Appliance Standards, Equity, and Climate Change—HVAC Opportunities

Suzanne Foster Porter, Kannah Consulting
Blake Ringeisen, Nicky Dunbar, and Maya Cutforth, Northwest Energy Efficiency Alliance
Vicki Fulbright, Redcliff Writing Hood
David Denkenberger, University of Canterbury, New Zealand

ABSTRACT

Appliance standards deliver critical reductions in energy use, greenhouse gas emissions (GHGs), and utility bills, but are these essential benefits of policy distributed equitably among all communities? This paper will build upon a prior case study of equity in US laundry equipment standards, which demonstrated unjust policy outcomes for marginalized, low-income communities (i.e., the citizens most likely to benefit from reductions in energy costs from standards do not receive them). This investigation focuses on residential single-dwelling HVAC equipment. Our analysis reveals that developing standards for HVAC equipment based on technology type has restricted the opportunity to deliver energy savings to marginalized communities. When the focus shifts to the end-use service to consumers, opportunities for significant HVAC equipment energy savings emerge in manufactured and multifamily homes used by marginalized, low-income communities that disproportionately include people of color. Energy savings associated with addressing these inequities are estimated at 13 quadrillion BTU (quads) over 30 years, four times the savings of the most recently adopted US Department of Energy central air conditioning (AC) and heat pump standards. These energy savings deliver 190 million metric tons (MMT) of carbon dioxide equivalent (CO_2e) over that same period while reducing utility bills of communities experiencing energy security by 170 billion dollars. This paper details the methodology and results of this analysis. It also outlines recommendations to increase equity and realize these reductions.

Introduction

The US Department of Energy (DOE) Appliance Standards Program is essential to delivering a 50% reduction in US energy use and greenhouse gas (GHG) emissions by 2050 (Nadal and Ungar 2019). The program has a legacy of substantial energy savings (deLaski and Mauer 2017) and historically has been one of the most significant energy-saving initiatives in the US (ASAP 2017). The Appliance Standards Program notably supports energy equity by continuously raising baseline appliance and equipment efficiency. These efforts are critical to low-income households—disproportionately households of color—that generally purchase or use lowest-cost equipment that is typically minimally compliant with the standard. Despite these achievements, DOE's standards development process is not immune to larger historical, cultural, and institutional dynamics that lead to inequitable distribution of benefits to communities. Exploring opportunities to improve equity illuminates previously overlooked energy savings that can help achieve essential climate goals while improving benefits distribution.

This paper explores the equity of DOE appliance standards by identifying and discussing inequitable program results for residential heating, ventilation, and air conditioning (HVAC) equipment. This second case study builds on prior work, which revealed an inequitable distribution of benefits associated with laundry equipment appliance standards policy (Foster

Porter 2022). Analysis showed that while the policy for in-dwelling laundry equipment is comprehensive and relatively stringent, the policy for vended laundry equipment—used more often by marginalized communities—is less comprehensive in scope and generally less stringent. The prior analysis quantified energy, GHG, and utility bill savings if laundry equipment inequities are addressed and offered several recommendations to state and federal policymakers and the DOE. This paper is a second case study that examines standards for HVAC.

To that end, we begin with a brief background on energy equity and then analyze HVAC standards. We also summarize the energy and GHG savings opportunities for improving equity and offer recommendations enabling more equitable appliance standards.

Energy Equity

Energy equity can be described as four interdependent threads (Park 2014):

- *Structural equity*—decision-makers recognize the historical, cultural, and institutional dynamics that have led to clean energy inequities.
- *Procedural equity*—decision-makers create inclusive and accessible processes.
- *Transgenerational equity*—decision-makers consider the impact on future generations.
- *Distributional equity* —clean energy policies and programs fairly distribute the benefits and burdens of efficiency across all segments of communities.

The focus of this analysis and discussion is on this fourth thread. Foster Porter et al. (2022) documented the nation's significant energy gaps in distributional energy equity. Multiple statistics illustrate that low-income households—which are disproportionately households of color—are marginalized by the existing energy system:

- Low-income households often spend three times more of their income on energy costs (8.1% versus 2.3%) than non-low-income households. This energy cost burden disproportionately affects Black, Hispanic, and Native American households.[1,2] One in four non-Hispanic white households is energy insecure, but nearly two-thirds of Native American/Alaskan Native households and half of Black and Hispanic households are energy insecure (Drehobl, Ross, and Ayala 2020, iii, 9).
- Nearly one in three US households (33 million) experience energy insecurity (i.e., the inability to adequately meet household energy needs). This includes 23 million non-Hispanic white households. (Sen, Griffin, and Bottger 2018, 39).
- Participants of residential energy efficiency programs tend to be disproportionately white, higher-income, college-educated homeowners (Amann, Tolentino, and York 2023).

