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The Costs of Decarbonizing Multifamily Buildings in DACs and Rural Areas

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Equity and Decision Making

TOTAL US Homes = 123.5 million*

*eia data from 2020/2021

► **Cost and affordability**

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?

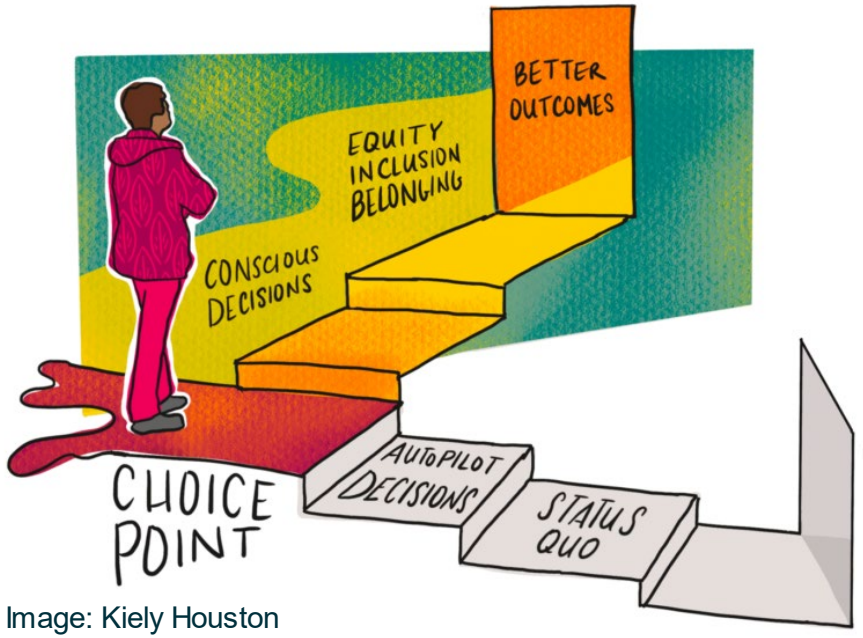
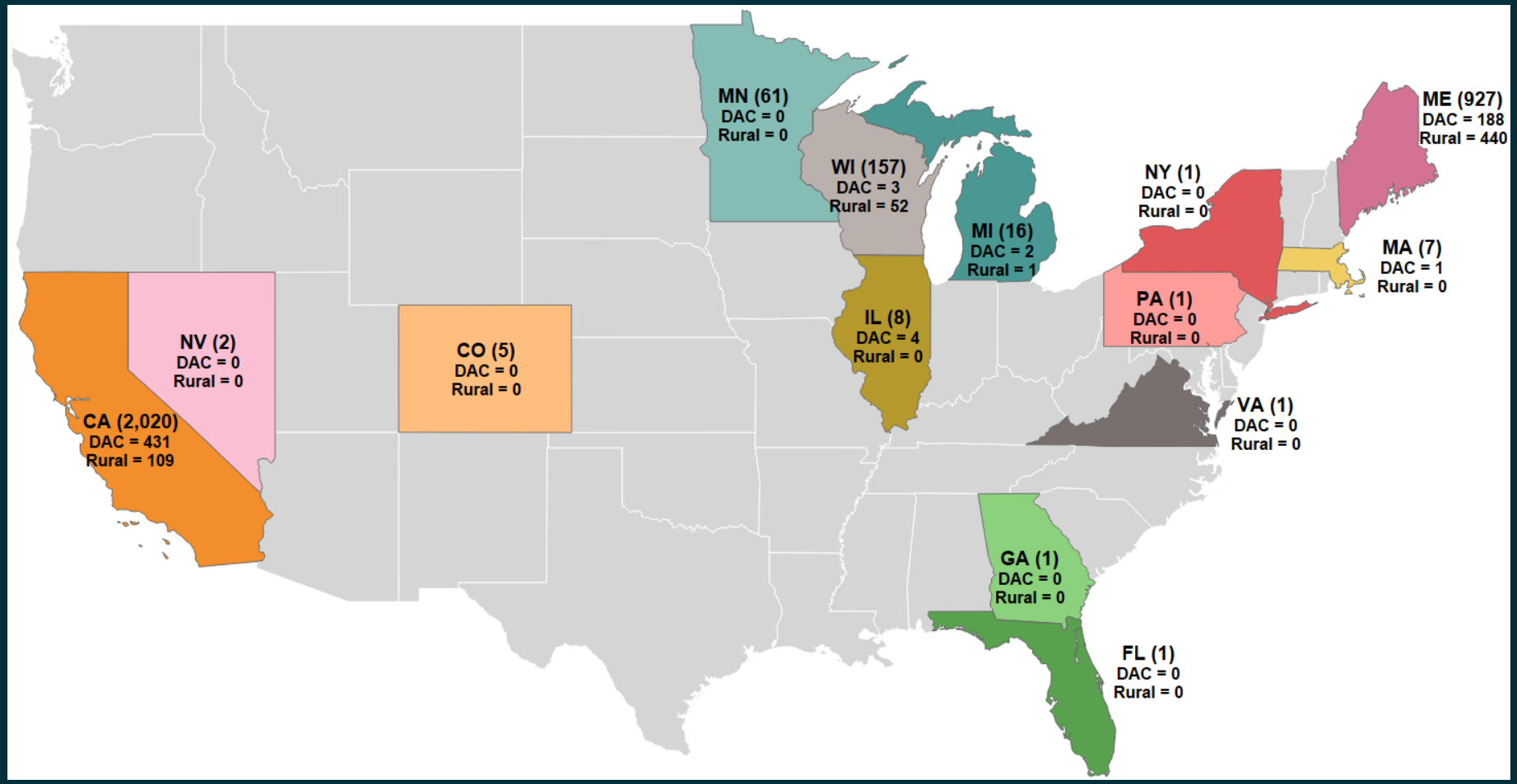


