Saving Energy and Water through State Programs for Clothes Washer Replacement in the Great Lakes Region

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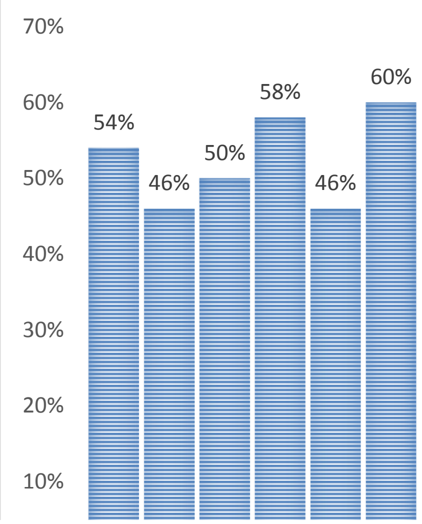
Executive Summary

The objective of this paper is to inform efforts to develop a statewide program for implementation in the Great Lakes states to save energy and water through clothes washer replacement. While the residential clothes washer market has seen significant success in a transition to high efficiency ENERGY STAR machines, a number of other clothes washer markets exist that are not well characterized and often not targeted by incentive programs. Clothes washers in multifamily, laundromat, and on-premise laundry settings are used more frequently than residential clothes washers and thus can yield more significant energy and water savings if made more efficient.

This paper begins with a characterization of existing clothes washer markets, both commercial and residential. As a result of the wide variation in commercial clothes washer applications, stock assessments for the commercial sector were determined in a variety of ways. We combined data and methodology from numerous sources to determine stock, energy, and water use estimates to produce a comprehensive estimate of residential and commercial clothes washers in the Great Lakes region. Next we highlight a number of opportunities for energy and water savings in a variety of sectors and also provide some cost savings estimates associated with replacement of different types of machines.

Figure ES-1: ENERGY STAR Market Share by State, 2009



Source: D&R International 2009

The next part of the paper focuses on how utility programs can lead to energy and water savings by targeting clothes washers. A summary of current state regulatory structures is followed by a summary of energy and water price trends over the past few decades. Next, we present a review of the existing utility programs that target clothes washers, as well as innovative programs from the Great Lakes region and beyond, which might provide useful examples of how to target markets that are more difficult to penetrate. We also explore potential options for appliance recycling as well as potential strategies for facilitating the removal of inefficient clothes washers.

The information presented in this paper will aid in the development of innovative programs that target clothes washer markets that have significant savings potential, but have largely been untapped at this point.

Residential Clothes Washer Market

Two equipment types dominate the residential clothes washer market: front-loading (horizontal axis) and top-loading (typically vertical axis) models, where front-loading models are more efficient largely due to lower water consumption and faster spin cycles that extract more water from clothing. The residential clothes washer market is reaching saturationwith 82% of U.S. households having a clothes washer (EIA 2009). Four primary manufacturers (Whirlpool/Maytag, GE, Electrolux — Frigidaire, and LG) comprise 92% of the market (DOE 2012d). The market share of ENERGY STAR residential clothes washers has increased significantly between 1997 and 2010, from 4% to 64% (Stevens and Fogle 2011). However, adoption by states in the Great Lakes region varies; this information can help us determine the states where there is room to realize energy and water savings from the adoption of ENERGY STAR clothes washers. Virtually all residential clothes washers on the market today are covered under federal energy and water efficiency standards, including compact, front-loading, and top-loading units, while only a small portion of the commercial clothes washer market has standards that apply.

COMMERCIAL CLOTHES WASHER MARKET

The commercial clothes washer market is significantly more diverse and varied than the residential market. The market can be broken down into four distinct sectors: coin-op, multifamily, on-premise, and industrial laundries. Clothes washer stock, equipment type, price, energy and water use, and policy context varies among sectors. A coin-op laundromat is a central, self-service location where customers can wash and dry their personal laundry. Machines are outfitted with coin slots or card readers for payment. Multifamily laundry facilities are located in common rooms of apartment buildings, dormitories, and other multifamily housing facilities. On-premise laundries are on-site laundry facilities in hotels/motels, bed and breakfast inns, hospitals, universities/colleges, prisons, nursing homes, and other facilities. Industrial laundries are characterized by large off-site facilities that have multiple customers and specialize in laundry care as a business.

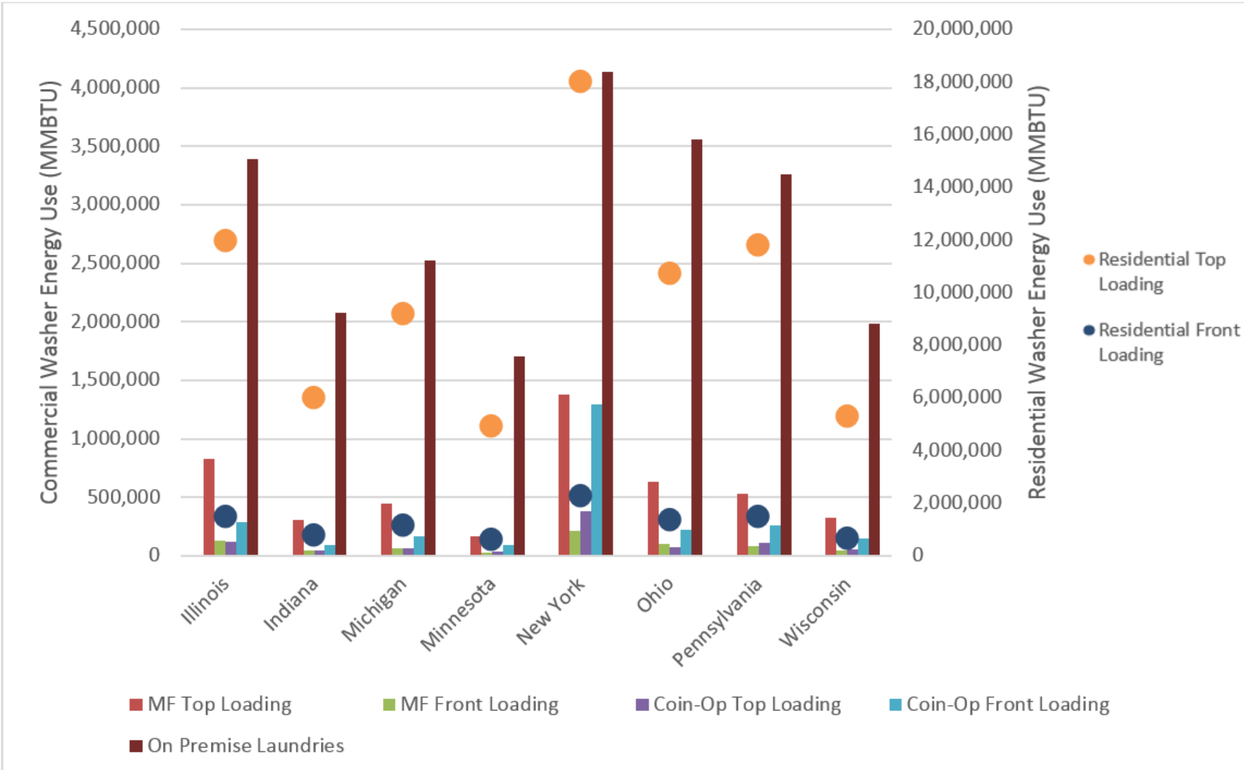
The two commercial clothes washer types we focus on in this paper are "family-size" commercial clothes washers, which are covered under federal efficiency standards, and larger multi-load clothes washers (also known as washer-extractors), which are not covered by federal efficiency standards. The largest industrial laundry facilities sometimes employ tunnel washers, which can process up to 2,000 pounds of laundry an hour, and are a different technology type than washer-extractors; as a result, the technology is not a focus of this paper. Because of the diversity in machine location, as well as the diversity in machine type and existing stock, the energy and water use of commercial clothes washers is estimated in a variety of ways for this study, as detailed in Table ES-1.

Table ES-1: Methodology for Commercial Stock Estimates, and Energy and Water Use

Machine Type	Existing Stock Assessment and Energy and Water Use
Multifamily Top-Loading and Front-Loading Machines	Multifamily washer stock estimates are based on DOE projections for 2011 total stock from the 2009 commercial clothes washer rulemaking, since almost all clothes washers found in multifamily laundromats are "family-size" and thus fall under the federal efficiency standards. State-specific estimates were scaled based on multifamily housing stock in each state. Energy and water use estimates are derived from the federal efficiency standard.
Coin-Op Top-Loading and Front-Loading Machines	The number of laundromat facilities in each state was used to determine total stock estimates for each state (U.S. Census 2010). Data on average laundromat machine composition was determined through interviews with the president of the Ohio Coin Laundry Association and corroborated with information from San Diego laundromats (WMI 2006; Lmaries 2013). Federal efficiency standard rulemaking and manufacturer estimates, with consideration of measured water use in San Diego laundromats, were used to make energy and water use estimates (Continental Girbau 2013; WMI 2006).
On-Premise Laundries (OPLs)	OPL washer frequency is determined based on estimates of each facility type in the Great Lakes states (hotels, motels, bed and breakfast inns, nursing care facilities, prisons, hospitals, and universities) (U.S. Census 2010). Estimates of pounds of laundry processed in each facility and the corresponding amount of water and energy used per pound are used to determine estimates for usage in each OPL type (Riesenberger 2006). Estimates on machine stock are not made because of the variation in machine size that occurs among OPLs. OPL laundry rooms are generally individually designed to meet the needs of each specific location.

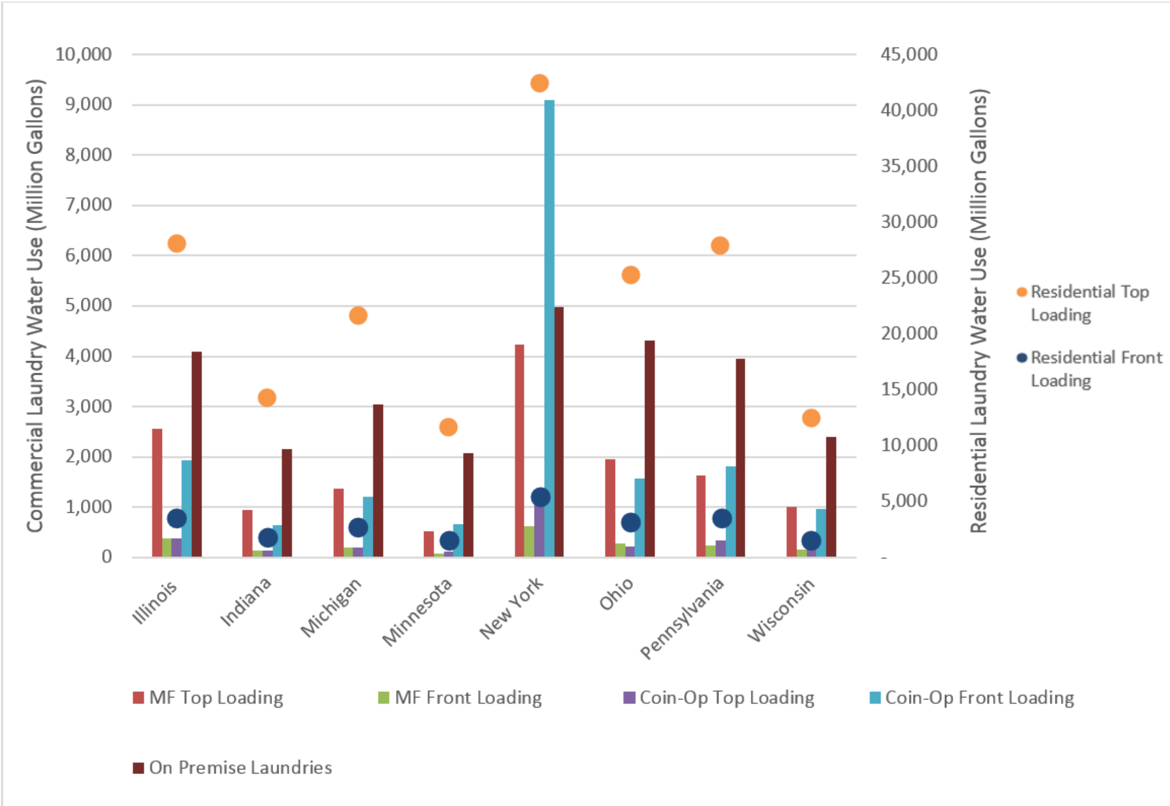
Annual water and energy use is estimated by sector based on the above methodology. On-premise laundries, which covers a large number of facility types, are the largest energy and water users among the facilities that use commercial clothes washers. Residential clothes washer use is also represented on the graphs (Figures ES-2 and ES-3). Because the number of machines in the market is much greater, water and energy use in the residential sector is significantly higher; it is represented on the right Y-axis.

Figure ES-2: Annual Energy Use by Sector



Notes: Stock and energy use estimates for each sector are derived from the most recent data available for each sector. Data sources and associated years are detailed above in Table ES-1.

Figure ES-3: Annual Water Use by Sector



Notes: Stock and water use estimates for each sector are derived from the most recent data available from each source. Data sources and associated years are detailed above in Table ES-1.

Technical and Economic Potential

Residential

The water and energy savings potential according for each sector are detailed next. For the residential sector, focusing on states that have a lower market share of ENERGY STAR units can yield greater results through machine replacement. Both Indiana and Ohio had a market share of 46% in 2009 for residential clothes washers, while all other Great Lakes States were above the national average of 48% (D&R International 2009).

Commercial

Targeting adoption of ENERGY STAR clothes washers in the commercial sector has the potential to yield significant savings, as market shares for ENERGY STAR units remain low at 32%, as of 2011 (ENERGY STAR 2011). Transitioning the remaining portion of total sales (68%) in the Great Lakes region, which is approximately 30,760 family-size commercial clothes washers units every year, to ENERGY STAR units in the multifamily and laundromat sectors could yield regional yearly electricity savings of 22 GWh/year, 215,000

MMBtu/year in natural gas savings, and 971 million gallons in water savings.[1] This amounts to the equivalent energy use of about 3,200 homes in the region, and the water use of over 6,600 households (EIA 2009, EPA 2008). This is based on savings expected over the existing average energy and water use of current shipments for units used in laundromats and multifamily settings. For both of these applications, fuel share estimates[2] and usage frequency plays into the difference in savings realized from machine replacement, rather than difference in machine type (Table ES-2).

Table ES-2: Average Yearly Energy and Water Savings per Unit Replaced, Family-Size Commercial Clothes Washers

	Electricity (kWh)	Natural Gas (MMBTU)	Water Usage (1000 gal)
Laundromat	365	11.0	37
Multifamily	565	4.8	21

Coin-op laundromats. Laundromat owners stand to realize significant energy and water savings from upgrades and adjustments to washer equipment in other ways that are not captured by the above estimates from replacement of family-size commercial washers. Upgrade of older front-loading technology with newer units can result in considerable energy and water savings. By transitioning from aging hard-mount front-loading units to new soft-mount front-loading units, laundromats can realize significant water and energy savings, particularly from the increase in spin speed capability that a soft-mount machine offers. Water savings of 9.3 to 29.6 gallons per cycle can be realized through machine upgrades while significant energy savings of 25,000 to 38,000 BTUs per wash cycle from reduction in dryer use can also be realized, depending on washer size (Continental Girbau 2013).

Creative replacement and upgrade options can help laundromat owners realize even more significant savings than would be expected from the upgrade of aging equipment to an equivalent but newer unit. Laundromats also stand to benefit from replacement of multiple single-load machines with multi-load machines. There is no single formula for replacement and associated savings that applies to all applications, but experience from completed retrofits serves as a helpful guide. In one case study, three single-load top-loading machines, with a capacity of 12 pounds each, were replaced by two multi-load washers with a capacity of 40 pounds each. This retrofit increased the capacity of the laundromat by 44

[1] Savings are estimated based on comparison to current unit shipments of commercial clothes washers average water and energy use, which are estimated to have an average MEF of 1.42, electricity usage of 910 kWh/year, gas usage of 7.76 MMBtu/year, and water usage of 34.74 thousand gallons/year. ENERGY STAR units were estimated to have an average MEF of 2.2, electricity usage of 645 kWh/year, gas usage of 4.5 MMBtu/year, and water usage of 19.82 thousand gallons/year (DOE 2010).

[2] The type of hot water heater (electric vs. natural gas) that is used to heat water for use in washing cycles is factored into the energy use attributed to clothes washers. According to DOE, 100% of laundromat facilities use natural gas hot water heaters compared to 80% for commercial washers in multifamily settings (DOE 2010).

pounds of capacity, while simultaneously decreasing the water factor[3] from 16.3 to 12 (WMI 2006).

Retrofitting existing laundromats with multi-load units can be beneficial for laundromat owners for many reasons, including:

- Increased total laundromat capacity, without changing facility size;
- Multi-load units that are highly customizable can be a benefit IF programmed correctly;
- Value increases for customers who visit a laundromat and use multiple machines to wash large quantities of clothing at once; and
- Avoided permitting and impact fees. Permitting fees for washers exist in some jurisdictions and require impact fees per washer. It is possible to reduce permit costs by replacing a single-load washer with multi-load units, while still increasing capacity.

Another creative strategy that provides savings to the laundromat and multifamily sector is incremental pricing for water temperature settings. An estimated energy use reduction of 25% to 30% can be realized from providing laundromat patrons or multifamily tenants the option of washing with hot, warm, or cold water (ASE 2011). Based on these findings, expected energy savings in the Great Lakes States would range from about 32,000 to 160,000 MMBtu.

On-premise laundries. There is no "one size fits all" solution for energy and water savings in on-premise laundry (OPL) facilities, as each facility varies considerably in machine composition, facility type and staffing, and laundry quality requirements. Upgrades from aging equipment can significantly reduce energy and water use from the washer itself, as well as for dryer energy use, while also providing additional benefits that are important in some on-premise laundries. In hotels, for example, replacing hard-mount washers with soft-mount washers provides a quieter wash cycle, which can be very important if the laundry facility is located near guest rooms. Additionally new machines generally have faster wash cycles and dry times that save time and improve productivity (Jorgensen 2009). In addition to machine replacement, technology options for the OPL sector can provide significant savings, such as ozonated laundry systems. Ozone is a cleaning agent that can be injected directly into the incoming water line for the laundry, which safely removes dirt from linens by breaking down soil molecules more effectively than chlorine and other cleaning agents. Water and energy savings from the installation of ozonated laundry systems have proven to be significant. In a hotel in California, hot water use was reduced by 95% and overall water usage dropped by 5-8% as a result of ozone acting as a more effective cleaning agent (PG&E 2011).

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[3] The metric used for characterizing water efficiency in clothes washers is Water Factor (WF). It is calculated by dividing the weighted per-cycle water consumption by the capacity of the clothes washer.

Cost Savings Estimates

The cost savings associated with upgrading a conventional residential clothes washer to an ENERGY STAR unit are considerable; this has been responsible in part for the large market share that residential ENERGY STAR clothes washers have gained in the last few years. As the residential market continues to be saturated with ENERGY STAR products, utilities can glean additional savings from offering innovative programs that encourage purchase of the highest efficiency ENERGY STAR machines on the market. There is significant variation among ENERGY STAR-ranked units, and honing in on the most efficient products on the list can provide additional savings benefits. TopTen USA, for example, ranks the top ten products on the ENERGY STAR list, which can often have hundreds of products with varying energy and water use characteristics, in addition to widely varying availability. The program highlights ten products that are the lowest energy consumers and that are also widely available to consumers. Using the utility rates of Indianapolis, Indiana to provide an example of expected annual energy and water savings, upgrading to an ENERGY STAR unit from a conventional clothes washer can save $52 yearly, while an additional $39 in yearly savings can be realized from upgrading to a TopTen USA ranked appliance, with little to no price difference between TopTen and ENERGY STAR units (EPA and DOE 2013, TopTen USA 2013).[4] Similarly, ENERGY STAR's Most Efficient list designates the most efficient products among those that qualify for the ENERGY STAR designation.

In the multifamily sector, the savings associated with switching to high efficiency machines are strengthened by the high frequency at which the units are used (Table ES-3).

Table ES-3: Annual Multifamily Clothes Washer Cost Savings in Indianapolis, IN

Machine Type	Electricity Use (kWh)	Electricity Cost	Natural Gas Use (Therms)	Natural Gas Cost	Water Use (gallons)	Water Cost	Total Cost
Conventional Unit (1.60 MEF, 8.50 WF)	1,570	$136.60	28	$28.28	29,702	$165.44	$330.32
ENERGY STAR (2.2 MEF, 4.5 WF)	1,341	$116.67	11	$11.11	15,725	$87.58	$215.36
						Annual Savings:	$115

Assumptions: 1,241 cycles/year, 7-year machine lifespan, building fuel hot water type — natural gas, dryer fuel — electric, 2.80 cubic feet capacity, 24 loads/week, Indiana commercial utility rates ($0.087 per kWh, $1.01 per therm, $5.57 per thousand gallons) (EPA and DOE 2013; Black & Veatch 2010).

