Louisville Communities LEAP Engagement: Improving Energy Efficiency in Affordable Housing

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National Renewable Energy Laboratory

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Notice

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What is Communities LEAP?

Communities LEAP (Local Energy Action Program)

- The U.S. Department of Energy's Communities LEAP pilot provides customized, high-quality technical assistance to 24 community-driven action plans for clean energy-related economic development.
- In each community, coalitions of local partners contribute to project oversight and delivery.
- The National Renewable Energy Laboratory (NREL) is the primary technical assistance (TA) provider.
- Louisville's scope falls under the "Clean Energy and Energy Efficiency" pathway.

Louisville’s Scope

Scoping Evolution

Context and Challenges

- ~30% of population is low-income.
- High energy burden.
- Exposure to environmental health hazards.
- High fossil fuel usage from utility vs. ambitious clean energy goals.
- Need for additional affordable housing.
- Need for equitable access to clean energy job opportunities.

Application Priorities

- 100% clean energy community-wide by 2040.
- DER/EE for residential sector.
- Benefits/access for low-income renters/owners.
- Improvement to existing programs, develop new ones.
- Financial sustainability, viable within context.

DER: Distributed Energy Resources
EE: Energy Efficiency

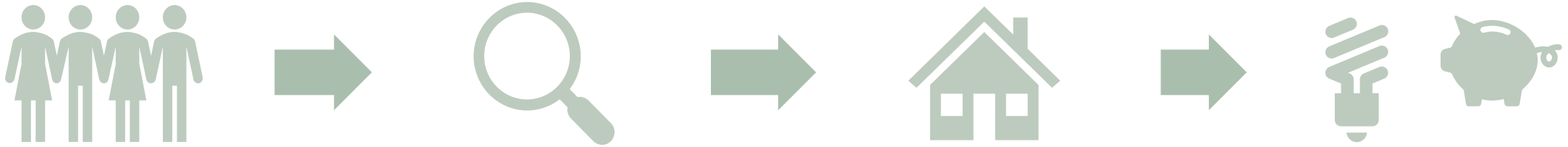
- Identify Low-hanging Fruit for Requirements in Affordable Housing
- Voluntary Community Benchmarking Ordinance
- Gap/Policy Analysis for DER/EE Programs
- Workforce Development
- Equitable Financing Solutions Identification

Communities LEAP
Louisville Energy Efficiency Analysis

Introduction/Objectives

- Core component in any energy efficiency strategy is determining which technologies to pursue.
- Each household and its needs will be unique, but modeling can highlight technologies worth considering.
- Here we highlight results for a single set of upgrade measures.

Approach



Community Input

- Local costs and inputs.
- Housing segments of interest to local community.

Take local data from national datasets.

- Focus on areas of interest chosen by community.
- Re-weigh samples to ensure results reflect community.

Process energy efficiency measures.

- Building envelope improvements
- Heat pumps
- Whole home electrification
- And more

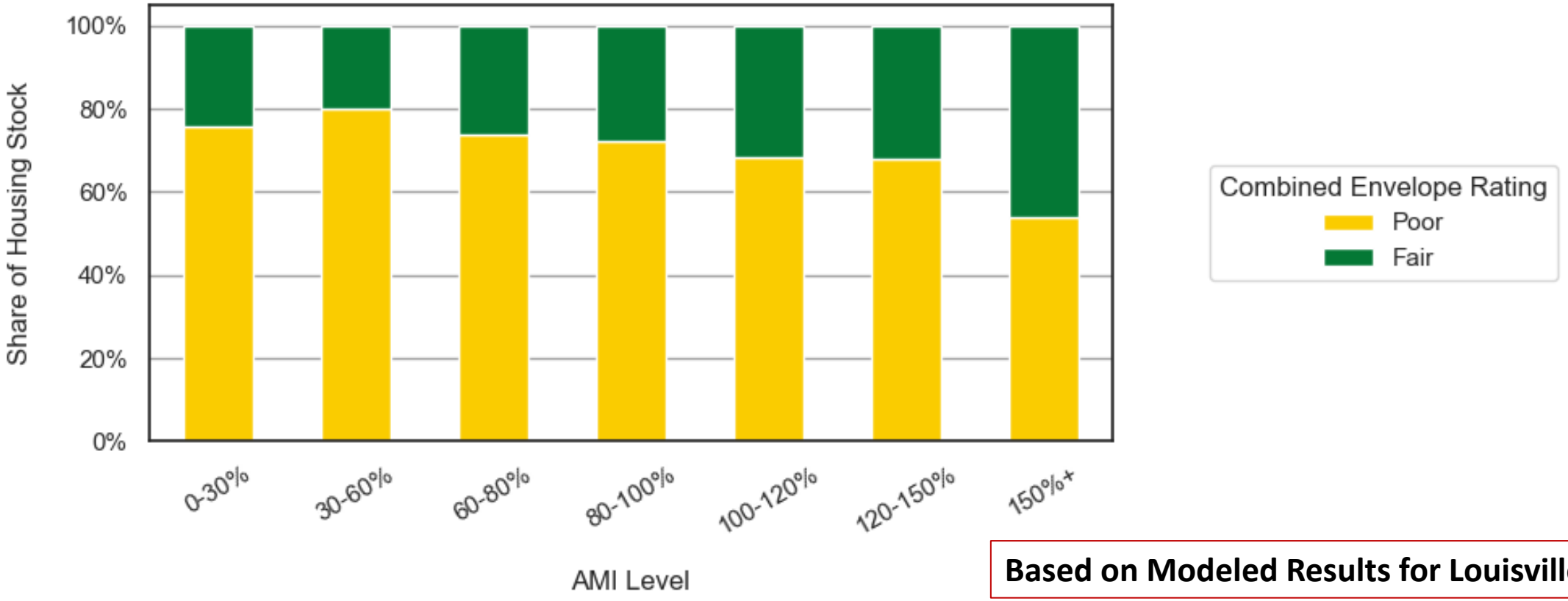
Calculate estimated savings.

- Energy
- Energy bills
- Emissions
- Estimated upgrade costs

Modeling Assumptions & Limitations

- Analysis is based on ResStock™-modeled energy consumption; all models have uncertainties.
- Modeling is aggregated across a generalized set of housing units; results for specific individual housing units in the community can vary substantially, and findings from this work are not necessarily applicable any specific individual home
- For the most part, national average costs, scaled based on a local cost/inflation adjustment factor, were used; costs do not include rebates; costs for any individual project can vary substantially.
- Utility rates were provided by the community.
- Specific measures and measure packages were modeled (not all potential technologies/ performance levels and packages).
- Heat pumps were modeled with existing heating system as backup and also separately modeled with electric backup; sized for cooling loads, which can produce more conservative estimates.
- Results are preliminary and may be updated prior to publication of final report and completion of Communities LEAP technical assistance.
- Building upgrades that are needed before electrification (remediation or a new electric panel) were not considered.