Image: Kiely Houston

Developing a Cost Database for Decarbonizing Existing Multifamily Buildings

Preliminary data from ongoing study

Multifamily Buildings - Database Summary



These costs don't include rebates

Total Projects = 14 states 3,208 projects 6,949 measures $395,750,685 (project cost)

Projects in DACs	=	6 states	629 projects	1,195 measures	$66,222,608 (project cost)
Projects in Rural area	=	4 states	602 projects	1,166 measures	$34,109,949 (project cost)

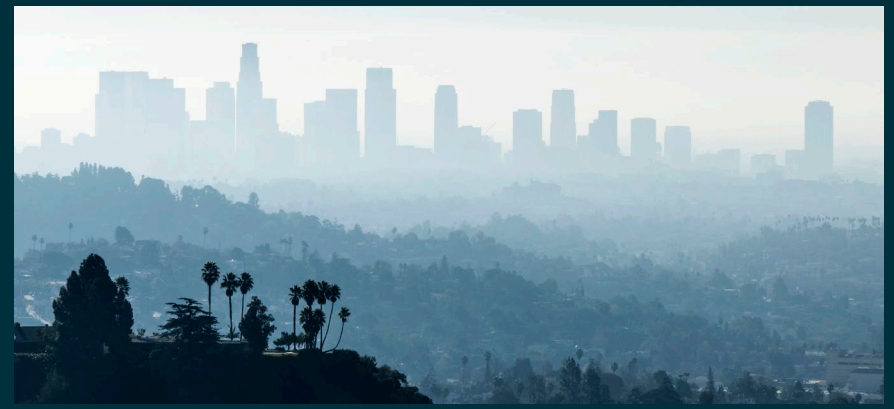
Decarbonization Costs

DOE / LBNL Effort to Create a Database of

- Costs - broken down by measure
- Energy (and calculated CO_2) savings, both real and modeled/predicted
- All costs in and $2023 and adjusted for location and inflation

Sample of Convenience

- Data not systematically recorded (e.g., separating labor materials and soft costs)
- No standard format
- Looking for buildings with significant energy reduction



Added Complexity for Multifamily

Single-family vs Multifamily

- **Housing type:** Affordable; Market rate
- **Building typology:** Attached; semi-attached; isolated
- **Rise:** Low-; Mid-; High-Rise
- **Unit ownership:** Renter; owner
- **Historical building:** Yes; No
- **Elevator:** Yes; No
- **Original use of the building**
- **Unit type:** SRO; 1B; 2B; 3B; etc.
- **Heating, cooling and DHW configuration:** Units; Central
- **Occupied during retrofit:** Yes; No
- **Retrofit type:** Retrofit; Gut Rehabilitation
- **Non-residential space:** Lobby; Laundry; Corridors

Metric ► $/unit

Equity Implication of Energy Retrofit Costs

Preliminary data from ongoing study

Equity-Related Information in the Database

► Ideally → Household-level demographic information to evaluate the distribution of costs and benefits

