The Real Deal with Heat Pumps

Midwest Building Energy Codes Conference
November 8, 2022

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Housekeeping

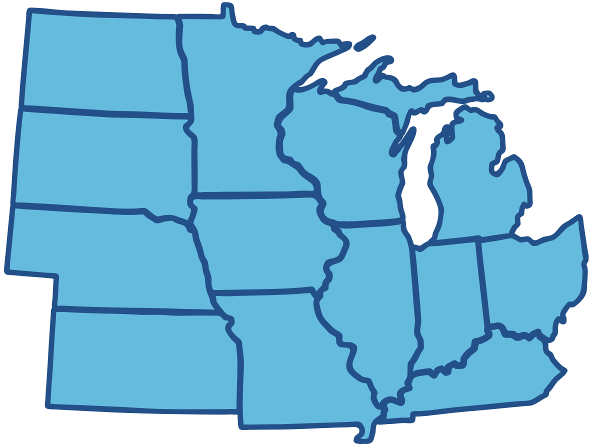
- Enter all questions you have for speakers in the Q&A feature
- Enter any other questions or comments in the chat
- Slides and recordings will be made available to participants after the conference
- Continuing Education Credits are available to participants – information will be shared at the end of the presentation
- Email Corie Anderson, Building Policy Associate, at canderson@mwalliance.org with questions

Agenda

- Mentimeter Poll
- Introductions
- Presentations
- Q&A Session

Midwest Energy Efficiency Alliance

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities.



MEEA is a non-profit membership organization with 160+ members, including:

Electric & gas utilities

State & local governments

Academic & Research institutions

Energy service companies & contractors

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

Mentimeter Poll

Open link in browser

Speakers

Matt Malinowski

Director for Climate Research

CLASP

Dan Wildenhaus

Senior Technical Manager

CEE

Emily Levin

Director of Strategic Market Development

VEIC

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Efficient Appliances for People & the Planet

Swapping ACs for Heat Pumps

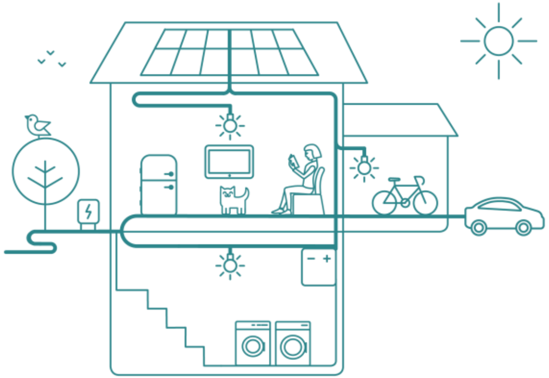
Matt Malinowski

MISSION

CLASP improves the energy and environmental performance of the appliances & equipment we use every day, accelerating our transition to a more sustainable world.

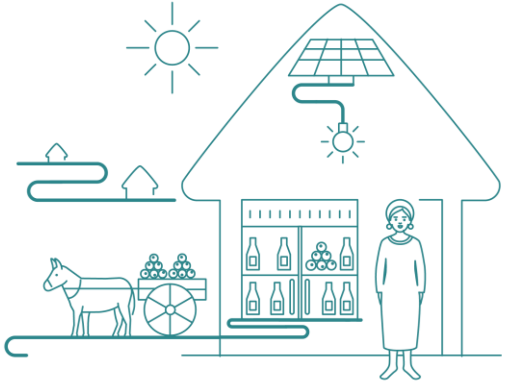
Affordable, low-impact, high-quality appliances, lighting & equipment

Climate



- Reduce carbon emissions
- Lower operating costs
- Decrease energy demand

Clean Energy Access



- Reduce energy supply cost
- Increase energy access
- Improve quality of life

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Goal:

- Transition to clean, efficient heat
- Cost-effectively
- At speed and scale

What Is This?

+$15
0

https://www.ruud.com/products/hvac/

US DOE, “Technical Support Document: Energy Efficiency Program For Consumer Products: Residential Central Air Conditioners and Heat Pumps”, December 2016, pp. 5-21, 5-23.

furnace) to deliver comfortable air to a living environment.

Air Conditioners

Heat Pumps

A Huge Opportunity for Decarbonization

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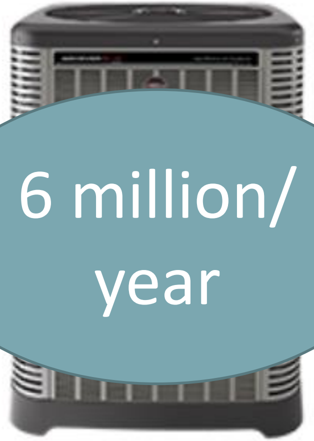
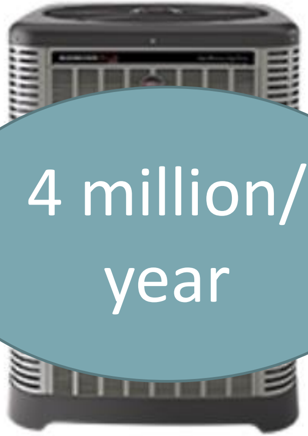