Many of Louisville's Buildings Are Not Well Insulated



Based on Modeled Results for Louisville

Criteria for Envelope Metric in Modeled Results

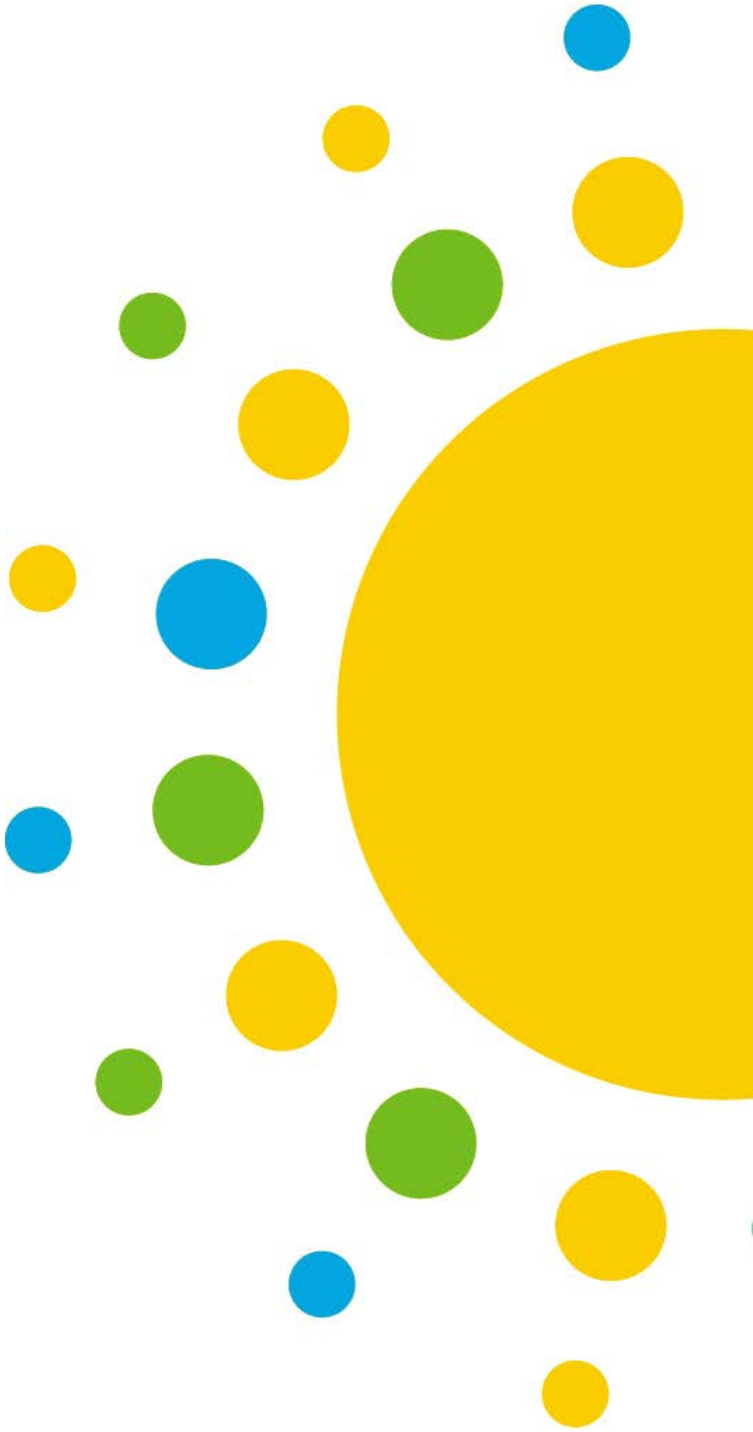
Source: Liu, L., Brossman, J., & Lou, Y. (2023). ResStock Communities LEAP Pilot Residential Housing Analysis — Detailed Methodology (Technical Report). NREL. https://data.nrel.gov/submissions/224

Envelope Metric (unit)	Good	Fair	Poor
Frame wall insulation (R-value)	$x \geq 30$	$7 \leq x < 30$	$x < 7$
Masonry wall insulation (R-value)	$x \geq 8$	$5 \leq x < 8$	$x < 5$
Ceiling or roof insulation (R-value)	$x \geq 60$	$14 \leq x < 60$	$x < 14$
Infiltration (ACH_{50})	≤ 3	$3 < x \leq 20$	$x > 20$

Area Median Income (AMI) levels up to 80% AMI based on 2019 HUD Section 8 income limits based on estimated household size, beyond 80% limits extrapolated.

	Family of four in 2019
80% AMI	$61,100 / year
50% AMI	$38,200 / year
30% AMI	$25,750 / year

Building Envelope Improvements



Home Envelope Overview

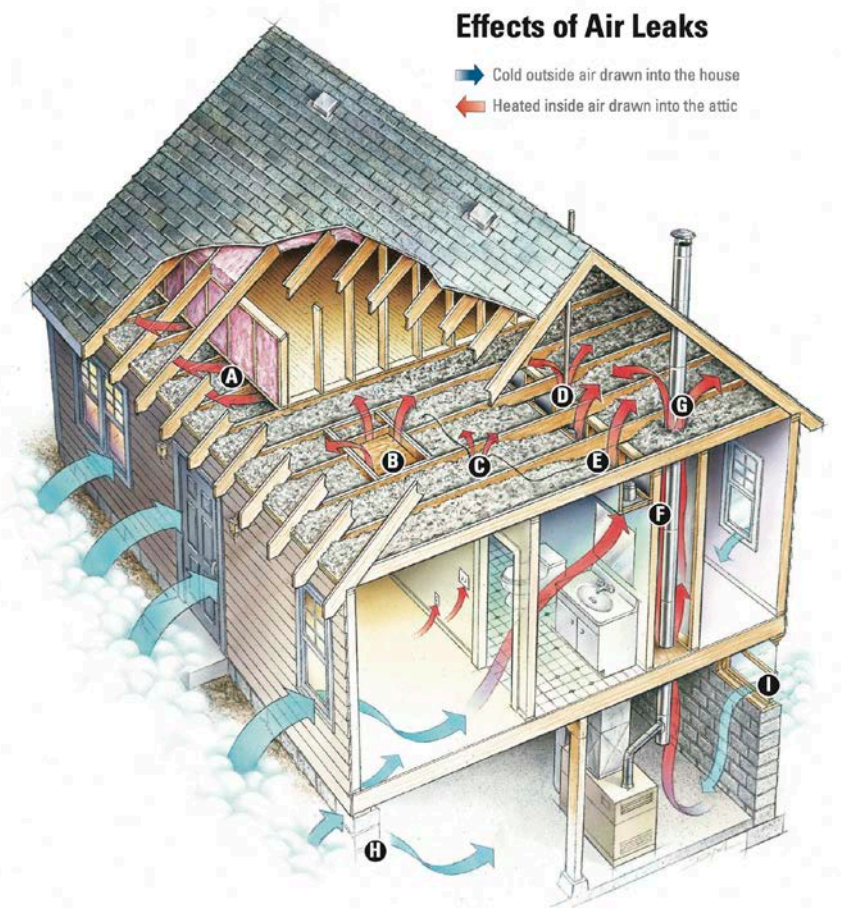
- Building Envelope: Everything that separates your home from the outside.
  - Walls
  - Windows
  - Attic and roof
  - Foundation floors and walls

- The envelope in Louisville matters:
  - Comfort: A well-insulated, tight home stays warmer in the winter and cooler in the summer.
  - Utility Bill Savings: Heating and cooling equipment does not have to work as hard and uses less energy to maintain indoor comfort.

Home Envelope Definitions

- Infiltration/Exfiltration: Air leaks into and out of a home.

