

Introduction to Comprehensive Retrofits and Decarbonization



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Residential Retrofits
for Energy Equity

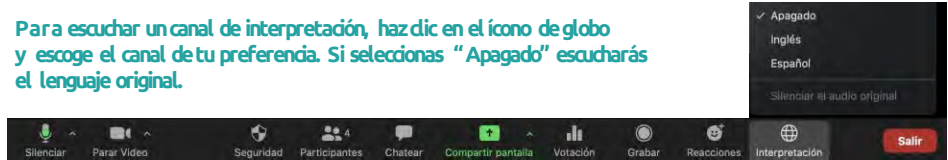
Buildings UP
The Buildings Upgrade Prize

Comprehensive retrofits of existing buildings include equipment replacement and envelope improvements and can reduce building energy use by 20-30%, playing a critical role in addressing climate change and improving the quality of our building stock. This webinar will provide an overview of the many benefits delivered by comprehensive retrofits—ranging from GHG reductions to lower energy bills and improved health, comfort, and safety. Speakers will also cover emerging retrofit technologies, approaches to achieving comprehensive savings, and strategies to scale up retrofits in your community.

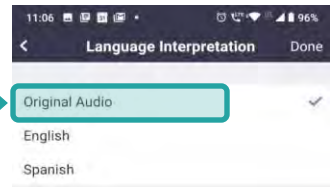
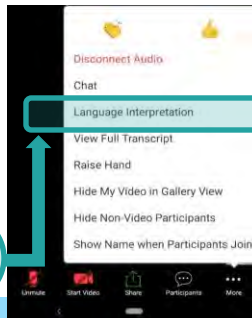
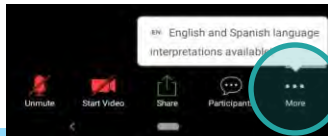
JAV Interpretation



Para escuchar un canal de interpretación, haz clic en el icono de globo y escoge el canal de tu preferencia. Si seleccionas "Apagado" escucharás el lenguaje original.



To listen to the interpreter, please select the globe icon and choose the language of your preference. If you choose "Off" you'll hear the original language.



Housekeeping Announcements

- We are recording this webinar and will be making it available to all registrants within a few business days.
- To ask a question during the webinar, please submit it via the Q&A button at the bottom of your screen.
- You can upvote questions in the Q&A box that you would like us to prioritize.
- Use the chat to engage in respectful and productive discussion with other participants.
- Code of conduct: R2E2 will not tolerate behaviors that cause harm or disrupt the learning environment. Please direct message Stephanie Sosa-Kalter if you feel unsafe in this space. Disruptive participants may be removed from the webinar.

Buildings UP

The Buildings Upgrade Prize

AMERICAN
MADE
U.S. DEPARTMENT OF ENERGY



Holly Jamesen Carr, U.S. Department of Energy, Building Technologies Office

The Buildings Upgrade Prize (Buildings UP)

Buildings UP is designed to rapidly scale energy efficiency and efficient electrification building upgrades in communities across the country. The prize is envisioned to consist of four phases over approximately five years.

Application support prizes available for new and under-resourced teams.



Phase 1: Concept

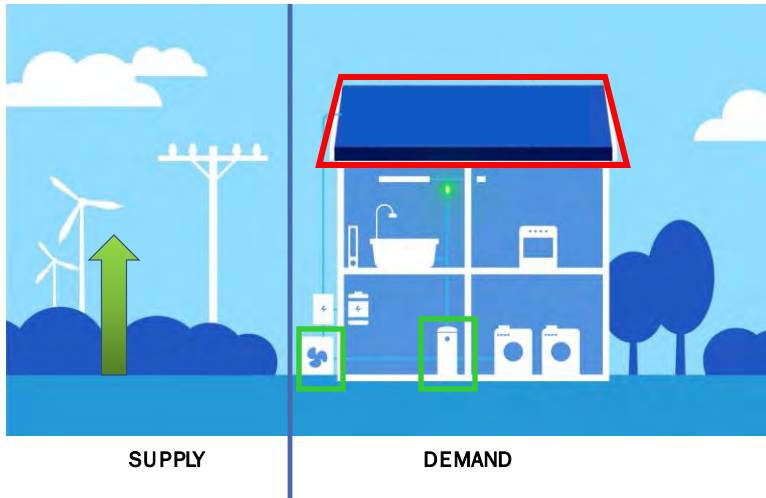
- \$22M+ in Prizes to Teams + Technical Assistance
- Applications due by July 18, 2023
- Seeking 20–60 teams to join the “coopetition.”



www.heroX.com/buildingsUP

Buildings UP | U.S. Department of Energy

Why Efficiency + Efficient Electrification?



Prize Goals

Buildings UP aims to address persistent non-technical barriers to improving building energy efficiency and reducing on-site emissions (e.g., administrative, financial, social, and other barriers).

Buildings UP is a capacity-building prize to support teams with solutions that:

- **Accelerate building upgrades** for efficiency and on-site emissions reductions beyond current best practices in the applicant's identified area of focus
- **Demonstrate scalability and replicability** across building type(s), climate zone(s), and/or, community type(s)
- **Advance holistic and lasting energy efficiency and efficient electrification** initiative development
- **Benefit underserved communities** by ensuring that benefits accrue to equity-eligible buildings*, their occupants, and surrounding communities.

*Equity-eligible buildings include buildings in disadvantaged communities; low- and moderate-income (LMI) households; and underserved commercial, nonprofit, and public buildings.

Phase 1: Pathways & Prizes

Equity-Centered Innovation Pathway

\$400,000 in cash prizes for each winning team

- Develop replicable, scalable, innovative building upgrade initiatives **in equity-eligible buildings*** (i.e., 80% equity-eligible).

