

Appliance Standards, Equity, and Climate Change – Issues and Opportunities

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ABSTRACT

Appliance standards deliver critical reductions in energy use, greenhouse gas emissions (GHGs), and utility bills. But are these important policy benefits distributed equitably among all segments of communities? This paper is a case study assessment of U.S. appliance standards for laundry equipment (clothes washers and dryers) through the lens of distributional equity. We demonstrate that an inconsistent application of test procedures that less effectively measure energy use and a lack of use pattern data for marginalized, low-income communities may both contribute to unjust policy outcomes. DOE's limited authority to address energy-using equipment may further inhibit an equitable distribution of cost-savings benefits to all. Together, the unintended consequence is a deprioritization of energy efficiency improvements for appliances used by marginalized, low-income communities that disproportionately include people of color. Furthermore, GHG counts may be inaccurate and savings opportunities overlooked. This paper will detail these assertions and make recommendations on future opportunities to increase equity while also realizing new GHG reductions.

Introduction

The U.S. Department of Energy (DOE) Appliance Standards Program is one of the largest energy-saving initiatives in the U.S., second only to its Corporate Average Fuel Economy (CAFE) standards program for vehicles (ASAP 2015). Data show substantial energy savings from the Appliance Standards Program over the years, which in turn reduce greenhouse gas (GHG) emissions and utility costs for households and businesses (deLaski and Mauer 2017). This program also supports energy equity by continuously raising baseline appliance efficiency (i.e., the lowest-cost equipment that is typically minimally compliant to DOE's energy standards). This is particularly important to low-income households that regularly purchase or use these lowest-cost models. Despite these important successes, DOE's standards development process is not immune to larger historic, cultural, and institutional dynamics that lead to inequitable distribution of benefits to communities. This paper explores this issue and analyzes specific inequitable program results.

To that end, we begin with a brief background on energy equity, then analyze laundry equipment (clothes washers and dryers) standards as a case study to examine distributional equity. We also summarize the energy and GHG savings opportunities of improving laundry equipment equity and offer recommendations for laundry equipment standards and appliance standards generally.

Energy Equity

Distributional energy equity is achieved when clean energy policies and programs fairly distribute the benefits and burdens of efficiency across all segments of communities (ACEEE 2021). However, multiple statistics illustrate that low-income households—which are disproportionately households of color (Creamer 2020)—are marginalized by the existing energy system:

- The American Council for an Energy Efficient Economy (ACEEE) finds low-income households carry a substantial energy cost burden, spending “three times more of their income on energy costs compared to non-low-income households (8.1% versus 2.3%)” (Drehobl 2020, iii).
- This energy cost burden disproportionately affects Black, Hispanic, and Native American households, which spend a higher percentage of income on utility bills than non-Hispanic white households (Drehobl 2020, 9).^{1,2}
- U.S. Energy Information Administration (EIA) 2015 Residential Energy Consumption Survey (RECS) found that one in three U.S. households (39 million) experience energy insecurity (i.e., the inability to meet household energy needs adequately). This includes 20 million non-Hispanic white households.
- Energy insecurity further disproportionately impacts people of color: One in four non-Hispanic white households are energy insecure, but nearly two-thirds of Native American/Alaskan Native households and half of Black and Hispanic households are energy insecure (Sen 2018, 39).

Many local programs exist to increase the energy efficiency of affordable housing to help reduce energy burden and energy insecurity, but opportunities for efficiency improvement remain (U.S. EPA 2018). This is particularly true for rural households, non-English speaking households, and other marginalized households with greater barriers to efficiency incentive program participation. Furthermore, while the building shell is important to energy use, lighting, appliances, and equipment also contribute to higher utility costs and energy insecurity of households within these marginalized communities. Achieving distributional equity in appliance standards could help address U.S. household energy insecurity. Equitable appliance standards policy that fairly distributes appliance first cost increases and energy cost reductions across all segments of communities can be one part of the solution to a more equitable energy system. Next, we consider the state of distributional equity in the context of appliance standards for laundry equipment, beginning with a background on vended laundries.