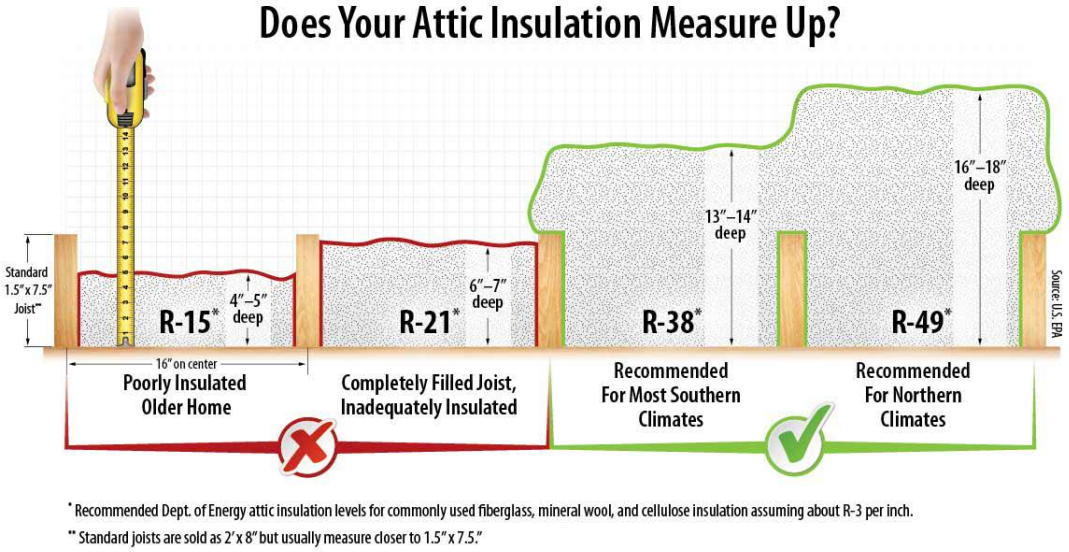
- Why does infiltration matter?
  - A leaky house requires more energy and is more expensive to heat and cool.
  - Poor infiltration is linked to home health hazards.



Source: https://www.energystar.gov/saveathome/seal_insulate
https://www.energyandfacilities.harvard.edu/green-building-resource/systems-materials-products/envelope-and-facade
***https://www.aafa.org/wp-content/uploads/2022/08/aafa-2021-asthma-capitals-report.pdf*

Home Envelope Definitions

- Insulation: Keeps the house cooler in the summer and warmer in the winter.
- R-Value: Measure of insulation's ability to resist heat traveling through it.
- E.g., for new single-family construction, ceiling insulation:
  - IECC 2009: R-38 (Louisville today)
  - IECC 2018: R-49
  - Enterprise Green Communities: R-49
  - IECC 2021 (latest codes): R-60



Ceiling insulation R-values and acceptability for residential homes based on climate.

Image: https://www.energystar.gov/products/energy_star_home_upgrade/attic_insulation

https://basc.pnnl.gov/information/2009-2021-iecc-and-irc-minimum-insulation-requirements-new-homes

Basic Enclosure Measure Package

Upgrade attic insulation to modern building codes (IECC 2021).

Reduce air leakage (infiltration) by 30%.

Seal ducts to 10% leakage, add R-8 insulation.

Drill and fill wall insulation to R-13.

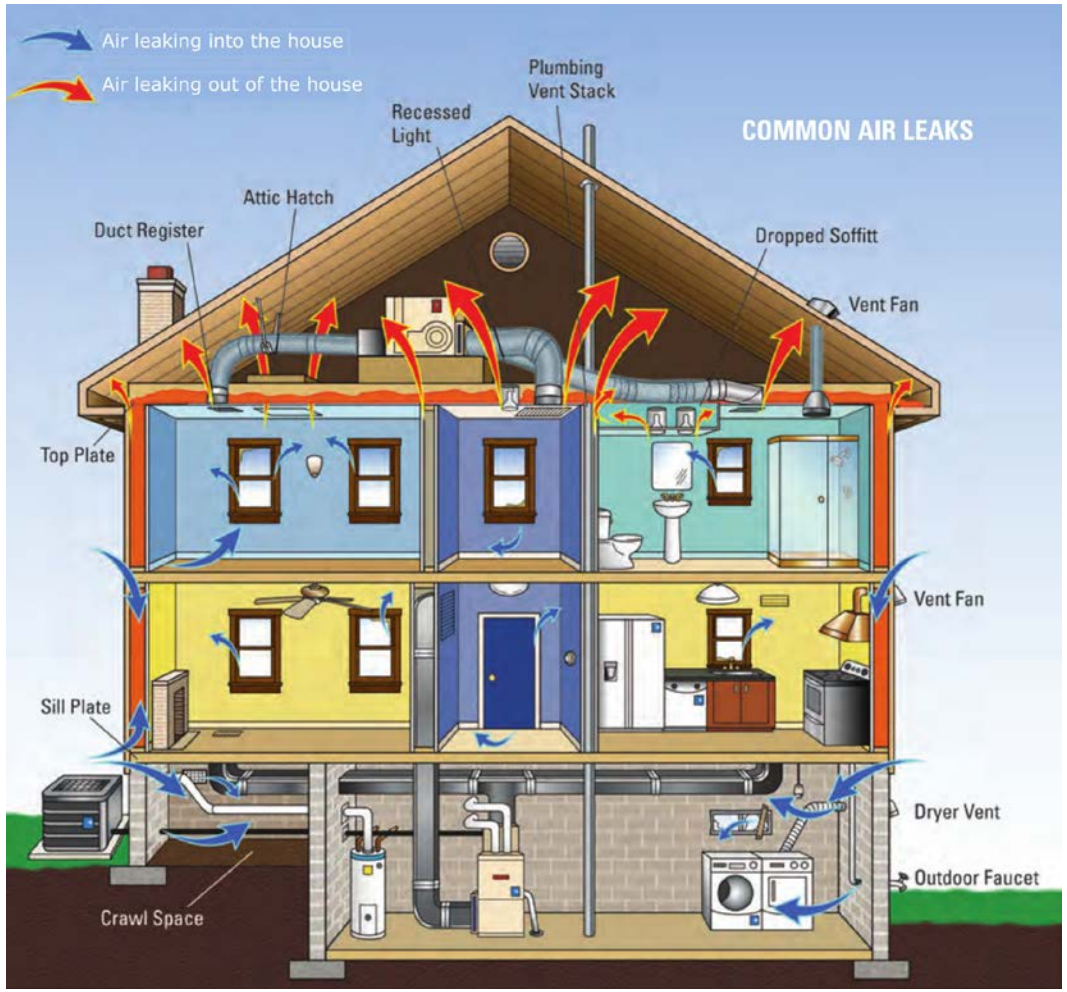


illustration: https://www.energystar.gov/sites/default/files/asset/document/HeatingCoolingGuide%20FINAL_9-4-09_0.pdf

Enhanced Enclosure Measure Package

Image: Dennis Schroeder, NREL 171785
Image: Cory Chovanec, NREL
Image: Dennis Schroeder, NREL 28694
Image: Dennis Schroeder, NREL 28725

Everything in the basic enclosure package, and…

Add R-10 to foundation walls and rim joists.

Seal crawlspace vents.

Insulate finished attic and cathedral ceilings to R-30.

