



ADVANCED WATER HEATING INITIATIVE®

Resource Guide

The Why, What, and How of Successful Heat Pump Water Heater Programs

Equity Benefits of Heat Pump Water Heater Adoption and Examples of Equitable Federal, State, and Regional HPWH Programs for Low-Income and Disadvantaged Communities



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Executive Summary

This resource guide discusses the need for and the benefits of Heat Pump Water Heaters (HPWHs) in Low- to Moderate-Income (LMI) households and across disadvantaged communities.

It also provides a summary of current successful and emerging federal, state, and regional HPWH programs for LMI households and disadvantaged communities. This resource guide was released in parallel with a white paper summarizing current methods and programs to overcome barriers to equitable HPWH adoption.

Heat pump water heater market transformation programs focused on LMI households and disadvantaged communities are critical to equitable decarbonization. The ultimate goal of these programs is to realize long-term energy and cost savings and other benefits in low-income to moderate-income (LMI) households and across disadvantaged communities.¹

This paper has been released in parallel with [“Increasing Equitable Access to Heat Pump Water Heaters” White Paper](#). This white paper aims to share data about current methods and programs used to overcome barriers to Heat Pump Water Heater (HPWH) adoption in Low-to-Moderate Income (LMI) households and disadvantaged communities. It details the need for and benefits of HPWHs in LMI and disadvantaged communities and compiles successful real-world examples and actionable recommendations for HPWH adoption in LMI communities.

This resource guide is a product of the Advanced Water Heating Initiative (AWHI), a market transformation initiative led by New Buildings Institute (NBI). AWHI is comprised of hundreds of industry, nonprofit, and governmental organizations aiming to transform the water heating market to energy-efficient heat pump water heaters for residential and commercial applications. AWHI created a dedicated task group of relevant national stakeholders to focus on increasing equitable access to HPWHs. That task group supported NBI in researching and compiling this report.

¹ U.S. Environmental Protection Agency (EPA) “EPA Report Shows Disproportionate Impacts of Climate Change on Socially Vulnerable Populations in the United States”, 2021. <https://www.epa.gov/newsreleases/epa-report-shows-disproportionate-impacts-climate-change-socially-vulnerable>

Benefits of Heat Pump Water Heater Adoption in LMI Households and Disadvantaged Communities

Heat pump water heaters are 2-4 times more efficient² than the legacy fuel-burning and electric resistance equipment they can replace. The substantial efficiency gain they offer can deliver real cost savings, reducing the energy burden (percentage of income spent on utility bills) for households.

ENERGY STAR estimates that replacing a residential electric resistance water heater with a HPWH can save a household of four approximately \$550 per year on its electric bills compared to a standard electric resistance water heater.³ This equates to over \$5,600 in net savings over a HPWH's 13-year lifetime. The Department of Energy estimates that switching to more efficient water heaters (e.g., HPWHs) would save American consumers over 11 billion dollars annually.⁴

Operating cost savings from replacing gas-burning water heaters with HPWHs are more variable. Most replacement scenarios see lower operating costs with HPWHs. However, in some locations where gas prices are relatively low and electric rates are relatively high, gas-to-HPWH conversions may end up increasing utility bills. In all cases, care must be taken to avoid increasing the energy burden on LMI and disadvantaged community members.

Compared to fuel-burning or electric resistance water heaters, HPWHs offer many benefits to low- to moderate-income households. Since HPWHs rely on electricity instead of fossil fuels, HPWHs reduce local and global air pollution while helping households save on their utility bills by taking advantage of lower-cost hours and decreasing the energy burden. Additionally, HPWHs help futureproof communities from variable and rising rates and from fossil fuel system and appliance obsolescence.

What are the Main Types of Water Heaters?

Nationally, there are more than 123 million existing residential water heaters in the United States, and more than half (53.6%) use natural gas or other fossil fuels to heat water.⁵ The two predominant types of water heaters are natural gas and electric resistance, which account for

² US ENERGY STAR, "ENERGY STAR Certified Heat Pump Water Heaters." 2023.

https://www.energystar.gov/sites/default/files/asset/document/ES_HPWH_Factsheet_July_2023.pdf

³ ENERGY STAR. "Save Money and More with ENERGY STAR Certified Heat Pump Water Heaters" 2024

https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/benefits_savings

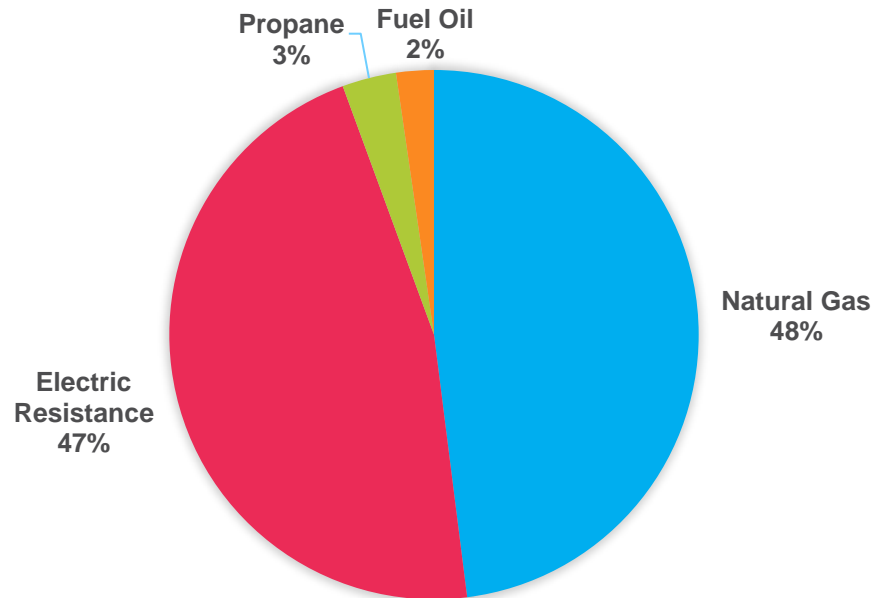
⁴ Department of Energy. "DOE Proposes New Energy Efficiency Standards for Water Heaters to Save Americans More Than \$11 Billion Annually on Utility Bills" 2023. <https://www.energy.gov/articles/doe-proposes-new-energy-efficiency-standards-water-heaters-save-americans-more-11-billion>

⁵ U.S. Energy Information Administration, "Table HC8.1 Water heating in U.S. homes, by housing unit type, 2020", Residential Energy Consumption Survey 2023.

<https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.1.pdf>

over 94% of water heaters in the US. Propane (3.3%), fuel oil (2.3%), and heat pump water heaters (less than 1%; not shown in the graphic below) are the remaining types.

FIGURE 1. WATER HEATING LANDSCAPE BY FUEL TYPE



Sources: 2020 Residential Energy Consumption Survey and ENERGY STAR Shipment Data⁶

The Need for the Switch to HPWHs in LMI Communities

Natural gas heat pump water heaters produce local pollution from the on-site combustion of fossil fuels. Such pollutants include particulate matter, nitrous oxide (NO_x), sulfur oxides (SO_x), formaldehyde, and other criteria and unregulated air pollutants. These pollutants impact outdoor air quality and may present indoor hazards when equipment is not properly vented to the outdoors. Improper venting is anecdotally reported as not uncommon by plumbers and contractors, but reliable data indicating how often it occurs are unavailable⁷. Disadvantaged

⁶ 2020 RECS: US Energy Information Administration (EIA), "Residential Energy Consumption Survey (Recs), 2020 Recs Survey Data," 2024. <https://www.eia.gov/consumption/residential/data/2020/> and ENERGY STAR®, "ENERGY STAR® Unit Shipment and Market Penetration Report Calendar Year 2021 Summary, 2021 USD Summary Report," 2021, p. 1-6. https://www.energystar.gov/sites/default/files/asset/document/2021%20Unit%20Shipment%20Data%20Summary%20Report_0.pdf;

⁷ American Lung Association "Health Impacts of Combustion in Homes" 2022. See Data Gaps on page 20. <https://www.lung.org/policy-advocacy/healthy-air-campaign/healthy-efficient-homes/residential-combustion>

communities, according to the American Lung Association, “often face higher exposure to pollutants and [are the ones] who may experience greater responses to such pollution.”⁸

Water heating accounts for 16%-30% of all energy use in US households, and in larger multifamily buildings, water heating is the largest energy end-use, surpassing space heating and cooling.⁹ The substantial energy consumption of these systems drives people to spend significant sums of money heating water. Covering utility expenses are a major reason households take out high-interest payday loans, and 20 million American households (15%) are behind on their utility bills.¹⁰

Heat pump water heaters can provide several benefits for low-income households and disadvantaged community members, including reduced and stabilized utility bills, local and global air pollution reduction, futureproofing against fossil fuel obsolescence, and workforce opportunities.

Utility Cost Savings – Reduced Energy Burden

The potential annual savings from HPWHs hold significant promise for easing financial challenges faced by energy-burdened communities. One study found that low-income households face an energy burden (percentage of income spent on utility bills) three times higher than other households.¹¹ For example, low-income communities in many southeast states spend over 10% of their incomes on utility bills, as seen in the following map. An additional financial benefit to HPWHs is bill stabilization: natural gas, propane, and oil prices are much more volatile than electricity prices. Unexpected savings are always welcome, but volatility cuts both ways: sudden spikes in energy prices can hit energy-burdened households especially hard and make budgeting difficult. Gas prices have increased dramatically in many regions over the last three to five years, often by much higher factors than electricity prices.¹²

⁸ American Lung Association, “Disparities in the Impact of Air Pollution”, 2023. <https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities>

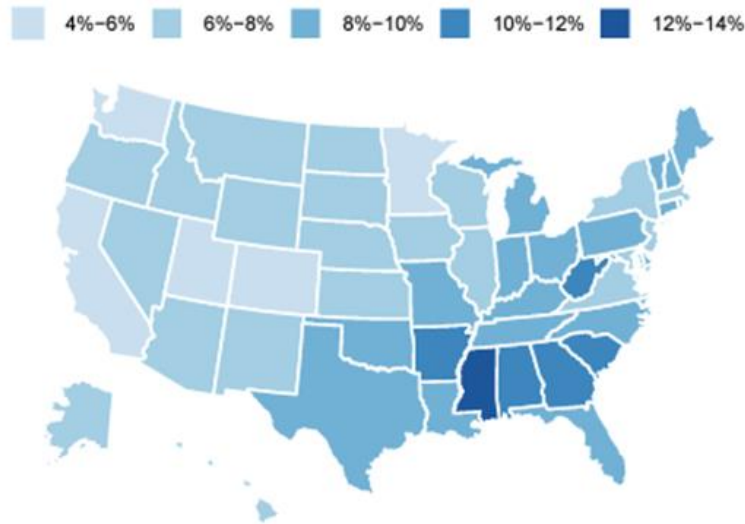
⁹ United States Department of Energy. “New Infographic and Projects to Keep Your Energy Bills Out of Hot Water” 2013. <https://www.energy.gov/energysaver/articles/new-infographic-and-projects-keep-your-energy-bills-out-hot-water>

¹⁰ CNN. “Nearly 20 million households are behind on their utility bills.” 2023 <https://www.cnn.com/2023/05/23/business/utility-bills-arrears-summer/index.html>

¹¹ U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy, “Low-Income Household Energy Burden Varies Among States — Efficiency Can Help In All of Them”, DOE/GO-102018-5122, 2018. https://www.energy.gov/sites/prod/files/2019/01/f58/WIP-Energy-Burden_final.pdf

¹² Talor Gruenwald/RMI, “Reality Check: The Myth of Stable and Affordable Natural Gas Prices”, 2021. <https://rmi.org/the-myth-of-stable-and-affordable-natural-gas-prices/>

FIGURE 2. LOW-INCOME ENERGY BURDEN (% OF INCOME)



Source: U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy. ¹¹

Electric Resistance to HPWH Conversions Save on Utility Bills Everywhere

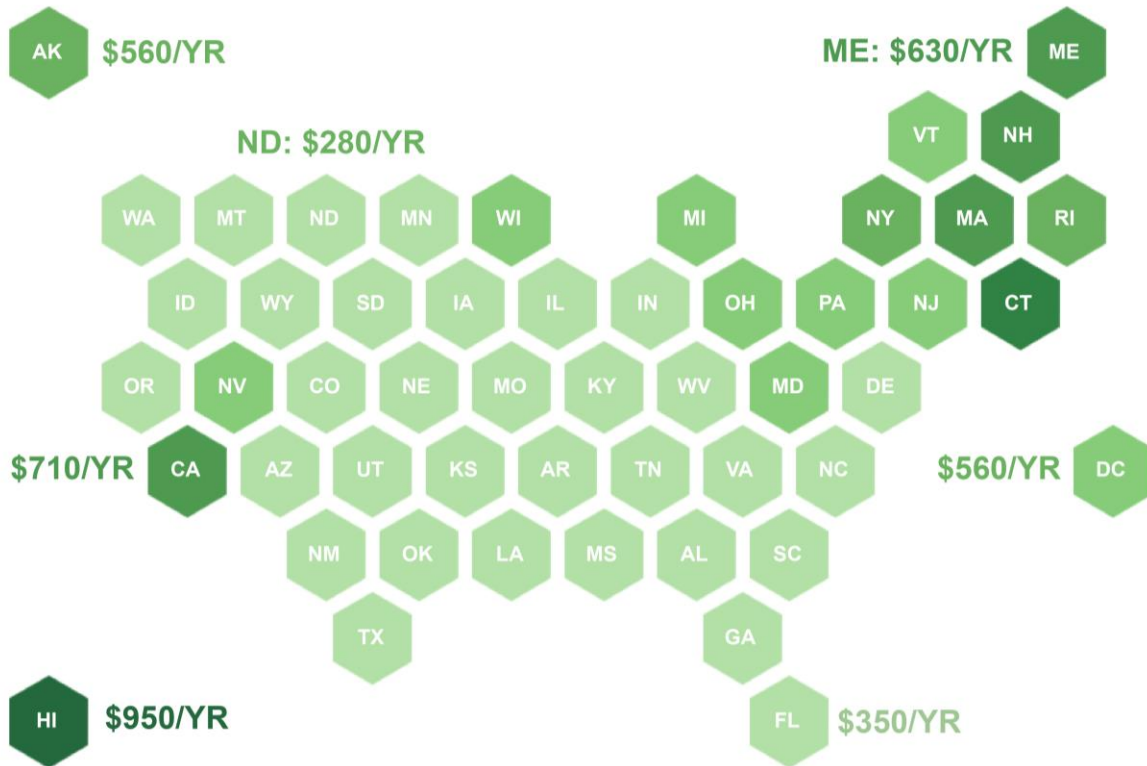
All households with electric resistance water heaters will save money on their utility bills when they install a HPWH. The amount of savings depends mainly on the amount of water used in the household, the local cost of electricity, and the efficiency of the equipment.

Both electric resistance and heat pump water heaters use the same fuel type (electricity), but heat pump water heaters are 200%-300% more efficient. In areas with time-of-use rate structures or demand response (DR) programs, a grid-connected smart HPWH that can reduce demand during peak (higher-cost) periods can deliver additional savings. Households that use more hot water can expect higher savings.

The map below indicates the expected savings by state for HPWHs when switching from electric resistance water heaters. Annual savings range from about \$350 to \$950.