6 million/ year

Air Conditioners



4 million/ year

Heat Pumps

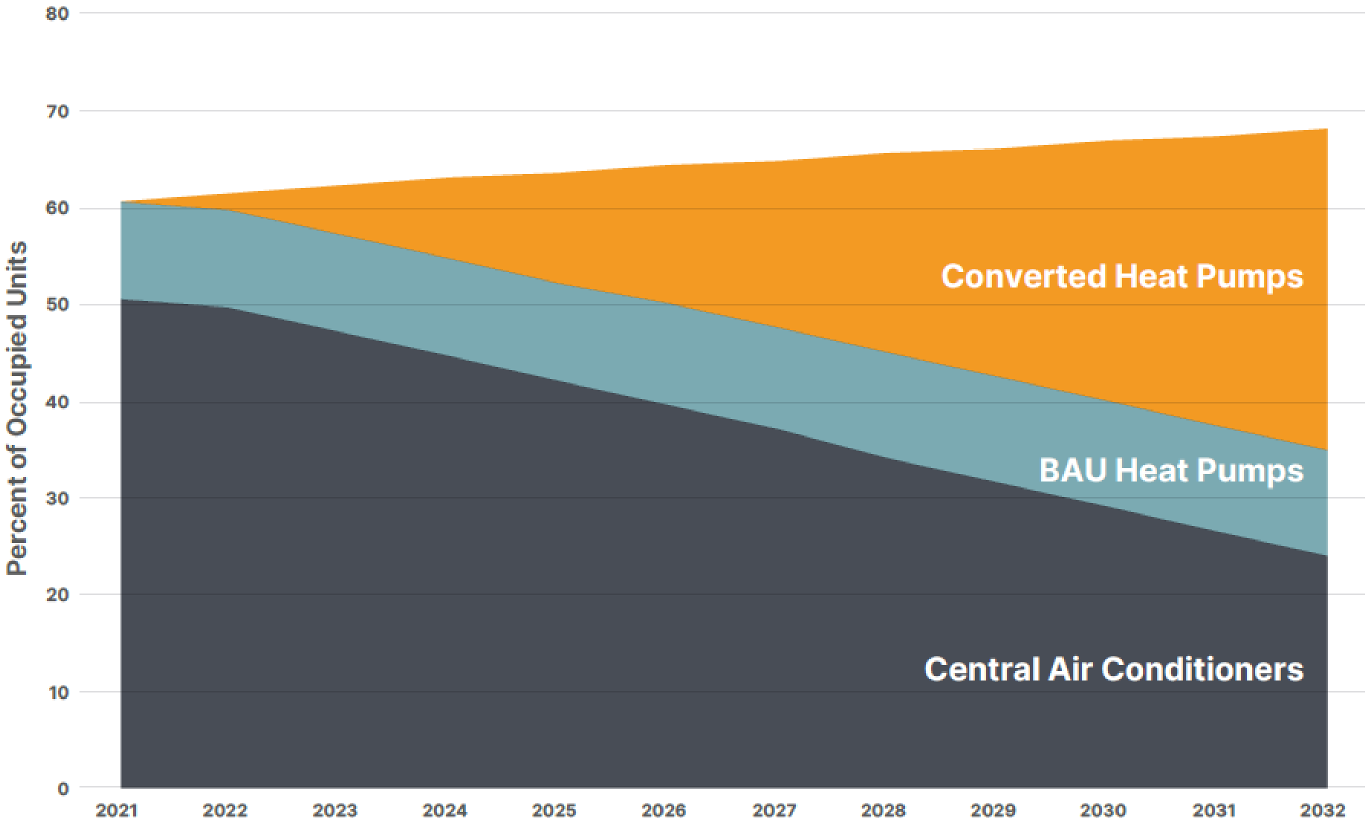
4 million/ year

Gas Furnaces

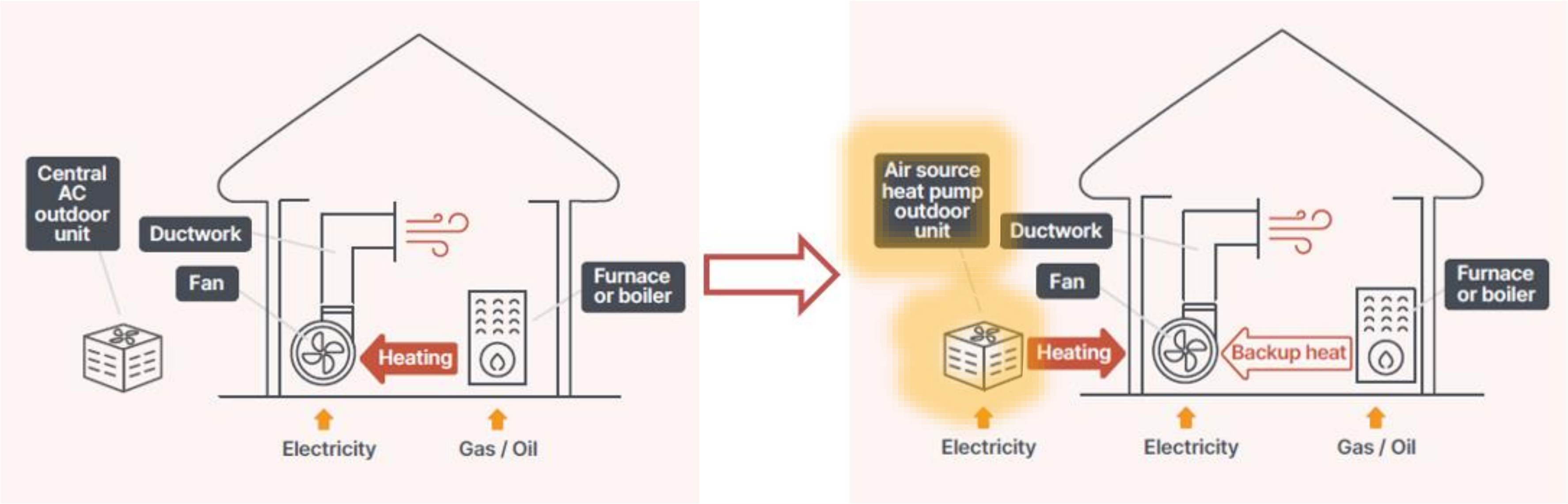
https://www.ruud.com/products/hvac/

Air-conditioning, Heating, & Refrigeration Institute (AHRI), “AHRI Releases December 2021 US Heating and Cooling Equipment Shipment Data”, February 11, 2022, pp. 3–4.

How Would This Look Over Time



How Does it Work?



- Could eliminate 39% of fossil fuel heating
- 11% utility bill and CO_2 reductions (50 MtCO2e annually in 2032)

The Benefits

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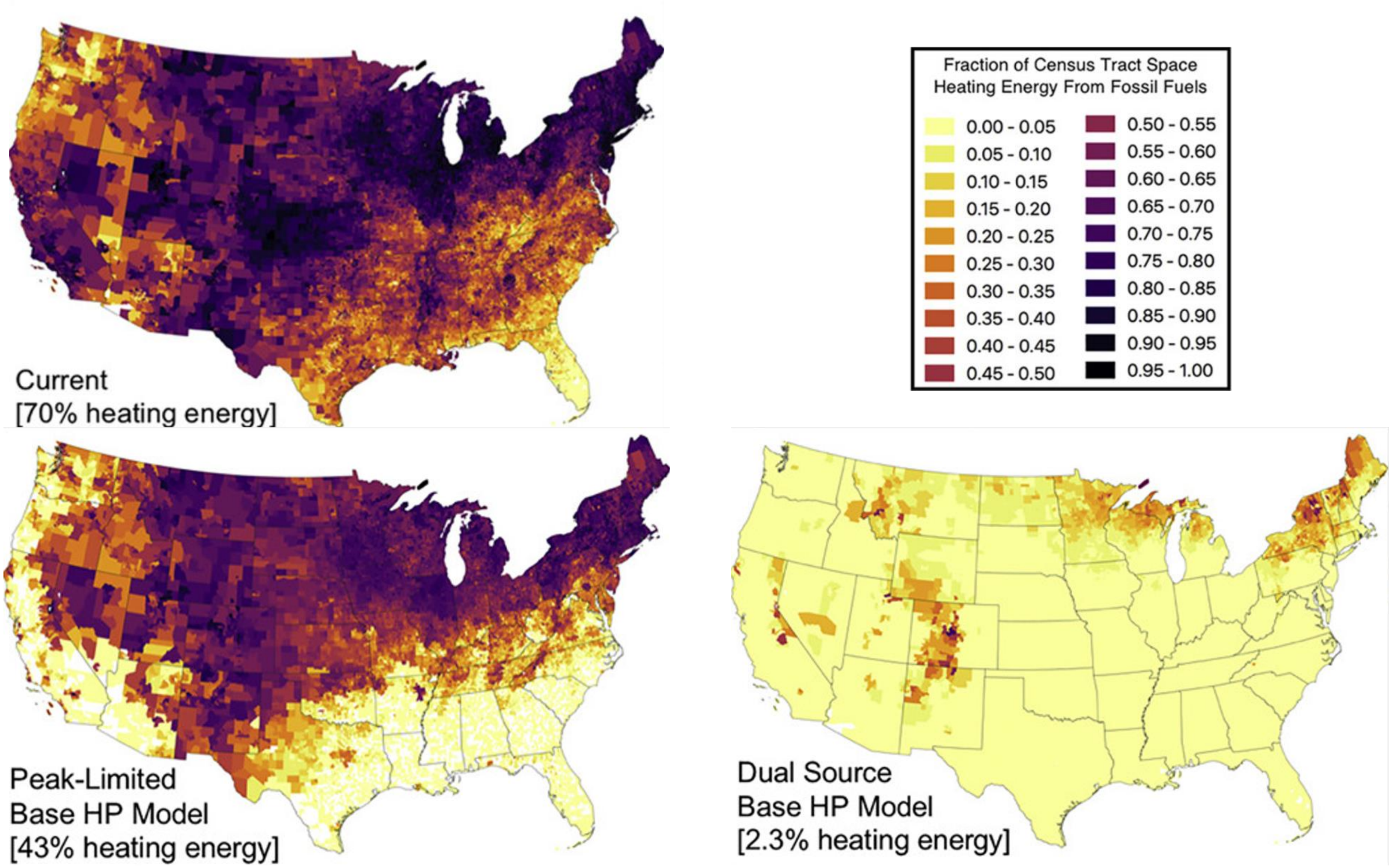
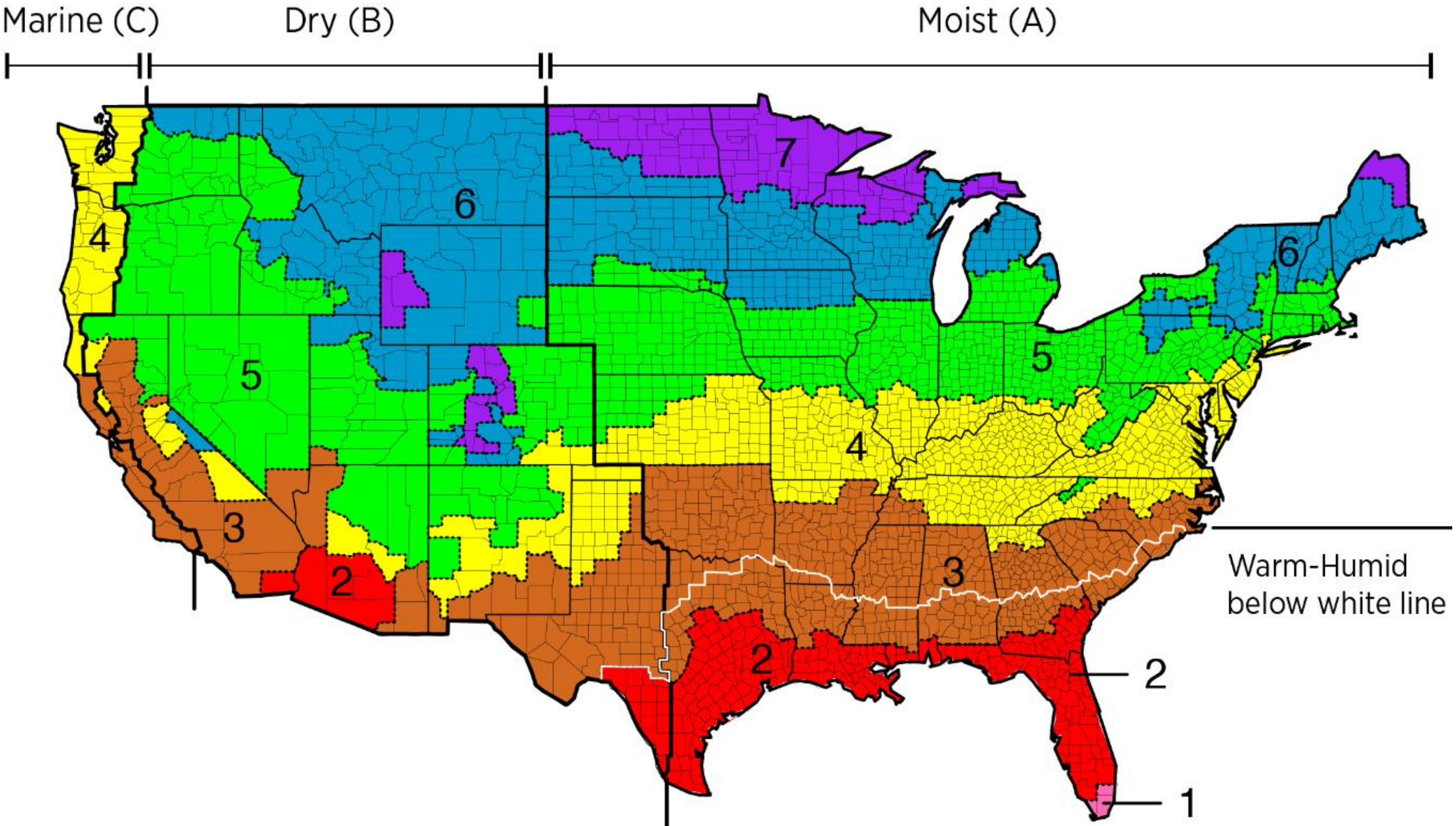
- Short-term solution (next 5 years)
  - Full electrification should take first priority
- **Fewer barriers**
  - Drop-in replacement using existing technology
  - Less concerns about fuel switching
  - Low-up front cost and $256 average annual heating bill savings
    - $400-$500 for oil, propane, or electric resistance
  - Less impact on the electric grid

