



**NHPC**  
2024 | MINNEAPOLIS



 **Xcel Energy**

# DECARBONIZING MELTING POT: REGIONAL STUDY OF HOUSEHOLD AND CONTRACTOR PREFERENCES

Minneapolis, 10<sup>th</sup> April, 2024

# PRESENTERS



U.S. DEPARTMENT OF  
**ENERGY**



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LBNL



# LEARNING OBJECTIVES

At the conclusion of this session, participants will:

- Learn about one of the largest surveys executed in the US about home occupant motivations for making home upgrades and technology choice
- Describe how different value propositions regionally can impact a home occupants technology choice
- Define messaging and other outreach opportunities to reach home occupants based on what they say is important to them

# Three Principles For Building Decarbonization

## Principle #1

Homes have to be electrified

## Principle #2

We can't "efficiency" our way to zero emissions

## Principle #3

Solutions need to be scalable and affordable

# Equity and Decision Making

TOTAL US Homes = 123.5 millions\*

## Housing Units

- ▶ **68% Single Family**  
26% Multifamily  
6% Mobile homes

## Ownership

- ▶ **SF = 88% units owned**  
SF = 28% units rented
- MF = 5% units owned
- ▶ **MF = 69% units rented**

## Low-Income

- 9% Single Family
- 27% Multifamily

Who pays ?  
Who benefits ?  
Solutions for renters?

\*eia data from 2020/2021

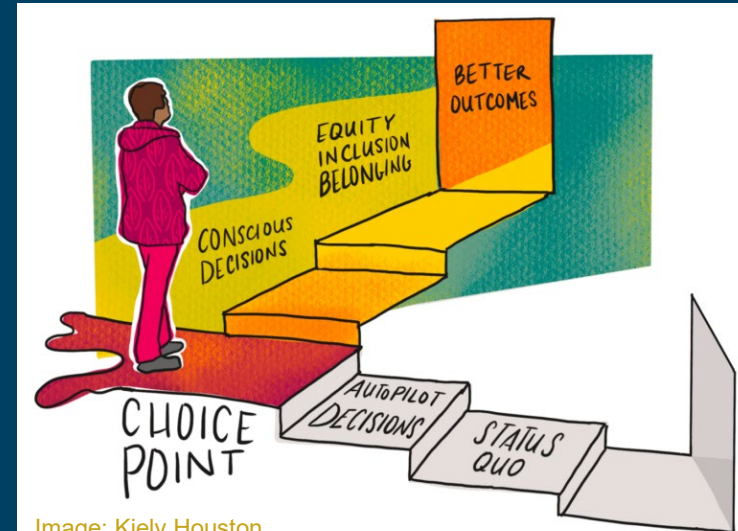


Image: Kiely Houston

HOW TO GET **AFFORDABLE** SOLUTIONS?



HOW TO **SCALE** ENERGY RETROFITS?

Problem ► to **SCALE** energy retrofits, needs:



**motivated** building industry and **motivated** households

**SURVEYS** to assess and understand:



What are **Building Industry** concerns? → What motivated them?

What are **Household** concerns? → What motivates them?

# The Decarbonization Melting Pot:

## Regional Study of Household Preferences & Insights

### ▶ Survey 1 - Households



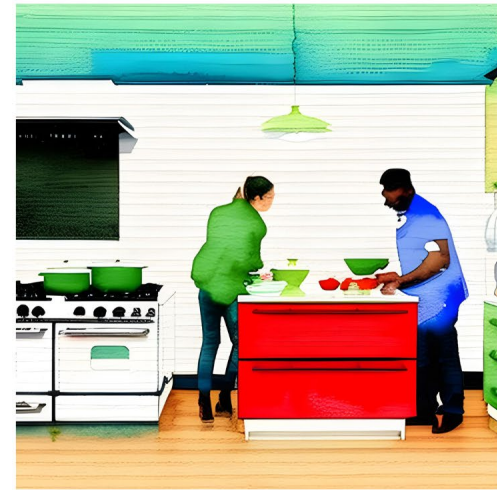
# THERE'S NO PLACE LIKE HOME

Human behavior is at the center of interactions between people and the homes they live in.... and the technology they interact with.

Residential building stakeholders grapple with complex sociotechnical dynamics when researching/diffusing technology in residential buildings.

Many factors make this dynamic more complex:

- Building stock characteristics
- Region and community density
- Income
- Race, cultural background, ethnicity
- Education, including technology background
- Age, life-stage
- Preference







U.S. Department of Energy (DOE) Building Technology Office (BTO) is funding research to investigate how residents make home energy decisions and to explore whether those decisions help meet decarbonization goals.

**Survey of 10,000 households**

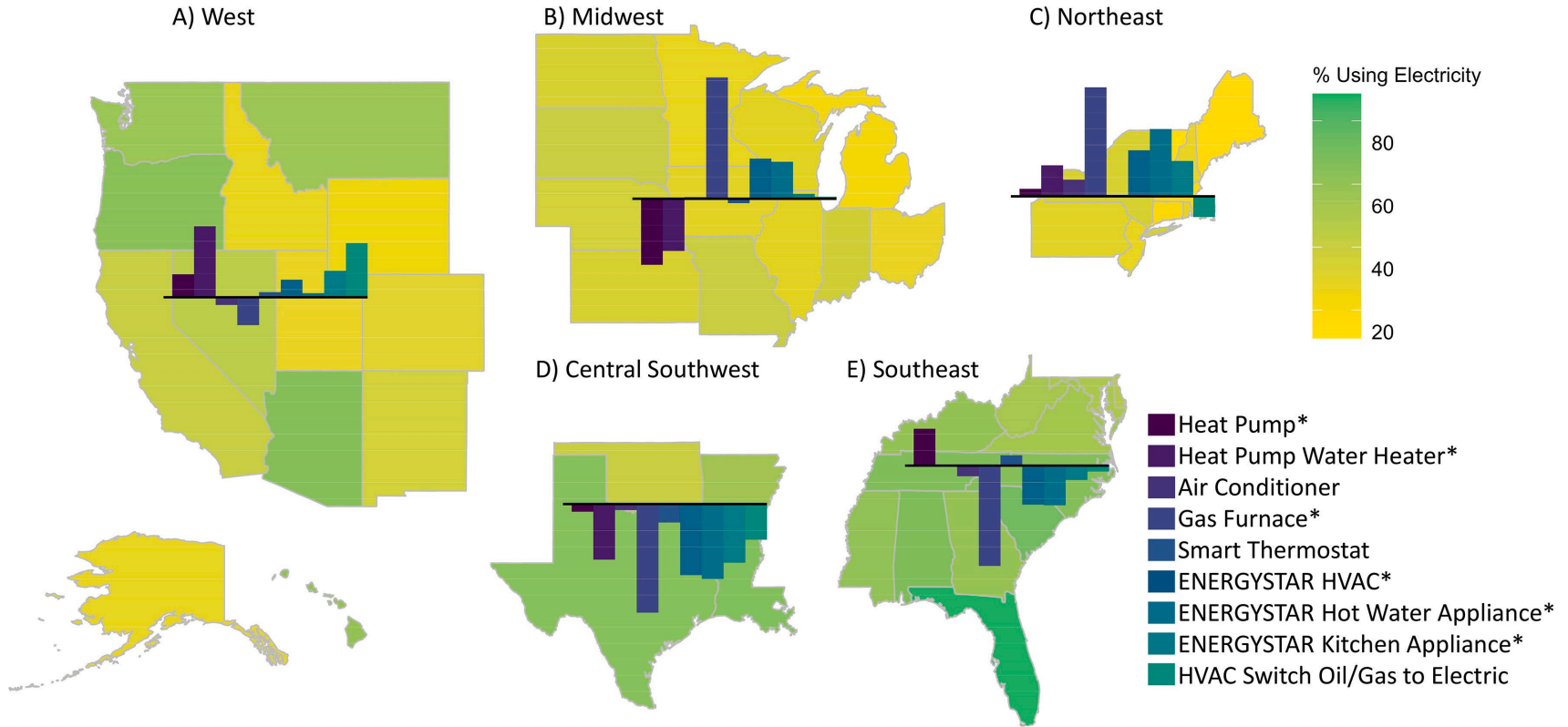
## Research Questions:

1. What are the motivations and key decision points for energy-related home renovations and upgrades?
2. How do different residential stakeholders decide to buy and use key technologies relevant for residential electrification?

**Interviews with 120 households**

# HOUSEHOLD UPGRADES

# WHAT DOES DECARB TECHNOLOGY ADOPTION LOOK LIKE THROUGHOUT THE US?

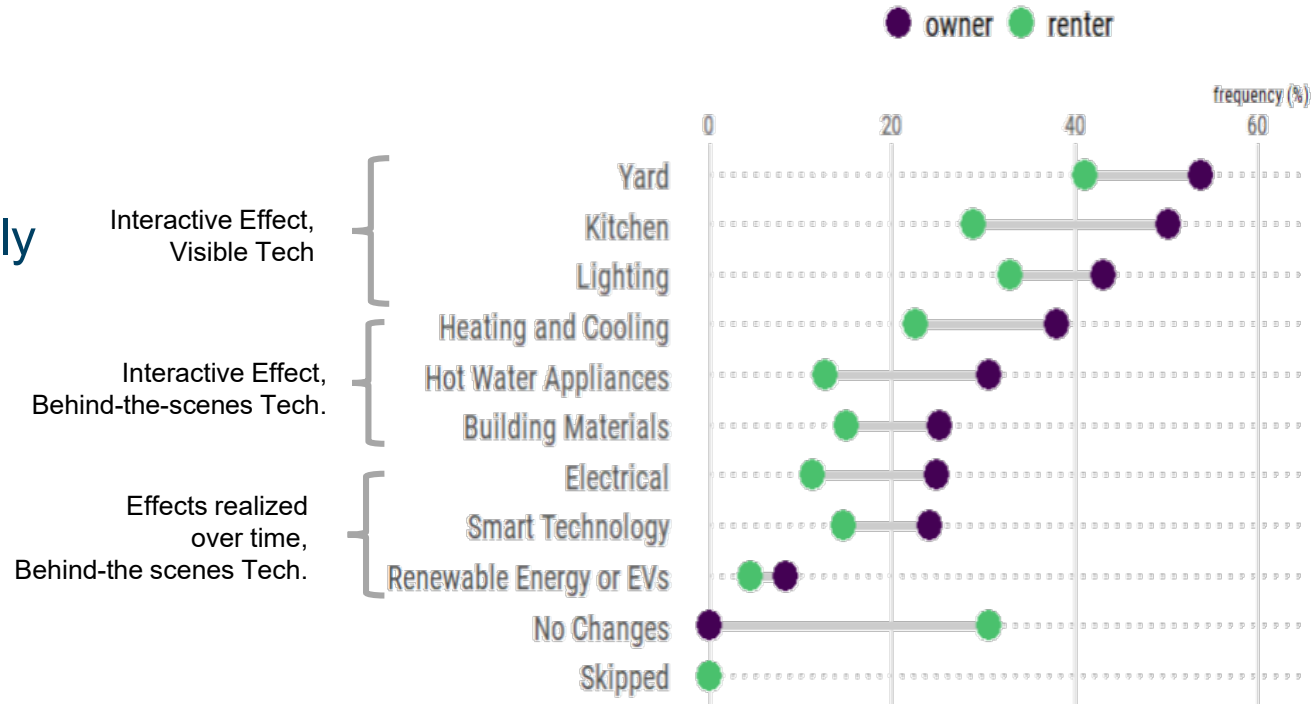


Bars represent tech adoption relative to the national mean. They are unitless. \* indicates significant difference between regions.