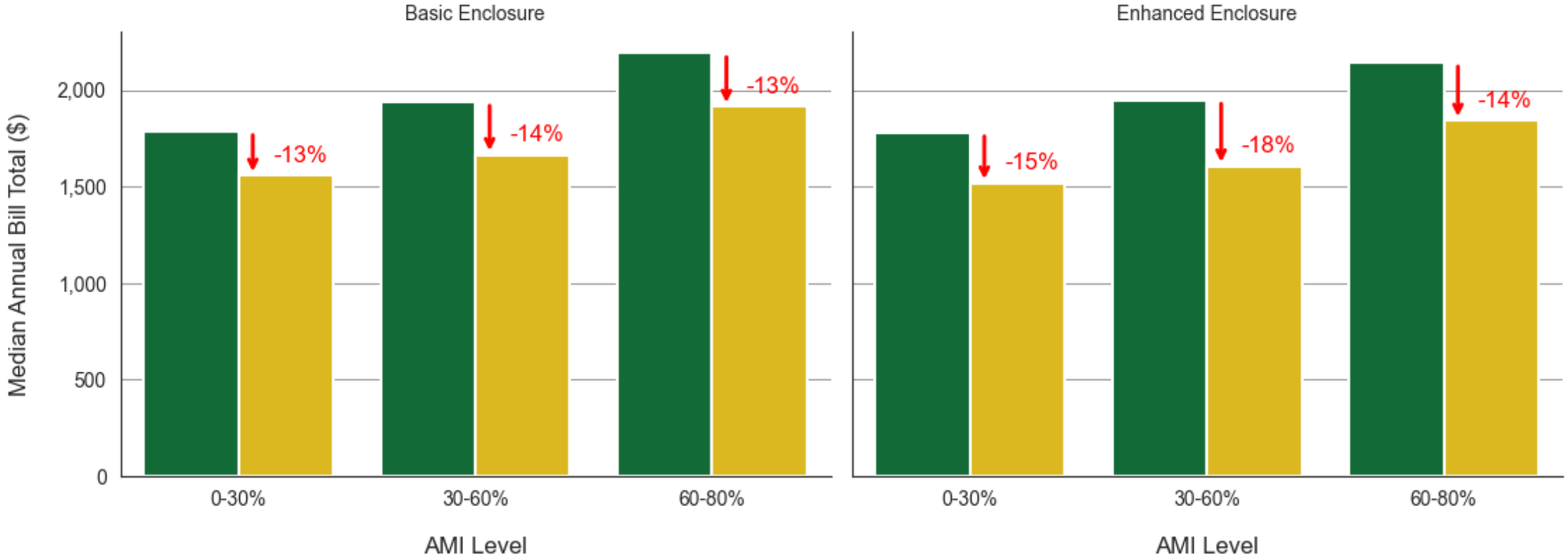
Installing attic insulation.

Installing exterior insulation.

Installing crawlspace insulation.

Rim joist installation.

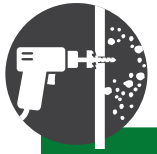
Building Envelope Improvements Can Lower Energy Costs in Many Low-Income Homes



*Does not include all costs associated with measure such as remediation and does not include program administration costs. Based on median costs.

Based on Modeled Results for Louisville

Median Modeled Savings Potential Per Household for Louisville



Basic Enclosure

		Single-Family	Multi-Family
Package Cost*		$3,700 – $8,500	$800 – $2,200
Bill Savings		$390/year	$140/year
Energy Savings	Electricity	8%	8%
	Nat. Gas	31%	20%
Emissions Reductions		19%	13%

Enhanced Enclosure

		Single-Family	Multi-Family
Package Cost*		$5,200 – $11,400	$900 – $3,400
Bill Savings		$480/year	$160/year
Energy Savings	Electricity	11%	10%
	Nat. Gas	37%	24%
Emissions Reductions		24%	15%

*Without incentives, does not include additional costs like remediation; range represents 25th and 75th percentile for respective household type.

Total Modeled Savings Potential for Louisville

Basic Enclosure

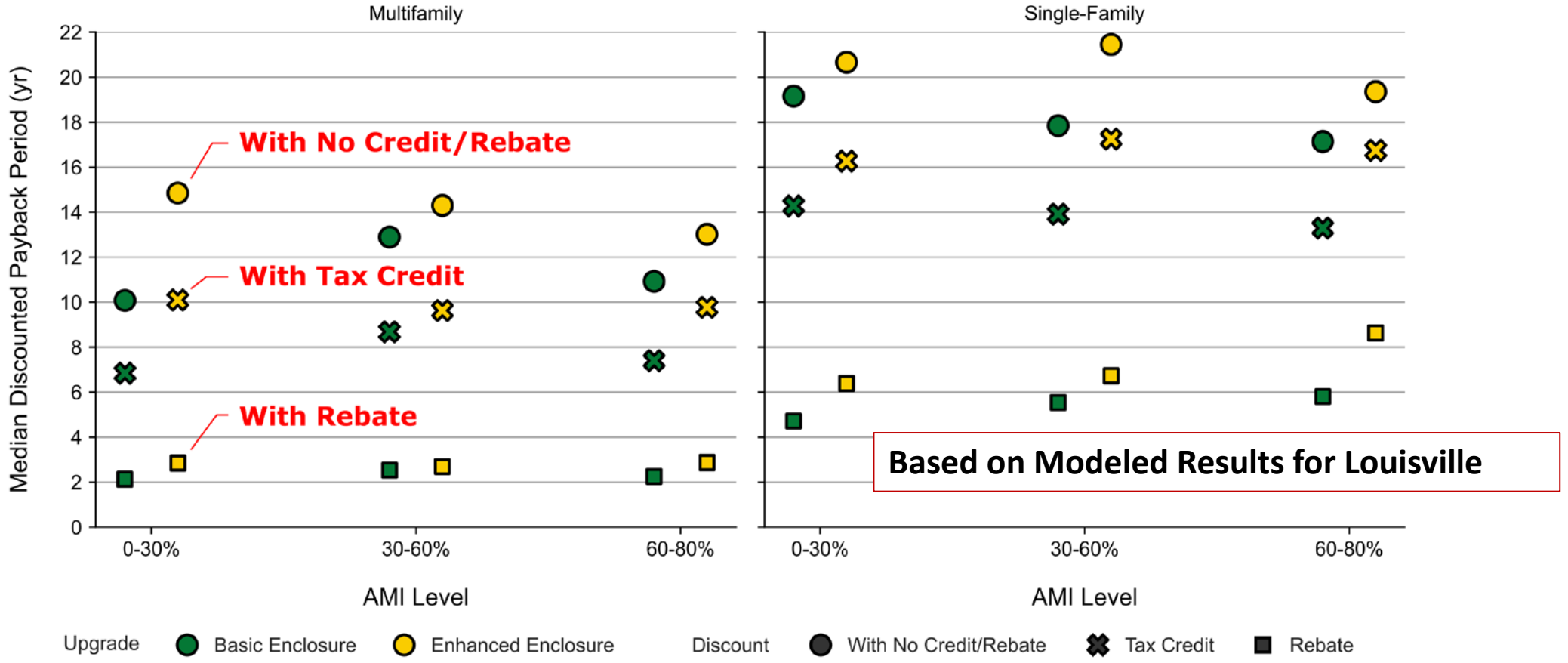
		Single-Family	Multi-Family
Dwelling Count		~251,000	~102,000
Annual Bill Savings		$120 million	$18 million
Annual Energy Savings	Electricity	14%	12%
	Nat. Gas	31%	26%
Annual Emissions Reductions		22% (~122,000 cars*)	16% (~16,000 cars*)

Enhanced Enclosure

		Single-Family	Multi-Family
Dwelling Count		~251,000	~102,000
Annual Bill Savings		$144 million	$23 million
Annual Energy Savings	Electricity	17%	15%
	Nat. Gas	37%	32%
Annual Emissions Reductions		26% (~146,000 cars*)	19% (~20,000 cars*)

*Equivalent number of cars removed from road based on assumption that a typical passenger vehicle emits ~4.6 metric tons of CO_2 per year. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle.