An equitable appliance standards policy that fairly distributes cost-effective energy savings across all segments of communities can be one part of the solution to a fairer energy system and help address energy insecurity in marginalized communities. Next, we consider the

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[1] Black, Hispanic, and Native American households have a median energy burden that is, respectively, 43% higher, 20% higher, and 45% higher than that of white households (Drehobl, Ross, and Ayala 2020, 11-13).
[2] The national studies reviewed for this paper do not address the average national energy cost burdens of Asian American households. Further discussion on this topic can be found in Foster Porter et al. 2022.

state of distributional equity in the context of appliance standards for HVAC equipment, beginning with a background on US housing types.

A Second Case Study: HVAC Equipment Standards

Who Lives Where?

Structural inequities in federal and local housing policy mean that families of different races are disproportionately housed in different building types: multifamily homes or apartments, manufactured homes, and single-family homes. Renters—found primarily in multifamily apartment buildings—are disproportionately low-income and people of color due to centuries of discriminatory policy, including redlining, discriminatory lending practices, and other federal and local policies (Lewis 2020).[3] These have created higher barriers to homeownership for households of color, while white households benefited from the same policies. Although ACEEE, NEEA, and others have developed strategies to encourage energy efficiency in rentals and manufactured homes, these housing types have received lower energy efficiency program investment overall due to split incentives and other barriers (Mah and Sussman 2023, NEEA 2023, Chilukuri 2023).

Table 1 summarizes some of the outcomes of these structural inequities in housing. Families living in multifamily and manufactured homes are more likely to experience energy insecurity than families in single-family homes. Also, due in part to high energy bills caused by these lower efficiency housing types, those in multifamily or manufactured homes are approximately twice as likely to set their heating or cooling system at an unhealthy indoor temperature to save money on utility bills, jeopardizing the health and safety of the most vulnerable occupants—the elderly, ill, and very young (EPA 2021). Additionally, certain types of HVAC equipment are more prevalent in certain buildings, which we discuss next.

Table 1. Demographics of households by building type

Building type	% renter occupied	Race of households	% energy insecure	% unhealthy indoor temp
Multifamily home	87%	Disproportionately households of color	35%	14%
Manufactured home	30%	Disproportionately white, non-Hispanic households; increasingly households of color	47%	17%
Single-family home	13%	Disproportionally white, non-Hispanic households	23%	8%

Notes: The percentage of homes that are renter-occupied (EIA 2023a Table HC2.2 and Zahalak 2020), the race of households (EIA 2023a Table HC9.1 and Ryan 2021), and the percentage of households living with energy insecurity and leaving their homes at an unhealthy temperature (EIA 2023a Table HC11.1).

[3] To learn more about redlining and explore interactive maps of U.S. cities, see https://dsl.richmond.edu/panorama/redlining.

HVAC Equipment by Building Type

To examine the distributional equity of HVAC equipment addressed in the Appliance Standards Program, we used the EIA RECS data (2023a Table HC6.1) to identify the types of HVAC equipment that are significantly more common in each building type (multifamily, manufactured, and single family). Equipment "significantly more common" in multifamily or manufactured homes has a household penetration ten or more percentage points higher than the same equipment in single-family homes (Figure 1). For example, window or wall AC is 22 percentage points more common in multifamily than single-family and therefore more prevalent in multifamily. Similarly, equipment "significantly more common" in single-family homes has a household penetration that is ten or more percentage points higher than the same equipment in multifamily and manufactured homes. HVAC equipment with similar prevalence (less than a 10-percentage point difference in household penetration) is excluded from the analysis. Finally, our study focuses on in-unit (single-dwelling) equipment due to the difficulty of using RECS to identify the relative prevalence of shared systems that may heat or cool multiple households and shared common spaces. Figure 1 summarizes our findings on each building type's most prevalent HVAC equipment.