Open Innovation Pathway

\$200,000 in cash prizes for each winning team

- Develop replicable, scalable, innovative building upgrade initiatives. **May include a focus on equity but are not required.**

Access to Technical Assistance is awarded to winning teams in both pathways.

Equity-Eligible Buildings

Geographic Location
(Justice 40 Census
Tracts, Tribal Lands,
Territories)

Affordable Housing
(Subsidized, Naturally
Occurring)

Underserved
Commercial
(including Title 1 Schools,
Community Services,
Non-profits)

Team-Defined

Additional information is in Section 3.5 of the official rules.

Example Projects*

A rural electric cooperative partners with a local CBO and the county to help LMI single-family home residents transition from propane heat to efficient electric heat pumps.



A CBO in a mid-sized town in the southeast partners with the local government to bring heat pumps (and air conditioning!) to affordable housing buildings throughout the community.



A business improvement district in a large city neighborhood partners with local houses of worship



to bring efficient electric heating and cooling equipment to small businesses.

A K-12 school district and an energy services company partner to electrify district buildings.



A national residential property owner teams up with multiple local governments and utilities on an initiative to electrify its properties in three major markets.



+Innovations!

*Minimum technologies and strategies teams must include in their initiatives:

- Weatherization and envelope improvements (e.g., insulation, air sealing, window improvements)
- Efficient electric heating and cooling equipment (e.g., heat pumps and/or heat pump water heaters).

Seeking Innovations to Address Non-Technical Challenges to Widespread Building Upgrades

- **Lack of contractor and occupant familiarity** with technologies
- **High first costs for upgrades**, limited short-term payback
- **Lack of retrofit materials** and equipment
- **Insufficient workforce** to complete upgrades
- **Lack of reach of funding and incentive programs** to historically underserved households and building owners
- **Inconsistent quality of work** and consumer mistrust.

Application Support Prize Overview

The Application Support Prize is available for the first 50 winners.

Award Criteria for Application Support Prize

In addition to the eligibility requirements of Phase 1, applicants must:

- Confirm no organizations on their team have secured funding from DOE's Building Technologies Office in the past 5 years
- Ensure the lead organization represents a community with equity-eligible buildings or its mission is to serve communities with equity-eligible buildings
- Demonstrate that application support would allow them to develop a competitive Phase 1 submission and confirm an intent to apply.
- Confirm concept includes minimum techs and strategies

*Later submission due dates may be canceled if prize funds are exhausted in earlier rounds. Cancellations will be posted on HeroX.

Application Support Prizes

- \$5,000 cash prize
- Up to 10 hours assistance

Support Provider

- Elevate
- <https://www.elevatenp.org/about/>

Rolling submission due dates*

- February 15
- March 15
- April 14

Next Steps for Competitors

- **Follow the prize on HeroX.com**, read the [rules](#), and review the [FAQs](#).
- **Register for an Informational Webinar:** April 7, 2 p.m. ET
- **Create an account on HeroX** and click on the “Solve this Challenge” button.
- **Apply for application support** (if eligible) by March 15 or April 14 at 5 PM ET.
- **Team up and submit a Phase 1 “Concept” application** via HeroX by July 18, 5 PM ET.

Follow www.HeroX.com/BuildingsUP

Questions: buildingsUP@nrel.gov

American-Made Challenges 4,091 < Share Follow (12)

Buildings UP
The Buildings Upgrade Prize

Buildings Upgrade Prize

Supports actionable and scalable solutions to advance energy efficiency and efficient electrification upgrades in existing U.S. buildings.

Energy, Environment & Resources Governance

Stage: Application Support Accepting Submissions
Prize: \$22,000,000+
Due Date Feb. 15, March 15, and April 15

SOLVE THIS CHALLENGE



Introduction to Comprehensive Retrofits and Decarbonization



Residential Retrofits
for Energy Equity

Meet Your Presenters



Amber Wood
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Residential Retrofits for Energy Equity (R2E2) is a new nationwide initiative that provides trainings to state, local, and tribal governments as well as community-based organizations and other partners to jumpstart energy upgrades for affordable housing that will lower utility bills, reduce greenhouse gas emissions, improve residents' health, create good-paying local jobs, and help advance racial equity. R2E2 is supporting the Buildings Upgrade Prize by providing training and technical assistance to applicants and awardees.



Activity #1: Polling

Which of the following best describes your organization?

- Government
- Non-government organization
- Foundation
- Corporation
- Consultant
- Community-based organization
- Utility
- Others

How familiar are you with this topic?

- Very familiar
- Somewhat familiar
- Not familiar



Learning goals

By the end of this session, you should be able to:

- Discuss the multiple benefits from building upgrades
- Define the terms 'energy upgrades', 'electrification', and 'decarbonization'
- Identify key energy efficient technologies for building upgrades
- Describe strategies for designing initiatives
- Understand the potential next steps for planning an initiative



For this presentation, when we talk about upgrades we mean retrofits. Many of the resources will say retrofits; we use the terms interchangeably.

Buildings UP Scoring Overview

Phase 1 Concept Plans (due July 18) are scored against scoring statements under each prize criterion.

One narrative is required for each criterion. The summation of narratives constitutes the Concept Plan.