# COMMON MODIFICATIONS

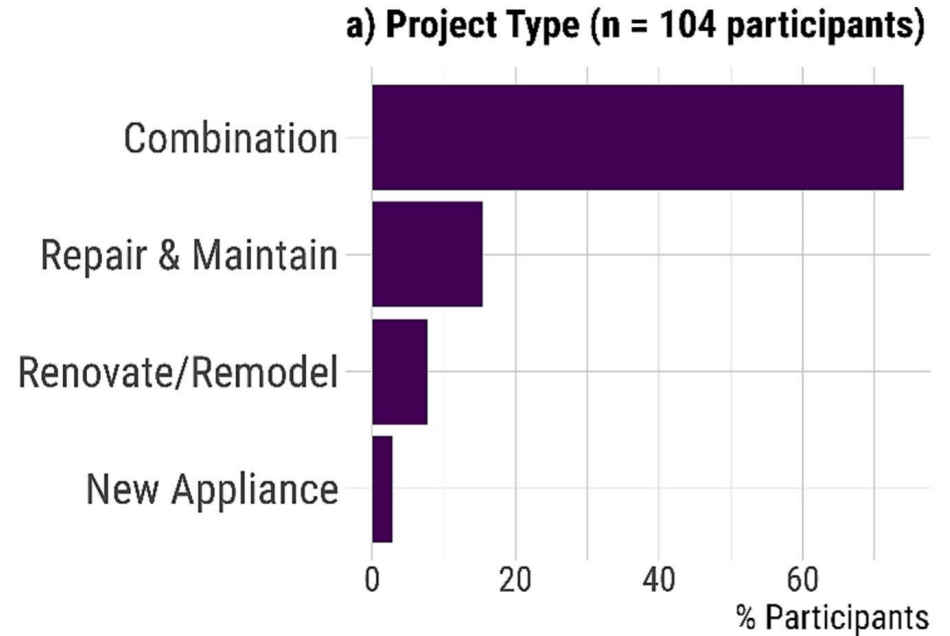
- More homeowners and renters changed **visible, interactive technologies** compared to "behind-the-scenes" technologies.
- Overall, homeowners more likely to make changes than renters.
- 50% of homeowners and 29% of renters have made changes in the **kitchen**.
- Fewer changes to **HVAC** for both groups (38% owners, 23% renters).

Frequency of Home Modifications by Homeowners (n = 7019) and Renters (n = 2900)



# OCCUPANTS MAKE CHANGES IN COMBINATION

- We found that nearly 70% of interview participants that were undergoing a house project were making multiple changes.
- Shows there is an opportunity for contractors to integrate decarbonization tech/measures during *other* types of projects.



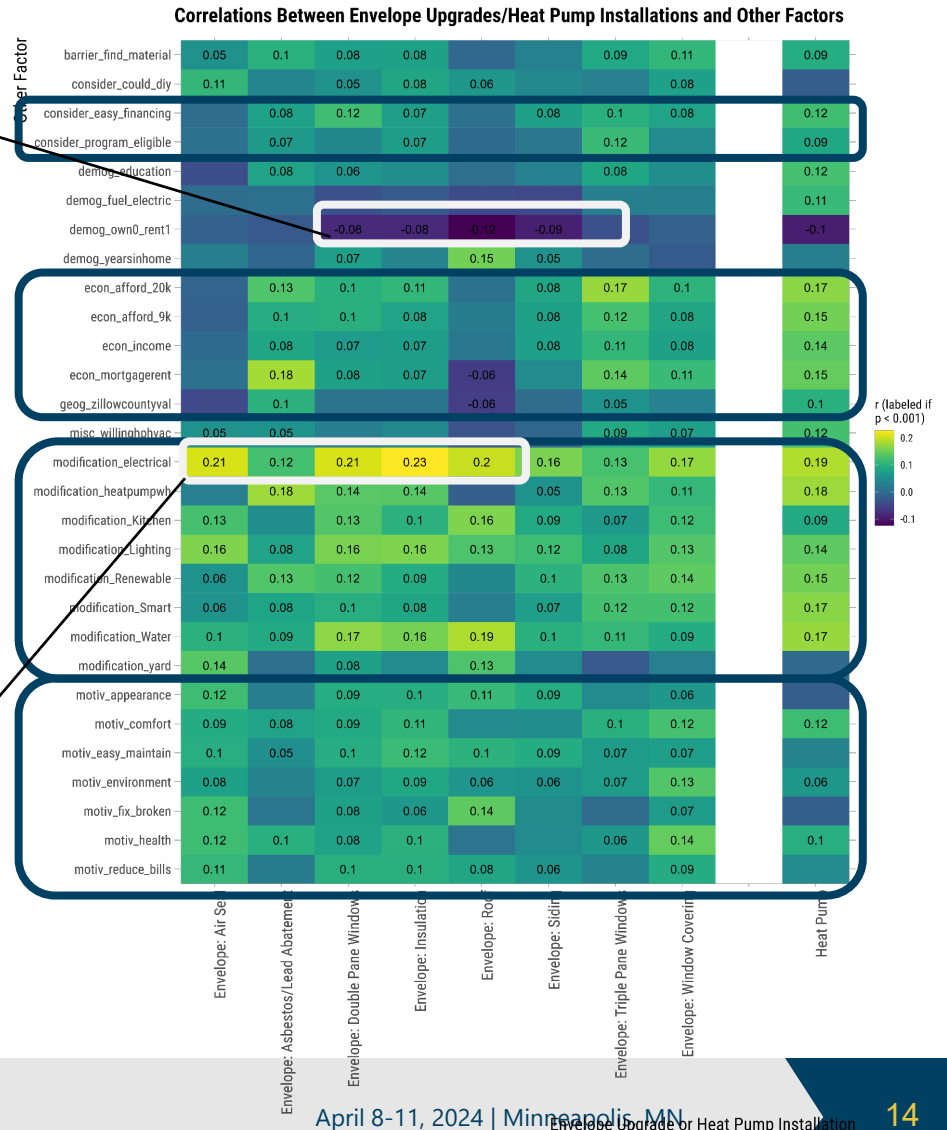
# ENVELOPES & HEAT PUMPS

*Renter + Envelope 0.08 – 0.12  
(2P windows, insulation, roof, siding)*

## What factors motivate households to upgrade envelopes, adopt heat pumps:

- Most correlations occur between tech and combo projects, especially electrical upgrades.
- Household economics, programs and ability to finance plays a role.
- Many non-energy factors also are important!

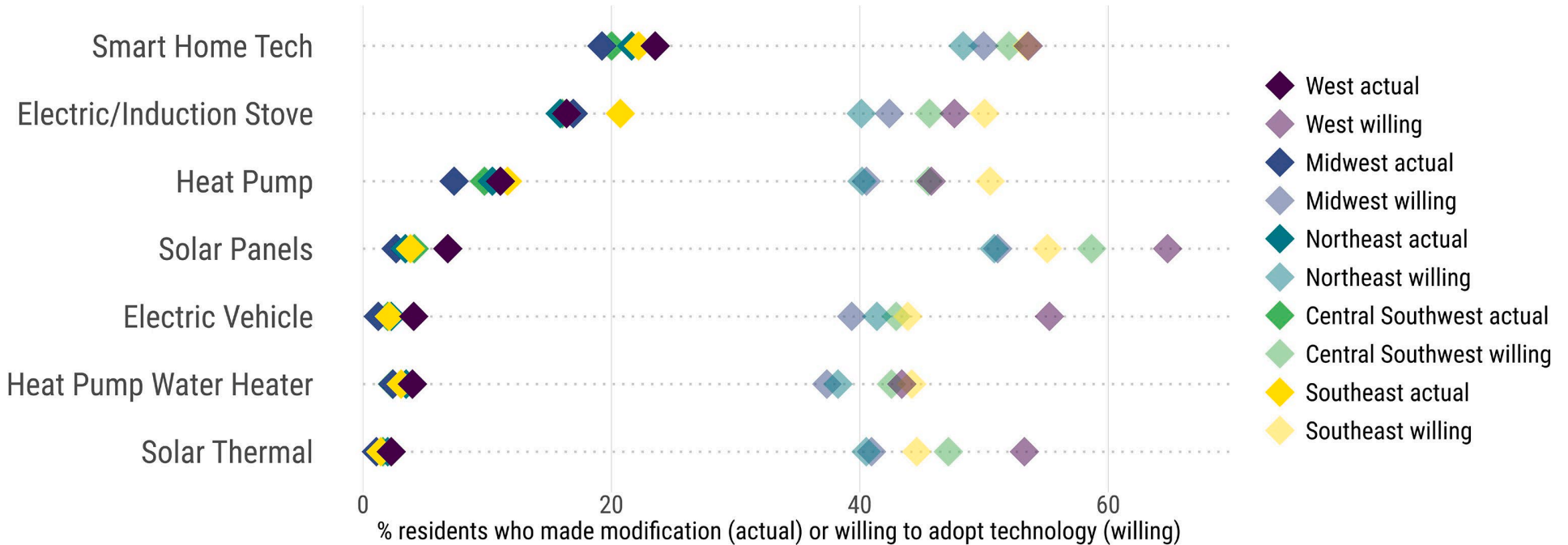
*Electric modification + Envelope 0.2-0.23  
(airsealing, abatement, 2P windows, insulation, roof)*