► Since we only have project / building level information → we use location data to identify some characteristics of the type of community that the retrofit took place in

We focus primarily on:

- Urban vs Rural
- non-DAC vs DAC

Now → Low + Moderate vs Mid + Upper income
→ Climate resilience, climate risk, etc.,

Identifying Equity Variables

Literature Review

State and local policies & initiatives for building decarbonization

Incentive program funding allocation criteria

Mapping tools and data availability

DACs

- Recently, more mapping tools have become available that identify **DACs**, allowing increased **policy and program** focus on these communities

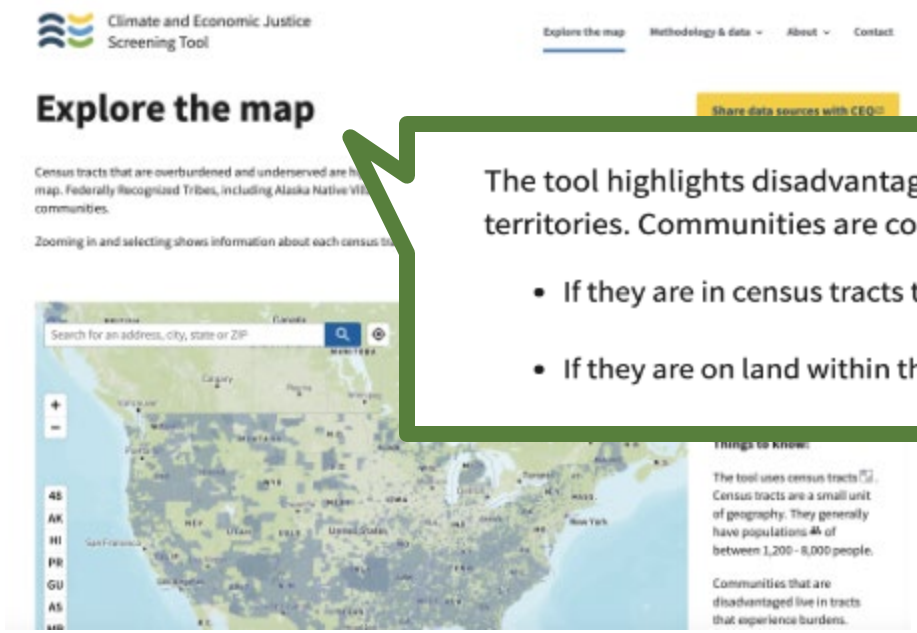
RURAL COMMUNITIES

- They face an **energy efficient housing gap** and receive less focus in **policy and incentives**

INCOME

- Commonly used as a factor in incentive programs and existing policies.
- The link between **income** and **energy burden** is well documented in the literature.

Defining Disadvantaged Communities



The tool highlights disadvantaged census tracts across all 50 states, the District of Columbia, and the U.S. territories. Communities are considered disadvantaged:

- If they are in census tracts that meet the thresholds for at least one of the tool's categories of burden, or
- If they are on land within the boundaries of Federally Recognized Tribes

- There are many different definitions of **DACs** used in various mapping tools

- Many mapping tools are state-level
- In this project – We used the definition from the **White House Climate and Economic Justice Screening Tool (CEJST)** (since we have a spread of data across different states)

Multifamily Buildings - Database Summary

		TOTAL Database		
	Project Characteristics	Reported Buildings	Low-rise	Mid- & High-rise
Home Vintage	Pre 1900	3%	4%	---
	1900 - 1959	32%	33%	27%
	1960 - 1979	27%	31%	15%
	1980 - 1999	16%	16%	13%
	2000 - 2020	22%	16%	46%
Project Year	2010-2018	22%	13%	60%
	2019	8%	6%	22%
	2020	4%	3%	4%
	2021	43%	50%	6%
	2022	23%	27%	6%
	2023	---	---	1%
	2024	---	---	---
Project Duration	≤1 month	31%	47%	---
	2 months	20%	19%	2%
	3 months	14%	8%	2%
	4 months	8%	4%	10%
	5 months	5%	3%	6%
	6 months	2%	3%	4%
	≤1 year	17%	10%	55%
	≤2 years	3%	5%	14%
	>2 years	1%	1%	6%
Number of Stories	Low-rise	91%		
	Mid-rise	7%		
	High-rise	2%		