The same upgrade in a laundromat can yield annual savings of $187 because of the even higher frequency at which the machine is used.

[4] The models listed on the TopTen clothes washers list in 2013 have an average price of $902 (TopTen USA 2013), while an analysis of front-loading machine price data (nearly all of which qualify for ENERGY STAR) indicates an average price of $993 (DOE 2012d). While the average price of front-loading units since the data was gathered in 2009 may have changed slightly, it is likely there is a negligible difference between TopTen and ENERGY STAR qualified units.

Savings in an on-premise laundry facility are highly variable. For example, a hotel with 95 rooms processes approximately 1,995 pounds of laundry every day (assuming 30 pounds/room/day with a 70% occupancy rate). Over $10,000 in annual savings could be realized by upgrading the facility to new high efficiency soft-mount machines (Table ES-4).

Table ES-4: Annual Savings from a Hotel OPL Facility in Indianapolis, IN

Machine Type	Washer Gas Use (therms)	Cost	Dryer Gas Use (therms)	Cost	Water Use (gallons)	Cost	Total Daily Utility Cost	Total Yearly Utility Cost
Conventional 30 lb hard-mount	2.66	$2.69	31.25	$31.56	2705.22	$15.07	$49.32	$18,000
High efficiency 30 lb soft-mount	1.33	$1.34	11.31	$11.42	1368.57	$7.62	$20.39	$7,440
							Annual Savings:	$10,560

Assumptions: Hotel OPL, 95 rooms, 30 pounds/room/day of laundry processed, 70% occupancy rate, Indiana commercial utility rates ($0.087 per kWh, $1.01 per therm, $5.57 per thousand gallons) (EPA and DOE 2013; Black & Veatch 2010; Riesenberger 2006). Machine energy/water use estimates from Continental Girbau 2013.

STATE REGULATORY STRUCTURES

To set the stage for the design and implementation of utility programs to target clothes washer replacement, a review of state regulatory structures in the Great Lakes Region is included in the paper. Within the Great Lakes states, state public utilities or public service commissions regulate a range of investor-owned and municipal electric and gas utilities. Energy utilities in all eight states are required to implement energy efficiency programs to meet annual energy savings targets, while only one state in the region — Wisconsin – requires water utilities to implement minimum conservation and efficiency measures (PSC 2013d).

REVIEW OF UTILITY CLOTHES WASHER PROGRAMS

Numerous utilities within the Great Lakes region offer rebates for the purchase of energy and water efficient clothes washers. The overwhelming majority of these utilities are located in Michigan and Minnesota followed by Ohio and Wisconsin. Major utilities in Pennsylvania also have rebate programs. Most of the existing utility incentive programs are targeted toward the residential clothes washer market, but there are a few programs for commercial clothes washers.

In preparation for developing innovative programs that target different sectors of the clothes washer market, where potential energy and water savings are significant but little effort has been made to transform the market to more efficient technologies, we looked at past programs in the Great Lakes states, including those funded through the 2009 American Recovery and Reinvestment Act, as well as rebate programs in other regions. Some of the innovative programs highlighted include:

- The Midwest Energy Efficiency Alliance (MEEA) and the Illinois Department of Commerce and Economic Opportunity worked with clothes washer manufacturers and electric utilities to offer rebates to consumers in 2004.
- Water and energy utilities in California have worked collaboratively to provide rebates to customers.

Additionally, ACEEE has identified a number of exemplary utility programs, including:

- **NYSERDA's New York Energy $mart Products Program** that works to promote ENERGY STAR products (and other energy efficient products) by increasing public awareness and by increasing the supply of qualifying products through partnerships with retailers, manufacturers, and distributors (ACEEE 2008).
- **Austin, Texas's Multifamily Energy and Water Efficiency Program**, which provides evaluations, rebates, and other incentives to multifamily properties to save water and energy (ACEEE and AWE 2013).
- **Windsor, California's Efficiency Pays Program**, where residents can make efficiency improvements to their homes with no upfront costs and immediate utility bill savings (ACEEE and AWE 2013).
- **Santa Rosa, California's Ozone Laundry Program**, which offers rebates of $200 for every 1,000 gallons of water use and wastewater flow that are sustained on a monthly basis by hotels and commercial laundry facilities through the use of ozone laundry technology (ACEEE and AWE 2013).

End-of-Life Options for Clothes Washers

An existing recycling market for old appliances exists, as a result of the financial profitability in recycling major appliances. However, existing rebate recycling programs largely target refrigerators and freezers. There are significant opportunities to advance the recycling of residential and commercial clothes washers by incorporating a recycling component into existing and future rebate programs. While residential clothes washers have been included in past recycling programs, commercial clothes washers are not recycled due to a lack of cost-effectiveness. Due to the popularity of take-back programs for refrigerators and freezers, there have been numerous data analyses conducted that point to important factors for the success of recycling programs, including:

- Effective marketing through advertisements and bill inserts; and
- Ensuring efficient appliance pick-up to facilitate customer participation.

Education about program goals, convenience over similar municipal programs, and outreach through schools/community groups also encourage increased customer participation (NMR Group 2011).

Conclusion

Significant potential exists for energy and water savings in the residential clothes washer stock because of the large number of units sold each year, as well as the large number of units in operation. However, existing and past incentive programs, more stringent federal residential clothes washer standards, and relatively high market penetration for ENERGY

STAR clothes washers already have resulted in substantial energy and water savings in the residential sector. An additional incentive program that exclusively targets the residential sector will be challenged to produce substantial increases in water and energy savings in a cost-effective way. However, additional opportunity exists to target only the highest efficiency products, like those ranked on TopTen USA and ENERGY STAR Most Efficient lists. There is potential for significant energy and water savings in the commercial sector due to the usage frequency of commercial clothes washer machines and the relatively few incentive programs that target the commercial market.

Targeting clothes washers in multifamily laundry rooms with incremental pricing for different water temperature washing options, and transitioning the single-load commercial clothes washer stock in multifamily laundry rooms and laundromats to ENERGY STAR units could yield the following savings in each state.

Table ES- 5: Potential Annual Energy and Water Savings from Improvements in the Laundromat and Multifamily Laundry Room Commercial Sectors

State	Savings from Single-load Machine Replacement to ENERGY STAR Units (multifamily and laundromat units)			Savings from Incremental Temperature Pricing (multifamily units)
	Electricity Savings (GWh/yr)	Natural Gas Savings (MMBtu/yr)	Water Savings (1000 gal/yr)	Natural Gas Savings (MMBtu/yr)
Regional Total	22	215,000	971,000	896,985
Illinois	3.90	38,700	175,000	161,677
Indiana	1.43	14,200	64,200	59,327
Michigan	2.09	20,700	93,600	86,520
Minnesota	0.79	7,870	35,600	32,891
New York	6.44	64,000	289,000	267,344
Ohio	2.97	29,500	133,000	123,152
Pennsylvania	2.47	24,600	111,000	102,674
Wisconsin	1.53	15,200	68,600	63,400

A focus on the commercial sector with consideration of the specific characteristics and needs of each sector, can aid in the realization of new cost-effective energy and water savings in the Great Lakes region.

Introduction

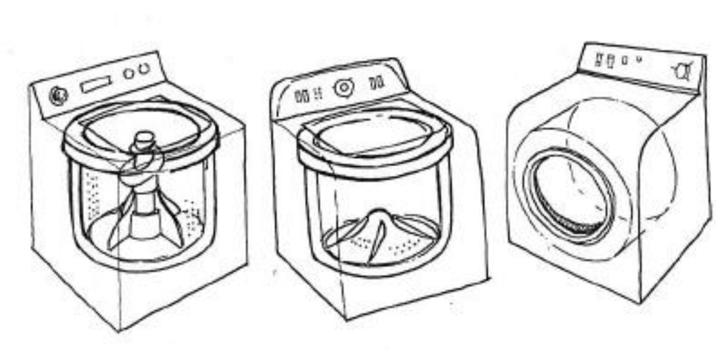
The Natural Resources Defense Council (NRDC) and the American Council for an Energy-Efficient Economy (ACEEE) are collaborating to identify opportunities for energy and water savings in the clothes washer sector as part of the development of an innovative program for the Great Lakes region. The Great Lakes states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin are the focus of this analysis, but Pennsylvania and New York also are included for comparison purposes. The research and analysis presented in this white paper represents the first phase of the project and will serve to inform the second and third phases of this project, which focus on the development of candidate program designs, recruitment of potential program partners, and the implementation of a pilot program. Phase one involved the assessment of energy and water savings opportunities and market potential for high efficiency washers for single family, multifamily, and commercial markets, including typical residential and commercial washers as well as multi-load washers and other products. This analysis also included a study of the technical and economic potential for water, energy, and cost savings in the residential and commercial markets, a review of the current regulatory structure, and a discussion of relevant utility clothes washer incentive programs.

Residential Clothes Washer Market

EQUIPMENT TYPES

Clothes washers manufactured today typically incorporate a variety of energy-saving technologies and features. Front-loading (horizontal axis) washers are generally more efficient than top-loading models (typically vertical axis), largely due to lower water consumption since there is no need to completely submerge clothes. Front-loaders also use advanced electronic controls to automatically adjust the water level depending on the load size. Some high efficiency top-loaders also employ electronic controls to sense the size of the load to adjust water levels appropriately. For top-loading models, typically an agitator is used to swirl the water and clothes around. However, there are models available that use a moving plate in the bottom of the tub to bounce clothes through the water, as well as a horizontal axis machine with top-loading access (Figure 1).

Figure 1: Clothes Washer Configurations



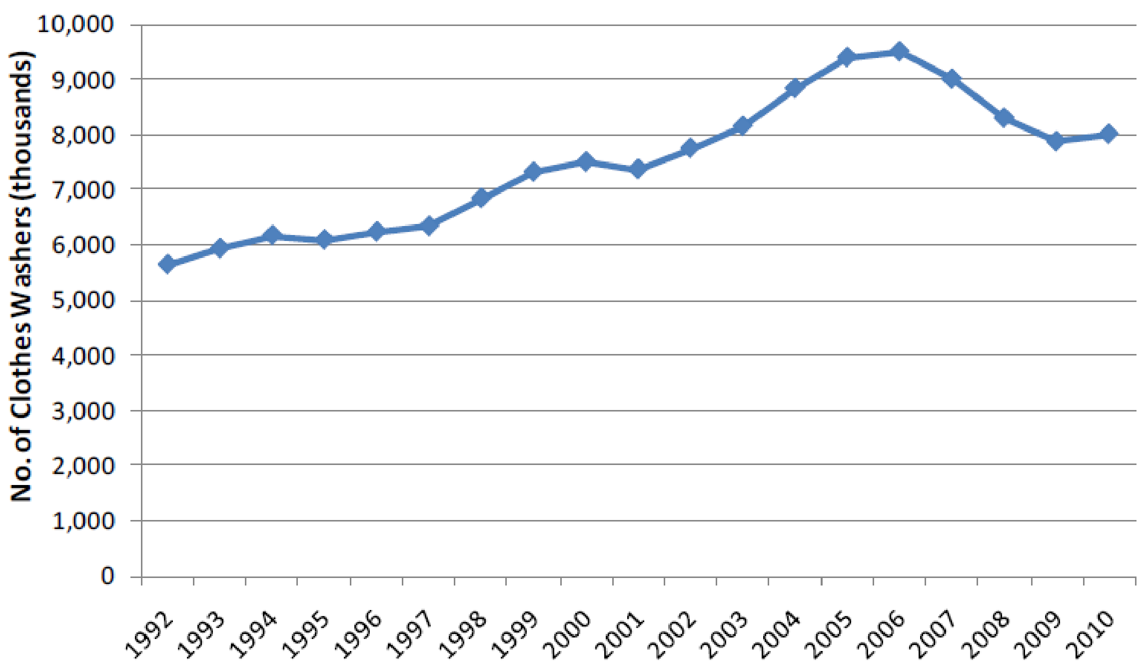
Notes: Clothes washer configurations from left to right: top-loading machine (vertical axis) with agitator, top-loading machine without agitator, front-loading machine (horizontal axis).

A faster spin cycle extracts more water from clothing, reducing clothes dryer energy consumption. This feature is especially important because clothes dryer energy accounts for about 75% of clothes laundering energy use with conventional machines (DOE 2011).

Market Characterization

As of 2009, there were approximately 93.2 million residential clothes washers in use in the United States. The market is reaching saturation, with clothes washers in 82% of U.S. households (EIA 2009). Figure 2 shows the past and future projected shipments of clothes washers in the United States.

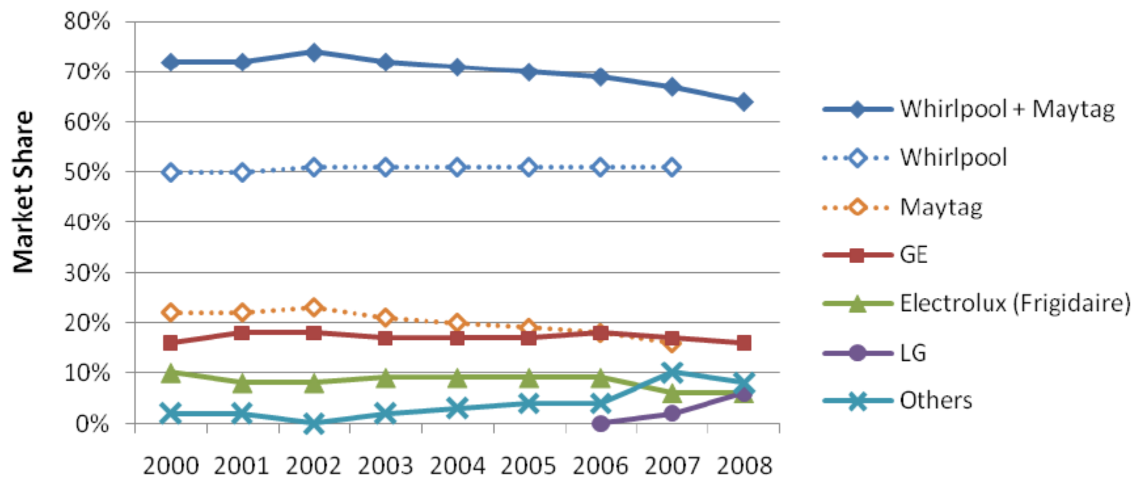
Figure 2: Annual Shipments of Residential Clothes Washers



Source: DOE 2012d

The major manufacturers of residential clothes washers are Whirlpool/Maytag, GE, Electrolux (Frigidaire) and LG Electronics (DOE 2012d). Figures 3 and 4 show the shipments by each manufacturer.

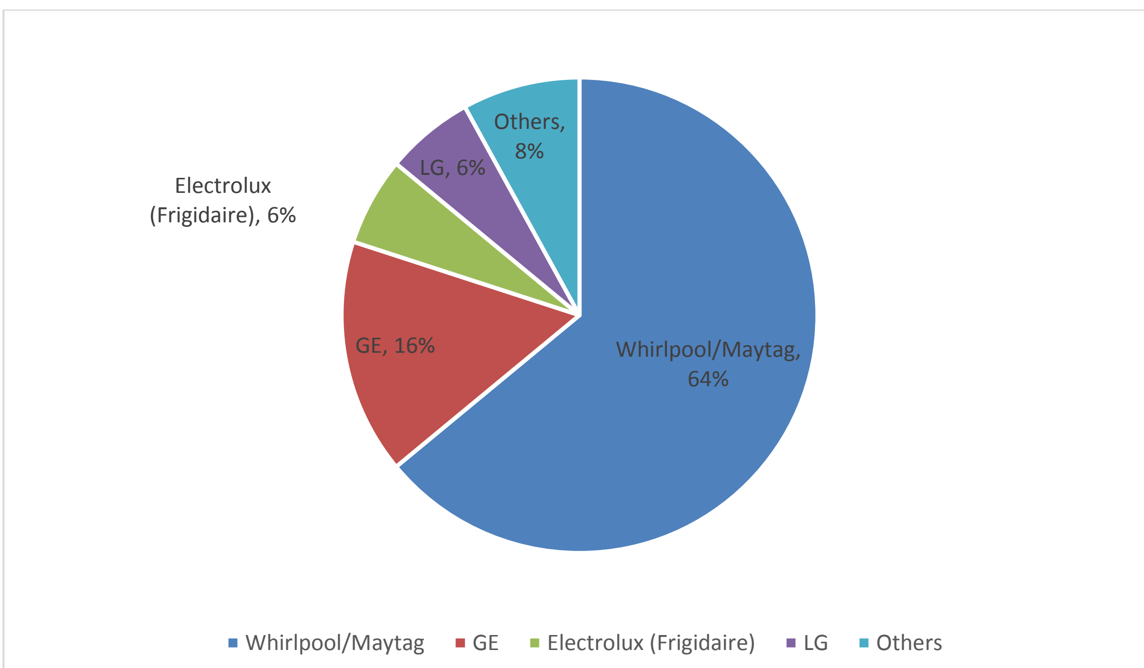
Figure 3: Market Share of Clothes Washers by Manufacturer



Source: DOE 2012d

Notes: Whirlpool and Maytag merged in 2006 but have continued to maintain both product lines. In the chart, Maytag and Whirlpool market shares are combined in the solid blue line.

Figure 4: Residential Market Share by Manufacturer, 2008



Source: DOE 2012d

Many manufacturers produce clothes washers under multiple brand names. Table 1 is a brief guide to which manufacturers are associated with which brands.

Table 1: Manufacturers and Brands of Residential Clothes Washers

Manufacturer	Brands of ENERGY STAR Qualified Products
Bosch	Bosch Siemens
Electrolux	Frigidaire
Fisher & Paykel	Fisher & Paykel
GE	GE GE Profile
LG	LG
Samsung	Samsung
Whirlpool	Amana KitchenAid Maytag Whirlpool

Note: Adapted from ENERGY STAR 2008

Some manufacturers have begun specializing in certain washer configurations. For example, Fisher & Paykel only manufacture top-loading washers, while LG, Electrolux, and Bosch only make front-loading models (ENERGY STAR 2008).

The top retailers of clothes washers include department stores and big-box home goods stores such as Sears, Home Depot, Lowe's, and Best Buy, along with local and regional independent stores. A wide selection of products are readily available both in-store and online.

In a survey conducted by the U.S. Department of Energy (DOE) in December 2009 on consumer retail prices for residential clothes washers, top-loading machines ranged from $319 to $1,259, with an average of $636. Front-loading machines ranged from $519 to $2,449, with an average of $1,041. When four outliers are removed, the average front-loading price is $993, approximately $357 more expensive than a top-loading machine (DOE 2012d).

ENERGY AND WATER USE

The metric used for characterizing energy-efficiency in clothes washers is MEF (Modified Energy Factor). It is calculated according to the following equation:

$$MEF = C / (M + E + D)$$

Where:
C = capacity of the clothes container
M = machine electrical consumption
E = hot water energy consumption
D = energy required for removal of final moisture content of clothing

In the newest clothes washer standards adopted by DOE, new metrics are used that incorporate standby and off mode energy consumption into the formula — IMEF (integrated modified energy factor) and IWF (integrated water factor) (ASAP 2013).

Clothes washers are a mature technology. Incremental improvements in energy efficiency, as noted above, offer opportunities for energy savings in product selection. However, there are no near-term emerging technologies likely to significantly change how clothes washers function or dramatically reduce clothes washer energy use on the residential level.

Water use is an important contributor to clothes washer energy consumption, operating cost, and overall environmental impact. While water conservation has long been an issue in more arid parts of the country and areas with freshwater supply issues, recent droughts and water shortages have demonstrated the importance in making the economic case for high-efficiency clothes washers. From 1996 to 2010, water and wastewater rates increased at an average annualized rate of 4.66% and 4.90% per year, respectively (AWWA 2009). Reduction in water use can also lower the energy consumption of clothes washers by reducing the amount of energy needed to heat the water. As noted above, clothes washer configuration (horizontal- or vertical-axis) is a major determinant of water consumption. Standard efficiency vertical-axis machines fully submerge the clothes, whereas horizontal-axis models do not. Horizontal-axis washers use an average of 30% to 50% less water than vertical-axis models (AWE 2009). The metric used for characterizing water efficiency in clothes washers is Water Factor (WF). It is calculated by dividing the weighted per-cycle water consumption by the capacity of the clothes washer.

