U.S. DEPARTMENT OF ENERGY | Pacific Northwest NATIONAL LABORATORY

Behavioral Science and Physics-Based Modeling for Equitable Decarbonization Pathways

UPGRADE-E and ResStock™ synthesis

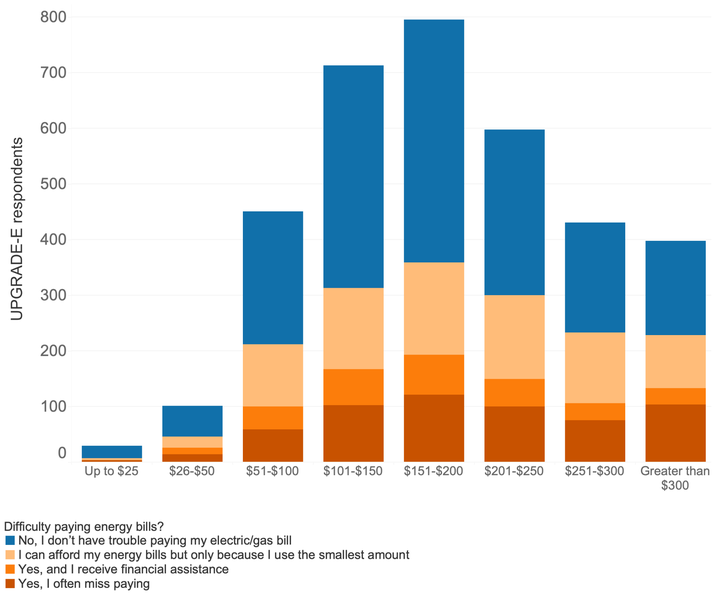
Last 5 digits of project number | 79133
Principal Investigator (PI) | Chrissi Antonopoulos
Lead Organization | Pacific Northwest National Laboratory
PI Email | chrissi.antonopoulos@pnnl.gov

BACKGROUND AND IMPACT

- Building decarbonization is essential to meeting climate goals. Market-based instruments (e.g. tax credits or rebates) are often used to increase technology uptake
- However, these instruments can create inequities in access to benefits, so policymakers are interested in using energy equity metrics to create equitable distribution. Energy burden, a common metric, only considers one dimension of energy challenges
- Social science + physics-based modeling using two powerful datasets allows cross comparison of additional dimensions, including energy security, which considers ability to pay bills and corresponding tradeoffs

Definitions

- **Energy burdened:** Ratio of utility bills to income is ≥6% (calculated)
- **Energy insecure:** Difficulty paying utility bills (self-reported)
- **% AMI:** Percent of Area Median Income (calculated)



Distribution of energy expenses for UPGRADE-E respondents, presented by self-reported energy security.

KEY PRODUCTS

- Successful synthesis of two powerful, complementary datasets in the residential buildings space
- ACEEE 2024 Summer Study Presentation
- ACEEE 2024 Summer Study Conference Paper
- Anticipating future opportunities for collaboration

METHODS

- Harmonization of UPGRADE-E and ResStock databases (both publicly accessible!)

Pacific Northwest NATIONAL LABORATORY

UPGRADE-E

10,000-household energy decision-making survey

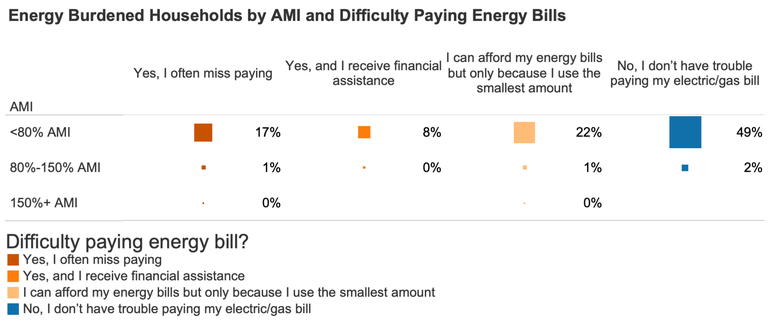
NREL NATIONAL RENEWABLE ENERGY LABORATORY

ResStock

550,000-household energy modeling database

Harmonized based on:
- Location (state)
- Dwelling type
- Dwelling vintage
- Heating fuel

1. What energy equity patterns emerge when considering home upgrades?
2. What factors indicate willingness to renovate?



Energy burdened households by Area Median Income (AMI) and their difficulty to pay energy bills. 95% of energy burdened households are classified as low-income (0%-80% AMI). 25% of low-income households reported challenges paying their energy bills.

CONCLUSION

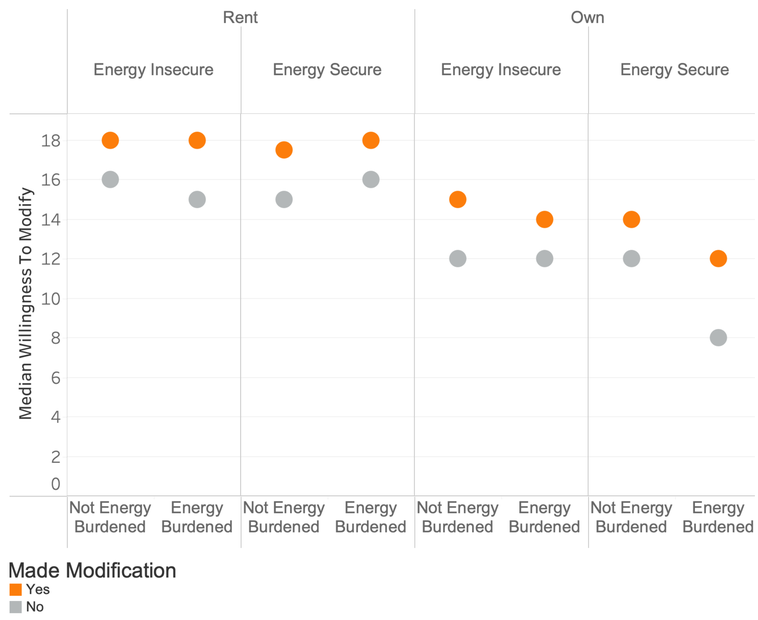
Key Takeaways

Low-income, energy-burdened, and energy-insecure don't correspond 1:1:1.
- Nuances can help shape energy upgrade messaging.

Past behavior can inform future behavior:
- Those who have already changed their home might be willing to make changes in other areas
- Start small when working with those resistant to change

Future Work

- Additional insights from synthesized dataset
- Actionable steps for reaching energy burdened/insecure households
- Addition of manufactured housing dynamics



Willingness to modify by own/rent, energy insecurity, energy burden, and prior experience modifying their dwelling. This figure shows how making past modifications is strongly associated with willingness to modify now. Renters are more willing to modify (provided rent doesn't increase).

PROGRAM OFFICE LEAD | Holly Carr
Supported by Residential Buildings Technology

PROJECT TEAM | Katelyn Stenger (NREL), Stacey Rothgeb (NREL), Kieren McCord (PNNL), Tracy Fuentes (PNNL), Chrissi Antonopoulos (PNNL).