Energy Affordability in Colorado

A Study by Physicians, Scientists and Engineers (PSE) for Healthy Energy and the Institute for Energy and Environmental Research (IEER)

Prepared for the Colorado Energy Office

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Bringing science to energy policy

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INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH

COLORADO
Energy Office

About PSE and ieer

Physicians, Scientists, and Engineers (PSE) for Healthy Energy is a nonprofit research institute that studies the way energy production and use impact public health, the climate, and the environment. We conduct original research, translate existing research for non-technical audiences, and disseminate scientific information and analyses to inform policy at the local, state, and federal levels.

The Institute for Energy and Environmental Research (IEER) is a nonprofit research institute that provides activists, policy-makers, journalists and the public with understandable and accurate scientific and technical information on energy and environmental issues. IEER's aim is to bring scientific excellence to public policy issues in order to promote the democratization of science and a safer, healthier environment.

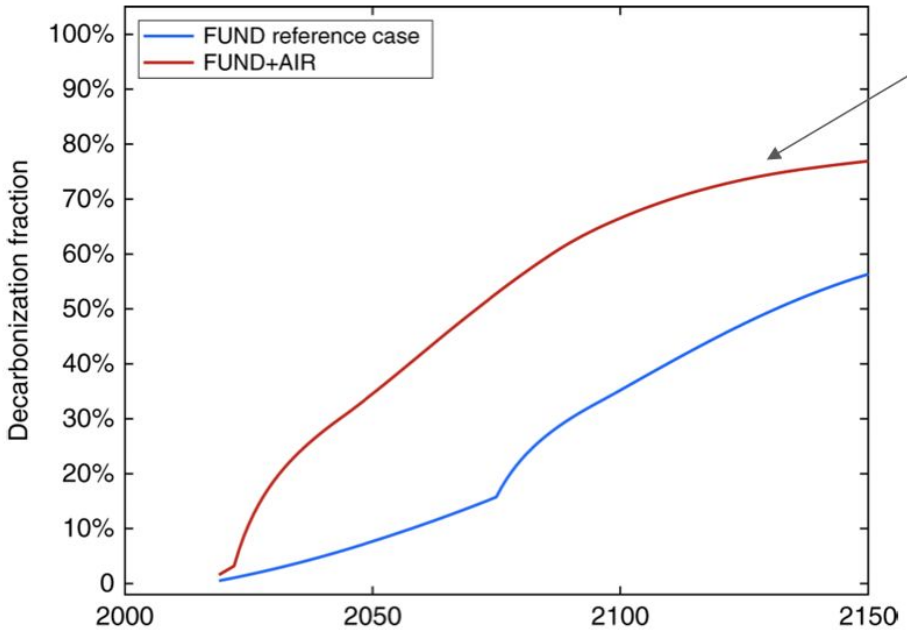
Motivation

Energy is unaffordable to hundreds of thousands of households across Colorado, and millions across the country. **One in three households in the U.S.** struggles with energy bills, **one in five** reports skipping essentials to pay energy bills, and **one in seven** reports receiving a disconnection notice for energy service.[1]

As Colorado tackles carbon emissions, we need to alleviate—rather than exacerbate—energy cost burdens. **When integrated with decarbonization pathways**, energy affordability considerations can actually help advance climate goals and accelerate the clean energy transition.

[1] U.S. Energy Information Administration. 2018. "One in Three U.S. Households Faces a Challenge in Meeting Energy Needs." *Today in Energy,* September 19, 2018. www.eia.gov/todayinenergy/detail.php?id=37072

Motivation



When health benefits are taken into account, global decarbonization happens **more rapidly**

Scovronick, N., Budolfson, M., Dennig, F. et al. "The impact of human health co-benefits on evaluations of global climate policy." Nat. Commun. 10, 2095 (2019). https://doi.org/10.1038/s41467-019-09499-x

[1] U.S. Energy Information Administration. 2018. "One in Three U.S. Households Faces a Challenge in Meeting Energy Needs." *Today in Energy,* September 19, 2018. www.eia.gov/todayinenergy/detail.php?id=37072

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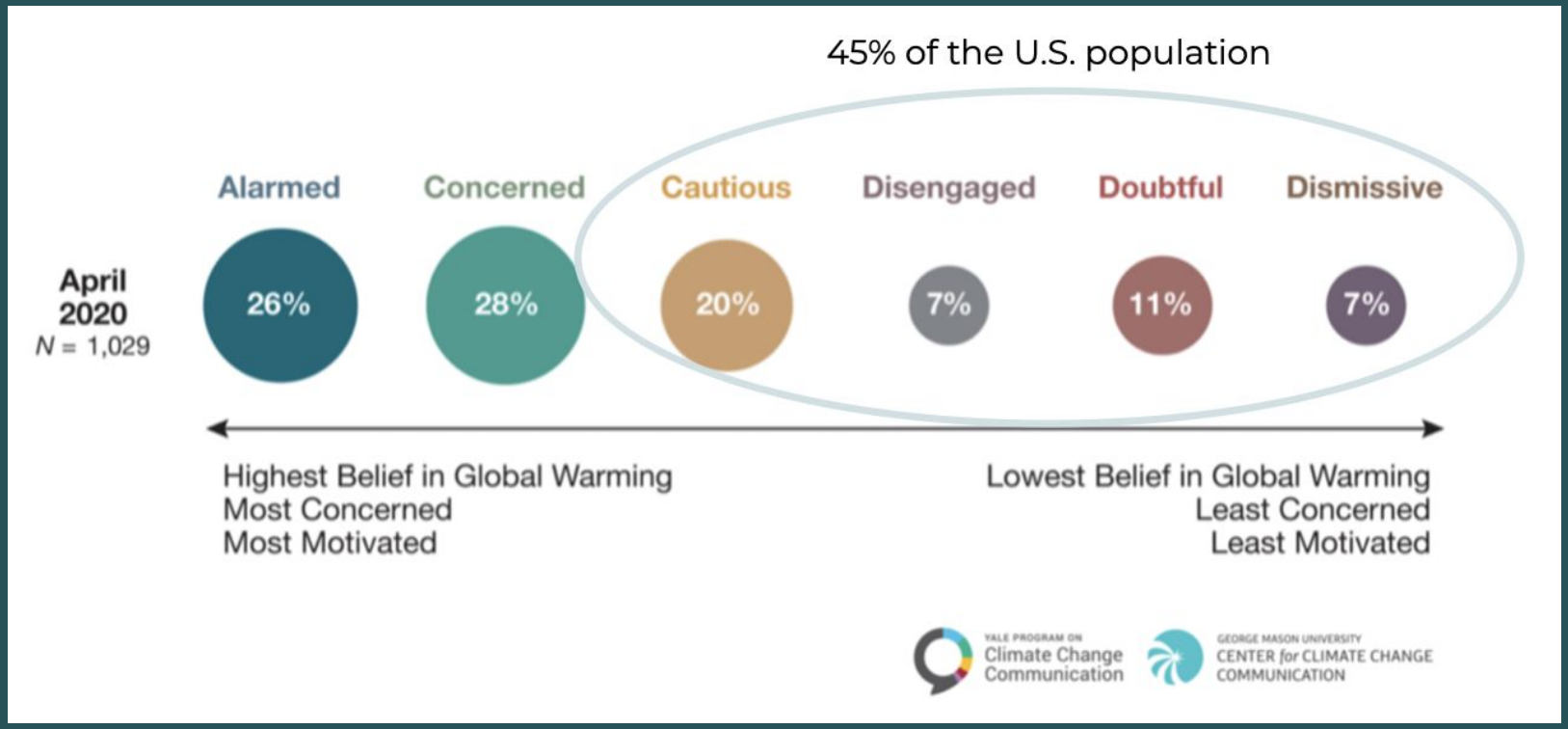

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Study Overview

Outline

The study was commissioned by the Colorado Energy Office in 2021 and includes three standalone sections:

- **Literature Review.** A review of existing analyses and metrics related to energy cost burdens.
- **Baseline Analysis.** A detailed analysis of existing energy cost burdens across the state of Colorado.
- **Policy Recommendations.** Strategies, priorities, energy cost burden projections, recommendations, and enabling considerations.

The report was prepared over the course of six months during the second half of 2021.

Energy Affordability and Why It Matters

- **Energy access and energy affordability** have profound implications on human happiness, welfare, and quality of life.
- **Energy insecurity and fuel poverty** lead to severe social harms and adverse health outcomes and perpetuate economic inequality.
- **Exist in a complex dynamic** with energy policy, socioeconomic factors, housing infrastructure, and historic inequities such as redlining policies.
- **Low-income and BIPOC** communities often face numerous economic, social, and informational barriers that impact their ability to access energy efficiency and other clean energy resources.

Energy Justice

Fuel poverty and energy insecurity are **social justice** issues

- Framing them as energy justice speaks to the nature of energy as a **physical necessity** and a **basic human need**.
- Energy policy discussions and technical analyses are too often framed in an **ethical and normative vacuum**.
- Concepts from **ethics** and **social justice** can provide an important framework to reexamine and remake a global energy system in transition.
- Viewing access to affordable energy as a **basic human right** requires the equitable implementation of energy policies and energy resources.