Several other features factor into a consumer's decision to purchase a clothes washer. Size is an important criterion. The majority of clothes washers are larger models (over 2.5 cubic feet of capacity). Additional features that influence consumer choice include advanced electronic controls and specialty wash options such as steam washing. Different configurations such as top- versus front-loading and the ability to stack the washer and dryer may play a role depending on the space available in a consumer's home. Aesthetics also play a role, as do noise levels. Finally cleaning performance is important to consumers. Cleaning performance varies across models, and there is no mandatory cleaning standard that models must meet. However, a voluntary standard (ANSI/AHAM HLW-1-2007) exists to measure cleaning effectiveness in clothes washers. There is some concern among manufacturers that as water efficiency standards become more restrictive it will become more difficult to maintain cleaning performance levels.

POLICY CONTEXT

New residential clothes washer standards were adopted by DOE in 2012 based on an agreement in 2010 between manufacturers and efficiency advocates. Standards for top-loading clothes washers in the 2012 rule are phased in, in two phases, while for front-loaders there is a single standard (Table 2) (ASAP 2013).

Table 2: Federal Residential Clothes Washer Standards

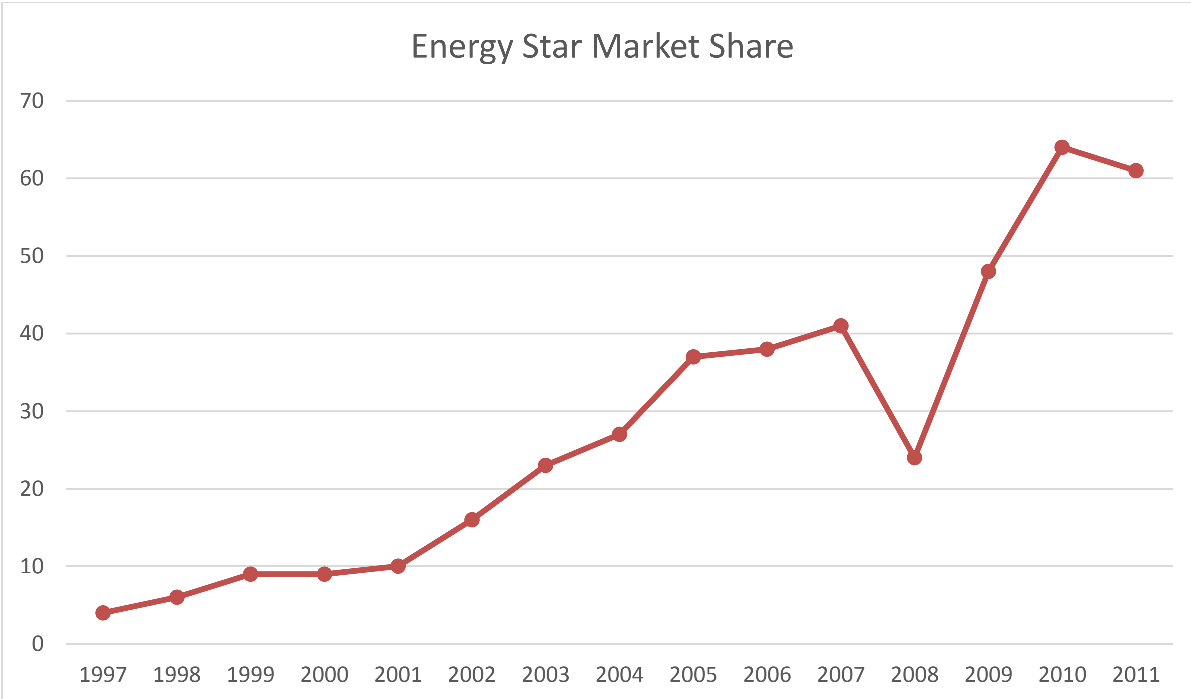
Machine Configuration	Rulemaking Year	Date Effective	MEF/IMEF	WF/IWF
Top-loading and front-loading	2007	January 2011	1.26 or greater	9.5 or less
Top-loading	2012	March 2015	1.29 IMEF (correlates to 1.72 MEF)	8.4 IWF (correlates to 8.0 WF)
Top-loading	2012	January 2018	1.57 IMEF (2.0 MEF)	6.5 IWF (6.0 WF)
Front-loading	2012	March 2015	1.84 IMEF (2.2 MEF)	4.7 IWF (4.5 WF)

The requirements for a residential clothes washer to qualify for the ENERGY STAR label were changed on February 1, 2013. Products must have an MEF of 2.0 or greater and a WF of 6.0 or lower to qualify for ENERGY STAR (ENERGY STAR 2013). The overall ENERGY STAR market share has increased significantly since 1997. Changes in ENERGY STAR efficiency criteria have an impact on market share levels. In 2008, market share levels declined due to implementation of new ENERGY STAR criteria, which increased the efficiency of clothes washers by 21% and added a new water efficiency requirement. Despite the decline in 2008, market share has increased to the highest levels yet — 64% in 2010 (Figure 5) (Stevens and Fogle 2011).

Market share of ENERGY STAR units varies by state. Sales are highest in states where Energy Efficiency Program Sponsor (EEPS)[5] programs are active (Table 3) (ENERGY STAR 2008).

[5] Energy Efficiency Program Sponsors are utilities, governments, or other organizations that are involved in administering and/or coordinating energy efficiency or environmental education programs that promote ENERGY STAR and have partnered with ENERGY STAR to commit to promoting ENERGY STAR through their programs.

Figure 5: ENERGY STAR Residential Clothes Washer Market Share



Source: Stevens and Fogle 2011

Table 3: ENERGY STAR Market Share by State, 2009

State	Market share
Illinois	54%
Indiana	46%
Michigan	50%
Minnesota	58%
Ohio	46%
Wisconsin	60%

Source: D&R International 2009

Commercial Clothes Washers

The commercial clothes washer market is most easily characterized when broken down into four distinct sectors: coin-op, multifamily, on-premise, and industrial laundries. Clothes washer stock, equipment type, price, energy and water use, and policy context varies with each sector.

- **Coin-Op Laundries.** A coin-op laundromat is a central, self-service location where customers can wash and dry their personal laundry. Machines are outfitted with coin slots or card readers for payment.
- **Multifamily Laundries.** Multifamily laundry facilities are located in common rooms of apartment buildings, dormitories, and other multifamily housing facilities and are operated by residents.
- **On-premise Laundries (OPLs).** OPLs are on site laundry facilities in hotels/motels, hospitals, universities/colleges, prisons, nursing homes, etc. that are operated by staff.
- **Industrial Laundries.** Industrial laundries are characterized by large off site facilities that have multiple customers and specialize in laundry care as a business.

EQUIPMENT TYPES

Family-Size Commercial Clothes Washers

Figure 6: Family Size Front-loading Washer (Source: Zogg et al. 2009)

Family-size commercial clothes washers (CCWs) utilize similar technology to the clothes washers in the residential sector, with a few variations. Similar to the residential sector, front-loading washers are generally more efficient than top-loading models. Commercial front-loaders are characterized by components that differ from top-loaders including variable speed motors, sophisticated electronic controls, and a sophisticated door system which includes high temperature impact resistant glass, a door/tub boot seal, a sophisticated lock system, and a heavy duty hinge. Top-loaders are characterized by a stamped metal door with a low cost hinge and a fairly simple switch to remove power from the machine basket drive during the spin function (AWE 2009).

Figure 7: Family Size Top-loading Washer (Source: Zogg et al. 2009)

For the purpose of our market characterization, family-size commercial clothes washers are defined as they are in the Federal Standard for Commercial Clothes Washers.[6] Family-size commercial clothes washers are the only commercial washers that are held to federal

[6] Commercial Clothes Washers are defined as soft-mount, front-loading or soft-mount-top-loading clothes washers that have a compartment that is (1) not more than 3.5 cubic feet for horizontal-axis (front-loaders), and (2) not more than 4.0 cubic feet for vertical-axis (top-loaders), for applications in which the occupants of more than one household will be using the clothes washer, such as multi-family housing common areas and coin laundries (DOE 2010).

energy and water efficiency standards. This distinction is particularly important in order to understand the disparity in information that is available from industry about stock and shipment estimates for some commercial machine types versus others.

The metrics used for evaluating energy efficiency and water efficiency are the same for family-size commercial clothes washers as they are for residential clothes washers. Modified Energy Factor (MEF) is used to characterize energy efficiency, and Water Factor (WF) is used to characterize water efficiency. The average price of a family-size top-loading machine (with coin box) is $824, while the average price for a family-size front-loading machine (with coin box) is $1,355 (Zogg et al. 2009). Family-size machines in a multifamily laundry have an average life of 11.3 years, while family-size machines in a coin-op laundry have an average life of 7.1 (Zogg et al. 2009).

Manufacturers

There are approximately six domestic and three foreign manufacturers for family-size commercial clothes washers. The majority of the market share is held by four major manufacturers: Alliance Laundry Systems LLC (Alliance), Maytag, Whirlpool, and GE. Maytag and Whirlpool merged in 2006 but have continued to maintain both product lines to date. Other manufacturers include AB Electrolux (Electrolux), Continental Girbau, Inc. (Continental), LG, Staber Industries, Inc. (Staber), and Bermil Industries Corporation (Wascomat) (DOE 2010).

Distribution Chain

Between 50 and 90 percent of multifamily housing facilities lease laundry facilities to a third party route operator, instead of buying equipment directly from a distributor. The primary difference between route operators and distributors is the length of service that is provided to clients. Route operators provide continuous support to clients while support from distributors ends at the time of sale (DOE 2010). Distributors are the second market channel for commercial clothes washers, selling washers to laundromats and multifamily building managers (CEE 1998).

On-premise laundries tend to purchase equipment through a distributor, who will also usually provide service support. Some OPLs are also serviced by route operators (Zogg et al 2009). Equipment at off-premise laundries is generally purchased by the business owner through a distributor.

Multi-load Clothes Washers/Washer Extractors

The multi-load clothes washer type is uniquely suited to the commercial market. Multi-load washers, also referred to as washer extractors, have a machine capacity of at least twice that of a family-sized washer. Large capacity machines generally are characterized by horizontal access drum technology (front-loading) and other water efficiency features that make multi-load washers more water efficient than traditional top-loaders such as more specialized controls for adjusting machine energy and water used based on load size. While family-size commercial clothes washers are sized by the cubic footage of the wash bin, multi-load washers are sized by the number of pounds of laundry they can handle. Multi-load washers are generally at least twice the size of a family-sized commercial clothes washer (the largest family-size front-loading commercial clothes washers are 3.5 cubic feet, which is roughly equivalent to 20 pound capacity).

Within the multi-load washer type, there are soft-mount and hard-mount washers. Soft-mount washers are freestanding and therefore can be installed very easily and inexpensively. The suspension of a soft-mount washer absorbs vibrations, eliminating the need to affix the machine to the foundation. Since soft-mount washers are not affixed to the floor, they can be reconfigured according to changing needs. Installation of hard-mount washers is more challenging and more expensive, often involving digging holes to pour reinforced concrete slabs that the washer can then be bolted to. Soft-mount and hard-mount technology are generally very similar in terms of water and energy usage. The increase in efficiency associated with some soft-mount machines results from better water extraction. Removal of more moisture from the load results in faster drying times and allows for smaller dryer capacities (Lmaries 2013). Soft-mount machines are equipped with shock absorbing systems that isolate the spinning drum from the shell of the unit, allowing them to spin at higher speeds that remove more water. As a result, soft-mounts are able to reach higher spin speeds that result in greater water extraction and faster drying times. Soft-mount machines are newer to the industry and have a smaller market share. While data on the market penetration of each mount type is limited, anecdotal evidence suggests soft-mounts are gaining ground on hard-mount machines because they are easier to install, result in faster drying times, and produce less noise and vibration. Replacement of existing hard-mount machines with new hard-mounts is more common among established laundromats, where foundations are already in place for attaching hard-mounts and where owners know and trust the hard-mount technology. Soft-mounts generally require more maintenance. Multi-load washers with a 50 pound capacity cost an average of $7,500, while washers with an 800 pound capacity cost $190,000 (Zogg et al. 2009). Multi-load washers are estimated to have an average lifetime of 15 years (Zogg et al. 2009).

Machine Size Labeling — Pound Capacity versus Tub Size

It can be challenging to compare multi-load washers with single-load, family-size washers because of the differences in the way sizes are commonly labeled. Manufacturers of commercial units commonly rate the size of washers in pounds of laundry a washer can process. However, different types of fabric have different densities, and a rating for a pound of laundry can be different between manufacturers (WMI 2006). In an assessment of water savings for coin-operated multi-load clothes washers prepared for the San Diego Water Authority, a tub volume versus rated pound capacity was performed for the equipment of seven different manufacturers of commercial machines (Table 4). Is important for our determination of clothes washer stock in commercial markets to find a common metric by which to categorize machines. Increasingly manufacturers are providing a tub volume size, but many still advertise machines by pounds per load (WMI 2006). Below is a table comparing tub volume size in cubic feet to nominal pound rating for a number of manufacturers. To normalize the relationship, tub volume was divided by the nominal capacity, which indicates a relationship of 0.14 cubic feet per pound of rated capacity. This relationship between nominal capacity and tub volume only holds true for commercial machines — residential machines can hold less weight per cubic foot, and have a relationship closer to 0.24 cubic feet per pound of rated capacity (DOE 2011).

Table 4: Pound Capacity versus Tub Size

Manufacturer	Tub Volume Size											
	18 lb	20 lb	25 lb	30 lb	35 lb	40 lb	50 lb	55 lb	60 lb	75 lb	80 lb	125 lb
Continental	2.54			4.2		6.3	7.4			11.2		19.4
Maytag	2.61		3.27		5.72		7.68				11.79	
Speed Queen/Huebsch		2.76	3.76	4.19		6.34			9		12.96	
IPSO	2.59		3.36		5.93	6.39	8.26			10.7 4		
Milnor					6.14			9				
Dexter	2.7		4			6		9				
Wascomat		3		4.6		6.4		8.8		11.7		

Source: WMI 2006

For the purposes of comparing DOE stock estimates for front-loading machines to the bottom up approach developed to determine clothes washer makeup in laundromats, we look at the tub volume size chart to determine what products are likely to fall under the DOE standard (3.5 cu ft tub volume limit for front-loading, soft-mount machines). From the tub volume size assessment, it is safe to say that units rated between 12 and 20 pounds fall under the federal standard. There may also be some units rated at 25 pounds that fall under the standard (2 out of 4 of the listed products qualify) but they are not included for our comparison to DOE estimates.

Tunnel Washers

The largest type of commercial clothes washer is known as a tunnel washer. Tunnel washers can handle up to 2,000 pounds of laundry an hour, and are generally found only in very large industrial laundry facilities. This type of machine is made up of long chambers and a series of compartments that laundry is pulled through for soaking, washing, and rinsing. Because tunnel washers are composed of different technology than that of a washer extractor, and not widespread across the country (there are an estimated 200 tunnel washers in use in the United States), they will not be included in this technical and economic potential study. Tunnel washers have an estimated average cost of $1.1 million, and have an average lifetime of 7 to 15 years (Navigant 2009).

Clothes Washer Stock, Energy, and Water Use

We use a number of methods to estimate commercial clothes washer stock estimates within each sector. Data is more readily available for family-size commercial clothes washers because these machines are subject to federal efficiency standards. Publicly available federal rulemaking documents include shipment and stock estimates from national appliance manufacturing associations. The specific estimation method for machines in each sector is detailed in the following section. Various methods and sources were used to categorize this diverse market, which are summarized below in Table 5. Detailed methodology for stock estimates, energy, and water use for each machine type can be found in the Appendix.

Table 5: Summary of Stock, Energy, and Water Use Estimate Methodology

<table>
<tr><th>Machine Type</th><th>Existing Stock Assessment</th><th>Energy and Water Use</th></tr>
<tr><td>Multifamily Top-loading</td><td colspan="2">Data from Federal Standard Rulemaking (DOE 2010)</td></tr>
<tr><td>Multifamily Front-loading</td><td colspan="2">Data from Federal Standard Rulemaking (DOE 2010)</td></tr>
<tr><td>Coin-Op Top-loading</td><td rowspan="2">Census County Business Patterns data on Laundromats (U.S. Census 2010); data on average laundromat machine composition (WMI 2006; Lmaries 2013); data from Federal Standard Rulemaking (DOE 2010)</td><td>Federal Standard Rulemaking (DOE 2010)</td></tr>
<tr><td>Coin-Op Front-loading</td><td>Manufacturer Estimates (Continental Girbau 2013), with consideration of measured water use in San Diego laundromats (WMI 2006)</td></tr>
<tr><td>Residential Top-loading</td><td colspan="2">Data from Federal Standard Rulemaking (DOE 2012)</td></tr>
<tr><td>Residential Front-loading</td><td colspan="2">Data from Federal Standard Rulemaking (DOE 2012)</td></tr>
<tr><td>On-premise Laundries</td><td colspan="2">Methodology from study prepared for the California Urban Water Conservation Council (Riesenberger 2006), and adapted for use in the Proposal Information Template for Commercial Clothes Dryers for the California Energy Commission (Zhang and Wei 2011). Data for state specific locations that house OPLs are determined from Census County Business Patterns (U.S. Census 2010). Additional data on average occupancy of facilities housing OPLs obtained through various associations or organizations (Pew 2010; AHLA 2012; CDC 2006; AHA 2011).</td></tr>
</table>

Commercial Clothes Washer Stock Estimates

The total number of machines in each commercial sector is presented in Table 6. There is wide variation in on-premise laundry (OPL) facility size and type depending on the location (hotels, motels, inns, prisons, hospitals, universities, etc.). Estimates for water and energy use from the OPL sector are based on pounds processed in each specific OPL type per day because there is little information available on the machine composition of OPLs. However, to present a number for comparison, we assume 2,871 loads per machine per year, as well as an average machine size of 40 pound capacity (Zogg et al. 2009). For more detail on machine type, size, and location, refer to the Appendix. Annual water and energy use by sector presents a more complete view of the scale of each commercial sector, as well as the residential sector (Figure 8 and Figure 9).