Multifamily Buildings - Database Summary

		TOTAL Database			Disadvantage Community (DAC)			Rural Community		
	Project Characteristics	Reported Buildings	Low-rise	Mid- & High-rise	Reported Buildings	Low-rise	Mid- & High-rise	Reported Buildings	Low-rise	Mid- & High-rise
Home Vintage	Pre 1900	3%	4%	---	4%	4%	---	---	---	---
	1900 - 1959	32%	33%	27%	13%	13%	---	---	---	---
	1960 - 1979	27%	31%	15%	35%	35%	---	---	---	---
	1980 - 1999	16%	16%	13%	19%	17%	---	40%	---	---
	2000 - 2020	22%	16%	46%	29%	21%	8%	60%	---	---
Project Year	2010-2018	22%	13%	60%	21%	17%	4%	6%	---	---
	2019	8%	6%	22%	6%	6%	---	2%	---	---
	2020	4%	3%	4%	2%	1%	---	1%	---	---
	2021	43%	50%	6%	45%	43%	---	60%	56%	---
	2022	23%	27%	6%	24%	23%	---	31%	29%	---
	2023	---	---	1%	1%	1%	---	---	---	---
	2024	---	---	---	---	---	---	---	---	---
Project Duration	≤1 month	31%	47%	---	34%	33%	---	50%	50%	---
	2 months	20%	19%	2%	26%	10%	---	26%	16%	---
	3 months	14%	8%	2%	6%	6%	---	6%	6%	---
	4 months	8%	4%	10%	2%	2%	---	2%	2%	---
	5 months	5%	3%	6%	2%	2%	---	1%	1%	---
	6 months	2%	3%	4%	3%	3%	---	1%	1%	---
	≤1 year	17%	10%	55%	22%	6%	1%	14%	3%	---
	≤2 years	3%	5%	14%	5%	5%	---	---	---	---
	>2 years	1%	1%	6%	---	---	---	---	---	---

Number of Stories	Low-rise	91%
	Mid-rise	7%
	High-rise	2%

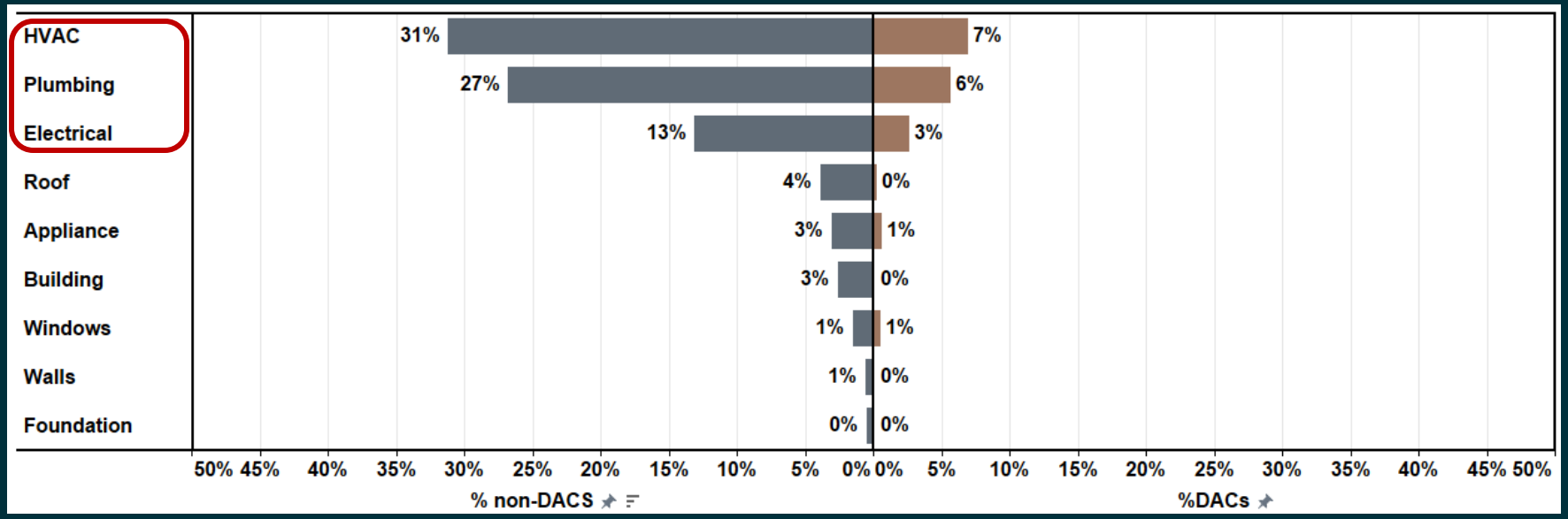
Multifamily Buildings – Project Cost Gross