FIGURE 3. EXPECTED ANNUAL ENERGY BILL SAVINGS

Switching from a 50-gal electric resistance water heater to a 80-gal heat pump water heater



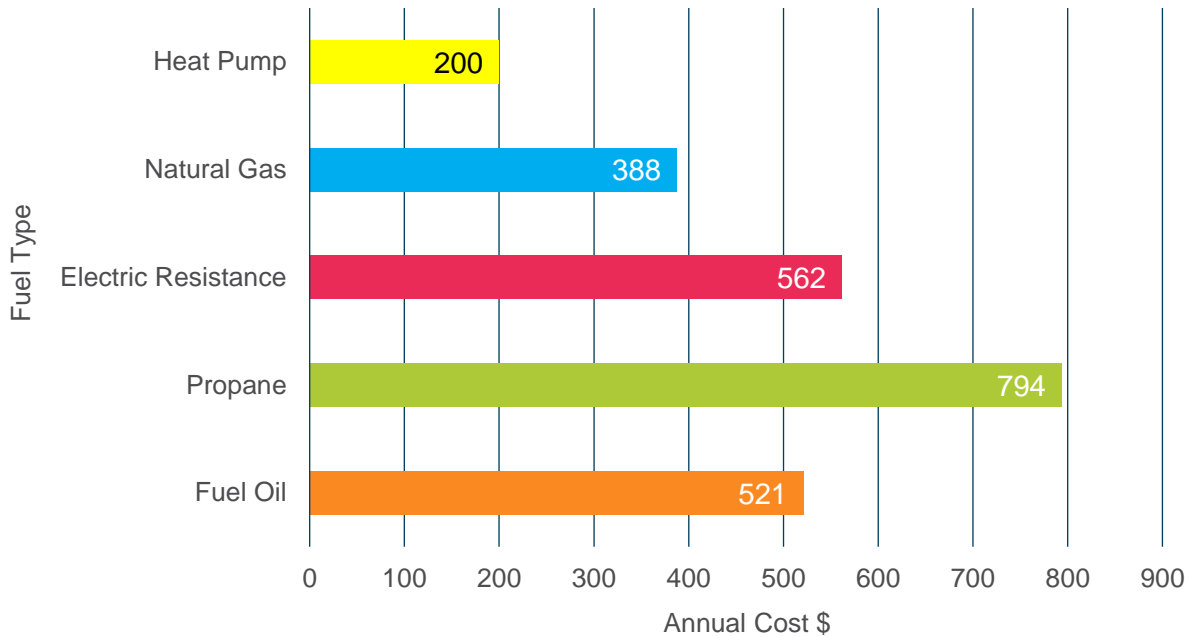
This graphic shows average expected electricity bill reductions by state when converting from an electric resistance water heater to a heat pump water heater. Data source: EIA for electricity prices and Energy Guide for water heater electricity consumption.

Gas to HPWH Conversions Save on Utility Bills in Most Places

In most cases, gas to HPWH conversions will save people a small to moderate amount of money on utility bills. Using national-average energy costs and Energy Guide usage assumptions, the average gas water heater costs \$382/year to operate. In contrast, the average heat pump water heater costs \$194/year, representing an average savings of \$188. However, those aggregated averages can hide substantial variability. At the state level (i.e., statewide averages), consumers will see between a \$100 and \$400 annual energy cost savings when switching from gas to a HPWH in every state except Alaska. Some gas-to-HPWH conversions result in higher operating costs in specific locations with both low-cost gas and high-cost electricity. In general, gas is less expensive than electricity per unit of energy, but this is more than counterbalanced by the fact that HPWHs can be up to 600% more efficient than gas water

heaters.¹³ That is why the national averages show that HPWHs cost about half as much per year as gas tank water heaters to operate, as shown in the figure below.

FIGURE 4. ANNUAL OPERATIONAL COSTS BY WATER HEATER TYPE

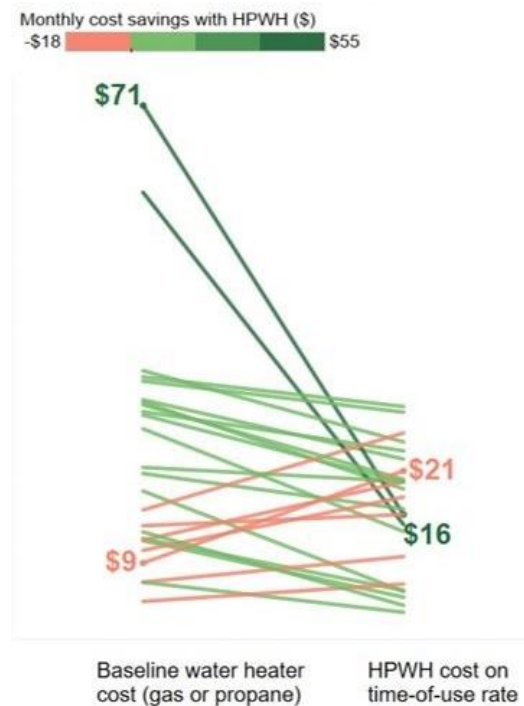


Based on comparison of Energy Guide ratings for a 50-gallon water heaters and EIA 2022 cost of fuel data.¹⁴
Graphic by NBI

¹³ According to Energy Guide, an 80 gallon HPWH uses 1219 kWh (4,159,000 BTU) per year while a 50 gallon gas tank water heater uses 242 therms (24,200,000 BTU). 80 gallon HPWH is used as a reference because homeowners are encouraged to upsize tanks two sizes.
Energy Guide, (image of Energy Guide Label), 2023. <https://images.thdstatic.com/catalog/pdfImages/78/78d02576-2b78-41c5-8cfa-0275b28db624.pdf>
Energy Guide, (image of Energy Guide Label), 2023. <https://images.thdstatic.com/catalog/pdfImages/5d/5df0a059-bf89-46bb-8edd-faacf8b52e0a.pdf>

¹⁴ Spreadsheet showing full costs can be found here - <https://docs.google.com/spreadsheets/d/1PF3XKKManwxvK3pUr02HkYBRBDzYTAefQDemZh3By-s/edit?usp=sharing>

FIGURE 5. CHANGES IN MONTHLY OPERATING COST FROM FOSSIL FUEL TO 120V HPWH IN CALIFORNIA FIELD STUDY



This diagram compares baseline (gas or propane, left side) to new (120-volt HPWH, right side) monthly water heating costs for field study participants in California. 72% of participants observed reduced operating with the HPWH (ranging from \$16/mo. to \$71/mo.) while 28% saw increased costs (ranging from \$9/mo. to \$21/mo.).¹⁵

It is crucial that heat pump water heater programs avoid increasing the energy burden of low-income households. Programs in areas with potential for bill increases should collaborate closely with community members and advocates to understand and mitigate any potential bill increases due to changing from gas to HPWHs. Mitigation could be achieved through layered rebates, targeted incentives, or special rate adjustments for low-income customers.

Ability to Use Energy During Lower-Cost Hours

Time-of-use rates charge different electricity prices at different times of the day. Most peak periods occur in the summer on weekday afternoons. Devices that can minimize their use during expensive on-peak hours and shift load toward lower-cost off-peak hours will help reduce utility costs in these settings.¹⁶

¹⁵ New Buildings Institute, “Plug-In Heat Pump Water Heater Field Study,” 2023. <https://newbuildings.org/resource/plug-in-heat-pump-water-heater-field-study-findings-market-commercialization-recommendations/>

¹⁶ For instance, customers enrolled in San Diego Gas & Electric’s (SDG&E’s) Summer TOU-ELEC Pricing Plan pay \$0.374/kWh during off-peak hours. However, between 4 and 9pm every day, electricity costs \$0.743/kWh. If an SDG&E customer does laundry or runs the dishwasher in the late afternoon, they will pay almost twice as much doing so in the morning.

Because water heaters are effectively large thermal batteries (due to water’s inherent ability to store thermal energy), they are prime candidates for load-shifting. Most HPWHs sold today are delivered with the capability to shift or defer energy loads and the communications equipment to participate in utility programs or otherwise optimize operations to reduce costs. Innovative programs are exploring the savings benefits to low-income customers by programming water heaters to run during times when electricity has the lowest cost. *See section: Current Equity-Oriented HPWH Programs and Their Successes.*

NBI is currently leading a research project that aims to quantify the capacity for and real-world cost savings from such load shifting in 120-volt HPWHs in California.

Pollution Reduction

Because heat pump water heaters are powered by electricity, they don’t produce local pollution from the on-site combustion of fossil fuels. This results in reduced indoor and outdoor pollution, which is critically important for disadvantaged communities in particular. Asthma rates are generally higher in low-income communities, and “respiratory health gaps persist between rich Americans and people from poor communities.”¹⁷

Heat pump water heaters also produce significantly lower carbon emissions than fossil fueled water heaters, saving 1 ton of CO₂ annually per water heater on average.¹⁸ Climate change is an extraordinary threat to all communities, but its impacts often fall more heavily on low and moderate income and disadvantaged communities.¹⁹

For further discussion on the benefits of pollution reduction from HPWHs, please see Appendix Three, Pollution Reduction and Air Quality Improvements.

Workforce Training

Another potential benefit of HPWHs for communities is the workforce opportunities inherent in market transformation. Replacing over 123 million gas and electric resistance water heaters with heat pump water heaters will require and drive significant workforce expansion.²⁰

¹⁷ Asthma and Allergy Foundation of America, “Asthma Disparities in America. 2020. <https://aafa.org/asthma-allergy-research/our-research/asthma-disparities-burden-on-minorities/>

¹⁸ Joe Wachunas/New Buildings Institute, “This Earth Day Invest in a Heat Pump Water Heater and Do The Equivalent of Planting a Tree (or Forest)”, 2023. <https://newbuildings.org/this-earth-day-invest-in-a-heat-pump-water-heater-and-do-the-equivalent-of-planting-a-tree-or-a-forest/>

¹⁹ U.S. Environmental Protection Agency (EPA), “EPA Report Shows Disproportionate Impacts of Climate Change on Socially Vulnerable Populations in the United States”, 2021. <https://www.epa.gov/newsreleases/epa-report-shows-disproportionate-impacts-climate-change-socially-vulnerable>

²⁰ U.S. Energy Information Administration, “Table HC8.1 Water heating in U.S. homes, by housing unit type, 2020”, Residential Energy Consumption Survey 2023. <https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.1.pdf>

Current Equity-Oriented HPWH Programs and Their Successes

This section showcases current successful, established, and emerging HPWH adoption programs for LMI households and disadvantaged communities. These program approaches and frameworks may be helpful for others seeking to deploy or improve equity-oriented HPWH deployment programs. The following list summarizes various programs aimed at increasing HPWH access in LMI and disadvantaged communities.

Real-world examples of each program type are included below.

Program Types	Description
<u>1. No-cost installations</u>	HPWHs can be installed at no cost to residents in qualifying households.
<u>2. Fixed price and bulk purchasing</u>	Lower upfront HPWH costs are attainable by offering water heaters purchased in bulk and a fixed price for installations.
<u>3. Upfront and zero/low-interest financing</u>	Eliminate the upfront cost barrier by financing the initial cost and installation of HPWHs, charging zero or low interest, and/or offering deferred loan repayment.
<u>4. HPWH leasing programs</u>	Eliminate the upfront cost barrier by installing HPWHs at no cost and charging low monthly lease fees for the water heater.
<u>5. Emergency replacement programs</u>	Offer same-day replacement of burned-out gas or electric resistance water heaters with HPWH installations and/or temporary equipment.
<u>6. HPWH programs for renters</u>	Offer HPWHs to rental properties, provided the renter will benefit from lower utility bills.
<u>7. Demand response programs to lower operational costs</u>	Lower operational costs by setting HPWHs to run during off-peak times when electricity rates are lower.
<u>8. Outreach to targeted communities</u>	Conduct targeted outreach about HPWHs to disadvantaged communities by partnering with trusted local organizations.
<u>9. HPWHs in weatherization programs</u>	Braided weatherization funding is needed to achieve cost-effective HPWH replacements, especially for electric resistance and propane water heaters.

Program Types

Description

[10. Workforce development programs](#)

By recruiting both licensed contractors and those interested in the workforce from disadvantaged communities, this program trains individuals on HPWH installation. The goal is to expand access to HPWH installation jobs.

This program type also helps minority-owned businesses capitalize on the HPWH market transformation.

[11. HPWH programs for manufactured housing](#)

Install HPWHs in manufactured housing, which often serves low-income communities and is all electric. Overcome space constraints through special installation techniques (including ducting) and specification of particular HPWH products that fit into smaller spaces.

[12. HPWH programs for multifamily buildings](#)


Install central or large unitary (distributed-central) HPWHs in multifamily buildings using central boilers with hot water circulation loops and overcome the split incentive problem.



1. No-Cost Installations for LMI households

The lowest-barrier method for LMI households to increase access to HPWHs involves programs that install them at no cost. Cost and scalability are the greatest challenges with no-cost installation programs for overall program implementation.

This approach allows low-income residents to immediately benefit from HPWH energy and utility bill savings (especially with electric resistance households). It bypasses the significant barrier presented by higher upfront costs. No-cost installations for LMI households also ensure that a certain percentage of energy efficiency and electrification funding reaches low-income communities. In comparison, rebate programs unevenly benefit middle- and upper-income communities that can afford the higher upfront equipment costs. Multiple state energy offices, nonprofits, and weatherization programs have successfully created and run no-cost installation programs. In the section that follows are examples.

Program Name	Program Description
	<p>Efficiency Maine runs the most successful low-income HPWH program in the United States, with approximately 850 income-qualified households receiving free HPWHs annually.²¹ The program conducts outreach to residents enrolled in state and federal assistance programs. Costs are kept low by using fixed-price installations and bulk purchasing (see section below). It is open to all fuel-type conversions, with over half coming from oil-burning water heaters.²²</p> <p>They spend \$3.5 million annually on the low-income HPWH program and \$19 million on HPWH rebates at retail and distributor locations. That equates to 15% of the total annual HPWH spending directed towards low-income Mainers.</p> <p>This percentage and total can serve as a guide to other entities when allocating budgets for low-income and standard rebate HPWH programs.</p>

²¹ For more information on Efficiency Maine’s programs see - [Midwest AWHI working group meeting recording featuring Efficiency Maine 7/2022](#) – and Efficiency Maine, “Low Income Water Heaters”, 2024. <https://www.energymaine.com/at-home/low-income-water-heaters/>

²² Based on information provided by Efficiency Maine in July 2023. For more detail on this program see: Joe Wachunas/CleanTechnica, “Converting from Fuel to Heat Pumps Would Save the US 47% of the Oil We Used from Russia”, 2022. <https://cleantechnica.com/2022/05/30/converting-from-fuel-oil-to-heat-pumps-would-save-the-us-47-of-the-oil-we-used-to-import-from-russia/>

Program Name

Program Description

Electrify Everyone²³



The Electrify Everyone program is a collaborative effort by Community Energy Project and Electrify Now in Portland, OR. The program combined nonprofit, corporate, and individual donations to achieve no-cost HPWH installations in low-income communities.²⁴ They received funding from the Energy Trust of Oregon to replace approximately 50 electric resistance water heaters with heat pump water heaters annually. The volunteer organization Electrify Now²⁵ helped fundraise to enable the Community Energy Project to replace gas water heaters with HPWHs. To date, the program has replaced 50 gas water heaters with heat pump water heaters.

The Electrify Everyone program shows the potential to braid complementary goals and funding sources to achieve no-cost HPWH installations through community-based organizations.



²³ For more information see Joe Wachunas/CleanTechnica, “Helping Families, One Electric Heat Pump at a Time”, 2020. <https://cleantechnica.com/2020/11/13/helping-families-one-electric-heat-pump-water-heater-at-a-time/>

²⁴ Community Energy Project, “Home Page”, 2024. <https://www.communityenergyproject.org/>

²⁵ Electrify Now, “Home Page”, 2024. <https://electrifynow.net/>

Two Stories Highlight the Impact of No-Cost HPWH Replacements²⁶



Desiree and Charlotte

Desiree and Charlotte live in Portland, Oregon. Desiree is a nurse who cares for her mom, Charlotte, who is retired. Charlotte has a fixed income and signed up to replace their 16-year-old gas water heater. They participated in the Electrify Everyone program with the nonprofit Community Energy Project, which provided the heat pump water heater and installation free of charge.

