
A NATIONAL STUDY OF WATER & ENERGY CONSUMPTION IN MULTIFAMILY HOUSING

In-Apartment Washers vs.
Common Area Laundry Rooms

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EXECUTIVE SUMMARY

- National Research Center, Inc. was contracted to conduct a national study comparing laundry-water use rates of apartment residents whose buildings have common area laundry rooms with use rates of apartment residents whose building have laundry facilities in each unit.
- From September to December 2000, laundry-water use was calculated in part using water meters attached to 191 in-unit washing machines and 50 common area washing machines in 8 apartment buildings matched for quality and size in 4 cities across the U.S. Results were adjusted to reflect residents' self-reports of off-site use during the study period.
- After adjusting for self-reported off-site laundry use and averaging figures for all four national sites, the study revealed that residents of apartments with in-unit laundry facilities used 3.3 times more water for laundry than residents in apartments utilizing common area laundry facilities.
- Further analysis revealed that residents with in-unit laundry facilities used 5 times more energy than residents in apartments utilizing common area laundry facilities.

STUDY RESULTS

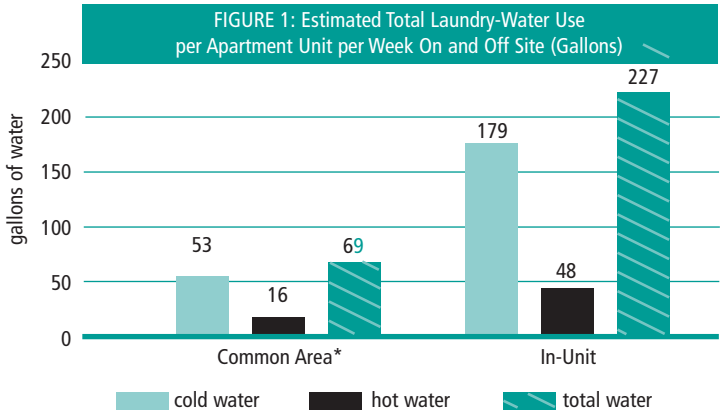
Estimated Total Utility Use

The study results show that residents with in-apartment laundry machines used more water, and consequently more energy, than those who used common area laundry facilities. Water usage was 3.3 times higher among residents who had in-apartment laundry machines, and energy usage was approximately 5 times higher.

Over a two-month period, washing machines from 191 units within properties with in-apartment-unit laundry facilities in four cities were metered (both hot and cold water). Likewise, washing machines from comparable properties with common area (or central) laundry facilities in the same four cities were metered during the same time frame. After the metering period ended, apartment residents were asked to complete a written survey questionnaire that elicited information utilized to adjust water use readings to account for laundry done away from the apartment buildings (referred to as “off-site”). (See Study Methods and Results beginning on page 4 for more information on how units were selected and how the overall study was conducted.)

Estimated Total Laundry-Water Use

Figures 1 and 2 display the total gallons of water used for laundry per week per apartment unit for both on and off site use. On average, apartment residents with common laundry facilities used 69 gallons per week per unit for laundry, while those with in-unit washing machines used 227 gallons per week per unit. Thus, those residents with in-unit laundry facilities used 3.3 times more water for laundry than those with common area laundry facilities.



* Differences between laundry-water use in common area versus in-unit properties were statistically significant $p < 0.05$.

FIGURE 2: Estimated Total Laundry-Water Use per Apartment Unit per Week On and Off Site (Gallons)

Meter Type	Type of Laundry Facilities*		
	Common Area	In-Unit	Ratio of In-Unit to Common Area
Cold Water	52.91	179.53	
Hot Water	16.22	47.58	
TOTAL	69.13	227.11	3.3 times higher

* Differences between laundry-water use in common area versus in-unit properties were statistically significant $p < 0.05$.