A framework for Energy Justice

A just energy system is a system that:

- Distributes the benefits and costs of energy services and resources fairly **(distributive justice)**
- Corrects for historic/systemic inequities while simultaneously honoring obligations to future generations **(intergenerational justice)**
- Contributes to a fully representative and impartial energy decision making process **(procedural justice)**

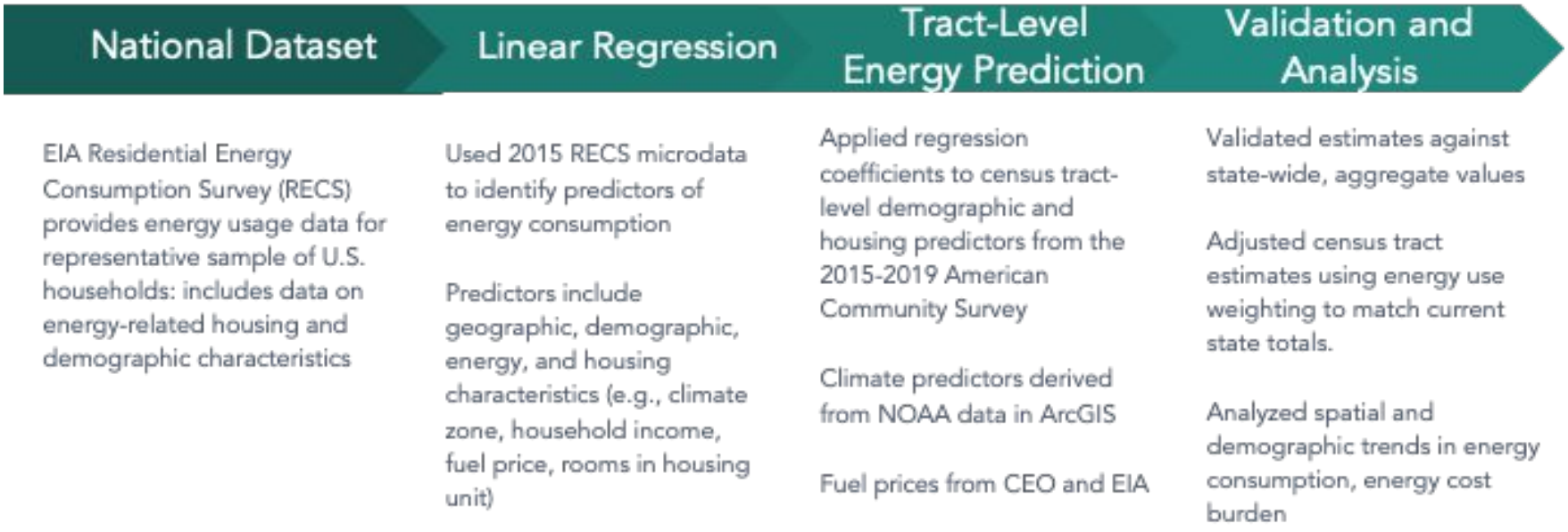
Energy Affordability Metrics

Metrics	Definition	Data Dimensions				
		Fuel Use	Fuel Price	Income	Utility Shutoffs	House Size
Energy burden (absolute)	Annual energy bills as a percent of household income	X	X	X		
Energy burden (variance)	One standard deviation above mean energy cost burden	X	X	X		
Energy burden (percentile)	Population share approach based on a percentile distribution	X	X	X		
Mean individual burden	Average of the percent of income spent on energy by each household	X	X	X		
Mean group burden	Overall energy expenditures as a percent of total income in the group	X	X	X		
Energy affordability gap	The sum of actual energy bills minus affordable energy bills	X	X	X		
Energy Use Intensity (EUI)	Energy use per square foot, used as a proxy for energy efficiency	X				X
Energy insecurity	Vulnerability to utility disconnections				X	
Gini coefficients and disparity ratios	E.g. energy use intensity (EUI) reported in the lowest income vs. highest income quintiles	X		X		

Methods

Census Tract Level Data

Residential energy use data not available at fine spatial resolution → requires interpolation



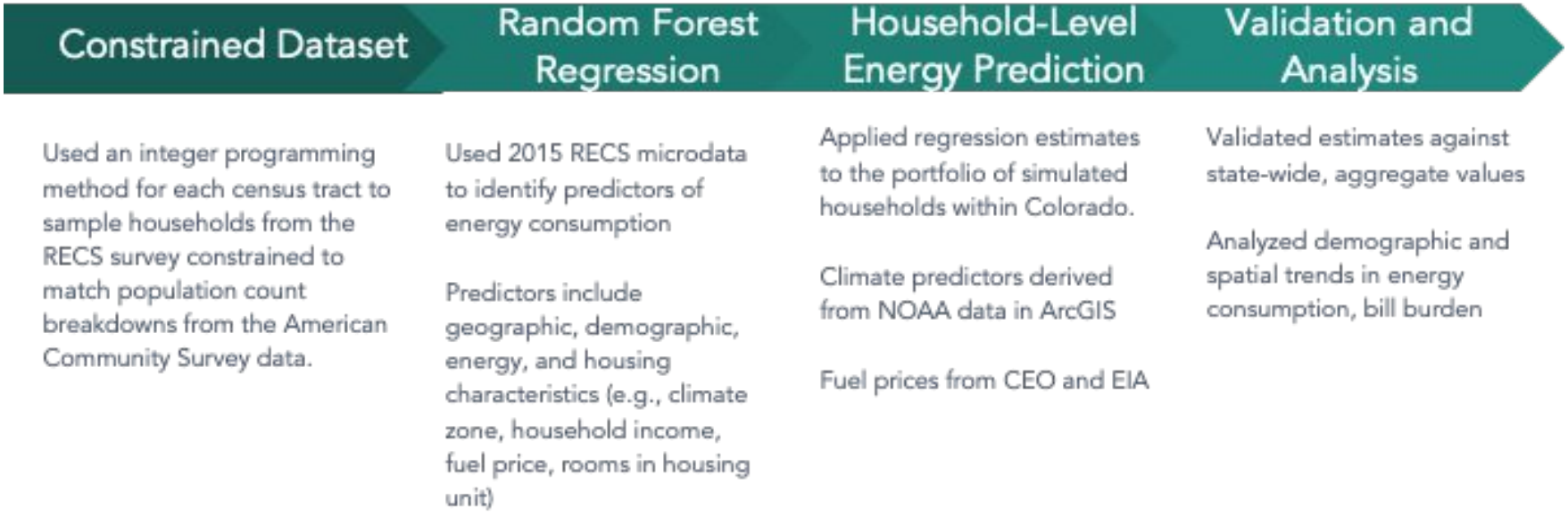
Min, Jihoon, Zeke Hausfather, and Qi Feng Lin. "A High-Resolution Statistical Model of Residential Energy End Use Characteristics for the United States." Journal of Industrial Ecology 14.5 (2010): 791-807

Jones, Christopher, and Daniel M. Kammen. "Spatial Distribution of US Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density." Environmental Science & Technology 48.2 (2014): 895-902.

Methods

Household Level Data

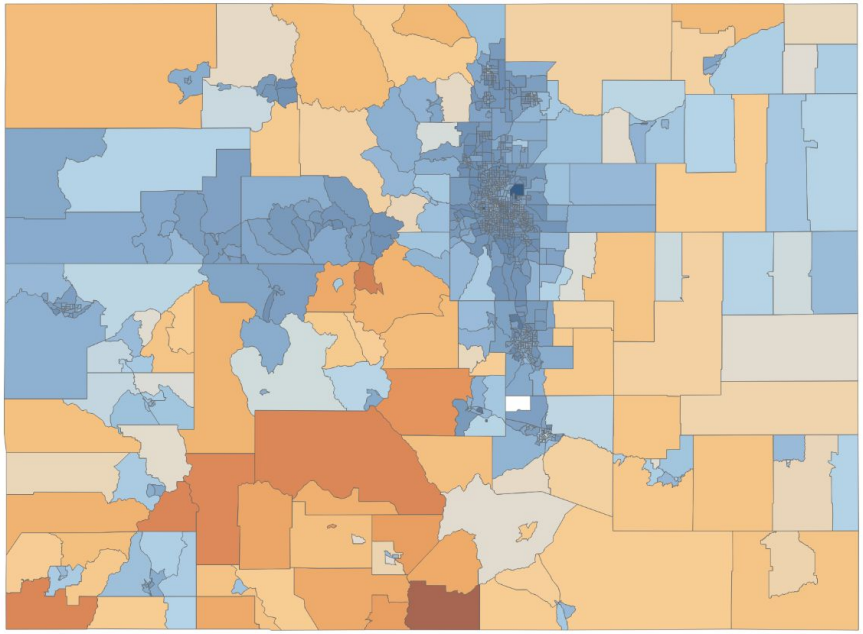
Needed for policy section in order to understand impacts on low-income households



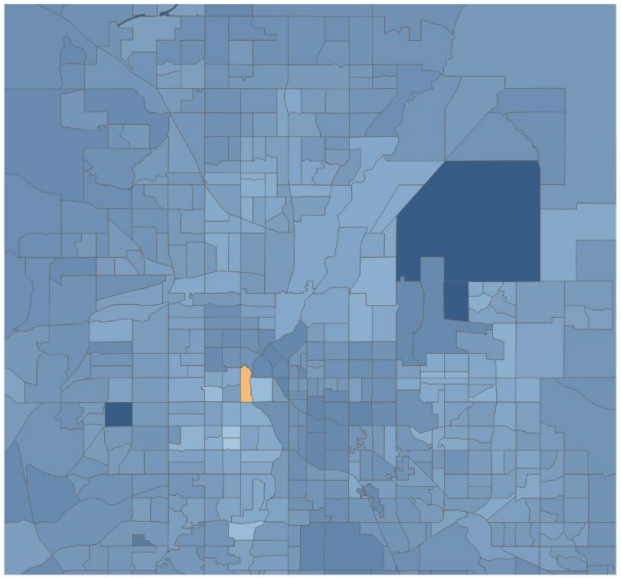
Energy Cost Burden Analysis

Geographic Distribution of Energy Cost Burden

Energy Cost Burden by Census Tract (2019)