This training is applicable to the following criteria:

- Assessing & Prioritizing Challenges
- Addressing Challenges Through Innovation: Initiative Scope and Impacts
- Scaling & Replicating Innovation through Community Involvement

Buildings UP Scoring Criteria (equally weighted)

1. Assessing & Prioritizing Challenges
2. Addressing Challenges Through Innovation: Initiative Scope and Impacts
3. Scaling & Replicating Innovation through Community Involvement
4. Demonstrating Capabilities & Team Characteristics Critical for Success
5. Achieving Equitable Building Upgrade Strategies (additional criterion: Equity-Centered Innovation Pathway)

Upcoming Buildings UP Informational Webinar: April 7, 2 p.m. ET

<https://www.herox.com/BuildingsUP/229-upcoming-webinars-recordings>

For the Buildings Upgrade Prize, teams will submit applications composed of narratives about their Concept Plans. Concept Plans are scored based on how strongly reviewers agree with scoring statements. The relevant scoring statements to this training are criteria one through three: Assessing and prioritizing challenges; Addressing challenges through innovation; and Scaling and replication innovation through community involvement.

Some examples of specific areas of evaluation under these three criteria include:

- The team demonstrates a comprehensive understanding of the challenges to

energy and efficient electrification in the building upgrade zone.

- The proposed portfolio of building upgrade technologies and strategies include at a minimum: (1) weatherization and envelope improvements and (2) efficient electric equipment installations, that are feasible for the climate zone(s) and building types identified in the building upgrade zone.
- The team articulated a compelling vision for how the innovation(s) can be scaled in the building upgrade zone.

Agenda

1 Non-energy impacts of comprehensive upgrades

2 Defining the terms

3 Key energy efficient building technologies

4 Strategies for designing initiatives

5 Next steps for planning an initiative

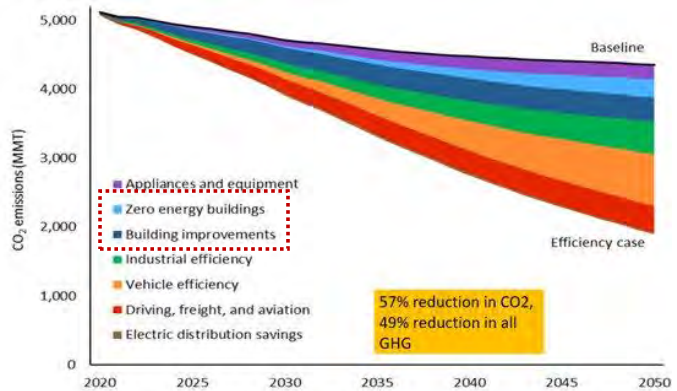
6 Q+A and Resources



- We want to start with how retrofits impact people. Retrofits can bring benefits to tenants, owners, and the community at large beyond energy savings and it is important to collaborate with the community to achieve these benefits.
- Here are examples of the types of benefits that initiatives can be designed to achieve. Retrofits help address frontline community priorities such as pollution reduction, gentrification concerns etc.
- This webinar is going to focus on the energy efficiency benefits and we will have detailed webinar on other related topics of financing, equity, and affordability.

Potential impact from decarbonizing buildings

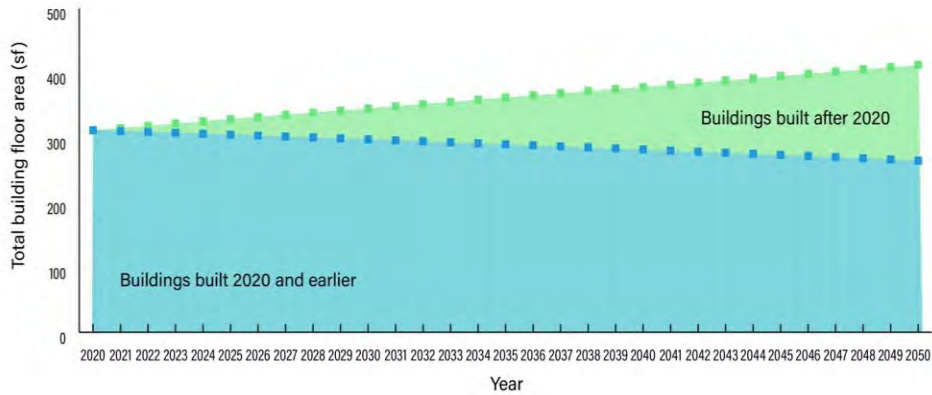
- Efficiency measures could halve 2050 energy use & emissions
- Buildings deliver 40% of total energy savings, and 33% emissions reduction



Source: Nadel, S., and L. Ungar. 2019.
www.aceee.org/research-report/u1907

Along with many co-benefits, upgrading buildings helps decarbonize the existing building stock

Upgrading existing buildings presents an enormous opportunity for energy savings and emissions reduction



Source: ACEEE calculations based on data in EIA AEO 2020

What is a building energy upgrade?

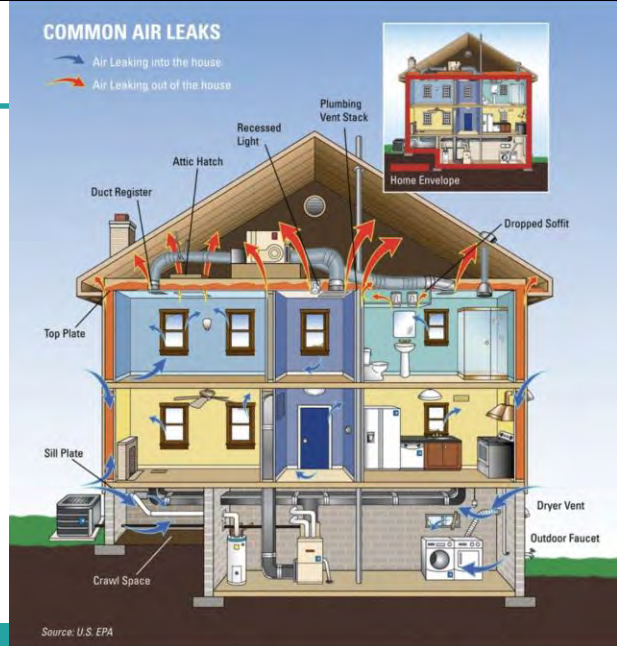
- The addition or update of new technology to an older system. The focus is on the **improved performance of the building**, rather than aesthetics.
- The goal is to make the building more efficient through the **tune up, repair, or replacement of a system or systems**.
- Where needed to **improve comfort and reduce energy costs, it may include upgrades to envelope, HVAC, plumbing, and/or ventilation**.
- Typically requires mechanical/electrical/plumbing engineers, general contractors, and special trades to implement



- People tend to approach building retrofits under three categories:
 - Single family
 - Multifamily residential
 - Commercial
- The scope of retrofits and service providers who offer services differ, and so does the financing.

