EFFICIENCY OPPORTUNITIES IN MULTIFAMILY COMMON AREA LAUNDRY FACILITIES

PREPARED BY STEWARDS OF AFFORDABLE HOUSING FOR THE FUTURE
FOR THE NATURAL RESOURCES DEFENSE COUNCIL

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Background and Purpose of the Study

Laundry facilities are an area where four utilities meet - electric, gas, water, and wastewater. This unique nexus makes laundry facilities a particularly interesting intervention point for energy and water efficiency. While the residential clothes washer market has evolved over the years, multifamily affordable buildings are an untapped conservation opportunity as they often lease commercial washers for placement in common area laundry rooms.

The Natural Resources Defense Council (NRDC) and Stewards of Affordable Housing for the Future (SAHF) are collaborating in support of the Energy Efficiency for All (EEFA) initiative to study the existing multifamily laundry landscape and provide facts related to common-area laundry facilities in twelve states that are the focus areas for the EEFA initiative: California, Georgia, Illinois, Louisiana, Maryland, Michigan, Minnesota, Missouri, New York, Pennsylvania, Rhode Island, and Virginia. The study also includes recommendations to utilities on how to incentivize water savings.

Study Overview

In the first section, the study provides an introduction to how laundry is managed in multifamily laundry facilities and the types of machines commonly used. This information was compiled through a literature review as well as interview surveys with owners of multifamily portfolios and with "route operators" - firms that provide leased laundry equipment to multifamily housing. In the second section, using the information and the stocks of multifamily housing in the twelve EEFA states, the study provides an estimate of the scale of the addressable market and the energy, water, and cost savings potential from three different upgrade scenarios.

In the third section, the study estimates the cost effectiveness of switching to more efficient laundry machines, using both the owner and the route operator perspective to identify mutually beneficial leasing arrangements. These findings may also be instructive for electric, gas, and water utilities interested in increased efficiency. In the fourth section, the study outlines different models of utility incentives for laundry equipment that could help spur action toward greater efficiency in multifamily laundry.

Multifamily Laundry Landscape

Multifamily properties are served by a range of laundry configurations. Common area laundry facilities are the most prevalent. Based on the prevalence of multifamily commercial machines and stocks multifamily housing, we estimate that 68% of the multifamily market is served by common area laundry facilities. Discussions with property owners and route operators revealed that there is a trend toward more properties having in-unit washers and dryers. This trend is more pronounced in market-rate properties rather than among affordable housing. This study focuses on common area laundry facilities both because it is the more common configuration and because it is where owners invariably pay for the utilities, and so have the highest incentive and ability to adopt greater efficiency levels.

Multifamily Laundry Equipment

The Multifamily Laundry Association in 2002 stated that about 3.5 million clothes washer units are used in laundry rooms in multifamily housing, on college campuses, or at independent, do-it-yourself laundromats (Multifamily Laundry Association, 2002). Multifamily common area laundry rooms are typically served by commercial clothes washers known as "family size" washers, which are made to withstand more frequent use. From our surveys we found that properties typically have one washer and dryer per 10 apartment units. Top-loading machines more prevalent in existing buildings, but there is increasing demand for Energy Star rated, high efficiency front-loading machines as owners pursue green certifications such as Enterprise Green Communities, LEED, or Energy Star. Across commercial clothes washers, Energy Star machines have achieved a 40% penetration rate (EPA Energy Star, 2016). The rate for Energy Star multifamily commercial machines may be higher or lower. We found through our survey that owners typically did not know what portion of their portfolio was served by Energy Star washers.

Although commercial washers represents just 3% of the total number of installed clothes washers in the U.S., they account for nearly 10% of U.S. clothes washer energy and water consumption because they are used three times more frequently (EPA Energy Star, 2008). Their higher use levels also mean that commercial machines wear out faster than residential machines and are replaced more frequently, giving more opportunities to upgrade to more efficient models.

The Energy Star program for clothes washers and dryers is a voluntary labeling program backed by the U.S. Environmental Protection Agency (EPA) and DOE which identifies energy efficient equipment through a qualification process. Energy Star washers and dryers must exceed federal minimum standards by a specified amount and exhibit select energy saving features. The other efficiency standard for laundry is run by The Consortium for Energy Efficiency (CEE). CEE standards typically are more stringent than Energy Star; however, they currently are being updated and of the CEE standards in effect today, only Tier 3 exceeds Energy Star.

In recent years, with technological advancement and better controls, manufacturers have developed efficient washer and dryer models that meet strict energy efficiency guidelines set by the U.S. Environmental Protection Agency (EPA) and The U.S. Department of Energy (DOE). This can translate into significant energy and water savings for laundry rooms. Two key metrics for evaluating the efficiency of a particular machine are its Modified Energy Factor (MEF) and its Water Factor (WF).

The MEF is a combination of Energy Factor and Remaining Moisture Content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency. The WF is the number of gallons of water needed for cold wash/cold rinse for each cubic foot of laundry tub capacity. A lower number indicates lower consumption and more efficient use of water.

In the March 2014 Notice of Proposed Rulemaking, DOE amended water efficiency standards based on Integrated Water Factors (IWF). IWF is calculated as the weighted per-cycle water consumption for all wash cycles, expressed in gallons per cycle, divided by the laundry tub capacity in cubic feet. DOE believes that the IWF metric provides a more representative measure of water consumption than the WF metric, which is based on the water consumption of only the cold wash/cold rinse temperature cycle.

Figure 1 below outlines minimum efficiency standards for commercial clothes washers and their related MEFs and WFs (DOE, 2015) (CEE, Super Efficient Home Appliances Initiative, 2011).

Level	Modified Energy Factor (MEF)	Water Factor (WF)
Federal Standard (In-effect)		
Top- Loading	≥ 1.6	≤ 8.5
Front-Loading	≥ 2.0	≤ 5.5
Energy Star® (v. 5.1 -- Before 2013)	≥ 2.00	≤ 6.0
Federal Standard (New, In-effect Jan 2018)		
Top- Loading	≥ 1.35[1]	≤ 8.4 (IWF ≤ 8.8)
Front-Loading	≥ 2.0	≤ 4.0 (IWF ≤ 4.1)
Energy Star® (v. 7.1 -- In-effect)	≥ 2.2	≤ 4.5
CEE Tier 1 (In-effect)	≥ 2.00	≤ 6.0
CEE Tier 2 (In-effect)	≥ 2.20	≤ 4.5
CEE Tier 3 (In-effect)	≥ 2.40	≤ 4.0

Figure 1: Current and New Energy and Water Efficiency Standards for Commercial Clothes Washers

The varying standards for front-loading and top-loading washers reflect the finding from DOE studies and field demonstrations that front-loaders perform better than top-loaders and can achieve higher efficiency levels.

Laundry Management Practices

Most appliances (i.e., energy and water consuming equipment) in a multifamily property are owned by either the property owner or the residents, but laundry equipment is an exception. Across the U.S., between 50% and 90% of multifamily housing facilities lease laundry equipment from a third party known as a "route operator" instead of buying equipment directly from a distributor (DOE, Chapter 3, 2014). The results of our survey of property owners indicate that 73% of properties have leased common area laundry facilities, with an additional 7% owning their common area equipment, and 20% offering in-unit laundry.