Desiree said,

“It’s not something that we, as a family, could possibly do on our own. To go out and pick [an appliance] that we would want– the best, the most efficient, the most responsible – just isn’t financially feasible for us. This program provided a way for us to do what we would want to do if we had the funds.”

Desiree emphasized that, for her mom, Charlotte, environmental reasons outweighed monetary savings as the most important factor for participation in this program.



Yameta



Yameta is a mom with two daughters, ages 5 and 22. Like Desiree and Charlotte, she participated in the Electrify Everyone Program through Community Energy Project in 2021. Her motivation to add a HPWH was similar, to help the environment, saying,

“I want my daughters to have clean air and water. The pollution and the fires scare me. We need to do what we can now to help the future. More people are interested in green energy than you think. It’s just cost, cost, cost! [With clean energy] it only works if 80% of us do it. It’s like a vaccine that way!”

²⁶ From article - Joe Wachunas/CleanTechnica, “Helping Families, One Electric Heat Pump at a Time”, 2020. <https://cleantechnica.com/2020/11/13/helping-families-one-electric-heat-pump-water-heater-at-a-time/>

2. Fixed Price and Bulk Purchasing

Fixed-price installations and bulk purchasing are two strategies that have been employed to reduce costs and bring price stability. Fixed-price installation programs partner with contractors to guarantee a HPWH installation price under certain conditions, such as electric resistance water heater replacements. Fixed-price installations and bulk purchasing clarify program costs and reduce the inflated installation pricing sometimes associated with maturing technologies. Bulk purchasing programs partner with HPWH distributors to purchase HPWHs in bulk rather than individually to realize equipment savings. Both fixed-price and bulk purchasing can be combined with other HPWH program strategies to increase impact and accessibility for LMI community members.



Program Name	Program Description
	<p>Efficiency Maine partners with installers to create a fixed price for HPWH installations to reduce costs and keep them consistent. In 2023, they had 25 installers statewide who participated in this program and installed HPWHs for \$3000.²⁷ This fixed price equates to approximately \$1,500 that is paid to the installer per installation (after \$1,350 for a water heater and approximately \$150 for supplies).²⁸ Efficiency Maine uses bulk purchasing to achieve the best prices for HPWHs and invites any distributor to participate in the program, with the requirement that they must sell water heaters at the specified price. In 2023, after researching market conditions, they set the HPWH price at \$1,350, and three distributors (with several locations each) across the state agreed to participate in the program.</p>
	<p>In 2022, the utility Tacoma Power pioneered an innovative HPWH program for both low- and standard-income households. Tacoma Power offered a short-term promotion for HPWH installations to all of its customers with electric resistance water heaters for a fixed price of \$2,500 for a 50-gallon, with additional fixed prices for 66- and 80-gallon units (tax and permit not included). Gas water heaters were excluded due to fuel-switching restrictions.</p> <p>Tacoma Power partnered with one installer, one distributor, Northwest Energy Efficiency Alliance, and Bonneville Power Administration to achieve a fixed-price offer for non-ducted installations. They installed 22 heat pump water heaters as part of this program.</p>

²⁷ Note: this fixed price is for electric resistance to HPWH. A higher amount is paid for fuel oil to HPWH conversions due to required electrical work. <https://youtu.be/6U7r9oAdLBI?si=7-ZArnI6dnp9XqH>

²⁸ The \$3,000 fixed price hasn't proved high enough to attract as many installers as the program would like and Efficiency Maine is hoping to increase the amount in future years.

3. Upfront and Zero Interest Loans and Deferred Loan Repayment Financing


Upfront financing for HPWHs can lower the barrier of high upfront costs by allowing HPWH equipment and installation to be paid for overtime. Often, the energy savings from heat pump water heaters will help offset a portion of the financing expenses. Both low-cost and zero-interest HPWH financing programs have been piloted through utility programs nationally. One such program allows low-income owner-occupied households to finance HPWH installation costs and does not require repayment until the house is sold. The strategy behind deferred loan paybacks is to allow low-income customers to realize energy and utility bill savings immediately but defer the upfront costs until homeowners are likely to have money available from the house sale.

Program Name	Program Description
	<p>As part of Tacoma Power’s 2022 HPWH promotion, the utility offered two loan types for HPWHs.</p> <ol style="list-style-type: none"> Zero percent interest financing: Zero-interest loans were provided to customers using in-house financing. Standard-income (not LMI) customers agree to pay the loan off over 3 years at \$70/month. A lien is placed on the property to ensure the loan is paid off. Deferred loan financing: Customers, income-qualified (<80% area median income), were offered a deferred loan repayment. They only pay the utility back when they sell their house. This means lower-income customers realize lower utility bills immediately after installation. A lien is put on the property to ensure the loan is paid off when the customer’s house is sold. <p>They had significant success, with a 175% increase in participation in the utility’s HPWH program. Of the installations conducted in the six months of the promotion, 75% of customers took advantage of a loan. Ten percent of these were income-qualified, and 100% of low-income customers accepted the deferred loan offer.</p>
	<p>Founded in 2014, Seeds for the Sol²⁹ is an Oregon nonprofit with a neighbor-to-neighbor funding model to promote renewable energy in income-qualified households. Seeds for the Sol has a HPWH offering in which low-income applicants can receive a HPWH for no money down and zero percent interest payments for four years (\$48/month). Since launching the program in 2020, Seeds for the Sol has helped replace approximately 20 water heaters in low-income homes.</p>

²⁹ For more information on the program see - Seeds for the Sol, “Hybrid Water Heater”, 2024. <https://www.seedsforthesol.org/hybrid-water-heater/>

4. HPWH Leasing Programs

Water heating leasing programs have been commonplace across utility programs for decades, though less so in recent years. HPWH leasing programs allow qualifying (i.e., LMI) households to install HPWHs with minimal upfront costs. Upfront costs are paid for in a monthly leasing fee, typically including any water heater maintenance expenses. Leasing programs allow households to realize energy and utility cost savings immediately, which can then be used for leasing expenses. Disadvantages include not owning the equipment and continued leasing fees after the installation and equipment have been paid. There are also concerns about predatory leasing practices. Programs must address these concerns and ensure a fair pricing structure for participants.

Program Name	Program Description
	<p>Vermont Gas Systems (VGS) is a gas utility in Vermont that is looking to transition its business model to decarbonized thermal energy services.³⁰ VGS has been running energy efficiency programs since the 1990s through home weatherization and space & water heating equipment installation. VGS is using utility resources and in-house technicians to help customers transition to decarbonized water heating.</p> <p>Historically, VGS rented or leased natural gas water heaters and on-demand water heaters. Beginning February 1, 2022, it started offering its customers and other qualifying Vermont residents an option to purchase or lease ENERGY STAR certified heat pump water heaters in 50- and 65-gallon sizes. Participants pay monthly fees ranging from \$39 for a 50-gallon tank to \$46 for a 65-gallon tank.³¹ After 10 years of payments, the homeowner owns the water heater. Additionally, low- to moderate-income customers get a \$200 rebate.</p>

³⁰ For more information see Advanced Water Heater Initiative (AWHI), “AWHI Connectivity Working Group Monthly Meeting”, 2023. https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe_newbuildings_org%2FDocument; VGS, “Heat Pump Water Heaters”, 2024. <https://vgsvt.com/savings/heat-pump-water-heaters/#:~:text=Beginning%20February%201%2C%202022%2C%20as,Efficiency%20Alliance%20Tier%203%20rated>

³¹ The customers of Burlington Electric Department (BED) get a further discount of \$10/month on these prices. More information is available on their website: VGS, “Heat Pump Water Heaters”, 2024 <https://vgsvt.com/savings/heat-pump-water-heaters/#:~:text=Beginning%20February%201%2C%202022%2C%20as,Efficiency%20Alliance%20Tier%203%20rated>

Program Name	Program Description
Énergie New Brunswick Power	<p>Énergie New Brunswick (N.B.) Power is a Canada-based utility company. NB Power currently has an electric resistance water heater rental program for as low as \$8 per month for a 40-gallon tank and \$10 per month for a 60-gallon tank, which are the lowest prices in the region.</p> <p>75% of their customers participate in the leasing program, showing its extensive reach. They are currently exploring HPWH rentals and hope to have an offering in 2024, though the utility is concerned about monthly payments being significantly higher than electric resistance water heaters. The current water heater rental program includes free installation, pipe wrap insulation, free delivery to new construction, and free removal/pickup and recycling of electric water heaters.³²</p>

5. Emergency Replacement Programs

An estimated 90% of water heater replacements happen on an emergency basis.³³ Replacing gas water heaters without advance planning can be especially challenging because potential electrical upgrade needs can require new circuits, electrical lines, and panel upsizing. This work can be difficult to achieve on a same-day basis due to electrician availability and permitting needs. Same-day water heater replacements are crucial so that homes don't have to go extended periods without hot water and customers don't feel forced to continue with the same type of water heater.

Nationwide programs are using innovative methods to replace a gas or electric resistance water heater with a HPWH in the same day. These include loaning gas water heater loaners and installing 120-volt plug-in HPWHs. While same-day replacement programs haven't yet focused on low-income households specifically, there is significant applicability to LMI households who, like most homeowners, wait until an existing water heater breaks to plan to install a new one.



120-volt HPWH installed as part of NBI's California field study

³² Energie NB Power (NB), "Water Heaters", 2024. <https://www.nbpower.com/en/products-services/water-heaters>

³³ US Energy Information Administration (EIA), "Residential Energy Consumption Survey (RECS) 2020 RECS Data Survey", 2020. <https://www.eia.gov/consumption/residential/data/2020/>

Program Name**Program Description**

Gas Water Heater Loaner Pilot

Barnett Plumbing specializes in HPWH replacements in the tri-valley area of California. Barnett won a TECH Clean California Quick Start Grant³⁴ award to offer a gas water heater loaner to homes wishing to switch from a gas water heater to a HPWH under urgent conditions when equipment fails. The loaner water heater installed by Barnett restored same-day hot water service to homes and provided sufficient time to complete the necessary electrical permitting and upgrades. Barnett has expanded their emergency replacement options by offering 120-volt plug-in HPWHs as either permanent replacements, temporary loaners, or permanent replacements, depending on customer water heating needs. Over the course of the pilot, Barnett installed 149 HPWHs, increasing emergency replacement gas water heater conversions from 1% to more than 17%.

120-volt plug-in water heater

The 120-volt (V) plug-in HPWH is an emerging technology that is ideal for same day gas to HPWH conversions. This HPWH plugs into a standard 120V outlet and doesn't need a 240V electrical connection. The 120V plug-in thus avoids new wires and potential panel and service upgrades, saving installation costs and time. New Buildings Institute conducted the first field study in the US in California with 120-volt HPWH technology and found high user satisfaction and broad applicability for gas replacements in households with 1-4 people.³⁵ This study is now in phase two, which focuses on time of use optimization in 120V HPWHs.


Other field studies evaluating the 120V HPWH are underway, including a field study in New Orleans led by Pacific Northwest National Labs (PNNL) and a Midwest 120V HPWH field study led by Slipstream.

³⁴ TECH Clean California, "2021 Quick Start Grant Recipient, Barnett Plumbing", 2021. <https://techcleanca.com/quick-start-grants/2021-quick-start-grant-recipients/barnett-plumbing/>

³⁵ Full 120-volt project report - New Buildings Institute (NBI), "Plug-In Heat Pump Water Heater Field Study Findings and Market Commercialization Recommendations", 2023. <https://newbuildings.org/resource/plug-in-heat-pump-water-heater-field-study-findings-market-commercialization-recommendations/>

6. HPWH Programs for Renters

Ensuring that renters also benefit from HPWHs is a key area for attention, as renters make up the majority of households in the lowest income brackets.³⁶ Programs for renters include specifically allowing no-cost HPWH installation in rental households as long as the tenant is paying utility costs (and realizing savings), as well as multi-family central heat pump water heater programs covered in the “HPWHs in multi-family buildings” section below.



Program Name	Program Description
	Efficiency Maine’s no-cost HPWH program for low-income customers is uniquely available to renters in addition to homeowners, provided renters are paying their own electric bills (and will benefit from the cost savings of HPWHs) and have their landlord’s permission to install a HPWH. This is the only program the AWHI equity task force encountered nationally that is open to renters.



³⁶ Peter J. Mateyka and Jayne Yoo/United States Census Bureau, “Low-Income Renters Spent Larger Share of Income on Rent in 2021 - Share of Income Needed to Pay Rent Increased the Most for Low-Income Households from 2019 to 2021”, 2023. <https://www.census.gov/library/stories/2023/03/low-income-renters-spent-larger-share-of-income-on-rent.html>

7. Lowering HPWH Operational Costs Through Time of Use Rate Optimization and Demand Response Programs

Across the vast majority of the country, HPWHs can offer significant utility savings to low-income communities. Still, electricity does not always cost the same during each hour of the year. In areas with time-of-use rates (where electricity costs more during peak demand times and less during off-peak times), shifting heat pump water heaters to use lower-cost off-peak electricity is an emerging strategy to further reduce utility costs. HPWHs can be programmed to increase tank temperature before peak hours and to defer or reduce operations during peak hours to reduce demand during high-cost periods. Several pilot programs are attempting to make the most of water’s inherent energy storage capabilities by shifting HPWH operations toward hours of low electricity cost without interfering with hot water service. The following program explores this potential with low-income customers.

Program Name	Program Description
<p>North Carolina HPWH Demand Response Project</p>  	<p>The North Carolina (NC) Justice Center and Energy Solutions received funding from the Energy Foundation and the Department of Energy to research heat pump water heaters as a tool for reducing low-income energy cost burdens. The NC HPWH Demand Response Project worked with Rebuilding Together of the Triangle to provide home health, safety, and energy efficiency improvements to low-income clients. The team installed 24 HPWHs in Wake, Chatham, and Orange County homes. All HPWHs have CTA-2045 (EcoPort) receptacles with E-Radio communications modules installed and communicate with the project over cellular networks. Pacific Northwest National Labs is providing significant material and technical support for the communications and demand management part of the project.</p> <p>During 2024, project staff will monitor the performance of the HPWHs and communicate with participants regarding performance. Most of the time, the HPWHs will heat water as guided by their internal algorithms. However, several times during the year, in different seasons for about a week each time, the team will take control of the HPWHs and run several different demand management experiments. These experiments aim to see whether it is possible to move HPWH electricity use mostly or completely off-peak without interfering with hot water service. This could help participants further reduce their electricity bills by taking advantage of residential time-of-use rates offered by North Carolina utilities.</p>

8. Outreach to Targeted Communities

Outreach and communication are core elements of successful HPWH programming in low- to moderate-income and disadvantaged communities. Building trust, educating on HPWH technology, collaborating with local community partners, and combining HPWHs with other services for LMI communities are key outreach strategies by projects working to increase access to HPWHs.



Program Name

Program Description

San Joaquin Valley DAC pilot project³⁷



The San Joaquin Valley DAC (disadvantaged communities) pilot project provided free electrification measures to customers in eleven small, underserved communities in the San Joaquin Valley. The program was designed to help households switch from propane or wood-burning appliances to efficient electric ones like HPWHs and induction stoves. This program conducted significant community outreach which was led by the nonprofit Self Help Enterprises (SHE), a nationally recognized community development and affordable housing organization.

SHE's role was to help collaborate with community members to help manage the transition to clean energy by working alongside residents on the ground. The project team enrolled over 950 families in the program from the project kick-off in February 2020 and has completed hundreds of HPWH installations at the time of writing.