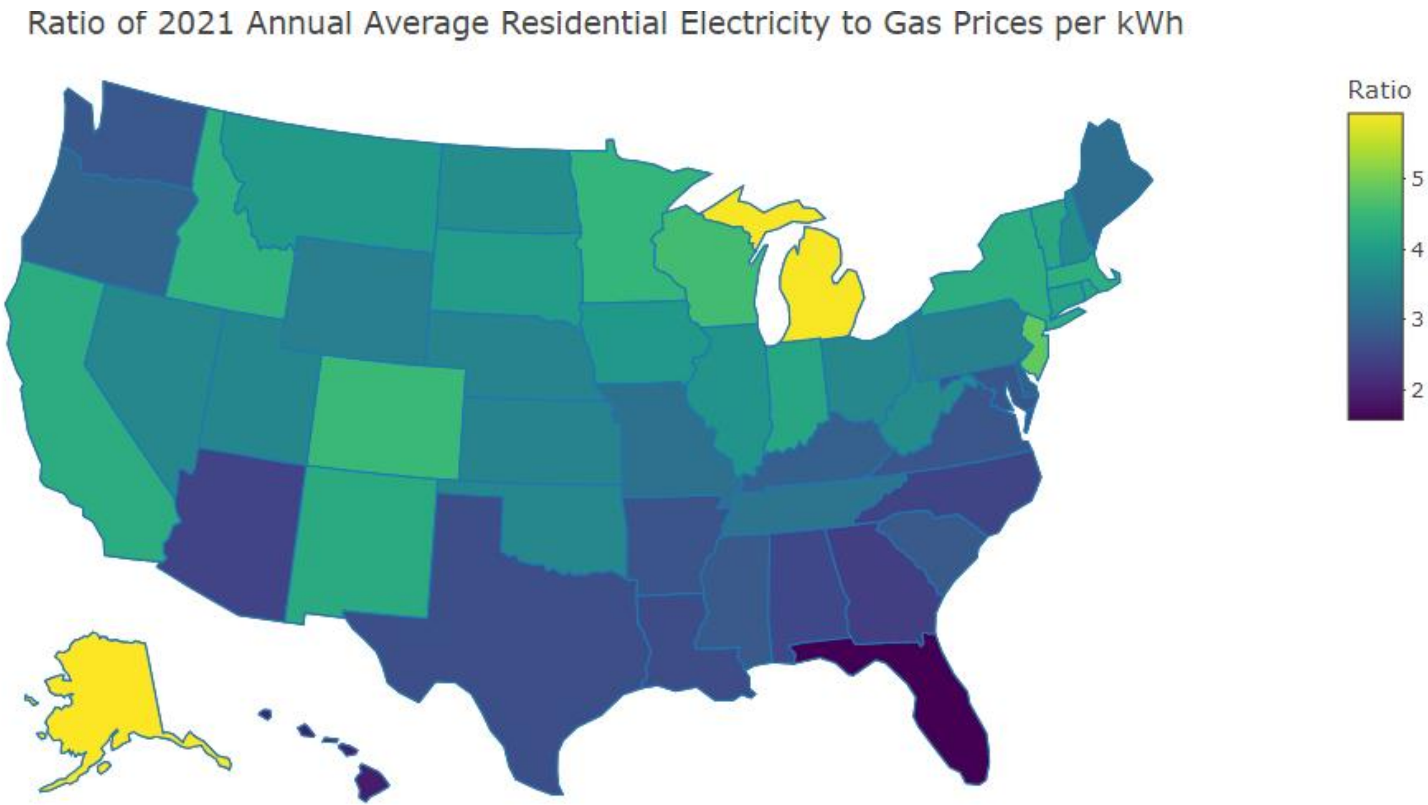


Waite, M. and V. Modi (2020a), "Electricity Load Implications of Space Heating Decarbonization Pathways," Joule 4, 376–394, February 19, 2020.

Opening up Opportunities in More Climates



Equitable Gas versus Electric Rates



How to Get It Done?

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Congress

- HEATR and ICEE-HOT Acts

Federal Programs

- Weatherization
- Federal buildings

State Standards

- Two-way operation requirement similar to water heater DR port

Utility Incentive Programs

CEE Split Central Air Conditioner (CAC) Specification

Level	SEER	EER
CEE Tier 1	≥ 16.0	≥ 12.5
CEE Tier 2	≥ 18.0	≥ 13.0

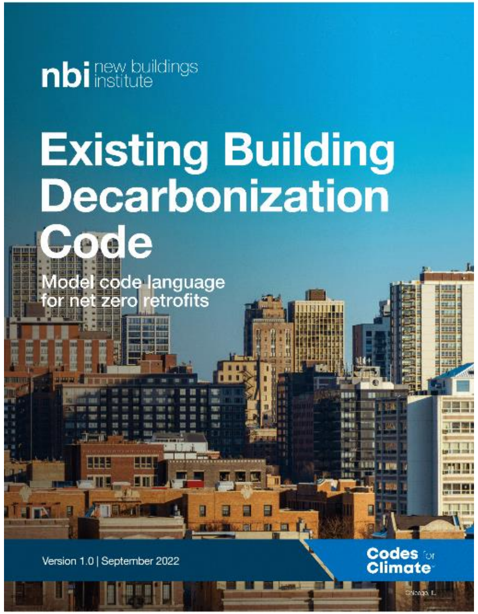
CEE Packaged Central Air Conditioner (CAC) Specification

Level	SEER	EER
CEE Tier 1	≥ 15.0	≥ 12.0
CEE Tier 2	≥ 16.0	≥ 12.0

TBD...

Building Codes

- Inclusion in NBI's Existing Building Decarbonization Code



R503.1.2 Cooling equiment replacements.

Where existing unitary air conditioners are replaced, they shall be replaced with heat pumps configured to provide space heating. Any other space heating systems that serve the same cooling zone shall be configured as supplementary heat in accordance with section **R403.1.2**.

R403.1.2 Heat pump supplementary heat.
Heat pumps having supplementary heat systems shall have controls that limit supplementary heat operation to only those times when one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat heating.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The thermostat malfunctions.

Building Code Successes

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- Denver, CO (proposed):

2025	2027 (or when partial electrification nears cost parity)
Step 3: Heat pumps required as the primary heating source - Fossil gas back-up allowed for gas furnaces and RTU's	Step 3: PTAC: Heat pumps (PTHP) required as the primary heating source (with fossil gas back-up allowed). Boilers and central systems: Have to convert, at least partially, to heat pumps if they can, and if

- San Mateo, CA:

Reach Code	Impacted Buildings	Reach Code Requirements for Remodels
Electric-readiness: panel capacity	All residential buildings	Requires panel replacement and panel upgrade projects to include panel capacity/breaker space for future electrification
Electric-readiness: outlets installed	Single family homes and duplexes	Requires all residential kitchen and laundry renovations include installation of an outlet to allow for the use of electric appliances in the future
Heat pump air conditioning	Single family homes and duplexes	Requires installation of heat pump air conditioning when new air conditioning is installed or replaced
Pools and outdoor	All residential buildings	Prohibits the extension of fuel gas infrastructure into the backyard for uses such

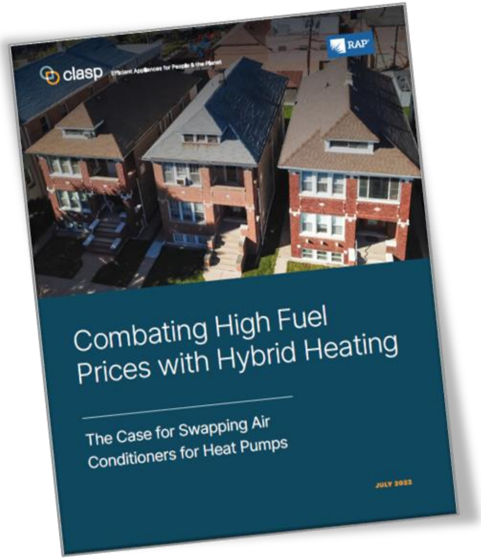
- Portola Valley, CA:

All residential construction additions, alterations, repairs, and/or accessory dwelling unit conversions that do not meet the definition of newly constructed that include the installation of a new or replacement, upgrade or relocation of an existing air conditioning condensing unit and/or the replacement/upgrade to the main electric panel shall comply with the following:

1. The installation of a new or replacement, upgrade or relocation of an existing air conditioning condensing unit shall be replaced with a reverse cycle air conditioning condensing unit (heat pump).