# BIG GAP BETWEEN WILLINGNESS AND ACTUAL ADOPTION

Technology adoption by region



**How do we close this gap?**

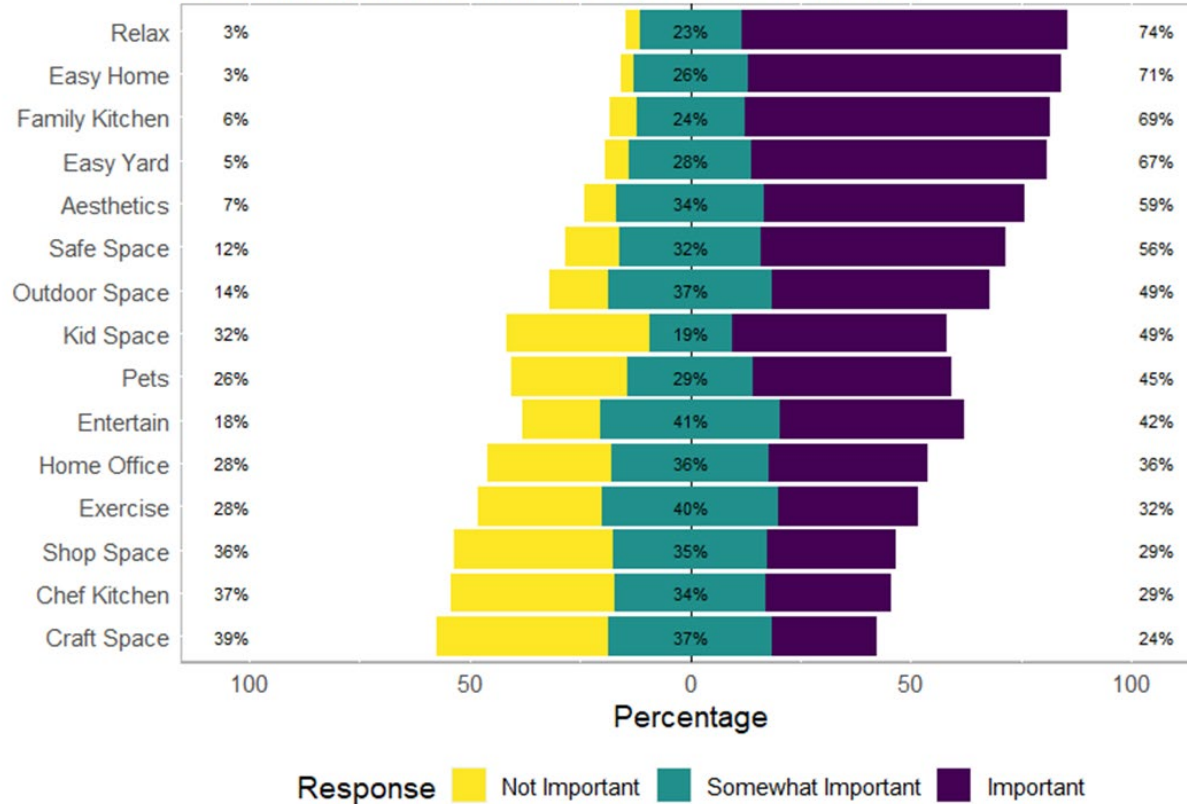
# INFLUENCING FACTORS FOR UPGRADES

# IDEAL HOUSEHOLD ENVIRONMENT

We asked what general preferences residents have for their home:

- **Most important:** A place to relax and a home/yard that is easy to care for (74%, 71%).
- **Important:** A family kitchen (69%).
- **Important:** Homeowners highly value the look of their home (60%).
- **Noted:** Safety and access to outdoor space were noted by about 50% of respondents.

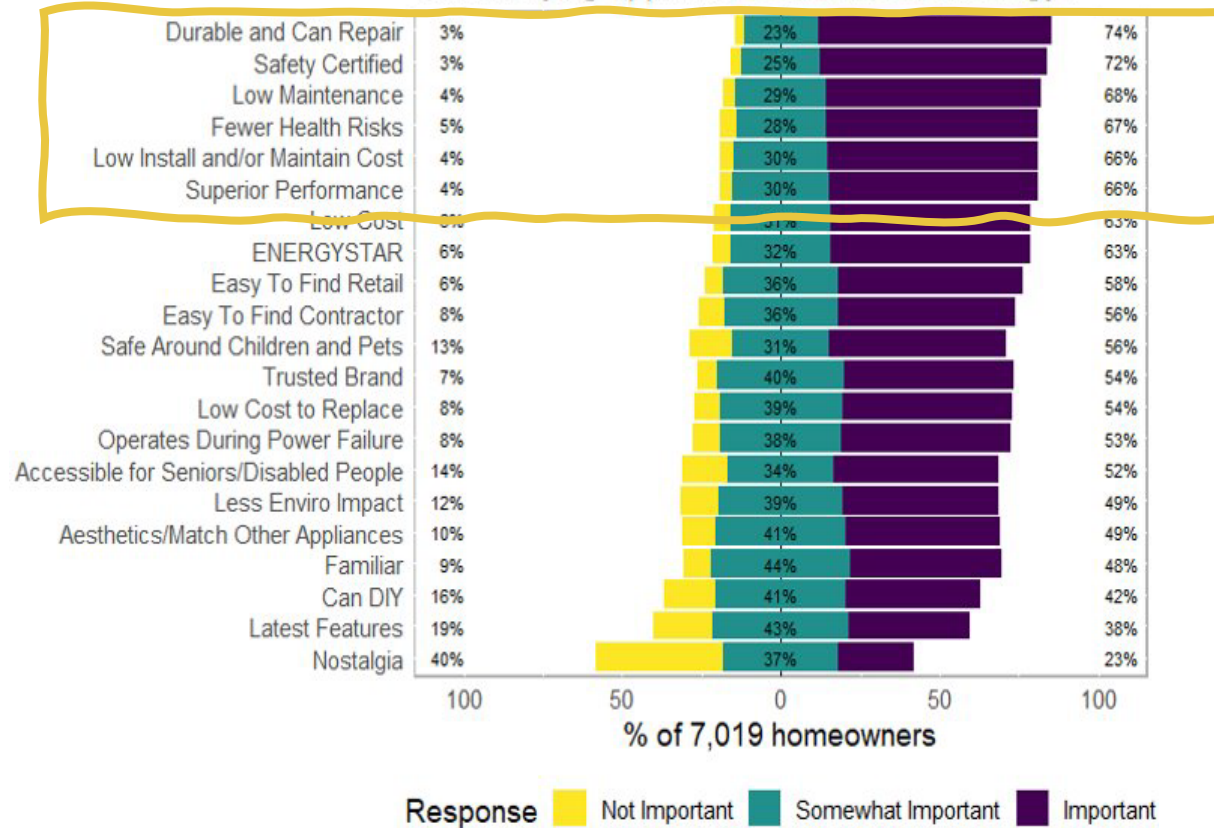
Resident Space Preferences (n=9,919 residents)



# NOT ALL DECISIONS ARE BASED ON COST

Households care more about the top benefits associated with decarbonization than about the cost!

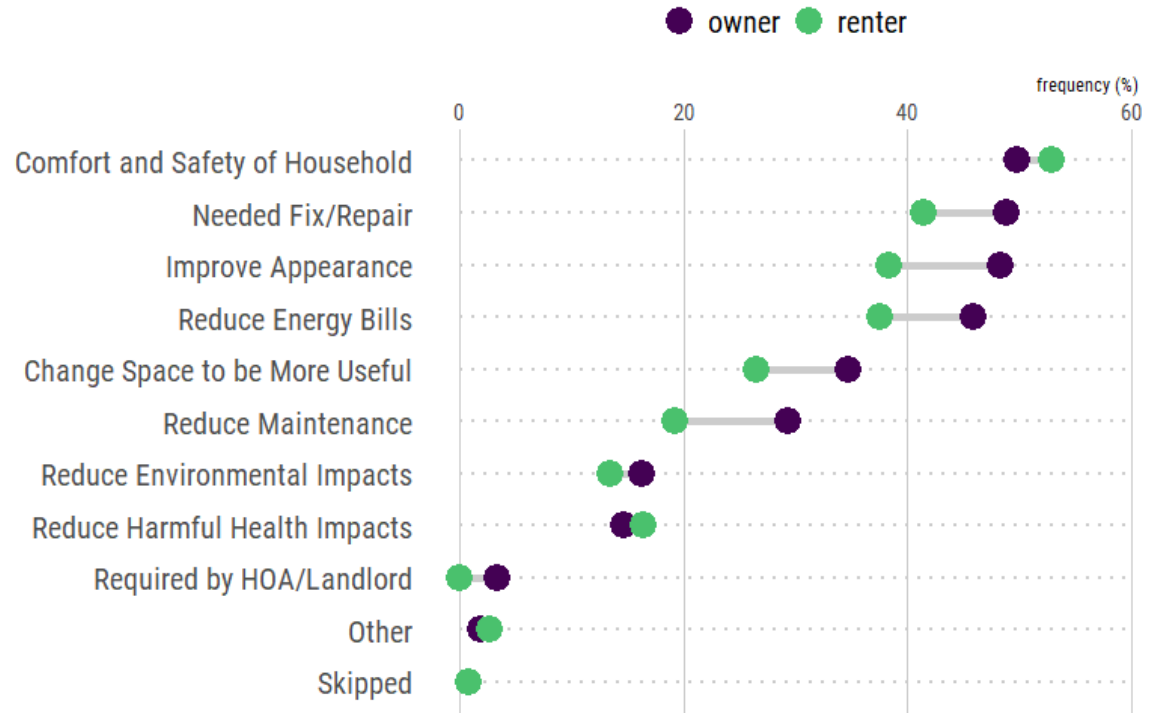
How important are the following factors when buying appliances or home technology?



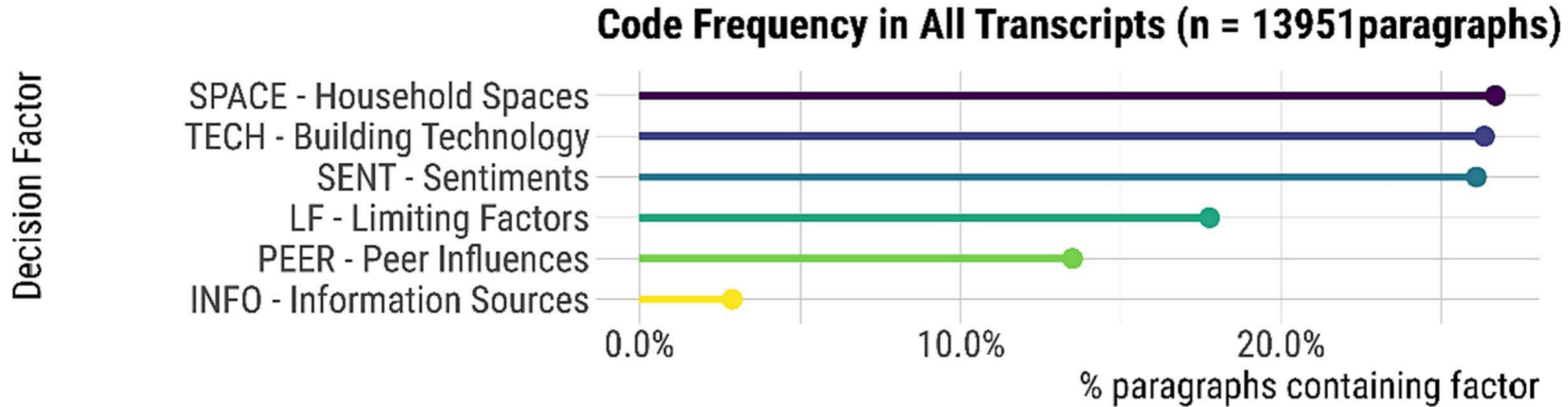
# HOUSEHOLDS PRIORITIZE MANY NON-ENERGY FACTORS

- **Comfort/safety for pets/children** is the most important decision-making factor for home modifications.
- **Repairing/replacing something broken** is second for both homeowners and renters.
- **Improving appearance and reducing energy bills** are also important.

