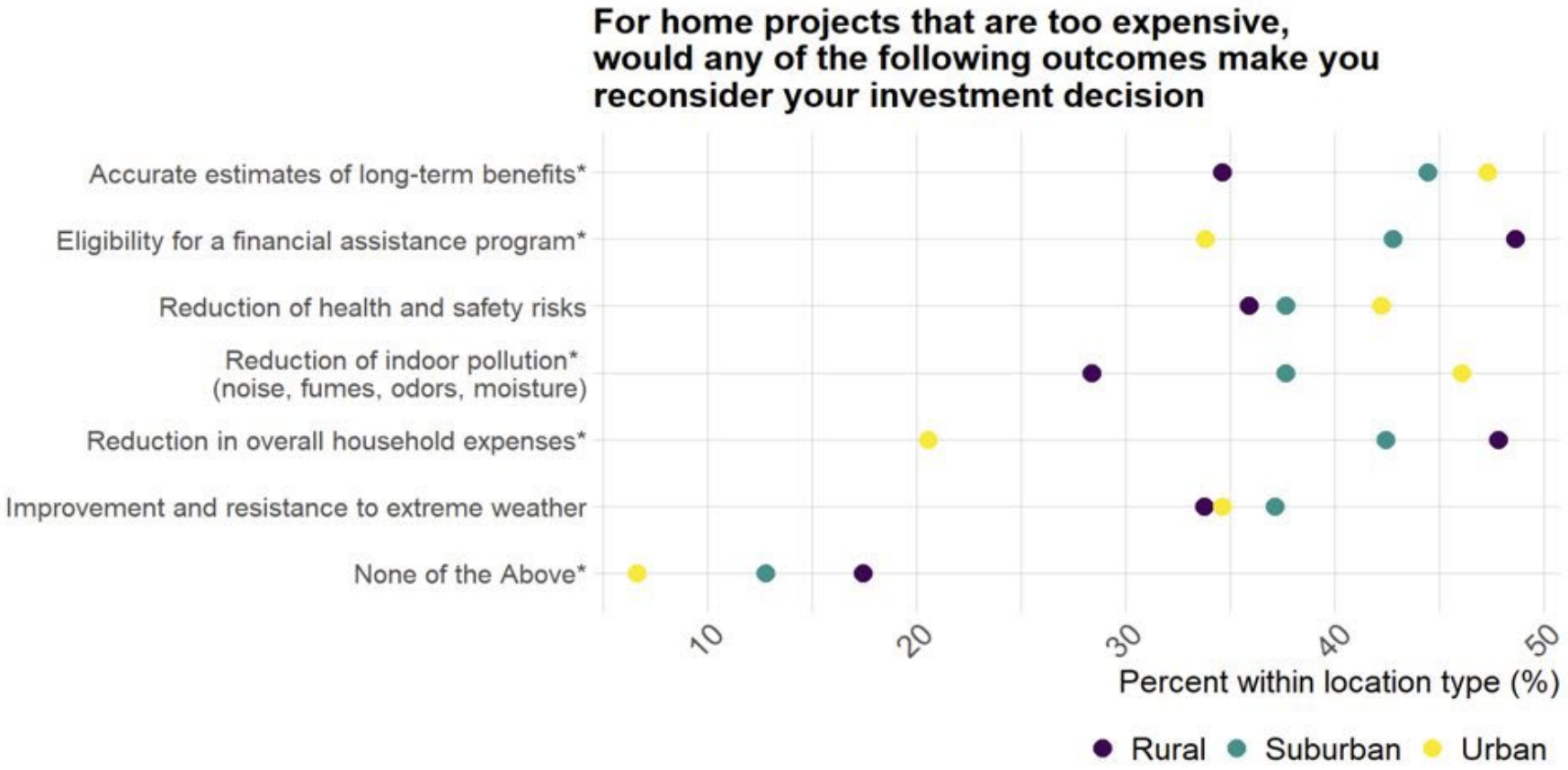
Rural MH respondents more likely to delay or cancel projects