Denver Area

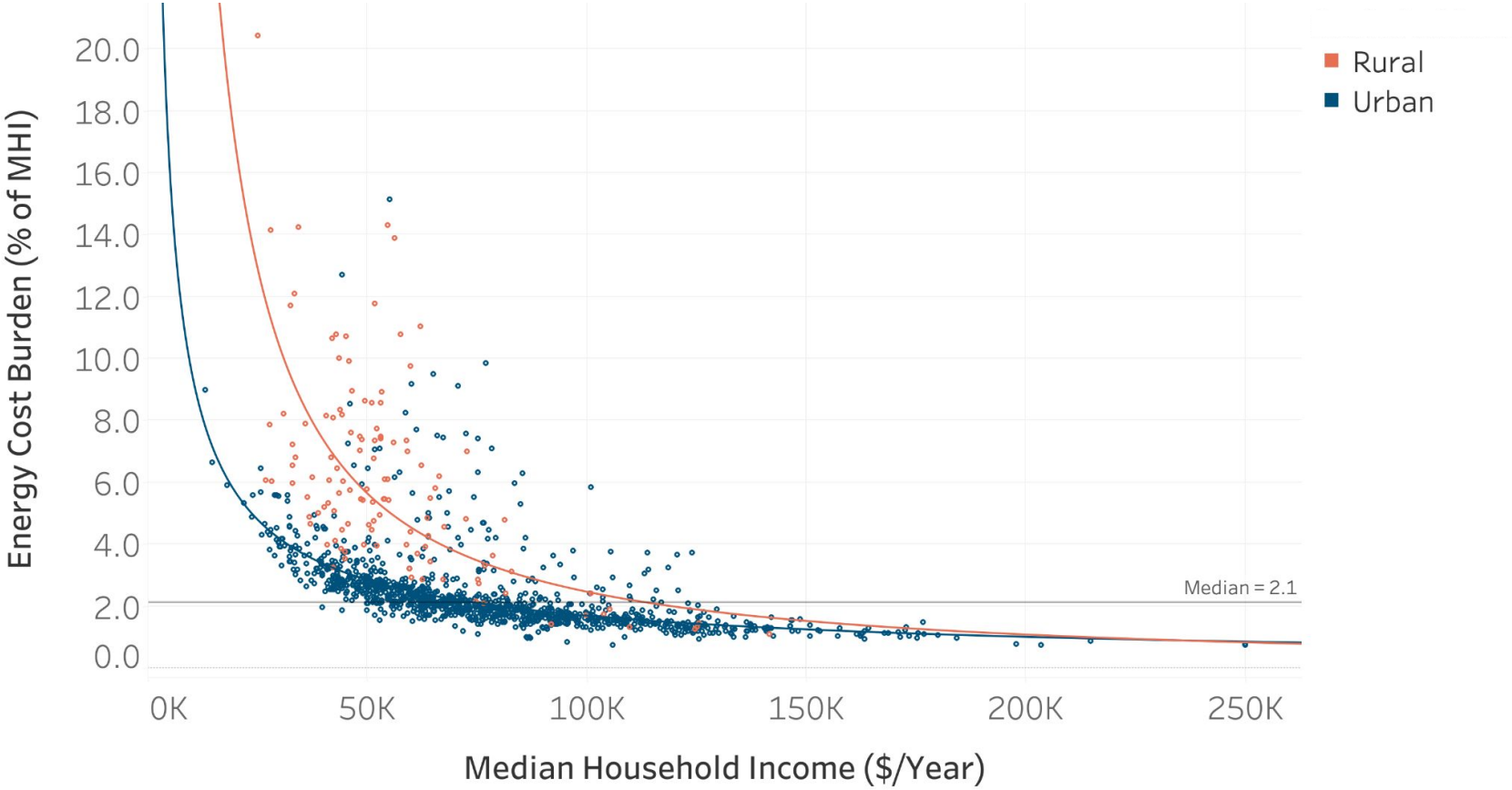


Energy Cost Burden (% of MHI)

0.0 — 20.4

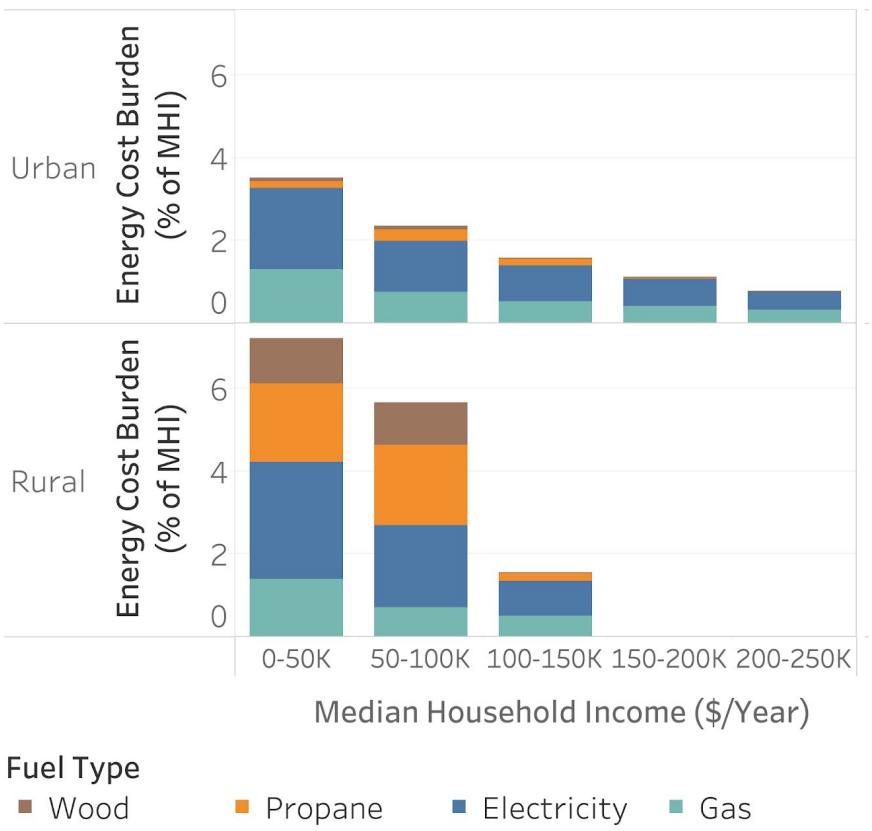
Energy cost burdens are unevenly distributed across the state, with many of the highest energy cost-burdened census tracts located in **rural areas**.

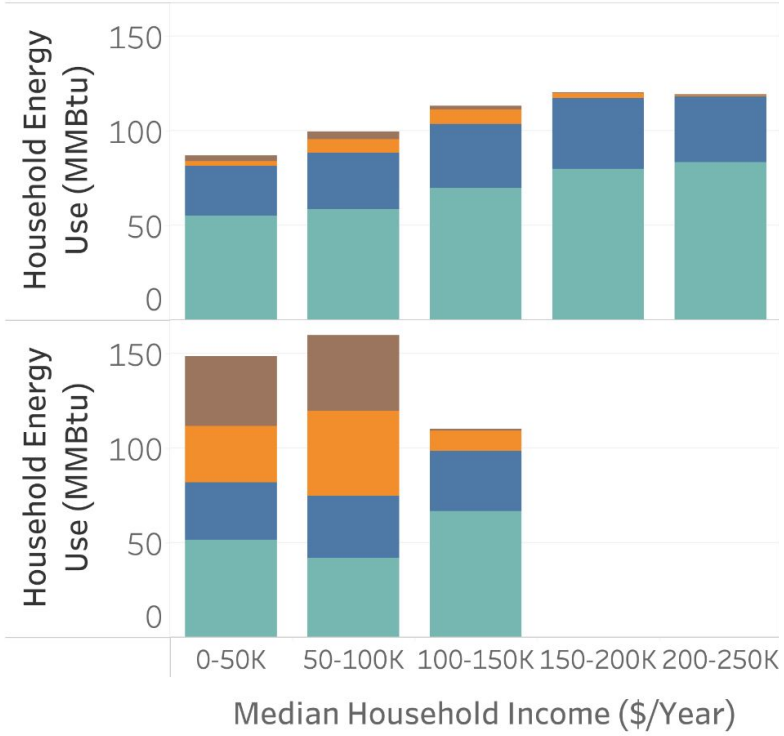
Energy Cost Burden and Income



There is a **nonlinear relationship** between energy cost burden and income, with low-income census tracts experiencing dramatically higher energy cost burdens