The program saw significant success and learned the vital importance of education and communication when electrifying homes in disinvested communities. SHE found that having a trusted community-based organization on the project team provided a crucial level of trust. This trust helps programs overcome "electrification hesitancy." Even though the appliances and installations in the San Joaquin project were free, some participants still hesitated to go all-electric because of perceptions of higher fuel costs.

SHE conducted education sessions to show the efficiency of heat pumps and induction technologies, which helped ease concerns. The project team found that as installations increased in a community, so did interest from hesitant and harder-to-reach community members. Once community members saw

³⁷ For more information see – "Heat Pump Programs and Implementation - San Joaquin Valley Disadvantaged Communities Pilot Projects"
https://www.calmac.org/publications/SJV_DAC_Process_Evaluation_Final_Report_102022.pdf
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=242592>

Program Name**Program Description**

their neighbors loving induction stoves and heat pump water heaters, they were more eager to participate in the program.

Finally, SHE found that creating user-friendly educational materials and offering residents opportunities to test efficient electric appliances (for example portable induction cooktops) decreased barriers and increased interest and participation in the program.

Community-Based Approach to Increase Demand for Clean Technologies³⁸

Pacific Northwest
NATIONAL LABORATORY




A community-based approach to increasing demand for heat pumps and other clean energy technologies is being piloted in an urban disadvantaged community in northeast Houston, Texas. Pacific Northwest National Laboratory (PNNL) has partnered with a local community organization, Launch Point CDC, Inc., which has served NE Houston and surrounding areas for 30 years. One crucial aspect of the approach involves helping disadvantaged community members understand the benefits of clean energy technologies, pathways to affordability, and what it takes to apply for funding assistance.

As part of the pilot project, a framework was developed to make the case for clean energy and energy-efficient technologies (e.g., heat pumps, solar energy storage, and electrification). The project is tailored for communicating with community leaders and organizations working with urban disadvantaged communities about quantified benefits, upfront costs of multi-level funding programs, and steps to access these technologies. A case study was also conducted for the Houston community, leveraging real-world data to provide insights into the quantifiable benefits of clean energy technologies. The framework can be adopted and applied to similar communities, empowering disadvantaged communities to make informed decisions regarding energy technologies. PNNL has published a summary of the project and related materials.

³⁸ For more information, see "Resources for Community Organizations" at <https://www.pnnl.gov/projects/resources-community-organizations>.

9. HPWHs in Weatherization Programs

Weatherization programs can be an essential mechanism and funding source for increasing access to heat pump water heaters. Installing HPWHs as part of whole-home weatherization upgrades can be a valuable and impactful strategy. High upfront costs can be overcome by braiding federal, state, utility, and nonprofit-led weatherization funding together with other funding streams such as IRA tax credits and programs. The following sections profile several types of weatherization programs and highlight some barriers and potential solutions to including HPWHs as part of weatherization programs.

Program Name	Program Description
HPWHs in Federal Weatherization Programs	<p>The US Department of Energy’s (DOE) Weatherization Assistance Program (WAP) is a federal program created in 1976 to help low-income households reduce their energy costs. WAP’s mission is to increase the energy efficiency of homes while ensuring health and safety, particularly for the elderly, people with disabilities, and children.</p>  <p>In the WAP program, projects with higher savings-to-investment ratio³⁹ (SIR) values are typically prioritized, as they typically provide more significant energy and cost savings for the program and the households it serves. For this reason, equipment repair and other water heating measures (such as tank wrap, pipe insulation, low-flow shower heads, faucet aerators, and setpoint reduction) are prioritized over water heater replacement. Water heater replacement is more often considered when there is a health and safety issue.</p> <p>However, DOE encourages ‘cost-effective’ fuel switching and indicates that switching away from delivered fuels⁴⁰ to HPWHs may be cost-effective.</p> <p>In this context, replacing a HPWH is generally “cost-effective” only for existing electric resistance water heaters, but not for existing natural gas water heaters, the dominant water heating fuel in housing types across most of the country. Propane- and oil-fired water heaters (generally, a small fraction of single-family and manufactured housing in most climates) are likely cost-effective candidates for HPWH replacement.</p> <p>(See complete discussion of HPWHs in federal weatherization programs in Appendix Two.)</p>
HPWHs in Weatherization Programs on the West Coast	<p>In general, weatherization programs in California are taking an increasingly proactive approach to electrification and decarbonization in line with the state’s climate goals. One of the primary goals in California’s weatherization programs is to protect customers from increases in utility bills. This can be a</p>

³⁹ The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure – Code of Federal Regulations, “436.21 Savings to Investment Ratio.” 1996. [ecfr.gov/current/title-10/chapter-II/subchapter-D/part-436/subpart-A/section-436.21](https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-436/subpart-A/section-436.21)

⁴⁰ ‘Bulk Fuel’ is usually more than 200L which is stored in a bulk fuel tank, either above ground or underground.

Program Name

Program Description

challenge when switching to HPWHs from gas water heaters, given California's high percentage of gas water heaters⁴¹ and in some cities, higher-cost electricity.

Installing HPWHs through weatherization programs in the Northwest has proved slower and more challenging than advocates hoped. On the one hand, it could be an ideal location for HPWH installations through weatherization programs. In Oregon, for example, over 50% of weatherization work happens in manufactured housing, and over 95% of this housing type is all electric⁴² (an ideal HPWH replacement scenario).

Braiding funding to achieve HPWH installations

Using WAP funding for HPWH replacements on the West Coast remains challenging due to their cost-effectiveness requirements, so programs are exploring other funding.

- The Energy Savings Assistance (ESA) weatherization program has partnered with the California TECH program to pool funding and manage HPWH installations in situations that require electrical upgrades.
- The California Farmworker Weatherization program is seeing an increase in the number of HPWH installations as the program has significant flexibility in its design that allows it to make greater investments.
- In the Northwest, it is possible to use Low Income Home Energy Assistance Program (LIHEAP) funding to install HPWHs. However, those funds usually prioritize other health and safety repairs (i.e., new roofs).



The Beneficial Electrification League (BEL) created the Weatherization and Electrification or WE Together program.⁴³ The program conducted a weatherization and electrification demonstration pilot with two homes in California and the Southeast where they paired traditional weatherization activities (such as upgrading door and window weatherization, sealing ductwork and registers, air sealing, and repairing insulation) with electrification

⁴¹ Claire Palmgren, Miriam Goldberg Ph.D., Bob Ramirez, Craig Williamson/DNV GL Energy Insights USA, Inc., "California Energy Commission CONSULTANT REPORT 2019 California Residential Appliance Saturation Study (RASS)", 2019. <https://www.energy.ca.gov/sites/default/files/2021-08/CEC-200-2021-005-PO.pdf>

⁴² For more information please see - AWHI's Residential Working Group [May 2023 Meeting](https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe%5Fnewbuildings%5F%2FDocuments%2FRecordings%2FAWHI%20Residential%20Working%20Group%20Standing%20Call%2D20230516%5F120328%2DMeeting%20Recording%2Emp4&ga=1&referrer=StreamWebApp%2EWeb&referrerScenario=AddressBarCopied%2Eview), https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe%5Fnewbuildings%5F%2FDocuments%2FRecordings%2FAWHI%20Residential%20Working%20Group%20Standing%20Call%2D20230516%5F120328%2DMeeting%20Recording%2Emp4&ga=1&referrer=StreamWebApp%2EWeb&referrerScenario=AddressBarCopied%2Eview

⁴³ For more information see - Weather and Electrification Together (WE Together), "Weatherization/Electrification Together Initial Findings Phase 1 Cohort of Transformed Low-Income Rural Homes", 2023. <https://beneficial-electrification.org/wp-content/uploads/2023/02/Final-WE-Together-2pager-012523.pdf>

Program Name**Program Description**

upgrades (such as upsizing subpanels, and installing HPWHs, induction stoves, and air source heat pumps).

BEL found that utility bills were lowered by \$190/month in one home. In the other, the homeowner appreciated that her new ductless heat pump removed the window air conditioner from her bedroom, and she could see outside her window for the first time in years.

The pilot encountered challenges fitting HPWHs into tight areas such as closets, which prohibited them from installing a HPWH in one site. They also encountered a need to train weatherization staff on what to look for when scoping homes for electrification upgrades, i.e., size of closet, whether existing electrical service goes to a closet or stove, etc.


They had to make multiple trips to acquire information. With better training, it could have been achieved in just one trip. BEL is hoping to expand this WE Together program through the Inflation Reduction Act funding.



10. HPWH Workforce Development in LMI Communities

There is a large workforce development opportunity for HPWH installers. Advocates want to ensure these opportunities are extended to low-income communities. Water heaters generally last for about 13 years,⁴⁴ which means that by 2035, nearly all currently used water heaters will likely need to be replaced.⁴⁵ The National Kitchen and Bath Association highlights an existing shortage of plumbers, estimating that 60,000 plumbers retire yearly while only 30,000 apprentices enter the field.⁴⁶ On top of this existing shortage of plumbers, there is expected to be a significantly increased need for specialists in decarbonization technologies across all trades.

Rewiring America estimates that a rapid electrification of the United States would create as many as 25 million jobs.⁴⁷ Ensuring that low-income communities have access to well-paying jobs and installing efficient technologies like heat pump water heaters can further improve the financial outlook for LMI communities. Several programs are exploring strategies for providing training and related services.

Program Name	Program Description
 Emerald Cities COLLABORATIVE	<p>Emerald Cities Collaborative is leading both contractor and workforce development programs on air source heat pumps (an adjacent technology to HPWHs) focused on training women, veterans, low-income, and BIPOC communities.⁴⁸ The workforce training program lasts 12 weeks and includes evening lectures, demonstrations, and four Saturdays of hands-on training. To assist targeted communities in course completion, the program includes wrap-around services such as career navigation, transportation, childcare assistance, meals, and \$500 worth of tools and a toolkit. These services are meant to address historical barriers to trade for disadvantaged communities. At the time of writing, Emerald Cities had six cohorts of trainees who had completed this course with an 85% graduation rate and a total of 78 attendees.</p>

⁴⁴ US EPA ENERGY STAR, “Save More with ENERGY STAR Certified Heat Pump Water Heaters.” Accessed 2024. https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/benefits_savings

⁴⁵ 2021 AWHI Progress Report, p 4. https://newbuildings.org/wp-content/uploads/2021/02/AWHI_PlaybookAndProgressReport202102.pdf

⁴⁶ Evans Plumbing, Inc., “Shortages of Plumbers in the US,” 2024. <https://www.evansplumbinginc.com/blog/uncategorized/shortages-of-plumbers-in-the-us/>

⁴⁷ Saul Griffith, Sam Calisch, and Alex Laskey/Rewiring America, “Jobs Report Mobilizing for a Zero Carbon Emissions America: Jobs, Jobs, Jobs, and More Jobs,” 2020. <https://www.rewiringamerica.org/policy/jobs-report>

⁴⁸ For more information, see - Emerald Cities Collaborative, “Emerald Cities’ Accelerated HVAC Training Certification,” 2024. <https://emeraldcities.org/our-work/hvac-r-training/>

Program Name	Program Description
<p data-bbox="185 262 479 325">TECH California Workforce Training</p> 	<p data-bbox="503 262 1367 556">A new initiative in 2023 supported the expansion of an existing TECH Clean California HPWH contractor demonstration program focused on accelerating the adoption of HPWHs. With additional funding made available through CalNEXT⁴⁹, the statewide electric emerging technology program, the workforce training demonstration program was expanded to target contractors living in and serving DAC communities by providing training on the new 120-volt HPWH models, as well as direct experience installing and owning a HPWH in their own home at no cost.</p>
<p data-bbox="185 598 479 672">SEEA Contractor Training and Outreach</p> 	<p data-bbox="503 598 1367 703">The Southeast Energy Efficiency Alliance (SEEA) is partnering with AZS Consulting, Inc. in Florida and Viridiant in Virginia to bring training for HPWHs and three other electrification technologies to the Southeast.</p> <p data-bbox="503 724 1367 913">The training focuses on the non-technical components, such as value proposition, dispelling myths, and incentive programs. While this effort is for all contractors and service providers in the Southeast, SEEA has a strong interest in supporting contractors serving LMI and energy-insecure communities in the region.</p> <p data-bbox="503 934 1367 1270">The program team recognizes that misinformation on clean energy technologies such as HPWHs is prevalent and attempts to combat it by addressing common myths as part of its curriculum. Additionally, SEEA addresses gaps missing from traditional technical education by discussing interdisciplinary topics, including market incentives, state and federal incentives, and regulatory requirements. SEEA also focuses on conveying the importance of energy efficiency work with trainees. Education programs explain the shortcomings of less efficient methods and describe the consumer benefits of switching to high-efficiency infrastructure.</p> <p data-bbox="503 1291 1367 1512">The ultimate goal of this project is to influence equitable outcomes in the transition to electrified building technologies. SEEA has a vested interest in getting these training materials to diverse groups in an effort to expand who is performing the work and to expand technology access to populations most in need. For example, materials are in the process of being developed and will be made available in English and Spanish.</p> <p data-bbox="503 1533 1367 1753">The materials developed under this initiative also highlight the tax credits and rebates available to income-qualified customers so that contractors and their customers are aware of the market opportunities available to them in low-income communities. Preparing contractors with this specific knowledge and technical confidence will encourage contractors to feel more comfortable expanding market penetration to necessary demographics.</p>


⁴⁹ CalNEXT, “Approved Projects”, 2024. <https://calnext.com/approved-projects/>

Program Name	Program Description
	Training resources have been created, and they will start administering them on the ground in late 2023 through early 2025.

11. HPWHs in Manufactured Housing

Manufactured housing is a key housing type for equitable decarbonization efforts. Manufactured housing residents tend to be lower income, older, and more likely to experience energy insecurity. For example, manufactured housing residents in California had only 60% of the median household income, and nearly half experienced energy insecurity. In Oregon, over 50% of residents served by weatherization programs reside in manufactured housing, and over 95% of manufactured housing units in the state are all-electric (predominantly using electric resistance heat).⁵⁰ Heat pump water heaters can potentially reduce the energy burden for residents in manufactured housing, but HPWH adoption still faces significant barriers.

These barriers include water heater location constraints, upfront cost, federal standards that require plumbing to be in the interior of a house (excluding the possibility of locating a HPWH in an exterior closet), master metered mobile home parks that don't incentivize household energy savings, and manufactured housing without adequate amperage service. Several pilots have attempted to overcome existing barriers and install HPWHs in manufactured housing with many lessons learned.

Program Name	Program Description
 <p>LPEA La Plata Electric Association, Inc.</p>	<p>La Plata Electric Association (LPEA)⁵¹ conducted a pilot for HPWHs in manufactured homes in 2021-2022. In this pilot, they installed HPWHs in income -qualified homes with a goal of conducting a demand response pilot and experimenting with shifting electrical load to off-peak times. The biggest challenges in this pilot were making HPWHs fit into tight closets and determining how to meet intake and exhaust airflow requirements.</p> <p>The LPEA pilot decided to use indoor air for the intake and exhaust the air to the outdoors which slightly depressurized the houses and added additional loads on the space conditioning system. The pilot also installed vibration and sound mitigation in the homes due to sound complaints about water heaters near bedrooms.</p>

⁵⁰ For both CA and OR references please see -" AWHI's Residential Working Group, Recording", May 2023 https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe%5Fnewbuildings%5F0rg%2FDocuments%2FRecordings%2FAWHI%20Residential%20Working%20Group%20Standing%20Call%2D20230516%5F120328%2DMeeting%20Recording%2Emp4&qa=1&referrer=StreamWebApp%2EWeb&referrerScenario=AddressBarCopied%2Eview

⁵¹ For more information please see - The Beneficial Electrification League, Weatherization/Electrification Together, "Heat Pump Water Heaters for Demand Response", 2024. <https://be-league.org/wp-content/uploads/2023/04/Heat-Pump-Water-Heaters-in-Manufactured-Housing.pdf>

Program Name

Program Description



The Energy Trust of Oregon⁵² conducted a HPWH pilot in 15 manufactured homes in 2020. Unlike the LPEA pilot above, the Oregon pilot avoided exhaust only installations and instead used intake and exhaust air from within the building envelope. Space limitations were a similar challenge within this project, so installers had to modify a significant number of closets to ensure there was enough room for the water heaters and any required ducting. The project team also used a variety of water heater models.