Upfront cost is less of a differentiator barrier for **urban** MH respondents





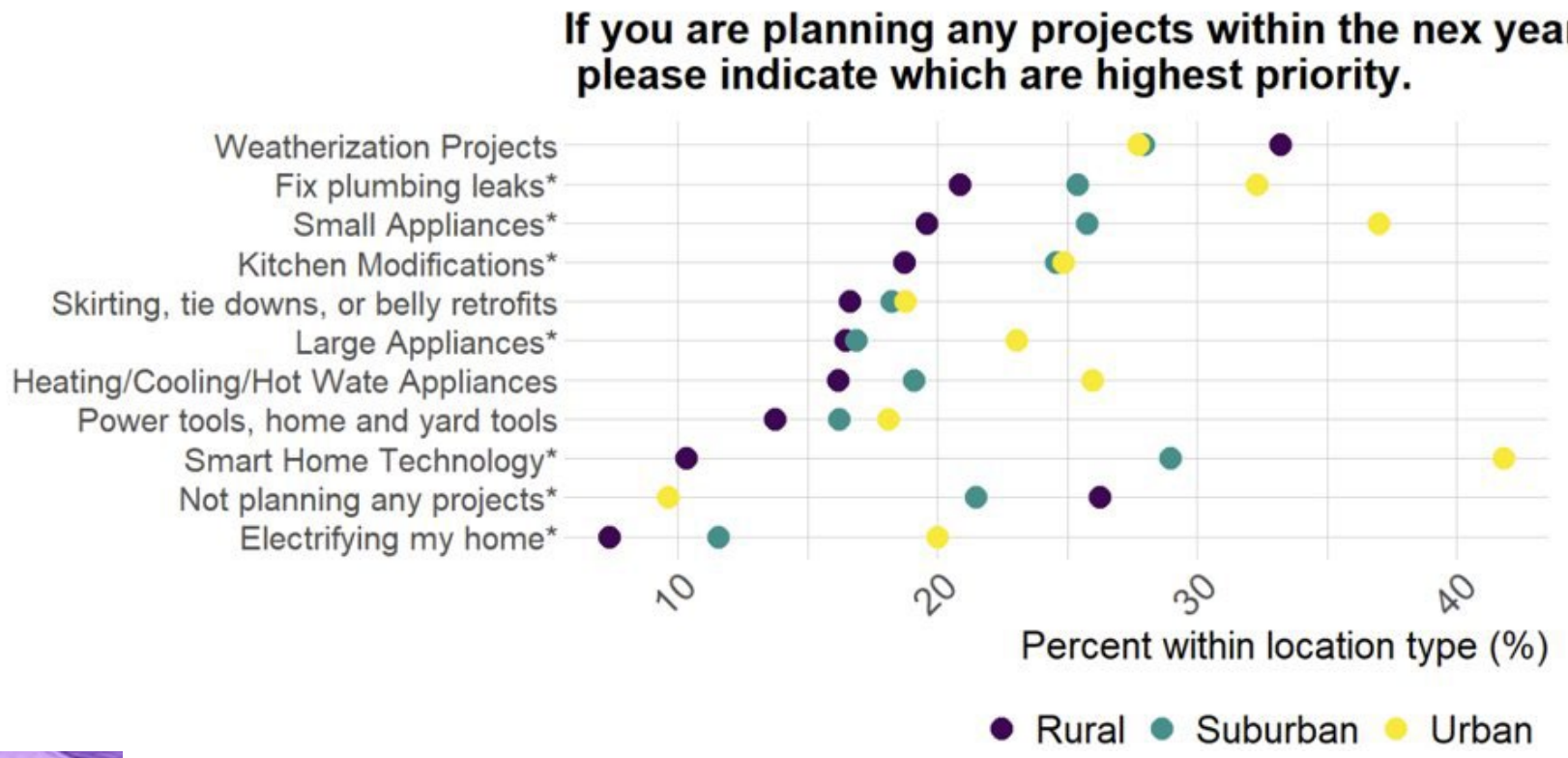
Decision-changing factors by location type



Rural MH respondents more likely to change decision if they were eligible for a financial assistance program and if they would see a reduction in overall household expenses

Urban MH respondents would change their decision with accurate estimates of benefits and to reduce indoor pollution