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 2020, 11-13).

² National studies reviewed for this paper do not address the average national energy cost burdens of Asian American households. However, local data suggest disproportionate energy burdens for Asian households may exist. Even though the average household Asian American income is greater than other minority groups and (nationally) it averages higher than non-Hispanic white households (U.S. Census 2021), the city of Oakland found that Asian households are not necessarily insulated from a disproportionate energy burden (2018, 97).

A Case Study: Laundry Equipment Standards

Who Uses Vended Laundries?

According to RECS, nearly one-fifth of U.S. households use a centralized laundry facility of some type to clean their family's clothing, bedding, and towels (U.S. EIA 2018). Low-income households—who are disproportionately people of color (Creamer 2020)—are much more likely to use vended commercial-grade washers and dryers in a centralized laundry facility for three primary reasons: The initial cost of in-dwelling (residential-grade) laundry equipment may be cost-prohibitive for these marginalized households, smaller low-income dwellings may not accommodate in-dwelling laundry equipment, and many multi-family buildings are designed with a central vended laundry space (particularly in urban areas).

Even with the pay-as-you-go option, these families still face barriers to affording clean laundry.³ In fact, by some estimates, using a laundromat over the long term may cost more than owning and operating in-dwelling laundry equipment (Hamm 2020). This issue affects families in both rural and urban areas. Urban families may have access to a centralized vended laundry facility within their multi-family development, but low-income families in rural areas are more likely to need to travel to a laundromat to clean their clothing, bedding, and towels, thus increasing the cost of laundry further.

Utility Costs and Efficiency Incentives in Laundromats and Multi-family Laundries

The perspectives of laundromat owners and the operational complexity of multi-family laundry facilities suggest the market for vended commercial-grade laundry equipment is unlikely to make a substantial shift toward efficiency on its own. These factors include:

- *Many laundromat owners are reluctant to upgrade to more efficient laundry equipment.* Laundromats typically operate as locally owned small businesses. Owners may not be familiar with energy savings opportunities associated with efficient laundry equipment or may have concerns that efficient equipment may have higher maintenance costs and may not deliver promised utility bill savings.⁴ Equipment manufacturers and industry associations report that many laundromat owners equate efficient equipment with higher cost, reduced customer satisfaction, and longer cycle times (AHAM et al. 2018).
- *“Route operators” create split incentives in multi-family laundries.* In multi-family developments, laundry equipment is often owned and maintained by third-party “route operators” that generally do not pay utilities but do collect some machine revenue. This outsourcing simplifies on-site property management duties but generally creates a split incentive for improving the efficiency of this leased laundry equipment. In some cases,

³ For more information, see <https://laundrylove.org>.

⁴ There is evidence that some laundromat owners do opt to upgrade to higher efficiency washers and dryers; approximately 10% of laundromats offer customers a fixed price to dry one load (CLA 2019, 28) to decouple drying time from revenue.

multi-family property owners may be paying more in utility costs than is earned through their contractual share of the vend price (Schaff and Shah 2017).

- *Utility incentive programs for laundromats are limited.* Utility incentive programs for centralized laundries focus on converting top-load washers to more efficient front-load and do not generally address clothes dryers (Schaff and Shah 2017, 18). This is partly due to the absence of a test procedure that fairly compares the energy use of commercial dryers and larger-sized commercial washers. Multi-family laundries are even more difficult to address with incentive programs because the laundry equipment is leased, and route operators are highly reluctant to install efficient equipment that is different from other multi-family sites, as it may increase maintenance complexity and cost.

However, utility cost is a substantial portion of laundromat operational cost. A 2019 Coin Laundry Association (CLA) survey reports that 60% of U.S. laundromat owners cite “high cost of utilities” as one of the biggest problems they face in their business, and 58% indicate that utility costs are 20% or more of their gross revenue (CLA 2019, 6, 21). These utility costs are ultimately passed along to laundromat customers in the vended price, and if utility costs are constant or lowered, vended laundry prices are less likely to increase over time. We can reasonably conclude that in the absence of increased adoption of energy efficiency programs or appliance standards policy, high utility costs of vended laundry are likely to continue to be passed on to the marginalized communities that most frequently use these facilities.