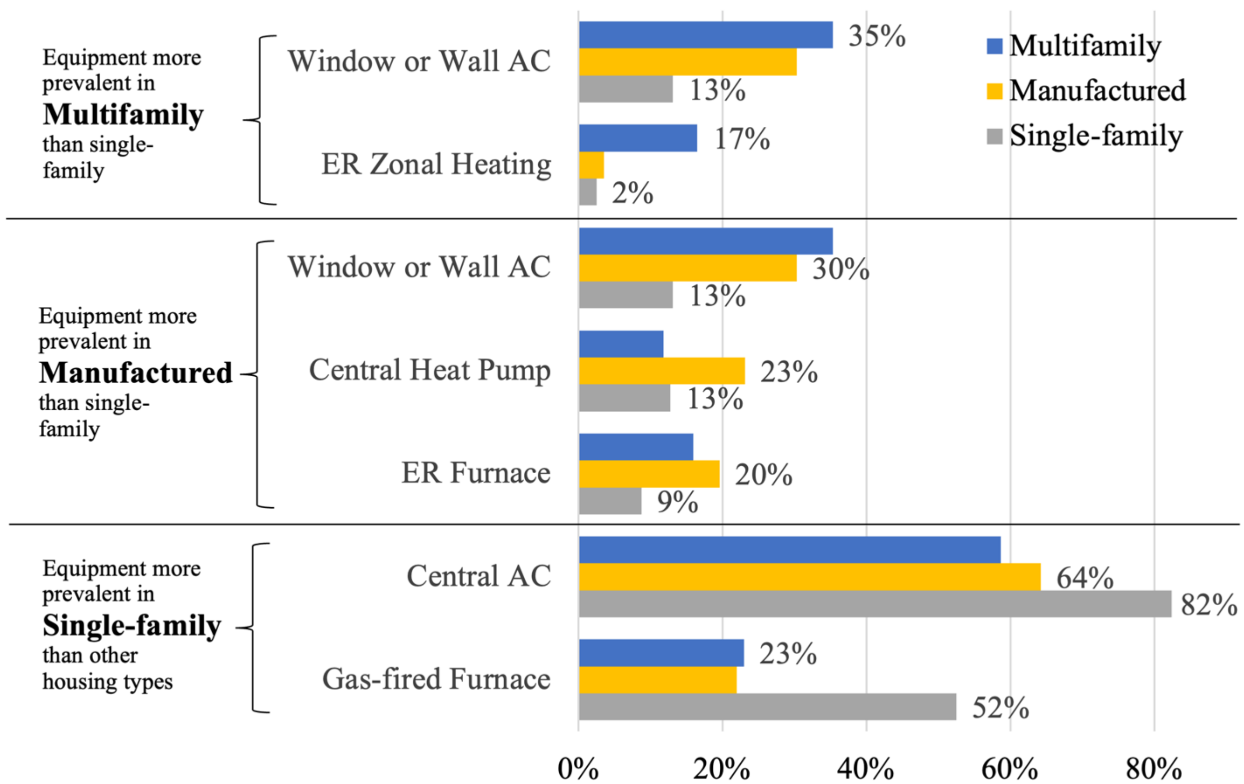

Figure 1. US HVAC Equipment Prevalence by Building Type
Notes: AC=air conditioner and ER=electric resistance. ER zonal heating includes electric baseboard, in-wall, in-floor, and in-ceiling. *Source:* EIA 2023a Table HC6.1.

We compared the RECS results to NEEA's 2016-2017 Residential Building Stock Assessment (RBSA) for validation (2019). Trends in the Northwest and the US were similar except for window and wall AC, which is more common in single-family homes in the Northwest than in US homes.

HVAC Appliance Standards

The US Congress directed DOE to set standards for some HVAC equipment as part of the National Appliance Energy Conservation Act of 1987 and the Energy Policy Act of 1992. Still, not all HVAC equipment has standards, and standards for some equipment categories have been updated more frequently than others. Table 2 summarizes the standards of the equipment prevalent in each building type.