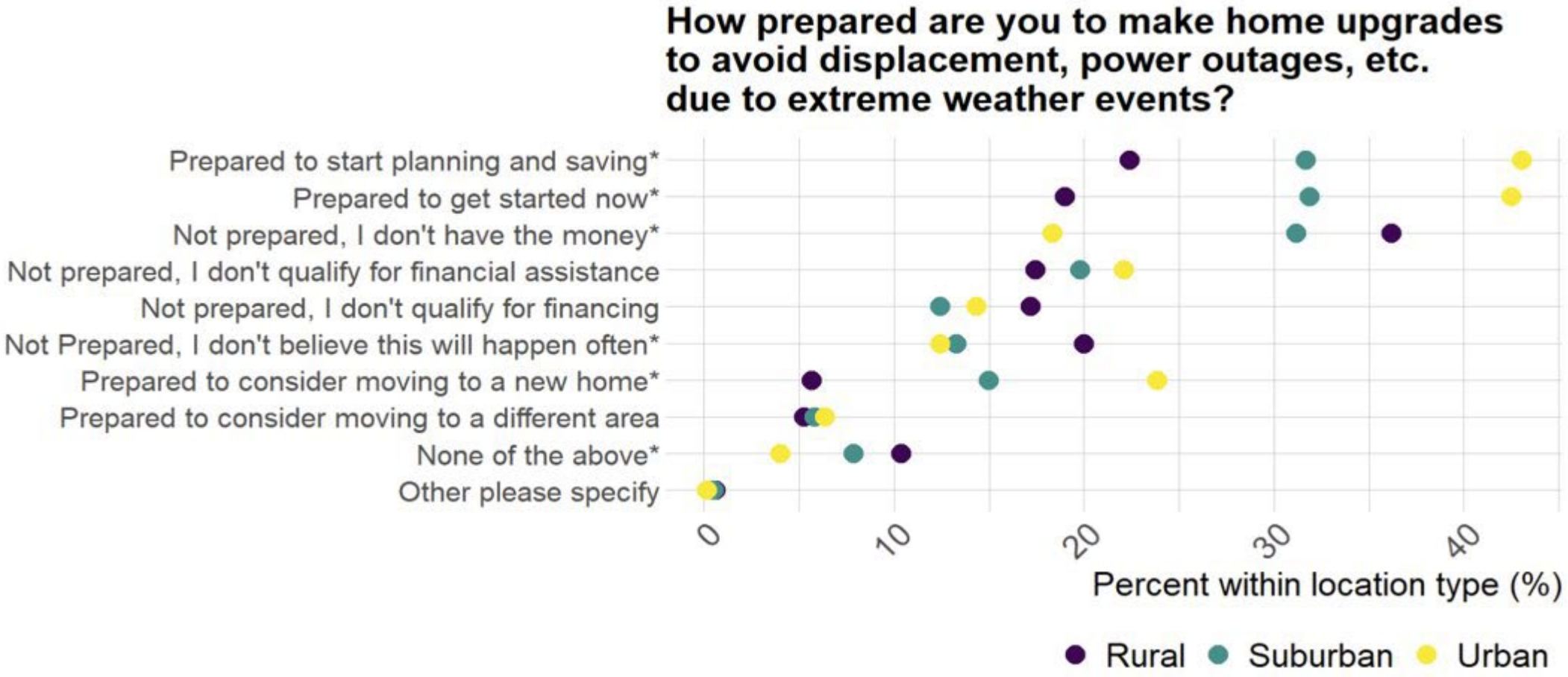
Project priorities



Rural MH respondents most interested in **weatherization** projects

Smart home technology is highest priority for **urban** MH respondents, followed by **small appliance** upgrades

Resiliency is important to many households



Rural MH respondents **less prepared** to make home upgrades to avoid impacts of extreme weather due to financial constraints

Urban MH respondents **more prepared** to plan and act on home upgrades to avoid impacts of extreme weather

Are respondents able to pay utility bills?