Find out More

New report by CLASP and Regulatory Assistance Project (RAP)



- Benefits for each state and heating fuel
- https://www.clasp.ngo/research/all/ac-to-heat-pumps/
- Or scan here:

MATT MALINOWSKI

Director of Climate Research |

mmalinowski@clasp.ngo

clasp

Efficient Appliances for People & the Planet

November, 2022

REAL WORLD CHALLENGES WITH ASHP'S AND HP REPLACING AC

Midwest Building Energy Codes Conference

Dan Wildenhaus – Sr Technical Manager

Decarbonization Training and Consulting Services

Center for Energy and Environment

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Goals for this section

- Tax Credits NOW and 2023 and beyond
- Real World Consideration
  - Equipment selection
  - Introducing Cost of Heat tools
  - Importance of sizing
  - Best Practice Considerations
- Contractor Training

The IRA of 2022 will have three benefits for most HVAC contractors

1. Tax Credits

2. HOMES Rebates

3. High Efficiency Electric Home Rebates

   - Total of 8.8 Billion Dollars invested in rebates

   - Tax Credits run through 2032

https://bpa.connectedcommunity.org/forums/community-home?CommunityKey=3c843d85-e6e9-4e6e-aa34-8fbd7c30b7c7

https://www.rewiringamerica.org/app/ira-calculator

https://incentives-calculator.radiantlabs.co/

25C Tax Credits

- For 2022
- Credit revived and made retroactive at original 10% of total installed cost
- Still has lifetime cap of $500
- $500 tax credit is available for homes built in 2022 tax year

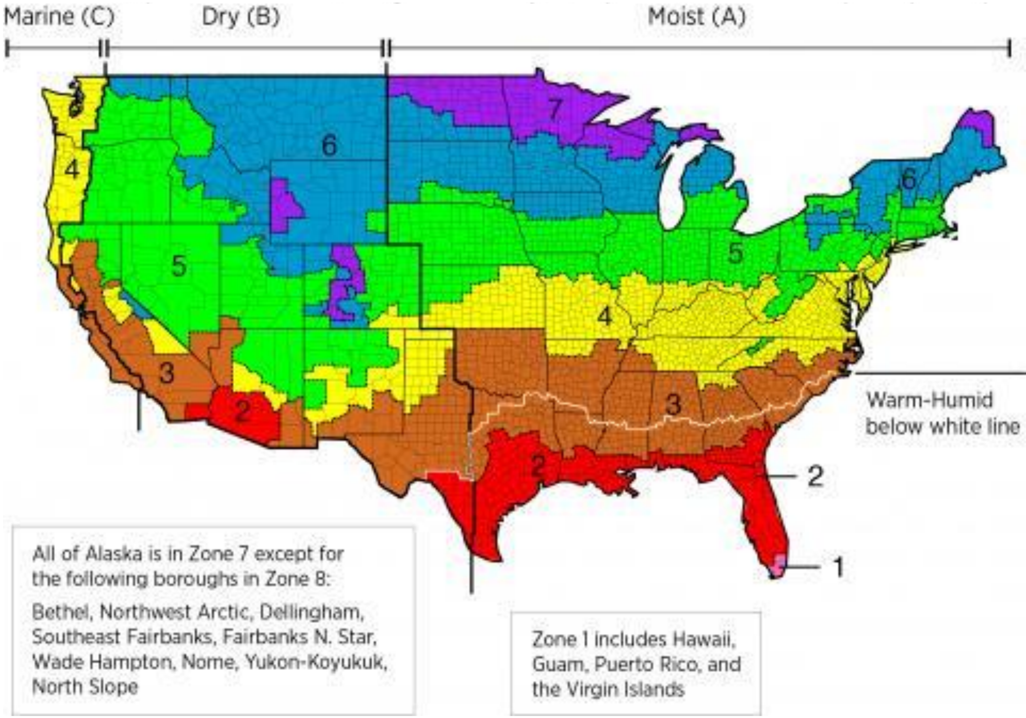
Due Soon!

System Type	SEER2	EER2	HSPF2
DRAFT 2023 Tax Credit Levels Ductless	15.2	9	8.5
DRAFT 2023 Tax Credit Levels Ducted	15.2	10	8.1

Real World Challenges

#1 Do I need a cold climate model? – Technical Answers

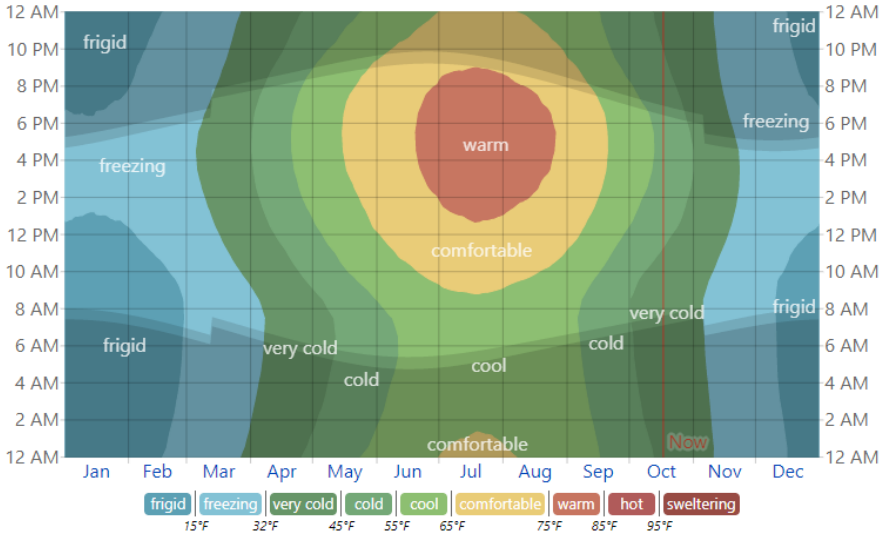
- Heating Degree Days
- Winter Design Temperature
- Heating Degree Days vs Cooling Degree Days
- Climate Zone Map



What is a cold climate? Visualizing

Average Hourly Temperature at Brainerd Lakes Regional Airport

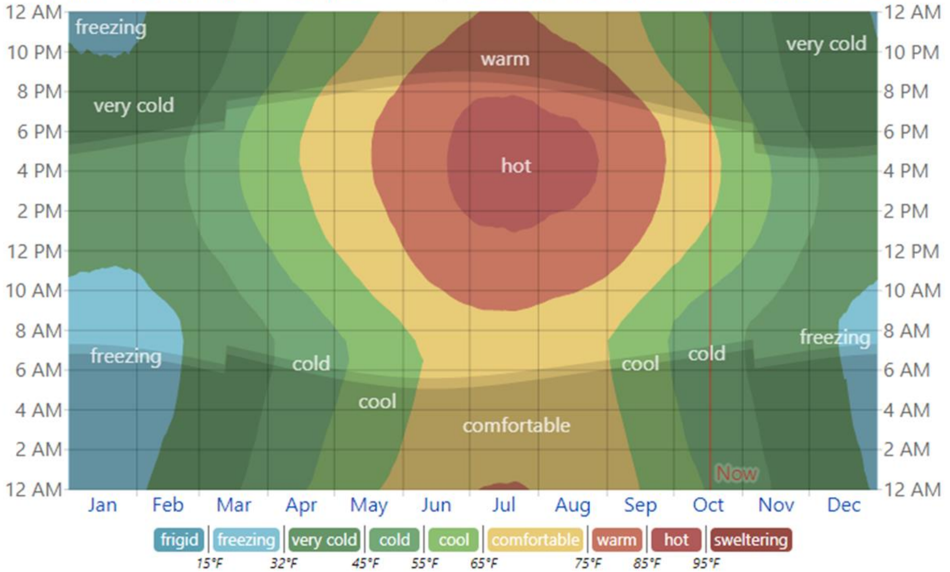
Link Download Compare History: 2022 2021 2020 2019 2018 2017 2016 2015 2014



The average hourly temperature, color coded into bands. The shaded overlays indicate night and civil twilight.

Average Hourly Temperature at Saint Louis Downtown - Parks Airport

Link Download Compare History: 2022 2021 2020 2019 2018 2017 2016 2015 2014



The average hourly temperature, color coded into bands. The shaded overlays indicate night and civil twilight.

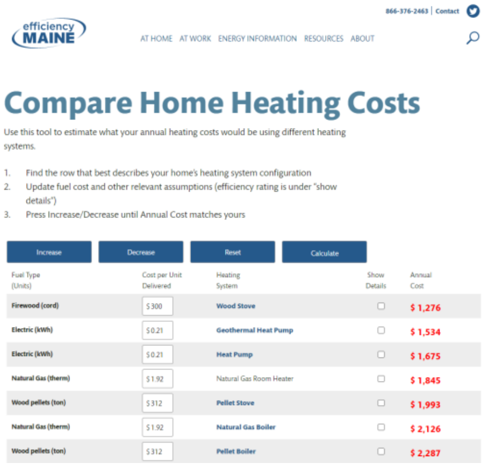
Center for Energy and Environment

https://weatherspark.com/y/146353/Average-Weather-at-Saint-Louis-Downtown---Parks-Airport-Illinois-United-States-Year-Round

#2 Cost of Heat. A Tool for Minnesotans ROCKS!

https://www.mnashp.org/cost-of-heat-comparison

Additional cost of heat tools



866-376-2463 | Contact

AT HOME AT WORK ENERGY INFORMATION RESOURCES ABOUT

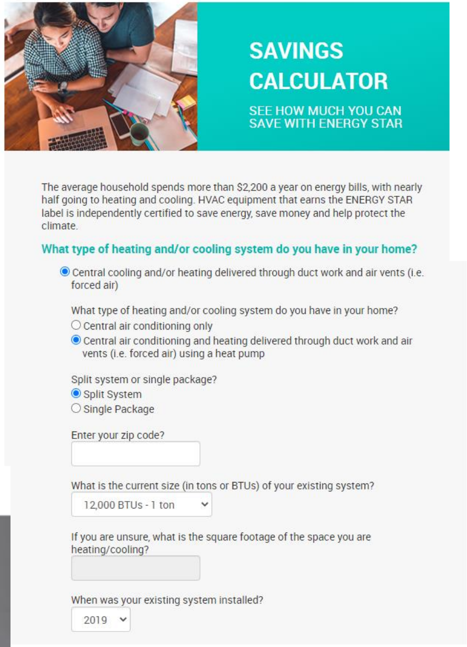
Compare Home Heating Costs

Use this tool to estimate what your annual heating costs would be using different heating systems.