Table 6: Summary of Commercial Stock Estimates by Facility Type

State	Facility Type	Machine Stock Estimate
Illinois	Multifamily Laundry Room	96,678
Illinois	Laundromat	22,201
Illinois	On-Premise Laundry	14,720
Indiana	Multifamily Laundry Room	35,475
Indiana	Laundromat	7,676
Indiana	On-Premise Laundry	9,007
Michigan	Multifamily Laundry Room	51,736
Michigan	Laundromat	11,272
Michigan	On-Premise Laundry	11,057
Minnesota	Multifamily Laundry Room	19,668
Minnesota	Laundromat	7,010
Minnesota	On-Premise Laundry	7,438
New York	Multifamily Laundry Room	159,864
New York	Laundromat	69,710
New York	On-Premise Laundry	18,178
Ohio	Multifamily Laundry Room	73,641
Ohio	Laundromat	13,211
Ohio	On-Premise Laundry	15,352
Pennsylvania	Multifamily Laundry Room	61,396
Pennsylvania	Laundromat	20,321
Pennsylvania	On-Premise Laundry	14,187
Wisconsin	Multifamily Laundry Room	37,911
Wisconsin	Laundromat	9,736
Wisconsin	On-Premise Laundry	8,665

Figure 8: Annual Water Use by Sector

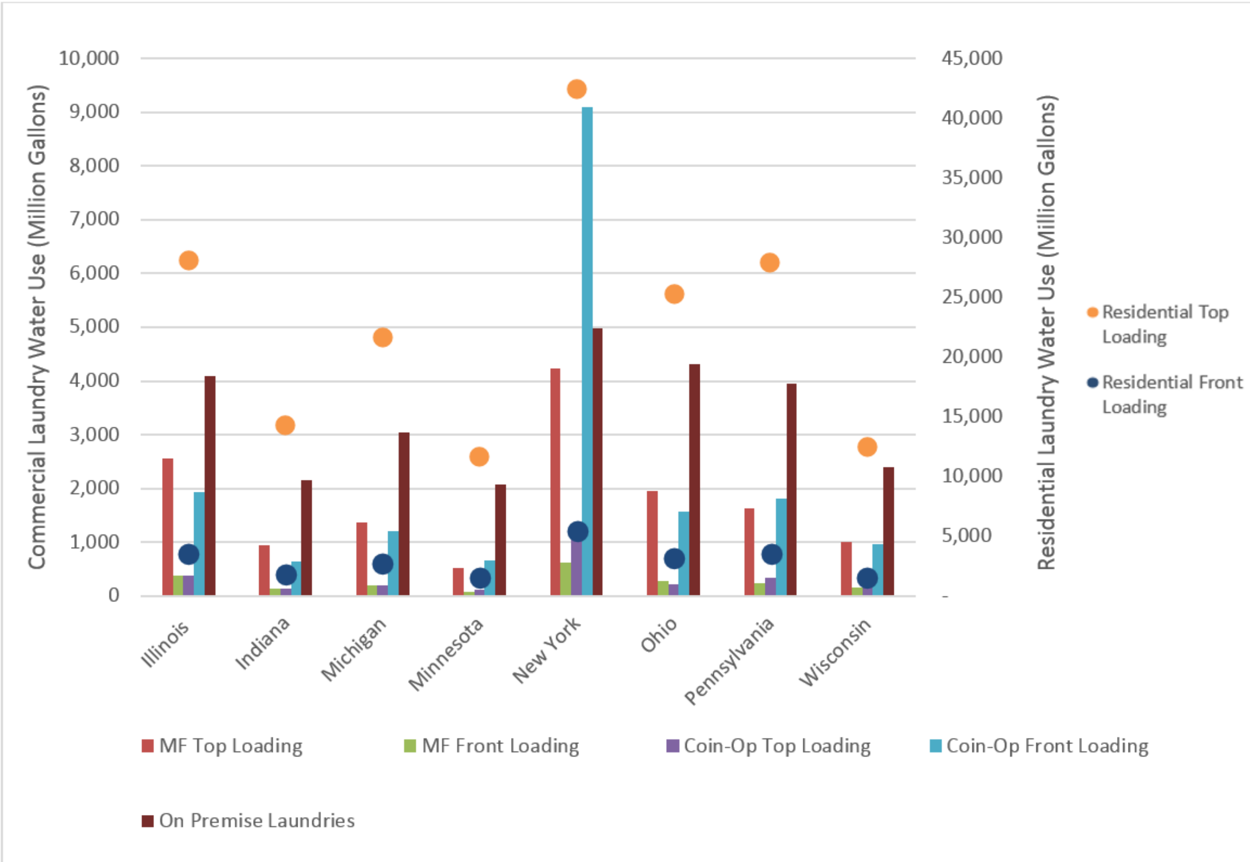
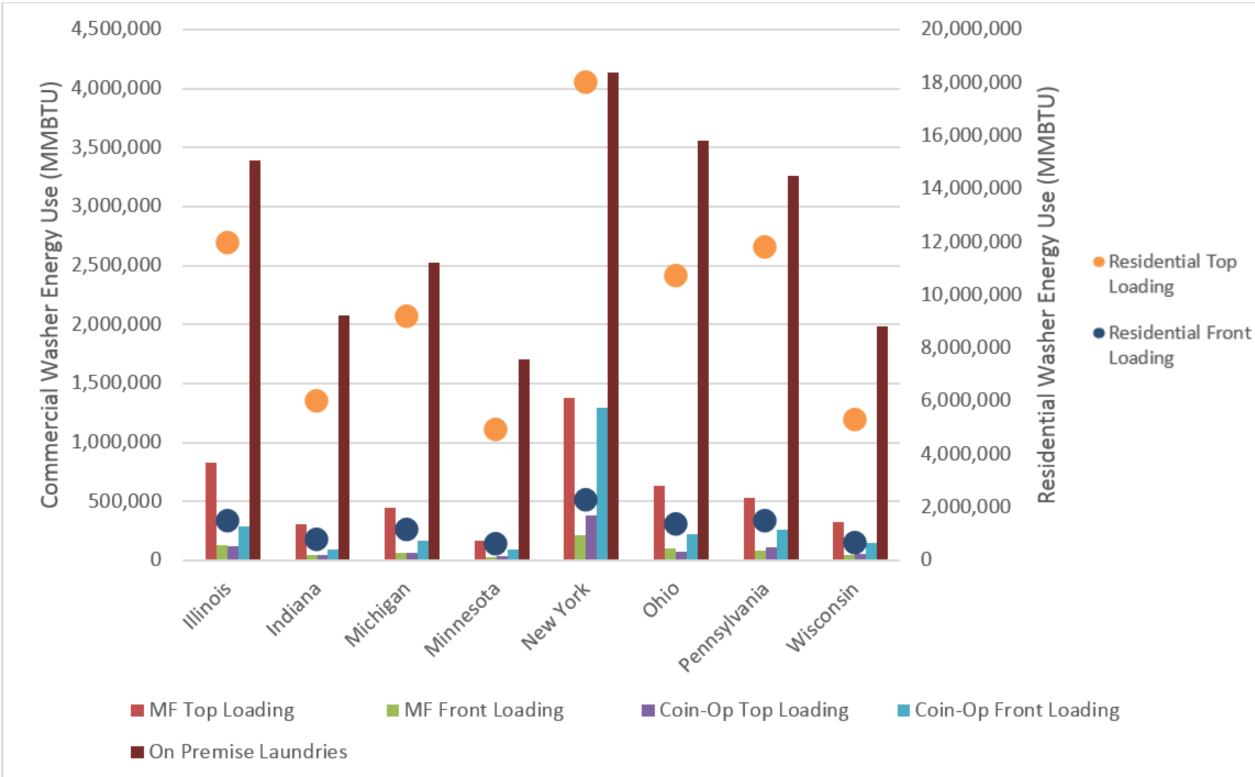


Figure 9: Annual Energy Use by Sector



Technical and Economic Potential

Opportunities for Energy and Water Savings from Machine Replacement

Significant potential for energy and water savings exist in clothes washer markets. While the ENERGY STAR program has been extremely successful in penetrating the residential clothes washer market, reaching 61% of total shipments in 2011, uptake in the commercial sector has not been as successful, making up only 32% of clothes washer shipments in 2011 (ENERGY STAR 2011). In the laundromat and OPL sectors, small case studies of programs and retrofit projects that have led to energy and water savings through machine replacement or other innovative changes serve as examples of the high potential in these largely untapped sectors. A variety of options targeting specific sectors of the clothes washer market, estimated savings, and a discussion of the potential challenges associated with addressing each sector are detailed below.

Residential Clothes Washers

While market penetration of high efficiency ENERGY STAR units is very high in some states, other states are lagging behind. Targeting states where consumers are lagging in the transition to ENERGY STAR clothes washers can produce significant savings. As shown through data on state clothes washer market share from 2009 (Figure 5), some states were lagging behind the national average of 48% in 2009. Both Indiana and Ohio had a market share of 46% for commercial washers, while all other Great Lakes states were above the national average, some with market shares as high as 60% (D&R International 2009). There is also potential for savings in all states from targeting only the highest efficiency products (i.e., TopTen USA and ENERGY STAR Most Efficient models) rather than all ENERGY STAR products.

Family-Size Commercial Clothes Washers

Some existing rebate programs for residential clothes washers also offer rebates for commercial washers, but there are few programs that specifically target the family-size commercial clothes washer market. Targeting sales in the multifamily and laundromat sector can lead to considerable energy and water savings. On an annual basis, approximately 160,000 family-size commercial clothes washer units are shipped in the United States (Table 7) (DOE 2012c).

Table 7: Commercial Clothes Washer Unit Shipments

Year	Total	Top-loading	Front-loading
2010	164,196	104,159	60,037
2011	160,973	106,592	54,381

Source: DOE 2012c

The base case for commercial clothes washers as utilized in the standard rulemaking process indicates the following energy and water usage information for current unit shipments (Table 8) (DOE 2010).

Table 8: Commercial Clothes Washer Efficiency

Efficiency	MEF	Electricity (kWh/year)	Gas (MMBTU/year)	Water (1000 gal/year)
Current Levels	1.42	910	7.76	34.74
High Efficiency (ENERGY STAR)	2.2	645	4.5	19.82

Source: DOE 2010

A transition to ENERGY STAR commercial clothes washers (2.2 MEF and 4.5 WF) can provide significant statewide savings. An estimated 32% of commercial clothes washer units shipped in 2011 were ENERGY STAR, which amounts to approximately 65,000 total units nationally (ENERGY STAR 2011). Transitioning the remaining commercial clothes washer shipments to machines that meet minimum ENERGY STAR requirements could result in the annual savings shown in Table 9 for each state.

Table 9: Potential Annual Energy and Water Savings from Transition to Commercial Washer ENERGY STAR Units

State	Adjusted State Sales	Electricity Savings (GWh/yr)	Natural Gas Savings (MMBtu/yr)	Water Savings (1000 gal/yr)
Regional Total	45,236	22	215,000	971,000
Illinois	8,154	3.90	38,700	175,000
Indiana	2,992	1.43	14,200	64,200
Michigan	4,363	2.09	20,700	93,600
Minnesota	1,659	0.79	7,870	35,600
New York	13,482	6.44	64,000	289,000
Ohio	6,211	2.97	29,500	133,000
Pennsylvania	5,178	2.47	24,600	111,000
Wisconsin	3,197	1.53	15,200	68,600

Sales for multifamily and laundromat applications as well as the associated use in each setting must be considered when determining energy and water savings potential. While the number of commercial clothes washers sold for multifamily applications is much greater than the number sold for laundromat applications (85% versus 15%, respectively), the number of cycles per year for each machine is significantly higher for machines found in laundromats (2190 versus 1246 loads per year on average, respectively) (DOE 2010). As a result, the savings per unit replaced are much higher for machines used in laundromats versus machines used in multifamily laundry rooms (Table 10). Utility programs targeting specific savings goals should also consider the differences in predominant fuel type in multifamily laundry rooms versus laundromats. A majority of the energy use attributed to the clothes washing process comes from energy used by hot water heaters. According to DOE, 100% of the fuel share of hot water heaters in laundromats is natural gas, while in multifamily laundry rooms 80% is natural gas and 20% is electric (DOE 2010). For utilities targeting electricity savings, focusing on programs that target multifamily building owners will likely lead to greater electric savings.

Table 10: Average Annual Energy and Water Savings per Unit Replaced

	Electricity (kWh)	Natural Gas (MMBTU)	Water Usage (1000 gal)
Laundromat	365	11.0	37
Multifamily	565	4.8	21

Figure 10: Annual Natural Gas Savings from Laundromat and Multifamily Machine Replacement

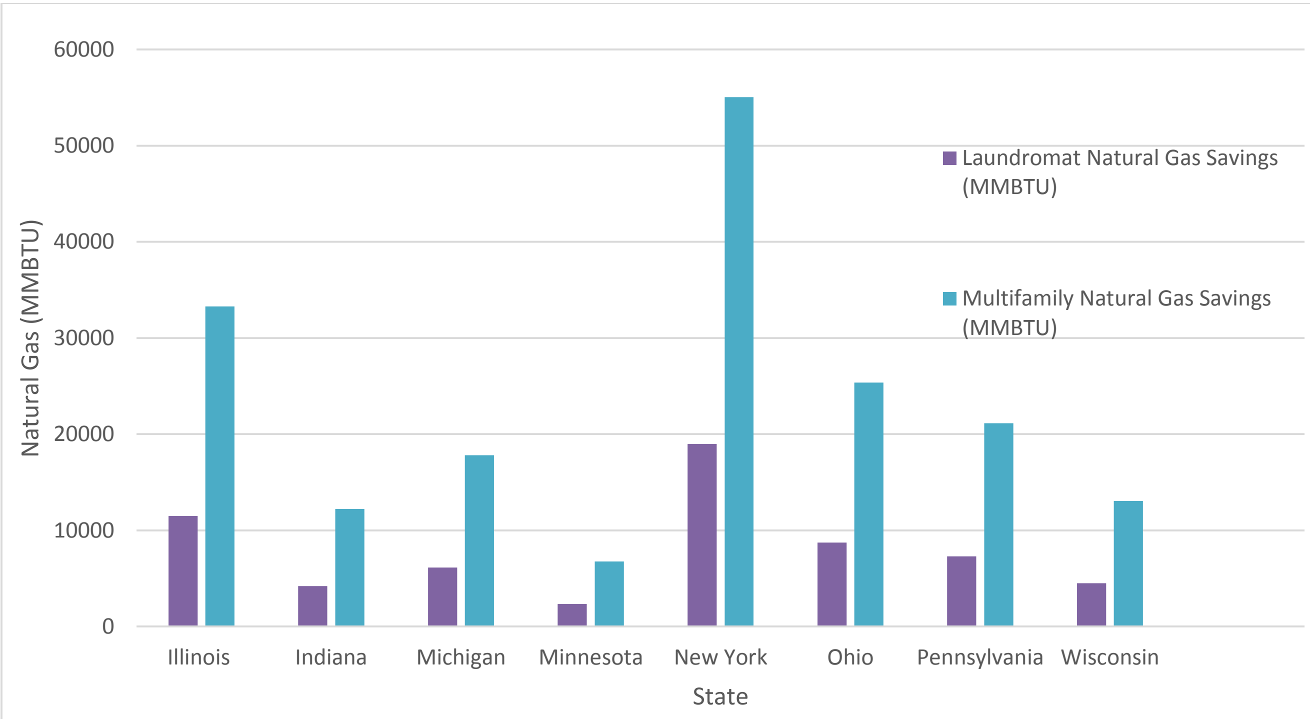


Figure 11: Annual Electricity Savings from Laundromat and Multifamily Machine Replacement

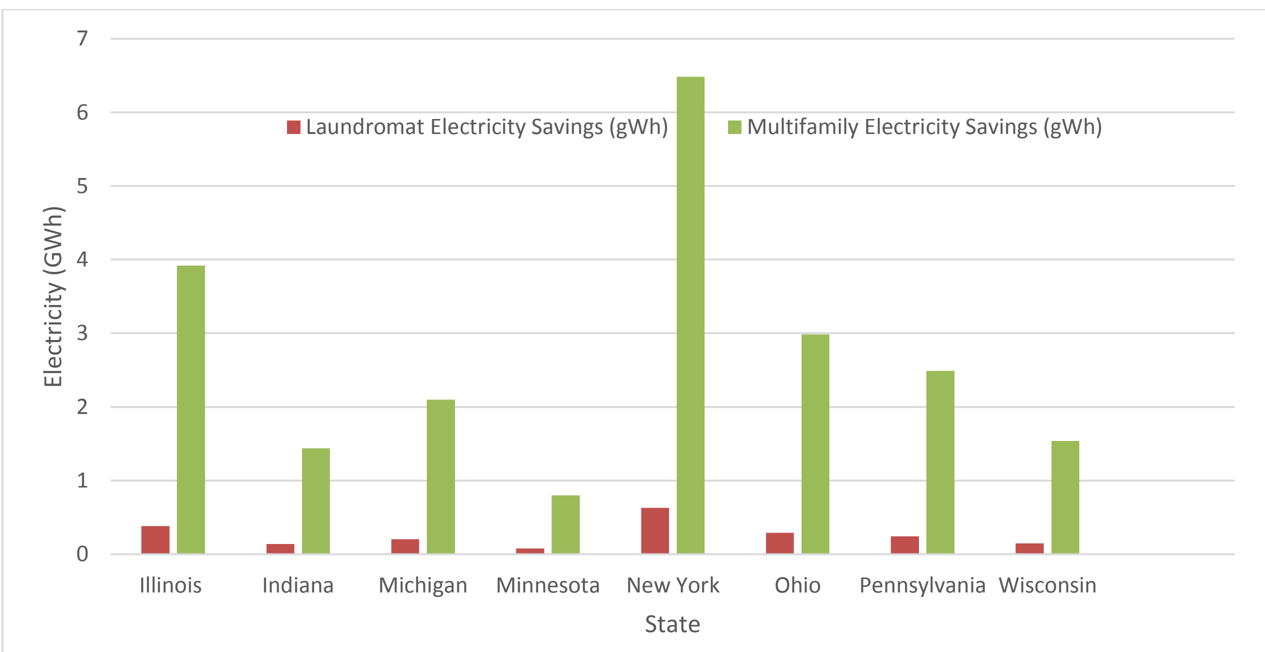
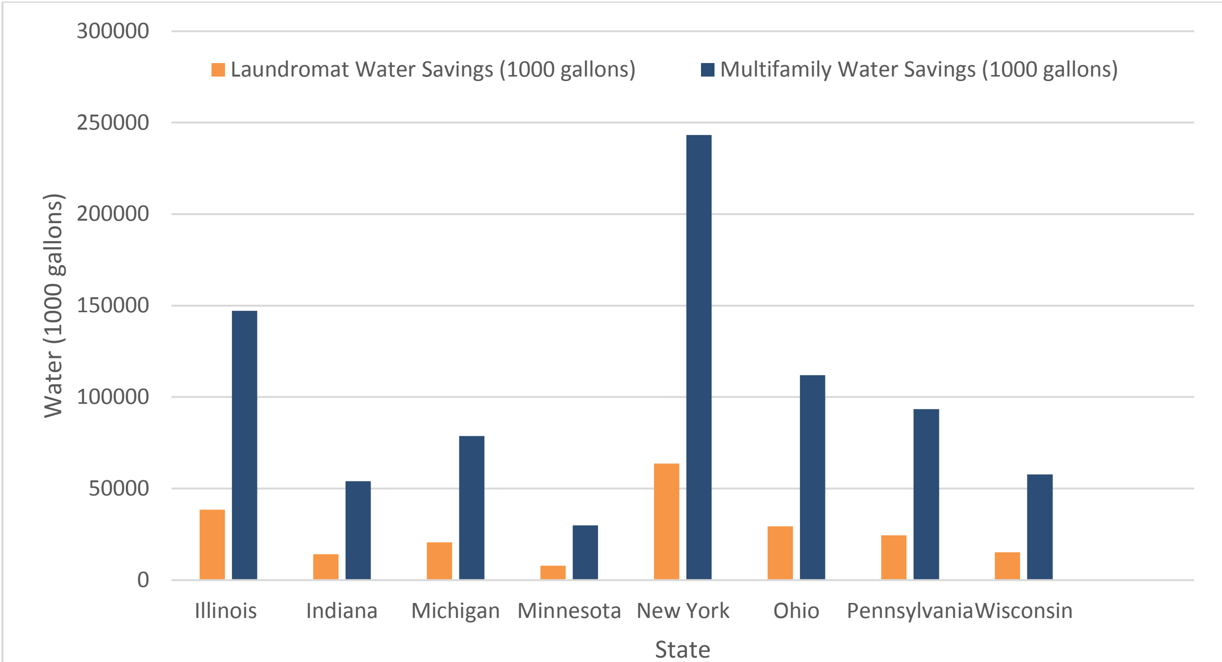


Figure 12: Annual Water Savings from Laundromat and Multifamily Machine Replacement



Opportunities for Energy and Water Savings in Laundromats

Laundromat owners stand to realize significant energy and water savings from upgrades and adjustments to washer equipment. The coin-op industry is primarily composed of individual owners and operators, with no significant franchises in operation (CLA 2013). The variety of energy and water saving technology applications, combinations, and permutations of this technology makes it challenging to present an accurate estimate of total statewide energy savings potential. While energy and water savings potential from upgrades in laundromats is significant, some upgrade options provide unique added value and increased options for laundromat owners that cannot be easily incorporated into an energy and water savings estimate. As a result, case study examples of expected and realized energy savings are presented in support of each upgrade option.

Upgrade to Soft-mount Machines

Upgrade of older front-loading technology to newer units can result in considerable energy and water savings. Energy and water savings from upgrading existing hard-mount front-loading units to newer soft-mount units are detailed in Table 11. Energy and water savings realized from upgrading older hard-mount equipment to newer hard-mount equipment are roughly equivalent to the energy and water savings from an upgrade to a soft-mount machine. However, soft-mount machines are included in Table 11 because of the savings associated with a reduction in dryer energy use (Continental Girbau 2013; Lmaries 2013). Water savings of 9.3 to 29.6 gallons can be realized by machine upgrade, while significant energy savings of 25,000 to 38,000 BTUs per cycle from reduction in dryer use can also be realized.

Table 11: Energy and Water Savings per Cycle from Multi-load Machine Upgrade

Machine Type	Water Use (Gallons)	Washer Natural Gas Use (BTUs)	Washer Electric Use (kWh)	Dryer Natural Gas Use (BTUs)
Low Efficiency 20lb Hard-mount	23.5	3000	0.19	29,000
High Efficiency 20lb Soft-mount	14.2	2000	0.28	4,000
Savings	40% (9.3 gallons)	33% (1000 BTUs)	47% increase (0.09 kWh)	86% (25,000 BTUs)
Low Efficiency 30lb Hard-mount	40.7	4000	0.46	47,000
High Efficiency 30lb Soft-mount	20.6	2000	0.3	17,000
Savings	50% (20.1 gallons)	50% (2000 BTUs)	40% (0.16 kWh)	63% (30,000 BTUs)
Low Efficiency 40lb Hard-mount	60.3	7000	0.56	60,000
High Efficiency 40lb Soft-mount	30.7	3000	0.57	22,000
Savings	49% (29.6 gallons)	57% (4000 BTUs)	1.8% increase (0.01 kWh)	63% (38,000 BTUs)

Source: Continental Girbau 2013

Single-load to Multi-load Machine Replacement

Creative replacement and upgrade options can help laundromat owners realize even more significant savings than would be expected from upgrade of aging equipment to a newer unit of the same size. Use of larger scale multi-load machines is growing in the laundromat sector. In a pilot program in San Diego County, incentives were given by the San Diego County Water Authority to encourage laundromat owners to replace single-load top-loading coin operated machines with more efficient, larger multi-load machines (WMI 2006). Data from manufacturers as well as actual water use data collected for an assessment of the pilot program concluded that multi-load washers are more water efficient than single-load top-loading machines. In this study, single-load top-loading machines have an average water factor (WF) of 12.6, 35 pound multi-load machines have an average water factor of 10.8, and the largest units (55 pounds) have an average water factor of 9.9 (WMI 2006).