[1] The nominally lower standard for 2018 is the result of a change in the test metrics adopted by DOE. DOE adopted 2018 efficiency levels based on the MEF_{J2} and IWF metrics as measured using appendix J2 of the test procedure. Since current equipment ratings are based on appendix J1 metrics, DOE performed testing on a representative sample of CCW models to determine the equivalent appendix J2 efficiency levels corresponding to each appendix J1 efficiency level. Chapter 5 of the final rule Technical Support Document describes the methodology DOE used to perform the translations between appendix J1 MEF/WF values and appendix J2 MEF_{J2}/IWF values.

This role of property owners and route operators is only a part of larger set of actors from laundry manufacturer to utility provider, illustrated in Figure 2 below, that ultimately determines the energy and water consumption of family-sized commercial washers in commercial laundries.

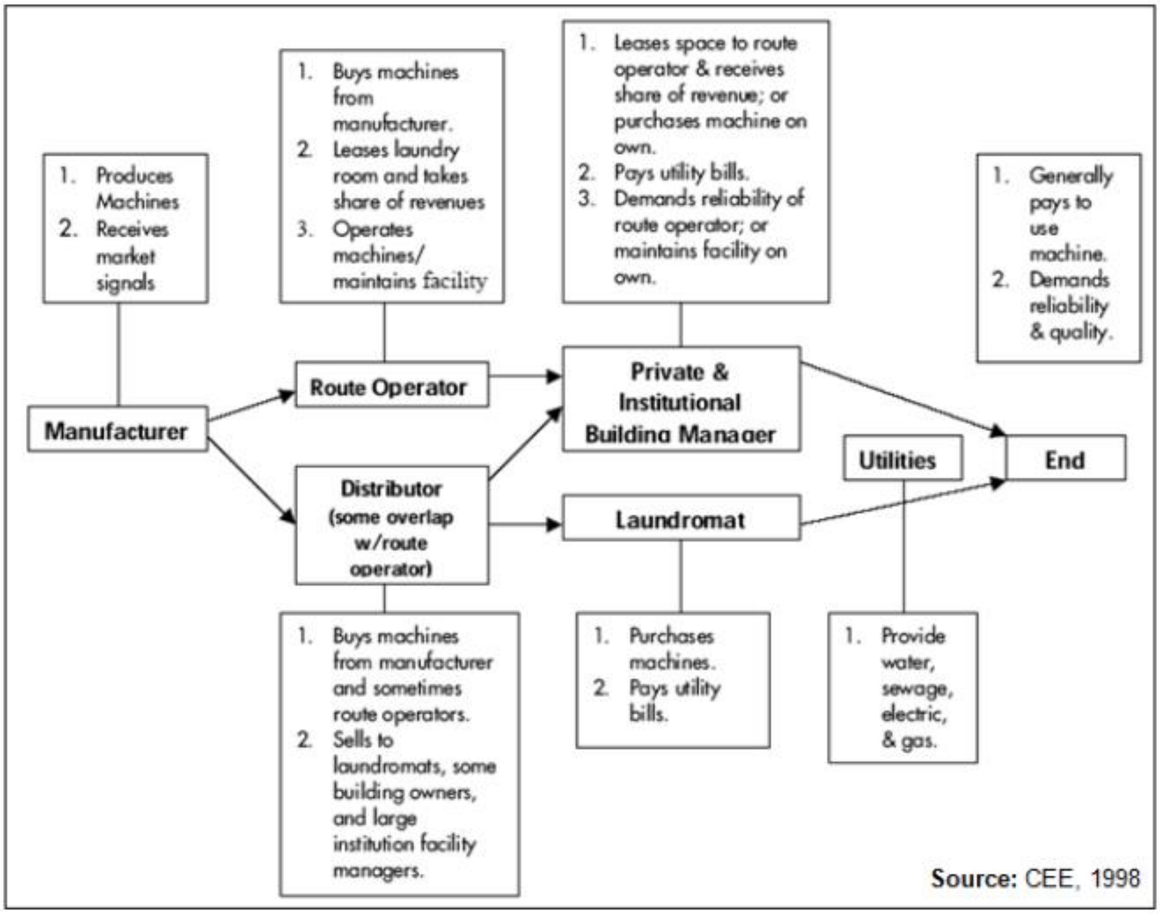

Figure 2: Distribution Channel for Commercial Clothes Washers (CEE,1998).

In a typical arrangement the route operators enter into contracts with owners, install their laundry equipment in the owners' designated common area laundry rooms, and residents use the equipment. The machines are typically coin operated, which might also contribute to lower usage per household as compared to in-unit machines. Route operators are responsible for maintaining the machines and typically collect and share the laundry revenues with the property owner. The property owner is responsible for maintaining the basic cleanliness of the laundry facilities, contacting the route operator when issues arise, and importantly, paying for all of the utilities.

Previously, many local small companies were prevalent in the route operator business, but there has been a trend toward consolidation. We found the business is now dominated by four main providers: CSC Service Works, MacGray, CoinMach and WASH. We interviewed representatives from WASH and CSC Service Works as well as five property owner representatives to understand the key influencing factors that lead to energy and water efficiency.

Contracts between properties and route operators govern the relationship, and our surveys along with review of four contracts gave us insights into typical terms. A typical contract length is 5 to 7 years, although we found cases of contracts as short as one year and as long as 11 years. Route operators reported that the laundry rooms typically have 4 to 5 year paybacks (i.e., periods over which revenue approximately equals the total cost of the equipment) to the route operator at common contract prices and terms, with a seven year term leaving it at least another few years to make additional revenue.

Contracts also lay out how the revenue from the facility will be split between the owner and the route operator. We found that owner shares ranged from 50% to 95% with owner shares most typically at 50% to 60%. The contracts we saw that included higher owner shares also included monthly payments from the owner to the route operator. However, all parties reported that each deal is negotiated individually based on the regional market, size of the laundry room, and the size of the business.

Another term laid out in the contracts is the vend price (i.e., the coin or card price paid by machine user), which is based on the local market. Route operators conduct the market analysis and suggest a vend price to the owner, and the vend price is charged via a coin box or a card reader. The prices are set per washing and drying cycle and in the case of card readers can be based on low, medium, or heavy wash cycles. Contracts allow for the vend prices to change during the course of the contract, but only if both parties agree to the new price.

We found that laundry facilities typically are not sub-metered for electric, gas, or water use within the building, which means that owners do not know the utility costs associated with laundry. Thus they do not know whether their share of the revenue is covering their utility costs. Submetering laundry facilities would have multiple benefits for owners – from helping to set appropriate vend prices over time to informing choices about new equipment to catching equipment problems that can lead to utility cost spikes.

A key question we seek to inform is the owner's interests in replacing of old clothes washers with newer, more energy and water efficient models. The time of contract renewal is the best time to get the most efficient equipment possible, as that is when the owners have the most leverage. Interviews with owners indicate that many are taking advantage of this opportunity to upgrade their equipment. Owners typically do not track the portfolio level of the prevalence of Energy Star certified machines in their stock, but a majority (66%) reported that they had a policy in place calling for Energy Star machines to be provided in all new contracts. While contracts for newly built or acquired properties likely are covered by these policies, it is unclear the extent to which contract renewals are treated as new contracts.