Estimated Total Energy Use

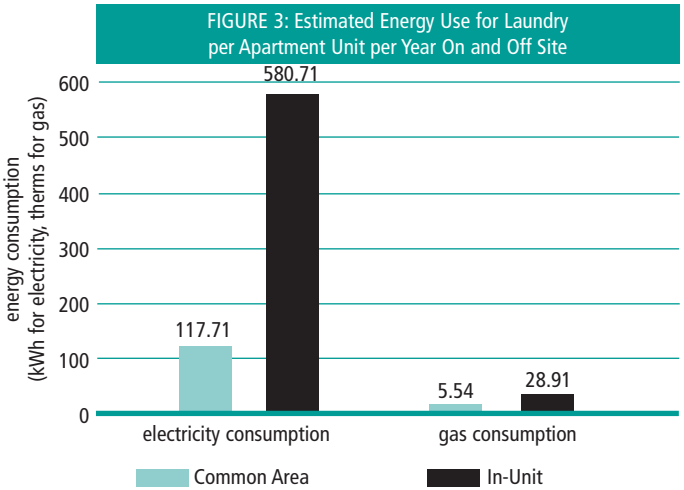
Based on the known number of gallons of water used, estimates were made of the number of loads this represented, given the types of machines used in both common areas and in-apartment-units in the study properties. These were then translated into energy costs per load, using the Energy Guides provided by manufacturers of the washing machines. Because some of the models used in the in-apartment-unit sample of the study were manufactured before the U.S. government mandated the publication of these Energy Guides, energy use estimates were derived by examining similar but newer models.

According to the metering information gathered through the study, apartment residents with in-unit washing machines do 5.22 loads of laundry per week per unit, while residents utilizing a common area laundry room do 2.16 loads of laundry per unit per week. By multiplying these numbers by 52 weeks per year and the estimated energy consumption for every load as calculated from the Energy Guides, a final estimate of the energy use per apartment unit per year was determined.

Gas vs. Electric

Most of the energy use associated with laundry comes from heating the water. Nationwide, most apartments with in-unit washing machines have an electric water heater while most common area facilities have gas water heaters. This study was consistent with the national averages; three of the four properties with in-unit laundry facilities had electric water heaters, and one had a gas water heater. Of the properties with common area laundry facilities, one had an electric water heater, and the remaining three had gas water heaters.

For simplicity, the study compared each type of energy (electricity or gas) in an in-unit and common area setting. The average electricity used by residents with in-unit washing machines with electric water heaters was 580.71 kWh per unit per year, compared to 117.71 kWh per unit per year for those residents who utilized common area laundry facilities with electric water heaters. The average gas used by residents with in-unit washing machines with gas water heaters was 28.91 therms per unit per year. Residents who utilized common area laundry facilities with gas water heaters used 5.54 therms per unit per year (see Figures 3 and 4).



	Type of Laundry Facilities		
	Common Area	In-Unit	Ratio of In-Unit to Common Area
Electricity Consumption	117.71 kWh	580.71 kWh	4.9 times higher
Gas Consumption	5.54 therms	28.91 therms	5.2 times higher

While the figures above show a direct comparison, please note that that 75% of common areas in this study used gas, while 75% of in-units used electricity. When comparing overall study results on energy, common area washing machines are significantly more energy efficient than in-unit washing machines.

In addition to energy savings associated with washing machines in common area laundry rooms, there is likely a comparable savings with dryers. This study did not review dryer efficiency (please see page 11 for additional information.)

STUDY METHODS

There were five stages to this study:

1. Selecting sites for the study
2. Monitoring washing-machine water use at these properties
3. Surveying residents about their laundry habits (to make adjustments, if necessary, to the metered laundry-water use rates)
4. Comparing estimates of number of loads and number of gallons used per apartment unit by various data collection methods
5. Estimating energy usage from the U.S. Government Energy Guides

Site Selection

To ensure a national sample, the sampling frame for apartment buildings included all properties that had laundry facilities maintained by members of the Multi-housing Laundry Association (MLA). This was crucial to the success of the study because the members of this organization have relationships with property owners and managers nationwide. MLA members provided access to install the meter in the common laundry rooms they manage, and coordinated installation of the meters on the washing machines in the individual apartments.