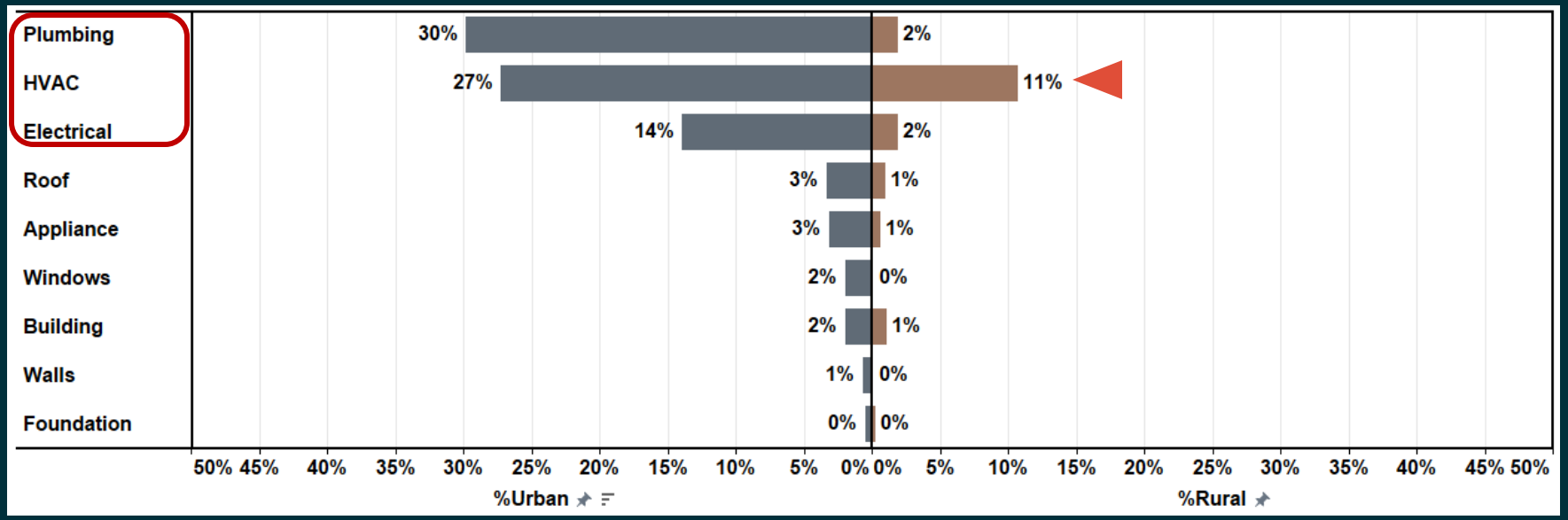
Project Cost Gross

Project Cost	TOTAL Database	Disadvantage Community (DAC)	Rural Community
	Median	Median	Median
Cost ($) per unit	$3,319 /unit (n=2,282)	$2,279 /unit (n=441)	$6,171 /unit (n=164)
Incentive ($) per unit	$760 /unit (n=2,000)	$1,239 /unit (n=403)	$1,681 /unit (n=107)
Incentive fraction of project cost per unit (%)	23% /unit (n=2,000)	54% /unit (n=403)	27% /unit (n=107)