Table 2. Summary of HVAC equipment standards more prevalent in each building type

Building type	More prevalent HVAC equipment	Standards outcomes				
		Does an energy standard exist?	First year standard level published	Last year current standard level was updated	Has the standard level stringency increased?	Recently proposed future updates?
Multifamily home	Electric resistance zonal heating[a]	No	NA	NA	Never	No
Multifamily home Manufactured home	Window or wall AC[b]	Yes	Window: 1997 Wall: 1992	Window: 2011 Wall: 2015[e]	Regularly	Yes
	Electric resistance furnace[c]	Yes	1987	1987	Never	No
	Central heat pump[d]	Yes	1987	2017[f]	Regularly	Yes
Single-family home	Gas-fired furnace[c]	Yes	1987	2015	Regularly	Yes
	Central AC[d]	Yes	1987	2017[f]	Regularly	Yes

[a] DOE calls this type of equipment "unvented direct heating equipment." Electric resistance zonal heating includes electric baseboard, in-wall, in-floor, and in-ceiling (DOE 2021). [b] This includes two DOE categories of equipment: consumer room ACs (DOE 2023d) and packaged terminal ACs (PTAC) (DOE 2023e Table HC6.1). This type of equipment is more prevalent in both multifamily and manufactured homes. [c] DOE 2023c [d] DOE 2016, 1-6 to 1-7. [e] Non-standard size wall AC (PTAC) was not updated in 2015; the last effective date was 2010. [f] Single-package, space-constrained, and duct systems designed for smaller living spaces were not updated in 2017 (DOE 2016).

Examining the standards for equipment more prevalent in each housing type shows key differences in the distributional equity of standards outcomes. Observations include:

- *There are no standards for heating equipment more commonly found in multifamily buildings.* DOE has <u>never</u> set standards for electric resistance zonal heating systems (what DOE calls unvented direct heating equipment), which are more widely found in multifamily homes than single family homes (Figure 1). DOE concluded again recently that no significant energy savings are possible for this equipment (DOE 2021). More recently, DOE directed resources to a new category of direct heating equipment likely more common in single-family homes: hearth heaters (gas fireplaces), and has issued an RFI for that product (DOE 2022).

- *Electric resistance furnaces, more common in manufactured homes, were last updated 30 years ago.* Since then, DOE has determined that improving their efficiency is not technologically feasible (DOE 2023c). These furnaces are often located in communities where nearly 50% of families experience energy insecurity (EIA 2023a Table HC11.1).
- *Window and wall AC standards were developed later than other equipment.* The first standards for window and wall ACs, both more common in multifamily and manufactured homes, were developed five to ten years later (1992 and 1997) than equipment used in single-family homes (1987), delaying opportunities for energy savings for low-income communities and communities of color more likely to live in these dwellings (DOE 2023d and 2023e).
- *Standards for single-family HVAC equipment are among the oldest standards that have been regularly updated.* Gas-fired furnaces and central ACs, significantly more common in single-family homes, have benefited from standards since 1987 and have been regularly updated since then to deliver energy savings to single-family households, which are disproportionately white, non-Hispanic families (DOE 2023c and 2016, 1-6 to 1-7).
- *Central heat pumps, more common in manufactured homes, benefited from proximity to central ACs.* DOE pairing this equipment with central air conditioning has benefited central heat pumps. Therefore, like central air conditioning, it has had standards with regular updates since 1987, benefiting those families with heat pumps in their manufactured homes (DOE 2016, 1-6 to 1-7).

We observe that policies for equipment more common in multifamily dwellings have had the least attention and focus from DOE's appliance standards program (no standard and a later standard), followed by HVAC equipment more common in manufactured homes (30-year-old standard, later standard, and regularly updated standard). The HVAC equipment prioritized by DOE has been predominantly in single-family homes. These differences in the Appliance Standards Program attention and focus have created an inequitable distribution of cost-effective energy savings across US demographics, with low-income families and families of color disproportionally affected. However, prioritizing efforts to improve HVAC equipment efficiency in multifamily and manufactured homes is possible through changes to DOE's processes and Appliance Standards Program practices.

Technologies Available to Improve Efficiency of Electric Resistance HVAC Equipment

DOE reviews equipment standards every six years to determine if a new standard is technologically feasible and economically justified. Electric resistance heating (both zonal equipment more common in multifamily and electric furnaces more common in manufactured homes) is regularly dismissed because electric resistance technology is nearly 100% efficient and cannot improve. However, heat pump efficiencies are greater than 100% because they move heat rather than generate it.