In order to be considered for selection, a property had to have:

1. A property evaluation grade of “B” (very good) or above
2. Accessible machines that could be metered
3. Laundry rooms in common area laundry-rooms that were in good condition or better
4. No off-site commercial laundromat closer than a half-mile

A matching process was implemented to select sites. Equal numbers of properties with in-unit laundry facilities and common area laundry rooms were selected. Buildings with common area laundry rooms could not have in-apartment-unit washing machines. Buildings with in-apartment units could not have common area laundry rooms. Each pair of properties had to be within the same city and have similar characteristics, as noted above.

Eight properties were selected for the study. The characteristics of these sites are displayed in Figure 5 on the following page. The four cities from which these properties were selected were San Diego, California; Atlanta, Georgia; Dallas, Texas and Portland, Oregon. Copies of forms used to gather this information may be found in the Appendix.

FIGURE 5: Characteristics of Selected Sites

Property Characteristics	California		Georgia		Oregon		Texas	
	Common Area	In-Unit	Common Area	In-Unit	Common Area	In-Unit	Common Area	In-Unit
Property Grade	B+	B+	B	B	A	A	B+	A
Average monthly rent for a one-bedroom apartment	\$1,000	N/A	\$600	\$750	\$560	\$645	\$450	\$738
Average age of washing machines	3 years	4 years	2 years	3 years	3 years	5 years	5 years	5 years
Distance to nearest off-site commercial laundry	2 miles	2 miles	1 mile	5 miles	2 miles	2 miles	1 mile	.5 miles
COMMON AREA LAUNDRY ROOM AMENITIES								
Overall condition	good		good		excellent		excellent	
Windows	no		yes		yes		no	
Good lighting	yes		yes		yes		yes	
Trash can	yes		yes		yes		yes	
Folding table	yes		yes		yes		yes	
Wash sink	yes		no		yes		no	
Chairs	no		no		no		yes	
Hanging rack	no		no		no		yes	

Monitoring Washing-Machine Water Use

Machine Selection

In each in-unit property, 50 apartments were selected for monitoring. In the common area properties, all washing machines were included in the monitoring.

Metering the Machines

A meter was attached to each machine selected for monitoring. The criteria for selecting the type of meter required that it be compact, highly accurate and able to measure both cold- and hot-water use. The meter chosen was *Model 50^{1/2}*. New meters were rented from the Daniel L. Jerman Company of Hackensack, New Jersey, which tested each one for accuracy before its use in this study.

The *Model 50^{1/2}* meter measures 4-3/8" end to end, has a 360-degree rotating register, 1-1/2% accuracy and sensitivity to 1/10 GPM. It is constructed of nickel-plated bronze with long-life internal parts. The cold-water meter (WFU10) is rated to 86 degrees F, and the high-temperature internal components of the hot-water meter (WFU20) allowed it to go up to 194 degrees F. *Model 50^{1/2}* meters meet stringent quality and calibration standards: they have been tested and approved by the California Department of Weights and Measures and also meet the American Water Works Association standards for accuracy and materials.

Representatives from the companies that install and maintain the washing machines in the apartment buildings deployed the meters in September and October of 2000. Approximately two months later, they removed the meters. Tracking forms were maintained for each meter, on which the installation date, disconnection date, and beginning and end meter readings were recorded.

In a few cases, readings were not available or had to be discarded due to problems with the meters, problems with the washing machines, missing meters, or in one case denial of permission to enter the apartment. Of a total of 241 metered machines, 8 (3.3%) had readings that could not be used. Copies of the meter tracking forms can be found in the Appendix.