Addressable Market in the Twelve EEFA States

The scale of the potential energy savings from upgrading common area clothes washers to more efficient machines is about the prevalence of multifamily properties with common area laundry facilities. To estimate the addressable market in the twelve states under consideration, our starting point was the multifamily share of the national family size commercial clothes washer stock of 1,971,000 machines per the 2015 DOE commercial clothes washer rule (DOE, Chapter 10, 2014). We allocated the total clothes washers to the states under consideration according to each state's share of multifamily units in buildings of 10 units or greater per the 2010-2014 Census data in the American Community Survey. The estimated commercial clothes washer stock for the twelve states under consideration is listed in Figure 3:

State	Multifamily Clothes Washer Stock
California	214,937
Georgia	42,693
Illinois	73,762
Louisiana	13,925
Maryland	35,356
Michigan	39,447
Minnesota	27,952
Missouri	21,782
New York	181,261
Pennsylvania	44,224
Rhode Island	5,202
Virginia	40,299

Figure 3: Multifamily Clothes Washer Stock in EEFA States in 2015

Surveys of multifamily owners indicate that within common area laundry facilities, approximately 91% of these use leased equipment, with the remaining 9% purchased and directly managed by the property owner. The different ownership/management configurations call for different approaches to upgrading the equipment, but both leased and owned equipment is considered part of the addressable market in this study. The stocks can be further differentiated between top-loading and front-loading laundry machines. In Figure 4 below we show the estimated share of top-loading and front-loading commercial clothes washers by state using national-level market shares of 73% for top-loading and 27% for front-loading machines (DOE, 2015).

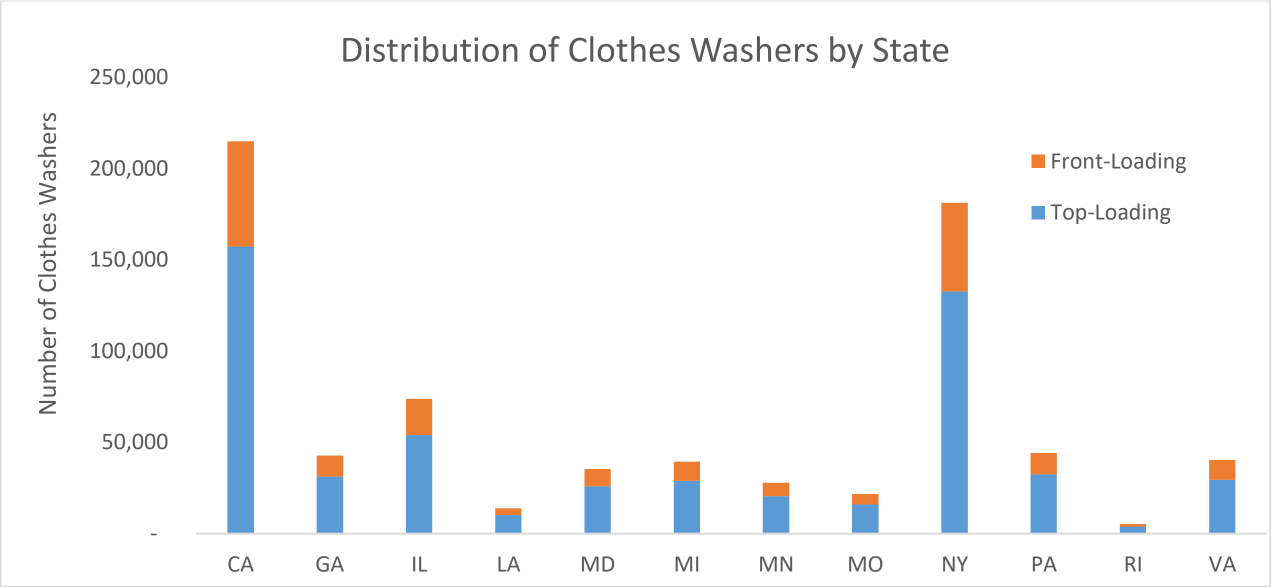

Figure 4: Distribution of Commercial Clothes Washers by State Stock in EEFA States

Savings Potential

The stock of the commercial clothes washers in each state helps determine the scale of the energy and water savings potential that could be realized from upgrading to more efficient machines. Another key factor is the baseline level of efficiency of the equipment currently serving the multifamily common area laundry rooms. To estimate the baseline level of efficiency, we extrapolated from 2013 data on the market shares of commercial equipment at different efficiency levels for both top-loading and front-loading machines (DOE, Chapter 3, 2014). Since each machine has an expected useful life of 11 years (Zogg, 2009), we extrapolated to market shares for the eleven year period spanning 2005 through 2016. This led us to the conclusion that the average top-loading machine in 2016 has a Modified Energy Factor (MEF) of 1.37 and a Water Factor (WF) of 9.2 and that the average front-loading machine in 2016 has an MEF of 2.0 and a WF of 5.8. The market share values and estimates used to generate these figures are laid out in Appendix A. (Note: with MEFs, higher numbers indicate greater efficiency, whereas with WFs, lower factors indicate greater efficiency.) Department of Energy annual consumption numbers based on average usages for the baseline top-loading machines (DOE, Chapter 10, 2014) and consumption numbers calculated using the MEF formula for the baseline front-loading machines are listed in Figure 5 below.

Baseline Stock	Electric (kWh/yr)	Natural Gas (MMBtu/yr)	Water (1000 gallons/yr)
2016 Top-Loading CCW	995	5.43	32.6
2016 Front-Loading CCW	640	3.49	19.3

Figure 5: 2016 Annual Baseline Usage of Commercial Clothes Washers

For top-loading machines, there are some efficiency gains to be had by switching to new top-loading machines. However, there are significant gains to be had by switching from top-loading to front-loading machines. There also is a wider range of efficiency levels available among front-loading machines. We considered two upgrade options based on the efficiency levels most prevalent in the EPA database of Energy Star certified commercial clothes washers – one with an MEF of 2.5 and a WF of 3.8 (37% of the Energy Star market, which we will refer to as "efficient front-loaders"), and a second upgrade option with an MEF of 2.98 and a WF of 3.9 (40% of the Energy Star market, which we will refer to as "highly efficient front-loaders").

Using the baseline efficiencies and upgrade options described above, we explored the energy and water savings potential under three scenarios:

- **Scenario 1**: Existing Top-loading machines are replaced with efficient front-loaders
- **Scenario 2**: Existing Top-loading machines are replaced with highly efficient front-loaders
- **Scenario 3**: Existing Front-loading machines are replaced with highly efficient front-loaders

The annual per machine energy and water consumption values associated with the two upgrade options was calculated assuming a capacity of 3.3 cubic feet for efficient front-loaders and 3.4 cubic feet for highly efficient front-loaders and using the formulae for MEF and WF. These values and are listed in Figure 6 below.

	Electric (kWh/yr)	Natural Gas (MMBtu/yr)	Water (1000 gallons/yr)
Efficient Front-Loaders (2.5/3.8)	545	2.97	13.8
Highly Efficient Front-Loaders (2.98/3.9)	471	2.57	13.9

Figure 6: Annual Usage for Commercial Clothes Washer Upgrade Options

Each of the scenarios represents an opportunity to reduce both energy and water consumption, at varying levels. Figure 7 below lays out the savings potential for each scenario.

	Energy	Water
Scenario 1	45%	58%
Scenario 2	53%	57%
Scenario 3	26%	28%

Figure 7: Energy and Water Savings for Each Efficiency Scenarios

At the state level, the total energy saving potential under each of these scenarios depends on the state's CCW stock. When considering the level of cost savings available to owners as a result of these efficiency gains, the cost savings also depends on local utility rates. Our analysis factors in a state-level average cost for electricity, natural gas, and water, and the results of the analysis are included in the figures below.