Clothes Washer and Dryer Appliance Standards

The U.S. Appliance Standards Program currently does not regulate the efficiency of commercial-grade clothes dryers. It only addresses these three types of laundry equipment: residential (in-dwelling) clothes washers, residential (in-dwelling) clothes dryers, and smaller commercial clothes washers, which include vended washers in multi-family laundries and laundromats and on-premises laundry (OPL) washers used in commercial facilities such as fire stations, hair salons, and spas. Key information about DOE-addressed laundry equipment includes:

- Residential and commercial washers are tested with the same Appendix J2 test procedure (CFR 2015). Machine energy, hot water energy, drying energy, and total water use are all included in the clothes washer test procedure.
- Residential and commercial washers utilize slightly different but comparable measures of efficiency. The value of residential clothes washer integrated modified energy factor—IMEF (cu ft/kWh/cycle)—is analogous to the commercial clothes washer J2 modified energy factor (MEF_{J2}).⁵

⁵ Commercial washers have a slightly different measure of energy efficiency given standby energy use is excluded. But, given that standby energy is a tiny fraction of overall residential washer energy use, residential and commercial clothes washer efficiency values can be fairly compared.

- Integrated water factor or IWF (gal/cycle/cu ft) is the current water efficiency measure for both residential and commercial washers.⁶
- Notably, top-load is the most sold washer type currently addressed by appliance standards, representing more than 70% of both residential and commercial sales (U.S. DOE 2021c, 9-11 and U.S. DOE 2014, 9-14).
- Residential dryers are tested using Appendix D1 or D2, and efficiency is quantified using the combined energy factor or CEF (lb/kWh) (CFR 2013a and 2013b).

Details of DOE's coverage and current efficiency requirements of these four classes of equipment are summarized in Table 1.

Table 1. U.S. DOE appliance standard coverage and levels for standard-sized laundry equipment

Equipment type			Capacity of covered equipment (cu ft)	Current mandatory standard levels	First standards effective date	User type
Residential (In-dwelling)	Washer	Top-load	Currently ≤ 6.0 , but proposed ≤ 8.0	1.57 IMEF 6.5 IWF	1988	Higher income, disproportionately non-Hispanic white
		Front-load		1.84 IMEF 4.7 IWF		
	Dryer	Electric	Not specified	3.73 CEF	1988	
		Gas		3.30 CEF		
Commercial (Vended and OPL)	Washer	Top-load	≤ 3.5	1.35 MEF _{J2} 8.8 IWF	2007	Vended: lower income, disproportionately people of color
		Front-load	≤ 4.0	2.00 MEF _{J2} 4.1 IWF		
	Dryer	Not included in appliance standards program				On-premises: employees

Cu ft = cubic feet, IMEF = integrated modified energy factor, IWF = integrated water factor, CEF = combined energy factor, MEF_{J2} = J2 modified energy factor, OPL = on-premises laundry. For IMEF and MEF_{J2}, a higher number is better; for IWF, a lower number is better. This comparison excludes consideration of in-dwelling compact washers (<1.6 cu ft) and dryers (<4.4 cu ft) because 1) they are sold in much fewer numbers than standard-sized equipment, 2) there is no compact commercial-grade equipment, and so efficiencies are not comparable, and 3) low-income households are highly unlikely to use in-dwelling compact equipment given the rationale discussed above. All-in-one in-dwelling washer dryers are also excluded for similar reasons. *Sources:* Capacity of covered equipment: CFR 2015, U.S. DOE 2021a, and CFR 2014; Mandatory standard levels: CFR 2022 and CFR 2016; First standards effective date: ASAP 2022.

⁶ Note that the U.S. DOE has proposed to revise energy and water metrics in its proposed Appendix J test procedure (U.S. DOE 2021a).