Because different manufacturers have different air intake and exhaust locations on their HPWHs, this allowed the installers to use the best-suited model for each location. The team also realized that most manufactured homes require 25-amp circuit breakers instead of 30 amps (standard amperage required by a 240-volt HPWH). Rather than add new circuits, which would have added additional electrical expense, the project team used Bradford White HPWHs which are compatible with 25-amp circuits along with the Rheem 15-amp version of their water heater where needed. Overall, the HPWHs in the Oregon pilot had a high user satisfaction.

California TECH program pilot⁵³



AESC will replace existing gas water heaters with HPWHs in ten manufactured homes in Winton, California, a disadvantaged community, at no cost to the participants. AESC will model and measure the interactive energy impacts that HPWHs have on existing air conditioning loads. The expectation is that the cool air byproduct of HPWH operation will reduce the residents' cooling needs and costs. AESC will also quantify the energy, cost, and greenhouse gas (GHG) impacts of the retrofits and customer satisfaction with the installed HPWHs, all while ensuring utility cost neutrality or cost savings for the participants.

Clayton Homes



Clayton Homes,⁵⁴ a manufacturer of mobile homes, has announced plans to include HPWHs in all their homes by the end of 2023. Including HPWHs in mobile homes from the outset is an ideal way to incorporate the technology and overcome barriers to HPWH retrofits, such as electrical capacity and space requirements. Clayton Homes is poised to install tens of thousands of HPWHs in manufactured homes starting in 2024

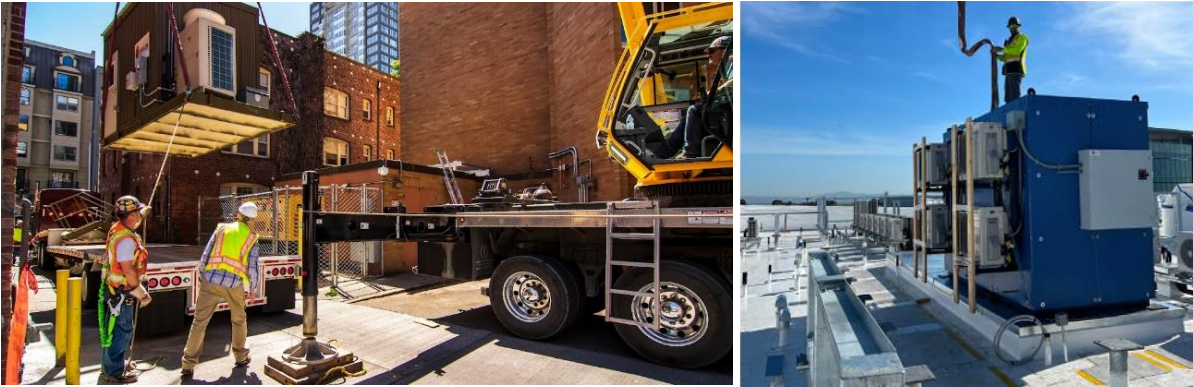
⁵² For more information please see -" AWHI's Residential Working Group, Recording", 2023 https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe%5Fnewbuildings%5F0rg%2FDocuments%2FRecordings%2FAWHI%20Residential%20Working%20Group%20Standing%20Call%2D20230516%5F120328%2DMeeting%20Recording%2Emp4&ga=1&referrer=StreamWebApp%2EWeb&referrerScenario=AddressBarCopied%2EView

⁵³ For more information please see - Tech Clean California, "AESC< Testing HPWH in Manufactured Housing", 2021. <https://techcleanca.com/quick-start-grants/2021-quick-start-grant-recipients/aesc/>

⁵⁴ For more information please see -Clayton, "Clayton® Commits to Build All Residential Manufactured Homes to DEO Zero Energy Ready Home™ Specifications by End of 2023, Home Specifications at the 2023 Berkshire Hathaway Shareholders Meeting", 2023. <https://www.claytonhomes.com/newsroom/press-releases/clayton-commits-to-build-all-residential-manufactured-homes-to-doe-zero-energy-ready-home-specifications/>

12. HPWHs in Multi-family Buildings

While central systems comprise most multi-family water heating systems, nearly half the multi-family market (47%) has in-unit unitary water heaters. Often, these in-unit water heaters are electric resistance, which offer the greatest operational savings when replaced with heat pump water heaters. However, in-unit multi-family installations can be challenging for HPWHs as they can lack adequate air space and easy solutions for condensation drainage. Multiple central HPWH pilots have been conducted in affordable housing locations across the United States, providing valuable lessons about the cost and scalability in various climates.



Program Name

Program Description

Bayview Towers⁵⁵



Bayview Tower is a low-income public housing facility for senior citizens located in downtown Seattle. An inefficient electric resistance central water heater had provided hot water for the residents of Bayview. In 2019, Ecotope, Seattle Housing Authority, Bonneville Power Administration, Steffes, SkyCentrics, Mitsubishi, and Seattle City Light came together to retrofit the building with a central HPWH system.

The central HPWH installed at Bayview broke lots of new ground. First, the CHPWH for Bayview was a packaged, skid-mounted (meaning it is permanently mounted on a metal pallet) system with components that were more or less ready to plug into place.

This water heater's "plug & play" nature meant Bayview Tower residents experienced only a couple of hours of hot water downtime while a whole new water heating system was installed. The water heater was installed in the summer of 2021. The system has now been operational for over a year and a half, meeting the residents' hot water needs while saving an estimated 135,000 kilowatt hours (kWh) annually and significantly reducing CO2 emissions and electricity bills.

⁵⁵ For more information please see - Steffes Plug-and-Play Package at Bayview Tower, Seattle, WA/Bonneville Power Administration, "Demonstration and M&V: Commercial Heat Pump Water Heating System Using the Mitsubishi Heat20 in Origin". 2022. <https://www.bpa.gov/-/media/Aep/energy-efficiency/emerging-technologies/20220505-mitsubishi-qahv-mv-study-task-3.pdf>

Program Name**Program Description**

**Chicago Central
HPWH pilot⁵⁶**

In an early effort toward cold climate multi-family decarbonization, Elevate and Bickerdike Redevelopment Corporation (BRC) electrified La Paz, a three-building, 44-unit affordable housing property in Chicago. These three-story brick walk-up buildings built in the early 1900s are good representations of Chicago's typical multi-family building stock. The project aimed to electrify the gas water heating equipment using efficient central HPWHs. ComEd provided funding for this project.

Lessons learned include:

1. Metering is critical to understanding how the system is performing and for troubleshooting.
2. Pipe insulation is important to reduce the heat losses in the return circulation loop, but insulating pipes that are not exposed is impractical.
3. The original system may have existing maintenance issues that need to be addressed.
4. Central HPWHs require significantly more hot water storage than gas systems.

**Packaged Central
Heat Pump Boiler
Project⁵⁷**

Small Planet Supply installed a packaged natural refrigerant central boiler (a heat pump water heater) in a 40-unit low-income farmworker community building in Delano, California to assess the viability of this novel, easy-to-install solution, here and for other similar buildings. The goal was to avoid custom designed central HPWH systems that are engineered for each individual building and assembled on site. The five central HPWH systems operate in all five buildings with no occupant complaints about the hot water temperatures or availability. The successful operation of the central HPWH systems provides a demonstration to inform future building code development in support of the transition to heat pumps. The planned 2024 post installation monitoring of all five buildings will specifically inform code and energy modeling development.

⁵⁶ AWHI - Increasing Equitable Access to HPWH - monthly meeting, Recording". 2023 https://newbuildings-my.sharepoint.com/personal/joe_newbuildings_org/_layouts/15/stream.aspx?id=%2Fpersonal%2Fjoe%5Fnewbuildings%5F%2FDocuments%2FRecordings%2FAWHI%20%2D%20Increasing%20Equitable%20Access%20to%20HPWH%20%2D%20monthly%20meeting%2D20230203%5F102232%2DMeeting%20Recording%2Emp4&ga=1&referrer=StreamWebApp%2EWeb&referrerScenario=AddressBarCopied%2Eview

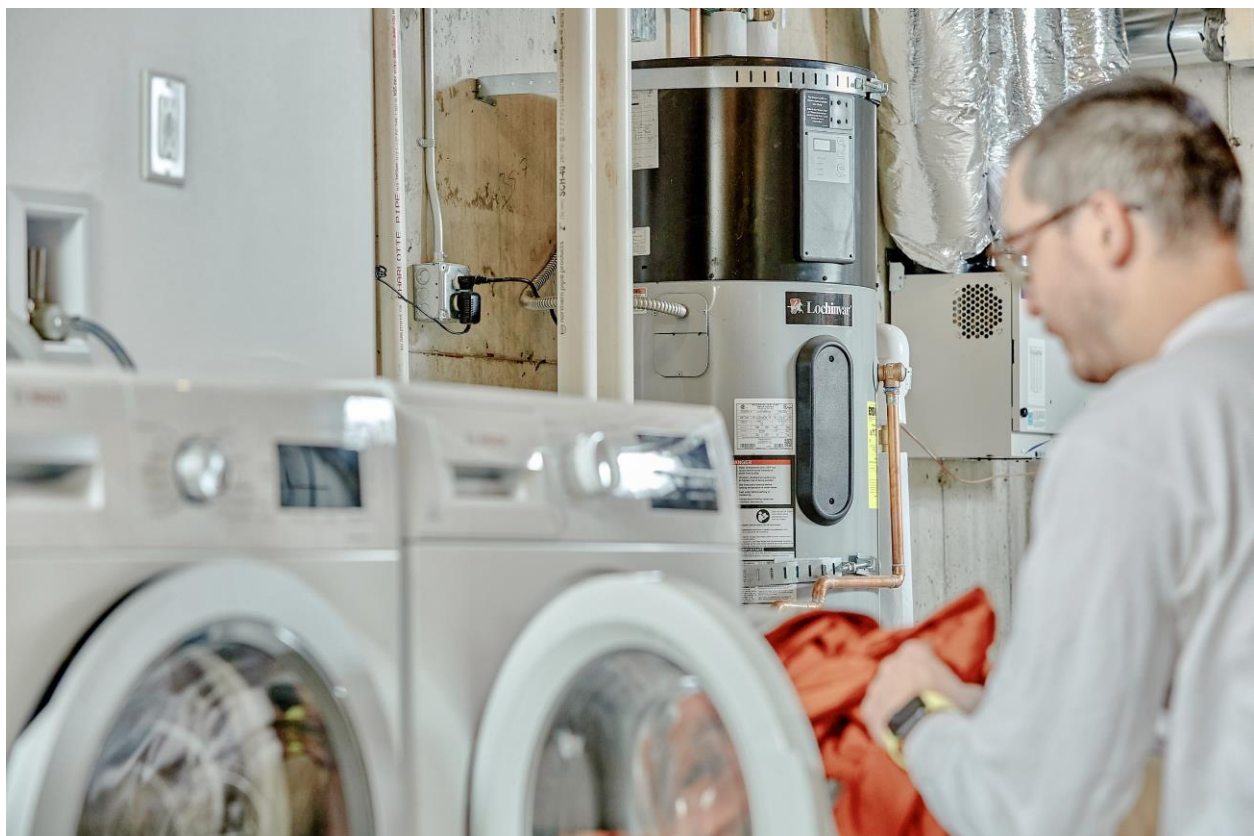
⁵⁷ Tech Clean California, "2021 Quick Start Grant Recipients, Small Planet Supply", 2021. <https://techcleanca.com/quick-start-grants/2021-quick-start-grant-recipients/small-planet-supply/>

Success Starts in Your Community

Successful HPWH program models for low- to moderate-income households have been pioneered across the country to overcome the upfront cost, split incentive, technical and workforce barriers to adoption. Program models exist to facilitate these partnerships, but more work is needed to implement them effectively. Equitable partnerships with low-income households and disadvantaged communities are essential for successful HPWH programs. Other country areas can follow the examples showcased in this paper to equitably transform the water heating market toward heat pump water heaters, starting with LMI households and disadvantaged communities.

To learn more about the barriers LMI and disadvantaged communities face in accessing HPWHs, forces advancing HPWH adoption for these people, successful program approaches and frameworks, and what the future holds, review the white paper released in parallel. This resource guide has been released in parallel with [“Increasing Equitable Access to Heat Pump Water Heaters” White Paper](#). This white paper aims to share data about current methods and programs used to overcome barriers to Heat Pump Water Heater (HPWH) adoption in Low-to-Moderate Income (LMI) households and disadvantaged communities.

Please send questions to joe@newbuildings.org.



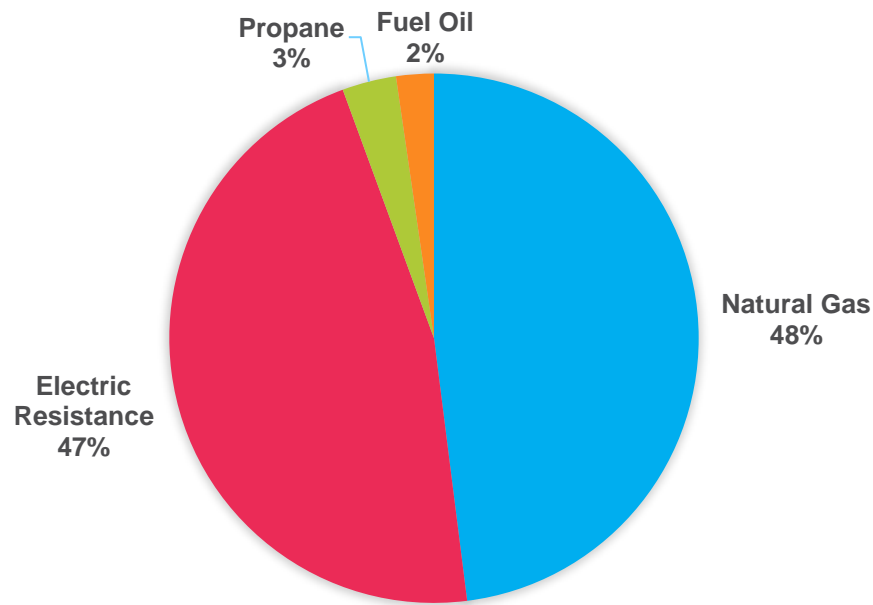
Appendices

Appendix One: Water Heater Landscape in the United States

Residential Water Heaters

Nationally, there are more than 123 million existing residential water heaters in the United States. Over half (53.6%) use methane (natural gas) or other fossil fuels to heat water.⁵⁸ Heat pump water heaters (HPWHs) currently make up less than 1% of all water heaters nationwide and are not shown in this figure.