Comprehensive building energy upgrades

- A **whole-building approach** to address **deficiencies in the building envelope** and necessary **upgrades to major building systems**
 - Include a **suite of measures**, across multiple systems (e.g., envelope, HVAC), undertaken to improve building energy efficiency and achieve savings larger than those possible from the installation of isolated measures.
 - Measures may also improve **indoor air quality, manage moisture and pests**, and make buildings more **resilient**
 - Typically **achieve 10-20% savings** and may reach **deeper savings of up to 40%**
- (Srivastava and Mah 2022; Kwatra and Essig 2014)



Electrification

- Replacing fossil-fuel end uses, such as heating, cooking, and transportation with electric-powered technologies.
- Can **reduce indoor air pollution and carbon emissions**, especially if the electricity is generated by low- or no- carbon resources.
- Combined with energy efficiency to reduce total building energy costs and carbon emissions, it is often considered “beneficial” or “strategic” electrification.

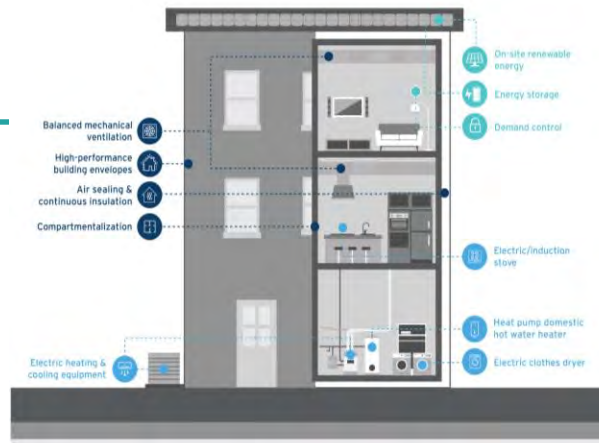


Bastian, H., and C. Cohn. 2022. Ready to Upgrade: Barriers and Strategies for Residential Electrification. www.aee.org/research-report/h2206.




Energy upgrades and electrification are intertwined strategies for decarbonization

- Decarbonization encompasses strategies for reducing building-related carbon emissions
- Key approaches include energy efficiency, beneficial electrification, distributed generation (e.g., solar), and/or use of carbon-free fuels
- Beyond reduced greenhouse gas emissions, other benefits may include improved indoor air quality, reduced utility bills, and greater ease of maintenance



Source: <https://mi.org/creating-a-one-stop-shop-for-whole-home-retrofits/>



Activity#2: What are your main priorities when you are thinking about developing a building upgrade initiative?

- Upfront costs for a building owner
- Increased rents for tenants
- Best return on investment, including shorter payback periods
- Biggest bill savings
- Biggest GHG savings
- Upgrades that are tailored to my region
- Potentially higher bills from electrification

Key Technologies

 Residential Retrofits
for Energy Equity



Key technologies for projects

- Envelope upgrades
 - E.g., air sealing, insulation, and window replacement
- Heat pumps for heating and cooling
- Heat pump water heaters
- Lighting, appliances and plug loads
- Alternative measures
 - E.g., storm windows, cellular shades, thermostatic restrictor valves, programmable thermostats
- Distributed energy resources and EV integration
 - Solar and battery storage

For more details see
https://www.energystar.gov/products/energy_star_home_upgrade



- It is important to select the right suite of technologies to achieve energy savings and improve comfort
- For the Buildings UP prize minimum technologies are 1) clean heating and cooling technologies, which includes heat pumps and/or heat pump water heaters and 2) envelope improvements where needed to reduce energy costs and improve comfort

Envelope upgrades

- Ensure the building can retain heat in the winter and keep it out in the summer, reducing HVAC load
- Measures include:
 - Air sealing and duct sealing using sprayable sealants, membranes, flashing, and sheathings
 - Insulating windows, walls, attic, and foundation
 - Window and door replacement
 - Install secondary windows
- Measures can save a typical home 15% on heating and cooling costs or 11% of all energy costs



- Building envelope is the separation of the interior and exterior of a building.
- A well-insulated and well-sealed building envelope is crucial to ensuring the installed technologies perform as expected. Older, leaky building will force the equipment and appliances to work harder to deliver comfort, particularly for space heating and cooling, and partially negate the benefits of upgrading to efficient electric technologies.
- Efficient envelopes reduce the needed capacity of HVAC equipment and the associated electrical capacity. This reduces up-front costs and yields lower energy costs. The same principle of high energy efficiency applies to other energy uses in homes and is especially important for affordable housing.
- Sprayable sealants are an innovative alternative to conventional tape and are an effective way of providing moisture and air sealing protection
- Envelope measures are critical in the heating-dominant cold, mixed-humid, and marine climate regions. Buildings in those regions benefit the most from envelope upgrades

Secondary windows

- Same performance for 10- 25% of the cost
- Light- weight, high-performance secondary windows use ultra- thin glass in an insulated low-profile fiberglass frame. These inserts are two to three times lighter than secondary windows made with standard glass.
- Reducing air infiltration can result in additional energy savings and accelerated payback, particularly in cold climates. Both the single- and double- pane secondary windows reduced infiltration to 0.06 cfm/sf, a 97% savings.
- In cold climates, double- pane secondary windows will be more cost- effective.
- In warm climates, the single-pane configuration may offer better return on investment.