1. Find the row that best describes your home's heating system configuration
2. Update fuel cost and other relevant assumptions (efficiency rating is under "show details")
3. Press Increase/Decrease until Annual Cost matches yours

Increase Decrease Reset Calculate

Fuel Type (Units)	Cost per Unit Delivered	Heating System	Show Details	Annual Cost
Firewood (cord)	$300	Wood Stove		$ 1,276
Electric (kWh)	$0.21	Geothermal Heat Pump		$ 1,534
Electric (kWh)	$0.21	Heat Pump		$ 1,675
Natural Gas (therm)	$1.92	Natural Gas Room Heater		$ 1,845
Wood pellets (ton)	$312	Pellet Stove		$ 1,993
Natural Gas (therm)	$1.92	Natural Gas Boiler		$ 2,126
Wood pellets (ton)	$312	Pellet Boiler		$ 2,287



SAVINGS CALCULATOR

SEE HOW MUCH YOU CAN SAVE WITH ENERGY STAR

The average household spends more than $2,200 a year on energy bills, with nearly half going to heating and cooling. HVAC equipment that earns the ENERGY STAR label is independently certified to save energy, save money and help protect the climate.

What type of heating and/or cooling system do you have in your home?

- Central cooling and/or heating delivered through duct work and air vents (i.e. forced air)

What type of heating and/or cooling system do you have in your home?

- Central air conditioning only
- Central air conditioning and heating delivered through duct work and air vents (i.e. forced air) using a heat pump

Split system or single package?

- Split System
- Single Package

Enter your zip code?

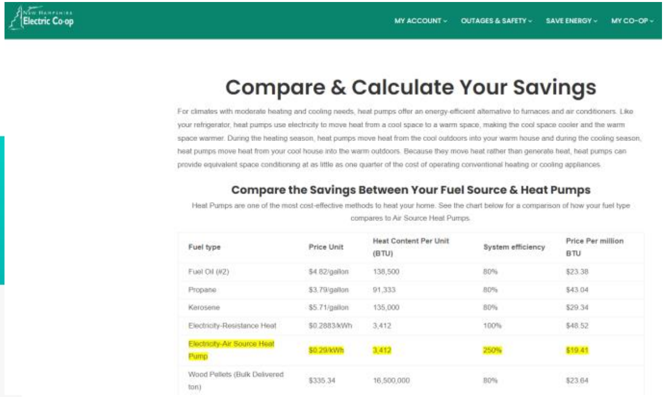
What is the current size (in tons or BTUs) of your existing system?

12,000 BTUs - 1 ton

If you are unsure, what is the square footage of the space you are heating/cooling?

When was your existing system installed?

2019



MY ACCOUNT OUTAGES & SAFETY SAVE ENERGY MY CO-OP

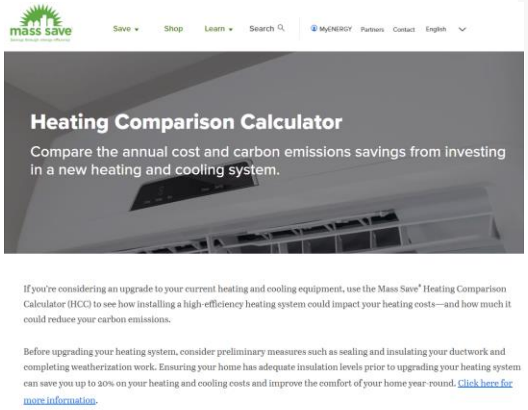
Compare & Calculate Your Savings

For climates with moderate heating and cooling needs, heat pumps offer an energy-efficient alternative to furnaces and air conditioners. Like your refrigerator, heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into your warm house and during the cooling season, heat pumps move heat from your cool house into the warm outdoors. Because they move heat rather than generate heat, heat pumps can provide equivalent space conditioning at as little as one quarter of the cost of operating conventional heating or cooling appliances.

Compare the Savings Between Your Fuel Source & Heat Pumps

Heat Pumps are one of the most cost-effective methods to heat your home. See the chart below for a comparison of how your fuel type compares to Air Source Heat Pumps.

Fuel type	Price Unit	Heat Content Per Unit (BTU)	System efficiency	Price Per million BTU
Fuel Oil (#2)	$4.82/gallon	138,500	80%	$23.38
Propane	$3.79/gallon	91,333	80%	$43.04
Kerosene	$5.71/gallon	135,000	80%	$29.34
Electricity-Resistance Heat	$0.2883/kWh	3,412	100%	$48.52
Electricity-Air Source Heat Pump	$0.29/kWh	3,412	250%	$19.41
Wood Pellets (Bulk Delivered ton)	$335.34	16,500,000	80%	$23.64



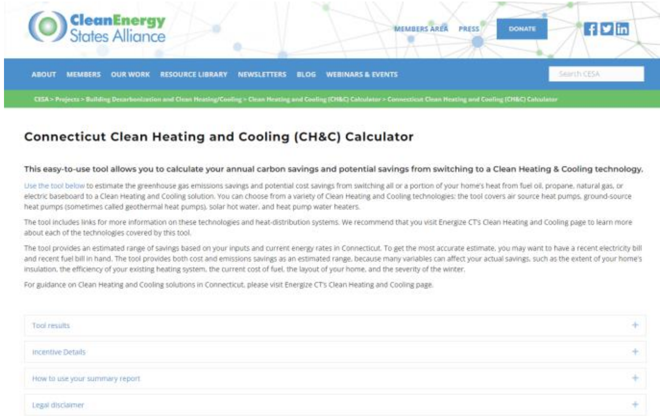
Save Shop Learn Search MyENERGY Partners Contact English

Heating Comparison Calculator

Compare the annual cost and carbon emissions savings from investing in a new heating and cooling system.

If you're considering an upgrade to your current heating and cooling equipment, use the Mass Save® Heating Comparison Calculator (HCC) to see how installing a high-efficiency heating system could impact your heating costs—and how much it could reduce your carbon emissions.

Before upgrading your heating system, consider preliminary measures such as sealing and insulating your ductwork and completing weatherization work. Ensuring your home has adequate insulation levels prior to upgrading your heating system can save you up to 20% on your heating and cooling costs and improve the comfort of your home year-round. Click here for more information.



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CESA > Projects > Building Decarbonization and Clean Heating/Cooling > Clean Heating and Cooling (CH&C) Calculator > Connecticut Clean Heating and Cooling (CH&C) Calculator

Connecticut Clean Heating and Cooling (CH&C) Calculator

This easy-to-use tool allows you to calculate your annual carbon savings and potential savings from switching to a Clean Heating & Cooling technology.

Use the tool below to estimate the greenhouse gas emissions savings and potential cost savings from switching all or a portion of your home's heat from fuel oil, propane, natural gas, or electric baseboard to a Clean Heating and Cooling solution. You can choose from a variety of Clean Heating and Cooling technologies: the tool covers air source heat pumps, ground-source heat pumps (sometimes called geothermal heat pumps), solar hot water, and heat pump water heaters.

The tool includes links for more information on these technologies and heat-distribution systems. We recommend that you visit Energize CT's Clean Heating and Cooling page to learn more about each of the technologies covered by this tool.

The tool provides an estimated range of savings based on your inputs and current energy rates in Connecticut. To get the most accurate estimate, you may want to have a recent electricity bill and recent fuel bill in hand. The tool provides both cost and emissions savings as an estimated range, because many variables can affect your actual savings, such as the extent of your home's insulation, the efficiency of your existing heating system, the current cost of fuel, the layout of your home, and the severity of the winter.

For guidance on Clean Heating and Cooling solutions in Connecticut, please visit Energize CT's Clean Heating and Cooling page.

Tool results

Incentive Details

How to use your summary report

Legal disclaimer

#3 Sizing

Many contractors, some builders, some code officials, and even some homeowners believe "bigger is better" despite what heat load calculations say.

Does any of this sound familiar?

Size for heating

Size for cooling

You need a big turndown ratio

You want a high COP

You need high capacity at low temperature

You want back up gas furnace

You don't want any back up heat

Short cycling is terrible

Don't worry about sizing, variable speed heat pumps are magic!

Center for Energy and Environment

Other considerations

- Turndown ratio
- Compressor cycling
- Auxiliary or backup heat
- Efficiency at low temps
- Capacity at low temps

What are your goals?

All about the Benjamins

- Inverter heat pump, but maybe not a cold climate model
- **High COP matters most**
- Block load sized at least (particularly for DHPs)
- May want gas back up heat for ducted
- Good turndown ratio (over 4:1)
- May want switchover temperature 35^{o}F-40^{o}F for dual fuel

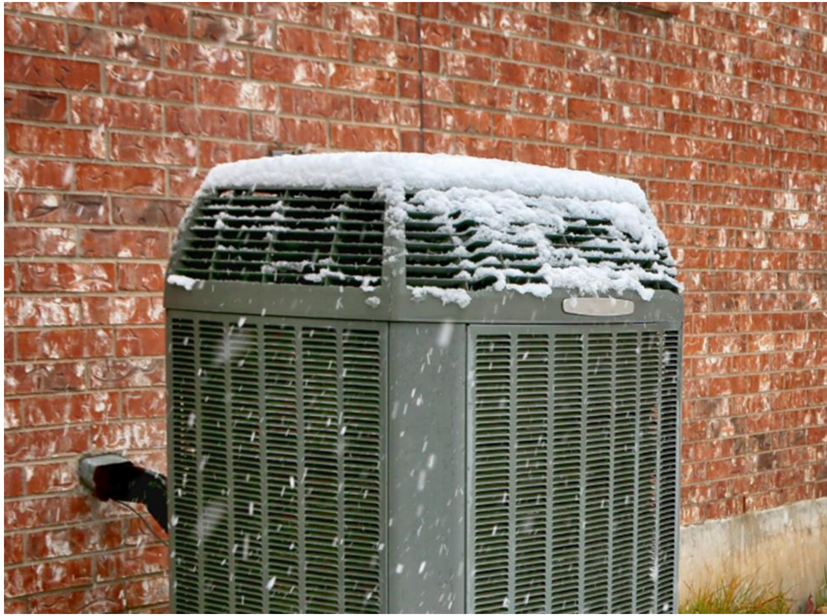
Net Zero – High-Performance – Low Carbon