Moreover, heat pump equipment for zonal and central heating is readily available today. Central heat pumps, already common in manufactured homes, can replace electric resistance furnaces. Zonal heat pump HVAC equipment includes:

- *Ductless heat pump mini-split systems*. Mini splits have the compressor outside and the fan inside. Notably, they can provide heat and cooling.
- *Through wall, window, or windowsill heat pumps*. This includes packaged terminal heat pumps (PTHPs)—which are through the wall—and window[4] and u-shaped windowsill heat pump ACs—which have the added advantage of easy non-contractor installation.[5]

These heat pump products can be used instead of electric resistance heating equipment, are expected to be highly cost-effective, and, in some cases, have been on the market for decades. DOE has not compared the efficiency of heat pumps to electric resistance HVAC equipment more commonly found in multifamily and manufactured homes for reasons we discuss next.

What Contributed to this Inequitable Program Focus?

Several characteristics of DOE's processes and institutional practices have contributed to the inequitable standards outcomes for HVAC equipment:

- Products are siloed by form factor or technology rather than by end-use service,
- Unique test procedures for each equipment type,
- Formative input from low-income communities and communities of color is deprioritized, and
- Lack of DOE workforce diversity.

Products are siloed by form factor or technology rather than by end-use service. When products are siloed by form factor or technology rather than by end-use service, they are more difficult for DOE and stakeholders to see in context with the ecosystem of technologies available to consumers. Builders, developers, and owners often compare technologies that provide the same service (e.g., zonal heat) with the same energy source (in this case, electricity). However, DOE considers electric zonal heat and electric furnaces separately from other electrically powered heating equipment. Instead, DOE groups products by form factor, and updates occur on different timetables. For example, DOE groups zonal electric resistance heating equipment with similar gas equipment rather than heat pump equipment (packaged and mini split). Electric furnaces are grouped with gas-fired and oil-fired furnaces rather than with central heat pumps. However, in recent standards updates, there are examples of DOE comparing different technologies that provide the same service using the same fuel:

- *Gas-fired furnaces.* DOE's recent rulemaking for gas-fired furnaces considered high-efficiency condensing technology alongside non-condensing technology and proposed a

[4] An example product https://www.homedepot.com/p/Amana-11-200-BTU-230-208V-Window-Air-Conditioner-Cools-600-Sq-Ft-with-Heater-and-Remote-in-White-AH123G35AX/206140959.
[5] One example is https://www.gradientcomfort.com.

standard that only condensing technology can meet. The outcome is proposed standards that raise the standard from ~85% to 95% efficiency (DOE 2023g).[6]

- *Tank electric water heaters.* In its last two rulemakings, DOE considered the cost-effectiveness and technological feasibility of electric resistance and heat pump storage water heaters side-by-side. Updated standards require heat pumps for the most common storage sizes, saving households more than $11 billion annually on utility bills, and capturing one of the largest energy savings ever in DOE Appliance Standards Program history (DOE 2024a).

While a full legal review of applicable law is not within the scope of this paper, these precedents indicate that DOE may have the authority to similarly consider the national benefits and the cost-effectiveness of electric resistance and heat pump side-by-side for space heating as well.

Unique test procedures for each equipment type. Siloed test procedures with different test conditions and metrics make it difficult for DOE and its stakeholders to compare heating and cooling products. We recognize that test procedures necessarily need to represent realistic installation conditions of the equipment and that in some instances (such as window air conditioning), DOE must use a particular metric (energy efficiency ratio or EER). However, in the limited group of HVAC products identified for this paper, there are <u>six</u> different test procedures for measuring the efficiency of the heating and cooling equipment, yielding six different measures of efficiency (AFUE, COP, EER, SEER2, CEER, and HSPF2). Due to these differences, this analysis does not include the relative stringency of these standards, as the authors could not definitively compare the stringency of even highly similar equipment (central ACs and window/wall ACs). This also makes it difficult for specifiers of manufactured homes, multifamily developers, and single-family homeowners to compare HVAC equipment.

Formative input from low-income communities and communities of color is deprioritized. The authors have observed that DOE generally reaches out to product manufacturers but makes less effort to include low-income communities and organizations that represent them. Procedural equity is a critical component of achieving equitable outcomes in standards, which requires the involvement of affected communities from design through implementation and evaluation (Park 2014). One model of procedural equity is The Colorado Health Foundation, which deploys program officers throughout the state to better understand community members and leaders, ultimately using gathered information to guide health initiative funding (2024). Though this community engagement model is still limited as it focuses only on gathering input and does not extend to shared decision-making, it creates a long-term partnership with communities. DOE is currently missing this type of information and input from affected communities, which is likely contributing to the observed inequitable program focus.