FIGURE 6. WATER HEATER LANDSCAPE BY FUEL TYPE



Sources: 2020 Residential Energy Consumption Survey and ENERGY STAR Shipment Data⁵⁹

⁵⁸ US Energy Information Administration (EIA), "Table HC8.1 Water heating in US homes, by housing unit type, 2020," 2023, p. 1-2. <https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.1.pdf>

⁵⁹ 2020 RECS: US Energy Information Administration (EIA), "Residential Energy Consumption Survey (Recs), 2020 Recs Survey Data," 2024. <https://www.eia.gov/consumption/residential/data/2020/> and ENERGY STAR®, "ENERGY STAR® Unit Shipment and Market Penetration Report Calendar Year 2021 Summary, 2021 USD Summary Report," 2021, p. 1-6. https://www.energystar.gov/sites/default/files/asset/document/2021%20Unit%20Shipment%20Data%20Summary%20Report_0.pdf,"

Every year, more than 7.5 million water heaters are replaced, with an estimated 90% of replacements occurring on an emergency basis.⁶⁰ According to ENERGY STAR, water heaters last about 13 years.⁶⁰

Water heating is the second largest energy user in the home, accounting for 16-30% of a typical home's energy usage.⁶¹ Average national costs to heat water annually for the four most common fuel types (excluding heat pump water heaters, which make up less than 1% of all water heaters nationwide) range from \$382/year for methane gas to \$788/year for propane.⁶² These bills account for between 15-30% of the average home's annual utility bills.⁶³

Fossil fuel combustion for water heating

More than half of all water heaters nationwide, especially those in single-family homes, burn methane gas, fuel oil, or propane on-site. Common methane gas product categories include standard tanks, instant water heaters, and condensing water heaters. Standard tank gas water heaters typically have low efficiencies (around 0.6 Uniform Energy Factor, UEF).⁶⁴ All fuel-

⁶⁰ ENERGY STAR®, "Save Money and More with ENERGY STAR Certified Heat Pump Water Heaters" 2023. https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/benefits_savings;"

⁶¹ EIA, US Energy Information Administration (EIA), "Use of Energy Explained, Energy Use at Home" 2023. <https://www.eia.gov/energyexplained/use-of-energy/homes.php;>"

⁶² For 50-gallon tank-type water heaters, estimated annual usage is: 269 therms Energy Guide, (image of Energy Guide Label), 2024. <https://images.thdstatic.com/catalog/pdfimages/5d/5df0a059-bf89-46bb-8edd-faacf8b52e0a.pdf;>,"

3493 kWh (electric, Energy Guide, (image of Energy Guide Label), 2024.

<https://images.thdstatic.com/catalog/pdfimages/88/88178ba2-29bc-4902-b751-d814edcbdd59.pdf;>,"

294 gallons (propane, Energy Guide-) Energy Guide, (image of Energy Guide Label), 2024.

<https://images.thdstatic.com/catalog/pdfimages/88/88178ba2-29bc-4902-b751-d814edcbdd59.pdf;>"

or 107 gallons (fuel oil, Efficiency Maine). Efficiency Maine, "Compare Home Heating Costs," 2024.

[https://www.efficiencymaine.com/at-home/heating-cost-comparison/;](https://www.efficiencymaine.com/at-home/heating-cost-comparison/)

For 2022 fuel prices EIA estimates national averages of \$1.42/therm (gas) US Energy Information Administration (EIA), "Natural Gas Prices," 2024. https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_a.htm;"

\$0.1591/kWh EIA

US Energy Information Administration (EIA), "Electric Power Monthly, Table 5.6.A. Average Price of Electricity to Ultimate Customer by End-Use Sector," 2023 and 2022.

https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a;"

\$2.68/gallon (propane)

US Energy Information Administration (EIA), "Petroleum & Other Liquid - Weekly Heating Oil and Propane Prices (October - March), (Dollars per Gallon Excluding Taxes)," 2024.

https://www.eia.gov/dnav/pet/pet_pri_wfr_a_EPLLPA_PRS_dpgal_m.htm;,"

and \$4.81/gallon (fuel oil – EIA), US Energy Information Administration (EIA), "Residential Heating Oil Weekly Heating Oil and Propane Prices (October - March), (Dollars per Gallon Excluding Taxes)," 2024.

https://www.eia.gov/dnav/pet/pet_pri_wfr_a_EPD2F_PRS_dpgal_m.htm;"

⁶³ Average total utility costs: Electricity - \$1,623

EIA, see Table 5A: US Energy Information Administration (EIA), "Electricity - Current Issues & Trends," 2024.

[https://www.eia.gov/electricity/;](https://www.eia.gov/electricity/)"

and Gas - \$964 (AGA),

American Gas Association (AGA), "2024 Gas Facts - Table 9-5 Average Residential Gas Bills By State 2005-2022 (Nominal \$/Mmbtu)," 2024, p.1. <https://www.aga.org/wp-content/uploads/2023/01/Table9-5.pdf>

⁶⁴ Uniform Energy Factor is a measure of water heater overall efficiency. The higher the UEF value is, the more efficient the water heater.

burning water heaters produce outdoor air pollution, and some cause indoor air pollution. To learn more, visit Appendix Three, *Pollution Reduction and Air Quality Improvements*.

Electric Resistance Water Heaters

Electric resistance water heaters comprise 45%⁶⁵ of all water heaters nationally and rely on heating elements in tanks to heat water. This electric resistance technology is identical to resistance heating found in other household appliances such as toasters, most electric stoves, and space heaters. While electric resistance water heaters are more energy efficient than fossil fuel-fired water heaters, with UEFs between 0.9 and 0.94, they consume significant amounts of electricity and are relatively expensive to operate. Electric resistance water heaters usually offer the lowest upfront equipment cost.



Image Courtesy of Efficiency Maine

Heat Pump Water Heaters

A heat pump water heater uses electricity and refrigerants to move heat from one place to another instead of creating heat directly. This enables HPWHs to be 200%-600% more efficient than other types of water heaters and saves typical households hundreds of dollars a year on operational costs (across areas of the country, but not in every location). Heat pump water heaters have a higher upfront cost, which drives the risk that low-income communities will be unable to take advantage of the long-term savings and other benefits that HPWHs can provide.

Heat pump water heaters first became a certified ENERGY STAR product in 2009. HPWHs are extremely efficient, with average efficiencies ranging from 2.75 to 3.5 UEF vs. 0.65 to 0.95 UEF for ENERGY STAR-certified gas and electric resistance water heaters (and lower for non-ENERGY STAR-certified equipment).⁶⁶

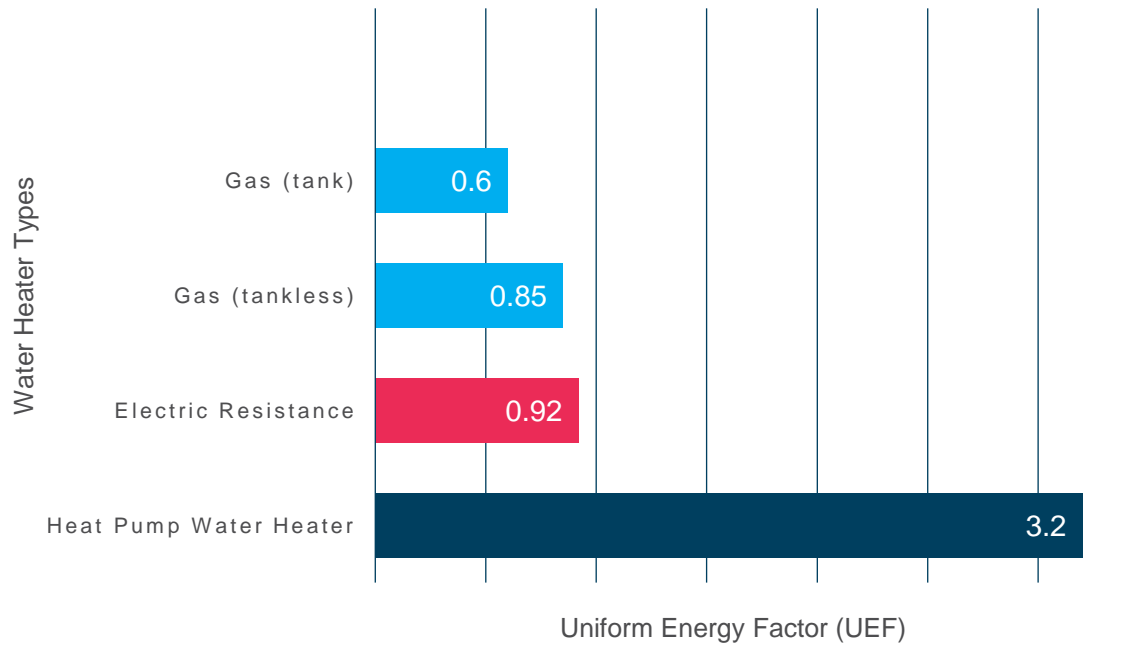
⁶⁵ RECS 2020 data for Electric Resistance water heaters subtracting 750,000 HPWH from ENERGY STAR unit shipment report - US Energy Information Administration (EIA), "Table HC8.1 Water heating in US homes, by housing unit type, 2020," 2022, 2023, p. 1-2.

<https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%208.1.pdf>;

⁶⁶ Hot Water Solutions, "Buyer's Guide to High-Efficiency Water Heaters," 2024.

[https://hotwatersolutionsnw.org/buyers-guide#:~:text=Uniform%20Energy%20Factor%20\(UEF\)%20rating&text=In%20general%2C%20ENERGY%20STAR%20certified,ratings%20of%202.75%20to%203.5.](https://hotwatersolutionsnw.org/buyers-guide#:~:text=Uniform%20Energy%20Factor%20(UEF)%20rating&text=In%20general%2C%20ENERGY%20STAR%20certified,ratings%20of%202.75%20to%203.5.;)

FIGURE 7. AVERAGE EFFICIENCIES OF WATER HEATER TECHNOLOGIES



HPWHs are by far the most energy-efficient water heaters. Exact efficiencies vary by manufacturer and product.
Source: NBI research⁶⁷

HPWHs have had a 15% annual growth rate since 2009 and, as of 2022, make up 1.6% of new electric water heater sales.

⁶⁷ Exact efficiencies vary by manufacturer and product. See the following sites for example products with average UEFs:

Gas (tank): Pace Supply, "Gs650Rcutg-400 Ng 50 Gal 50K Btu Lo Nox Hi Rec 22X61 W/ Side Loop," 2024. "<https://pacesupply.com/Product/stanIn50sl;>"

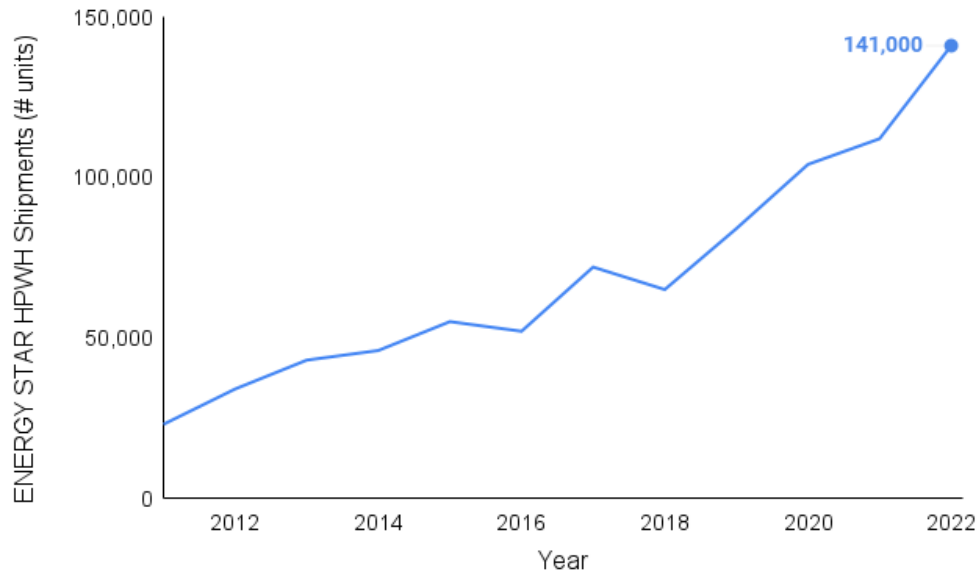
Gas (tankless): ACWholesalers, "Noritz 5.0 GPM at 60F Rise 0.85 UEF NG DV Tankless Water Heater," 2024 "<https://www.acwholesalers.com/Noritz-NR83DVC/p73560.html;>"

Electric Resistance: AO Smith, "50 Gallon Tall 6-Year 4500/4500-Watt Elements Electric Water Heater," 2024. "<https://www.aosmithatlowes.com/products/water-heaters/electric-water-heaters/e6-50h45dv;>"

Heat Pump Water Heater: AO Smith, "Voltex® 120V Plug-In 66-Gallon Hybrid Electric Heat Pump, Model HPTV-66," 2024. "<https://www.hotwater.com/products/decarbonization-heat-pump-voltex-120/hptv-66-200/100361937.html;>"

FIGURE 8. ANNUAL REPORTED ENERGY STAR HPWH SHIPMENTS

Source: ENERGY STAR Unit Shipment and Market Penetration Report (2022)



Source: 2022 ENERGY STAR unit shipment data⁶⁸

HPWH Equipment, Form Factors, Ideal Locations, and Climates

The great majority of residential heat pump water heaters are packaged unitary tank water heaters. These water heaters consist of a compressor on top of a water tank and use a direct-expansion refrigeration cycle to pull heat from the surrounding air and transfer it to water. Additionally, several manufacturers of split systems for residential applications separate the compressor from the tank (though these are currently less common in the US).

HWPWHs require at least 450 cubic feet of surrounding air space to function efficiently and exhaust a moderate amount of cool, dry air. The compressor and fan make some noise when running. As such, they are best located in garages or basements. However, HPWHs can also be located in higher-use areas of a building when cooling, noise, and air space are considered. Residential water heaters typically require 240 volts (V) of electricity, though emerging 120V plug-in water heaters have now reached the market and are available to consumers (see Emergency Replacement Programs below).

HPWHs work in any climate. While compressors typically function down to 35 degrees Fahrenheit, most units have electric resistance backup elements that can kick in when ambient temperatures fall below this level. Water heaters should be placed, and usually are, in locations that avoid the possibility of freezing pipes. The case for HPWH market transformation can be more easily made in warmer climates where HPWHs work more quickly and efficiently due to

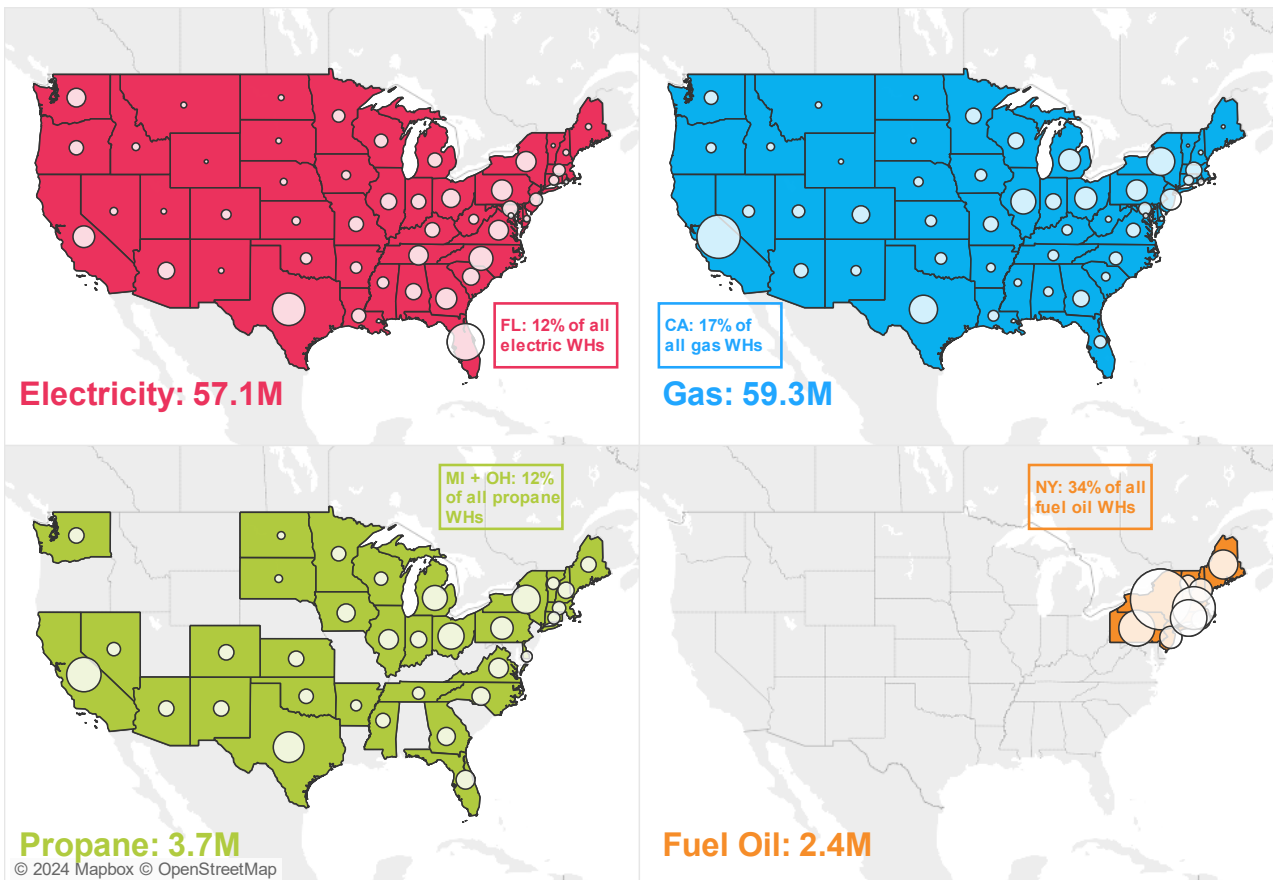
⁶⁸ ENERGY STAR, "ENERGY STAR® Unit Shipment and Market Penetration Report Calendar Year 2022 Summary," 2023. <https://www.energystar.gov/sites/default/files/2022%20Unit%20Shipment%20Data%20Summary%20Report.pdf>;

warmer ambient temperatures. Additionally, HPWHs are a natural replacement option for electric resistance water heaters for two main reasons: the efficiency and operating cost savings are substantial, and the existing electrical infrastructure enables 240V HPWH installation (240V HPWHs are less expensive and more widely available than 120V units). The map below shows the existing water heater stock in the United States.