- **Cold climate appropriate across the CZs 4c and higher (high % of capacity below your winter design temp)**
- Decent turndown ratio (1.3:1 or better)
- Switchover temperature near balance point
- Reduce hours of compressor cycling
- May not need any back up/Auxiliary heat
- Decent COP or HSPF

Going All Electric with a ccASHP

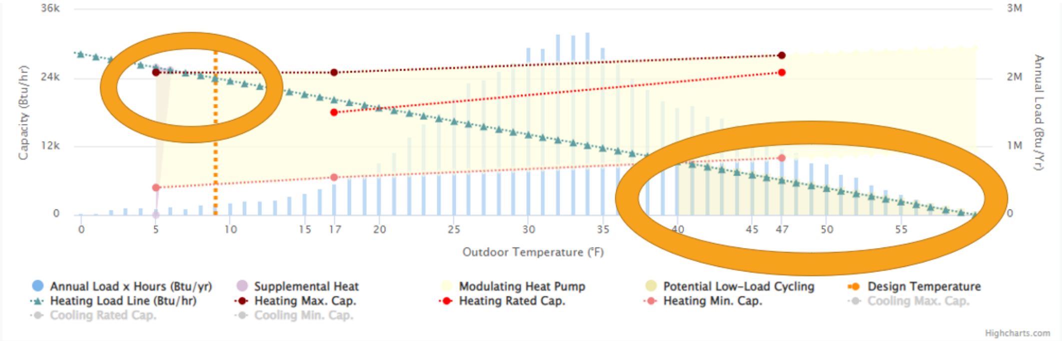
How to achieve best cost efficiency with all electric systems

- **Size for heating load**
  - Don't significantly oversize (limit oversizing to 125% of heat load calculation)
  - Use maximum capacity at 5°F
- **Backup heat/controls**
  - Use a central thermostat with integrated controls
  - Electric plenum heater meets load when needed
- **Homeowner education**
  - No or low thermostat setback
- **When might this be the right suggestion**
  - Already considering electric solutions
  - Looking to hit Net Zero
  - Carbon impact or future driven outlook



All Electric ccASHP

- **Success with new construction**
- **Think envelope reduction first**
  - ENERGY STAR® v3.1 or higher
  - Eliminate thermal bridging
  - ENERGY STAR v6.0 or 7.0 windows
- **Air tightness and ventilation**
  - Aim for 2.5 ACH 50 or lower
  - Think through ventilation strategies
    - Heavily consider heat / energy recovery
- **Size system as indicated, checking your sizing**
  - 2450 sq ft home, 11 BTU h / sq ft with improved envelope
  - 2.5-ton equipment



Product Sizing For Heating

Field Information

Capacity Balance Point (°F)	7
Minimum Capacity Threshold (°F)	40
Maximum Capacity at Design Temp (Btu/hr)	25,000
Percent Design Load Served	104.2%
Annual Heating Load (MMBtu)	59.1
Percent Annual Heating Load Served	99.0%

Field Information

Annual Btu's Covered by Supplemental Heat (MMBtu)	0.6
Hours Requiring Supplemental Heat	22
Percent Hours Requiring Supplemental Heat	0.4%
Percent Annual Load Modulating	72.1%
Percent Annual Load with Low-Load Cycling	24.3%

Dual Fuel: ccASHP and Furnace – The Hybrid

Achieving the best first cost and operational cost (in colder climates)

- **Size for heating load**
  - Up to 115% of load for heat pump
  - Use max capacity at 17°F or 5°F
  - Build tight and quality install insulation in home
- **Furnace choice?**
  - Lowest first cost = Federal minimum standard
  - Lowest operational cost = 95+% efficient gas system
- **Backup heat/controls**
  - Thermostat – temperature-based switchover*
  - Integrated load-based backup heat
- **Homeowner education**
  - No or low thermostat setbacks
  - No constant fan operation

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use balance point or economic switchover temperature

Dual-Fuel - Standard ASHP and Furnace

- **How to achieve best cost efficiency for singe- and two stage-systems**
- **Size at the high end of the cooling load**
  - Don't significantly oversize only a ½ - 1 ton more than cooling need
  - Use maximum capacity at 17°F
  - Minimum efficiency ≥16 SEER
- **Furnace selection**
  - ECM blower
  - 95% AFUE or higher if using economic switchover temperature
- **Thermostat and other controls**
  - Enter a customized temperature-based switchover based on findings from customer discussion
- **Homeowner education**
  - No thermostat setback or very minimal setback (no more than 4 degrees)
  - Avoid the use of constant fan (utility bill penalty)

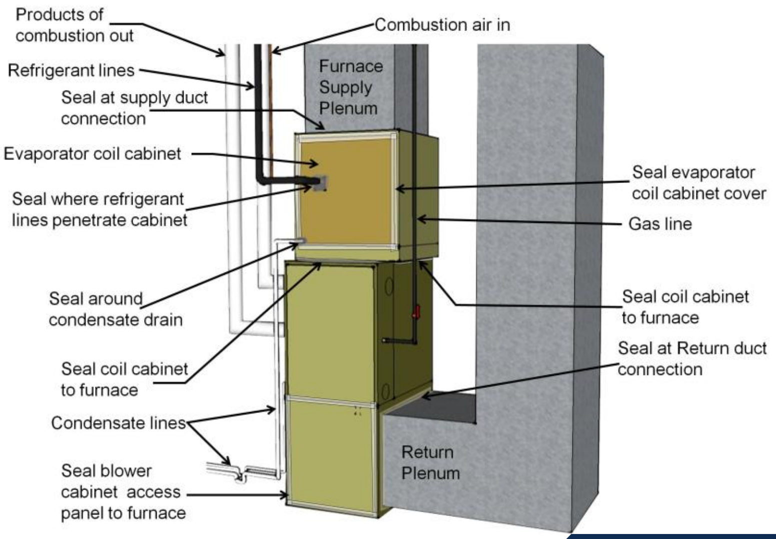

Image courtesy Building America Solution Center

Is my contractor ready to install a heat pump?

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Heat pump myths and misconceptions

- Almost all manufacturers have their own blog or resource on heat pump myths!
- There are several third-party sites with *mythbusting* heat pump posts and resources:
  - https://www.efficiencymaine.com/docs/Heat-Pump-Myths-and-Facts.pdf
  - https://www.ase.org/blog/myth-busting-common-misconceptions-about-heat-pumps
  - https://carbonswitch.com/do-heat-pumps-work-in-cold-weather/
- There are numerous case studies available for homeowners and contractors:
  - https://www.mnashp.org/guides
  - https://concordma.gov/2776/Heat-Pump-Case-Studies
  - https://sustainabletechnologies.ca/app/uploads/2022/03/HP_Case_Study_4_Final.pdf

Is your contractor trained?

All HVAC contractors likely have some formal training and many years of on-the-job training!

Insist that they have training on:

- Manufacturer training on cold climate and dual fuel or "hybrid" heat pumps
- Heat pump controls, hybrid system controls, and homeowner guidance on settings
- Sizing and selection of variable speed heat pumps

Action Items

- Track the IRA of 2022 developments

- Familiarize your self with one of these sizing guides
  - NEEP
  - NRCAN

- Mythbust heat pump misconceptions!
  - Here
  - Here
  - and Here

Thank You!

Dan Wildenhaus
Sr Technical Manager
Decarbonization Training and Consulting Services

Center for Energy and Environment

Equitable Electrification: Solving the Affordability Catch-22 for LMI Households that Heat with Natural Gas

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MEEA Codes Conference 2022

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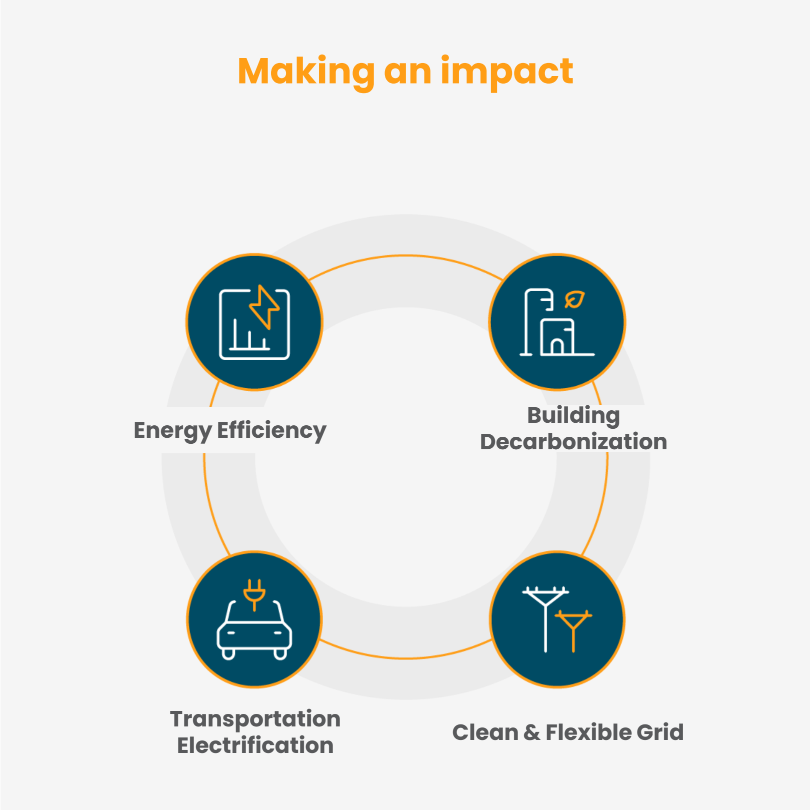