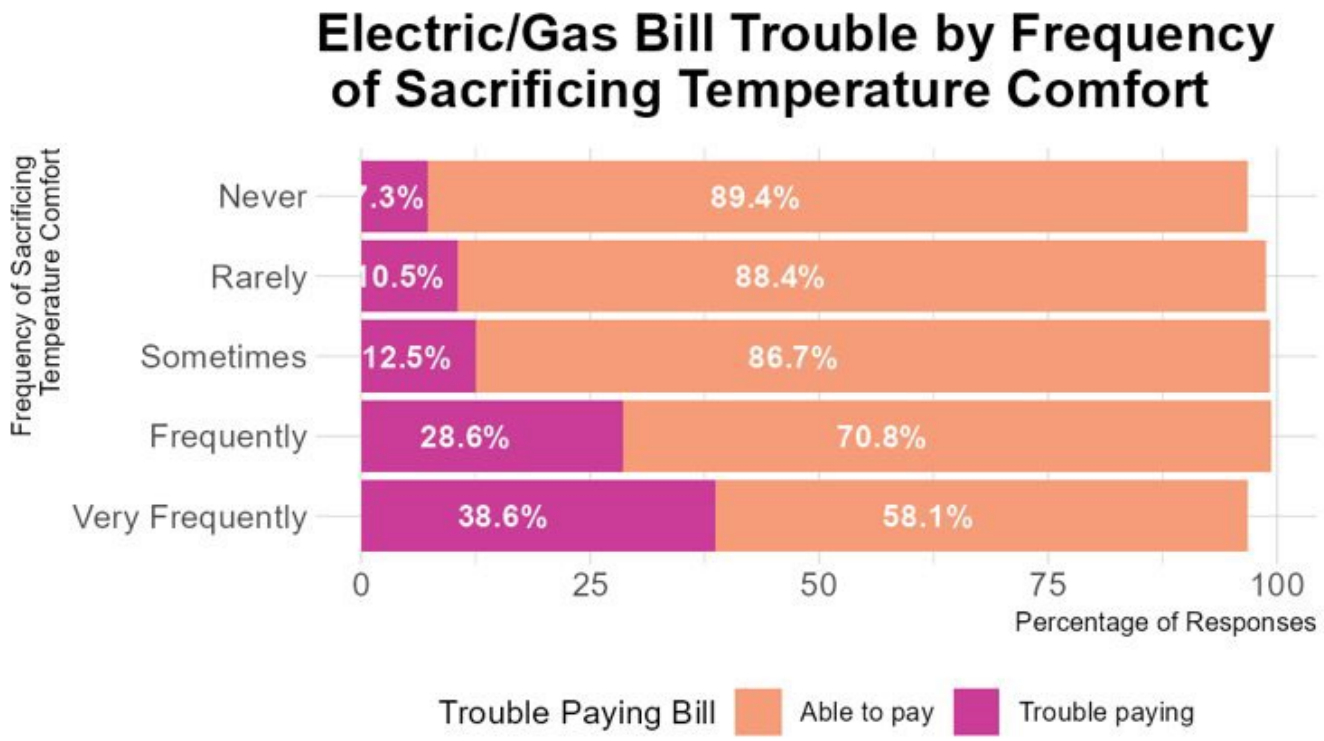
Able to Pay

n = 1,589 (80%)