IRA-Like Tax Credits/Rebates Can Improve Economics of Modeled Envelope Measures in Louisville



Methodology for IRA-Styled Impacts

- **IRA rebate funds subject to state rules; ultimately, may vary from certain assumptions made for this example analysis.**
- Original assumes the original costs from ResStock.
- Tax Credit assumes 30% tax credit applied to project cost, up to $1,200.
  - Not all residents will have the tax burden to fully utilize the credit.
- Assumed rebates are based on two programs:
  - HOMES: Homes Energy Performance Based, Whole House Rebate
    - Rebate depends on modeled savings, AMI level: Max is 80% of costs up to $1,600.
    - Applies to entire project cost.
  - HEAR: Home Electrification and Appliance Rebate
    - Rebate depends on AMI level: Max is 100% of costs up to $1,600.
    - Applies to material/equipment. Assumes labor costs make up 25% of total ResStock costs.

Community Benchmarking Ordinance

Voluntary Multi-Family Affordable Housing Benchmarking Ordinances

What is Energy Benchmarking?

- Measuring how a building uses energy relative to the same building over time or similar “peer” buildings.
- Has been applied to municipal, commercial, and multi-family buildings.
- Can identify good candidates for investments in energy efficiency, can help monitor the performance of upgrades to ensure anticipated savings materialize.
- Existing tools can help automate this process, in particular if utility can provide data.
  - e.g., Standard Energy Efficiency Data (SEED) Platform

Image: http://www.louisvilleenergyalliance.org/kilowatt-crackdown.html

State and & Local Energy Efficiency Action Network. (2012). *Energy Benchmarking, Rating, and Disclosure for Local Governments* [Fact Sheet]. U.S. Department of Energy.

Community Benchmarking and Building Performance Standards are Being Adopted Around the Country

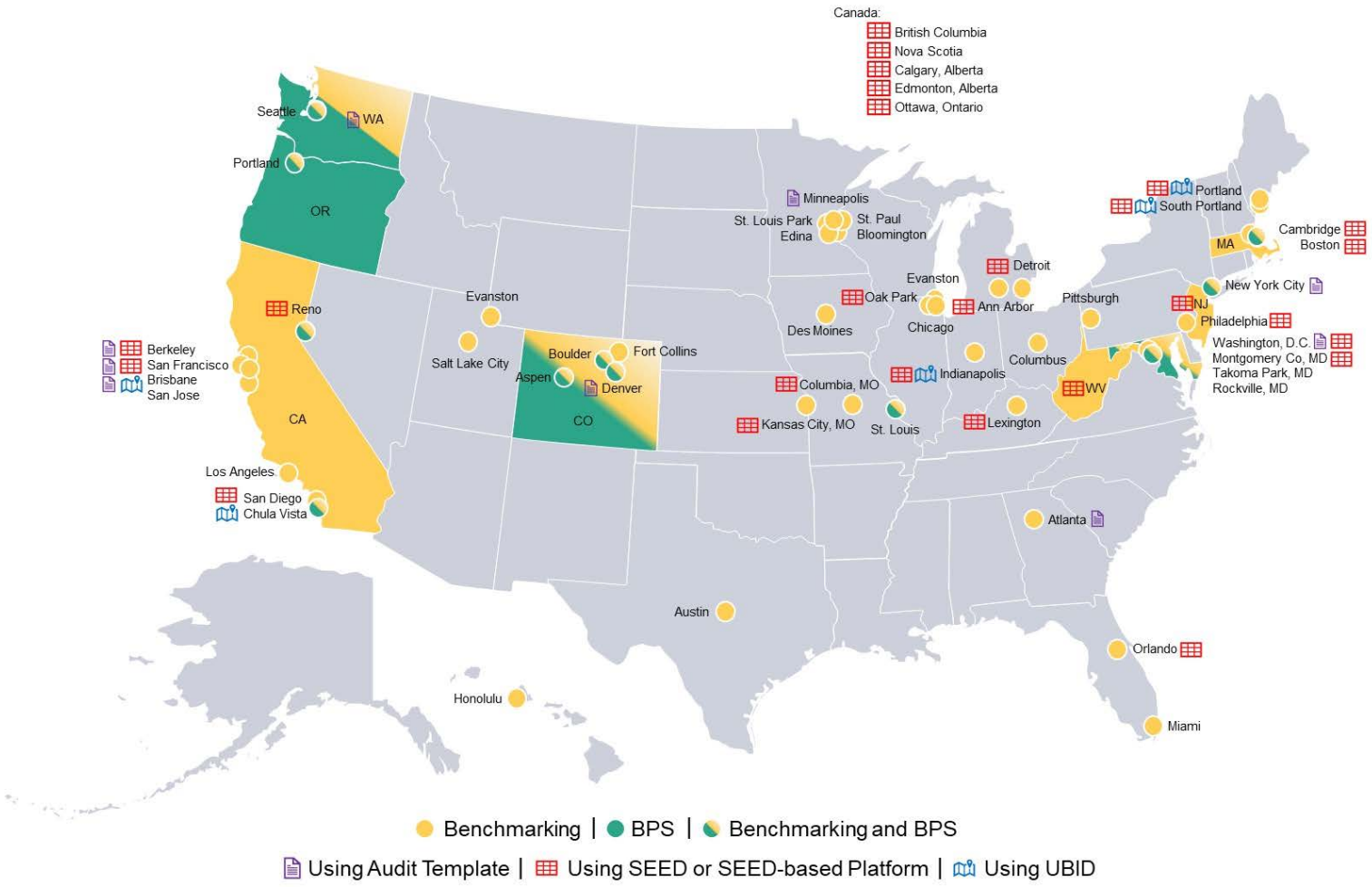
Map of Benchmarking and Building Performance Standards (BPS) Jurisdictions and Suite Adoption (as of September 2023)