Energy Cost Burden and Income

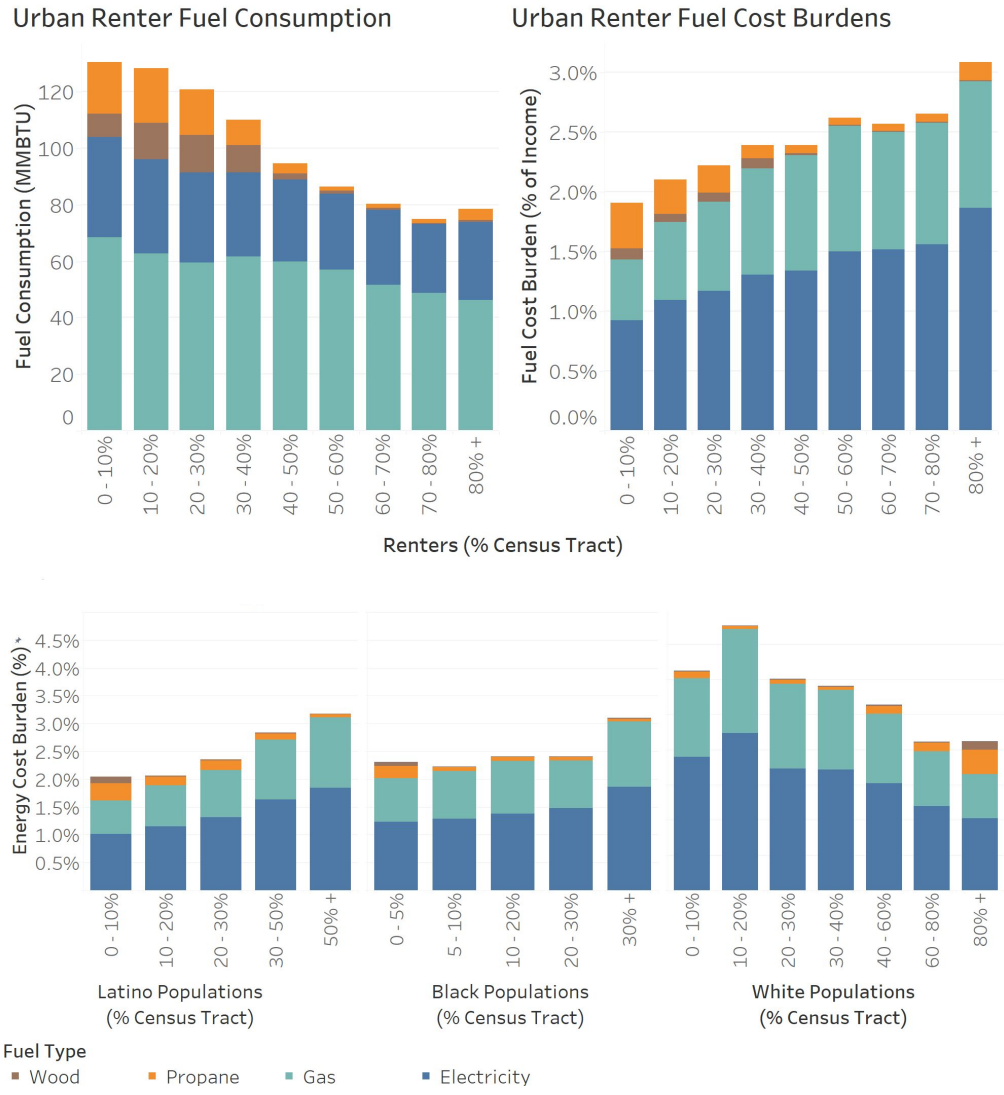




Fuel Type
Wood Propane Electricity Gas

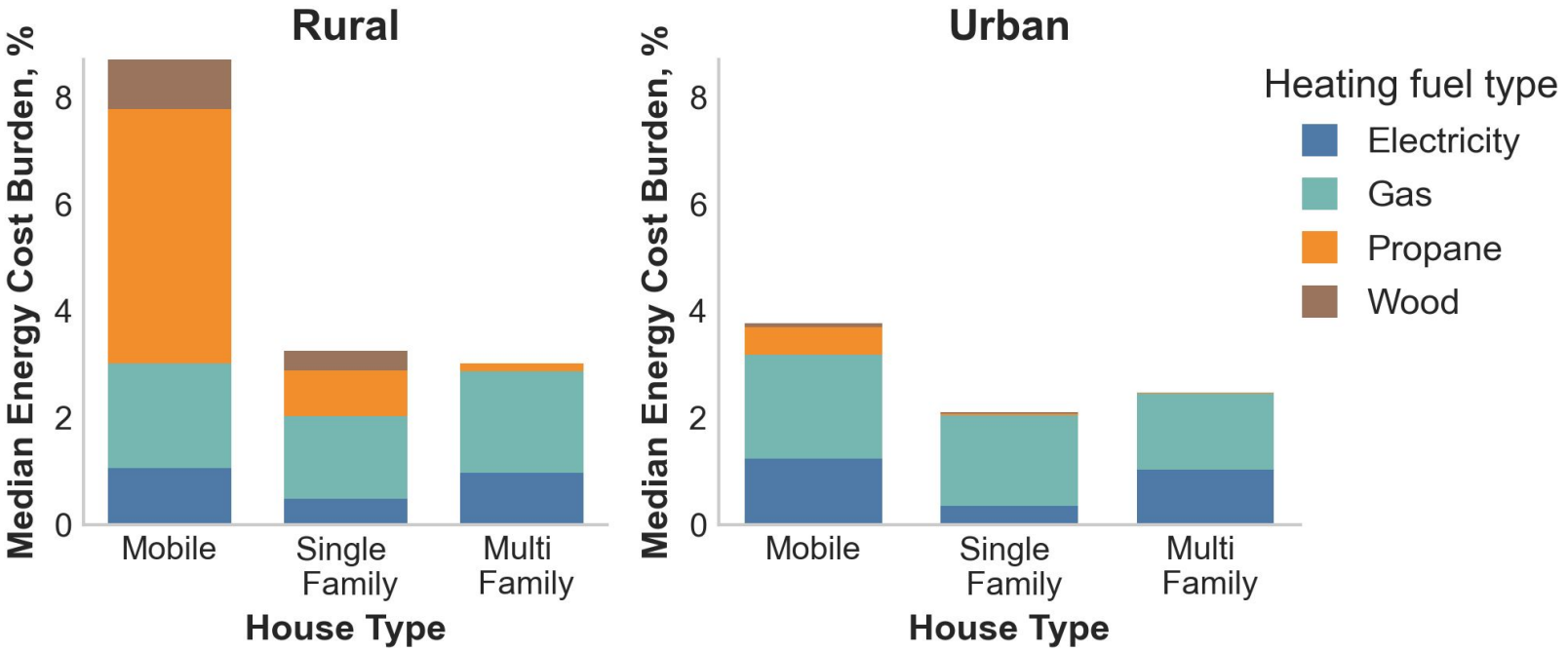
Low-income households are **more likely to use less energy, but spend a larger fraction** of their income on energy bills.

Energy Cost Burden and Demographics



Census tracts with a high proportion of renters, a high proportion of people of color, and lower average education levels tend to face higher energy cost burdens **even when controlling for income.**

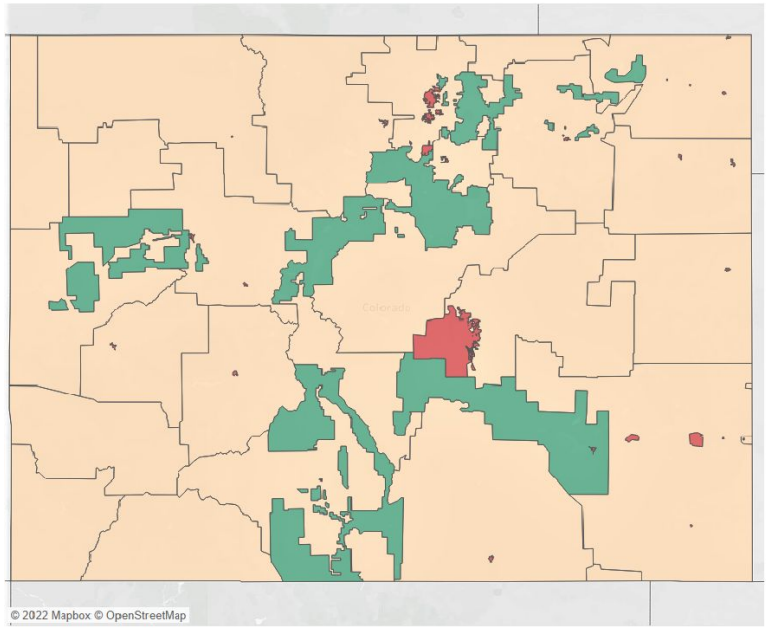
Energy Cost Burden and Housing Type



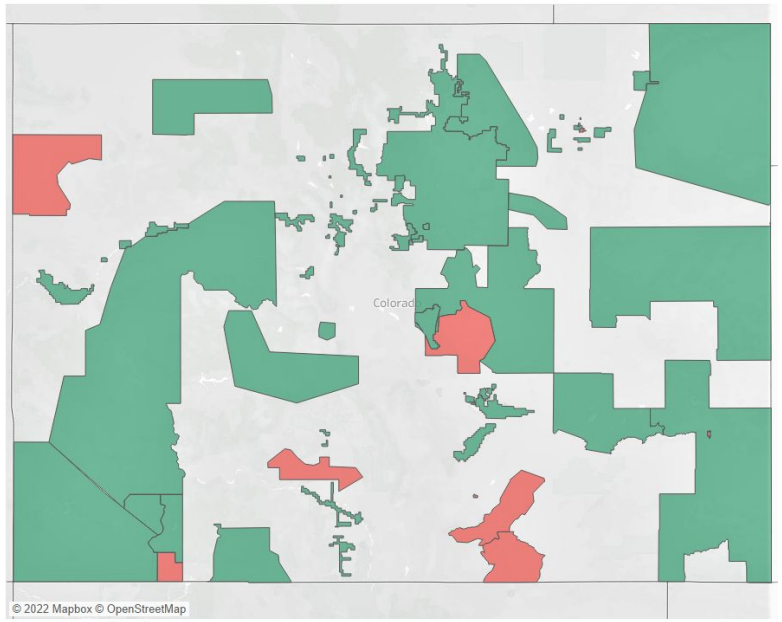
By far the highest energy cost burdens are in **rural, mobile** homes, heated primarily with **propane**.

Colorado Utility Service Territories

Electric Utility Service Areas



Gas Utility Service Areas

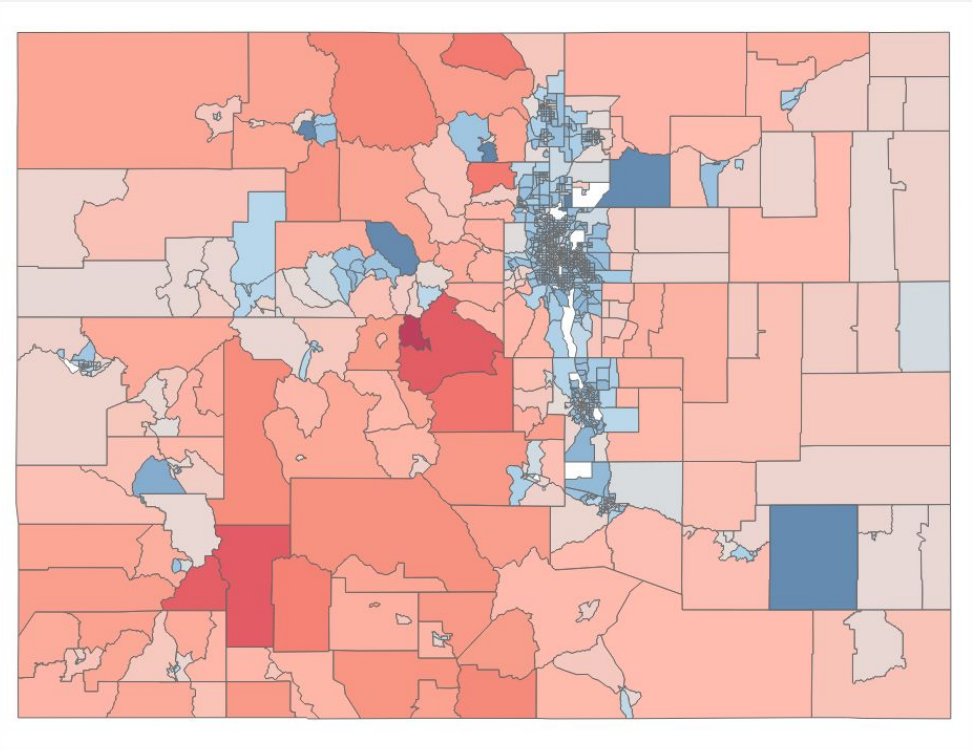


Utility Type
- Investor Owned
- Municipal
- Rural Cooperative

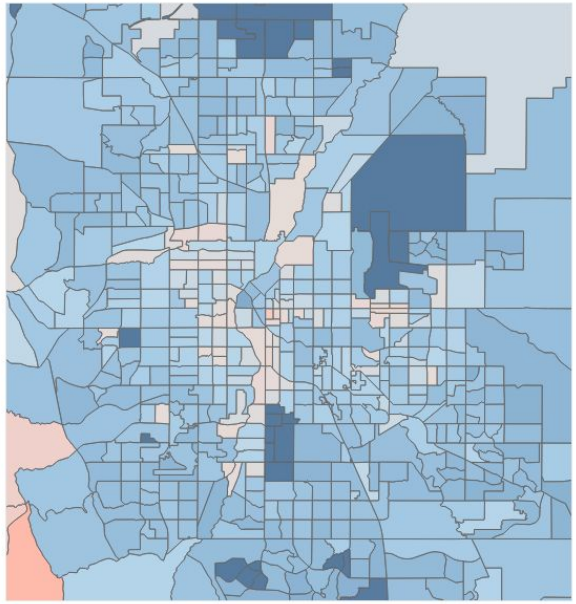
Energy Use Intensity Analysis

Energy Use Intensity by Census Tract

Household Energy Use Intensity by Census Tract (2019)