Trouble Paying

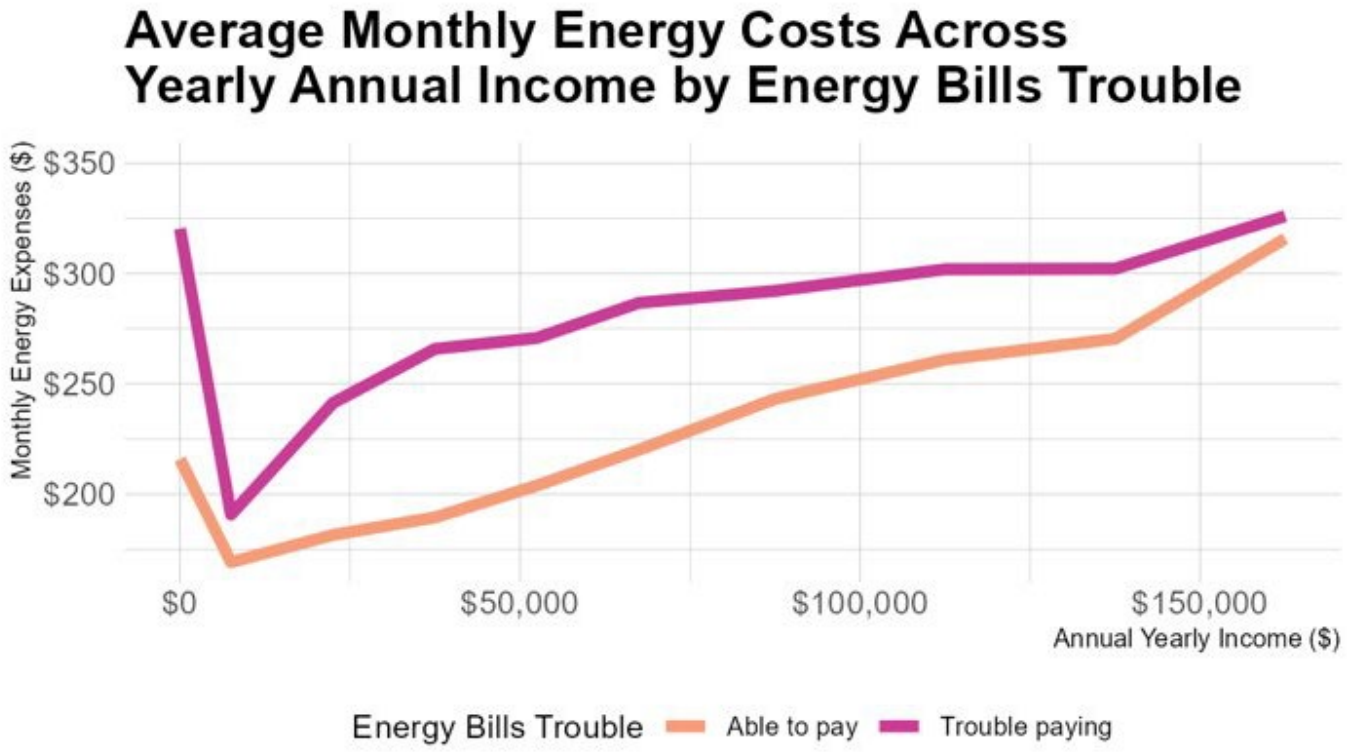
n = 400 (20%)

Are Manufactured Home residents sacrificing comfort to pay energy bills?



MH residents who more **frequently sacrifice comfort** to pay energy bills also more frequently have **trouble paying energy bills**

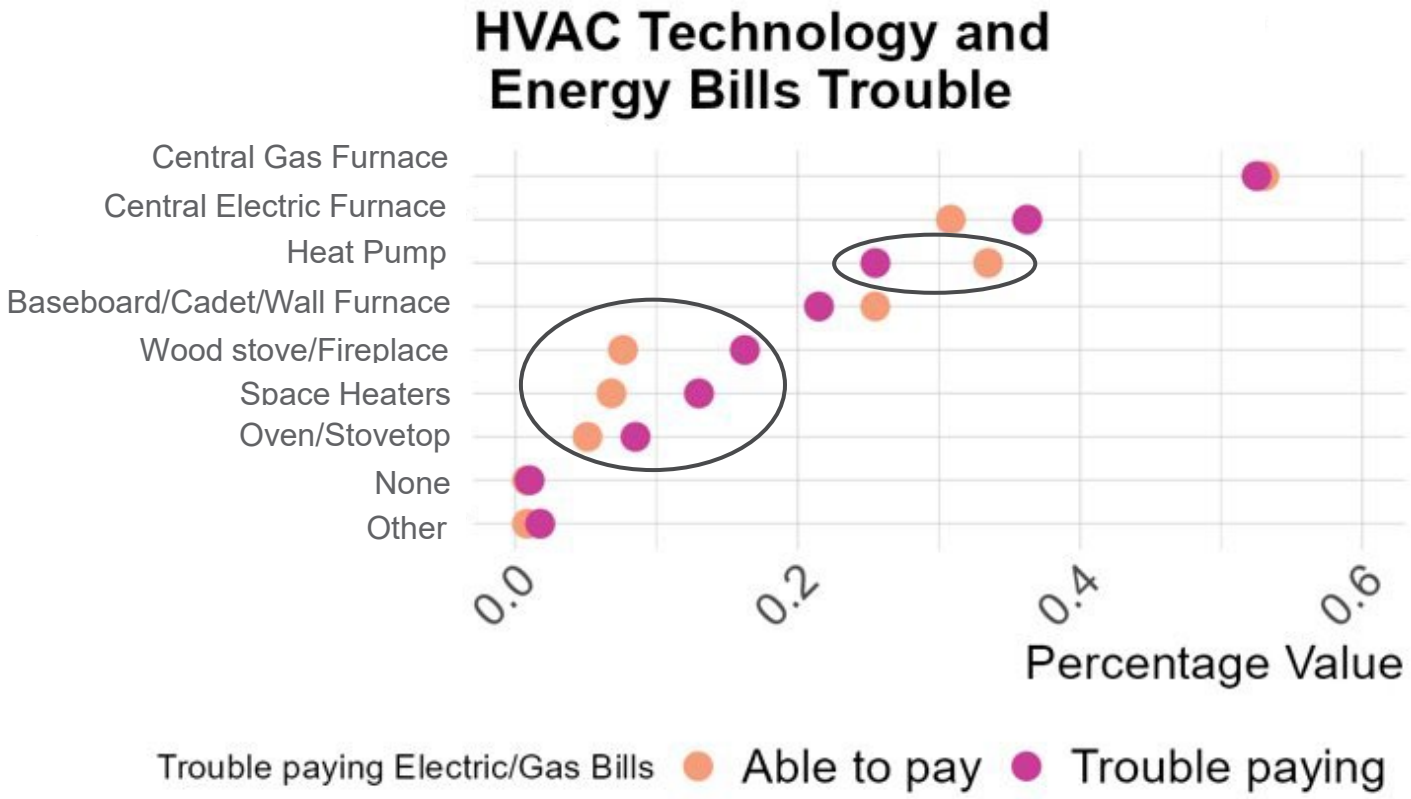
Do residents that have trouble paying energy bills have higher energy costs?