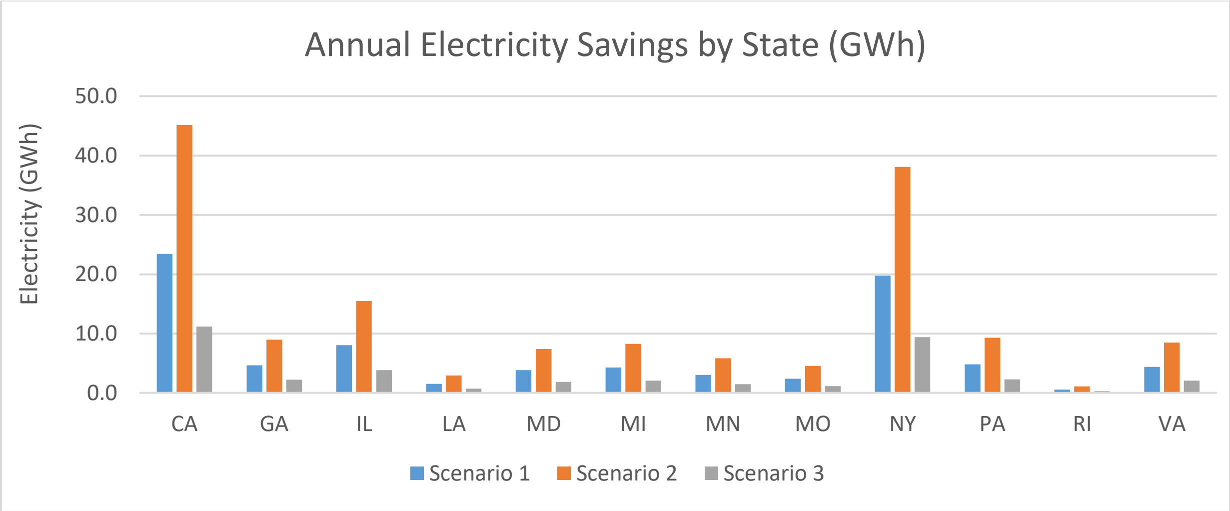

Figure 8: Annual Electricity Savings by State for Each Scenario

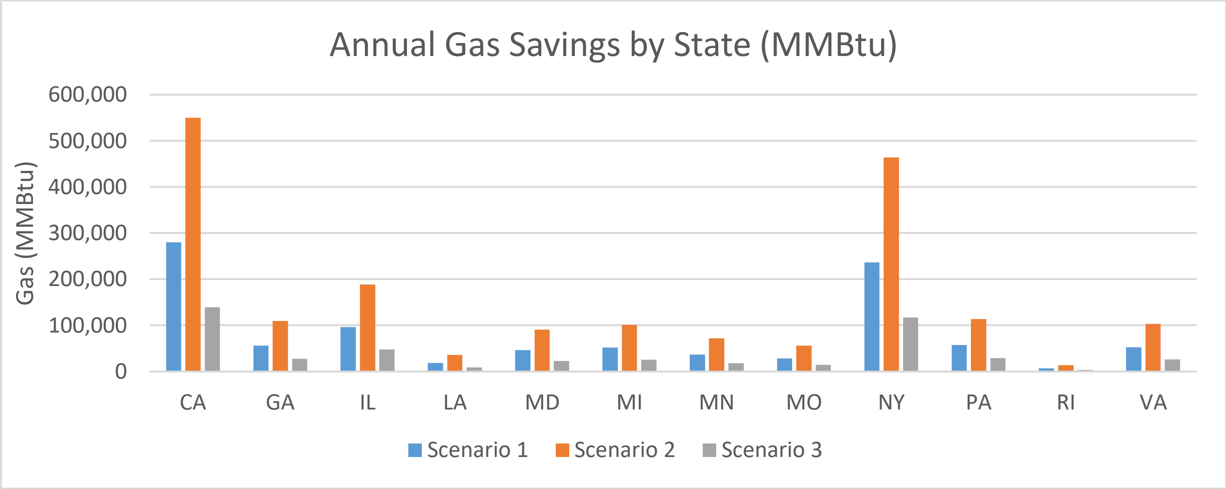

Figure 9: Annual Gas Savings by State for Each Scenario

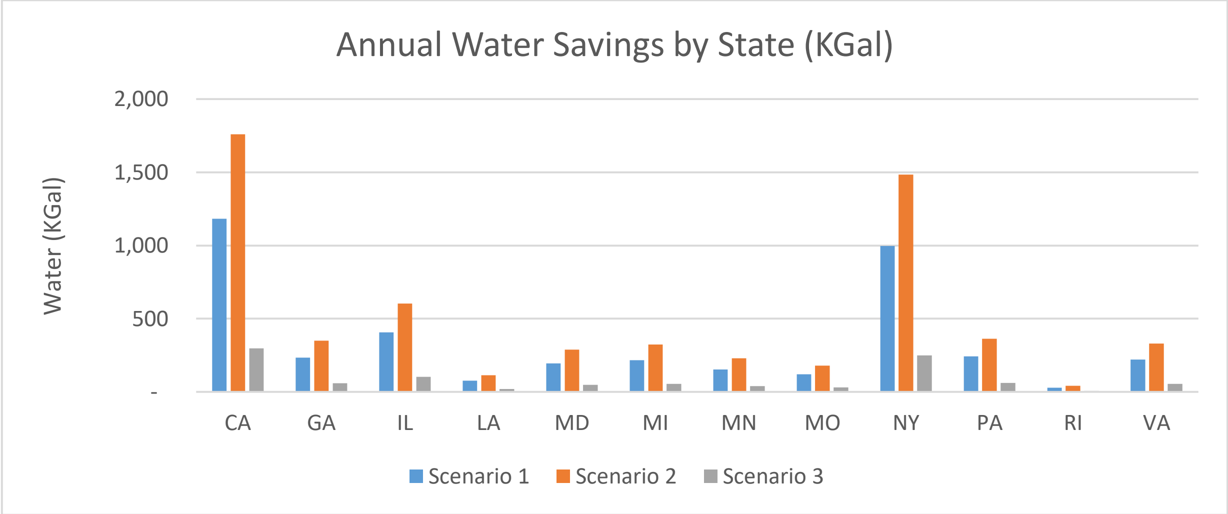

Figure 10: Annual Water Savings by State for Each Scenario

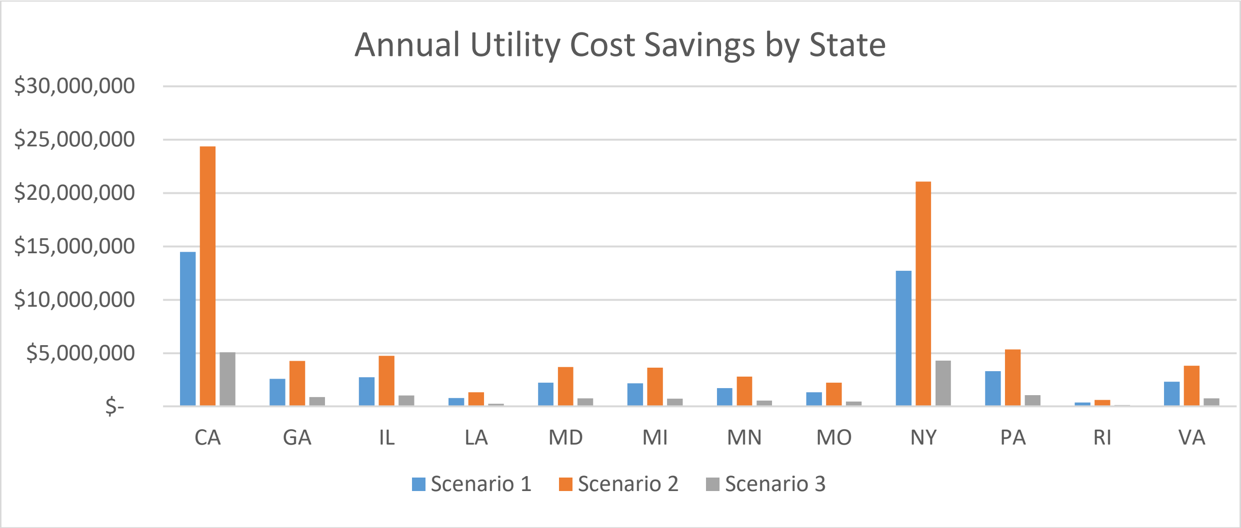

Figure 11: Annual Cost Savings by State for Each Scenario

As would be expected, the higher efficiency gains come from replacing top-loading machines, with the greater efficiency gains in scenario 2, where the machines are replaced with the more highly efficient front loaders.

Cost Effectiveness

Traditional measures of cost effectiveness such as payback or return on investment are not as straightforward in the laundry leasing scenario, where one party (the route operator) faces the upfront cost and a separate party (the property owner) benefits from the utility savings. In this case, the mechanism for adjusting the balance of the incentives and ensuring that both parties realize both costs and benefits is an adjustment to the contract terms. Discussion with leasing companies affirmed that they understand owners' interest in more efficient equipment and are prepared to offer more efficient equipment if they can recoup their upfront cost through an increased share of the laundry revenue or other payments.

Another option would be for owners to take on the purchasing and maintenance of the machines directly, in which case they would realize the full amount of the revenues, have greater control over their purchasing options, and could benefit from the tax depreciation of the asset.

We tested the cost effectiveness of the three scenarios outlined above considering the primary costs and benefits to each of the parties as mediated through an expected change in the leasing agreement that gives the route operator a greater share of the revenue in exchange for providing higher efficiency machines. The costs and benefits to each party are outlined in Figure 12 below:

Party	Costs	Benefits
Owner	Decreased share of revenue or larger periodic payments	Decreased utility spending
Route operator	Increased upfront equipment cost	Increased share of revenue

Figure 12: Cost and Benefits for Each Party in Multifamily Buildings

The cost benefit analysis applies certain values for the owner's decreased utility spending and the route operator's increased upfront equipment cost, using the assumption that laundry leases have a seven-year term. The analysis identifies whether there is potential for a win-win adjustment to revenue split in the twelve states under consideration and if so, the amount of savings expected.

The values used for owner utility savings numbers follow the pattern for the state level energy and water savings potential laid out above. Energy and water consumption savings are calculated using the values associated with the baseline and upgrade MEF and WFs noted above. The year one cost savings associated with the consumption savings are based on state level average prices for electricity, natural gas, and water. The cost benefit analysis assumes an energy cost escalation rate of 1% annually. The 1% figure for electricity and gas conforms to the figure used in the EEFA study on the potential for energy savings in affordable multifamily housing (Mosenthal & Matt, 2015). On the water side, the analysis uses a rate of 6% annually (American Water Works Association and Raftelis Financial Consultants, Inc., 2014).

The variations in the levels of savings available to the owner vary between states based on the different utility rates used and vary between scenarios based the different levels of efficiency achieved in each scenario. Figure 13 below shows the average (i.e., year 4) annual savings in each state for each of the three scenarios.