When we compare efficiency standards of in-dwelling and vended laundry, we observe key inequities:

- *The efficiency of in-dwelling clothes washers has been regulated for nearly 20 years longer.* In-dwelling clothes washer standards have been in place for 35 years, while standards for vended washers have only 15 years. This means families that can afford laundry equipment for their homes have benefited from cost-effective energy savings for longer than those using vended equipment.
- *In-dwelling top-load washer standards are more stringent.* The appliance standards program addresses all in-dwelling and vended models of top-load washers, the most popular style covered by current standards. However, top-load vended models are allowed to use more energy and water than in-dwelling equipment. Mandatory energy efficiency for vended washers is 14% less stringent than in-dwelling washers, and vended washer mandatory water efficiency is 35% less stringent than the requirement for in-dwelling washers. Shorter cycle times demanded by customers may justify some additional energy use for vended equipment; still, opportunities remain to reduce their energy use.
- *Many front-load vended clothes washers remain unregulated.* While the scope of the appliance standards program addresses all available models of top-load vended washers and all in-dwelling washers, the energy use of larger capacity front-load washers—common in laundromats and multi-family laundries—remains unaddressed. According to the CLA, approximately 60% of front-load washers in laundromats have baskets larger than 4.0 cu ft (2019, 24). These larger washers enable customers to clean bulky articles (e.g., bedspreads, blankets) and combine multiple small loads. So, even though standards for vended front-load washers are more stringent than comparable in-dwelling washers, significant energy savings (and vended laundry cost savings) opportunities remain.
- *Vended dryers have no efficiency standards at all.* While residential-size vended dryers may benefit from some product line design changes implemented to comply with standards for in-dwelling dryers, 85% of dryers in laundromats are larger than this (CLA 2019, 26) and are not influenced by any U.S. policy.

We can reasonably assume that these policy differences between in-dwelling and vended laundry equipment translate into lower average efficiencies for the latter, creating an inequitable distribution of cost-effective energy savings for cleaning laundry. In other words, marginalized communities ultimately pay higher laundry costs because they do not benefit from the more stringent standards for covered equipment.

Recent Actions to Update Laundry Equipment Standards

Over the last two years, DOE has considered updated standards for in-dwelling and vended washers, but the disparities in energy equity remain. Specifically, the appliance standards analysis effort for in-dwelling washers was significantly higher than for vended washers. Key observations include:

- *A new test procedure was considered for in-dwelling washers but ignored for vended washers.* In 2021, DOE conducted an extensive standards analysis of in-dwelling washers with its newly proposed test procedure, Appendix J (U.S. DOE 2021c), but retained its 2014 analysis of vended washers that employs the older Appendix J2 test procedure (U.S. DOE 2021b). DOE’s proposed Appendix J test procedure can be applied to both in-dwelling and vended washers and more effectively considers drying energy use, an essential aspect of improving vended washer efficiency (NEEA 2020, 3-5).
- *Technology to reduce drying energy was considered for in-dwelling washers (U.S. DOE 2021c) but not for vended washers.* In DOE’s analysis for vended washers, higher spin speed (which reduces drying energy) is explicitly excluded (2021b, 71850). However, this technology was previously included in DOE’s 2014 analysis (p. 4-4). There are several reasons why higher spin speed is highly likely to deliver cost-effective energy savings in vended washers (NEEA 2022, 3-5). Furthermore, higher spin speed technology was included in DOE’s analysis of in-dwelling washers (2021c).
- *Analysis of vended washers prioritizes the financial burdens placed on businesses over those placed on low-income families.* DOE does not consider the cost-savings benefits to low-income families. At the same time, it does consider impacts on disproportionately affected manufacturers (2021b, 71855) and manufacturer concerns about increased cycle time and reduced cleaning efficacy (2021b, 71849-71850). Vended washer energy cost reductions are particularly beneficial for low-income communities and communities of color, as monetary savings can be redirected to other important household needs—such as housing, food, and transport—where low-income families spend a higher proportion of their income as compared to middle- and high-income families (Seigel 2022).