Multifamily Buildings – Measure Cost

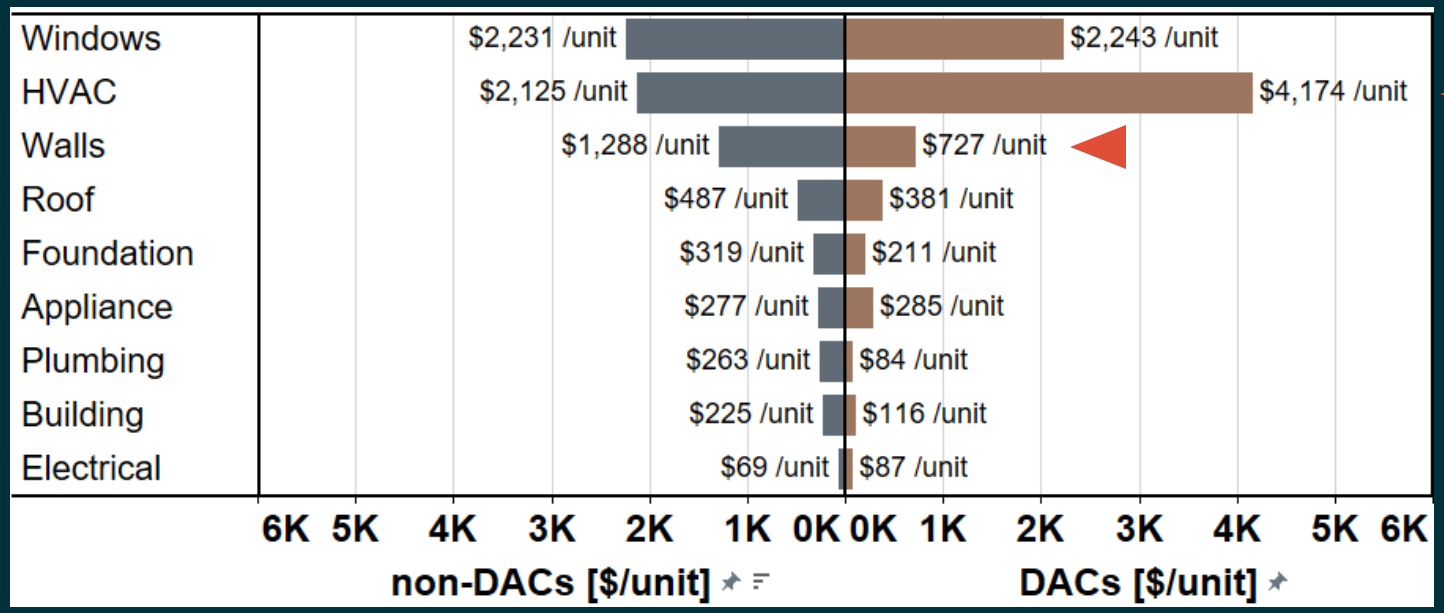
RECORDED Measures

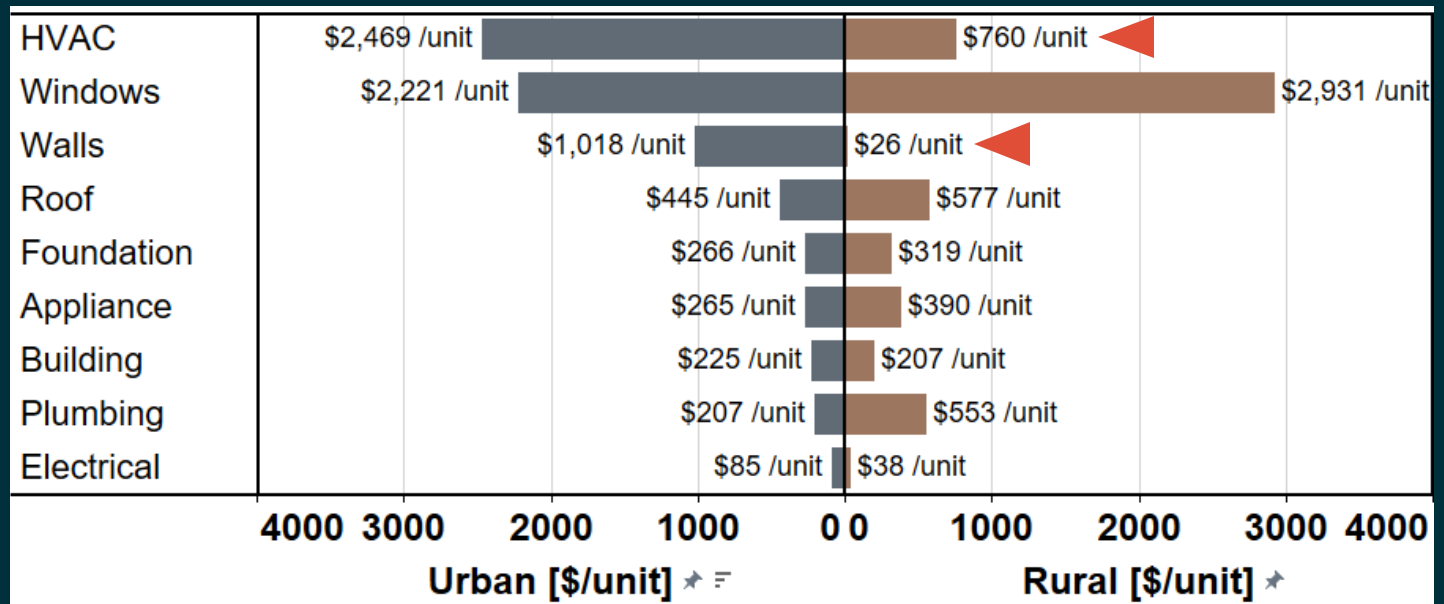




Multifamily Buildings – Measure Cost

Median Recorded Costs ($) per Unit





Equity Implications of Project Costs and CO_2 Savings

Regression Analysis of Project Cost ($) per Unit

CLIMATE ZONE
- Cold /Mixed Humid ► $6,363 /unit HIGHER than hot/warm climate