State	Scenario 1	Scenario 2	Scenario 3
California	$264	$279	$16
Georgia	$137	$147	$10
Illinois	$223	$232	$9
Louisiana	$239	$251	$12
Maryland	$213	$224	$11
Michigan	$240	$250	$10
Minnesota	$236	$247	$11
Missouri	$279	$293	$14
New York	$290	$301	$10
Pennsylvania	$261	$276	$15
Rhode Island	$221	$230	$9
Virginia	$233	$243	$11
Average	**$236**	**$248**	**$12**

Figure 13: Average Annual Utility Cost Savings per Machine by State

Equipment costs for the different types of machines analyzed were drawn from present day internet research. Incremental costs are based on the difference in cost of choosing a higher level machine for the replacement (i.e., in Scenario 1, the difference between purchasing a standard efficiency top-loading machine and purchasing an efficient front-loader). The standard incremental cost for each scenario is shown in Figure 14 below.

Scenario	Incremental cost
1	$241[2]
2	$967[3]
3	$726[4]

Figure 14: Incremental Cost per Machine for Each Scenario

To account for regional variation on equipment costs, we applied a state level measure cost factor, drawing on information from the 2015 EEFA report (Mosenthal & Socks, 2015). For states not covered in the report, we assigned values from comparable states either based on geography or reputation. We also calculated an annualized cost number by dividing the adjusted incremental cost by the seven-year term of the lease. The adjusted annualized cost of an upgrade under each of the scenarios is shown in Figure 15 below.

State	Scenario 1	Scenario 2	Scenario 3
California	$39	$156	$117
Georgia	$28	$113	$85
Illinois	$39	$156	$117
Louisiana	$28	$113	$85
Maryland	$32	$130	$97
Michigan	$32	$130	$97
Minnesota	$32	$130	$97
Missouri	$32	$130	$97
New York	$39	$156	$117
Pennsylvania	$32	$130	$97
Rhode Island	$32	$130	$97
Virginia	$32	$130	$97
Average	**$33**	**$134**	**$100**

Figure 15: Annualized, Adjusted Incremental Cost per Machine

The calculations on savings to owners and incremental costs to route operators gave us a point for comparison to answer the questions: How much decrease in revenue could the owner bear and still see savings? How much increase in revenue would the route operator need to offset the increased upfront cost? The answers to these questions depends on level of laundry facility revenue. We calculated this value assuming that the machines see 1074 cycles annually (DOE, 2015) (U.S. EPA and DOE, 2016) and that one cycle (washing and drying) cost ($2.75).

The feasibility of owners and route operators agreeing on a revised contract amount requires that owners be willing to give up at least as much as route operators would need to be made whole.

2 http://www.abt.com/product/83406/Speed-Queen-White-Commercial-Top-Load-Washer-SWNSX2PP112TW01.html

3 https://www.ajmadison.com/cgi-bin/ajmadison/MHN30PDCWW.html?mv_pc=fr&utm_source=google&utm_medium=cse&utm_term=MHN30PDCWW&gclid=CN-cuvyJu9ACFdgPgQodGJgNew

4 http://www.abt.com/product/93359/Speed-Queen-White-Commercial-Front-Loading-Washer-SFNSXRSP113TW01.html

In the figures below, this condition is met when the maximum owner decrease in revenue is higher than the minimum route operator increase in revenue. While the precise differentials differ by state, this condition is met in all of the twelve states in scenario 1, and in every state except Illinois in scenario 2. In scenario 3 the level of compensation the route operator would need to recoup its costs is higher than the level of utility savings realized by the owner in all twelve states.