Recent actions by the U.S. Appliance Standards Program demonstrate that fundamental inequities in appliance standards for in-dwelling and vended laundry equipment persist. At the time of this writing, DOE had tentatively concluded to consider updated standards for in-dwelling washers (2021c), but that updated standards for vended washers were not appropriate (2021b). Furthermore, while DOE analyzes standards options for in-dwelling dryers (2021d), energy use of vended clothes dryers continues to be unaddressed by U.S. policy. We posit that significant gaps in research for commercial laundry equipment may be largely to blame.

Lack of Data for Commercial Laundry Equipment (Vended and OPL)

Lack of commercial laundry equipment data contributes to the inequitable application of policy between in-dwelling and vended equipment. The U.S. EIA regularly administers RECS to quantify energy use patterns of in-dwelling clothes washers and dryers (2022a). While there are limitations to RECS methodology and opportunities for improvement (Ameren et al. 2022, 16-18), no regular federal study examines the energy use patterns of vended and OPL washers and dryers. In its last complete analysis of commercial washers, DOE calls available data for vended laundromats “sparse” and omits energy use of OPL installations entirely (2014, 7-5 to 7-6). More recently, DOE rejected a California study of OPL installation rates and duty cycles due to its regional (and not national) sample and continues to omit quantification of energy use and savings for businesses with OPL equipment in its analysis (U.S. DOE 2021b, 71853). In total, DOE’s failure to collect quality data inhibits its ability to quantify commercial laundry equipment

energy impacts and ultimately justifies lower analysis effort of commercial laundry equipment overall.

Technologies Available to Improve Efficiency of Commercial Laundry Equipment

Technology is not a key barrier to improving the efficiency of commercial washers and dryers. While a full technical discussion is outside the scope of this paper, key technologies available in the commercial market today can improve efficiency. Some examples include:

- *Increasing washer spin speed for both top- and front-load washers.* Increasing spin speed extracts more water from the textile load and therefore reduces drying energy counted in the clothes washer measure of efficiency (MEF₁₂). NEEA research indicates standard commercial washers generally do not spin as fast as their residential counterparts (2020, 4). Increasing spin speed does not necessarily lengthen washer cycle time and would shorten dryer cycle time.
- *Changing dryer airflow design.* All residential dryer drums are designed with axial airflow. Air comes in at the back of a non-perforated drum, mixes with the wet tumbling textiles, and then exits near the door of the dryer. This more efficient airflow design is sometimes not employed in commercial dryers. The lowest efficiency dryers utilize radial airflow (air blows from top to bottom) and a perforated drum, allowing the air to circumvent the textile load and waste heat (Foster Porter and Denkenberger 2016, 9).
- *Reducing standby energy use of washers and dryers (vended and OPL).* DOE does not currently consider standby energy for vended systems, but standby power is relatively high and can be cost-effectively reduced while retaining functionality (NEEA 2020, 5-6).

Other market-ready technologies available to improve commercial clothes washers include adaptive water fill, higher efficiency direct-drive motors, spray rinse, and thermostatically controlled mixing valves, among others (U.S. DOE 2014, 4-4). Market-ready technologies for clothes dryers include reclaiming motor heat, enabling drum reversal, modulating the burner and fan, and utilizing a heat exchanger (Foster Porter and Denkenberger 2016, 44 - 51). All of these technologies can be employed without increasing cycle time.

Impacts of Laundry Equipment Standards Inequity

Not only does the current laundry equipment policy create an inequitable utility bill cost savings for communities, but it also overlooks opportunities for reducing U.S. energy use, water use, and greenhouse gas (GHG) emissions. Table 2 compares quantifiable energy, GHG reductions, and utility bill savings not yet realized in U.S. policy to the DOE estimated max tech energy savings for in-dwelling clothes washers and dryers. (Max tech is the highest efficiency standards level DOE considers for standards adoption, and for laundry equipment, it is equivalent to the most efficient in-market technology.) Reductions in machine energy, hot water energy, and drying energy are included in clothes washer savings shown in Table 2; however, water reductions are not included for comparison because they are not quantified in available sources addressing commercial laundry equipment.