**Factors Influencing Home Modifications by Homeowners (n = 7019) and Renters (n = 2900)**



# HOUSEHOLDS WANT COMFORT NOT COST SAVINGS!



Households' primary decision factors for making upgrades include:

- Create better household spaces
- Integrate new building technologies
- As reactions to personal sentiments, judgements and/or perceptions



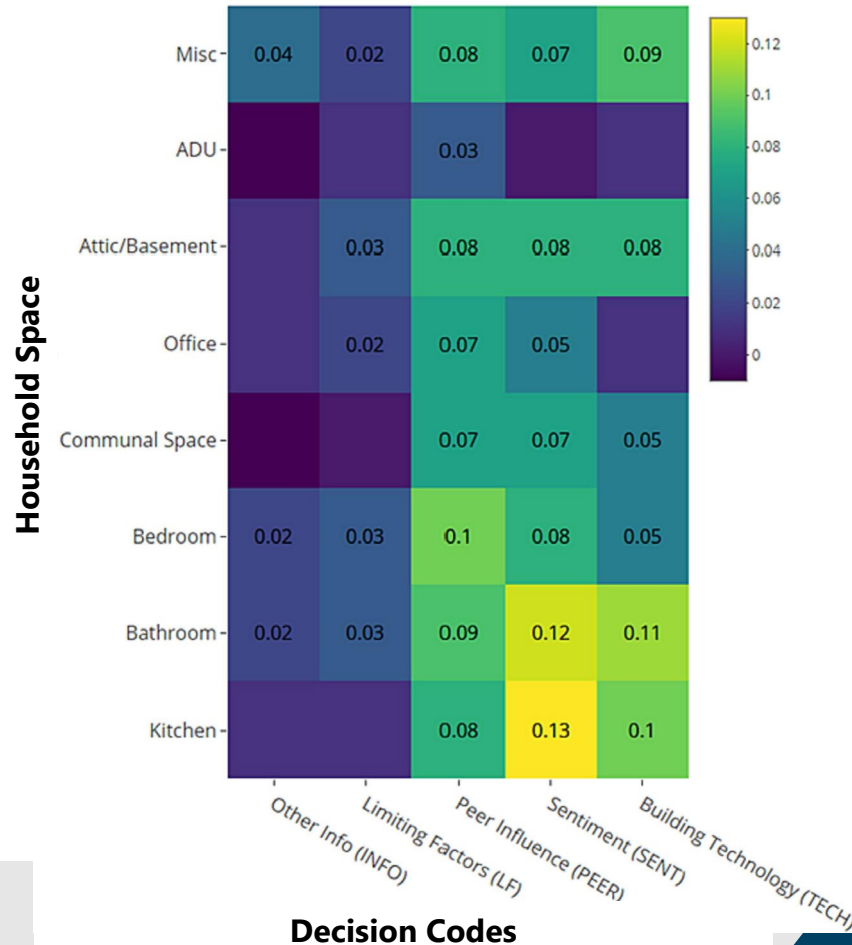
# DECISION FACTORS AND HOUSEHOLD SPACES

Influential factors when considering specific spaces in the home:

- personal sentiment
- technology choice
- peer influence

## Space Correlation with Decision Codes by Paragraph

(n = 104 participants, n.paragraphs = 13951)



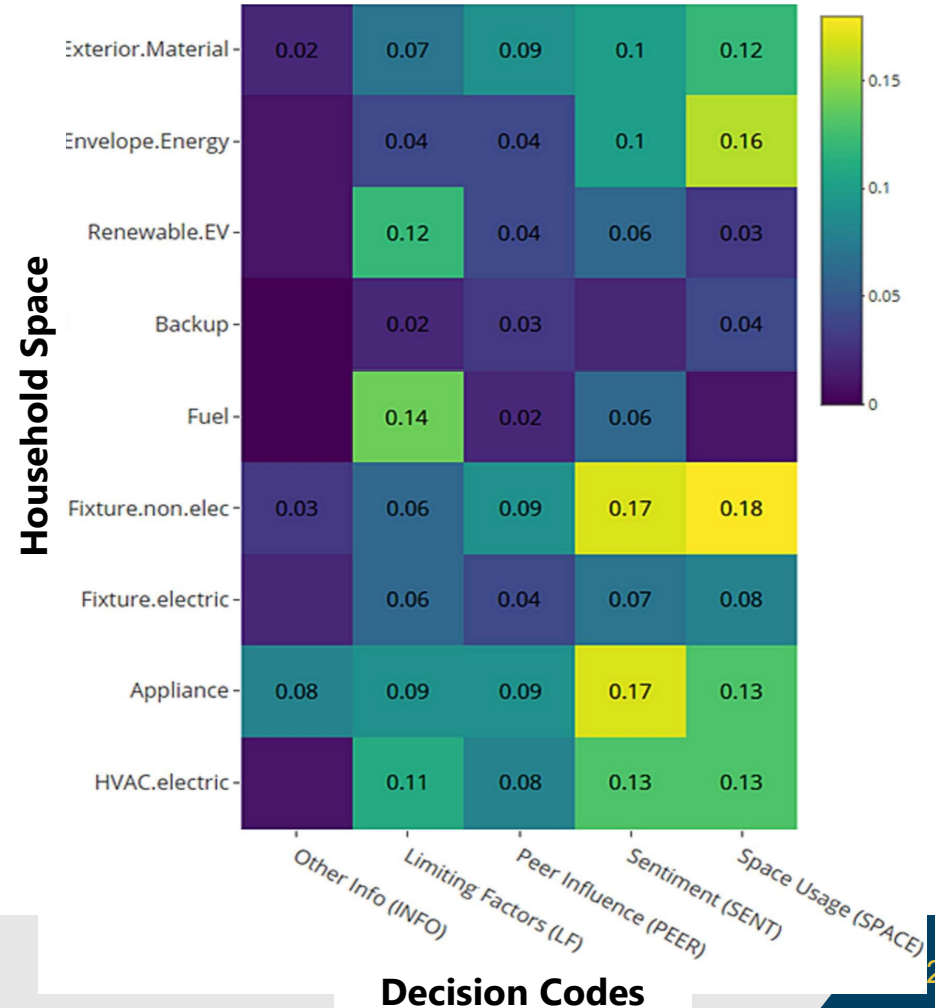
# DECISION FACTORS AND HOUSEHOLD TECHNOLOGY

Influential factors when choosing specific technologies:

- How space is used
- Personal sentiment
- Limiting factors/barriers (often economic and contractor related)
- Peer influence

## Technology Correlation with Decision Codes by Paragraph

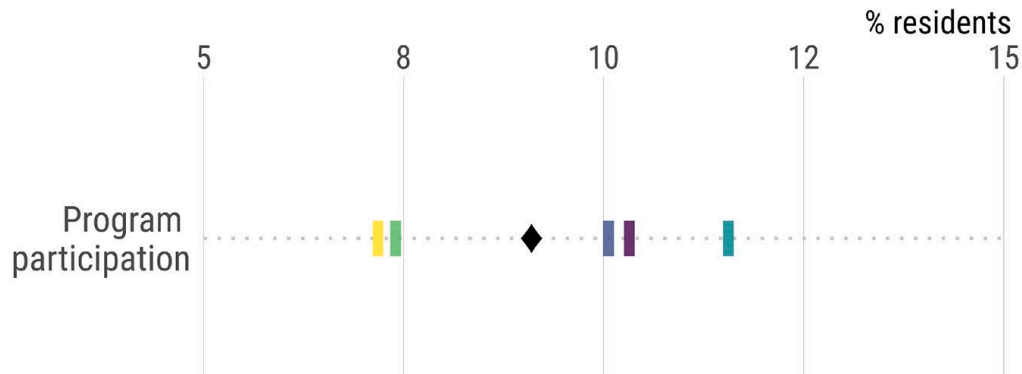
(n = 104 participants, n.paragraphs = 13951)



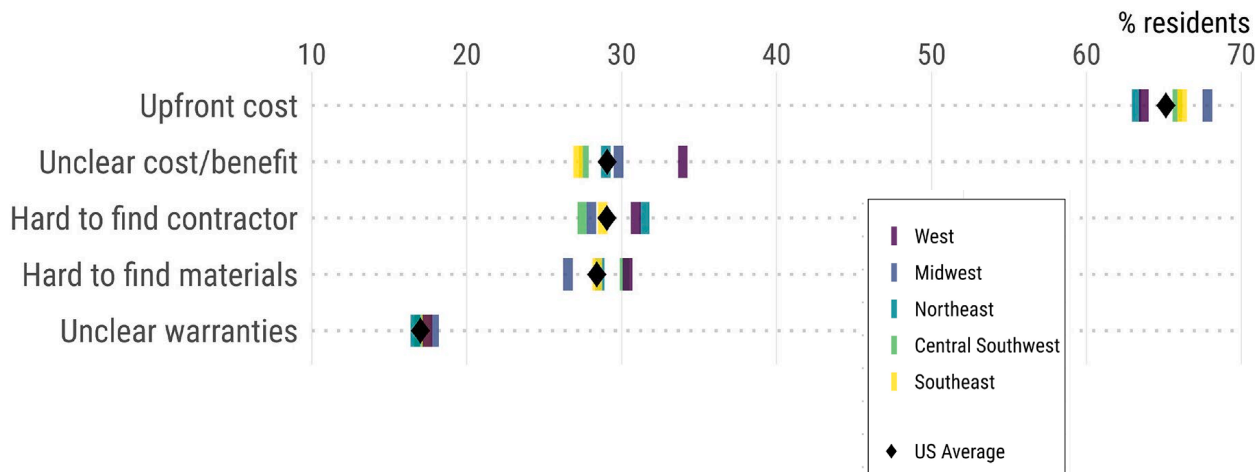
# CONTRACTORS PLAY AN IMPORTANT ROLE!

- Only 9% of households are participating in programs.
  - Contractors can help bring these numbers up.
- 30% of households note they can't find contractors to do the work they need done.