Source: <https://thinkalpen.com/products/winsert/>

RESULTS

How did lightweight secondary windows perform in MBV?

15%
AVERAGE
WHOLE-
BUILDING
ENERGY
SAVINGS*

*Savings for Alumin-glass insert with 4 panes in single pane window

**EASY
INSTALLATION**
< 10 MINUTES
FOR 1 PERSON

NO DRILLED HOLES
OR PERMANENT
DEVICES*

**COMFORT
INCREASED**

20" WARMER
INTERIOR GLASS*

73% REDUCTION IN
CONDENSATION*

97% LESS AIR LEAKAGE*

Source: https://www.gsa.gov/cdnstatic/Applied_Research/GPG%20049-Lightweight%20Secondary%20Windows-1-2021.pdf



- Single-pane windows are the weakest energy efficiency link in a building envelope. They account for approximately 39% of the annual U.S. energy used to heat commercial buildings and 28% of the energy used to cool buildings
- Higher performing windows could reduce the annual U.S. energy use due to windows by up to 75%, but replacement can be costly; even more so in older buildings where lead paint and/or asbestos must be remediated as part of a window replacement.
- New secondary windows are manufactured with ultra-lightweight thin glass, making them easy to install and suitable for structures that cannot handle extra weight, and significantly improve existing window performance:
- Reduce operating expenses through lower heating, cooling and fan loads, and improve occupant comfort
- Easy to install without the need to drill holes or have permanent attachment devices
- Reduce exterior noise, exterior window condensation, air leakage, and interior glare

Heat pumps for heating and cooling

- Used for both heating and cooling—mostly with electricity
- Instead of generating heat through electric resistance, it transfers heat from one place to another, much like refrigerators and air conditioners do
- **3-5 times** more efficient than standard electric or gas heating systems
- Comes in **many varieties**, including ducted and ductless, air-source, and ground-source
- New market-viable **packaged units for multifamily buildings** are being tested and leverage technological advancement opportunities for bulk procurement

Ducted split system
(heat pump and air handler)



Source: York, D., C. Cohn, D. Morales, and C. Tolentino. 2022

Ductless mini-split



Ground-source heat pump system



Source: TLJ Consultant 2020

Packaged units



Source: Stopwaste 2021



- Heat pumps (HP) have emerged as an important technology as they perform both space and water heating. They are a vital strategy to help decarbonize the affordable housing sector due to their high efficiency, ability to provide cooling in addition to heating, and increasing capability to function in cold climates.
- Ducted HPs are split systems that rely on ductwork and can make use of existing central distribution systems to distribute hot or cold air throughout the building. In buildings without existing ductwork, ductless mini-splits may be a suitable option. They are smaller, in-unit systems that provide enough heating and cooling for a specific zone of the house (1–5 rooms), similar to window AC units
- New market-viable packaged units for multifamily buildings are being tested. The New York City Housing Authority (NYCHA), New York Power Authority (NYPA), and New York State Energy Research and Development Authority (NYSERDA) program brings to market simple cold-climate heat pump replacements for room ACs found in NYCHA's multifamily properties.
- Two manufacturers have been selected to develop HP models. The heat pumps will - reduce energy use and carbon emissions to meet state and city climate targets and provide opportunity to procure low-cost, accessible window heat pumps for homeowners and tenants

- Envelope improvements may be needed to maintain comfort and energy bills with heat pump installation. For electrification in general, gas bills formerly paid for by landlord, may become responsibility of tenant if electrified.

Heat pump water heaters (HPWHs)

- HPWHs heat water instead of indoor space
- Use electricity, refrigerant, and coils to extract heat from the air to efficiently heat water
- Available products for multifamily and commercial buildings:
 - In-unit water heater in the dwelling unit
 - Shared HPWH with high-efficiency, high-capacity unit between 2-3 apartments
 - Central systems located in mechanical rooms
- Retrofit-ready, plug-in **120V HPWH technology** available, without requiring expensive panel upgrades and/or home rewiring
- HPWHs have some unique installation considerations including, location and space considerations, and attention to noise from the system

Emerging retrofit-ready 120V water heaters include (from left to right) A. O. Smith and the Rheem Professional Prestige ProTerra Plug-in.



Source: Provided by manufacturers in Perry, Khanolkar, and Bastian, 2021



- HPWHs can be 2 to 3 times more energy efficient than conventional electric resistance water heaters.
- Both in-unit and central water-heating systems can be retrofitted with HPWHs, but each type comes with its own unique considerations, such as allowing adequate space for airflow, accounting for increased noise, and ensuring sufficient electrical capacity. Customers need to be aware of HPWH noise and issues with placing them in living spaces, planning for exhaust and condensate exits, as well as size considerations for small spaces.
- 120V HPWH technology represents a good solution for retrofit applications to replace existing storage tank type water heaters. The technology is expected to be well suited to smaller homes with lower hot-water demand, which are characteristics shared by many apartments.