COMMUNITY TYPE
- DAC ► $805 /unit LOWER than non-DAC
- Rural Community ► $3,314 /unit HIGHER than urban communities
- Income ► not significant

Equity Implications of Project Costs and CO_2 Savings

Regression Analysis of CO_2 Savings per Unit

CLIMATE ZONE

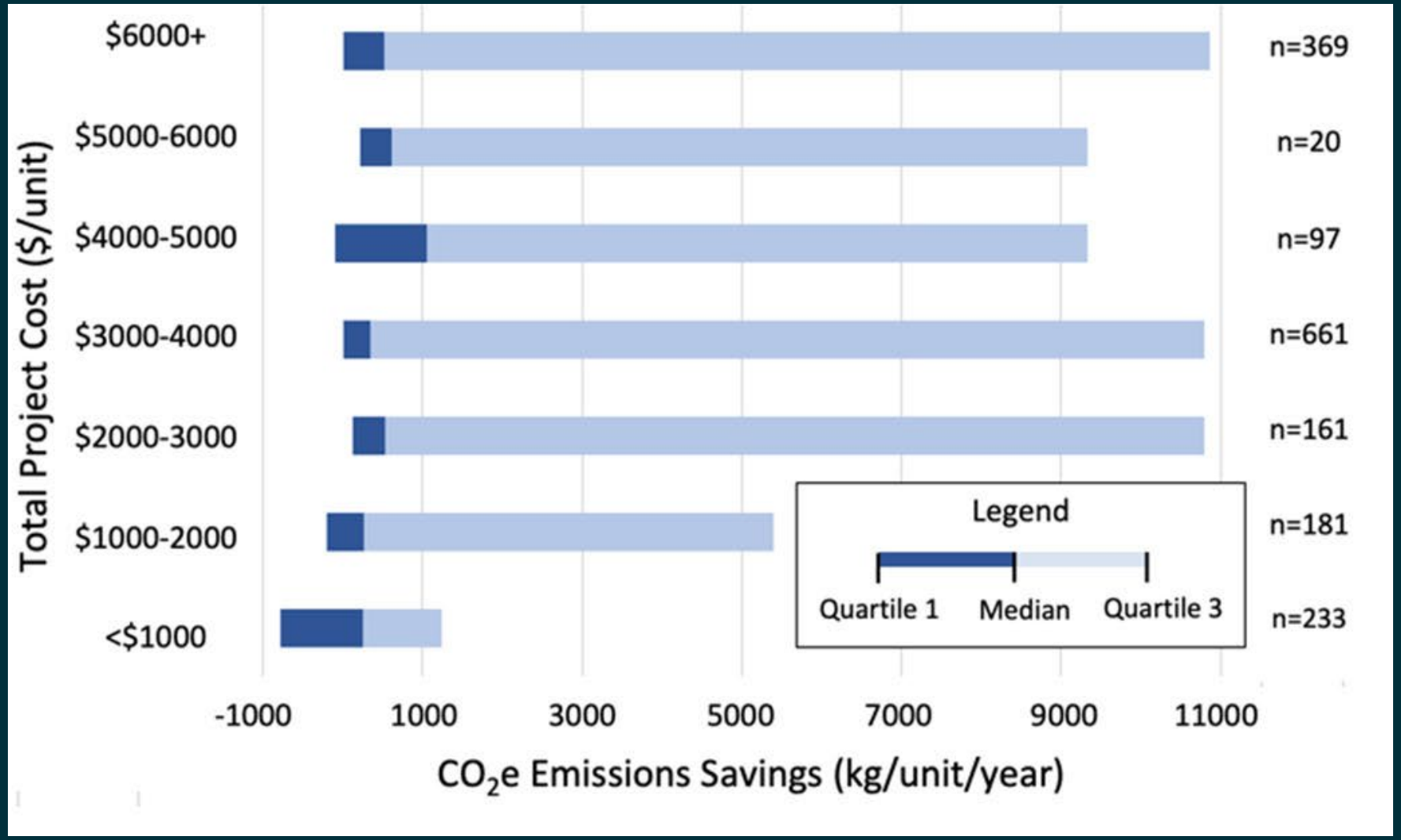
- Cold /Mixed Humid ► 2,193 /unit MORE than hot/warm climate
- Marine ► 509 /unit MORE than hot/warm climate