Lack of workforce diversity affects investigation questions and outcomes. Blei (2020, 60) identified unintended bias of decision-makers, who have historically been white individuals with higher incomes living in single-family homes. Additionally, women, Black, and Hispanic workers are more poorly represented in clean energy than the rest of the economy (E2 et al. 2021, 3). This lack of workforce diversity means those most affected by structural injustices are

[6] The gas industry petitioned the U.S. Court of Appeals for the District of Columbia Circuit in December 2023 for review of the rule, arguing the requirement would eliminate non-condensing products. See utilitydive.com/news/doe-Earthjustice-appeals-court-furnace-efficiency-rule/719349/.

less likely to have their voices included in crucial decision-making processes. The result of this bias leads to unintentional deprioritization of products like zonal heating equipment and electric resistance furnaces.

Impacts of Inequitable HVAC Equipment Standards Program Focus

The impacts of the low efficiency of electric resistance zonal and central heating equipment in multifamily and manufactured homes are glaring, contributing to higher energy bills and energy insecurity for families in manufactured homes and multifamily homes, the latter of which are disproportionately households of color. This low-efficiency electric resistance heating equipment likely contributes to high utility bills and unhealthy indoor temperature set points more common in low-income communities and communities of color (Table 1). Furthermore, relatively simple but inefficient electric resistance equipment can last a long time, lowering generational equity and burdening future generations with higher energy bills.

Additionally, because of this inequitable Appliance Standards Program focus, the US is missing opportunities to reduce energy use by 13 quadrillion BTU (quads) over 30 years, save 190 million metric tons (MMT) of carbon dioxide equivalent (CO_2e) over that same period, and reduce consumer utility bills by 170 billion dollars (Table 3). These savings are four times higher than the most recently adopted central air conditioning and heat pump standards (3.2 quads, DOE 2017). This savings estimate assumes that all US homes with primary electric heating adopt more efficient heat pumps with a COP of 2 (which is the average COP of the current heat pump standards). We exclude energy savings from households with supplementary (secondary) electric heating systems, but also exclude potential increased cooling in summer months for air conditioning. Finally, these estimates do not consider impacts of current electrification efforts that encourage switching HVAC equipment from gas to electric.

Table 3. Summary of US energy, GHG, and energy bill reductions for replacing electric resistance zonal and central heating equipment with heat pump technology

HVAC equipment	30-year FFC energy savings (quads)[a]	30-year GHG savings (MMT of CO_2e)[b]	30-year energy savings (Billions US$)[c]	Building type in which equipment is most common
Electric resistance zonal heating	4.8	190	61	Multifamily home
Electric resistance furnace	8.6	350	110	Manufactured home
Total:	13	540	170	

Notes: FFC = full fuel cycle (source energy savings), Quads = quadrillion British thermal unit (BTU), GHG = greenhouse gas emissions, MMT of CO_2e = million metric tons of carbon dioxide equivalent. [a] The calculation of FFC energy savings assumes primary central electric warm air furnaces and built-in (zonal) electric resistance heaters are replaced with heat pumps (EIA 2023a Table CE4.1). To calculate the savings, we assign a coefficient of performance or COP of 1.0 for electric resistance (100% efficient) and COP of 1.99 for heat pumps. The heating COP of heat pumps is derived by taking the heating seasonal performance factor 2 (HSPF2) in BTU per watt hour and dividing it by 3.41 to get COP.