Denver Area

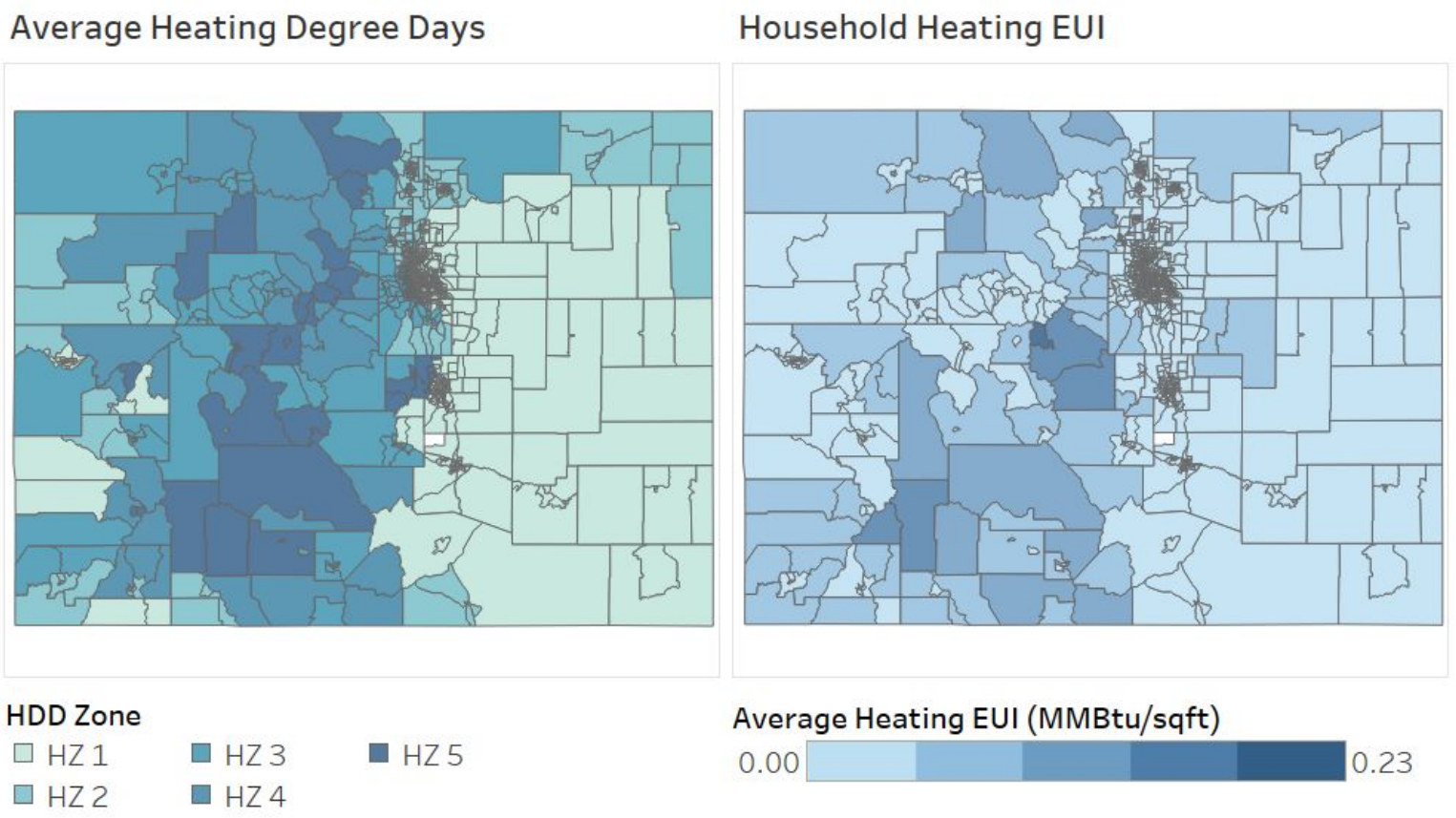


Average Household EUI (MMBtu/sqft)

0.00 — 0.24

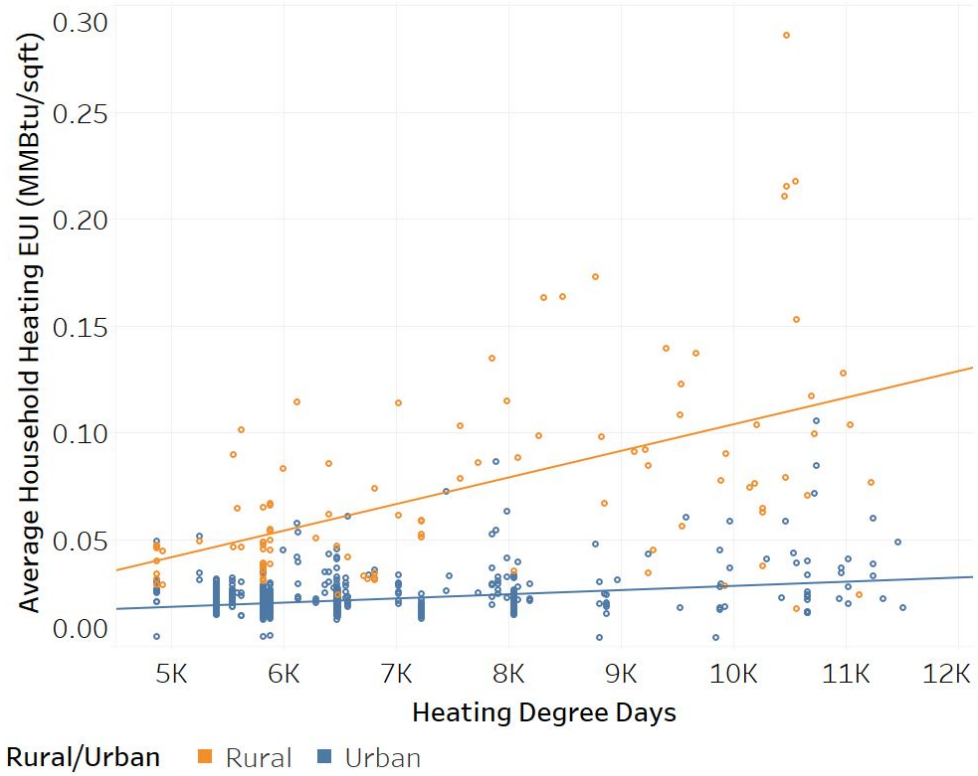
Energy Use Intensity is a metric for measuring home energy efficiency. Homes in **rural census tracts have by far the highest average Energy Use Intensities**, meaning they generally have the **least energy efficient homes**.

Heating Energy Use Intensity and Climate Zones



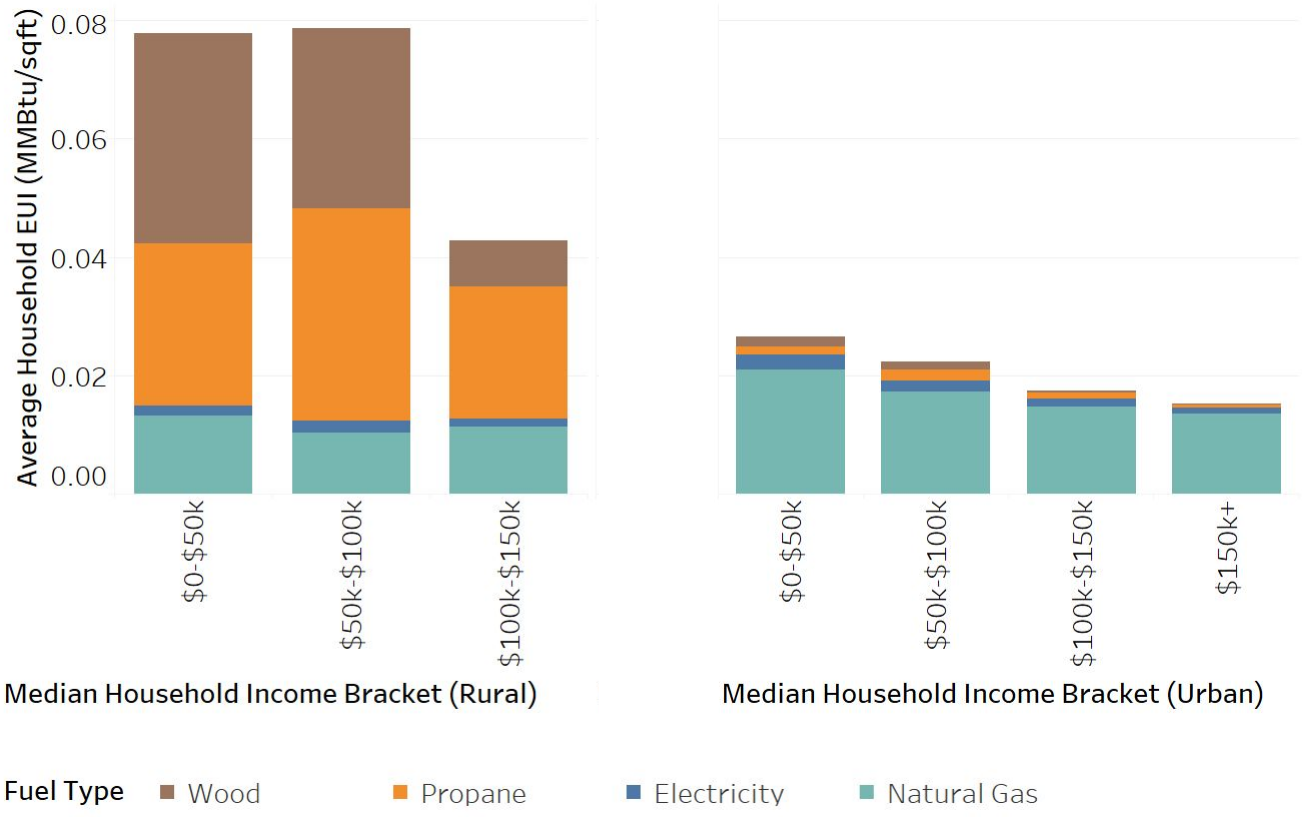
Census tracts in the coldest regions of the state tend to have the **highest average heating energy use intensities**.