FIGURE 9. WHICH STATES HAVE THE MOST GAS, ELECTRIC, PROPANE, AND FUEL OIL WATER HEATERS?⁶⁹

Which states have the most gas, electric, propane, and fuel oil water heaters?

According to 2020 Residential Energy Consumption Survey data

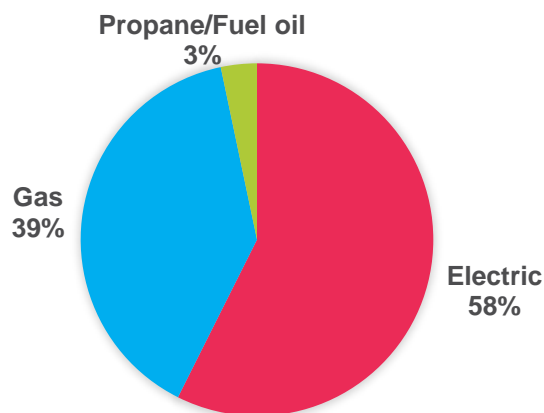


⁶⁹ EIA, "2020 RECS Survey Data," <https://www.eia.gov/consumption/residential/data/2020/#waterheating>

Commercial/Multi-family Water Heating

Water heating is the largest energy end-use in multi-family buildings of five or more units (30%), surpassing space heating and cooling.⁶⁹ In the United States, more than one-third of households rent rather than own.⁷⁰ The majority of those renters live in multi-family buildings.⁷¹ The water heaters in multi-family buildings are central systems (53%) and in-unit (47%).⁷² Data show that at a national level, electricity powers the majority (57%) of water heaters in multi-family buildings and that most multi-family water heaters are located within individual apartments (54%) as opposed to centrally located (46%).⁷³

FIGURE 10. WATER HEATING FUEL TYPE IN MULTI-FAMILY HOUSING UNITS IN THE U.S.



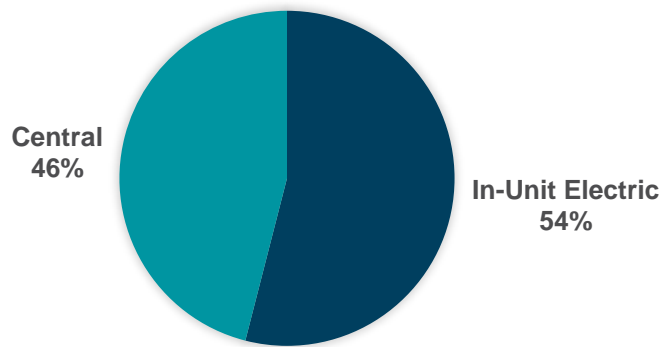
⁷⁰ Drew Desilver/Pew Research Center, “As national eviction ban expires, a look at who rents and who owns in the US” 2021. <https://www.pewresearch.org/short-reads/2021/08/02/as-national-eviction-ban-expires-a-look-at-who-rents-and-who-owns-in-the-u-s/>;

⁷¹ United States Census Bureau, “Profile of Owners and Renters,” 2021. <https://www.census.gov/library/visualizations/2022/demo/2021-profile-of-owners-and-renters.html>;

⁷² Chris Perry, Amruta Khanolkar, and Hannah Bastian/New Buildings Institute (NBI) and American Council for an Energy-Efficient Economy (ACEEE), “ACEEE Report - Increasing Sustainability Of Multifamily Buildings With Heat Pump Water Heaters,” 2021, p. 8. <https://newbuildings.org/wp-content/uploads/2021/11/IncreasingSustainabilityofMultifamily.pdf>;

⁷³ US Energy Information Administration (EIA), “2020 RECS Survey Data,” 2024. <https://www.eia.gov/consumption/residential/data/2020/#waterheating>;

FIGURE 11. ELECTRIC IN-UNIT VS CENTRAL WATER HEATING IN MULTI-FAMILY BUILDINGS



Data Source: 2020 RECS⁶⁹

In-unit electric resistance to HPWH water heater replacements in multi-family installations is promising for cost savings. Still, it can be challenging as multi-family installation sites may lack adequate air space and solutions for condensate drainage. More research is needed on developing small water heater form factors⁷⁴ to fit in small closets in multi-family buildings.



⁷⁴ Form factor is a hardware design aspect that defines and prescribes the size, shape, and other physical specifications of components, particularly in electronics.

Central Systems

Central heat pump water heater systems are designed to serve a multi-family or commercial load (typically with at least 120 gallons of storage volume). Examples of Central HPWH systems are shown in the following table.

FIGURE 12. COMPARISON OF VARIOUS COMMERCIAL AND SPLIT HPWH PRODUCTS

Manufacturer	A.O. Smith	Colmac	Mitsubishi	Nyle	Rheem	ECO2 Systems (Sanden)
Product Image						
U.S. / International	U.S.	U.S.	U.S., International	U.S.	U.S.	U.S.
Model Line	CAHP	CxA Series	Heat2o	C-Series	HPHD	SANCO ₂
Type	Commercial HPWH	Air-source heat pump (combo space heating and DHW)	Commercial HPWH	Commercial HPWH	Commercial HPWH	Split HPWH
Sector (SF/MF)	MF	MF	MF	MF	MF	SF/MF
Accompanying tank (gallons)	119	N/A	N/A	Up to 2,500	Up to 940	43, 83, 119
COP	Up to 4.2	Varies by size	Up to 4.11	Varies by size	Varies by size	Up to 5.5
Grid Connectivity	N	Y	Y	BACnet add-on	BACnet add-on	Y
Voltage (V)	208/240	208/230	208/230	208/230	208/240	208/230
Refrigerant	R134A	R134A	CO ₂	R134A	R134A	CO ₂
Ambient Operating Range (° F)	40 to 110° F	23 to 110° F	-13 to 110° F	25 to 110° F	40 to 104° F	-20 to 110° F

Source: Redwood Energy⁷⁵ with NBI updates.

Central heat pump water heaters typically separate the compressor from the storage tanks. At least one manufacturer, A. O. Smith, makes a unitary 120-gallon water heater. Like residential heat pump water heaters, central HPWHs offer a system efficiency 200%-600% higher than centralized electric resistance or gas systems, though cost savings can vary significantly by fuel type and region (see table above).

The Advanced Water Heating Initiative (AWHI) Commercial Working Group has worked with manufacturers to promote packaged, skid-mounted, “plug-and-play” solutions to increase the ease of market adoption.⁷⁶ These solutions streamline the design process by housing all the system's key components in one package, thus decreasing installation complexity and cost.

⁷⁵ Redwood Energy, “Redwood Energy's Pocket Guide to All-Electric Commercial Retrofits,” 2024. <https://www.redwoodenergy.net/research/redwood-energys-pocket-guide-to-all-electric-commercial-retrofits>

⁷⁶ Bonneville Power Administration. “Demonstration and M&V: Commercial Heat Pump Water Heating System using the Mitsubishi HEAT2O in Origin by Steffes Plug-and-Play Package at Bayview Tower, Seattle WA,” 2022. <https://www.bpa.gov/-/media/Aep/energy-efficiency/emerging-technologies/20220505-mitsubishi-qahv-mv-study-task-3.pdf>

Appendix Two: Federal Weatherization Programs

The US Department of Energy’s (DOE) Weatherization Assistance Program (WAP)⁷⁷ is a federal program created in 1976 to help low-income households reduce their energy costs. WAP’s mission is to increase the energy efficiency of homes while ensuring health and safety, particularly for the elderly, people with disabilities, and children.⁷⁸ The state, district, tribal, and territorial governments operate the programs, working with experienced local delivery agencies, primarily Community Action Agencies, that use advanced technologies and diagnostic testing protocols to deliver energy conservation measures (ECMs) to low-income households. Lower energy use cuts carbon emissions and reduces utility bills, thereby decreasing household energy burden while improving the home’s health, safety, comfort, durability, and climate resiliency.⁷⁹

WAP is governed by various federal regulations⁸⁰ designed to help manage and account for the resources provided by DOE. WAP is a formula grant program.⁸¹ Funding, derived from annual appropriations from Congress, flows from DOE to grantees (including all 50 states, the District of Columbia, Native American tribes, and five US Territories) and then to subgrantees (including local governments and weatherization agencies).⁸² Federal statutes and policies encourage the WAP network to supplement federal funding with non-federal funding to maximize investments in eligible units.

Federal funds include, but are not limited to	Non-federal funds include, but are not limited to
<ul style="list-style-type: none"> • DOE WAP formula funds • DOE WAP competitive funds (Sustainable Energy Resources for Consumers (SERC), Enhancement & Innovation (E&I)) • Low-Income Home Energy Assistance Program (LIHEAP) funds • Community Development Block Grant Program (CDBG) 	<ul style="list-style-type: none"> • Utility investments from systems benefit charges or efficiency programs • State funds from special set-asides • Other rehabilitation funds • Private funds from landlord contributions or foundations • Other private sources

Source: Weatherization Program Notice⁸³

⁷⁷ Office of State and Community Energy Programs, “Weatherization Assistance Program,” 2024. <https://www.energy.gov/scep/wap/weatherization-assistance-program>

⁷⁸ State and Community Energy Programs, (SCEP) “Weatherization Assistance Program Fact Sheet,” 2023, p. 1-2. https://www.energy.gov/sites/default/files/2023-07/2023_WAP_Fact_Sheet.pdf;

⁷⁹ National Association for State Community Service Programs, “Weatherization Assistance Program - Funding Report Program Year 2021,” 2022, p 1-11. https://nascsp.org/wp-content/uploads/2022/12/PY21-WAP-Funding-Report_Final-1.pdf;

⁸⁰ For example, 10 CFR 440: National Archives, Code of Federal Regulations (CFR), “Part 440–Weatherization Assistance for Low-Income Persons,” 2024. <https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-440>

⁸¹ State and Community Energy Programs, (SCEP), “Weatherization Program Notices and Memorandums,” 2024. <https://www.energy.gov/scep/wap/weatherization-program-notices-and-memorandums>;

⁸² Corrie E. Clark - Analyst in Energy Policy, Lynn J. Cunningham - Senior Research Librarian/Congressional Research Service, “The Weatherization Assistance program Formula,” 2021, p. 1-27. <https://crsreports.congress.gov/product/pdf/R/R46418>;

⁸³ US Department of Energy (DOE), “Weatherization Program Notice 22-9,” 2022, p 1-11. <https://www.energy.gov/sites/default/files/2022-06/wpn-22-9.pdf>;

Based on WAP annual funding surveys, the share of WAP, Low-Income Home Energy Assistance Program (LIHEAP), and non-federal funds averaged 32%, 40%, and 28% of the total annual investment, respectively.⁸⁴ The share of non-federal funds has grown to fund a variety of smaller sub-grantee projects from sources such as local government contracts, foundation grants, partnerships with health services providers, and charitable donations. In program year (PY) 2021, many were directed towards testing electrification and renewable energy installations.

Water Heater Measures in WAP

WAP evaluation reports provided useful statistics on the characteristics of water heaters and the frequency of different water heating measures installed under WAP in different housing types and parts of the country.⁸⁵ Note that these statistics concern WAP installations, which are a subset of all water heaters nationwide, which is why some of these percentages differ somewhat from the RECS 2020 and EIA data cited elsewhere in this report.

Water Heating Fuel

Nationally, methane gas was dominant in all housing types except in manufactured housing, where electric water heaters dominated. By climate zones, the share of electric water heaters in single-family and manufactured housing was higher in moderate, hot, and humid climates than in other climates. Specifically:

- a. In single-family homes, 55% of water heating systems were gas-fired, followed by 35% electric water heaters.
- b. In manufactured housing, electricity was the dominant water heating fuel except in the hot-dry climate, where methane gas water heaters were predominant (40%), followed by propane (34%).
- c. In small multi-family buildings, 68% of water heating systems were methane gas-fired, followed by 26% electric water heaters.
- d. In large multi-family buildings, 70% of water heating systems were methane gas-fired. Also, fuel oil was a common water-heating fuel in very cold and cold climates, and propane in hot-dry climates.

⁸⁴ National Association For State Community Service Programs (NASCS) Weather Assistance Program (WAP), “WAP Annual Funding Survey,” 2022. <https://nascsp.org/wap/weatherization-publications/wap-annual-funding-surveys/>;

⁸⁵ WAP evaluation reports document the Retrospective Evaluation—a national evaluation of the WAP for PY 2008. These are reflective of a typical year in WAP operations and provide a comprehensive picture (including the characteristics of clients, housing stock, and service providers) and assess program administration. The primary data source for WAP statistics and charts here is <https://weatherization.ornl.gov/wap-retrospective/>.