All the data collected for this study were entered into an electronic format for analysis. The information about the properties included in the study and the meter readings were entered into a Microsoft® Access database. The meter tracking data (water use) were then imported into SPSS, a statistical software package, for additional analysis. Microsoft® Excel spreadsheets were also used for some analyses. An ASCII dataset was created of the survey data, which was likewise imported into SPSS for statistical analysis.

Calculations were performed to determine the total water used per day during the study period. This was then multiplied by seven to create an estimate of water used per washing machine per week.

For in-unit machines, the average of all machines was reported as the on-site laundry-water use per week per unit.

For common area laundry rooms, an average per machine per week was calculated for each building. This number was then multiplied by the total number of washing machines in the building. The next step was to divide this number by the number of occupied apartment units in the building to derive the estimated on-site laundry-water use per week per unit.

Summary of Results of the Metering

As shown in Figure 6, residents of properties with in-unit laundry facilities used much more water per apartment unit than residents of properties with common area laundry facilities.

The average laundry-water user in in-unit properties required 221 gallons per apartment unit per week, which was approximately 3.5 times more than the average laundry-water user in common area properties, who required only 57 gallons per apartment unit per week. This figure also displays the on-site water use observed at each of the four sites included in the study. Similar use patterns were noted at each site with the exception of Oregon, where in-unit laundry-water use was lower and common area use higher. This may be because there were significantly more residents per unit in Oregon in the apartment building with common area laundry facilities than there were in the other states.

FIGURE 6: Metered On-Site Laundry-Water Use per Apartment Unit per Week per Site (Gallons)

Meter Type by Site		Type of Laundry Facilities	
		Common Area	In-Unit
California	Cold Water	58.26	244.70
	Hot Water	17.05	88.10
	TOTAL	75.31	332.80
Georgia	Cold Water	31.19	175.06
	Hot Water	13.29	33.46
	TOTAL	44.48	208.52
Oregon*	Cold Water	62.91	108.91
	Hot Water	14.51	32.42
	TOTAL	77.42	141.33
Texas	Cold Water	38.95	175.86
	Hot Water	12.77	25.95
	TOTAL	51.72	201.81
Total	Cold Water	43.86	175.04
	Hot Water	13.45	46.39
	TOTAL	57.31	221.43

* Oregon buildings with common area laundry rooms had more residents per apartment than in-unit buildings did.

Respondents were asked what proportion of their laundry they did on site and off site in order to determine the total amount of water used to do laundry, both in the apartment buildings and off site. As seen in Figure 7, residents of properties with common area laundry facilities were more likely to do laundry off site than were those living in apartments with in-unit laundry facilities. (More information about the Resident Survey and its results can be found in following sections.)

FIGURE 7: Average Percent of Laundry Done On and Off Site by Location

Meter Type by Site		Type of Laundry Facilities	
		Common Area	In-Unit
California	On Site	95.2%	98.9%
	Off Site	4.8%	1.1%
	TOTAL	100.0%	100.0%
Georgia	On Site	36.3%	97.2%
	Off Site	63.7%	2.8%
	TOTAL	100.0%	100.0%
Oregon	On Site	83.5%	95.7%
	Off Site	16.5%	4.3%
	TOTAL	100.0%	100.0%
Texas	On Site	92.7%	98.7%
	Off Site	7.3%	1.3%
	TOTAL	100.0%	100.0%
Total	On Site	82.9%	97.5%
	Off Site	17.1%	2.5%
	TOTAL	100.0%	100.0%

These figures (from the table above) were used to estimate off-site water use based on the formula shown in Figure 8. No adjustments were made for absent residents, as the absence rates were similar for both property types. (See Figure 12 on page 9.)

FIGURE 8: Formula Used to Calculate Off Site Laundry Use

a = gallons of water used off site for laundry

b = gallons of water used on site for laundry (known from meter tracking)

x = proportion of laundry done on site (known from resident survey)

$$a = \frac{b(1-x)}{x}$$

Using the formula from Figure 8 and the information from Figure 6 & 7, estimated off-site laundry-water use was calculated. These estimates are shown in Figure 9 below. Total laundry-water use was then computed as the sum of on-site and off-site use.