Scenario 1	Max. Owner Decrease in Revenue	Min. Route Operator Increase in Revenue
California	8.9%	1.3%
Georgia	7.9%	1.0%
Illinois	4.6%	1.3%
Louisiana	7.5%	1.0%
Maryland	8.1%	1.1%
Michigan	7.2%	1.1%
Minnesota	8.1%	1.1%
Missouri	8.0%	1.1%
New York	9.5%	1.3%
Pennsylvania	9.8%	1.1%
Rhode Island	8.8%	1.1%
Virginia	7.5%	1.1%

Figure 16: Cost-Effectiveness for Scenario 1

Scenario 2	Max. Owner Decrease in Revenue	Min Route. Operator Increase in Revenue
California	9.5%	5.3%
Georgia	8.2%	3.8%
Illinois	5.0%	5.3%
Louisiana	7.8%	3.8%
Maryland	8.5%	4.4%
Michigan	7.6%	4.4%
Minnesota	8.5%	4.4%
Missouri	8.4%	4.4%
New York	9.9%	5.3%
Pennsylvania	10.2%	4.4%
Rhode Island	9.3%	4.4%
Virginia	7.8%	4.4%

Figure 17: Cost-Effectiveness for Scenario 2

Scenario 3	Max. Owner Decrease in Revenue	Min. Route Operator Increase in Revenue
California	0.5%	4.0%
Georgia	0.4%	2.9%
Illinois	0.3%	4.0%
Louisiana	0.3%	2.9%
Maryland	0.4%	3.3%
Michigan	0.4%	3.3%
Minnesota	0.3%	3.3%
Missouri	0.4%	3.3%
New York	0.5%	4.0%
Pennsylvania	0.3%	3.3%
Rhode Island	0.5%	3.3%
Virginia	0.3%	3.3%

Figure 18: Cost-Effectiveness for Scenario 3

The variations in the levels of savings available to the owner vary between states based on the different utility rates used and vary between scenarios based the different levels of efficiency achieved in each scenario. The greater the level of efficiency, the greater the level of cost savings achieved by owners and the higher the percent of revenue they can give up. The highest savings to owners are realized in scenario 2, which switches from the least efficient baseline to the most efficient machines. In this scenario, owners could decrease their revenue between 3.8% and 8.2% and still achieve net savings. The second highest savings to owners are realized in scenario 1, in which top-loading machines are switched to efficient front-loaders with MEFs of 2.5. In this scenario, owners could yield between 3.5% and 7.8% of revenue in exchange for the more efficient machines and still come out ahead. Scenario 3, switching from baseline front-loaders to highly efficient front-loaders with MEFs of 2.98, sees the lowest levels of savings to owners, with the maximum decrease in their share of revenue that owners could bear ranging from just 0.3%-0.5%.

The variations in the levels of savings available to the route operators is driven by the incremental costs noted in Figure 14 above. The higher the incremental cost, the greater the percent of revenue the route operator would need to gain to recoup the greater upfront cost. In scenario 1, the incremental cost is low, and route operators could see increased profits by increasing their share of the revenue by as little as 1%. Scenario 2 entails the highest incremental cost, and route operators would need to see their share of the revenue increase between 3.8% and 5.3%. Scenario three, with the mid-level incremental cost, would require an increased revenue of between 2.9% and 4.0% to be worthwhile for route operators.

Given the total savings at stake, both the parties should be able to realize savings through a revised revenue split. A mutually beneficial agreement is possible, but whether the parties find it worth their time to renegotiate the agreements also depends on just how much money is at stake. While each scenario and state involves a range of cost sharing arrangements that could satisfy both parties, to evaluate how much savings would be seen on each side, we assumed the total savings available was split 50/50 and that the laundry facility in question has ten washers and dryers. Both of these assumptions are reflected in the savings values in Figure 19 below.

Annual Net Savings	Scenario 1	Scenario 2
California	$1,123	$616
Georgia	$1,022	$650
Illinois	$491	N/A
Louisiana	$972	$592
Maryland	$1,034	$605
Michigan	$904	$471
Minnesota	$1,036	$600
Missouri	$1,017	$586
New York	$1,201	$687
Pennsylvania	$1,290	$854
Rhode Island	$1,142	$731
Virginia	$945	$503
Average	**$1,015**	**$627**

Figure 19: Annual Net Savings at a Property with 10 Washers and Dryers in EEFA States

While not negligible, these sums are modest, and owners and route operators might reasonably decide that the value of the time they would spend negotiating new terms might exceed their savings. This points to the importance of utility incentives to owners or route operators to sweeten the deals and spur the parties to action in acquiring/leasing more efficient machines.

Regulatory and Utility Programs

To identify which of the twelve EEFA states might be good candidates for clothes washer savings opportunities and where there might be the best opportunity to implement a laundry program, we looked at the energy and water regulatory structures and utility programs incentivizing clothes washers.

States, utilities, and other local agencies have a variety of motivations to design programs that include energy and water efficiency. One proxy for utilities' general posture toward energy efficiency is whether the state has policies that establish specific energy savings targets that utilities' or related agencies need to meet through customer energy efficiency programs. These policies are known as "energy efficiency resource standards." An EERS sets multi-year electric and gas efficiency targets measured against a baseline of retails sales. Currently, EERS policies include three distinct types of approaches: a statewide EEES, long-term energy savings target set by utility commission specific to each utility, and incorporating energy efficiency as part of renewable portfolio standards (Sciortino, et al., 2011). In 2011, an ACEEE Study aggregated EERS policy approaches by each state as shown in Figure 20 below.

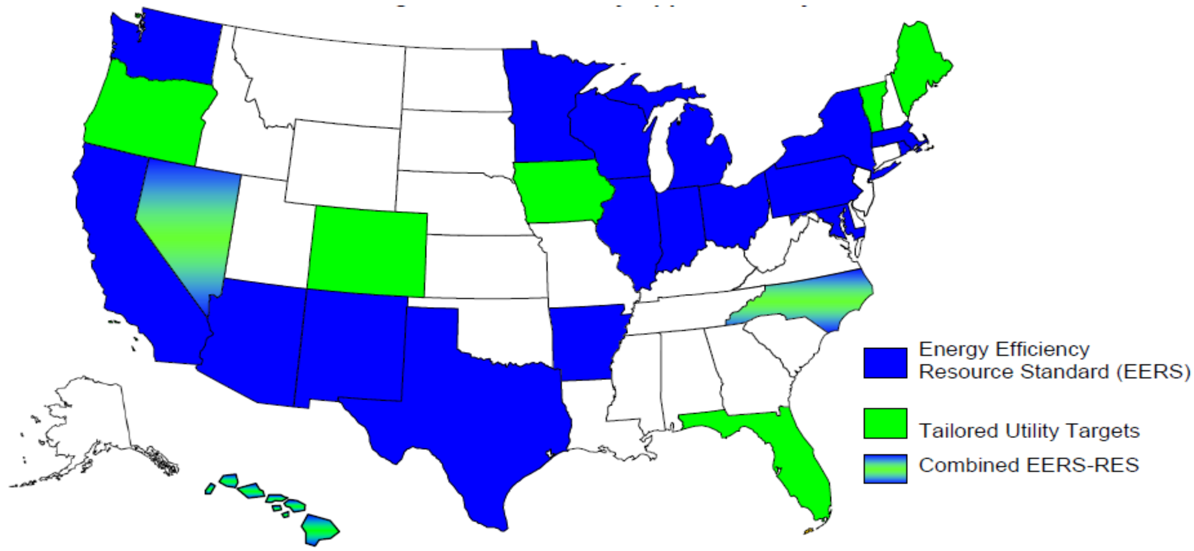

Figure 20: EERS Policy Approaches by State

The American Recovery and Reinvestment Act of 2009 (ARRA) funded a U.S. Department of Energy (DOE) grant program to all 56 states and territories to provide rebates to consumers for energy-efficient replacement appliances. The State Energy Efficient Appliance Rebate Program (SEEARP) also allowed the State Energy Office (SEO) of each state and territory to design its own program for delivering rebates. These rebate programs ran between December 2009 and February 2012 and many included rebates for energy-efficient clothes washers (BTO, DOE, June 2015).