COMMUNITY TYPE

- DAC, Rural Community and Income ► not significant

Equity Implications of Project Costs and CO_2 Savings

Project ($) per Unit vs CO2 Savings



SUMMARY

COST and SOCIAL DIMENSION

- **Cost Variability** → The costs for decarbonizing MFs vary widely depending on the project scope and measures chosen, ranging from simple heat pump installations to comprehensive retrofits.
- **Data Sources** → Limits the understanding of comprehensive decarbonization impacts.
- **Cost Comparison** → Costs are lower per dwelling unit compared to SF.

- **Cost Variability** → Due to significant variability in project costs, it's difficult to definitively determine if costs are higher or lower for DACs.
- **Cost Variability** → Rural projects tend to have higher costs.

SUMMARY

CLIMATE and SOCIAL DIMENSION

- **CO2e Reductions** → Project costs do not correlate with CO2e reductions, suggesting a need for better optimization of projects to enhance CO2e savings.
- **Carbon Savings Impact** → DAC status, rural status, and income have minimal effect on project carbon savings.

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.org/10.20357/B7XG7T

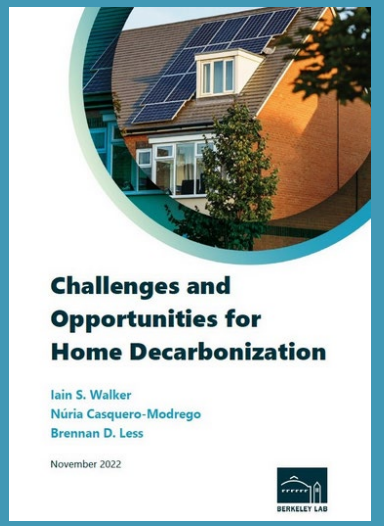
► Less, B. D., Casquero-Modrego, N., & Walker, I. S. (2022). Home Energy Upgrades as a Pathway to Home Decarbonization in the US: A Literature Review. Energies, 15(15), 5590. https://doi.org/10.3390/en15155590

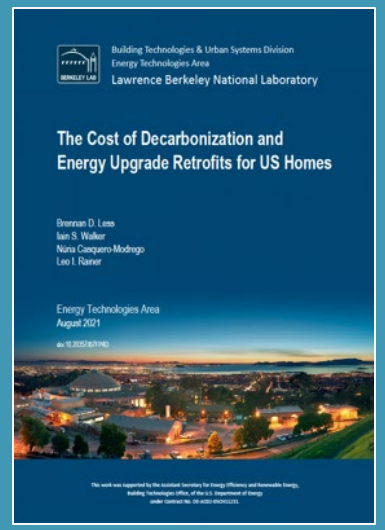
► Walker, I. S., Less, B. D., & Casquero-Modrego, N. (2022). Carbon and energy cost impacts of electrification of space heating with heat pumps in the US. Energy and Buildings, 259, 111910. https://doi.org/10.1016/j.enbuild.2022.111910

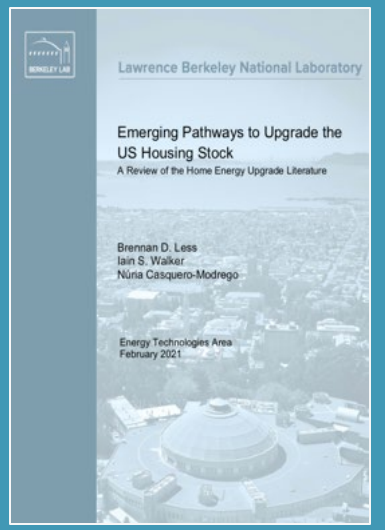
► Less, B. D., Walker, I. S., Casquero-Modrego, N., & Rainer, L. (2021). The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes. Lawrence Berkeley National Laboratory. https://doi.org/10.20357/B7FP4D

► 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







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Thank You…!
Questions?

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