The savings realized from a variety of machine replacements and upgrades in the San Diego example are significant. The profiles of a number of laundromats pre- and post-retrofit provide an example of the potential gains in efficiency and in overall laundromat capacity from upgrading single-load top-loading machines to multi-load machines. There is no single formula for replacement and associated savings that applies to all applications, but experience from completed retrofits serves as a helpful guide. In the first example, three single-load top-loading machines, with a capacity of 12 pounds each were replaced by two multi-load washers with a capacity of 40 pounds each. This retrofit increased the capacity of the laundromat by 44 pounds while simultaneously decreasing the water factor from 16.3 to 12 (Table 12).

Table 12: Top-loading Machine Replacement

Washer Size	Number of Units	Water Use per Cycle (gallons)	Water Factor (WF)
12 lb Top-loading	3	41.3	16.3
40 pounds (post-retrofit)	2	76.1	12

Challenges and Benefits of Multi-load Machine Replacement

Retrofitting existing laundromats with multi-load units can be very beneficial for laundromat owners for numerous reasons: energy and water savings, increased capacity, and reduced load time. A number of the benefits are elaborated on below:

- **Increase total laundromat capacity without increasing laundromat facility size**. Multi-load machines can provide increased capacity without significantly increasing space demands in a laundromat. While increasing machine size can provide a significant capacity increase for a laundromat, accommodation of washers with larger footprints can present a challenge. Table 13 details average footprint size for a number of washer sizes (WMI 2006). While size differences will likely require reconfiguration of existing machines to accommodate new machines, laundromat owners likely will replace multiple machines simultaneously, thereby only making incremental reconfigurations necessary. A survey from American Coin-Op on 2012 equipment additions indicated 48% of respondents purchased at least one piece of equipment in 2012, with the following average purchases of machine types:
    - 12.7% of buyers purchased at least one top-loader, with the average purchase size of 5.4 machines;
    - 16.1% of buyers purchased at least one front-loading machine with a capacity of up to 25 pounds, average purchase of 6.0 machines;
    - 29% of buyers purchased at least once machine with a capacity of 25-50 pounds with an average purchase size of 4.8 machines; and
    - 35% of buyers purchased at least one machine with a capacity of more than 50 pounds, with an average purchase size of 2.6 (Beggs 2013).

Table 13: Washer Sizes and Corresponding Footprint

Washer Sizes	Washer Sizes	Footprint	
		Width (inches)	Depth (inches)
Top-load			
Single-load Washer	12	25-27	26.75-28.25
One and a Half Load Washer	18	27	28
Double Load Washer	20	26	26
Front-load			
Single-load Washer	12	26.75	27
One and a Half Load Washer	18	27	28.25
Double Load Washer	20	26-27	27-30
Triple Load Washer	30	28-29	31-33
Four Load Washer	40	31	36
Four and a Half Load Washer	55	33	39

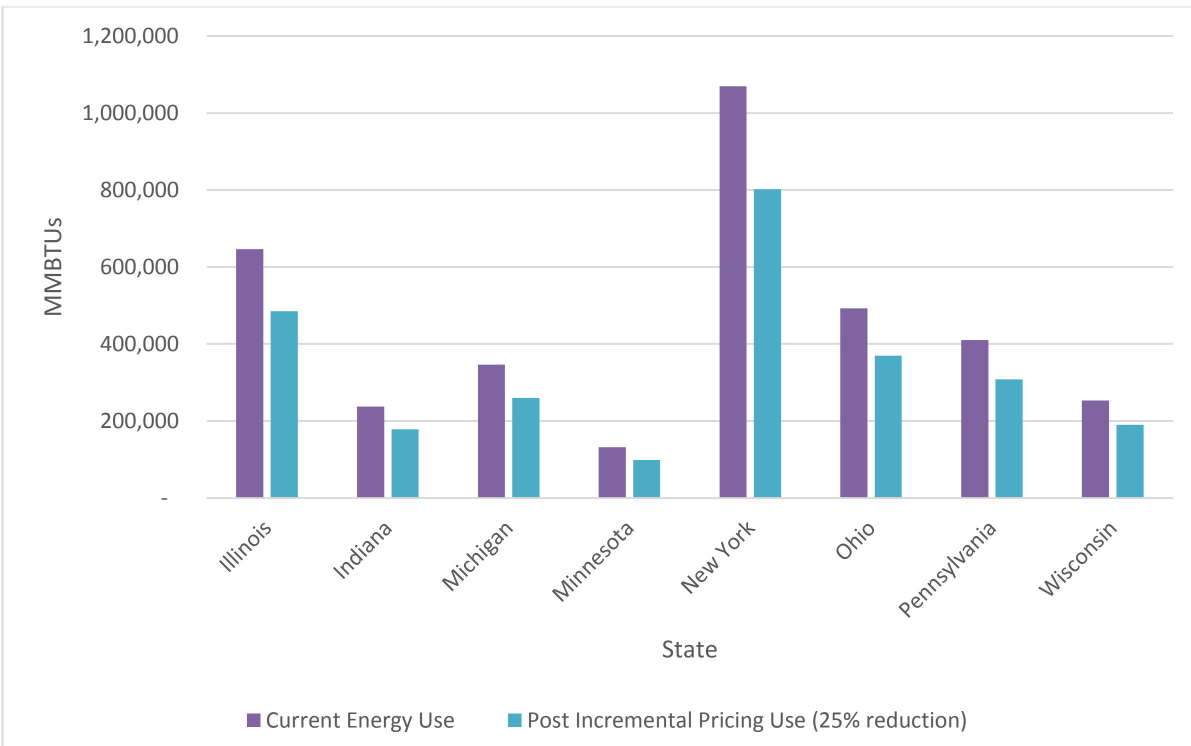
- **Multi-load units are highly customizable**. Microprocessor technology in multi-load units allows manufacturers to produce machines with more than 30 different rinse and wash features to accommodate the needs of a specific laundry facility. As a result, however, energy and water use can vary significantly according to how each unit is programmed. The balance between maximizing savings while also making sure laundry is cleaned to satisfactory levels is key to laundromat owners.
- **Changes in customer use.** Multi-load washers can be of great use and value to customers who visit a laundromat and use multiple machines to wash large quantities of clothing. Marketing of multi-load laundromats to customers who may be unfamiliar with the machine type is important to educate customers on the capacity of machines. In the San Diego study, retrofit data indicated consumers were filling multi-load machines to only approximately 50-60% of the total capacity (WMI 2006). Experience with multi-load retrofits in San Diego indicates that customers migrate to larger washers only when they perceive they are getting a better deal. Pricing and "obvious appearance of more capacity" are important for laundromat owners facilitating customer transition to new technology (WMI 2006).
- **Permitting fees per washer.** In some jurisdictions, laundromat owners are required to have a permit for each washer in the laundromat; these fees are known as impact fees and are usually set by individual municipalities (Lmaries 2013). In San Diego County, for example, each washer requires a permit at a cost of $3,130 (WMI 2006). Laundromat owners oftentimes can avoid permit costs by replacing single-load washer with multi-load units, while still increasing capacity. Many municipalities in the Great Lakes states have impact fees that most commonly apply to new construction that requires new water and sewer connections. Depending on the locality, changes in the use of existing buildings also may be subject to impact fees as well as any clothes washing machine additions that would require changes to existing water and wastewater lines.

Savings from Incremental Pricing

Multifamily Laundry Rooms

Since the majority 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 Corp., laundry loads cost $1.25 with the cold water setting, $1.50 for warm washes, and $1.75 for hot washes. As a result of this pricing scheme, the management company has reported residents have switched from using almost exclusively hot water to using cold water, resulting in an estimated energy use reduction of 25-30% (ASE 2011). Based on these findings, expected annual energy savings in the Great Lakes States would range from about 32,000 to 160,000 MMBTU as demonstrated in Figure 13.

Figure 13: Annual Energy Savings from Incremental Pricing in Multifamily Laundry Rooms



Laundromats

A similar opportunity exists for incremental pricing in laundromats. Many coin-op washers have programming options that allow for differential pricing for user-selected washing options (e.g., water temperature, number of rinse cycles, and extended wash cycle). Multi washing option pricing is used more readily in very competitive markets, such as in California. However, in markets like Ohio, it is not believed to be used as readily (Lmaries 2013). There is concern among laundromat owners that different cycle options and pricing will cause customer confusion — some customers may end up choosing cycles based solely on the lowest price rather than laundry condition, and then complain that clothes are not clean. Laundromat owners often simplify the process for customers by offering only one wash type to ensure a quality wash for customers who may not know to choose the correct wash cycle (Lmaries 2013).

An opportunity exists to allow incremental pricing for a limited number of options, as was demonstrated in the multifamily laundry room example. Instead of allowing customers the option to choose from a host of rinse, wash, and temperature permutations, keeping it simple to allow cold, warm, and hot washes with incremental pricing is important to minimizing consumer confusion and increasing energy savings.

On-Premise Laundry Energy and Water Savings

Machine Replacement

There is no "one size fits all" solution for energy and water savings in on-premise laundry facilities, as each facility varies considerably in machine composition, facility type and staffing, and laundry quality requirements. Upgrades from aging equipment can significantly reduce energy and water use from the washer itself, as well as for dryer energy use.

In an OPL retrofit example from a hotel in San Antonio, TX, new soft-mount machines cut hotel water usage by 3.6 million gallons a year. While processing about 2.6 million pounds of linens, the facility was able to transition from using 3 gallons of water per pound of laundry to 1 gallon per pound (Jorgensen 2012). This represents a significant water savings compared to average OPL laundries, which are estimated to use 2.4 gallons per pound of laundry.

Unique value additions to machine replacement in the OPL sector should also be considered. Machine replacement can provide OPLs with distinct advantages, so that the value of new machines does not solely have to rest on expected energy and water savings. The amount of time employees spend washing laundry is a unique consideration in the OPL sector. By installing new machines that (1) take less time to complete a wash cycle and (2) more consistently clean linens so they do not have to be washed a second time, hotels can save time and improve productivity (Jorgenson 2012). Additionally, replacement with soft-mount washers provide a quieter wash cycle that does not disturb guests because the unit's suspension absorbs most of the vibration during extraction cycles (Jorgensen 2009).

Technology Upgrades

In addition to machine replacement, technology options for the OPL sector can provide significant savings. In a hotel in California, an ozonated laundry system was installed for use with existing machines. Ozone is a cleaning agent that can be injected directly into the incoming water line for the laundry. It safely removes dirt from linens by breaking down soil molecules more effectively than chlorine and other cleaning agents. It is most effective when used in cold water, which serves to drastically reduce water heating costs for laundry facilities where this technology is used (PG&E 2011). Water and energy savings from installation of an ozonated laundry system proved to be significant. Hot water use was reduced by 95%, which reduced gas usage by 6,500 therms. In addition, overall water usage dropped by 5-8% because laundry requires less water to get clean with the use of a more effective cleaning agent (PG&E 2011). Added benefits noticed by hotel staff included increased life of linens, decreased use of cleaning chemicals, and less chemical smell in towels and linens after washing (PG&E 2011). While OPL managers may be hesitant to abandon traditional chemical washing formulas and hot water washes in favor of ozone wash technology, successful examples of retrofits are shown in Table 14. A number of retrofit examples were profiled by Pacific Gas and Electric (PG&E) in California, which offered an incentive for installation of ozone technology.

Table 14: Energy and Water Savings for Ozone System Retrofits

	Location	Guest Rooms	Savings	Savings/Guest Rooms	Total Water Savings	Hot Water Savings	Water Savings/Guest Room/Year	Project Cost	PG&E Paid Incentive
Hotel		#	*Therms*	*Therms*	*Gallons*	*Gallons*	*Gallons*		
Hilton Garden Inn	Mountain View	160	2,944	18.4	465,950	473,828	2,912	$15,140	$2,159
El Rancho Motel Inc.	Milbrea	306	13,126	42.9	529,630	1,166,099	1,731	$23,165	$10,501
Vintner's Inn/John Ash & Company	Santa Rosa	44	3,411	77.52	157,375	296,740	3,577	$13,000	$2,729
Hotel Valencia	San Jose	213	10,530	49.44	1,418,304	2,066,792	6,659	$15,662	$7,831

Notes: Adapted from PG&E profile of ozone retrofit projects (PG&E 2011).

COST SAVINGS ESTIMATES

Residential Savings

Cost savings associated with upgrading a conventional residential clothes washer to an ENERGY STAR unit are considerable, which has been responsible in part for the large market share that residential ENERGY STAR clothes washers have gained in the last few years. There is significant variation among ENERGY STAR-ranked units, and honing in on the most efficient products on the list can provide additional savings benefits. TopTen USA, for example, ranks the top 10 products on the ENERGY STAR list, which can often have hundreds of products with varying energy and water use characteristics, as well as varying availability, and highlights the ten products that are the lowest energy consumers that are also widely available to consumers. Similarly, ENERGY STAR's Most Efficient list designates the most efficient products among those that qualify for the ENERGY STAR designation. Innovative program designs can target additional savings in the residential clothes washer market by offering rebates for the highest ranked products. Cost savings estimates for one year of use between a conventional residential washer (top-loading), a baseline ENERGY STAR unit, and a top rated ENERGY STAR unit that qualified for the TopTen USA list are detailed in Table 17.

Utility rates differ across the Great Lakes States. While savings estimates for each state are not presented here, Indianapolis, IN is used as an example to illustrate cost savings potential based on the utility rates in Tables 15 and 16.

Table 15: Gas and Electric Rates by State

State	Commercial electric rate ($/kWh)	Commercial gas rate ($/therm)	Residential electric rate ($/kWh)	Residential gas rate ($/therm)
U.S. average	$0.100	$0.891	$0.115	$1.079
Illinois	$0.087	$1.261	$0.116	$1.616
Indiana	$0.087	$1.007	$0.100	$1.608
Michigan	$0.104	$1.140	$0.131	$1.558
Minnesota	$0.088	$0.871	$0.110	$1.240
New York	$0.161	$0.861	$0.183	$1.966
Ohio	$0.097	$0.931	$0.114	$2.321
Pennsylvania	$0.101	$1.198	$0.133	$1.988
Wisconsin	$0.105	$0.825	$0.130	$1.462

Source: EPA and DOE 2013

Table 16: Water and Sewer Rates for Select Cities in the Great Lakes Region

City	Residential $/1,000 gallons)	Commercial ($/1,000 gallons)
U.S. Average	$8.37	$6.98
Chicago, IL	$3.25	$3.26
Cleveland, OH	$7.98	$8.28
Columbus, OH	$8.53	$7.60
Detroit, MI	$6.96	$6.14
Indianapolis, IN	$6.91	$5.57
Milwaukee, WI	$4.67	$3.90
Minneapolis, MN	$7.36	$7.40
New York, NY	$7.98	$8.02
Philadelphia, PA	$8.81	$9.55

Source: Black & Veatch 2010

Table 17: Annual Residential Clothes Washer Energy and Water Cost in Indianapolis, IN

Machine Type	Energy Use (kWh)	Energy Cost	Water Use (gallons)	Water Cost	Total Cost
Conventional Unit (1.26 MEF, 9.5 WF)	768	$76.65	9188	$63.49	$140.14
ENERGY STAR Unit (2.0 MEF, 6.0 WF)	484	$48.30	5803	$40.10	$88.40
Top Ten Unit (3.3 MEF, 3.0 WF)	293	$29.24	2902	$20.05	$49.29

Assumptions: 312 cycles/year, 11 year machine lifespan, hot water fuel type and dryer fuel type- electric, 3.1 cubic feet capacity, 6 loads/week, Indiana residential utility rates ($0.098 per kWh, $1.61 per therm, $6.91 per thousand gallons) (EPA and DOE 2013; Black & Veatch 2010).

In Indiana for example, switching to an ENERGY STAR unit from a conventional clothes washer would yield savings of $52 a year in energy and water savings (EPA and DOE 2013). An additional $39 annually can be saved by upgrading to a TopTen USA ranked appliance instead of a baseline ENERGY STAR model—this represents a total savings of $91 a year over a conventional unit (Table 17) (EPA and DOE 2013).

Multifamily Savings

In the multifamily sector, the value proposition for switching to a high efficiency machine is strengthened by annual and lifetime water and energy cost savings as well (Table 18).

Table 18: Annual Multifamily Clothes Washer Cost Savings in Indianapolis, IN

Machine Type	Electricity Use (kWh)	Electricity Cost	Natural Gas Use (Therms)	Natural Gas Cost	Water Use (gallons)	Water Cost	Total Cost
Conventional Unit (1.60 MEF, 8.50 WF)	1,570	$136.60	28	$28.28	29,702	$165.44	$330.32
ENERGY STAR (2.2 MEF, 4.5 WF)	1,341	$116.67	11	$11.11	15,725	$87.58	$215.36
						Annual Savings:	$115

Assumptions: 1,241 cycles/year, 7 year machine lifespan, building fuel hot water type — natural gas, dryer fuel — electric, 2.80 cubic feet capacity, 24 loads/week, Indiana commercial utility rates ($0.087 per kWh, $1.01 per therm, $5.57 per thousand gallons) (EPA and DOE 2013; Black & Veatch 2010).

Shifting from a conventional top-loading commercial washer in a multifamily laundromat can yield significant savings for a building owner paying for utilities. Because of the frequency of use of multifamily machines (an average of 1,241 cycles/year versus an average of 312 cycles/year in a residential unit), replacement of multifamily washing machines with a unit at the minimum ENERGY STAR efficiency level can yield an annual savings of $115 (EPA and DOE 2013).

Laundromat Savings

Due to the high frequency in use of clothes washers in a laundromat setting, savings associated with switching from a conventional top-loading commercial washer to a front-loading unit that meets the minimum ENERGY STAR requirements can yield even more significant savings. Replacement of a conventional top-loading washer in a laundromat can yield an annual savings of $187 (Table 19).

Table 19: Annual Laundromat Clothes Washer Cost Savings in Indianapolis, IN

Machine Type	Electricity	Electricity Cost	Gas	Gas Cost	Water	Water Cost	Total Cost
Conventional Unit (1.60 MEF, 8.50 WF)	269	$23.46	133	$133.93	51,979	$289.52	$446.91
ENERGY STAR (2.2 MEF, 4.5 WF)	108	$9.39	96	$96.96	27,518	$153.27	$259.62
						Annual Savings	$187.29

Assumptions: 2,190 cycles/year, 7 year machine lifespan, building fuel hot water type — natural gas, dryer fuel — natural gas, 2.80 cubic feet capacity, 42 loads/week, Indiana commercial utility rates ($0.087 per kWh, $1.01 per therm, $5.57 per thousand gallons) (EPA and DOE 2013, Black & Veatch 2010).

Commercial On-premise Laundry Savings

Expected savings from commercial machines vary widely based on on-premise laundry location and type. For an average hotel size of 95 rooms, in Indianapolis, Indiana, expected usage and savings associated with replacing aging front-loading, hard-mount clothes washers with new soft-mount machines is detailed in Table 20. Determining savings in the on-premise laundry sector is more challenging because usage differs significantly, but this example serves as an indicator of the magnitude of water and energy savings that can be realized under the following conditions in a hotel.

For an average size hotel with 95 rooms, approximately 1,995 pounds of laundry are processed every day (assuming 30 pounds/room/day with a 70% occupancy rate), over $10,000 annual savings could be realized by upgrading an entire OPL facility to new high efficiency soft-mount machines.

Table 20: Potential Cost Savings for a Commercial OPL Facility in Indianapolis, IN

Machine Type	Washer Gas Use (therms)	Cost	Dryer Gas Use (therms)	Cost	Water Use (gallons)	Cost	Total Daily Utility Cost	Total Annual Utility Cost
Conventional 30 lb Hard-mount	2.66	$2.69	31.25	$31.56	2705.22	$15.07	$49.32	$18,000
High Efficiency 30 lb Soft-mount	1.33	$1.34	11.31	$11.42	1368.57	$7.62	$20.39	$7,440
							Annual Savings:	$10,560

Assumptions: Hotel OPL, 95 rooms, 30 pounds/room/day of laundry processed, 70% occupancy rate, Indiana commercial utility rates ($0.087 per kWh, $1.01 per therm, $5.57 per thousand gallons) (EPA and DOE 2013, Black & Veatch 2010, Riesenberger 2006). Machine energy/water use estimates (Continental Girbau 2013).