Water utilities are not required to implement demand management programs, but many utilities choose to implement voluntary programs. In the case of investor-owned water companies, these programs must be approved by a public utility regulatory commission, which also allows utilities to recover certain conservation program costs through rate increases. In Wisconsin, water utilities can spend one percent of total operating revenues on conservation programs (PSC 2013d, February 2013).[5] Other decoupling and performance incentives tend to improve the environment for utility efficiency programs as they have the flexibility to spend their program budget from unsuccessful to successful programs that helps them meet their savings targets.

The Database of State Incentives and Renewables and Efficiency (DSIRE) shows that there are about 285 clothes washers rebate programs across the U.S. serving residential sector. In many cases, multifamily was included, but it was not clear for all programs what sectors were covered (DSIRE, 2016). It is our understanding that many utilities' programs that are deemed "residential" programs are not available to owners of multifamily properties, which are often classified as commercial accounts. A number of utilities within the twelve EEFA states offer rebates for the purchase of energy and water efficient clothes washers. Most of the existing utility incentive

[5] Wisconsin is one of the few states that extends the regulatory authority of its Public Service Commission to both investor-owned and publicly-owned water suppliers.

programs are targeted toward the residential clothes washer market, but some programs do not appear to specifically exclude commercial multifamily clothes washers.

Most investor-owned utilities (IOUs) are required to submit annual reports to their state public service or utilities commission documenting energy savings and program costs. Since the data reported is aggregated (e.g., all residential or Energy Star program data are reported together), it is difficult to determine energy savings and program costs directly related to the clothes washer component of many utilities' energy efficiency programs (Cluett, Amman, Osann, & Chou, 2013). To understand further, we followed up with third-party program administrators and utility staff to understand multifamily laundry programs.

Promising Program Models

Include Leased Laundry Equipment

Given the fact that across the U.S., between 50 and 90 percent of multifamily housing facilities lease laundry equipment from a route operator, we were surprised to find that few utilities offered rebate programs for which leased laundry equipment was eligible. Those that did cover leasing included programs in California run by Pacific Gas & Electric (PG&E), East Bay Municipal Utility District, Contra Costa Water District and one in Washington D.C. run by The District of Columbia Sustainable Energy Utility. In these programs, owners get the rebate amount after producing evidence of a lease agreement for clothes washers at qualifying efficiency levels. Although the incentive structures in leasing arrangements are complex, incentivizing owners who lease laundry equipment can be an effective way to prompt them to negotiate for more efficient equipment.

An alternative way to include leased laundry would be to offer incentives directly to route operators. However, one route operator we interviewed indicated that the incentive would have to be sufficient to overcome their preference for maintaining their current stock of machines. Limiting the variety of machines they offer gives them the benefits of a streamlined set of replacement parts and familiar maintenance requirements. Further research with route operators, including those that currently lease high-efficiency washers, may provide additional insight for the design of utility incentives.

A second alternative approach would be to move even higher up the distribution chain and incentivize efficient laundry equipment at the retail level including commercial equipment. Many utilities offer such "upstream" programs, typically to manufacturers and retailers of energy efficiency equipment.

Incentivize Higher Levels of Efficiency

Looking across a range of the laundry rebate programs in EEFA states, we found significant variation in the type of rebates, amount of rebates, and energy and water efficiency requirements.

State	Requirements	Rebate Type	Rebate Amount	Total No. of CW Rebates
Illinois	Energy Star	Instant	15% of purchase price (max $400 on 4/15 or $250 on 9/24)	15,183
Michigan	MEF >= 2.2; WF <= 4.5	Mail-in	$50	n/a
Minnesota	Energy Star	Mail-in	$200	n/a
New York	Energy Star	Mail-in	$75 ($100 with proof of recycling)	82,616

Figure 21: Summary of Clothes Washer Rebates for the Great Lakes States offered through DOE SEEARP

The Rebate amounts range from $20 to $500 per washer depending on the efficiency levels of the washers and sponsoring utilities. The San Francisco Public Utilities Commission provides a rebate of up to $500 per commercial high-efficiency clothes washer with a WF of 4.5 or below. This incentive also is eligible to leased laundry equipment in multifamily common areas. Since they are a water utility, they care more about WFs to get higher water savings than corresponding MEFs for energy savings.

Some utilities in Michigan including DTE Energy, Michigan Gas Utilities, and Xcel Energy offer laundry rebate programs, which provide a $50 rebate for commercial clothes washers that meet CEE Tier 2 criteria. In Minnesota, Alliant Energy offers a $50 rebate on the purchase of Energy Star clothes washers if the utility provides the energy for the water heater used and an additional $50 if the utility provides the energy for the clothes dryer used ($100 max total), with a maximum of six units rebated (Alliant Energy 2013). The energy utilities owned by FirstEnergy in Pennsylvania (Met-Ed, Penelec, Penn Power, West Penn Power) offer a $50 rebate on purchases of commercial clothes washers that have an MEF ≥ 1.8 for customers that have electric water heaters and dryers (Cluett et al., 2013).

There are also certain programs that specifically target rebates to replace old inefficient top-loaders to high efficacy front-loaders or require installation of the most efficient Energy Star Clothes Washer model in the market. The San Diego County Water Authority also has targeted the replacement of single top-loading commercial clothes washers with multi-load front-loading washers in the past through a pilot program that offered a $775 incentive to customers who switched (WMI, 2006). PG&E and local participating water agencies are offering up to $150 cash back on most efficient Energy Star models. The Energy Trust Oregon offers $75 cash back when you purchase a qualifying Energy Star front-load clothes washer with an IMEF of 2.38 or higher (Energy Trust Oregon, n.d.).

Combine Incentives from Multiple Agencies

In Austin, the electric, gas, and water utilities collaborated to create the Multifamily Energy and Water Efficiency program. The three main utilities in the Austin area (Austin Water Utility, Austin Energy, and Texas Gas Service), provide evaluations, rebates, and other incentives to multifamily properties to save water and energy (Mackres & Young 2013). By bundling the incentives for different entities and providing a "one-stop shop," the program can solicit better participation from property owners. Facilities initially undergo an energy evaluation where water and energy conservation opportunities and eligibility for rebates and other incentives are determined.

Once these measures have been identified and a plan determined, property owners work with contractors to make the necessary modifications and upgrades. The city and the energy utilities provide water and energy-saving devices and appliance (including clothes washers) and irrigation system rebates (Mackres & Young, 2013).

While the rebate programs found in most of the states are almost exclusively offered by electric and gas utilities, many water utilities in California and other western states offer clothes washer rebates to customers. In the San Francisco Bay Area, water utilities, in partnership with Pacific Gas & Electric and with funding from Proposition 84 grants, provide rebates to customers on the purchase of CEE Tier 3 clothes washers (Pacific Gas and Electric, 2016).

A clothes washer incentive program can be very effective when offered in conjunction with local gas and/or electric and water utilities as the incentive can be increased and marketing efforts can be coordinated. Despite these benefits, there are regulatory barriers to collaboration between utilities as well as sometimes competing priorities, lack of awareness, and coordination issues. Despite its promise, there are very few jointly administered laundry programs.