Table 2. Summary of energy, GHG, and energy bill reductions for max tech levels of in-dwelling laundry equipment in comparison to reductions available from vended and OPL equipment

Equipment Type		Covered by U.S. Appliance Standards?	30-year site energy savings (quads)	30-year GHG savings (MMT of CO ₂ e) ^a	30-year energy savings (Billions US\$) ^b	Source for 30-year site energy savings
Residential (In-Dwelling)	Washers	Yes	1.3	104	32	U.S. DOE 2021c, 10-12
	Dryers	Yes	2.6	263	90	U.S. DOE 2021d, 10-13
Commercial (Vended and OPL)	Washers (small)	Yes	0.04	2.2	0.4	U.S. DOE 2021b, 71856
	Washers 4 to 8 cu ft	No	0.3	17	2.9	NEEA 2020, 20-22
	Dryers < 65 cu ft	No	3.4 ^c	199	38	Foster Porter and Denkenberger 2016, 55

Quads = quadrillion British thermal unit (BTU), GHG = greenhouse gas emissions, MMT of CO₂e = million metric tons of carbon dioxide equivalent, cu ft = cubic feet, OPL = on-premises laundry. Commercial “small” washers are ≤ 3.5 cu ft top-load and ≤ 4.0 cu ft front-load. 30-year site energy savings for residential washers and dryers are for max tech (highest) levels analyzed by DOE. ^a Site quad energy savings are converted to GHG savings for all estimates using 5.3 kg CO₂ per therm (U.S. EPA 2022) and 0.39 kg CO₂ per kWh (U.S. EIA 2022e). ^b Residential utility bill savings are calculated using \$1.24 per therm (U.S. EIA 2021) and \$0.1375 per kWh (U.S. EIA 2022d). Commercial utility bill savings are calculated using the average share of site fuel use of laundromats: 96% natural gas and 4% electricity (U.S. DOE 2014) and 2021 average commercial energy prices of \$0.88 per therm and \$0.1127 per kWh (U.S. EIA 2021 and 2022c). No discount rate is applied. ^c Commercial dryer savings assume the 50% reduction in total energy use scenario given in Table 7.2 (Foster Porter and Denkenberger 2016, 55) for total stock turnover and is scaled by the population ratios of California to the U.S. using a no-growth assumption.

Table 2 calculations demonstrate that expanding standards coverage to all commercial laundry equipment could yield substantial national energy savings of more than 3 quads. U.S. appliance standards for commercial laundry equipment only consider the energy use of small commercial washers. However, the estimated energy, GHG, and utility bill savings of expanding coverage to include 4.0 to 8.0 cu ft clothes washers and commercial dryers are more than 85 times larger than the energy savings of (small) commercial washers currently subject to U.S. standards. Furthermore, energy savings from commercial dryers (3.4 quads) are similar in magnitude to DOE’s estimates of residential laundry equipment max tech savings opportunities (1.3 quads for washers and 2.6 quads for dryers).

Clearly, these inequities in standards coverage mean substantial U.S. energy savings are overlooked, but there are also missed opportunities to reduce the financial energy burden for centralized laundry users. Furthermore, because no U.S. test procedure measures the energy use of commercial clothes dryers, utility incentive programs cannot easily address the energy use of commercial dryers either. This leaves U.S. commercial dryer energy use completely unchecked.

Recommendations to Improve Appliance Standards Equity

There are several opportunities 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 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" (Executive Order 13985). To achieve this goal, the DOE should target appliances primarily used by low-income communities for research and standards development. The following recommendations also align with other DOE efforts to drive more equitable energy investments in disadvantaged communities (U.S. DOE 2022). We first discuss specific recommendations to increase distributional equity in laundry equipment and then offer opportunities for improving equity in appliance standards more broadly.