Notes (continued): 1.99 is the arithmetic average of the derived heating COP of current standard levels of all heat pump product classes, including centralized heat pumps, split systems, space-constrained heat pumps, and others (CFR 2023). There are 42.6 million US households with primary electric heating of any type, and over half of those—21.5 million—have an electric resistance furnace or zonal electric resistance heat as the primary heat source (EIA 2023a Table HC6.1). We assume that the share of electric resistance and of heat pumps is consistent across climate zones and derive a weighted average COP of electrically heated households of 1.33 (using COP of 1.0 for electric resistance and 1.99 for heat pump). This is found by taking the percentage of households with electric resistance divided by the COP of electric resistance, adding the percentage of households with heat pump divided by the COP of the heat pump, and then taking the reciprocal of the sum. This is the equivalent COP for the current technology mix of electrically heated households. Electrically heated homes use a total of 472 trillion BTU of site energy per year for space heating, which is 11.1 million BTU of site energy per year per household (EIA 2023a Table CE4.1). Since the equivalent average COP of these households is 1.33, electric resistance households use 1.33/1.0 times that amount, or 14.7 million BTU site energy per year (and heat pump households use 1.33/2 times that amount, or 7.4 million BTU). Thus, switching those households to heat pumps would save 7.3 million BTU per year of site energy. We convert site energy savings to FFC using 2.83 (DOE 2023). This results in saving 0.45 quadrillion BTU (quads) FFC per year, moving from electric resistance to heat pump, or 13 quads saved over 30 years. Since 64% of the electric resistance households are central furnaces (EIA 2023a Table CE4.1), and 36% are zonal, the energy savings scales with these percentages. Additional notes on FFC energy savings: 1) We only consider savings from the primary electric heating households, but there would also be energy savings from secondary heating systems, increasing savings. 2) We assume no product type substitution or fuel switching; these effects would reduce savings. 3) We also assume no increase in cooling energy associated with heat pump products that provide air conditioning in warm months. [b] Site quad energy savings are converted to GHG savings for all estimates using 0.39 kg CO_2 per kWh (EIA 2022). [c] Residential utility bill savings are calculated using $0.1236 per kWh (EIA 2023b).

Recommendations to Improve Appliance Standards Equity

Several opportunities exist to improve the equitable distribution of appliance standards benefits while realizing additional energy and GHG reductions. Considering distributional equity in the context of appliance standards aligns with President Biden's Executive Order 13985 (2021) on *Advancing Racial Equity and Supporting Underserved Communities Through the Federal Government*, which states, "the Federal Government should pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality." The DOE has adopted equity action plans to achieve this goal and launched the new Affordable Home EnergyShot™ to drive innovative clean energy solutions for affordable housing (DOE 2024b and 2023b). These recommendations align with these DOE efforts to drive more equitable energy investments in disadvantaged communities. We first discuss specific recommendations to increase distributional equity in standards for HVAC equipment and then offer opportunities for improving equity in appliance standards more broadly.

HVAC Standards Recommendations

To increase the distributional equity of HVAC standards, we recommend that *DOE adapt its rulemaking approach to group electric HVAC equipment by the consumer-provided service (zonal or central) rather than separating equipment by technology or form factor*. We have identified two alternative approaches that could reveal cost-effective energy savings and improve equity. We summarize the advantages and disadvantages of the current and our recommended alternative (better and best) approaches in Figure 2. Note that DOE will likely need to conduct a review of applicable law to confirm these approaches are possible.

Current. Products are siloed by form factor or technology rather than by end-use service.	
Advantages	Disadvantages
It is easy to compare similar HVAC form factors to one other (e.g., furnaces). It does not require DOE to change its rulemaking grouping and process.	Overlooks cost-effective opportunities to replace electric resistance with heat pump. Enables equipment with low initial cost and high energy costs to persist.
Better. Group electrical heating equipment into rulemakings based on heating service delivered (zonal or central).	
Advantages	Disadvantages
Enables DOE to compare the cost-effectiveness of electric zonal heating systems to one another[a] and electric central systems to one another.[b] Mimics to the way consumers compare electric heating solutions.	Requires resources to adjust DOE's approach to HVAC categorization. Test procedure work may be needed to enable comparison across electric technologies.
Best. Group zonal electric heating and air conditioning together in one rulemaking.	
Advantages	Disadvantages
Same as Better, plus DOE may identify further cost-effective savings in heating and cooling within one piece of equipment. DOE has already combined some electric heating and cooling equipment.[c]	Further resources are required to combine electric heating and cooling categories and test procedures.

Figure 2. Approaches to improve distributional equity of standards for electric HVAC equipment
Notes: [a] Electric resistance heating (or unvented direct heating equipment), window, wall, and mini-split systems [b] Central electric furnaces and central heat pumps. [c] DOE already groups centralized (ducted) heat pump and air conditioning products into one rulemaking. DOE also groups PTAC and PTHP into one rulemaking, and this could further include room ACs and mini splits.