## A) Program participation

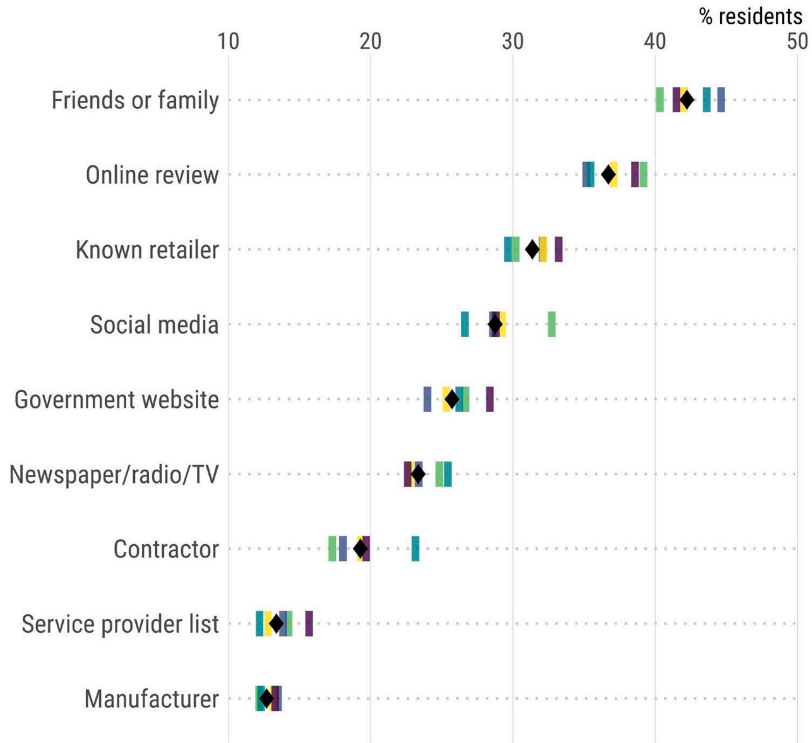


## B) Barriers to Modifications

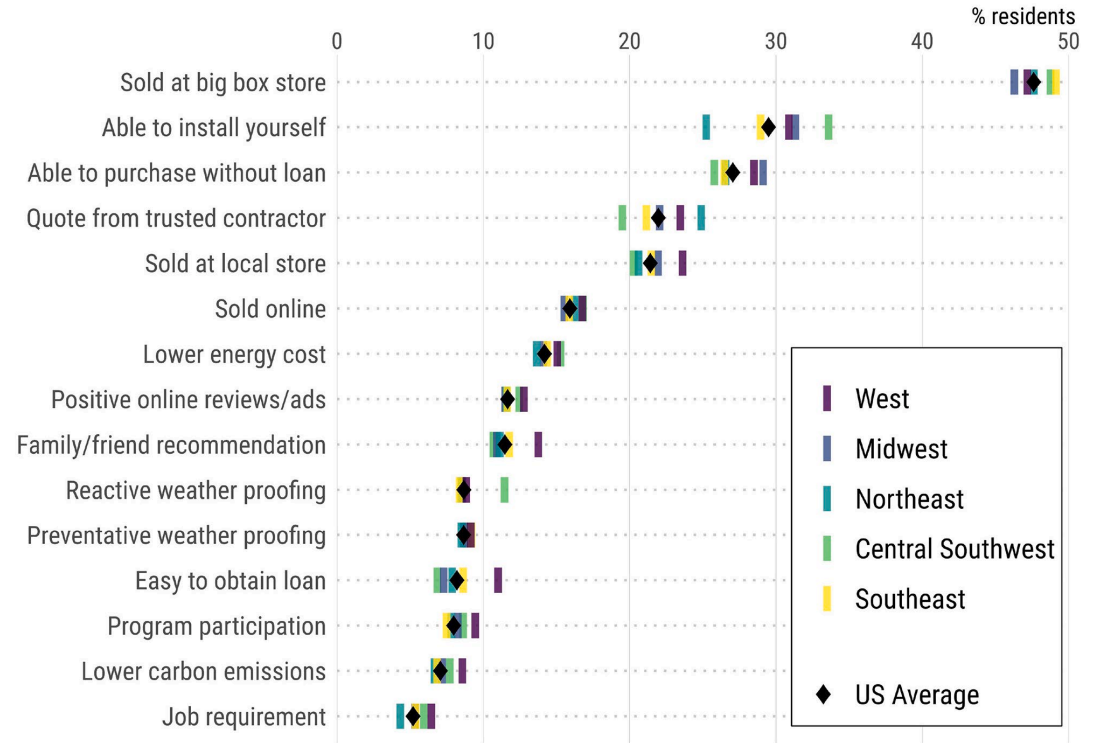


# INFORMATION SOURCES ALSO IMPORTANT!

C) Sources of Information



D) Considerations when Making Modifications



Households rely on friends/family, online/social media, and big box stores for information

# What do Industry Professionals Think?

## ► Survey 2 - Construction Industry

Survey originally for Deep Energy Retrofits (DERs) – but most answers apply to decarbonization also

# Market Survey

- ▶ Qualtrics survey platform
- ▶ 20-minute online survey to gather information from building energy professionals on their experiences and opinions
  - What motivates and deters energy retrofit projects in today's market?
  - Promising strategies and technologies
  - Non-cost aspects of retrofit measures
- ▶ 73 survey participants
  - Home performance contractor (25%)
  - Consultant (15%)
  - Program manager (14%)
  - Researcher (12%)
  - General contractor (11%)
  - Other (23%), e.g., engineer, architect, energy rater





# Market Survey

## Survey Questions Organized By Main Sections Of Topic:

- ▶ Background information about past experiences of the respondent
- ▶ Consumer perspective on energy retrofit projects
- ▶ Home performance contractor perspective on challenges
- ▶ Promising technologies and approaches to advance carbon savings
- ▶ Work scope and approaches from past experiences
- ▶ Project costs



# Survey: Customer Perspective

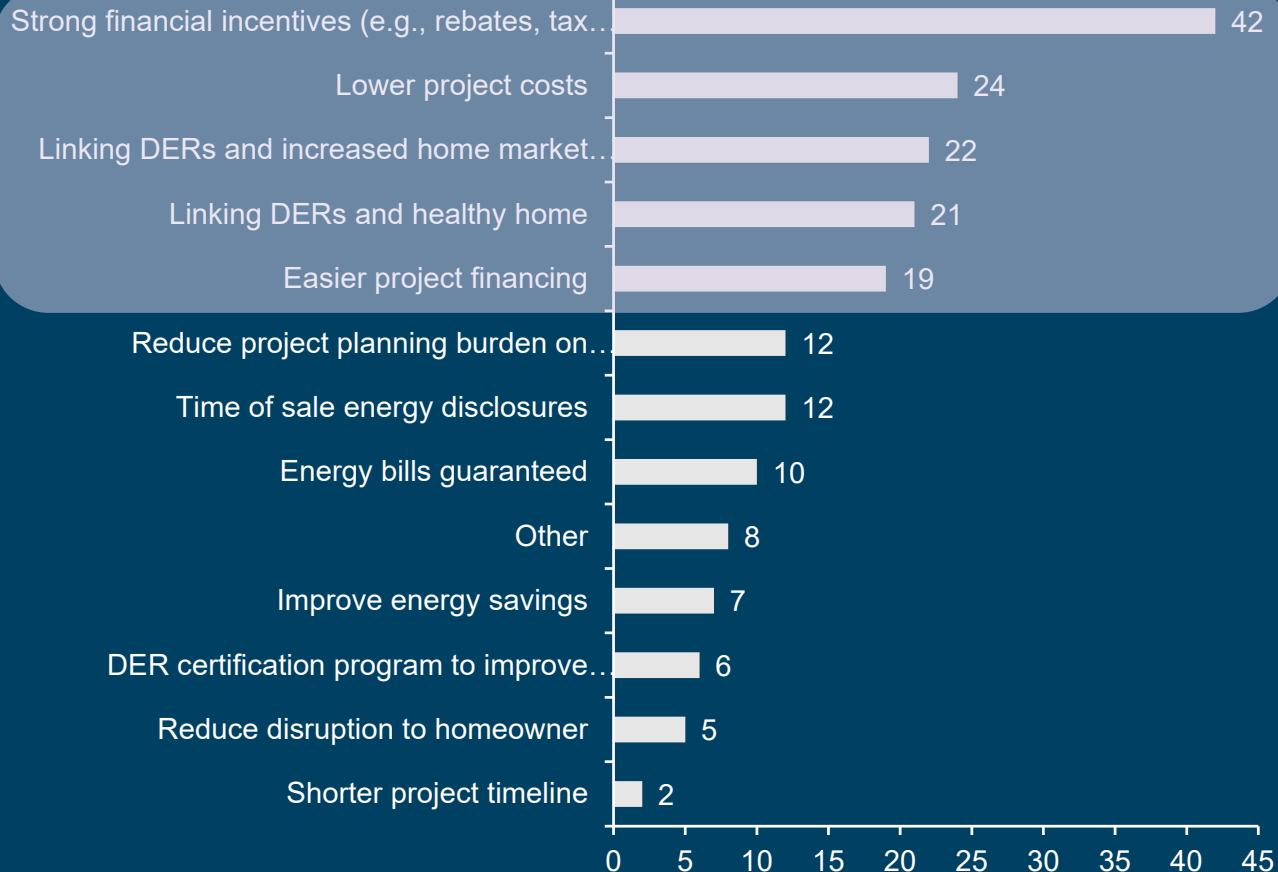
**What are the main motivations of homeowners / building owners?**

Residential <> Commercial

**Profit is not the motive**

ROI, payback and other traditional investment metrics are misleading and the wrong ones to use.

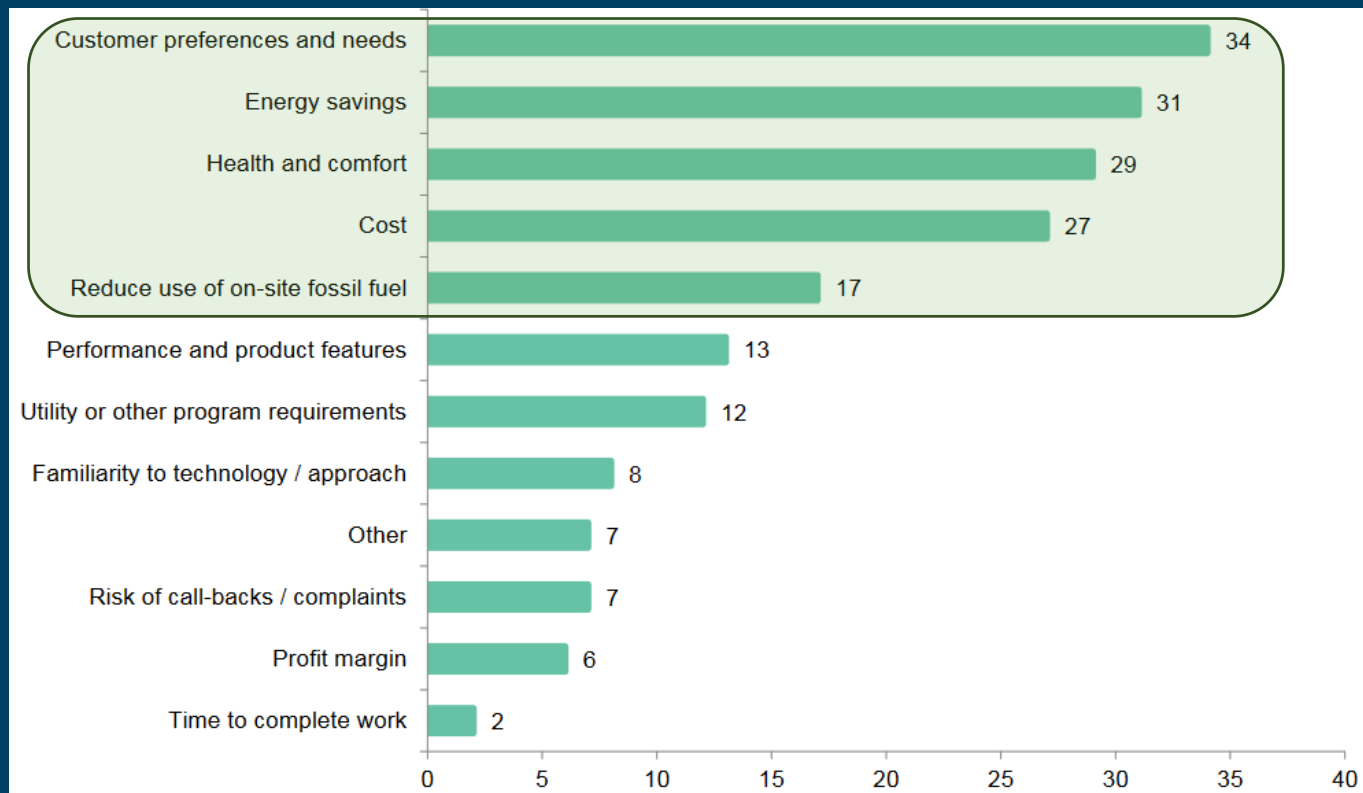
**Affordability and financing are key.**



# Survey: Industry Perspective

What are the factors that significantly influence the **decision-making** process among contractors?