Laundry Equipment Appliance Standards Recommendations

Multiple opportunities exist to increase laundry equipment standards distributional equity. First, we recommend that DOE:

- *Conduct a more thorough analysis of commercial clothes washer standards to identify cost-effective energy savings for vended laundry.* DOE recently proposed not to update efficiency standards for vended laundry (2021b), but the analysis effort was relatively low compared to in-dwelling equipment (U.S. DOE 2021c). DOE has an opportunity to revise that determination, updating its analysis of commercial clothes washers to utilize the newly proposed Appendix J test procedure and consider higher spin speeds.
- *Invest in studies to better quantify installations and use patterns of vended and OPL laundry equipment.* These studies will enable more accurate energy use and savings estimates for commercial washers, leading to more effective policy development.

Second, we encourage:

- *Federal legislators to enlarge the scope of commercial clothes washers to include washers greater than 3.5 cu ft for top-load and greater than 4.0 cu ft for front-load.* The Energy Policy and Conservation Act (EPCA) limits the coverage of commercial washers to the smallest sizes (U.S. DOE 2021b), but larger washers are commonly used in laundromats. Proposed test procedure updates enable them to be tested (US. DOE 2021a).
- *Federal legislators to direct DOE to consider laundry equipment test procedures that simultaneously measure energy use, cleaning performance, and cycle time.* Simultaneously measuring efficiency and consumer-valued performance metrics could help address industry concerns about customer satisfaction and more efficient equipment cycle time. Laundry equipment test procedures that include performance measures are commonly used in Europe and other key markets (e.g., IEC 60456 and IEC 61121).

- *Federal or state policymakers to develop a mandatory standard for vented and OPL commercial dryers.* No standards currently exist for commercial dryers, and significant savings opportunities remain given the limited adoption of high-efficiency technology in current models (Foster Porter and Denkenberger 2016, 44-52). California has already developed a draft test method for commercial dryers (Foster Porter et al. 2017), and the International Electrotechnical Commission (IEC) is developing a one as well (IEC 2017).

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 U.S. economic vitality.
- *Policymakers and stakeholders should target research and standards development for appliances primarily used by low-income communities.* Inequitable distribution of cost-savings benefits is unlikely to be limited to laundry equipment alone. Marginalized communities may not realize the full cost-savings benefits of other equipment categories addressed by appliance standards. For example, space heating and cooling equipment form factors may differ based on income and housing type. Direct heating equipment and room air conditioners may be more likely in small multi-family apartments or dwellings with lower construction costs. Residential boilers, furnaces, central air conditioners, and heat pumps may be installed more often in single family dwellings. Comparing the efficiency levels within this group of equipment (and other groups) may yield specific additional distributional equity findings.
- *State-level policymakers should consider appliance standards equity.* Equity starts with the states. This discussion has focused on the U.S. 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 hire a more diverse appliance standards workforce.* Studies have shown that a lack of diversity amongst researchers affects investigation questions and outcomes (Blei 2020, 60). Women, Black, and Hispanic workers are more poorly represented in clean energy than they are across the rest of the economy (E2 et al. 2021, 3). For appliance standards research and policy to best serve the diverse communities within the U.S., we must become an industry with professionals from a diversity of races, genders, educational institutions, geographic areas, amongst several other dimensions of diversity.
- *DOE and other appliance standards stakeholders should examine and improve 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 (ACEEE 2021)—could lead to institutional awareness that reveals other distributional equity opportunities. Various legislation, analyses, and regulatory decisions that have led to inequitable laundry 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 laundry equipment appliance standards and may be contributing to other appliance standards distributional inequities as well.

Conclusion

Considering distributional equity of appliance standards policy specifically for laundry equipment revealed an inequitable distribution of cost-saving benefits to communities. Although policy for in-dwelling laundry equipment is comprehensive and relatively stringent, policy for vended laundry equipment—used more often by marginalized communities—is less comprehensive in scope and generally less stringent for most of the equipment covered. Quantifying missed opportunities in vended laundry equipment efficiency revealed additional significant energy, GHG, and utility bill savings if inequities are addressed. Our recommendations offer a starting point for the U.S. DOE, policymakers, and stakeholders to better incorporate and quantify distributional equity into the appliance standards development process, furthering movement toward a more equitable energy future.

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