Current (Known) Adoption

8 Audit Template

5 UBID

24 SEED or SEED-Based



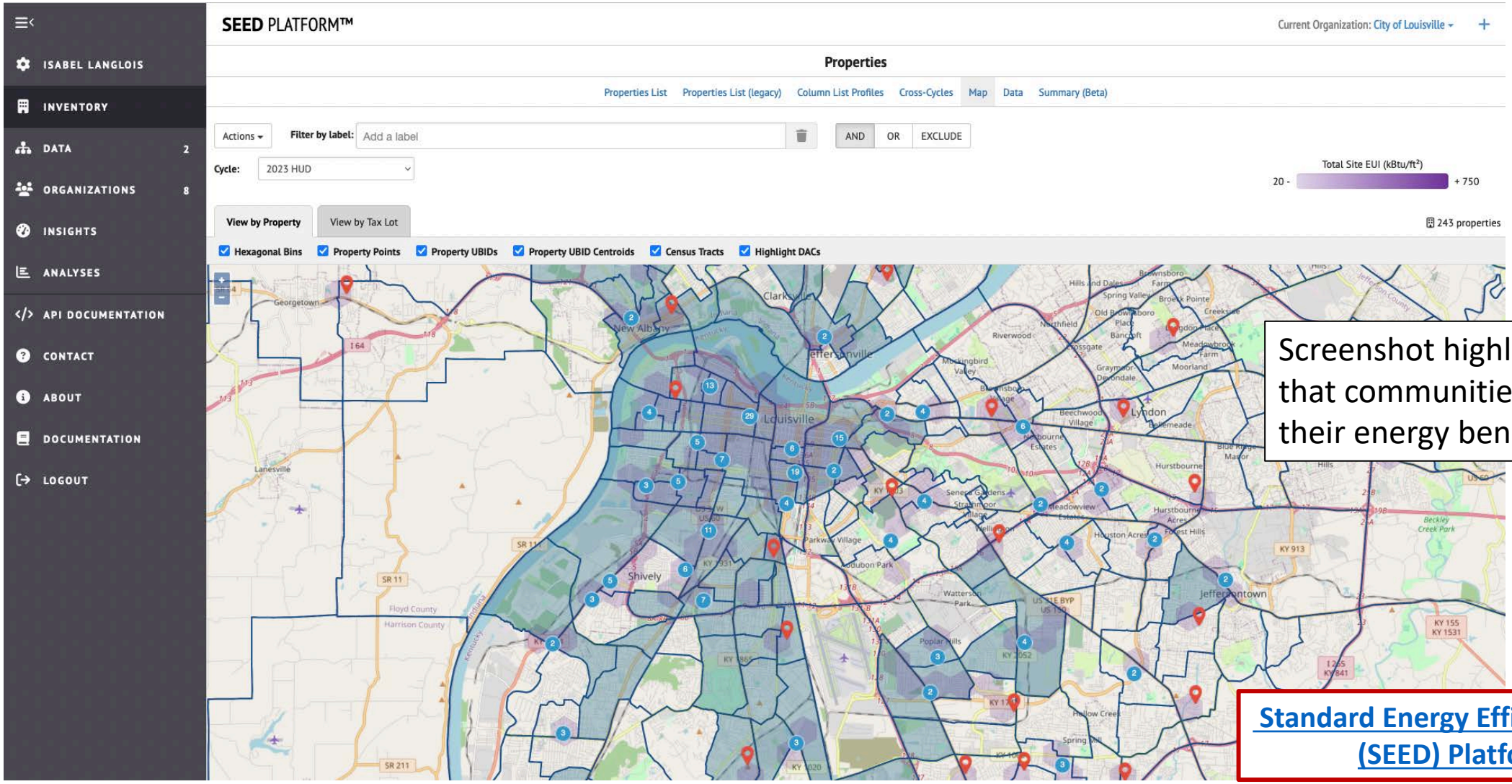
Source: Benchmarking and Building Performance Standard Implementation (2023)

Considerations

1. Build on the existing benchmarking structure: Kilowatt Crackdown.
2. Leverage free technical assistance from U.S. Dept. of Housing and Urban Development (HUD) for qualifying buildings.*
3. Leverage support from U.S. Environmental Protection Agency and HUD to automate data entry for participating buildings.

*Through its HUD Green and Resilient Retrofit Program (GRRP)

SEED + ENERGY STAR Portfolio Manager



Screenshot highlights SEED tool that communities can leverage in their energy benchmarking efforts

[Standard Energy Efficiency Data (SEED) Platform]

SEED + ENERGY STAR Portfolio Manager

Screenshot highlights tool that New York City uses to track building energy performance

[NYC Energy & Water Performance Map]

Workforce Development

Workforce Overview

Purpose

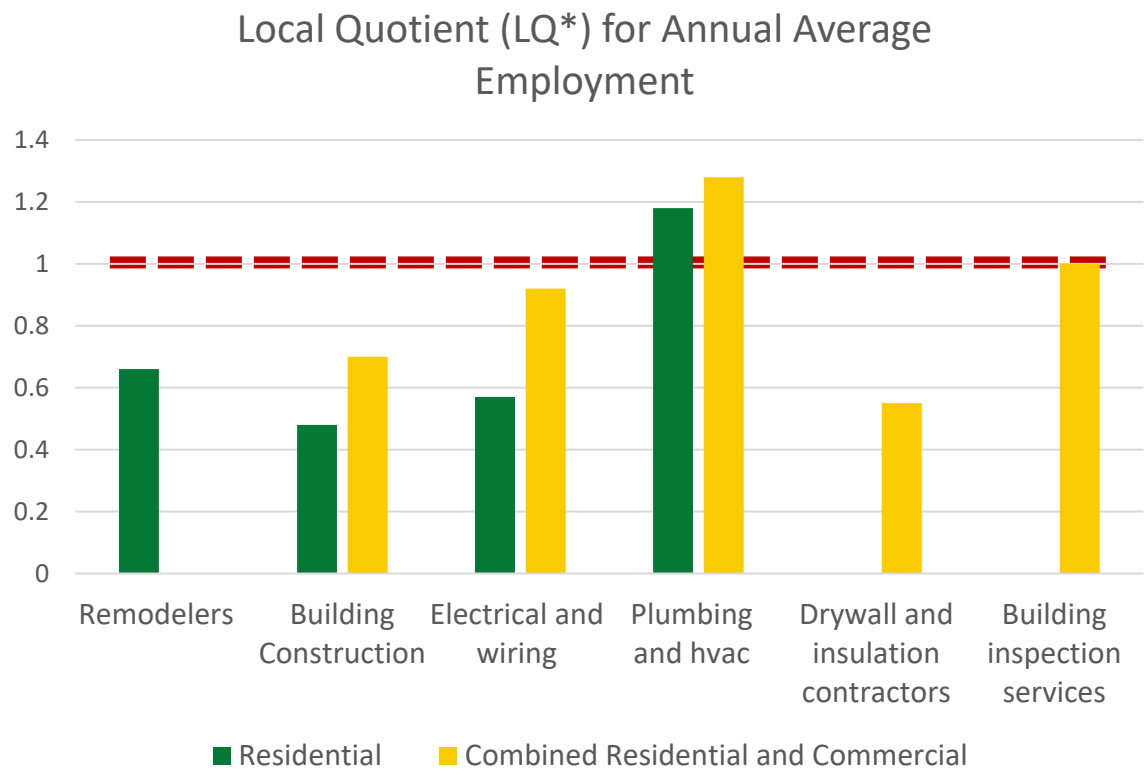
- A key enabling factor for large-scale deployment of energy efficiency upgrades is an appropriately sized, well-trained workforce.
- This analysis sought to estimate where Louisville's workforce stands today, where it might be in the future, and how Louisville could bolster the workforce to meet its ambitions.

Resources

- Clean Energy Workforce Impacts Factsheet
- Building Energy Efficiency and Electrification Occupation Analysis
- Contractor Engagement Toolkit + Webinar (January 24, 2024)
- Louisville workforce baseline analysis
- Louisville workforce ecosystem gap analysis