Summary of Energy and Water Cost Trends

Data on energy and water/wastewater cost trends also support the adoption of more efficient clothes washer technology. Increases in both electric and natural gas prices have been observed over the last few decades. Figures 14 and 15 show the trend in residential electric and commercial natural gas prices over the past two decades. Price trends for commercial electric and residential natural gas are similar to the electric and gas trends shown.

Figure 14: Average Annual Residential Electric Price (1990-2011)

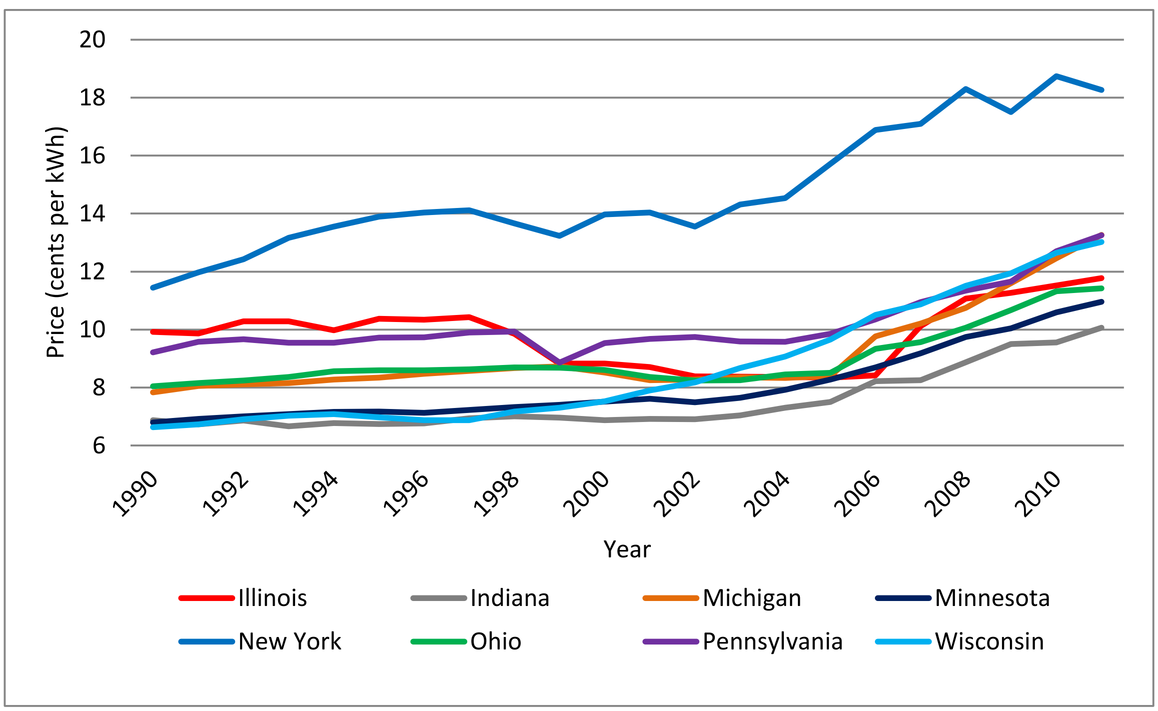
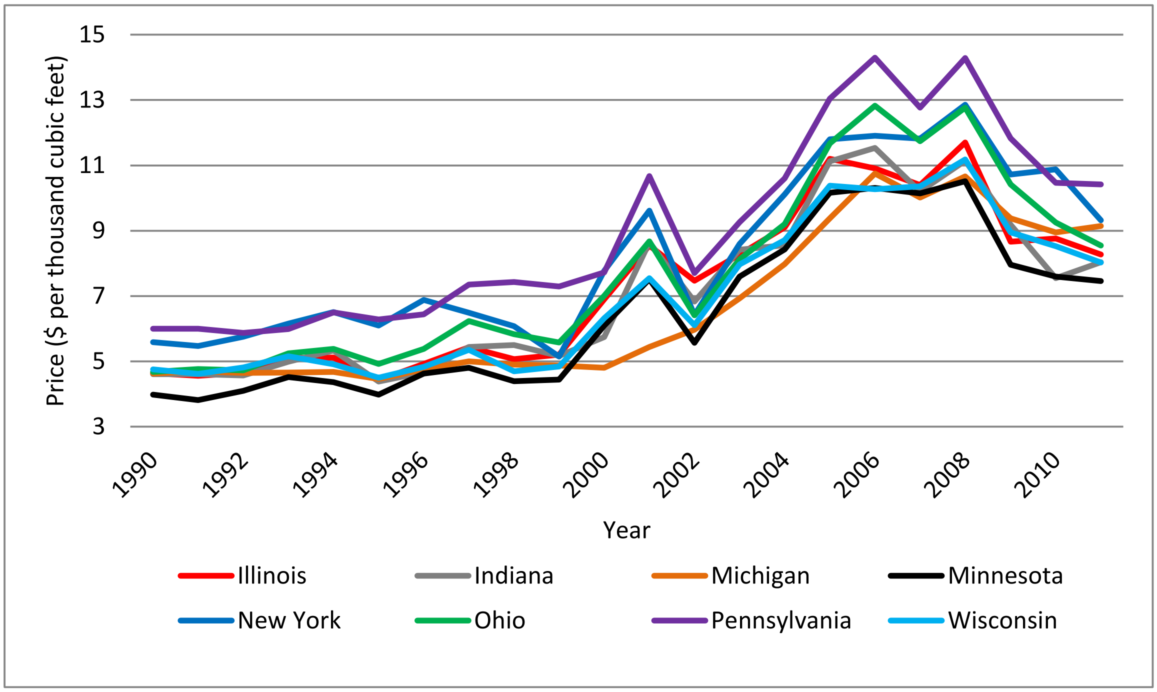


Figure 15: Average Annual Commercial Natural Gas Price (1990-2011)



From 1990 to 2011, average annual residential electric prices increased by 19% to 96% and average annual commercial electric prices increased by 11% to 80% in the eight Great Lakes states (EIA 2013a). Over the same period, average annual residential natural gas prices increased by 70% to 106% and average annual commercial natural gas prices increased by 67% to 97% (EIA 2013b).

Table 21. Percent Change in Average Annual Residential Electric, Commercial Electric, Residential Natural Gas, and Commercial Natural Gas Prices

Energy Type	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
Residential Electric	+19%	+46%	+69%	+61%	+60%	+42%	+44%	+ 96%
Commercial Electric	+11%	+45%	+27%	+44%	+51%	+30%	+24%	+ 80%
Residential Natural Gas	+74%	+76%	+109%	+91%	+85%	+104%	+89%	+ 70%
Commercial Natural Gas	+78%	+74%	+97%	+87%	+67%	+83%	+74%	+ 69%

Over the next five years, average electricity and natural gas prices are projected to decline slightly. However, energy prices are projected to increase in the long-term. In the Great

Lakes region, average residential and commercial electric prices are projected to increase over the next thirty years at an annual rate of 0.1% to 0.4% and 0.3% to 0.6%, respectively, depending on economic growth. Similarly, average residential and commercial natural gas prices for the region are projected to increase at an annual rate of 1.3% to 1.6% and 1.2% to 1.6%, respectively, depending on economic factors (EIA 2013c).

The prices of water and sewer services are likely to continue to increase in the Great Lakes as well as across the country. Recent surveys from various sources indicate that prices have increased within the past decade, and it is likely that prices will continue to increase due to a combination of factors, including increasing water scarcity, fixed costs, aging infrastructure, and costs associated with regulatory compliance (Beecher and Kalmbach 2011; EPA 2012). According to a national survey by Black & Veatch, typical bills for a residential customer using 7,500 gallons per month have increased at a rate over twice the consumer price index since 2001 due to commodity price increases, pension obligations and health benefits, and wastewater consent decrees, in addition to previously listed factors (Black & Veatch 2010). Increases in water rates over the past twelve years for select cities in the Great Lakes states are shown in Table 22.

Table 22. Change in Water Rates over the Past 12 Years for Select Cities in the Great Lakes States

City	% change over past 12 years
Rochester, NY	+ 21%
Green Bay, WI	+ 27%
Rochester, MN	+ 34%
Grand Rapids, MI	+ 35%
Akron, OH	+ 35%
Harrisburg, PA	+ 49%
Milwaukee, WI	+ 56%
Cincinnati, OH	+ 71%
Minneapolis, MN	+ 77%
Indianapolis, IN	+ 80%
Allentown, PA	+ 108%
Lansing, MI	+ 113%
Chicago, IL	+ 116%
Columbus, OH	+ 118%
Detroit, MI	+ 119%
Cleveland, OH	+ 130%
Binghamton, NY	+ 143%
New York, NY	+ 151%
Philadelphia, PA	+ 164%

Source: *USA Today* 2012

Summary of Current State Regulatory Structures

To help identify states in the Great Lakes region where a clothes washer incentive program might be most easily implemented, we analyzed the electric, gas, and water utility regulatory structure of each state. These results are summarized in Table 23.

Within the eight Great Lakes states, state public utilities or public service commissions regulate a range of investor-owned and municipal electric and gas utilities. Energy utilities in all eight states also are required to implement energy efficiency programs to meet annual energy savings targets. Five states have approved electric rate decoupling, and six states have approved rate decoupling for natural gas utilities.[7] Both Wisconsin and Indiana regulate both investor-owned and municipal water utilities; however, utilities in Indiana are allowed to opt-out of the Indiana Utility Regulatory Commission's jurisdiction pursuant to Indiana Code (IURC 2011). Pennsylvania regulates investor-owned utilities and municipal water utilities that provide service outside their corporate boundaries (PUC 2013). Most other states only regulate investor-owned water utilities with the exception of Michigan and Minnesota, which do not regulate any water utilities at all. There are no known water or sewer rate cases in these eight states where rate decoupling has been allowed.

Wisconsin also is the only state that requires water utilities to implement minimum conservation and efficiency measures, such as controlling losses and leaks in the distribution system, metering of all water sales, and reporting water audit information to the PSC. Water utilities are not required to implement demand management programs, but many utilities choose to implement voluntary programs. These programs must be approved by the PSC, which also allows utilities to recover conservation program costs through rate increases. In general, water utilities are able to spend one percent of total operating revenues on conservation programs (PSC 2013d).

[7] In the traditional model of establishing rates for utilities, higher sales lead to higher utility revenues and profits. This provides a strong financial disincentive for utilities to engage in customer efficiency programs since these programs reduce sales, revenues, and profits. Decoupling separates utilities' sales from revenues and profits, thereby helping to neutralize this disincentive. Decoupling mechanisms use modest annual rate reconciliations to compensate for the under- or over-collection of fixed costs and to adjust utility rates accordingly.

Table 23. Summary of regulatory structure for electric, natural gas, and water utilities in the Great Lakes states

State	No. of Electric Utilities Regulated	Is Electric Rate Decoupling Approved?	No. of Gas Utilities Regulated	Is Gas Rate Decoupling Approved?	No. of Water Utilities Regulated	% of Total Population Served by Regulated Water Utilities	Is Water Rate Decoupling Approved?
Illinois	4	No	9	Yes	25	7%	No
Indiana	17	No	22	Yes	82	51%	No
Michigan	17	Yes	11	Yes	n/a	n/a	n/a
Minnesota	6	Yes	6	Yes	n/a	n/a	n/a
New York	47	Yes	19	Yes	277	4%	No
Ohio	11	Yes	27	No	12	3%	No
Pennsylvania	11	No	35	No	95	23%	No
Wisconsin	96	Yes	11	Yes	583	86%	No

Notes: Data from ACEEE 2012a, 2012b, 2012c, 2013a; ICC 2011, 2013; IURC 2013a, 2013b; Latham 2013; Maier and Chen 2012; MPSC 2012, 2013; MPUC 2013a, 2013b; NRDC 2012; NYS PSC 2013; PSC 2012, 2013a, 2013b, 2013c, 2013d; PUC 2013; PUCO 2013.

Clothes Washer Incentive Program Review

SUMMARY OF UTILITY CLOTHES WASHER PROGRAMS

Numerous utilities within the Great Lakes region offer rebates for the purchase of energy and water efficient clothes washers. The overwhelming majority of these utilities are located in Michigan and Minnesota followed by Ohio and Wisconsin. Major utilities in Pennsylvania also have rebate programs. Up until recently, there were at least two such programs in Illinois; however, they are no longer active. Indiana and New York are the only two states in the region that do not currently appear to have utility rebate programs for clothes washers. Incentive programs for clothes washers offered in the past by the New York State Development and Research Authority (NYSERDA) are no longer active. Most of the existing utility incentive programs are targeted toward the residential clothes washer market, but some programs do not specifically exclude commercial clothes washers. While several states have annual sales tax holidays for ENERGY STAR appliances, none of the Great Lakes states have such tax incentive programs currently in place.

Most investor-owned utilities (IOUs) are required to submit annual reports to their respective state public service or utilities commission documenting energy savings and program costs. However, most of the data is reported in aggregate form (e.g., all residential or ENERGY STAR program data are reported together). Consequently, it is difficult to determine energy savings and program costs directly related to the clothes washer component of many utilities' energy efficiency programs. Follow-up with third-party program administrators and utility staff to obtain more detailed data has not been successful.

Residential Clothes Washer Programs in the Great Lakes

There are approximately 136 existing utility rebate programs specifically for residential clothes washers in the Great Lakes states. An additional 32 utility rebate programs appear targeted towards residential clothes washers but do not seem to preclude commercial clothes washers from eligibility. Most utilities offer a mail-in rebate of $50 to $75 on the purchase of an ENERGY STAR rated clothes washer—though there are some that offer as little as $25 and others that offer as much as $200. Some utilities restrict rebates to the purchase of even more efficient clothes washers, namely CEE Tier 2 or even CEE Tier 3. Most of the rebate programs are offered by electric utilities though some of the smaller utilities that also provide gas and water services offer combined rebates for customers of those services (e.g., $50 for electric customers, $25 for water customers, and $25 for gas customers). In addition, many utilities, particularly those in Michigan, require that customers have the corresponding type of water heater to qualify for the rebate (e.g., electric customers must have electric water heaters to be eligible). There are no known rebate programs in the region that are offered by stand-alone water utilities.

Commercial Clothes Washer Programs in the Great Lakes

As previously mentioned, approximately 32 residential clothes washer rebate programs do not specifically exclude commercial clothes washers from eligibility. However, these programs appear to target residential clothes washers. There are approximately 13 utilities in Michigan, Minnesota, and Pennsylvania that offer rebate programs specifically targeting commercial clothes washers. Major utilities in Michigan including DTE Energy, Michigan Gas Utilities, SEMCO Energy, Wisconsin Public Service and Xcel Energy offer commercial rebate programs, which provide a $50 rebate for commercial clothes washers that meet CEE Tier 2 criteria. Maximum amounts range from $5,000 to $200,000 annually per customer for all prescriptive efficiency measures taken.

In Minnesota, Alliant Energy offers business customers 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). Hutchinson Utilities offers business customers a $75 rebate on the purchase of ENERGY STAR commercial clothes washers with a limit of $2,000 per service address (Hutchinson Utilities 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. Pre-approval is required for amounts over $3,000 (First Energy Companies 2009).

There also are programs that do not utilize rebates and/or do not target clothes washer purchases to increase efficiency. In Michigan, the City of Ann Arbor allows commercial property owners to make energy efficiency improvements, including the purchase of ENERGY STAR appliances, through a financing program that uses a special property assessment for repayment. Projects must range from $10,000 to $350,000 and cannot exceed 20% of the property's value (City of Ann Arbor 2013). DTE Energy in Michigan and Consumers Energy also offer a $40 rebate per pound on the installation of laundry ozone generation systems with a limit of $150,000 to $200,000 per facility or customer for all commercial incentives (Consumers Energy 2013; DTE Energy 2013). Many utilities also have custom efficiency programs for commercial businesses that presumably would include the purchase and installation of high efficiency commercial clothes washers.

Past Innovative Utility Programs in the Great Lakes

Within the Great Lakes region, the Midwest Energy Efficiency Alliance (MEEA), in conjunction with manufacturers, electric utilities, and the Illinois Department of Commerce and Economic Opportunity, conducted an innovative clothes washer rebate program in 2004. Over 4,500 clothes washer rebates were issued during the three-month duration of the program (April 15 to July 15). Estimated 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. The two partnering utilities were ComEd and Southern Minnesota Municipal Power Authority, and nine manufacturers (Maytag, Frigidaire, Fisher & Paykel, General Electric, Miele, Bosch, Equator, LG, Asko) participated. 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. Honeywell Utility Solutions was contracted to implement the program by coordinating manufacturers and retailers, developing marketing materials, training retail staff, processing rebates, and providing program reports. Furthermore, a reservation system was used to control the distribution of rebates with customers having to call before purchasing to obtain a reservation number. Rebate eligibility was limited to purchases from participating retailers (MEEA 2004).

One relatively recent program, the ComEd Energy Efficiency Loan program, provided financing for customers to purchase clothes washers from participating retailers (ComEd 2013). If approved, loan payments were added to the monthly utility bill. Customers had to purchase clothes washers that met ComEd's Smart Ideas clothes washer rebate eligibility requirements and that had a minimum in-store advertised price of $475. Interest rates were 4.99% and loan repayment terms were up to 10 years (AFC First Financial 2013). While the program is still in effect for central AC systems and refrigerators, clothes washers are no longer eligible. There are no publicly available results for the clothes washer component of this program yet.

Relevant Rebate Programs in Other Regions

While the rebate programs found in the Great Lakes region 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,[8] provide rebates to customers on the purchase of CEE Tier 3 clothes washers. PG&E

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[8] Proposition 84 (also known as the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006) authorized approximately $5.4 billion in general obligation bonds to fund a variety of projects, including water conservation efforts.

provides a $50 mail-in rebate and participating water utilities offer a $50 or $75 rebate (PG&E 2013a). The Los Angeles Department of Water and Power (LADWP) in conjunction with the Metropolitan Water District of Southern California (MWD) offer residential customers a $300 rebate for the purchase of clothes washers with a water factor less than 4.0 (LADWP 2013).

There are also programs in Western states that provide rebates specifically for commercial clothes washers. California Water Service and the Santa Clara Valley Water District offer $400 rebates on the purchase of high efficiency commercial clothes washers (Santa Clara Valley Water District 2013). Contra Costa Water District offers rebates of $220 on qualifying CEE Tier 3 commercial clothes washers installed at commercial laundries or multi-family housing common areas (Contra Costa Water District 2013). Denver Water offers a $150 rebate per high-efficiency commercial clothes washer machine purchased or leased and installed (Denver Water 2013). Utilities in the Puget Sound region and other areas of Washington State also offer these rebates. The City of Seattle and participating local water utilities provide $200 rebates for the purchase of efficient coin-operated commercial clothes washers (Tier 3) or up to 50% of large system improvements through the Saving Water Partnership (Saving Water Partnership 2013). Avista Utilities also offers $200 rebates toward the purchase of ENERGY STAR and CEE rated commercial clothes washers (Avista Utilities 2013). 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). 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).

TopTen USA, a nonprofit organization that identifies the top ten most-efficient products in various categories, also has ranked clothes washers.[9] Utilities such as Connecticut Light and Power and the United Illuminating Company (CT) restrict their clothes washer rebate programs to only TopTen-qualified products so that rebates are offered only for the most efficient products on the market that are widely available (TopTen USA 2013). Other TopTen supporters are considering similar programs.

SELECT EXEMPLARY UTILITY PROGRAMS AS IDENTIFIED BY ACEEE

ACEEE has published several reports that honor and highlight some of the best energy saving programs across the country. ACEEE's best practice program reports have examined

[9] TopTen USA identifies the ten most efficient models in each of the most energy intensive consumer product categories. TopTen encourages the adoption of high-efficiency consumer products by promoting the best products on a consumer facing website that makes it easy for consumers to find efficient options. TopTen USA was founded in 2009 with the support of utilities, regional and national energy efficiency alliances, and national environmental groups. TopTen's experts identify the ten most efficient models in each of the most energy intensive consumer product categories. TopTen USA is allied with TopTen organizations in 16 European countries and China (TopTen USA 2013).

leading energy efficiency programs funded through utility rates, programs run by state governments, and joint energy and water saving programs. The Exemplary Programs projects have three main objectives: (1) to identify programs that work to save energy and, in some cases, water and provide details on their design, implementation, and performance so that others can improve their own programs; (2) to publicly recognize with awards the programs that are exemplary and innovative in reducing energy and other resource use, cost-effectively and in a replicable manner; and (3) to share best practices and improve peer learning among existing programs.

Four programs that have been identified in past ACEEE reports are discussed below. These programs have been included here because they contain design components that may be applicable to the design of a candidate program for the Great Lakes region.