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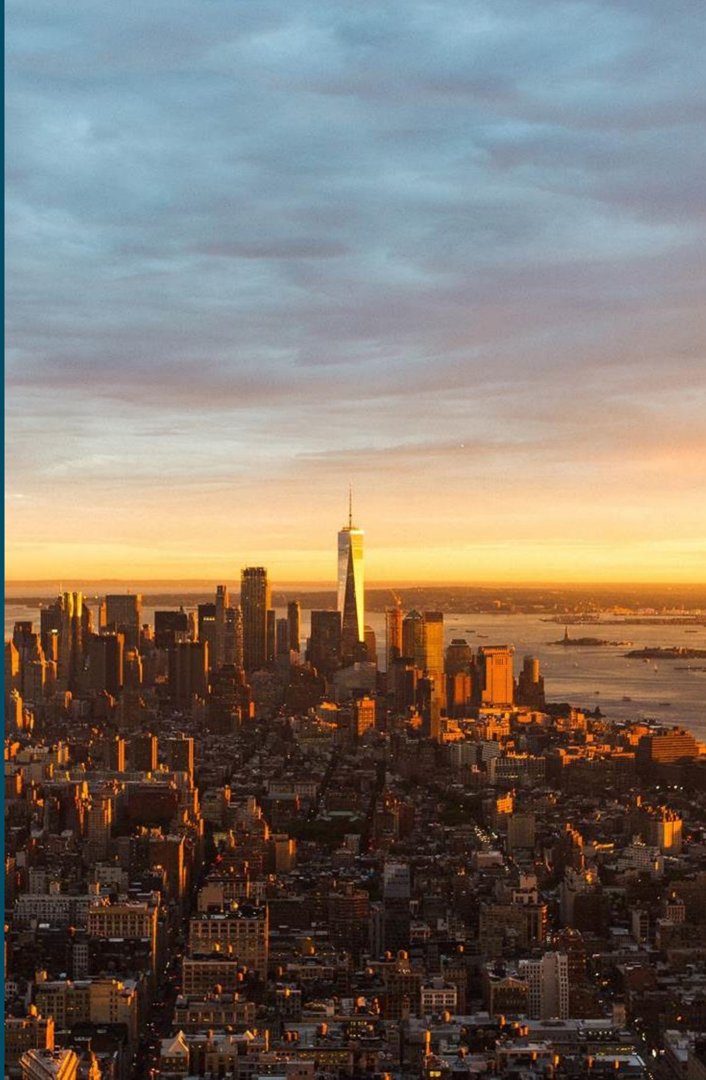
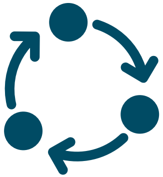
Framing the Issue: Applying an Affordability Lens to Building Electrification



What Do We Mean by Equitable Electrification?



Procedural Equity

Distributional Equity

Structural Equity

Transgenerational Equity

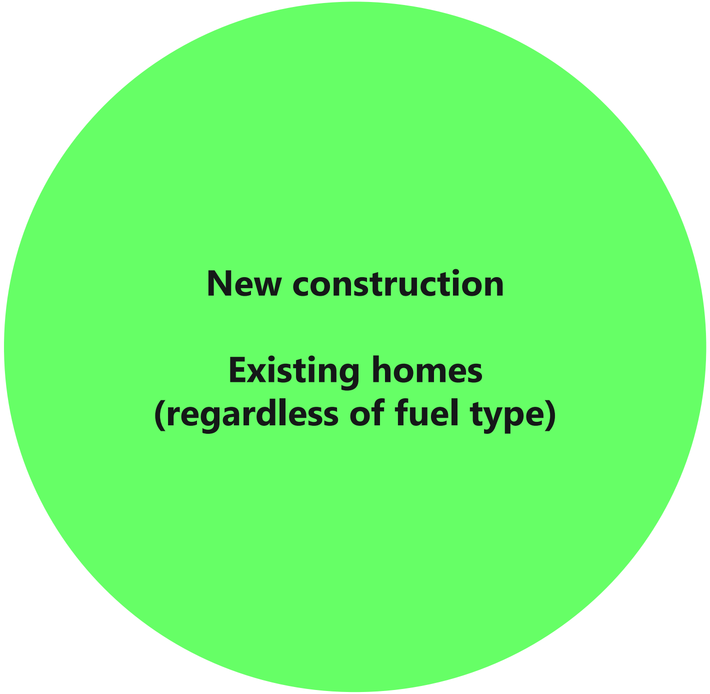
From ACEEE Measuring and Tracking Equity Progress: Equity-focused Metrics and Lessons Learned and Equity in Sustainability: An Equity Scan of Local Government Sustainability Programs

Applying An Affordability Lens

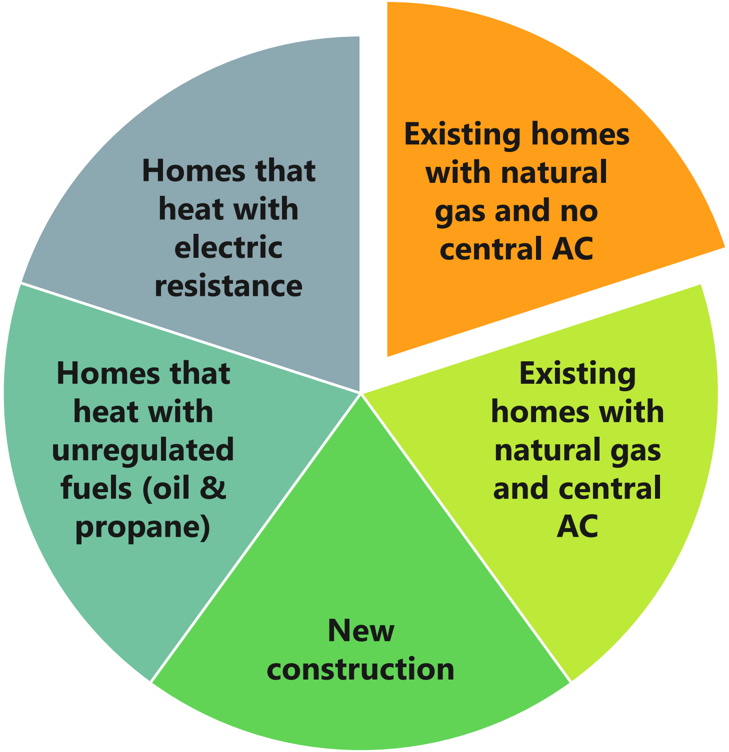
Distributional equity: How do we ensure that building electrification does not increase energy burden, particularly for low- and moderate-income (LMI) households?

Structural equity: Housing occupied by LMI households has been chronically underinvested and may need additional repairs before electrification

Building Electrification: GHG Perspective



Building Electrification: Cost Perspective

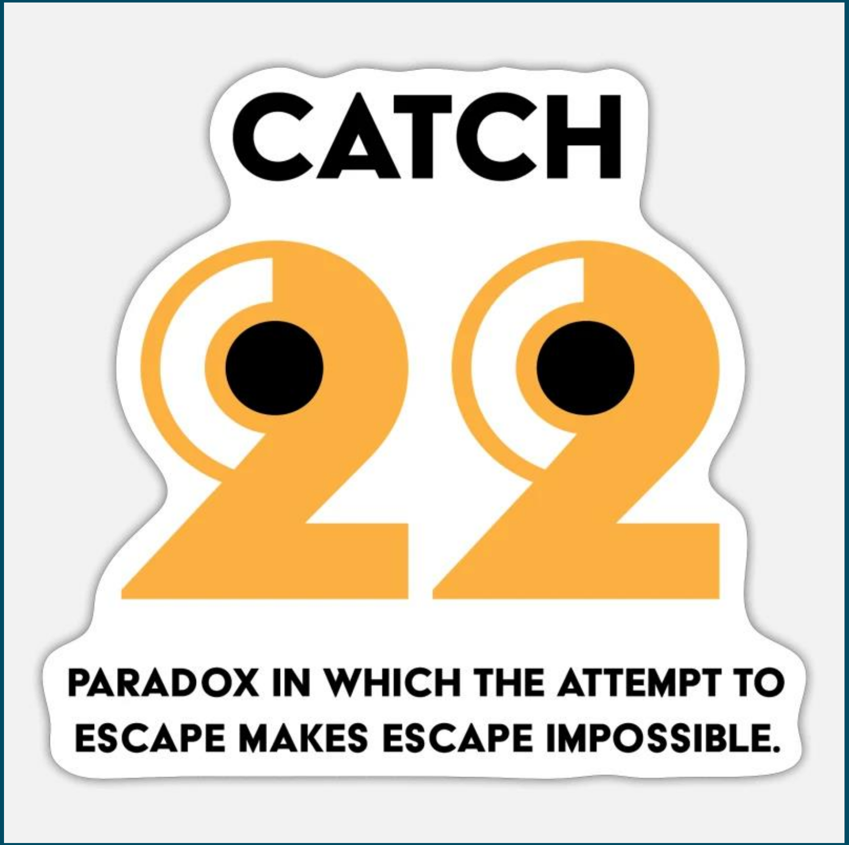


Affordability Catch-22 for Natural Gas Customers

Heat pumps are more expensive to install (equipment and labor)

Heat pumps may cost more to operate in the **short-term** than natural gas equipment