U.S. Bureau of Labor Statistics Data Indicates That in 2022 …

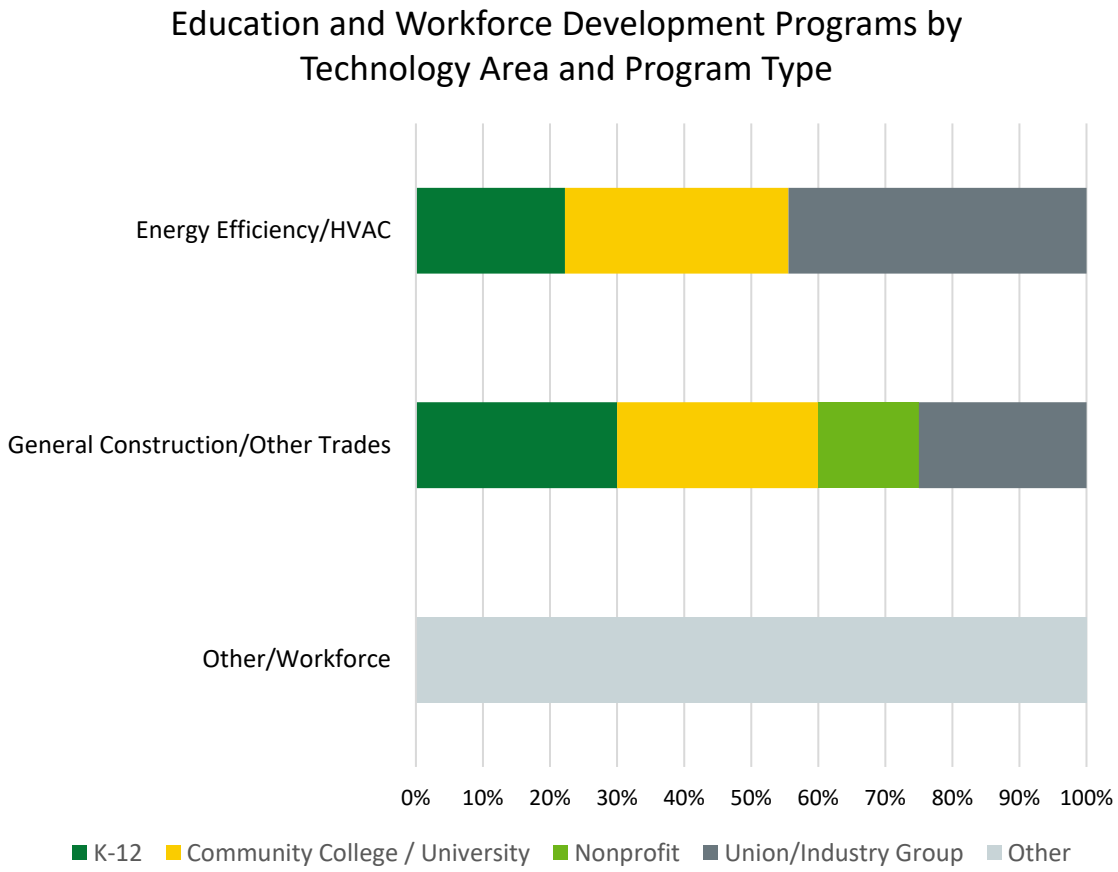
- For many related residential energy efficiency jobs, Louisville has a below-average number of contractors (excluding, notably, HVAC and plumbing).
- This could present a barrier both to retrofitting the existing housing stock ***and*** building new housing.
- Annual total wages per employee appear to be in-line with national averages (80%–100%).



*LQ compares the share of jobs, or average wages, for an industry group within a region compared to the share of jobs or average wages for the entire country.

Louisville Has a Good Mix of Potential Partners

- An overview of relevant workforce development groups that Louisville could partner with has been compiled through Communities LEAP.
- Mix of related programs for HVAC and construction skills across high school, college and industry groups.
- ***Not*** many programs devoted specifically to residential energy efficiency.

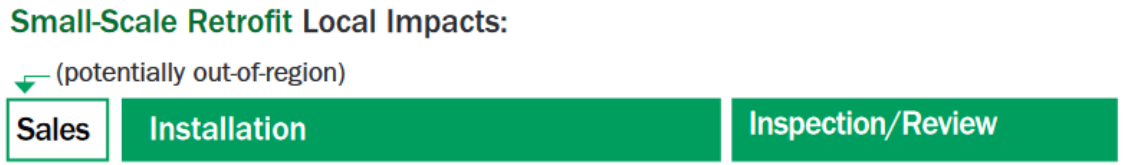


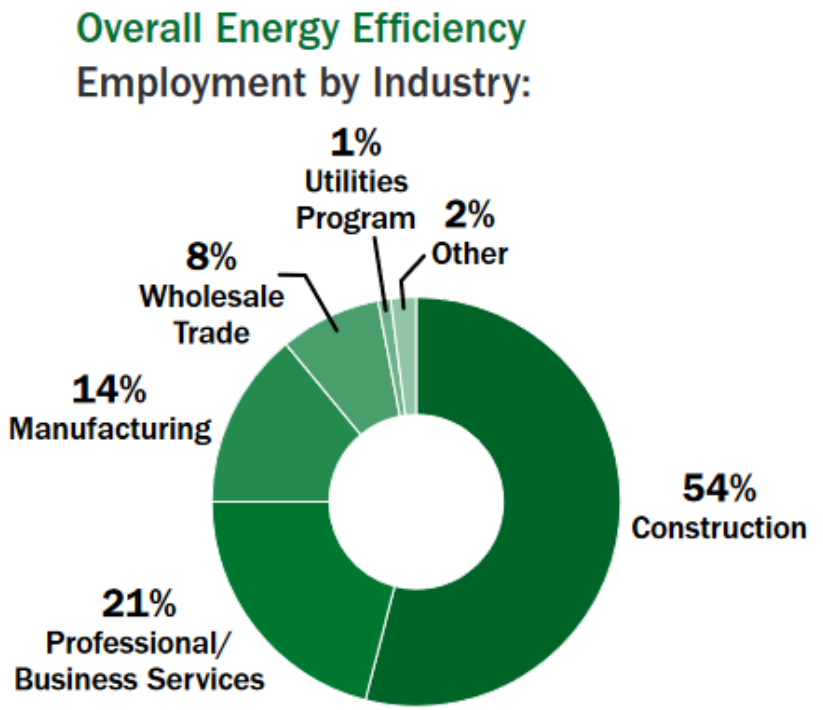
Potential Options for Expanding Workforce Development Efforts

- Work with existing programs in city to incorporate building science content.
  - BPI's Building Science Principles; or
  - U.S. Green Building Council (USGBC)
- Expand on resources in other parts of the state such as the Residential Energy Efficiency Training.
  - Offered through the Kentucky Housing Corporation.
- Explore case studies compiled by NREL as models for partnering with local organizations to bolster the residential energy efficiency workforce.

Energy Efficiency Investments *Can* Create Local Job Opportunities

- ResStock analysis indicates:
  - ~250,000 residential units have a poor envelope rating.
- Assume ~15,500 units retrofitted for improved envelopes per year between now and 2040.
- Given upgrade costs and job multiplier, estimated that packages could support:
  - Basic Enclosure: ~550 jobs per year.
  - Enhanced Enclosure: ~750 jobs per year.





Source: https://www.nrel.gov/docs/fy23osti/86712.pdf

Policy Overview

Examples of Policy Strategies Used by Other Communities

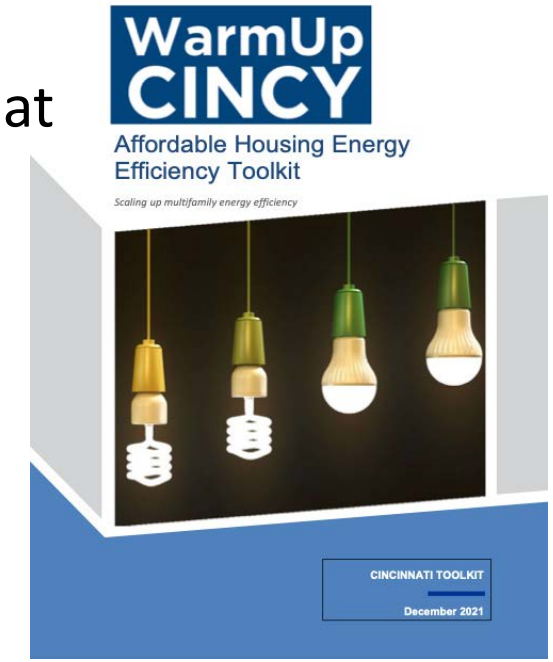
Benchmarking & assessments	Assessments/Audits Energy Scores Disclosures
Neighborhood-scaled approach	Green/Eco districts Overlay zones Demonstration projects
City-sponsored incentives	Rebates Permit streamlining
Energy efficiency standards for rentals	Business license Special Permit condition of approval Energy-aligned leases and tenant education
Timing certain energy efficiency upgrades	Time of Permit Time of Sale

Case Studies: Energy Efficiency Standards for Rentals

Cincinnati, Ohio

WarmUp Cincy Initiative

- Property owner/management education.
- Tenant engagement.
- Checklist for upgrades at unit turnover.
- Energy-aligned lease agreements.