Lighting, appliances, and plug loads

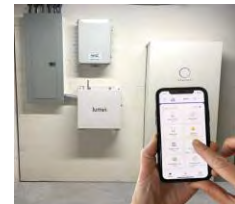
- Lighting upgrades
 - 100% LED lighting
 - Sensors and controls
- Upgrading home appliances
 - **Induction stoves** are the better option for performance, health, and safety considerations. Immediate temperature response offers precision and control over the cooking process
 - **Heat pump/hybrid dryers** offer better performance, convenience, and aesthetic benefits
- **Smart electrical panels** and **smart circuit splitters** (EV charging and appliances) for load shifting and prioritization to limit simultaneous power draw
- Upgrade to ENERGY STAR certified consumer electronics



Induction Stove. Source: Seals and Krasner, 2020



Heat pump dryer.
Source: StopWaste, 2021



Smart Electrical Panel.
Source:
<https://www.leanpower.com/learn-more>



- Energy management systems such as smart electrical panels and circuits can make a panel upgrade unnecessary as two high-power appliances will not run at the same time or require more voltage
- Smart panel is smart technology-enabled electrical panel which monitors energy in homes and lets customers control the loads. These panels utilize relays to control circuits, and report back to a smartphone app. Not only can the user see how much each circuit is drawing, but they can also turn each circuit on or off, and program schedules based on priority.
- Smart circuit breakers allow two devices (typically high power) to share a circuit, which can avoid an electrical panel upgrade (For example, like an EV charger and a Dryer).

Alternative measures

- High-performing window attachments products including **low-e storm windows (interior and exterior), cellular shades, and solar screens** can improve existing windows and achieve energy performance equivalent to that of ENERGY STAR-qualified windows at **less than 1/3 of the cost**.
- **Ceiling fans** can eliminate the need for air-conditioning in milder climates and in regions with short summers. They also reduce the need for air-conditioning in shoulder seasons.
- **Thermostatic shutoff valves (TSVs) and tub spout diverters (TSDs)** present energy and water savings opportunities
- **Drain water heat recovery (DWHR)** to capture waste heat from a shower's drain line. DWHR reduces energy used for water heating by 20–45%



Starting from top left: storm window, cellular shade, exterior roller shutter, sheer shade, roller shade, and retractable awning.

Source: AERC (Attachments Energy Rating Council). 2018



Source: <https://www.thinkevolve.com/pages/showerstart-tsv3>



- The Attachments Energy Rating Council (AERC) provides rating, certification, and labeling of window attachment products with energy performance scores to simplify consumer comparisons of heating and cooling season performance across products and categories. Published U-value, solar heat gain coefficient (SHGC), and visual transmittance data also allow comparison to replacement windows.
- Tub spout diverters reduces wait times by delivering hot water up to 2X faster and automatically diverts hot water to the shower head when it arrives. Helps hot water last longer - saves gallons every shower.



Strategies for Initiative Development

 Residential Retrofits
for Energy Equity

Effective strategies for designing initiatives

- Understand community priorities
- Collaborate with stakeholders
- Standardize retrofit packages
- Incorporate low-cost measures
- Stage retrofits: prioritize which measures to address first
- Couple electrification with comprehensive retrofit projects
- Offer low- or no-cost financing and incentives



Understand community priorities

- Engage and collaborate with community around their priorities
 - Health, safety, and comfort
 - Bill savings, housing affordability
 - Financing options
 - Integrating renewables
 - Local workforce opportunities
 - Resilience
- Different segments of a community may have different priorities
- How can the program tailor offerings to meet different needs?
- Include plans to mitigate potential negative impacts from building upgrades, such as higher rents



Buildings UP is designed to support widespread building electrification, teams should be looking for building types where they can complete high numbers of upgrades in their region

Collaborate with stakeholders

- Build a planning team representing various stakeholders
- Involve residents/building occupants in creating and implementing building upgrade initiatives to address their needs, interests, and abilities
- Engage with partners, including:
 - Building owners
 - Property managers
 - Contractors
 - Government agencies
 - Developers
 - Financiers
 - Utilities
 - Community-based organizations
 - Environmental justice organizations
 - Philanthropies



Avoid structural silos in both development and implementation

Standardize retrofit packages

- Develop a set of standard measure packages designed to **address common needs and opportunities** in the building types you plan to address
- Ensure that all packages, even the most basic, reduce carbon emissions, energy costs, and increase comfort
- Offers mechanisms to combine more visible or desirable measures
- May enable more contractors and customers to undertake a retrofit project by decreasing project costs, acquisition times, and customer inconvenience associated with a highly customized approach



Task/ambient lighting combined with plug load occupancy controls

- 30-41% lighting and plug load savings (office)
- 12-20% whole building savings (small - large office)

Automated shading with daylight dimming (excludes fixture upgrade)

- Lighting savings 36% (office), 30% (school)
- 5-9% whole building savings (office, school)

Integrated Systems for Commercial Buildings

Source: <https://www.energy.gov/sites/default/files/2019/05/f62/bto-peer%E2%80%932019-ibnl-getting-beyond-widgets.pdf>

Good	Better	Best
Seal and Insulate Attic and Rim Joist	Seal and Insulate Attic and Rim Joist and Insulate Walls and Floors	Seal and Insulate Attic and Rim Joist, Insulate Walls and Floors, and Retrofit Windows to ENERGY STAR
Incentive: \$1,000*	Incentive: \$2,500*	Incentive: \$4,000*

City of Fort Collins Utilities Efficiency Works Program

Source: [https://www.toolsofchange.com/userfiles/Tools%20of%20Change-%20Fort%20Collins%20Case%20Study\(2\).pdf](https://www.toolsofchange.com/userfiles/Tools%20of%20Change-%20Fort%20Collins%20Case%20Study(2).pdf)



- The packages are still customized for homes - the specifications for the equipment/technologies will be determined based on the existing condition
- Provides opportunities for bulk purchasing, outsourcing customer acquisition, utilizing a standard process for customer information intake that determines best-fit packages
- There are existing tools to help identify opportunities such as the Department Of Energy's Building Retrofit Tool