NYSERDA's New York Energy $mart Products (NYE$P) Program

Unlike most appliance programs, the New York Energy $mart Products (NYE$P) Program works to promote ENERGY STAR products (and other energy efficient products) by increasing public awareness and by increasing the supply of qualifying products through partnerships with retailers, manufacturers, and distributors (ACEEE 2008). Retailers become partners in the program by offering at least four models of ENERGY STAR products and reporting monthly sales data to NYSERDA. In exchange, retailers receive assistance with advertising, sales staff training, and free promotional materials. Manufacturers become partners by producing at least one ENERGY STAR (or qualified energy-efficient product) and reporting quarterly shipping data.

In 2012, NYSERDA released a market characterization and assessment evaluation of the program over its first 10 years (1999-2009). The 2009 market penetration for ENERGY STAR clothes washers for program retail partners was approximately 61 percent. Based on surveys completed for the report, appliance/electronics stores were the main distribution channel for clothes washers (39%), followed by home improvement stores (31%) and department/discount stores (24%). Further, 69 percent of all clothes washer purchases occurred at just five retailers (Sears, Home Depot, Lowe's, PC Richard, Best Buy). For clothes washers, the most important features in model selection were energy efficiency (50%), size (33%), price (21%), special features (20%), and water efficiency (20%). In addition, the most mentioned special feature was a front-loading design. Consumers relied heavily on store visits and the internet (predominantly store websites and consumer websites) for product information. In 2009, an estimated 20,088 clothes washer unit sales were attributable to the NYE$P Program, resulting in approximately 2.5 million kWh in energy savings (The Cadmus Group and Navigant Consulting 2012).

City of Austin, TX — Multifamily Energy and Water Efficiency Program

The Multifamily Energy and Water Efficiency program, a collaboration between the three main utilities in the Austin area (Austin Water Utility, Austin Energy, and Texas Gas Service), provides evaluations, rebates, and other incentives to multifamily properties to save water and energy. By bundling the incentives for different entities and providing a "one stop shop," the program is able to solicit the participation of property owners who otherwise would have no incentive to make efficiency improvements because tenants pay the utility bills. 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 (ACEEE and AWE 2013).

Town of Windsor, CA — Windsor Efficiency Pays Program

The Windsor Efficiency Pays Program is based off the Energy Efficiency Institute's Pay As You Save (PAYS) system, where financing is repaid through energy savings from installed measures. The program allows residents to make efficiency improvements to their homes with no upfront costs and immediate utility bill savings. Participating residents receive new water saving fixtures and appliances (including high efficiency washing machines) and drought resistant landscaping. In turn, they pay a surcharge on their monthly utility bills that is guaranteed to be less than their estimated savings. If the resident moves, their obligation ends and the next resident receives the utility bill savings and continues to pay the monthly surcharge.

There are two packages available through the program, Basic and Basic Plus, in addition to optional Co-Pay measures. The Basic package includes high efficiency toilets, showerheads, and aerators while Basic Plus includes clothes washers, drought-resistant landscaping, and compact fluorescent light bulbs (CFLs). Optional Co-Pay measures, which require a partial up-front payment, include more fully featured clothes washers, high efficiency refrigerators, on-demand hot water recirculation pumps, and enhanced landscaping. Efficiency measures are installed by certified contractors to ensure proper installation. Depending on the measures installed, surcharges are added for either 5, 10, or 15 years and include repayment with a 7% interest rate (ACEEE and AWE 2013).

City of Santa Rosa, CA Utilities — Ozone Laundry Program

The Ozone Laundry Program is one of several pilot programs mandated and approved by the California Public Utilities Commission (CPUC) and implemented by the state's investor-owned utilities (IOUs) in partnership with the state's water service utilities. In the Ozone Laundry Program, the city offered rebates of $200 for every 1,000 gallons of water use and wastewater flow reduction that are sustained on a monthly basis by hotels and commercial laundry facilities through the use of ozone laundry technology. Because ozone is active in cold water, it eliminates the need for hot water, helping to save energy. Ozone also is used in the place of detergents and other chemicals, thereby reducing the number of rinse cycles necessary and saving water. Ozone systems are attachments to existing commercial clothes washers. The installation of ozone generators into existing commercial clothes washing systems results in a 40 percent decrease in water demand and a 98 percent reduction in natural gas consumption. The technology typically has a payback period of two years or less, but with incentive programs in place, no cost implementation is possible (ACEEE and AWE 2013).

The State Energy Efficient Appliance Rebate Program (SEEARP)

The 2009 American Recovery and Reinvestment Act (ARRA) provided funding to states through the State Energy Efficient Appliance Rebate Program (SEEARP) to offer rebates to consumers on the purchase of energy-efficient appliances. States were given discretion on how to administer and distribute funding through the program. Final data regarding SEEARP has not been released by the U.S. Department of Energy (DOE). The program did not officially close until February 2012 (even though many states had exhausted their funding much earlier), and states had until May 2012 to submit final reports. D&R International is currently working to compile information submitted by the states to DOE on SEEARP. It is anticipated that a final report will be completed in summer 2013, which is much later than anticipated due to funding shortages (Swope 2013).

Based on preliminary information from DOE and the National Association of State Energy Officials (NASEO), all of the eight Great Lakes states, with the exception of Indiana and Pennsylvania, included clothes washers as part of their state appliance rebate program. Illinois, Michigan, Minnesota, New York, Ohio, and Wisconsin offered rebates ranging from $75 up to 15% of the purchase price ($400 max) for ENERGY STAR-rated clothes washers. In the case of Michigan and Wisconsin, clothes washers were required to meet more stringent energy and water efficiency requirements. Rebates were issued by mail after purchase with the exception of Illinois, which offered an instant rebate at the point-of-sale (DOE 2012a; NASEO 2010). Rebate programs in Illinois, Minnesota, and Wisconsin were explicitly limited to residential consumers only. Eligibility criteria for Michigan, New York, and Ohio seem to suggest that rebates were limited to residential households as well.

Table 24. Summary of Clothes Washer Rebates for the Great Lakes States Offered through DOE SEEARP

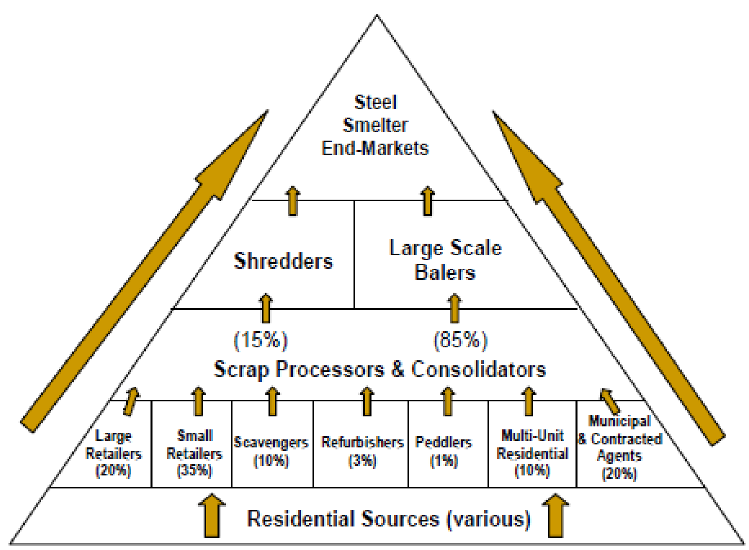
State	Requirements	Rebate Type	Rebate Amount	Total CW Rebates
Illinois	ENERGY STAR	Instant	15% of purchase price (max $400 on 4/15 or $250 on 9/24)	15,183
Michigan	MEF ≥ 2.2; WF ≤ 4.5	Mail-in	$50	n/a
Minnesota	ENERGY STAR	Mail-in	$200	n/a
New York	ENERGY STAR	Mail-in	$75 ($100 with proof of recycling)	82,616
Ohio	ENERGY STAR	Mail-in	$150	n/a
Wisconsin	MEF ≥ 2.2; WF ≤ 4.5	Mail-in	$100	n/a

Because DOE has not released final results for SEEARP, there are few in-depth case studies available. Within the Great Lakes region, MEEA has developed a two-page fact sheet regarding Illinois's program. The State of Illinois worked with MEEA to design an appliance incentive program to distribute funding from SEEARP and additional funding contributed by the Department of Commerce and Economic Opportunity (DCEO). Rebates were made available through three phases: water heater rebates, HVAC rebates, and appliance rebates. Appliance rebates were available as point-of-sale, instant rebates to consumers through participating retailers, who were reimbursed following the submission of required documentation. A total of 15,183 clothes washers were rebated through the program with rebate amounts set at 15% of the purchase price, limited to either $400 or $250 depending on when purchased (MEEA 2011).

Lawrence Berkeley National Laboratory (LBNL) also has developed a report examining the interactions between ARRA-funded state energy efficiency programs and utility customer-funded programs in 12 states, including Minnesota, Michigan, New York, and Wisconsin. Of these 12 states, five states, including Minnesota, chose to offer rebates for appliances under SEEARP that also were covered by existing utility rebate programs. Rebate programs in seven states, including New York, included appliances that were not covered by existing utility programs. Michigan offered rebates both for appliances that were already covered by existing programs as well as appliances that were not. In two states, Hawaii and Wisconsin, SEEARP funds were fully integrated into existing utility programs. According to the report, the most influential drivers of collaboration between SEEARP and utility customer-funded energy efficiency programs appear to have been common goals and complementary capabilities. In the most integrated states, SEEARP administrators took advantage of existing utility rebate delivery channels while utility program administrators saw opportunities to share marketing and outreach activities (Goldman et al. 2011).

Appliance Recycling Programs

Figure 16: Process for Recycling of Major Appliances from Collection to End Market



Source: AHAM Canada and RCC 2012

Approximately 90 percent of discarded appliances are recycled each year due to their high steel content (60 to 65 percent) (Steel Recycling Institute 2011). Many states also have instituted bans on the disposal of white goods in landfills, including the Great Lakes states of Illinois, Minnesota, and Wisconsin (BioCycle and Columbia University 2010). The EPA estimates that about 67 percent of major appliances by weight were recovered for recycling in 2009 (EPA 2010). The average clothes washer is approximately composed of 63.1 percent ferrous metal, 5.7 percent non-ferrous metal, 19.5 percent plastic, and 11.7 percent other materials (AHAM Canada and RCC 2012).

Because of the financial profitability in recycling major appliances, an existing recycling system exists by which collectors, small pre-processors, mid/large processors, and end markets process major appliances. Collectors typically include retailers, municipalities, and contracted agents, among others. Once collected, major appliances undergo decommissioning (generally applicable only to appliances that contain refrigerants), dismantling, and disassembly. During processing, major appliances are either baled with other scrap metal or shredded to sort composition materials. Finally, shred and bales of mixed scrap steel are smelted and primarily recycled into reinforcement bar for construction use (AHAM Canada and RCC 2012).

Some states required old appliances to be recycled (e.g., California) or provided an added rebate with proof-of-recycling (e.g., New York) for rebates received through the State Energy Efficient Appliance Rebate Program (SEEARP). Many municipalities also offer curbside pick-up services for large appliances—though these services oftentimes must be scheduled in advance and may require a fee. A cursory search online reveals municipalities that have no fees for this service and others that charge a pickup fee plus a fee per appliance.

The overwhelming majority of existing rebate recycling programs target refrigerators and freezers, due to the energy savings associated with removal of these appliances from service and the refrigerants contained within these appliances. Due to the popularity of these take-back programs, there have been numerous data analyses conducted. Incentive programs offered in California, Oregon, Utah, and Massachusetts have been utilized to motivate residential customers to recycle older, less-efficient but still functional refrigerators and freezers. Important factors for the success of these programs include effective marketing through advertisements and bill inserts and ensuring that appliance pick-up is convenient to facilitate customer participation. Greater education about program goals (e.g., energy savings, environmental benefits), convenience over similar municipal programs (e.g., no pickup fee charges, no need to move to curb), and outreach efforts through schools/community groups also can enhance program participation (NMR Group 2011). Based on surveys, most customers were motivated to participate in the appliance recycling programs due to the cash incentive, convenience of pick-up, and environmental concerns (ADM Associates 2008; Innovologie 2010a, 2010b; NMR Group 2011; The Cadmus Group 2010).

Clothes Washers

Despite the existing market for appliance recycling, few municipalities and utilities offer take-back or recycling rebates for clothes washers.

In California, recyclers of clothes washers are required to be certified due to the presence of used oil in discarded clothes washers. Assembly Bill 2277 (2004) requires that the used oil be removed from the clothes washers prior to them being disposed of or processed in a manner that could result in hazardous material leakage.

As a part of the 2009 American Recovery and Reinvestment Act (ARRA)-funded appliance program in California, customers were required to submit proof of recycling in order to receive the $100 rebate. The majority of recycling occurred through Appliance Recycling

Centers of America (ARCA) and JACO (ADM Associates 2008). However, these recyclers do not recycle commercial clothes washers due to a lack of cost-effectiveness, primarily due to the heavy weight of these appliances. It is assumed that commercial clothes washers are scrapped at the end of their service lives.

British Columbia

As of July 2012, producers of major household appliances that wish to sell, offer for sale, or produce products in British Columbia are required to have a plan to manage product end-of-life. The intent of this regulation is to divert end-of-life products from landfill to recycling and to shift the responsibility and cost of managing end-of-life to producers (British Columbia Ministry of Environment 2011). In June 2012, the Association of Home Appliance Manufacturers (AHAM) Canada and the Retail Council of Canada (RCC) received approval of their product stewardship plan. Due to the existing efficiencies present in the market for major appliance recycling, their plan aims to enhance accountability and oversight of the recycling process by developing an appliance processing standard, a processor certification process, program branding, best practices for collection, and a performance monitoring and reporting system (AHAM Canada and RCC 2012).

Potential Strategies for Facilitating Removal of Inefficient Clothes Washers

In an analysis for NRDC, Energy Solutions identified the most promising strategies for accelerating the removal of inefficient clothes washers from the market: early retirement in conjunction with an existing residential or commercial clothes washer rebate program or the addition of a regular recycling component to an existing residential clothes washer rebate program (Energy Solutions 2011). Early retirement programs use a large rebate amount to dramatically accelerate the rate at which owners replace their old washers. The goal of such a program is to target units that are operational and less efficient than a specified threshold but that are not too old and would likely be replaced even in the absence of an incentive. This can be achieved by limiting eligibility to specific efficiency bands or ages. When the new clothes washer is delivered, qualified and non-qualified old units are sent away for recycling.

In the second program option, a recycling rebate is offered in addition to an existing residential clothes washer rebate program. This option encourages the recycling of all used clothes washers regardless of their age or efficiency. Customers submit proof of recycling along with their completed rebate application. Used washers are de-manufactured and scrapped.

A statewide ban of the resale of inefficient clothes washers or the adoption of energy efficiency standards regulating the sale of used clothes washers also were considered by Energy Solutions but were deemed too difficult to implement and enforce.

Conclusion

The potential energy and water savings associated with increasing the efficiency of the residential clothes washer stock is substantial due to the large number of units in operation. Previous and existing rebate incentive programs, increasingly more stringent federal residential clothes washer standards, and the relatively high market share for ENERGY STAR clothes washers have resulted in declining energy and water usage for the residential sector. Given these factors, it is unlikely that the development of an additional incentive program only targeting the residential market in the Great Lakes would result in significant transformation of the energy and water efficiency of the residential sector. Yet there remain several potential areas for improvement. To facilitate the removal of inefficient yet still functional residential clothes washers from service, utility incentive programs in the region should combine existing rebates on the purchase of new clothes washers with rebates for the recycling of used clothes washers and/or offer free pick-up and disposal services. Greater public outreach regarding the energy and water savings associated with ENERGY STAR clothes washers also can help increase the market share of these products, especially in Indiana and Ohio where the market penetration for ENERGY STAR clothes washers lags the national average. Additional opportunity also exists to target only the highest efficiency products like those ranked on TopTen USA and ENERGY STAR Most Efficient lists with incentive programs.

In contrast, there are relatively few incentive programs directed at the commercial clothes washer sector in the Great Lakes region. The few incentive programs in existence also only offer rebate amounts comparable to residential clothes washer incentive programs even though commercial clothes washers generally are more expensive. Targeting sales in multifamily and laundromat facilities can lead to considerable energy and water savings. An estimated 32% of commercial clothes washer units shipped in 2011 were ENERGY STAR rated, which is approximately half the market share for the residential clothes washer sector. Transitioning the remaining commercial clothes washer shipments to machines that meet minimum ENERGY STAR requirements every year could result in substantial annual energy and water savings – the equivalent yearly energy use of about 3,200 homes and over 6,600 households (EIA 2009, EPA 2008). Table 25 details the expected annual energy and water savings from improvements to the laundromat and multifamily laundry room sectors.

Table 25. Potential Annual Energy and Water Savings from Improvements in the Laundromat and Multifamily Laundry Room Commercial Sectors

State	Savings from Single-load Machine Replacement to ENERGY STAR Units (multifamily and laundromat units)			Savings from Incremental Temperature Pricing (multifamily units)
	Electricity Savings (GWh/yr)	Natural Gas Savings (MMBtu/yr)	Water Savings (1000 gal/yr)	Natural Gas Savings (MMBtu/yr)
Regional Total	22	215,000	971,000	896,985
Illinois	3.90	38,700	175,000	161,677
Indiana	1.43	14,200	64,200	59,327
Michigan	2.09	20,700	93,600	86,520
Minnesota	0.79	7,870	35,600	32,891
New York	6.44	64,000	289,000	267,344
Ohio	2.97	29,500	133,000	123,152
Pennsylvania	2.47	24,600	111,000	102,674
Wisconsin	1.53	15,200	68,600	63,400

While the number of commercial clothes washers sold for multifamily applications is much greater than those sold to laundromats, washers in laundromat applications process 75% more loads on average than multifamily machines. There are several energy and water savings opportunities for laundromat facilities including upgrading to soft-mount machines, replacing single-load machines with multi-load machines, and differential pricing for machine settings based on energy and water usage. Similarly, incremental pricing for water temperature settings in multifamily laundry rooms has the potential to result in significant energy savings. Promoting cold water clothes washing through incremental pricing in can lead to energy savings of 25-30% (ASE 2011). On-premise laundry facilities also can realize energy and water savings through machine replacement and technology upgrades, such as the use of ozone as a cleaning agent to reduce hot water demand and the number of rinse cycles necessary. However, the complexity and variation among OPL facilities with respect to equipment type, staffing, and laundry quality requirements likely preclude their inclusion in a more general and broad-based incentive program. The most primed opportunities for an incentive program in the Great Lakes region likely lie with the transformation of commercial clothes washer water and energy usage in multifamily and laundromat settings.

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Appendix: Commercial Clothes Washer Stock, Energy, and Water Use Estimates

ON-PREMISE LAUNDRIES (OPL) STOCK ESTIMATE

Since there is significant diversity in washer size and facility type in the On-Premise Laundry (OPL) market sector, it is difficult to obtain data on size and number of machines in use. For assessing commercial clothes washer stock in the OPL sector, we use an "end use" approach that was developed for a study carried out by the California Urban Water Conservation Council and adapted for use in the California Appliance Efficiency Standards commercial clothes dryer Proposal Information Template (Riesenberger 2006; Zhang and Wei 2011). This method is used for estimating the annual end use load and the associated energy and water consumption.

Methodology

According to research for the California Urban Water Conservation Council, the primary locations for OPL laundries are in hotels/motels, nursing homes, prisons, hospitals, and universities (Riesenberger 2006). Additionally, we include bed and breakfast inns in our calculations of OPLs. We determine the number of OPL facilities in each of the Great Lakes States by obtaining data from the 2010 Census County Business Patterns. Data from the Pew Trust Prison Count from 2010 was used to determine the number of prisons per state.

Table A-1: OPL Facilities in the Great Lakes Region

State	Hospitality (Total)	Hotel	Motel	Bed and Breakfast Inns	Nursing care facilities	State/Federal Prisons (# incarcerated)[1]	Hospitals	State/Private Universities Total
Illinois	1417	113	1304	37	732	45,161	230	175
Indiana	880	70	810	32	465	29,818	160	71
Michigan	1218	97	1121	78	429	45,478	190	101
Minnesota	863	69	794	45	368	10,064	145	68
New York	2004	160	1844	176	672	58,648	307	277
Ohio	1291	103	1188	48	873	51,606	224	157
Pennsylvania	1335	107	1228	108	672	51,429	294	173
Wisconsin	1029	82	947	58	366	23,112	143	71
Average beds/rooms/ population[2,3,4,5,6]	95			6	108	N/A	161	1000

Source: Hospitality, nursing care facility, hospital, state/private university data — U.S. Census 2010, [1] Pew 2010, [2] AHLA 2012, [3] CDC 2006), [4] AHA 2011, [5] Riesenberger 2006, [6] PAII 2013.