MH residents who self identify as having **trouble paying energy bills** have on average **higher monthly energy expenses** across every level of yearly household income.

We find that the median cost per month in our sample ($201-250) was approximately **2x higher than the U.S. median** ($108; American Housing Survey, 2024).

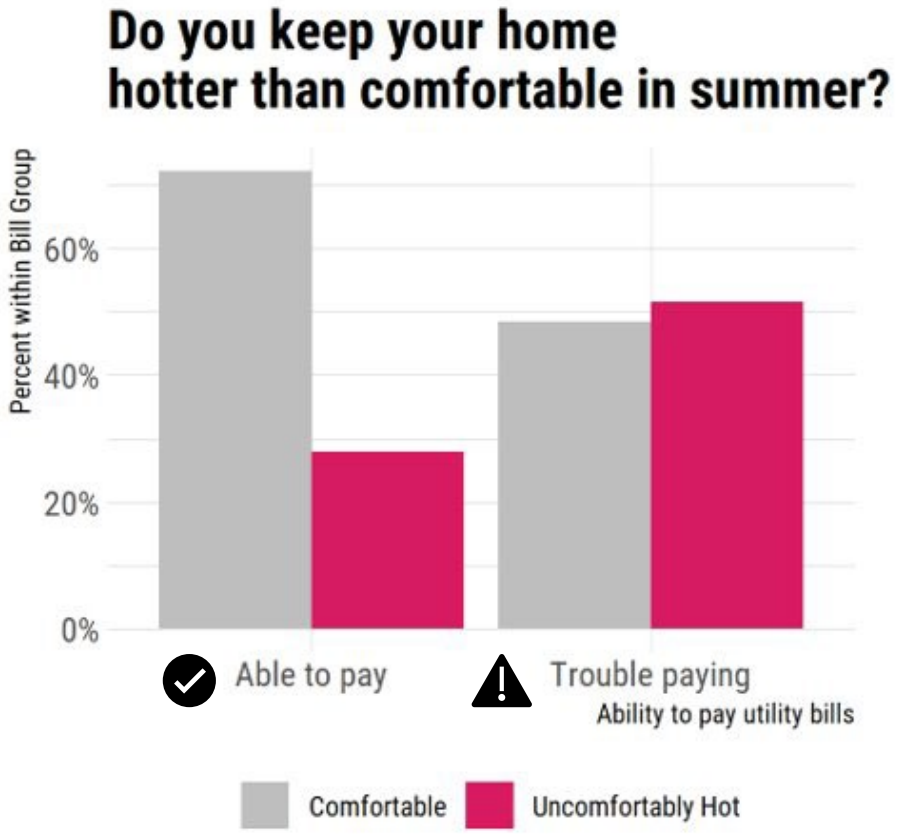
Do residents with difficulty paying energy bills have different HVAC types?