Incorporate low-cost measures

- Reduces energy use, utility bills, and emissions while improving comfort
 - Lowers total project costs
 - Includes alternatives to traditional measures addressing heating, cooling, water heating, and lighting
 - Weatherstripping, pipe wraps, and door sweeps
 - storm windows, cellular shades, ceiling fans
 - Tub spout diverters
 - Supplemental measures that save energy in other end-use categories
 - Consumer electronics such as set-top box
- Plug load management
- Smart power strips



Storm windows courtesy Larsen Windows. Image source: <https://www.energy.gov/energysaver/storm-windows>



Tub Spout diverter (TSD). Image source: <https://www.showerstart.com/products/tub-spout-diverter>



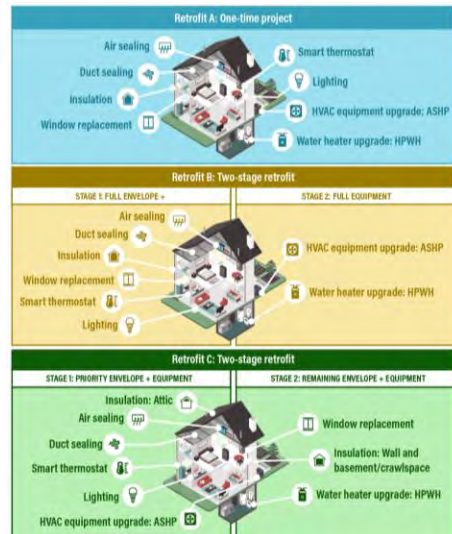
Set-top box alternatives. Image source: Amann, J., R. Sivasatava, and N. Henner. 2021



- Some measures are better suited to particular climates or housing types (e.g., dehumidifiers). Requires planning to find and incorporate high-efficiency alternatives in initiatives - Utility marketplaces, contractors, and in-store rebates for direct-install measures are possible options
- A "set-top box" is a cable, satellite, Internet Protocol or other device whose primary function is to receive television signals from a specific source and deliver them to a consumer display and/or recording device, such as a television or DVR. ENERGY STAR certified set-top boxes are on average 25% more efficient than conventional models.

Stage retrofits to meet customers where they are

- Splitting into stages can make the process less overwhelming and provide room to address deficiencies
 - Pre-retrofit measures: health and safety measures such as deferred maintenance mold remediation
 - Stage 1: envelope upgrades ideally, but there might be immediate needs while considering a full package
 - Stage 2: equipment upgrades
- Allows customers to tackle immediate needs first
- Ongoing engagement can support completion of the full retrofit over time
- May include in-unit measures such as high-performing shading devices in the first stage, with opportunities for more comprehensive upgrades later



Source: Amann, J., R. Srivastava, and N. Henner. 2021. [aceee.org/research-report/h2103](https://www.aceee.org/research-report/h2103).



- Just like one size does not fit all, one design solution will not fit, it will depend on the climate, housing stock, and age of the buildings.
- All things being equal, envelope upgrades should be considered first as they make the building more efficient, then equipment/systems upgrades. This approach helps optimize the system and avoids oversizing. And for the Buildings-UP prize, plans must include efficient electrification -- equipment upgrades -- not just weatherization.
- Instances where a system is nearing end of life, equipment replacement becomes a priority and there are other measures that can complement the upgrade.

Couple electrification with retrofit projects

- Coupling electrification with a retrofit project maximizes emissions reductions and improves overall performance
- Reduces cost of electrification where natural gas is cheaper
- At the project level, electrification can increase cost-effectiveness
- Facilitates the transition to a decarbonized building stock
- If done together, does not require many additional steps such as panel upgrades or additional appliances however, it does influence equipment choices

Energize Denver Electrification Program

Starting on **March 1, 2023**, the requirements for pulling a permit to replace your AC units, gas-fired furnaces, and hot water heaters in commercial and multiunit buildings is going to change. For the fastest permitting process, we strongly recommend that you plan now for the new requirements.



Planning for Equipment Replacement

Starting on March 1, 2023, the requirements for pulling a permit to replace your gas-fired appliances is going to change. Learn more about what to expect.



Equipment Replacement Code Changes in 2023, 2025, and 2027

Energize Denver requires electrification for space and water heating equipment. This will happen through a series of updates to the Denver Building Code. Learn more about what to expect.



Electrification Feasibility Reports

Denver's updated building code will soon require you to look at whether electrifying your space and water heater and cooling is a good choice for you. Find out more about these requirements.



Building Electrification Incentives

Sign up to participate in the Building Electrification Pilot Program. This program provides funding to buildings acting as leaders in building electrification. The goal is to show how electrification can work in a variety of building types, sizes, and uses.



Resources for Homeowners

Single family houses, duplexes, and townhomes are not subject to the Energize Denver Electrification Program. However, they are eligible for rebates that make electrifying equipment more affordable. Save thousands of dollars on home upgrades that will heat and cool your home while improving indoor air quality.



Why Electrify?

Switching to electric equipment like heat pumps has many benefits. Learn more about why Denver is making the shift to all-electric buildings and read our Renewable Heating and Cooling Plan.

Image source: <https://www.denver.gov/our-governments/agencies-departments-offices/agencies-departments-office-director/climate-action-sustainability-resiliency/high-performance-buildings-and-homes/energize-denver-hub/building-25000-square-foot-or-larger/energize-denver>



As more states adopt aggressive clean energy goals, electrification is becoming an important focus for residential retrofit programs

Offer financing and other incentives

- Customers have limited access to capital to invest in efficiency and/or electrification measures
- Affordable financing approaches and incentives can help reduce the cost barrier
- Helps lock in the full project
- Encourages customers and owners who split the retrofit project into phases to follow through with later stages

The Mass Save® Residential HEAT Loan Program

Through the Mass Save Residential HEAT Loan Program, qualified customers can apply for a 0% loan for the installation of approved energy-efficient improvements in their homes or rental properties. Zero percent loans are available up to \$25,000* with terms up to 7 years (depending on the loan type). In addition to financing, Mass Save offers generous rebates and incentives for a variety of qualified energy efficiency improvements.