Institute for Market Transformation. 2021. "WarmUp CINCY: Affordable Housing Energy Efficiency Toolkit." https://www.cincinnati-oh.gov/sites/oes/assets/Cincinnati%20Affordable%20Housing%20Energy%20Efficiency%20Toolkit%20FINAL%20122021.pdf

City/County of Boulder, Colorado

SmartRegs Policy - Energy Smart Advisory

- Rentals must meet or exceed certain level of energy efficiency.
  - Prescriptive path (score of 100).
  - Performance path (Home Energy Rating Score of 120 or below).
- Property owners risk losing business license if noncompliant.
- City/County provides additional incentives (above utility incentives and aids in finding/scheduling contractors).

City of Boulder. 2024. "SmartRegs Guide." https://bouldercolorado.gov/smartregs-guide
EnergySmart. 2024."EnergySmart: Your Energy Efficiency Solutions." https://energysmartyes.com

Case Studies: Timing for Disclosures and Requirements

Montgomery County, Maryland

Energy Disclosure at Time of Sale

- Affects single-family homes (including condos).
- Requires sellers to disclose to the buyer 12 months of energy usage and cost.
- Goal is educational, with an aim to inform buyer of improvement financing options prior to signing contract.
- Realtors often include this energy data on Multiple Listing Service.

Montgomery County, Maryland, Department of Environmental Protection. 2024. "Energy Requirements for Homeowners." https://www.montgomerycountymd.gov/DEP/energy/homes/energy-req-for-homeowners.html

Piedmont, California

Home Energy Score & Upgrades at Permit

<u>At Time of Sale</u>

- Home Energy Score, or an energy assessment/audit from the last five years required for all residential buildings over 10 years.

<u>At Time of Permit</u>

- Audits required for certain Design Review permits which have an energy impact.
- Any renovation project with a major alteration must include efficiency upgrades, based on a menu of options:
  - > $30,000 in valuation must include one measure.
  - > $115,000 in valuation must complete two measures.

City of Piedmont. 2024. "Home Energy Assessments." https://www.montgomerycountymd.gov/DEP/energy/homes/energy-req-for-homeowners.html

Case Studies: Neighborhood-Scaled Approaches

Minneapolis, Minnesota

Green Zone Initiative

- Designation concentrates city resources to certain neighborhoods.
- Connect residents with workforce training.
- Energy efficiency and sustainability upgrades at scale.
- Low-income residents in the zone receive free energy audits.
- City-sponsored rebates are higher within the zone.

Minneapolis. 2024. "Green Zones." https://www2.minneapolismn.gov/government/departments/health/sustainability-homes-environment/sustainability/green-zones/

Oakland, California

EcoBlock – Fruitvale Neighborhood

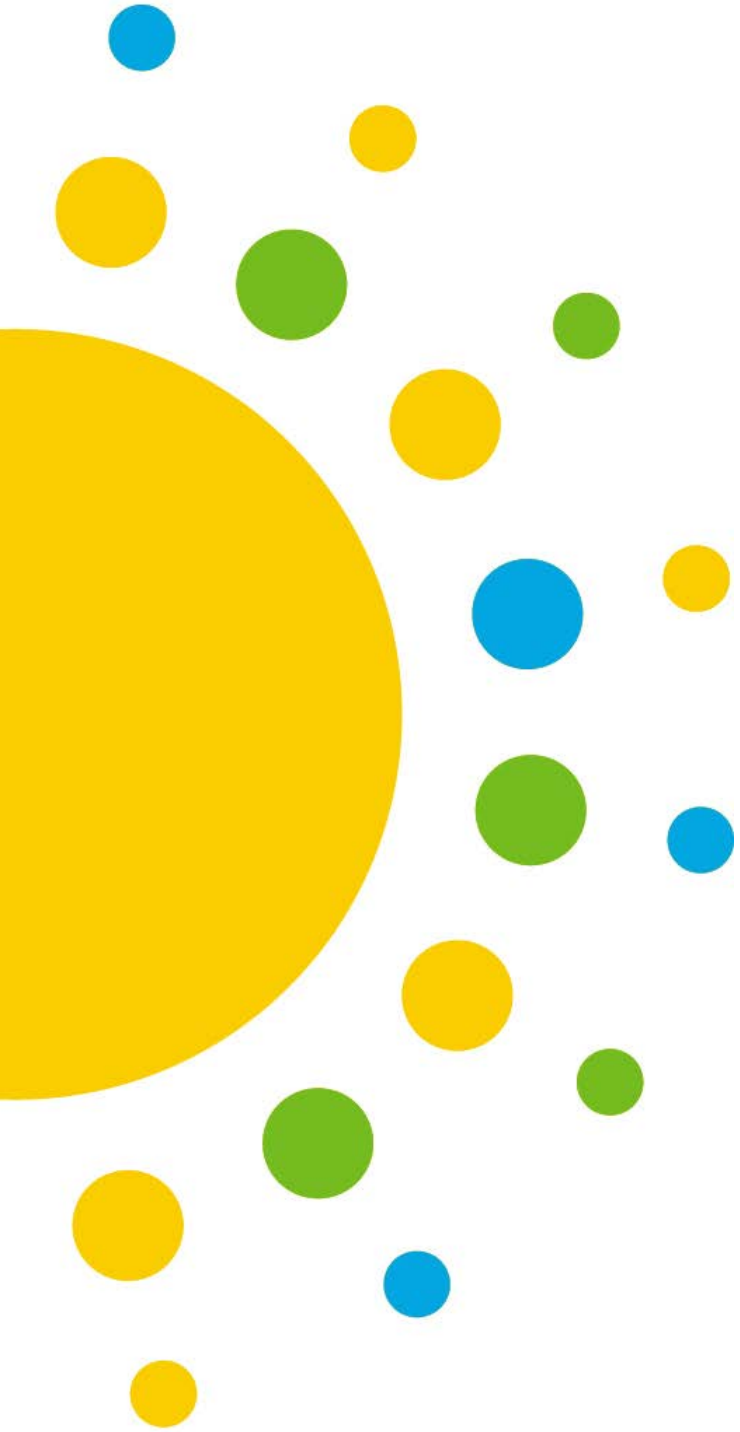
- Deep retrofits and decarbonization of existing housing stock.
- Targets both single-family and multi-family properties.
- Energy and water efficiency upgrades done at scale to maximize affordability.
- Community assets including solar PVs, electric vehicle carshare, curbside charging ports and battery storage.
- Neighborhood association stood up to support strong community involvement.

EcoBlock Research Project. 2024. "EcoBlock." https://ecoblock.berkeley.edu/about/

Developing a Long-Term Strategy

Reaching Louisville's Clean Energy Goals

- Net-zero by 2040 will require changes to both residential end-use and the bulk power system.
- Key strategies for upgrading residential buildings to help reach Louisville's 2040 clean energy goals could include:
  - Retrofitting ~250,000 residential units with 'poor' combined envelope rating (15,500 per year).
  - Appliance switching in residential dwelling units with natural gas or propane for:
    - Heating: ~230,000
    - Hot water: ~200,000
    - Cooking: ~90,000
    - Heating, hot water AND cooking: ~60,000



Thank You

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