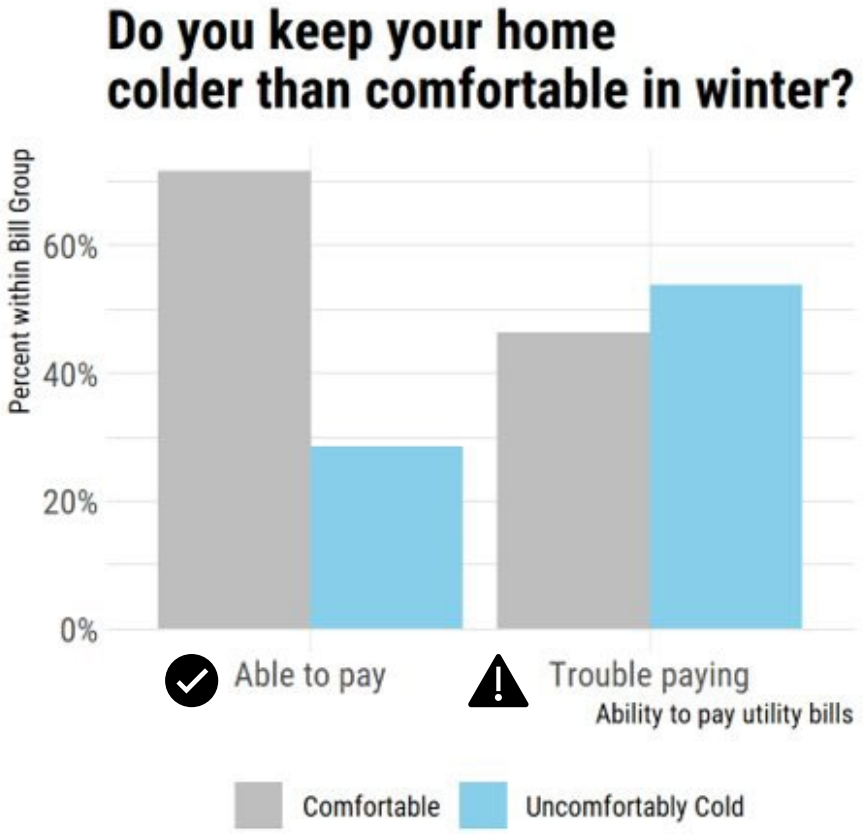


Within those who heat their MH by **wood**, respondents **are more likely to have trouble paying bills than to be able to pay**

Within those who heat their MH by **heat pump**, respondents are more likely to be **able to pay** their energy bills

Do those with bill troubles have to change their behavior to be less comfortable?





Those **with trouble paying bills** are more likely to report being subjectively **uncomfortably hot in the summer** and **uncomfortably cold in the winter** based on their own thermal comfort actions

Market Delivery Barriers

- Highly diverse resident segments complicate standard delivery
- Energy cost trouble is widespread and deep:
  - Median monthly energy costs in our sample was roughly 2x the US median
  - Residents who struggle to pay bills experience higher costs at all income levels
- Technology type matters for energy stability
- Upgrade actionability varies by geography
  - Rulal residents face more financial constrains and are less prepared for extreme weather
- Financial barriers remain a major limiter
  - Less program participation my MH households compared to single-family
  - Rural residents change decisions when offered financial assistance
- Limited reach without targeted approaches

Key Opportunities for Improved Market Delivery

- Segmented delivery pathways
  - Tailor upgrade packages and messaging to urban, suburban and rural decision patters
- Priority focus on high-energy cost households
  - These households show the highest savings potential
  - Pair weatherization, HVAC and bill-stability messaging for maximum impact
- Promote heating technologies that improve bill stability
  - Findings reinforce opportunities for heat pump adoption as a bill-stabilizing pathway
- Strengthen extreme-weather preparedness programs
  - Rural residents are least prepared but express high interest in weatherization – a strong match for incentives and outreach
- Use trusted local channels to improve reach
  - Trusted community networks dramatically improve access to hard-to-reach residents
- Tailored decision support tools
  - Providing benefit estimates, IAQ information and clear upgrade pathways

Study Team

- This work was possible with the dedication, creativity and persistence of the PNNL study team:
  - Chrissi Antonopoulos, PI
  - Kieren McCord
  - Tracy Fuentes
  - Sarah Gonzales-Coffin
  - Charlotte Roiger
  - Thomas Benson
  - Sharlissa Moore

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Thank you