We also recommend a corollary approach to testing HVAC products: *Develop or modify existing test procedures to address all electrical heating and cooling equipment with the same testing approach and metric of efficiency.* As discussed in the prior section, the range of tests and metrics developed by form factor instead of end-use service make it difficult for DOE, stakeholders, manufacturers, builders, and homeowners to compare the relative efficiency of equipment that performs the same function.

General Appliance Standards Recommendations

More broadly, we offer these recommendations to increase distributional equity for appliance standards:

- *DOE should broaden its technical support document (TSD) content to quantify the positive economic impacts of energy/cost savings in low-income communities.* DOE often considers possible negative impacts on low-income communities in its consumer subgroup analysis but does not currently consider the extra economic benefit of utility cost savings to low-income families, who are more likely to spend saved money immediately on goods and services, boosting the economic vitality of the local economy.

- *DOE should actively seek input from marginalized communities housed in multifamily and manufactured homes.* DOE spends significant time considering impacts on manufacturers by conducting interviews and quantifying negative impacts. DOE could take a similar interview approach to get input and insights from organizations representing marginalized communities' residents. DOE could further investigate how to better engage stakeholders from various backgrounds and community groups, utilizing key tenets of community engagement.[7] This differs from the current public comment approach, which is inaccessible to many people and organizations who have not been involved in past decisions or may need more resources to participate (Gonzalez 2019).
- *Policymakers and stakeholders should target research and standards development for appliances primarily used by low-income communities.* Our findings in this paper confirm that the inequitable distribution of cost-savings benefits is not limited to laundry equipment (as documented in our prior analysis) but also extends to HVAC. Marginalized communities may not realize the full cost-savings benefits of other equipment addressed by appliance standards. Comparing appliance standards outcomes of other equipment groups may yield specific additional distributional equity findings.
- *State-level policymakers should consider appliance standards equity.* Equity generally starts with the states. This discussion has focused on the US Appliance Standards Program, but many appliance standards adopted by the federal government start at the state level. Given this, distributional equity considerations can begin with state policy.
- *DOE, its consultants, and other appliance standards stakeholders should seek to hire a more diverse workforce.* For appliance standards research and policy to best serve all communities, the industry needs professionals from diverse races, genders, educational institutions, and geographic areas, among other dimensions of diversity.
- *DOE and other appliance standards stakeholders should examine structural equity to improve distributional equity.* Moving toward structural equity—i.e., when decision-makers recognize historical, cultural, and institutional dynamics that have led to clean energy inequities and seek to remedy those dynamics (Park 2014)—could lead to institutional awareness that reveals other distributional equity opportunities. Various legislation, analyses, and regulatory decisions that have led to inequitable housing and HVAC equipment policies discussed herein have been seemingly objective and rational. However, underlying structural inequity likely contributes to the inequitable distribution of cost savings benefits of both laundry equipment and HVAC standards. These attributes may contribute to distributional inequities for other appliance standards as well.

Conclusions

Considering the distributional equity of appliance standards policy for HVAC equipment revealed an inequitable program focus that overlooks equipment in manufactured homes and multifamily buildings. Families in these housing types are twice as likely to experience energy

[7] Organizations could include fair housing or manufactured home advocacy groups. One example is https://www.mhaction.org.

insecurity, and those who live in multifamily buildings are disproportionately families of color. Although standards for HVAC equipment more common in single-family homes equipment are in place and DOE has updated them more regularly, some HVAC equipment more common in multifamily dwellings does not even have minimum energy standards, and standards for some equipment in manufactured homes have never been updated. Quantifying missed opportunities in HVAC equipment efficiency revealed additional significant energy, GHG, and utility bill savings if inequities are addressed. Our recommendations offer a starting point for the US DOE, policymakers, and stakeholders to better incorporate and quantify distributional equity into appliance standards development, furthering a more equitable energy future.

In closing, psychologist and author Beverly Tatum (2017) referred to racism—and other forms of injustice—as a moving walkway at the airport. If the energy efficiency community stands on the walkway, it will move in the direction the walkway heads, enabling continued inequitable focus of appliance standards policy. DOE and other stakeholders must walk faster in the opposite direction of the walkway to counteract the system of inequity that disadvantages communities of color and low-income communities. This moving walkway is fast-moving and hard to fight against. Thus, the energy efficiency community *must* actively notice and work against existing systemic inequities – or else it adds to the speed of the walkway.

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