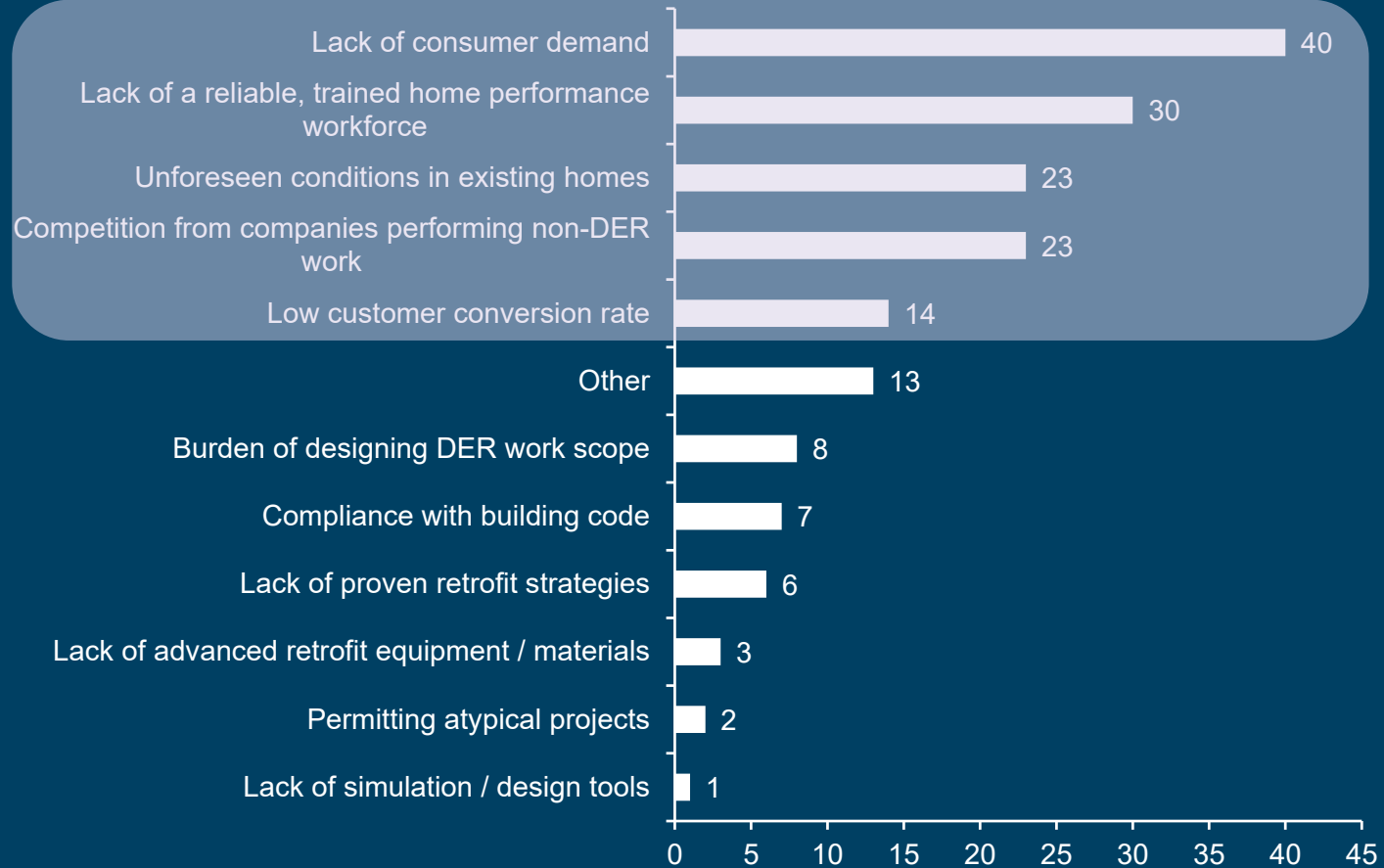
- ▶ Households' needs
- ▶ Households' wellbeing
- ▶ CO<sub>2</sub> reduction
- ▶ Energy savings



# Survey: Industry Perspective

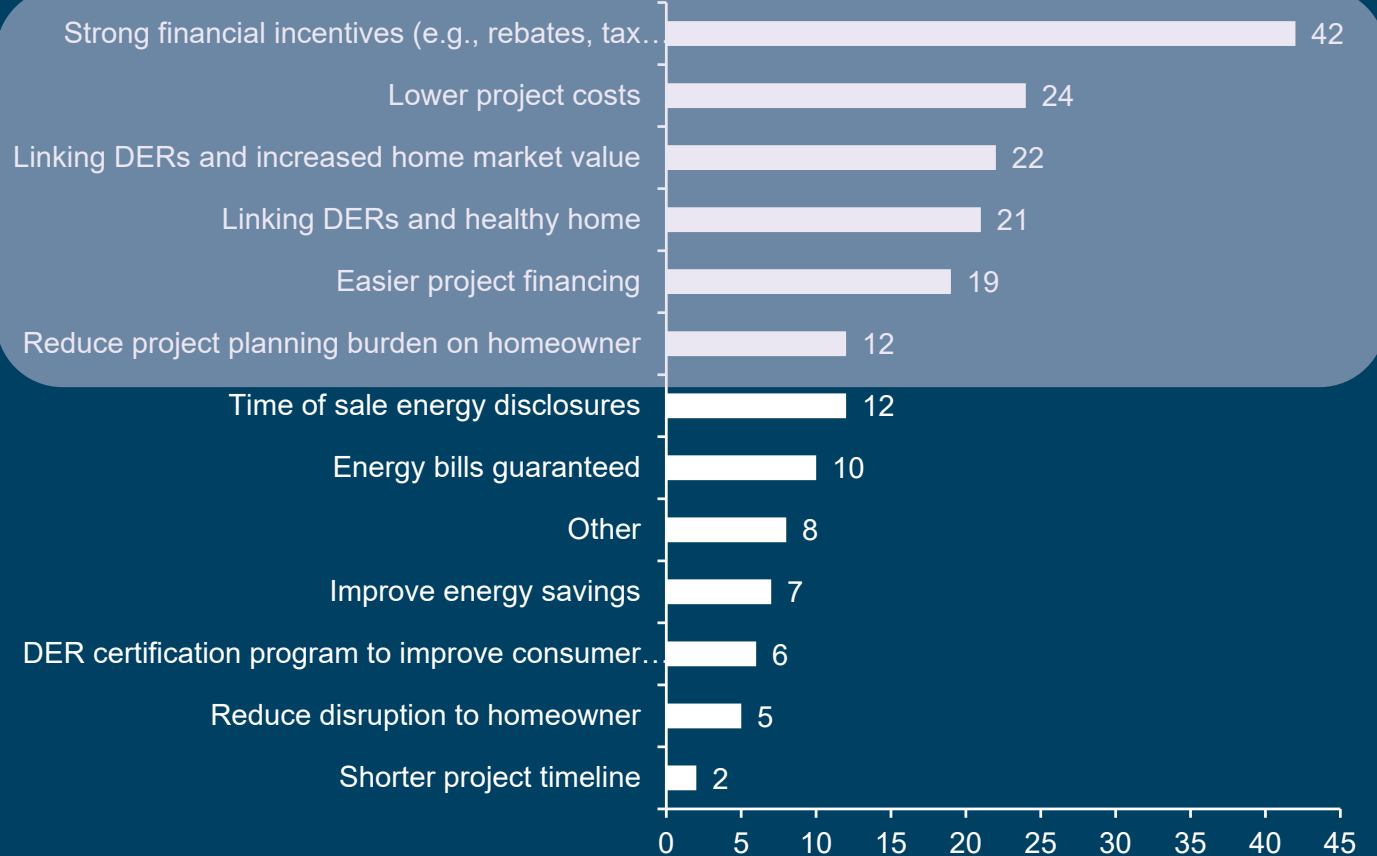
**Aside from costs:**  
What are the biggest barriers?