An example of utilities partnering with other agencies interested in promoting laundry efficiency comes from the Midwest, where in 2004 the Midwest Energy Efficiency Alliance (MEEA), in conjunction with nine clothes washer manufacturers (Maytag, Frigidaire, Fisher & Paykel, General Electric, Miele, Bosch, Equator, LG, and Asko), electric utilities (ComEd and Southern Minnesota Municipal Power Authority), and the Illinois Department of Commerce and Economic Opportunity conducted an innovative clothes washer rebate program. More than 4,500 clothes washer rebates were issued during the three-month duration of the program (April 15 to July 15) with an annual energy and water savings for the program were nearly 1.5 million kWh of electricity, 61,100 therms of natural gas, and approximately 38.5 million gallons of water. Kenmore and Whirlpool, two of the largest manufacturers, declined to participate. Partnering utilities contributed $50 towards each rebate while manufacturers contributed $25 or $50, depending on the MEF rating of the washer. This might be a good model to increase market penetration of clothes washers as all interested parties will be marketing for higher efficiency washers (MEEA, 2004).

Other Unique Clothes Washers Programs

One particularly unique example is the LOTT Clean Water Alliance, a collaboration among the cities of Olympia, Lacey, and Tumwater in Washington State. The alliance offers business and institutional sewer customers a rebate of up to 75% on projects, such as laundry equipment replacement, that reduce wastewater inflow into the LOTT Budd Inlet Treatment plant, which is nearing capacity (LOTT Clean Water Alliance, 2011).

Since a significant portion of the energy used in clothes washing is for water heating, some innovative multifamily housing facilities have begun to promote cold water washing by employing incremental pricing in multifamily laundry rooms (ASE, 2011). In the Washington, DC area multifamily buildings managed by Edgewood Management Corporation have variable vend prices based on water temperature. Laundry loads cost $1.25 with the cold water setting, $1.50 for warm washes, and $1.75 for hot washes. The management company reported that as a result of this pricing scheme residents switched from using almost exclusively hot water to using cold water, resulting in an estimated energy use reduction of 25-30% (ASE, 2011).

Conclusions

This study's investigation into the nature and scale of the opportunity to improve energy and water efficiency in multifamily laundry facilities indicates that there is a significant opportunity to increase efficiency and substantial value to be realized from reduced electricity, gas, and water use. Recent advances in the efficiency of commercial clothes washers yield high savings rates, and the more efficient models are not yet widely deployed in multifamily common area laundry. The prevalence of leasing arrangements means that there is a complex incentive structure at play. The route operators who purchase and maintain the equipment are not directly impacted by the utility costs generated by the machines. At the same time, owners appear to not have good information about the utility costs they bear from the laundry equipment.

These barriers have inhibited the uptake of more efficient equipment in multifamily laundry rooms, but they are not insurmountable. There are savings to be had by both owners and route operators through upgrading laundry equipment. Factors that could help prompt these upgrades include information to owners on how to evaluate the savings available from upgrading, model language for contracts that call for efficient equipment, and utility incentives that are tailored to leasing situations.

While the study has focused on the potential for upgrading laundry equipment, there also are ways to generate savings from existing equipment. Alternative pricing schemes that reward residents for choosing shorter cycles or cold water washes could yield savings. Keeping hot water boilers well maintained and at appropriate set points is another way that owners can reduce energy costs from their laundry facilities without replacing the machines. There also is potential to see savings when replacing a water heater if its size can also be reduced due to decreased hot water demand from more efficient laundry machines.

Often, a move to more efficient laundry washing machines means that a water heater has a greater capacity than is needed, and the optimal replacement would be a smaller size rather than replacing like with like. This was demonstrated by Battelle's Pacific Northwest Division in the laundry rooms of three multifamily apartment buildings in La Crosse, Wisconsin. After installing efficient clothes washers in two of the three rooms, the water heaters were downsized from 120 gallons to 52 gallons; in the third room, the water heater was downsized to an 80 gallon unit. An average of 871 kwh/yr energy savings resulted at the water heater due to reduced standby energy use. Also, capital cost savings of $250 can be accrued by moving from a 120-gallon to 52-gallon water heater (Sullivan, Parker, & Jenkins, 2004).

Another necessary course of action with the potential to generate energy savings is resident engagement. Even without pricing signals, resident engagement programs can prompt residents to adopt conserving behaviors, especially those that go beyond information sharing and employ social norming techniques. Resident engagement is particularly important when moving to efficient machines that require less detergent. Residents' using too much detergent can lead to maintenance issues with the efficient equipment, and both owners and route operators noted additional maintenance as a reason they do not prefer the more efficient equipment. Yet with fewer mechanical parts than top-loading machines, it is by no means inevitable that front-loading machines should have higher maintenance costs. Engaging residents on the how to use the equipment can not only lead to savings, it also can help prompt owners and route operators to seek out more efficient equipment.

Any number of factors could spur increased efficiency in multifamily common area laundry facilities, and the savings available from these upgrades are significant. This study has examined the markets in twelve individual states and examined the cost effectiveness from both the owner and the route operator perspective. At the property level, owners struggle to divide their time between competing needs at the property, and efficiency is one of many priority areas. Yet tools and incentives to improve laundry facilities have significant savings potential.

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Appendix A: Baseline Efficiency Calculations

Top-Loading Washers

		Estimated Average Efficiencies					AHAM Data from DOE Report				Estimated Average Efficiencies			
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Average**
MEFs	**1.26**	100%	100%	100%	100%	100%	82%	80%	77%	43%	0%	0%	0%	65%
	1.42	0%	0%	0%	0%	0%	18%	20%	22%	0%	0%	0%	0%	5%
	1.6	0%	0%	0%	0%	0%	0%	0%	1%	57%	100%	100%	100%	30%
													Baseline MEF:	**1.37**
WFs	**9.5**	100%	100%	100%	100%	100%	100%	100%	99%	43%	0%	0%	0%	70%
	8.5	0%	0%	0%	0%	0%	0%	0%	1%	57%	100%	100%	100%	30%
													Baseline WF:	**9.2**

Front-Loading Washers

		Estimated Average Efficiencies					AHAM Data from DOE Report				Estimated Average Efficiencies			
		2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Average**
MEFs	**1.42**	100%	100%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	17%
	1.72	0%	0%	100%	100%	0%	1%	0%	0%	0%	0%	0%	0%	17%
	1.8	0%	0%	0%	0%	100%	1%	0%	0%	0%	0%	0%	0%	8%
	2	0%	0%	0%	0%	0%	28%	28%	30%	0%	0%	0%	0%	7%
	2.2	0%	0%	0%	0%	0%	68%	34%	20%	31%	31%	31%	21%	20%
	2.4	0%	0%	0%	0%	0%	0%	38%	50%	69%	59%	59%	69%	29%
	2.6	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	3%
													Baseline MEF:	**2.0**
WFs	**8.5**	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%
	8	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
	7.5	100%	100%	100%	100%	100%	1%	0%	0%	0%	0%	0%	0%	42%
	5.5	0%	0%	0%	0%	0%	28%	28%	30%	0%	0%	0%	0%	7%
	5.1	0%	0%	0%	0%	0%	68%	34%	20%	31%	31%	31%	21%	20%
	4	0%	0%	0%	0%	0%	0%	38%	50%	69%	59%	59%	69%	29%
	3.7	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	3%
													Baseline WF:	**5.8**