HEAT Loan Eligible Improvements may include:

- Attic, Wall and Basement Insulation
- High-Efficiency Heating Equipment
- Central Air Conditioning/Air Source Heat Pumps
- Ductless Mini Split Heat Pumps
- High-Efficiency Domestic Hot Water Systems
- Solar Hot Water Systems
- 7-Day Digital & Wireless Enabled Thermostats
- ENERGY STAR®-Qualified Replacement Windows

How to Qualify*

- Eligible customers must schedule and complete a Mass Save Home Energy Assessment
- Financing is available for qualified energy efficiency improvements only
- Upon approval, participating lender will provide financing of the total cost of improvements(s) less any eligible incentives/rebates

Get started today by scheduling a no-cost Home Energy Assessment. Call 866-627-SAVE (7283) or visit www.MassSave.com/HeatLoan

*Some restrictions may apply. Subject to eligibility for credit approval.

ABOUT MASS SAVE

Mass Save is an initiative sponsored by Massachusetts gas and electric utilities and energy efficiency service providers, including Berkshire Gas, Cape Light Compact, Columbia Gas of Massachusetts, Everource Energy, Liberty Utilities, National Grid and Unitil.

The sponsors of Mass Save provide a wide range of services, incentives and information promoting energy efficiency that helps residents manage energy use and related costs.



We just briefly touch on this strategy here but do join the "Accessing Funding Sources" to learn more about what funds might be available

Other strategies for successful initiatives

- Establish a single project point of contact for the customer
- Leverage remodeling and other projects/transactions
- Market the multiple benefits of efficiency and decarbonization
- Update and expand direct-install measure offerings
- Incorporate smart features to improve project outcomes
- Plan to mitigate potential negative impacts from building upgrades
 - E.g. increased cost of utilities or rent, displacement, gentrification
- Provide post-project follow-up with the customer



Potential Next Steps for Planning an Initiative



Residential Retrofits
for Energy Equity



Next steps

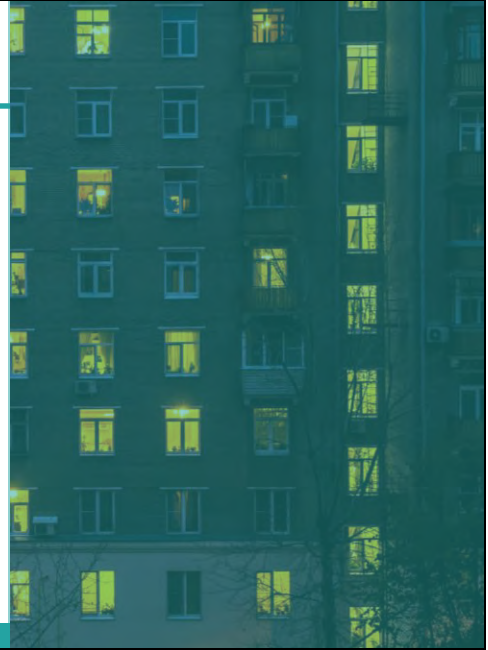
- Build your team
- Engage with tenants and residents in creating and implementing initiatives
- Establish requirements for energy efficiency
- Set specific carbon reduction goals
- Establish collaborations among stakeholders
 - Establish partnerships among the many organizations
 - Include local governments, housing authorities, developers, financiers, utilities, community-based organizations, environmental justice organizations, and building owners
- Educate residents, building owners, contractors, and suppliers
- Secure funding and financing
 - Create and offer attractive financing options
 - Braid complementary funding streams
- Incorporate strategies to meet community goals
- Establish accountability mechanisms
 - Steps to measure and track impacts



- Of these, securing adequate funding and financing is perhaps the biggest hurdle, particularly for retrofitting buildings to achieve high energy efficiency and to electrify existing fossil fuel technologies. Affordable housing providers generally cannot do substantial upgrades without financial and technical assistance.
- Phase 1 winning teams in Buildings UP will receive technical assistance to support many of these next steps. We encourage forming a team and submitting a Phase 1 application by July 18 to be eligible to receive additional support.

Learning goals/Takeaways

- Discuss the multiple benefits from building upgrades
- Define the terms “energy upgrades”, “electrification”, and “decarbonization”
- Identify key energy efficient technologies for building upgrades
- Describe strategies for designing initiatives
- Understand the potential next steps for planning an initiative



Resources

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- StopWaste and Association for Energy Affordability Inc. 2021. Accelerating Electrification of FCA's Multifamily Buildings – Policy Consideration and Technical Guidelines https://www.stopwaste.org/sites/default/files/Elect%20to%20CA%20MF%20Bldgs_webinar%20slides_61521.pdf

Upcoming Training Webinars

Webinar Title	Presenter Organizations	Date
Introduction to Community-Driven Planning	People's Climate Innovation Center	April 10
Accessing Funding Sources for Affordable Housing and Equity-Eligible Commercial Building Retrofits	Elevate	April 12
Energy Efficiency Programs 101	Elevate	April 14
Considerations for Underserved Commercial Buildings	ACEEE	April 26
Drivers of Energy Efficiency in Affordable Housing	HR&A, HUD	April 28
Choosing Your Building Upgrade Zone: Structural Equity Considerations	ACEEE, DOE OEID	May 10
Building Upgrades: An Opportunity for Workforce and Economic Inclusion	Emerald Cities, ACEEE	May 11

Learn more: www.aceee.org/r2e2-upcoming-events

Sign up: <https://www.herox.com/BuildingsUP/229-upcoming-webinars-recordings>



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