Heating Energy Use Intensity and Climate Zones



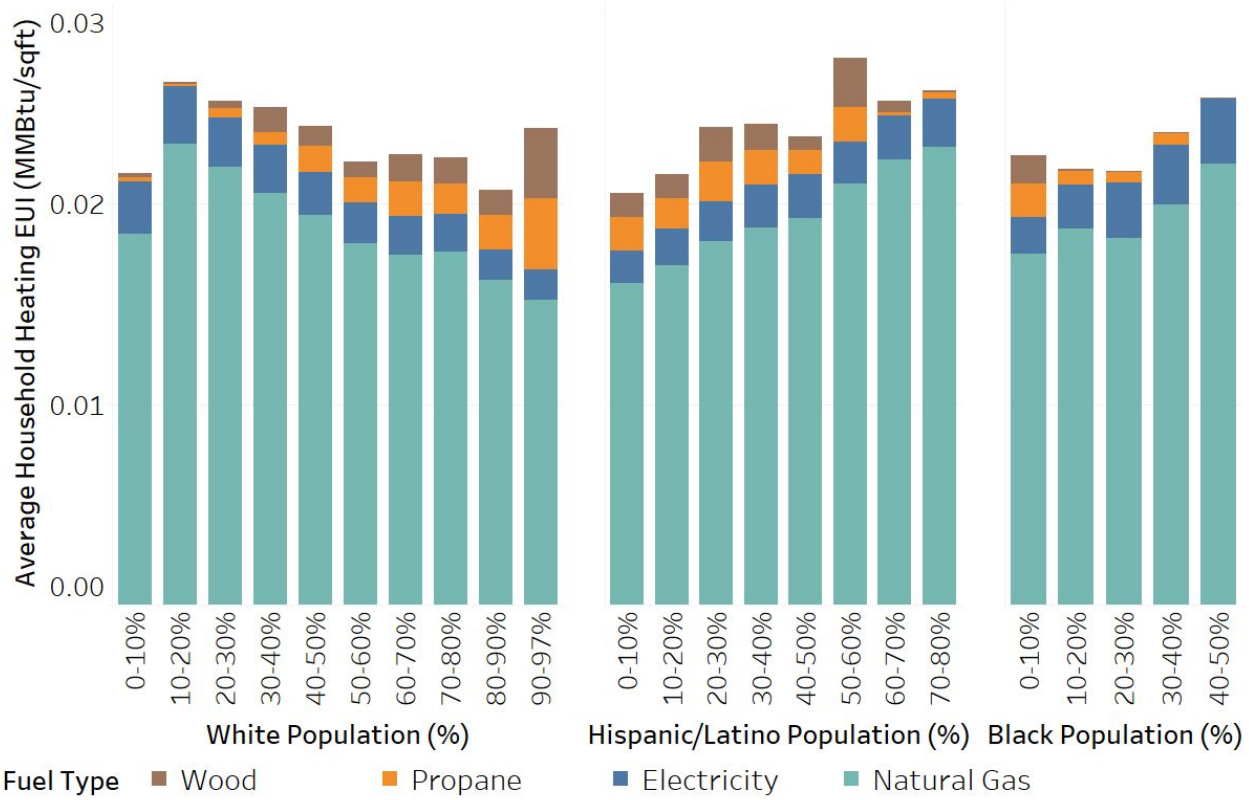
A higher number of Heating Degree Days is correlated with higher average household heating energy use intensity, however, **this trend is far more pronounced in rural areas**. Census tracts in the coldest regions with very high household energy use intensity are almost exclusively in rural areas.

Energy Use Intensity and Income



Across all income brackets, rural census tracts have higher average household energy use intensity than their urban counterparts. This stark difference is largely driven by the **heavy reliance on wood and propane in rural areas**.

Energy Use Intensity and Demographics



With some exceptions, urban census tracts with a higher percentage of white residents tend to have **lower average household heating EUI**, whereas **the opposite is true for tracts with higher percentages of Hispanic/Latino and Black residents**. **Gas** is the primary driver of heating EUI in urban census tracts.

Themes and Takeaways

- **Rural areas** across Colorado have higher energy cost burdens than urban areas, higher EUIs, and are more likely to use propane and wood. Homes in **urban areas** use less energy and are subject to lower energy prices on average.
- **Population characteristics** are important. Low-income households face disproportionately high energy cost burdens, and so do populations of color, even when controlling for income.
- **Tenure and housing type** are also correlated with energy cost burden. In urban areas, communities with a large fraction of renters have higher energy burdens, even though they use less energy on average and apartment buildings tend to be more energy efficient.
- **Colder climate** areas have higher energy use intensities and higher energy cost burdens. When controlling for climate and differences between rural and urban areas, lower income households are still less efficient.

Policy Recommendations

Our Approach

- **The Context**:
  All homes in Colorado will need to go through efficiency upgrades and electrification over the next 20-30 years to achieve state climate goals.

- **The Goal:**
  Reduce energy cost burdens to **below 6 percent** across Colorado over the next 20 years mainly with systemic investments.

- **The Path :**
  Achieve the goal through investments in weatherization and electrification, electrify energy use, and make the energy renewable.

  Change the role of bill assistance from the principal means to reduce energy cost burdens to a supplement.

Six Core Strategies

1. **Bill Assistance.** Expand enrollment in assistance programs—notably using the new resources for PIPP—in the near term.
2. **Energy Efficiency and Weatherization.** Greatly expand weatherization grants for the lowest income households (< 50% of Federal Poverty Limit, FPL) and provide low- to no-interest loans for the rest.
3. **Community Solar Gardens.** Expand community solar gardens to supply discounted energy.
4. **Demand Response.** Expand demand response for additional economic opportunities to LMI households.
5. **Beneficial Electrification.** Heating electrification will decrease overall energy use and most bills, electricity demand will go up as fossil fuel use goes down.
6. **Reduce Bill Assistance** over time as other measures start to effectively reduce energy cost burdens.

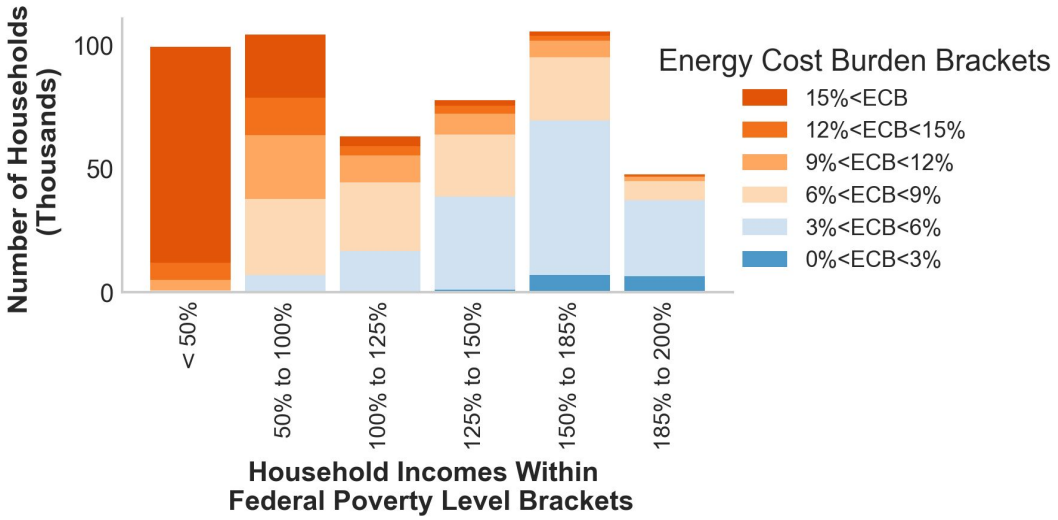
***Results:* Lower cost to reduce energy burdens and elimination of carbon emissions.**

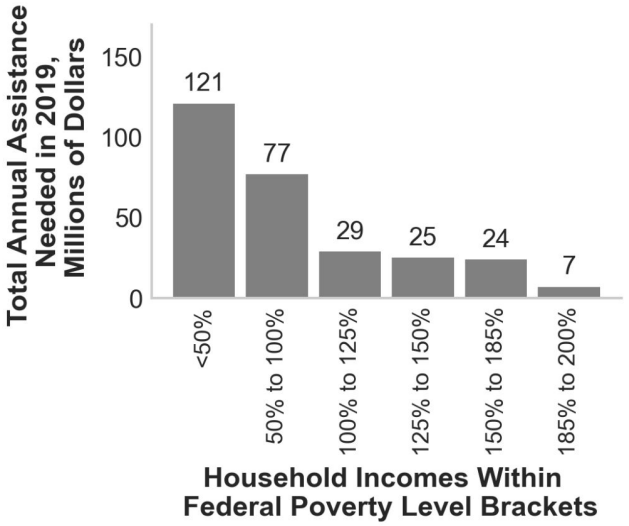
Bill Assistance: The Present Mainstay

- Total energy affordability gap: **~$280 million/year**
- **~70%** of the gap is households with incomes below 100% FPL
- Present assistance covers ~ **20%** of gap