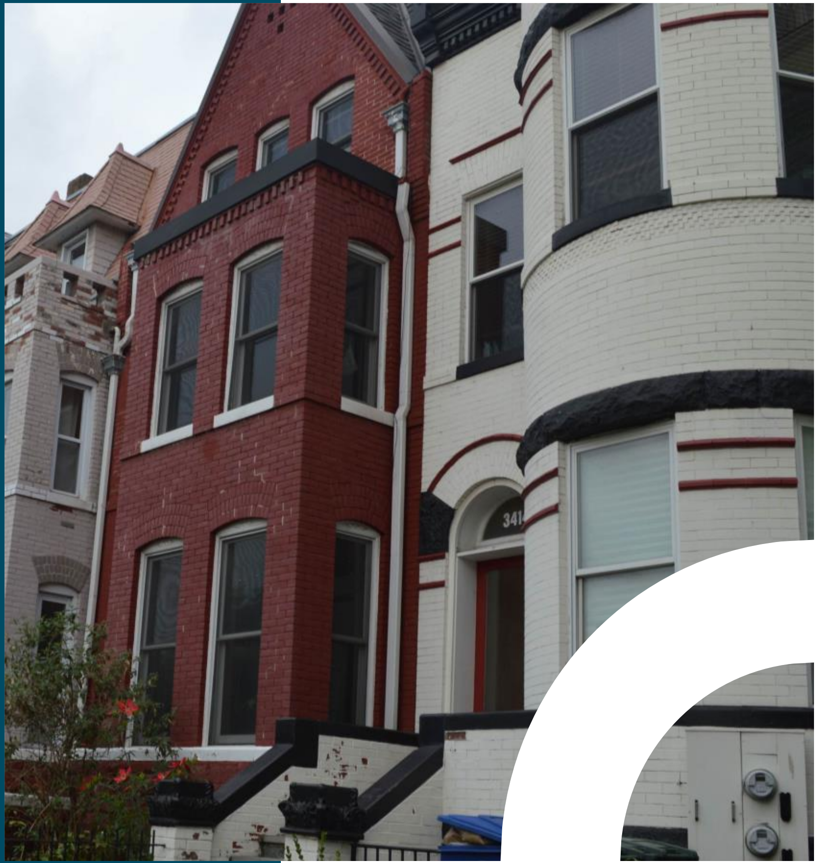
Customers that remain on a shrinking gas system are at risk of cost increases in the **long-term** if they do not electrify



Why it Matters for LMI Households

- 44% of low-income housing is heated by natural gas
- Low-income households already face disproportionate energy burdens
- Many low-income households are underserved for AC

How can we help these homes electrify without worsening energy burden?



Compounding the Challenge: Housing Barriers

- Addressing pre-existing health and safety hazards or repair requirements increases project cost
- Lack of proven, commercially available electrification solutions for mobile homes and large multifamily buildings
- 61% of low-income households are renters; owner-resident dynamics in rental housing complicate electrification projects
- Higher operating costs affect subsidized housing developers' ability to leverage debt

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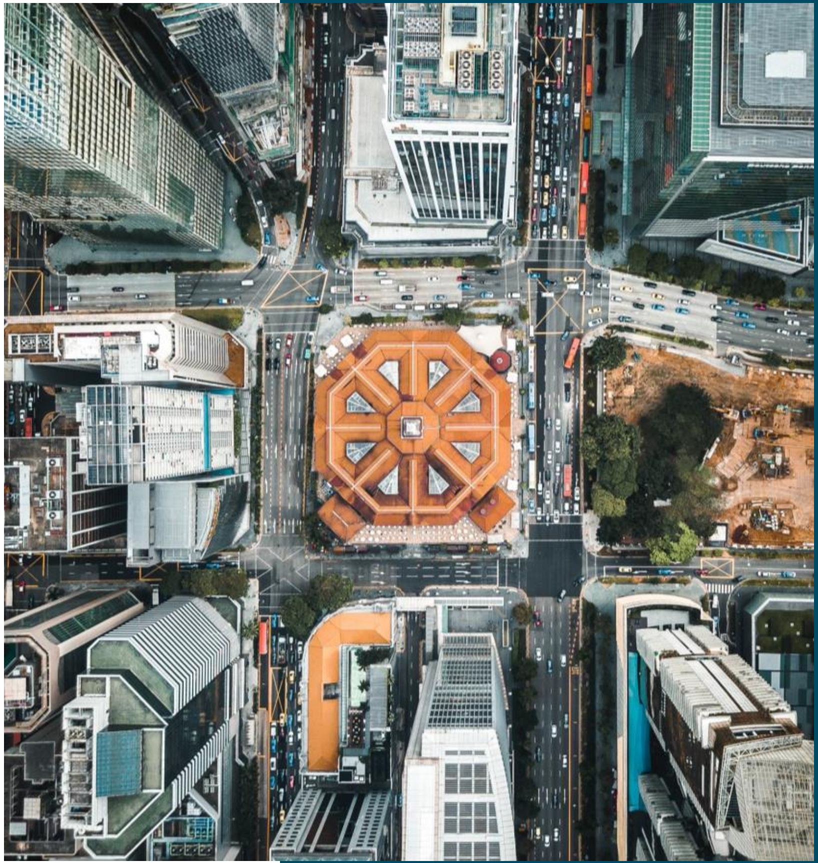
Solutions to Advance Equitable & Affordable Electrification

Project Design & Planning

- **First, do no harm:** screen LMI electrification projects for short- and long-term customer cost impacts to determine whether cost control strategies are needed
- **Create electrification roadmaps for multifamily buildings** to control costs by syncing the timing of electrification investments with end-of-life equipment replacement, major renovations, or refinancing opportunities



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Promote (and Fund) Comprehensive Retrofits

- **Bundle electrification with energy efficiency and solar** to bring down operating costs
- **Design LMI-targeted programs to be comprehensive** and avoid equipment-only replacements
- **Revise program rules** to allow fuel switching, increase cost caps, and update cost-effectiveness screening practices
- **Braid funds from multiple sources**, including for health & safety barrier mitigation (WAP, LIHEAP)

Advance Technologies to Meet the Need

- **Drive down costs** with new technologies that avoid the need for electric panel and wiring upgrades (e.g., "retrofit-ready" 120-volt HPWHs)

- **Accelerate RD&D for multifamily building technologies** (e.g., central hot water heating replacement, through-the-wall heat pump HVAC units)

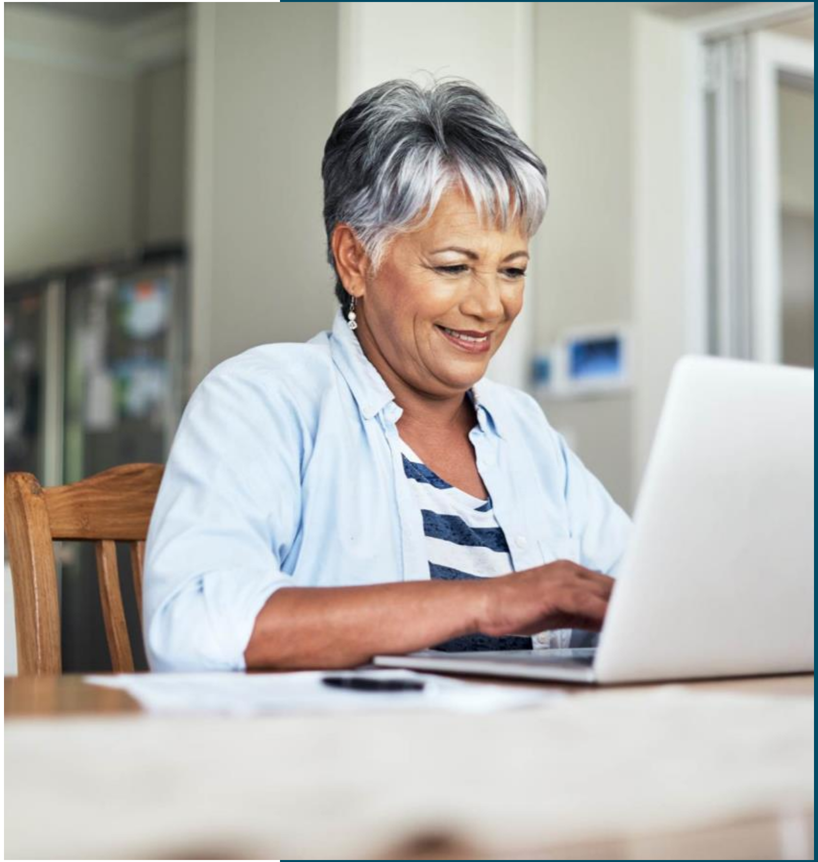
Housing Policy

- **Coordinate incentive programs** with project financing timelines

- **Adjust state housing finance agency funding criteria** and design guidelines to support all-electric buildings with well-insulated and tight envelopes
- **Update utility allowances** for electrification
- **Establish affordability requirements** to ensure residents are protected from rent increases or displacement

Bill Assistance & Rate Design

- **Preserve and streamline bill assistance** for customers who electrify
- **Expand income-qualified utility rates** and Percentage of Income Payment Plans
- **Advance rate structures** to encourage electrification and optimize time-of-use
- **Gas transition planning** to holistically consider electric and gas system and customer impacts and zonal strategies like community geothermal



Key Takeaways

The affordability catch-22 is a real challenge for electrifying natural gas customers.

This is a particular concern for low-income households, which already face disproportionate energy burden.

Comprehensive projects that include efficiency, heat pumps, and solar are key to controlling operating costs – but are expensive. Enabling these projects will require stacking funds from multiple sources, plus project, program, technology, and policy strategies to advance equitable electrification.

Defining Equitable Beneficial Electrification

Building on the RAP definition, equitable beneficial electrification should meet at least one of the following conditions without adversely affecting the other two:

1. Saves consumers money over the long run without increasing energy costs for LMI households in the short run
2. Enables better grid management
3. Reduces negative environmental impacts

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