- ▶ Lack of consumer demand
- ▶ Lack of workforce



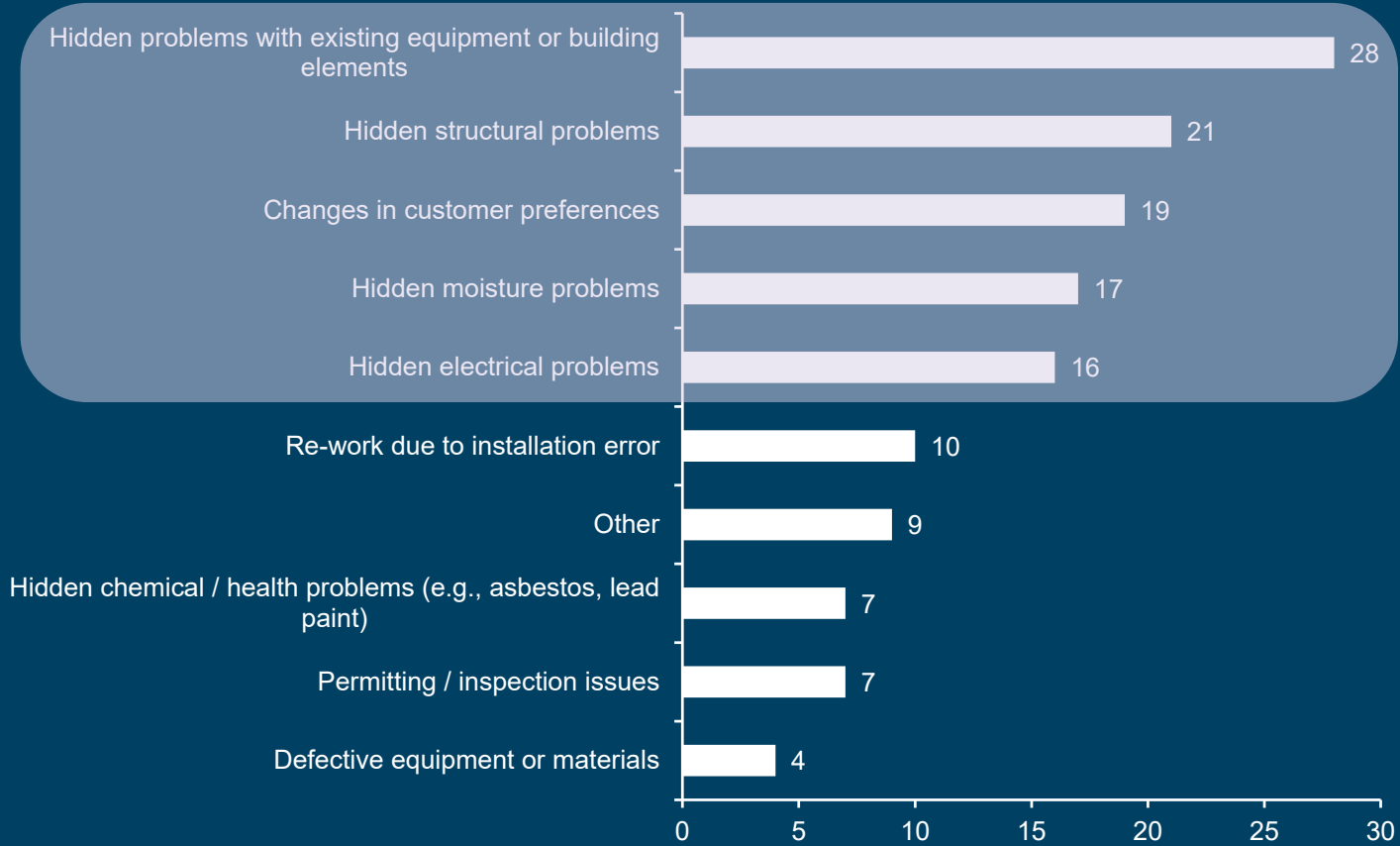
# Survey: Industry Perspective

**Aside from costs:**  
What are the most effective ways to increase customer demand?



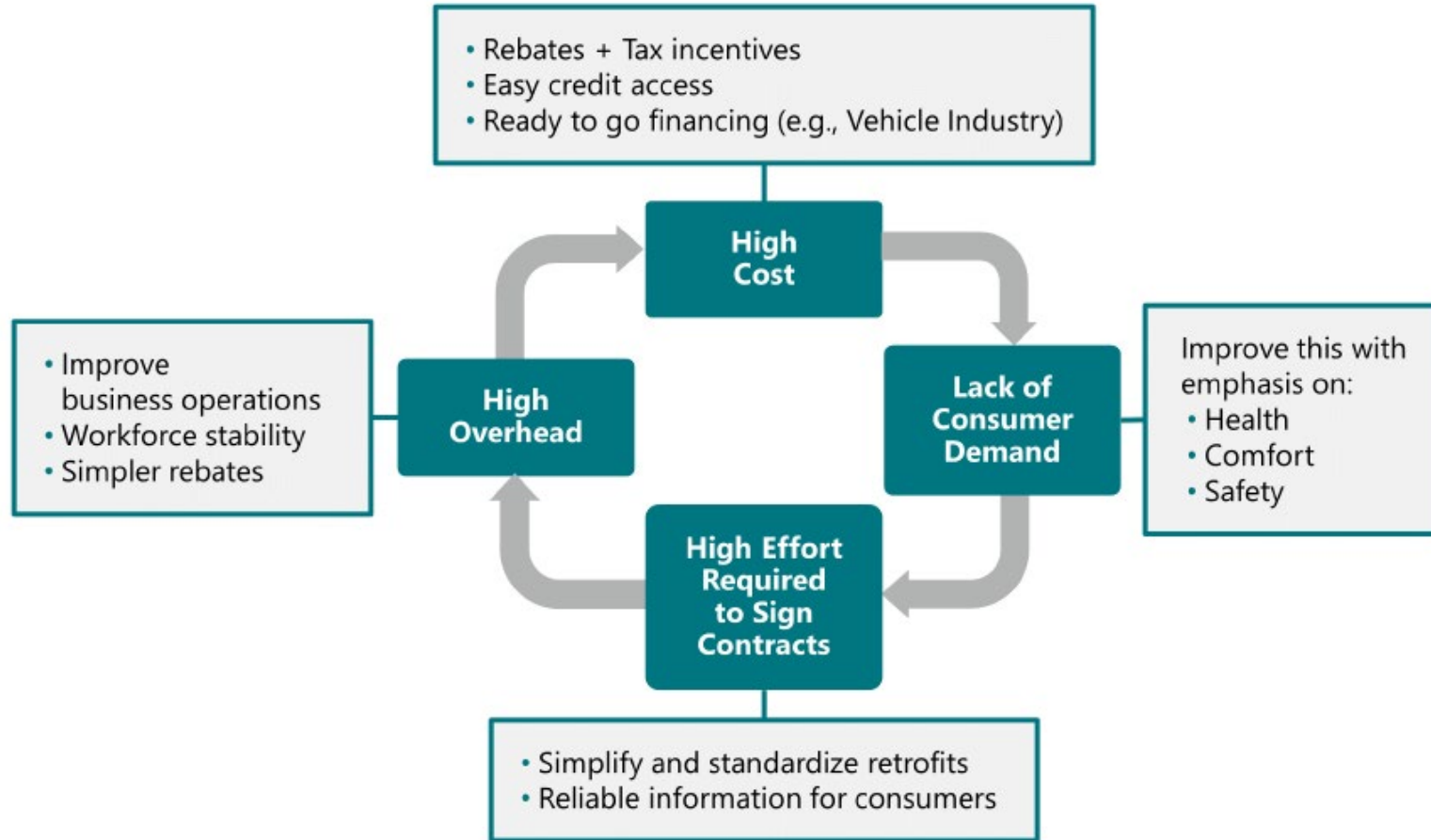
# Survey: Project Cost Estimates

**Common causes of project cost increase.**





# Addressing “Lack of Demand” Issues for the Building Industry



# A Comparative Analysis:

What are the **Perceptions** and **Behaviours** of Households and Construction Professionals?

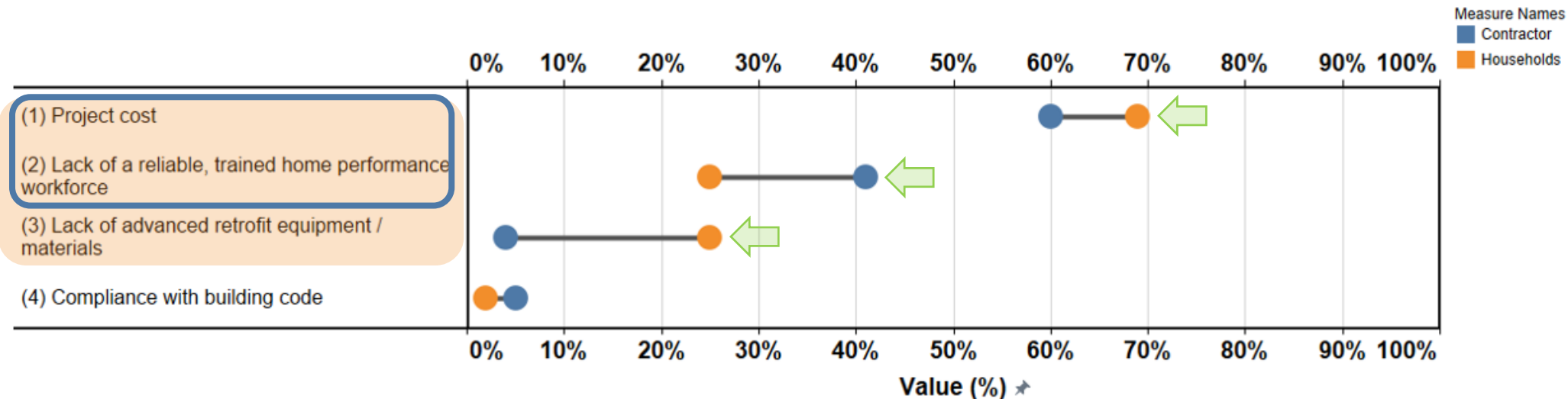
# Addressing Gaps: A Comparative Analysis

## Questions

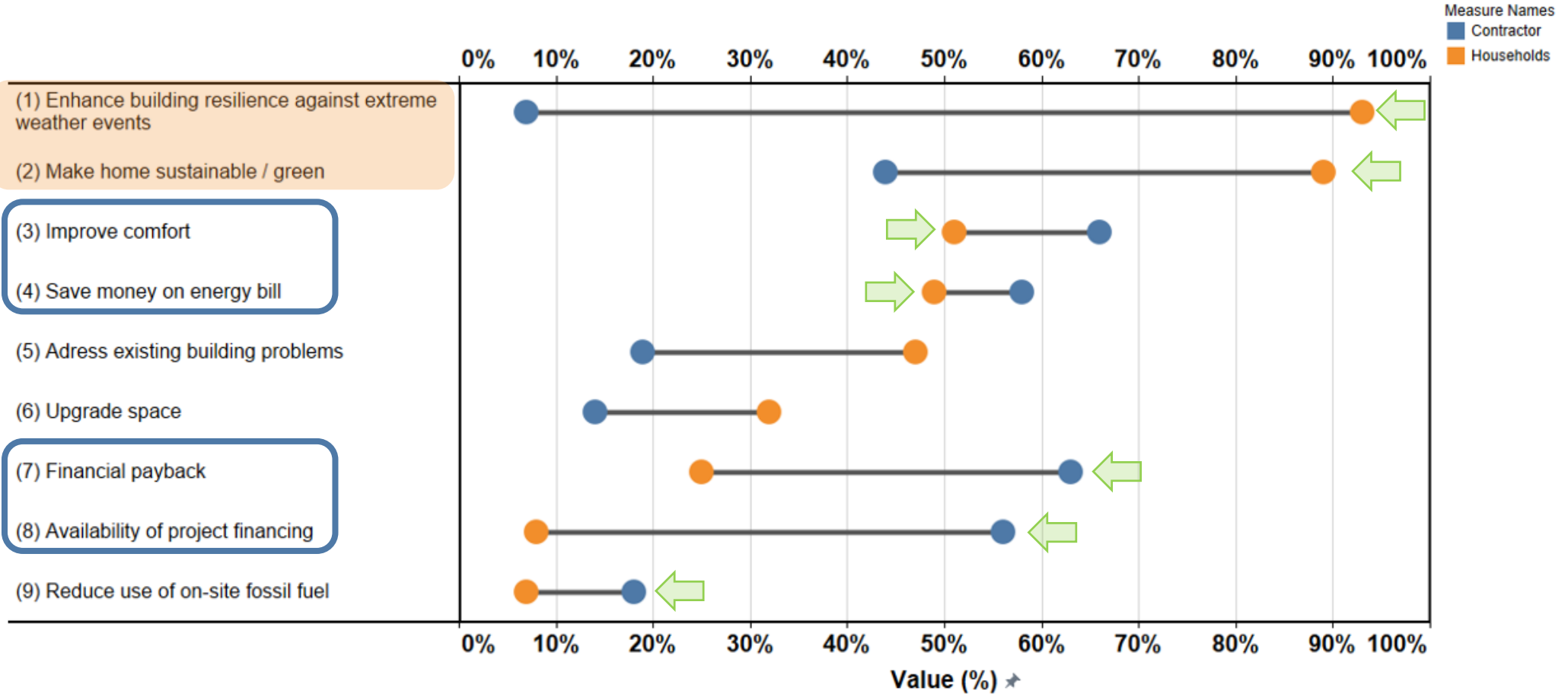
- a) What drives and hinders households and construction professionals in deciding to retrofit (decarbonize) a home?
- b) How does the construction industry supports building decarbonization for households?
- c) What are the top strategies to scale decarbonization for households and professionals?