Oak Ridge National Laboratory (ORNL), “WAP Retrospective Evaluation,” 20__ <https://weatherization.ornl.gov/wap-retrospective/>;

Water Heater Replacement

Nationwide, WAP water heater replacement rates in PY 2008 varied from 10% to 22%. Specifically:

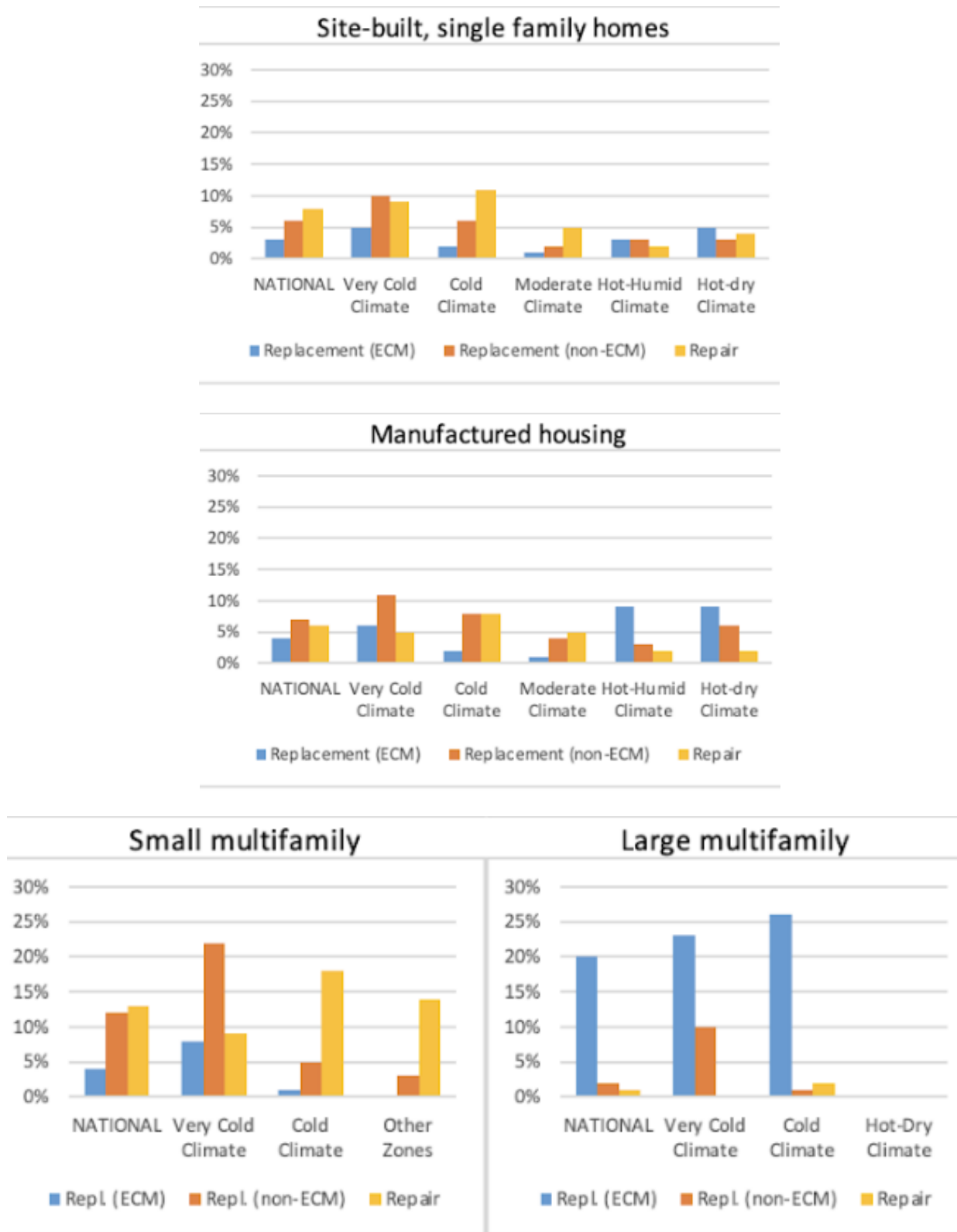
- a. In single-family homes, 10% of equipment was replaced for health and safety reasons. Another 10% of water heaters were repaired.
- b. In mobile homes, 13% of water heaters were replaced; only one-third of these projects were listed as ECMs.
- c. In small multi-family buildings, 16% of water heaters were replaced, again mostly for health and safety reasons. Replacement rates were highest in the Very Cold Climate Zone.
- d. In large multi-family buildings, 20% of water heating systems were replaced. Most of these projects were listed as ECMs.



FIGURE 13. WATER HEATING FUEL IN DIFFERENT HOUSING TYPES WEATHERIZED IN PY 2008⁶⁹



FIGURE 14. WATER HEATING EQUIPMENT MEASURES IMPLEMENTED IN DIFFERENT HOUSING TYPES IN PY 2008⁶⁹



Programs and Policies That Could Support Electrification Under WAP

Weatherization Program Notice⁸⁶

WAP is governed by various federal regulations designed to help manage and account for the resources provided by DOE. The requirement for cost-effectiveness for a measure to be implemented with WAP funds is stated below.

Cost-Effective Installations: All weatherization measures must be “cost-effective” as defined by DOE, except for measures to eliminate health and safety (H&S) hazards that meet the Grantee’s approved H&S plan. “Cost-effective” means that each measure and package of measures installed in a dwelling unit must have a savings-to-investment ratio (SIR) that meets or exceeds 1.0.⁸⁷

Projects with higher SIR values are typically prioritized, as they provide more significant short-term cost savings for the program and the households it serves. For this reason, equipment repair and other water heating measures (such as tank wrap, pipe insulation, low-flow shower heads, faucet aerators, and setpoint reduction) are prioritized over water heater replacement. Water heater replacement is more often considered when there is a health and safety issue.

However, DOE encourages ‘cost-effective’ fuel switching, as stated below, and indicates that switching away from bulk fuel may be cost-effective.

Fuel Switching: Due to increasing financial and environmental costs associated with the continued use of fossil fuels, DOE strongly encourages WAP Grantees to implement cost-effective fuel switching whenever possible. This may be particularly cost-effective when switching away from delivered bulk fuels (e.g., Liquid Propane (LP), and Fuel Oil) and when implementing Social Cost of Carbon enhancements as outlined in WPN 22-10—Including Non-Energy Impacts within the Weatherization Assistance Program.

In this context, replacement with a HPWH is generally cost-effective (so, prioritized) for existing electric resistance, propane, and oil water heaters but not for existing methane gas water heaters.

WAP Innovation Grant

These are competitive funding opportunities available to WAP grantees, subgrantees, and non-profit organizations to demonstrate innovative technologies and approaches that go beyond the scope of the WAP formula program. Currently, WAP Innovation grants include the

⁸⁶ See WPN 23-6: State and Community Energy Programs, (SCEP), “Weatherization Program Notice 23-6: Revised Energy Audit Approval Procedures, Related Audit and Material Approvals Including Fuel-Switching and Solar PV,” 2023. “<https://www.energy.gov/scep/wap/articles/weatherization-program-notice-23-6-revised-energy-audit-approval-procedures>.”

⁸⁷ There is a single exception: blower door guided air sealing may have an SIR less than 1.0, if the cumulative SIR of the package of measures is equal to or greater than 1.0, not including H&S measures.

Enhancement & Innovation (E&I) grant and the Sustainable Energy Resources for Consumers (SERC) grant.⁸⁸

State-Based Energy Efficiency Contractor Training Grants

This Contractor Training Program provides funding to state energy offices to train, test, and certify energy efficiency and electrification contractors.⁸⁹

Weatherization Readiness Program⁹⁰

This program brings clients that WAP cannot serve because of the condition of their homes into weatherization-ready status. Electrification is not included. DOE has yet to issue any program-wide guidance on the use of weatherization readiness funds to support electrification-readiness (or direct electrification⁹¹).

Incorporating the social cost of carbon

When incorporated within the WAP, this would provide a compelling incentive to replace fossil fuel water heaters with heat pump water heaters (HPWHs) for eligible low-income households. The social cost of carbon represents the long-term environmental, health, and societal impact of carbon emissions, including the contribution to climate change and associated damages.⁹²

Weatherization Leveraged Partnerships Project (WLPP)

This is a collaborative initiative encouraging strategic partnerships among federal, state, and local agencies, along with community organizations, utilities, and private stakeholders, to leverage resources and expertise to maximize the number of homes weatherized, increase the range of energy-saving measures implemented, and extend the program's reach to more eligible families.⁹³

⁸⁸ State and Community Energy Programs, (SCEP) Weatherization Assistance Program (WAP), "About the Weatherization Assistance Program Innovation Grants," 2024. "<https://www.energy.gov/scep/wap/weatherization-innovation>;"

⁸⁹ Erin Cosgrove/Northeast Energy Efficiency Partnerships, "We Have Energy Efficiency Workforce Funding...Now What?," 2023. "<https://neep.org/blog/we-have-energy-efficiency-workforce-fundingnow-what/>;"

⁹⁰ See WPN 23-4: US Department of Energy (DEO), "Weatherization Program Notice 23-4," 2023 p. 1-4. "https://www.energy.gov/sites/default/files/2023-01/WPN_23-4_Weatherization_Readiness_Funds_Expansion_of_Scope.pdf;"

⁹¹ Sam Whillans (Alum)/National Resource Defense Council (NRDC), "Better Weatherization is Within Sight," 2022. "<https://www.nrdc.org/bio/sam-whillans/better-weatherization-within-sight/>;"

⁹² See WPN 22-12: US Department of Energy (DEO), "Weatherization Program Notice 22-10 Revised," 2022, p.1-7. "https://www.energy.gov/sites/default/files/2022-10/WPN-22-10-Revised-NEI_0.pdf;"

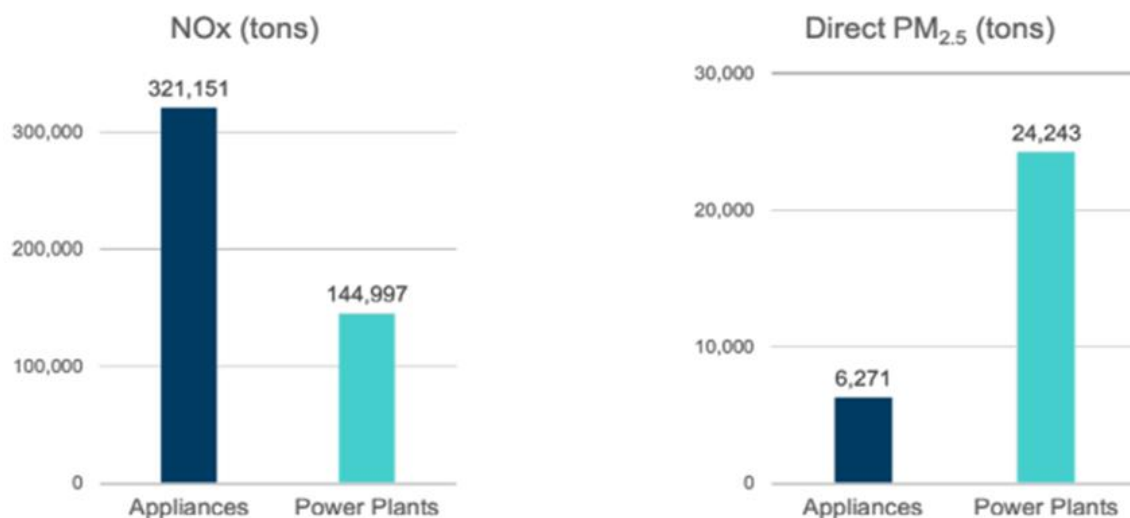
⁹³ Community Action Partnership, "Affordable Energy Partnerships and Programs (Browse Resources)," 2024. "<https://communityactionpartnership.com/energy-partnerships/>;"

Appendix Three: Pollution Reduction + Air Quality Improvements

Gas water heaters and furnaces, which account for 96% of all gas burned in homes, create significant amounts of outdoor and sometimes indoor air pollution. While gas furnaces and water heaters are vented to the outside, leaking gas appliances or gas lines are found in approximately 15-25% of all residences.⁹⁴ Despite the lack of rigorous data on the frequency of improper exhaust venting from water heaters,⁹⁵ plumbers and contractors anecdotally report that it is not uncommon.

Gas-combusting appliances such as gas water heaters create significant outdoor pollution through nitrogen oxide (NOx) emissions, carbon monoxide, fine particles, and greenhouse gas emissions. RMI estimates that NOx emissions from gas appliances are more than twice the emissions of gas power plants, as those facilities have been regulated for decades.⁹⁶

FIGURE 15. U.S. GAS APPLIANCE POLLUTION RIVALS OR EXCEEDS GAS POWER PLANT POLLUTION⁹⁶



Source: CMC Energy Services⁹⁵

⁹⁴ According to CMC Energy Services as by Canary Media: Sarah Wesseler/Canary Media, “We Know Gas Stoves Have Health Risks. What About Other Gas Appliances?,” 2023. “<https://www.canarymedia.com/articles/fossil-fuels/we-know-gas-stoves-have-health-risks-what-about-other-gas-appliances;>”

⁹⁵ See Data Gaps on page 20 of this report: American Lung Association, “Health Impact of Combustion in Homes,” 2022. “<https://www.lung.org/policy-advocacy/healthy-air-campaign/healthy-efficient-homes/residential-combustion;>”

⁹⁶ Rocky Mountain Institute (RMI), “Fact Sheet - Why EPA Must Address Appliance Pollution,” 2021 p. 1-4. “https://rmi.org/wp-content/uploads/2021/04/rmi_factsheet_appliance_pollution.pdf;”

In March 2023, the Bay Area Air Quality Management District (BAAQMD) adopted regulations requiring the elimination of nitrogen oxide (NOx) emissions from new water heaters by 2027 for larger water heaters and 2031 for smaller (generally residential size) and new furnaces by 2029.⁹⁷ These new Bay Area emissions standards are the first in the nation to phase out existing gas water heaters. In a few years, homes in the region will no longer be able to install gas combusting gas water heaters or furnaces. Other organizations, like the Regulatory Assistance Project, have also created a water heater model rule that can help jurisdictions around the US phase-out NOx emissions based in part on the BAAQMD standards and other existing water heater regulations that exist in CA, UT, and TX.

The Regulatory Assistance Project (RAP) model rule⁹⁸ for NOx emissions standards for water heaters is designed to be used by US state and local air quality regulators. Establishing NOx emissions standards is an excellent tool for reducing the environmental impact of water heaters and is designed to support and promote electrification and market transformation.

RAP focused this model rule on NOx standards for water heaters for three important reasons.

1. NOx contributes to various environmental hazards and is formed when fuel is combusted.
2. Most, if not all, local and state air quality agencies have the authority to propose regulations to control NOx emissions from water heaters without seeking legislative authority. The authority to regulate GHG is less clear in many areas.
3. Air quality agencies have a lot of experience regulating NOx emissions from larger but similar sources to water heaters, e.g., larger combustion facilities.

The RAP model rule prohibits the sale of water heaters (including those using methane, propane, and fuel oil) that do not meet the required emission standards and covers water heaters with up to 2 MMBtu/hr heat input. The rule has three tiers, two of which allow for some NOx emissions (like the Bay Area). It also includes a phase in date when only non-emitting water heaters (a zero NOx standard) may be sold, which is currently set for 2035. RAP is working with the Northeast States for Coordinated Air Use Management (a regional group of air quality agencies in the Northeast) to update a few aspects of the rule, including adjusting the dates for the phase-out of fossil-fired water heaters. However, that date has not been decided as of August 1st, 2023.

The RAP model rule includes standards for oil and propane water heaters, which other existing rules have not yet been included. This was added because those fuels contribute to significant air pollution from water heaters in many parts of the US and are cost-effective to replace with

⁹⁷ Bay Area Air Quality Management District, "Rules 9-6 Building Appliances," 2023. "<https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances;>"

⁹⁸ <https://www.raonline.org/wp-content/uploads/2023/02/rap-model-rule-nox-water-heaters-2023-february.pdf>

heat pump water heaters. The model rule also includes provisions that air quality agencies normally need, such as certification and testing protocols, auditing, and enforcement.

RAP prepared a support document describing the research and background that led to their model rule.⁹¹ That document includes a discussion of equity considerations like the need for environmental agencies to coordinate with their energy colleagues on incentives to lower costs for low-income customers. It also includes a discussion of consumer costs and the benefits of enacting emission requirements and other important aspects of regulating water heaters using environmental standards, such as test procedures to ensure that low NOx water heaters meet the required emission standards.



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The Advanced Water Heating Initiative (AWHI) is a member-funded collaborative of building owners, utilities, federal agencies, state and local governments, manufacturers, engineers, installers, advocates, researchers, and building industry professionals from across the U.S.

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