The percentage of each facility type that is estimated to have laundry facilities, as well as the amount of laundry produced per person is determined based on the Riesenberger (2006) study. We can use this methodology to determine estimates for pounds of laundry produced per facility in each state.

Table A-2: OPL Assumptions for Various Facility Types

Facility Type	Percentage of facilities with OPLs	Pounds/Person /Day	Pounds/Room/ Day	Occupancy Rate
Hotel	100%		30[1]	70%[2]
Motel	100%		23	60%[3]
Bed and Breakfast (B&B) Inn	100%		23	44%[4]
Nursing Home	100%		25	86%
Prisons	100%	12		100%
Hospitals	5%		25	70%
State/Private Univ.	16%	20		75%

Source: All data unless otherwise specified is derived from Riesenberger 2006,[1] Pounds/room/day estimate reduced from Riesenberger study estimate of 36 pounds — Wei 2013, [2] AHLA 2012, [3] CDC 2006, [4] PAII 2013.

Limited data is available on OPL equipment composition. Manufacturer design guides and case studies of OPL retrofits from manufacturers can be used to provide composition estimates and potentials for energy and water savings for some OPL types, but since machine type can vary significantly based on OPL type and size and information detailing composition of all OPL types is limited, we will not attempt to make estimates of machine stock numbers in the OPL sector. Instead, estimates of water and energy use are derived from the pounds of laundry per day that each facility produces. The amount of water and energy used per load is based on laundry soil classification and the approximate distribution across soil classifications (Table A-3).

Table A-3: Soil Classification for Determining Energy and Water Use per Pound of Laundry

Facility	Soil Classification	Estimate percent distribution among classifications	Baseline gallons per pound of laundry	Baseline BTUs per pound of laundry
Hotels	Heavy	15%	3.22	2570
	Medium	30%	2.57	1990
	Light	55%	2.02	1798
Motels/B&B Inns	Heavy	5%	3.22	2570
	Medium	30%	2.57	1990
	Light	65%	2.02	1798
Nursing Homes	Heavy	35%	3.22	2570
	Medium	40%	2.57	1990
	Light	25%	2.02	1798
Prisons	Heavy	15%	3.22	2570
	Medium	30%	2.57	1990
	Light	55%	2.02	1798
Hospitals	Heavy	40%	3.22	2570
	Medium	40%	2.57	1990
	Light	20%	2.02	1798
Universities	Heavy	10%	3.22	2570
	Medium	25%	2.57	1990
	Light	65%	2.02	1798

Source: Adapted from Riesenberger 2006

Table A-4: Energy and Water Use in OPL Facilities

State	Facility	Pounds of Laundry (Pounds/Year)	Water Use (Million Gallons)	Energy Use (Million BTUs)
IL	Hotels	82,545,918	195	162,731
	Motels	623,811,295	1,400	1,181,623
	B&B Inns	820,024	2	1,553
	Nursing Homes	620,391,960	1,650	1,330,741
	Prisons	197,805,180	468	389,953
	Hospitals	11,826,456	32	25,824
	Universities	153,300,000	349	294,827
IN	Hotels	50,972,250	121	100,487

	Motels	387,597,150	870	734,187
	B&B Inns	709,210	2	1,343
	Nursing Homes	394,101,450	1,048	845,348
	Prisons	130,602,840	309	257,470
	Hospitals	8,227,100	22	17,965
	Universities	62,196,000	142	119,615
MI	Hotels	70,632,975	167	139,246
	Motels	536,415,315	1,204	1,016,078
	B&B Inns	1,728,698	4	3,274
	Nursing Homes	363,590,370	967	779,901
	Prisons	199,193,640	471	392,690
	Hospitals	9,769,681	27	21,333
	Universities	88,476,000	202	170,157
MN	Hotels	50,244,075	119	99,051
	Motels	379,940,910	853	719,684
	B&B Inns	997,326	2	1,889
	Nursing Homes	311,891,040	830	669,006
	Prisons	44,080,320	104	86,900
	Hospitals	7,455,809	20	16,281
	Universities	59,568,000	136	114,561
NY	Hotels	116,508,000	276	229,684
	Motels	882,381,660	1,981	1,671,407
	B&B Inns	3,900,653	9	7,389
	Nursing Homes	569,540,160	1,515	1,221,664
	Prisons	256,878,240	608	506,410
	Hospitals	15,785,748	43	34,470
	Universities	242,652,000	553	466,668
OH	Hotels	75,002,025	177	147,859
	Motels	568,475,820	1,276	1,076,807
	B&B Inns	1,063,814	2	2,015
	Nursing Homes	739,893,690	1,968	1,587,072
	Prisons	226,034,280	535	445,604
	Hospitals	15,117,296	41	33,010
	Universities	137,532,000	313	264,502
PA	Hotels	77,914,725	184	153,601
	Motels	587,616,420	1,319	1,113,063
	B&B Inns	2,393,582	5	4,534
	Nursing Homes	569,540,160	1,515	1,221,664
	Prisons	225,259,020	533	444,076
	Hospitals	15,117,296	41	33,010
	Universities	151,548,000	345	291,457
WI	Hotels	59,710,350	141	117,713
	Motels	453,153,705	1,017	858,364
	B&B Inns	1,285,442	3	2,435
	Nursing Homes	310,195,980	825	665,370
	Prisons	101,230,560	239	199,566
	Hospitals	7,352,971	20	16,056
	Universities	62,196,000	142	119,615

MULTIFAMILY COMMERCIAL CLOTHES WASHER STOCK ESTIMATE

Methodology

Estimates for the existing stock of family-size commercial clothes washers are publicly available as a result of the commercial clothes washer federal standard rulemaking. Existing stock estimates (2,243,000) are based on the DOE projections for 2011 of total stock from the 2009 commercial clothes washer rulemaking. Data on commercial clothes washers on a state by state basis, however, is limited. Methodology that has been used to determine stock estimates by state from national stock data was developed by ACEEE for the State Clean Energy Resource Project. For these studies, commercial clothes washer national stock data is used to determine state equipment estimates based on a factor determined by commercial electric and natural gas usage at the state level. For our market characterization, we rely on a factor based on housing units per state for structures with three or more units that can be considered multifamily housing. Approximately 85% of the family-size commercial clothes washer stock is used in multifamily housing applications, and the remaining 15% is estimated to be found in laundromats, which are used predominantly by people in multifamily housing with no laundry facilities (DOE 2010).

According to data from federal rulemaking, the national stock of family-size commercial clothes washers is 80% top-loading and 20% front-loading, with 85% of the total stock found in multifamily laundry rooms, and 15% in coin-op laundromats. A very small percentage that is not accounted for in the estimates are used in other applications (DOE 2010). We determine the number of commercial clothes washers in multifamily housing applications for each state based on data submitted for the federal commercial clothes washer standard scaled by multifamily housing per state (Table A-5).

Table A-5: Family-Size Commercial Clothes Washer Stock, Multifamily Laundry Rooms

State	Top-loading	Front-loading	Percent of National Stock
United States	**1,525,240**	**381,310**	**100%**
Illinois	77,342	19,336	5%
Indiana	28,380	7,095	2%
Michigan	41,389	10,347	3%
Minnesota	15,734	3,934	1%
New York	127,891	31,973	8%
Ohio	58,913	14,728	4%
Pennsylvania	49,117	12,279	3%
Wisconsin	30,329	7,582	2%

LAUNDROMAT CLOTHES WASHER STOCK ESTIMATE

Methodology

Determination of the equipment in laundromat settings is accomplished through a bottom-up approach that is based on the number of laundromats in every state according to the 2010 Census. Information on laundromat composition from two markets informs our laundromat clothes washer stock estimates.

- The average machine composition of a laundromat in Ohio, courtesy of Duane Lmaries, President of the Ohio Coin Laundry Association
- The average laundromat composition from a survey of laundromats in the San Diego area, which surveyed 29 laundries (WMI et al. 2006).

For the purposes of our market characterization, we rely on the Ohio laundromat equipment composition since it is a part of the Great Lakes region (Table A-6). Based on our research, we do not anticipate equipment composition to drastically differ among Great Lakes states. These estimates are corroborated with data from the San Diego area survey.[10]

Table A-6: Average Laundromat Machine Composition in Ohio

Machine Type	Total Units	Percentage
Top-loaders	10.2	34%
Front-loaders	20.2	67%
18lb	8	26%
25 lb	3	10%
30-40lb	6.2	20%
50-55lb	2.1	7%
75-80lb	0.4	1%
Other	0.5	2%
Total	30.3	100%

Source: Lmaries 2013

It is important to note that while some of the machines found in laundromats fall under the federal commercial clothes washer standard, others (generally above the 25lb size) are not accounted for. Thus for the purposes of consistency in determining stock in laundromats, we rely on a bottom up approach to determining machine quantities based on the number of laundromats in each state rather than the top down allocation of national stock

[10] Between the two data sets of laundromat machine composition, the number of top-loading machines to front-loading machines is very similar. The front-loading versus top-loading equipment composition averages are fairly well aligned for what we currently see for clothes washer laundromat estimates in San Diego and Ohio - San Diego has an average of 39.3% top-loaders and 60.7% front-loaders, while Ohio has an average of 34% top-loaders and 66% front-loaders. The San Diego laundromat assessment had an average laundromat size that was larger than the Ohio example – 48 machines per laundromat versus 30.3 per laundromat in Ohio. However the sample of laundromats in San Diego, which was estimated to cover about 10% of the machines in the city, produced an estimate of machines per laundromat that is higher than that which was estimated for the city in a separate estimate by the San Diego County Water Authority (SDCWA). The SDCWA estimates 30-25 washers per laundromat (WMI et al 2006).

projections from the DOE rulemaking used to determine multifamily stock estimates (Table A-8).

To cross check estimation results, we performed a comparison of the top-loading machine stock estimates based on the two methods; both methods produce similar estimates (Table A-7):

Table A-7: Top-loading Machine Stock Estimates for Laundromats

State	Estimate 1: Stock Data from Federal Standard	Estimate 2: Laundromat Data
United States	**269,160**	**244,045**
Illinois	13,649	11,210
Indiana	5,008	3,876
Michigan	7,304	5,692
Minnesota	2,777	3,539
New York	22,569	35,200
Ohio	10,396	6,671
Pennsylvania	8,668	10,261
Wisconsin	5,352	4,916

However, there is a significant difference between the estimates for front-loading machines between the two approaches, which could be attributed to a few factors:

(1) The makeup of front-loading machines versus top-loading machines has been changing in recent years. Sales data from 2010 and 2011 from AHAM indicate that front-loading single family washers made up 37% and 34%, respectively, of sales. An online survey from American Coin Op of clothes washer distributors found that newly constructed laundries had an average of 4.5 top-loaders and 30.0 front-loaders in 2011. Between surveys from 2007 and 2011, the number of top-loaders purchased went from 6.7 to 4.5, while front-loaders increased from 27.7 to 34.1 units per new store.

(2) Disparities between how machines are labeled (nominal pounds versus tub volume) increase the margin of error in determining how machines sizes are labeled.

Table A-8: Front-loading Machine Stock Estimates for Laundromats (Laundromat Data)

	Machine Size					
State	18lb	25lb	30-40lb	50-55lb	75-80lb	Other
United States	**191,408**	**71,778**	**148,341**	**50,245**	**9,570**	**11,963**
Illinois	8,792	3,297	6,814	2,308	440	550
Indiana	3,040	1,140	2,356	798	152	190
Michigan	4,464	1,674	3,460	1,172	223	279
Minnesota	2,776	1,041	2,151	729	139	174
New York	27,608	10,353	21,396	7,247	1,380	1,726
Ohio	5,232	1,962	4,055	1,373	262	327
Pennsylvania	8,048	3,018	6,237	2,113	402	503
Wisconsin	3856	1446	2,988	1,012	193	241

Water and Energy Use by Sector and State

The source of water and energy use estimates differ by sector. Estimates for existing water and energy use for residential and family-size commercial clothes washers are derived from the base case average energy and water use estimates for existing clothes washer stock from rulemaking data (DOE 2010; DOE 2012b). For the multifamily and laundromat sectors, energy and water use was determined based on the differences in average cycles per day and differences in fuel types in both sectors based on assumptions in the federal rulemaking (Table A-9) (DOE 2010).

Table A-9: Multifamily and Laundromat Clothes Washer Use Information

		Multifamily	Laundromat
Cycles per year		1246	2190
Water Heating Fuel Shares			
	Gas	80%	100%
	Electric	20%	0%
Market Share		85%	15%

Source: DOE 2010

Water and energy use for larger multi-load machines in laundromats is determined based on estimates for water and energy savings from (1) manufacturer's energy and water savings estimates for machine replacement and (2) measured water use from various size machines in laundromats in San Diego (Continental Girbau 2013; WMI et al 2006). Water and energy use for OPL applications is determined based on methodology developed in a study prepared for the California Urban Water Conservation Council (Riesenberger 2006). These estimates were based on the soil classification of the load of laundry, which was determined based on manufacturer's estimates. Water and energy use per pound of laundry is estimated, and does not account for differences that may result from machine size (Table A-10) (Riesenberger 2006).

It is expected that water and energy use baseline levels are higher for OPL laundry applications than general laundromat use because of the condition of laundry that OPL facilities are laundering. Multi-load machine water and energy usage varies based on the way a multi-load machine is programmed — microprocessors in the machines allow for highly specialized wash and rinse features that can be set based on the needs of the customer. It is likely that OPL applications have machines programmed to perform more water and energy intensive washing and rinsing to launder materials that are more soiled than in a standard application in a laundromat.

Table A-10: OPL Water and Energy Use

Soil Classification	Baseline gallons per pound of laundry	Baseline BTUs per pound of laundry
Heavy	3.22	2570
Medium	2.57	1990
Light	2.02	1798

Source: Riesenberger 2006

The estimates from the San Diego study focus on measured water use from clothes washers of a number of different sizes in a number of different laundromats. The average water usage determined from measured usage is detailed in Table A-11. For the San Diego study, energy usage was not measured; the baseline BTU usage per pound of laundry determined by Riesenberger is used for multi-load washers in laundromats as well. While very similar machines are used for both laundromat and OPL settings, the way machines are programmed may differ significantly in both settings. Programming of multi-load commercial washers has a significant effect on the amount of water a machine uses (Machines can be programmed to do multiple rinses, which has an effect on the amount of water and energy that is used in one wash cycle (Continental Girbau 2013).

Table A-11: Measured Laundromat Machine Water Use

Washer Size	Gallons per pound of laundry
12 pounds	2.76
20 pounds	1.74
30 pounds	1.48

Source: WMI et al. 2006

Water and energy use estimates for a variety of multi-load machines from the manufacturer Continental Girabau are detailed in the graphs below (Figure A-1 and A-2). The standard machines are hard-mount units of a variety of sizes. The higher efficiency machines are soft-mount machines manufactured by Continental Girbau. Water and energy use for the washer itself is comparable to higher efficiency hard-mount machines. The savings from soft-mount machine performance are primarily realized during the drying cycle because soft-mount machines extract more water from laundry during an average cycle.

Figure A-1: Commercial Clothes Washer Energy Usage: Manufacturer Estimates

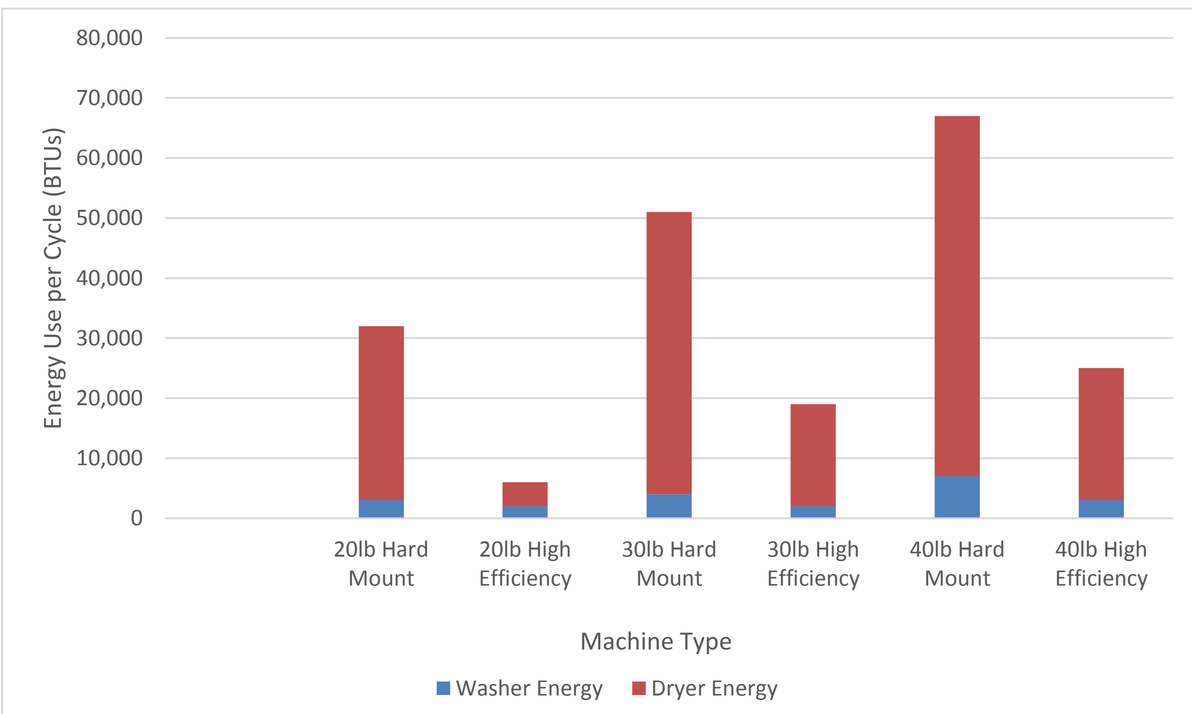
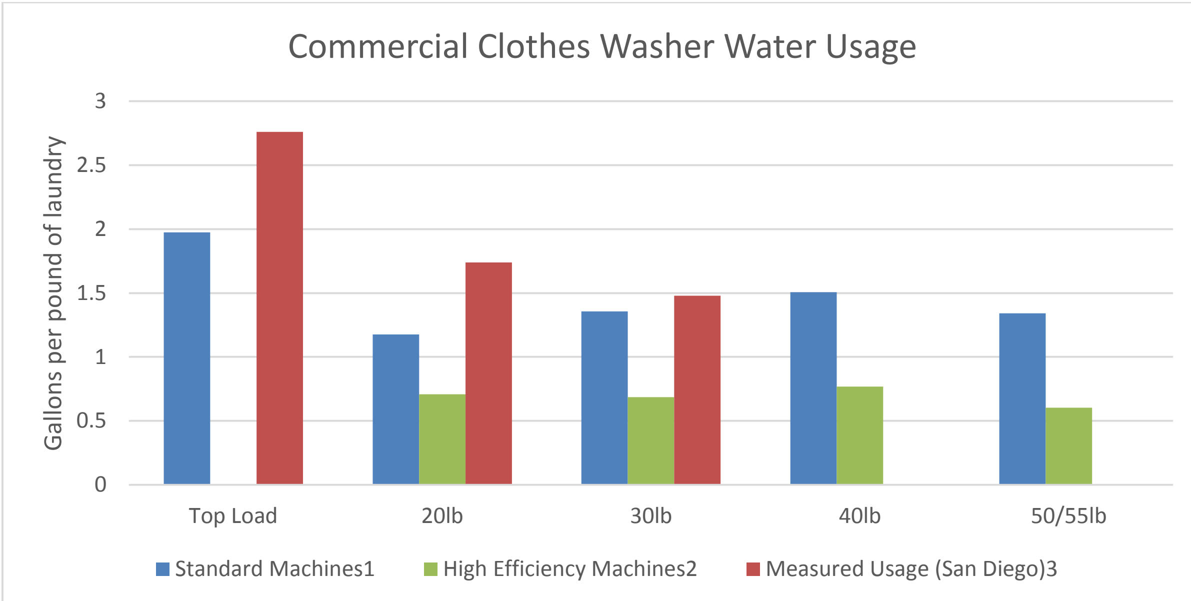


Figure A-2: Commercial Clothes Washer Water Usage: Manufacturer Estimates



Notes: [1,2] (Continental Girbau 2013), [3](WMI et al 2006)

Top-loading machine energy and water use at the laundromat level is estimated based on data from the federal standard rulemaking (DOE 2010). For the purposes of estimating energy and water use for front-loading machines at the laundromat level, we use the Continental Girbau energy and water estimates for baseline efficiency machines using two rinse cycles, keeping in mind that usage may be slightly higher from what we see as measured water usage from the San Diego study. Since energy usage was not measured in the San Diego study, we rely on both the energy and water usage estimates from Continental Girbau for a standard machine. Water and energy use estimates are based on an estimated 6 cycles per day per machine, or 2,190 cycles per year (DOE 2010).