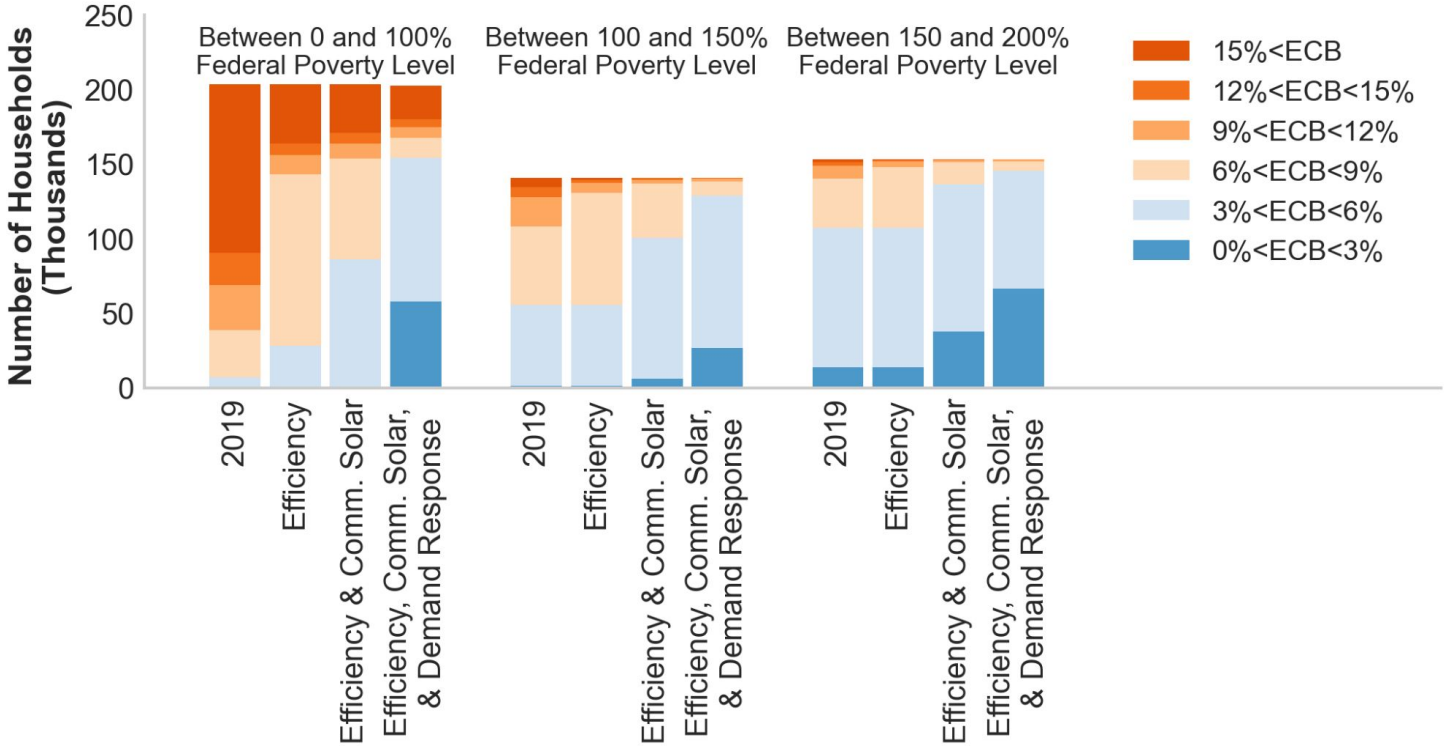
Key Recommendations

- Increase funding and enrollment efforts to expand PIPP
- Decouple LEAP and PIPP enrollment
- Use self-attestation for income
- HB21-1105 has started process of expansion and simplification





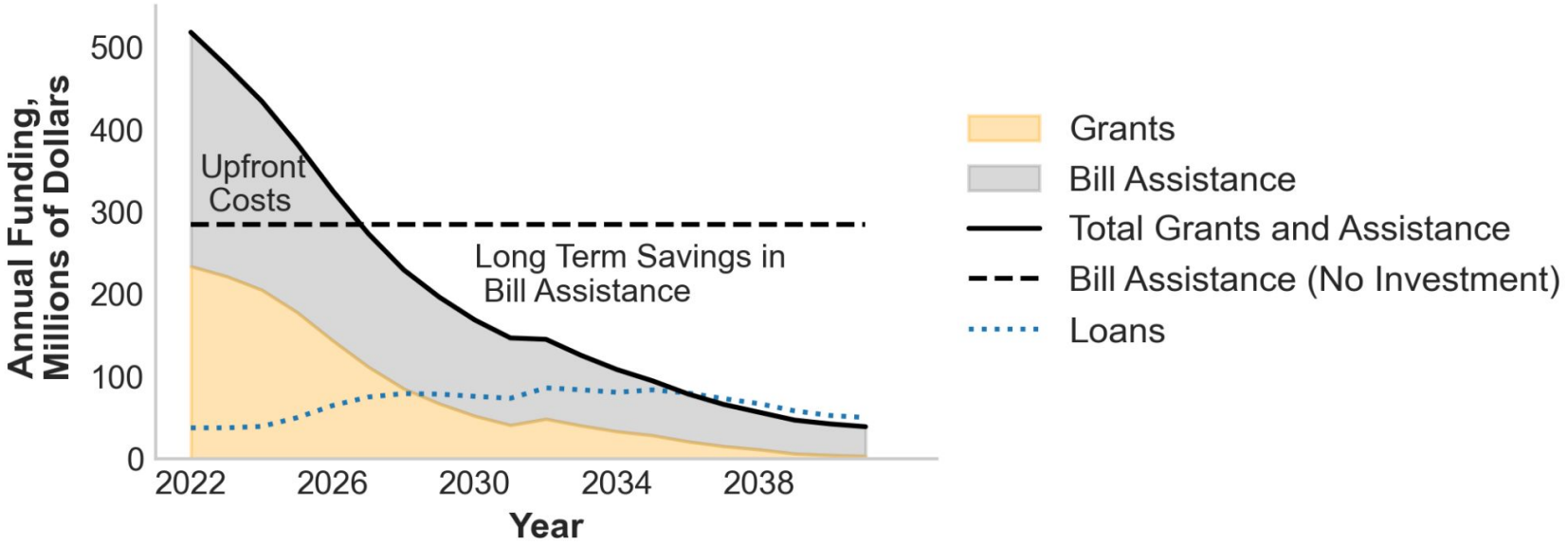
Efficiency, Community Solar Gardens, & Demand Response



Key Recommendations

- **Energy Efficiency and Weatherization**. Provide grants to households with the lowest incomes < 50% FPL with loans gradually replacing grants at higher incomes.
- **Community Solar Gardens.** Build out solar gardens to cover electricity needs for all households with incomes under 200% FPL. Subscriptions discounted at 20% and guaranteed with a loan-loss reserve by the CCEF.
- **Demand Response.** Support smart appliance adoption, expand broadband, and provide incentives for landlords.
- **Electrification**: Electrify fossil fuel heating, increasing the benefit of community solar discounts.
- **Combination** eliminates emissions and reduces the need for assistance to lowest income homes as a supplement.

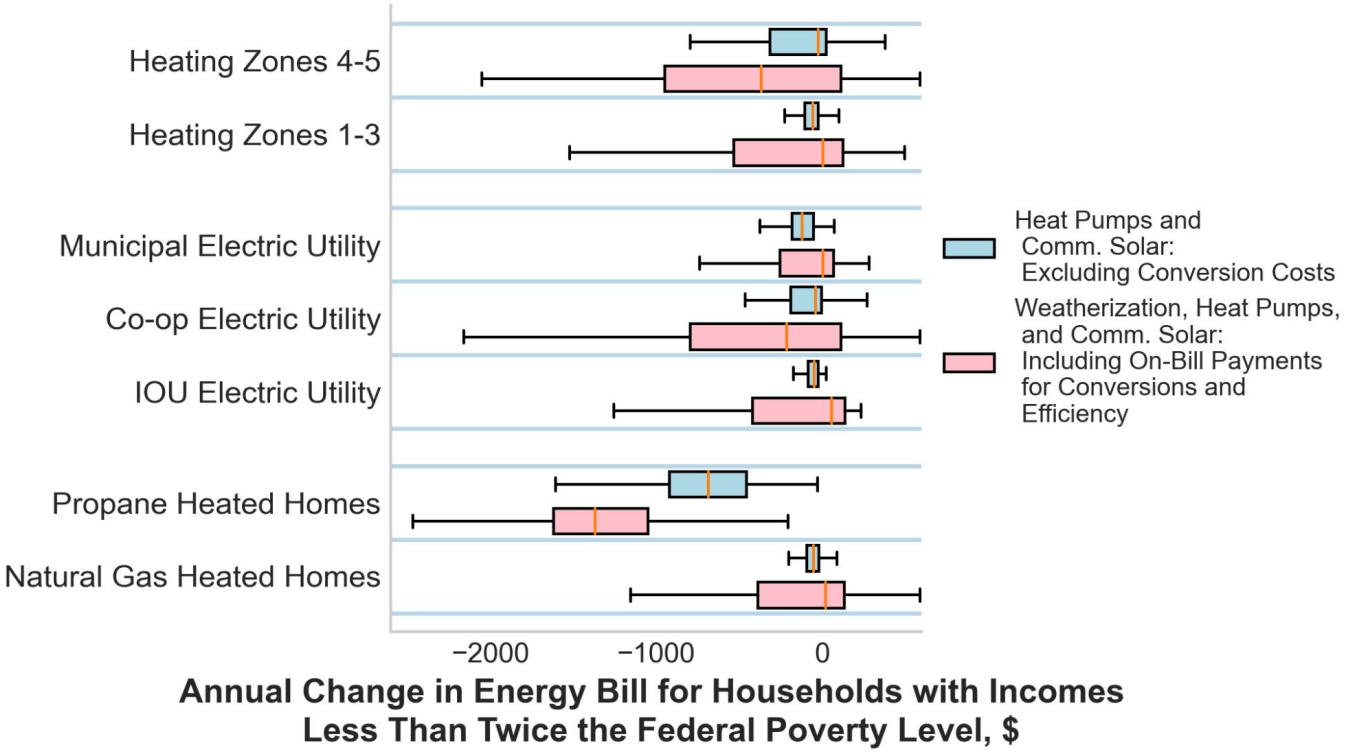
Policy and Financing Implications



- Systemic investments to reduce bills will reduce energy cost burdens at much lower cost than simple assistance to reduce burdens by the same amounts.
- Estimated cumulative savings over 20 years: $1.5 billion; (range: $1.3–$1.8 billion).
- Despite lower cost to reduce energy cost burdens, carbon dioxide emissions would be eliminated.
- Some assistance for lowest-income households would remain as a supplement.