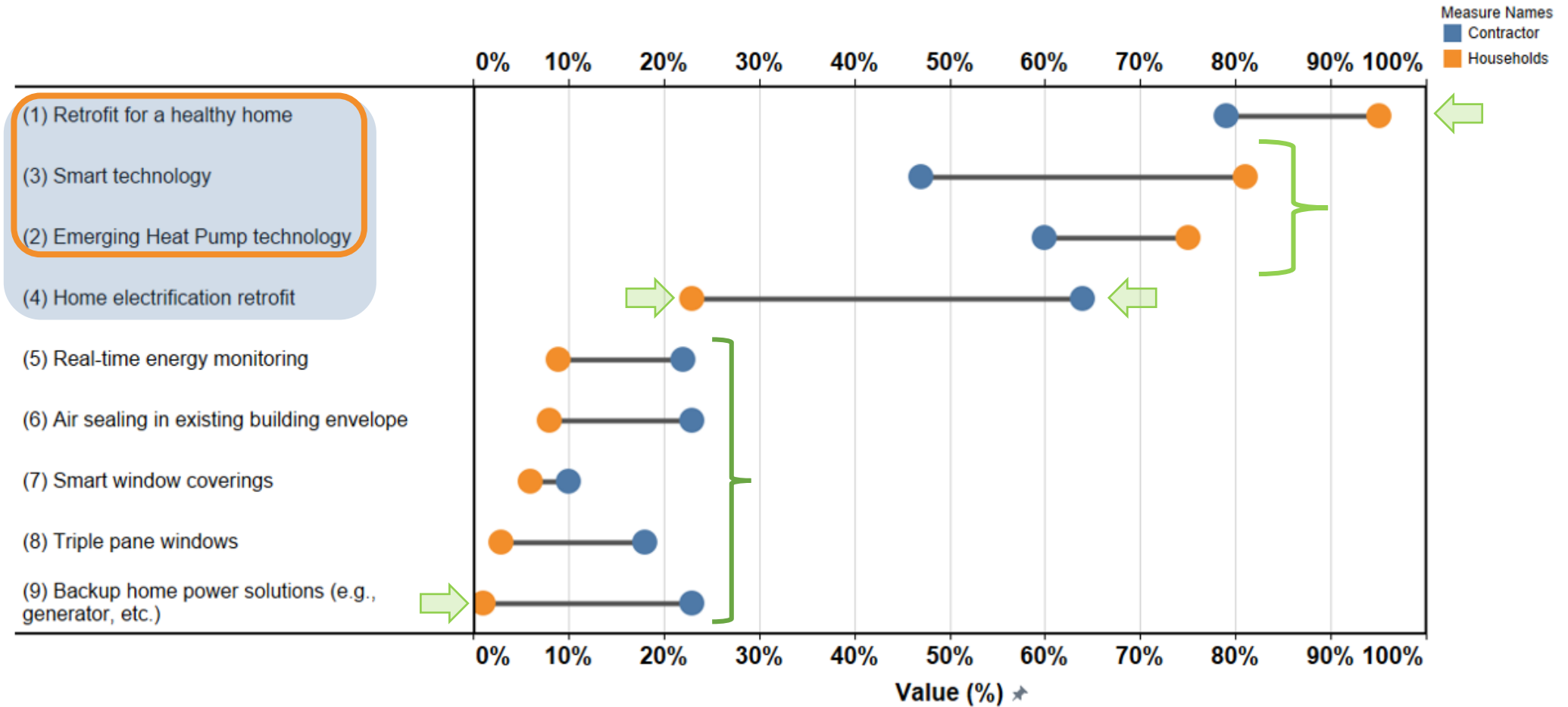
# Key Barriers for the Building Industry and Households



# Households Priorities and Motivations

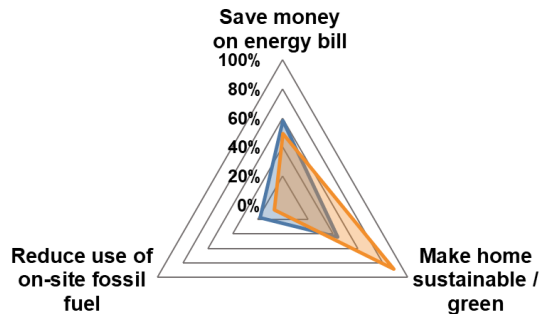


# Advanced Technology for Energy Retrofits

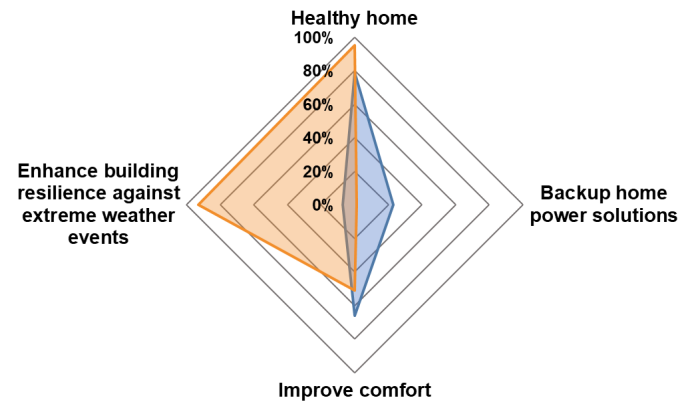


# Other Survey Intersections

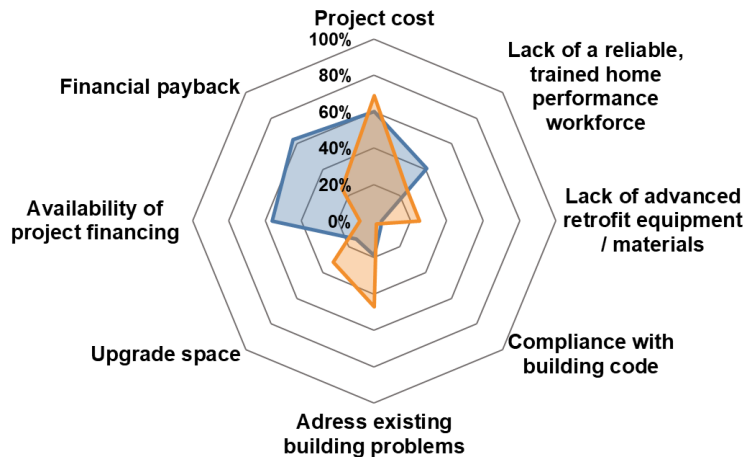
## Climate Change and Energy Concerns



## Non-Energy Benefits and Resilience



## Project Building Concerns



# Summary

**Constructors need to align messaging with household goals**





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# Thank You... QUESTIONS ?



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**ENERGY**

## Connect with us:

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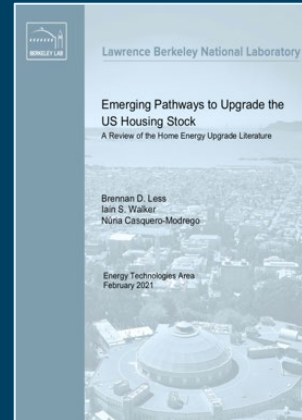
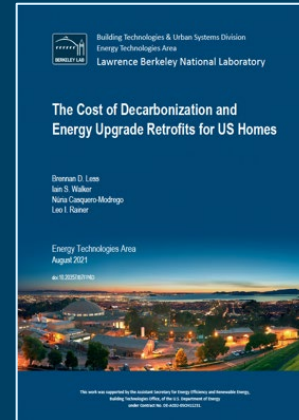
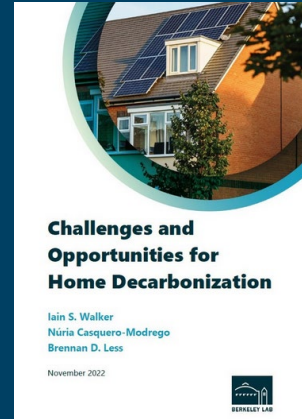


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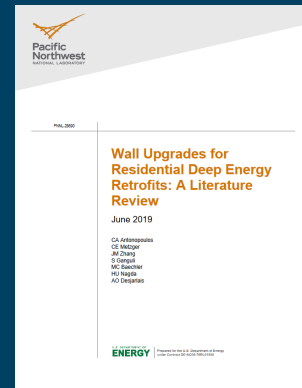
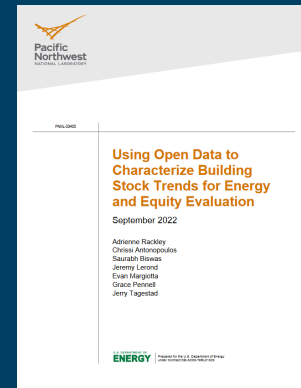
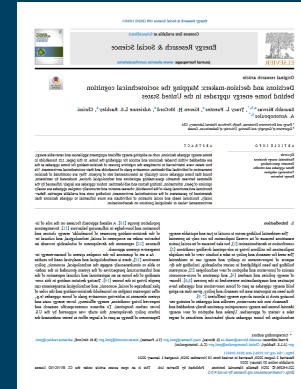
# LBNL Resources @ homes.lbl.gov

- ▶ Walker, I. S., Casquero-Modrego, N., Less, B. D. (2023). Challenges and Opportunities for Homes Decarbonization. Lawrence Berkeley National Lab. <https://doi.org/doi.10.20357/B7XG7T>
- ▶ Less, B. D., Casquero-Modrego, N., & Walker, I. S. (2022). Home Energy Upgrades as a Pathway to Home Decarbonization in the US: A Literature Review. *Energies*, 15(15), 5590. <https://doi.org/10.3390/en15155590>
- ▶ Walker, I. S., Less, B. D., & Casquero-Modrego, N. (2022). Carbon and energy cost impacts of electrification of space heating with heat pumps in the US. *Energy and Buildings*, 259, 111910. <https://doi.org/10.1016/j.enbuild.2022.111910>
- ▶ Less, B. D., Walker, I. S., Casquero-Modrego, N., & Rainer, L. (2021). The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes. Lawrence Berkeley National Laboratory. <https://doi.org/10.20357/B7FP4D>
- ▶ Less, B. D., Walker, I. S., & Casquero-Modrego, N. (2021). Emerging Pathways to Upgrade the US Housing Stock: A Review of the Home Energy Upgrade Literature. Lawrence Berkeley National Lab. <https://doi.org/10.20357/B7GP53>
- ▶ Chan, W. R., Less, B. D., & Walker, I. S. (2021). DOE Deep Energy Retrofit Cost Survey. Lawrence Berkeley National Laboratory. <https://doi.org/10.20357/B7MC70>



# PNNL Resources

- ▶ Antonopoulos, C. A., Fuentes, T. L., McCord, K. H., Rackley, A. L., & Biswas, S. (2024). Regional assessment of household energy decision-making and technology adoption in the United States. *Energy Policy*, 185, 113940. <https://doi.org/10.1016/j.enpol.2023.113940>
- ▶ Biswas, S., Fuentes, T. L., McCord, K. H., Rackley, A. L., & Antonopoulos, C. A. (2024). Decisions and decision-makers: Mapping the sociotechnical cognition behind home energy upgrades in the United States. *Energy Research & Social Science*, 109, 103411. <https://doi.org/10.1016/j.erss.2024.103411>
- ▶ Rackley, A. L., Antonopoulos, C. A., Biswas, S., Lerond, J., Margiotta, E. R., Pennell, B. G., & Tagestad, J. D. (2022). Using Open Data to Characterize Building Stock Trends for Energy and Equity Evaluation (No. PNNL-33405). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).
- ▶ Antonopoulos, C. A., Metzger, C. E., Zhang, J. M., Ganguli, S., Baechler, M. C., Nagda, H. U., & Desjarlais, A. O. (2019). Wall upgrades for residential deep energy retrofits: a literature review. Pacific Northwest National Lab.(PNNL), Richland, WA (United States).







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