**This slide was updated from the version originally presented to CEO.*

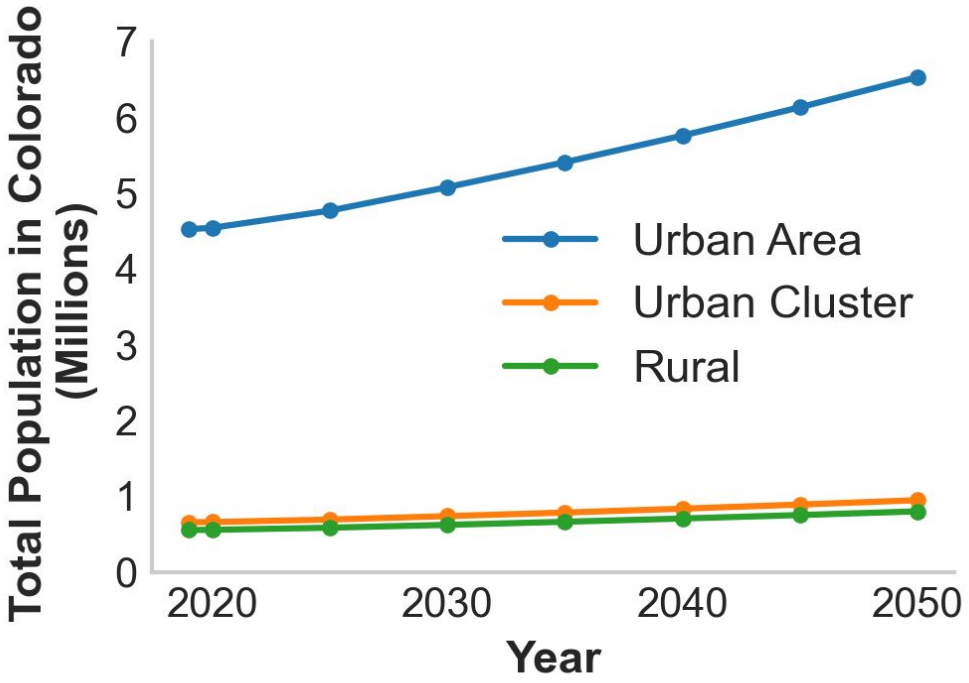
Beneficial Electrification: Differential Impacts



- Prioritize areas with propane heating, especially those with high electricity rates.
- Couple electrification with weatherization, especially in heating zones 4 and 5.
- Implement pilot projects that include seasonal thermal storage, especially in climate zones where resilience and the management of winter peaks will be important.
- Complement with demand response, especially focusing where where electrification of gas heating increases bills when investment costs are included.

Additional Considerations

- **Building standards:** Net zero energy for new buildings will lay the foundation for reducing grants for weatherization by gradually improving building stock.
- **Grid strengthening:** Particularly in rural areas.
- **Avoid new gas connections:** Electrify rather than add gas lines to avoid emissions and stranded cost risk.



Costs of High Burdens

- Severe conflicts between paying rent/ mortgage and utility bills, buying medicines, and food.
- At lowest income levels, energy cost burdens are typically more than 20 percent and sometimes more than 30 percent.
- Safety and health issues, such as using stoves and ovens for heating, and being too cold in the winter and hot in the summer.
- Conflicts result in ~five percent of low-income households getting LIHEAP assistance losing their homes each year.
- Cost to non-low-income people too. Example: homelessness leads to rise in emergency room visits. Cost per homelessness event: ~$20,000.
- Loss of productivity at school and work.

Benefits of Reducing Them

- Reduced indoor air pollution, better health.
- Reduced financial stresses and conflicts.
- Green and Healthy Homes data indicate that energy cost burden reduction to affordable levels can nearly eliminate foreclosure notices.
- Reducing energy burdens with systemic investments in weatherization, community solar, and electrification eliminates need for utility bill assistance for most low- and moderate-income households and associated social stigma that many feel with assistance.
- Integration of energy cost burden reduction with the energy transition eliminates carbon emissions at much lower cost than straight assistance payments.

Enabling Considerations

1. **Renter-landlord split incentives**
   a. Rebates for landlords to buy efficient, smart, demand-response-ready appliances
   b. Sharing demand response revenues between renters and landlords
2. **Universal broadband access**
   a. Critical for enabling households to participate in demand response programs
3. **Reducing barriers to accessing utility bill assistance**
   a. Self-attestation of income
   b. Expand PIPP enrollment pathways outside of LEAP
   c. Automatic enrollment for those receiving other benefits, such as nutrition assistance
   d. HB21-1105 has made a solid advance in this direction
4. **Capitalization of the Colorado Clean Energy Fund**
   a. CCEF will require adequate capitalization to take on the greatly expanded role of integrating equity with the energy transition

Key Recommendations
Integrating Equity into the Energy Transition

1. Increase funding and enrollment efforts to expand the PIPP program to alleviate energy cost burdens
2. Provide weatherization and electrification grants to the lowest-income households at or below 50 percent of the Federal Poverty Level.
3. Use funds from the CCEF to finance weatherization and electrification, preferably through on-bill financing.
4. Expand community solar gardens to provide electricity at discounted rates for low- and moderate-income households with a CCEF loan-loss reserve as an enabling financial instrument.
5. Support the adoption of smart appliances and expand demand response to provide additional energy cost benefits to residential households.
6. Adjust PIPP and other energy assistance programs over time as the other measures reduce overall energy cost burdens.
7. Stop the expansion of gas infrastructure to areas that do not have it and upgrade the grid in those areas with priority.

Key Recommendations
Integrating Equity into the Energy Transition

1. **Fuels:** Prioritize areas with propane heating for all investments.
2. **Urban areas:** Prioritize community solar gardens in urban areas.
3. **New buildings:** Set net-zero electricity and all-electric construction standards for new homes.
4. **Net-metering equity:** Extend net-metering indefinitely to low- and moderate-income households.
5. **Heat pump incentives:** Consider added incentives for conversion to electric heating for homes that have no air-conditioning at present.
6. **Pilot projects:** Implement pilot projects, such as community seasonal thermal storage in the coldest climate zones, to help manage winter peaks as heating electrification is increased and improve resilience.

Thank You!

Conclusion

PSE Bringing science to energy policy

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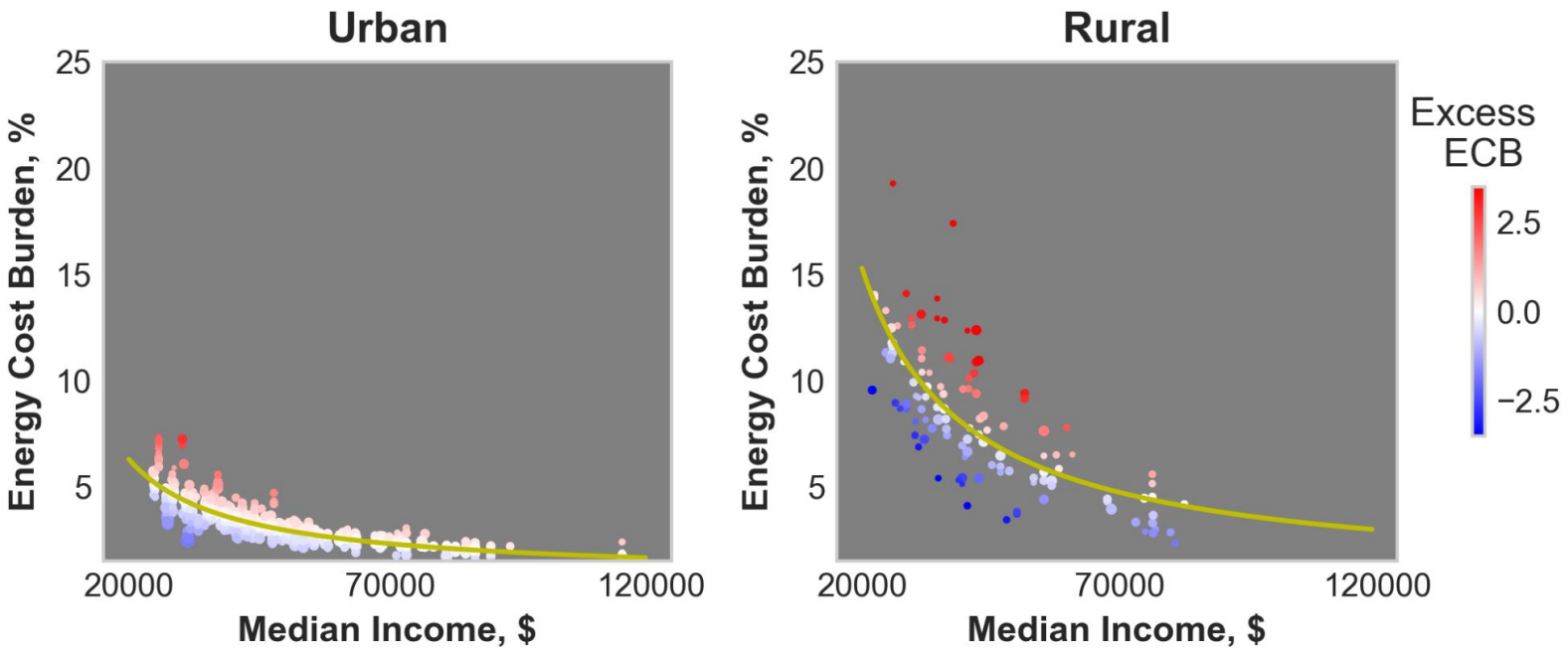
Supplemental Slides

Controlling for Income



Energy Cost Burden Differential and Demographics