FIGURE 9: Estimated Off Site Laundry-Water Use per Apartment Unit per Week per Site (Gallons)

Meter Type by Site		Type of Laundry Facilities	
		Common Area	In-Unit
California	Cold Water	3.02	2.72
	Hot Water	0.88	1.06
	TOTAL	3.90	3.79
Georgia	Cold Water	54.73	5.04
	Hot Water	23.31	0.96
	TOTAL	78.05	6.01
Oregon	Cold Water	12.43	4.89
	Hot Water	2.87	1.46
	TOTAL	15.30	6.35
Texas	Cold Water	2.48	2.32
	Hot Water	0.76	0.34
	TOTAL	3.24	2.66
Total	Cold Water	9.05	4.49
	Hot Water	2.77	1.19
	TOTAL	11.82	5.68

Residents' Self-Reported Questionnaires

To gain a more complete picture of laundry-water use, a one-page survey of five questions was sent to participants of the study. The survey was sent to occupants of each selected apartment with an in-unit machine that was metered and to the occupants of each selected property with common area laundry facilities. Among other questions, the survey asked residents how many loads of laundry they typically did in a week, and what proportion of their laundry was done on the property versus off site. Copies of the survey instruments may be found in the Appendix.

To encourage participation, a five-question survey, a self-addressed and stamped envelope, and a one-dollar bill were mailed to each resident. A cover letter explained the purpose of the survey and promised an additional \$10 to each resident who returned the survey. Of the 641 surveys that were mailed to occupied apartments, 310 were returned, providing a response rate of 48%. Figure 10 displays the response rate for each property included in the study.

FIGURE 10: Mailing and Response Characteristics of Selected Sites

Property		Number Mailed to Occupied Units	Number Returned	Response Rate
California	Common Area	110	60	55%
	In-Unit	46	19	41%
Georgia	Common Area	105	34	32%
	In-Unit	49	18	37%
Oregon	Common Area	105	50	48%
	In-Unit	50	22	44%
Texas	Common Area	131	89	68%
	In-Unit	45	18	40%
OVERALL		641	310	48%

Summary of Stated Results of the Resident Questionnaires

The five questions on the survey were:

1. About how many total loads (a load is defined as each time the washing machine is used) of laundry did everyone in your household do in a typical week in any location?
2. During the last three months, were you or anyone else who lives in your apartment away on a trip or for any other reason out of the apartment? (if yes, for how many days? for how many people?)
3. About what percentage of laundry is done here in your apartment's washer and dryer/your apartment's laundry room or off-site (e.g., someone else's home, laundromat)?
4. Answer only if some laundry is washed off-site. Why isn't the washer in your apartment used/Why aren't you using the apartment's laundry room?
5. How would you rate the overall condition of the laundry equipment in your apartment/your apartment complex?

The answer to the third question was shown in Figure 7. The answers to the remaining questions are displayed in Figures 11 through 13. As indicated earlier, the self-reported laundry patterns of residents of buildings with common area laundry rooms were strikingly different from the laundry patterns of in-unit property residents. In-unit property residents reported doing more loads of laundry per week on average, and they were more likely to do almost all of their laundry on site. The number of self-reported loads of laundry done per week by residents of in-unit properties 1.5 times greater than the number of self-reported loads of laundry done per week by residents of common area properties.

FIGURE 11: Total Laundry Loads per Week

Number of Loads	Type of Laundry Facilities	
	Common Area	In-Unit
0	2%	0%
1	11%	9%
2	28%	13%
3	22%	13%
4	19%	14%
5	6%	14%
6	6%	14%
7*	6%	23%
TOTAL	100%	100%
Average Loads	3.32	5.08

* Differences between respondents from common area versus in-unit properties were statistically significant $p < 0.05$.

As shown in Figure 12, there was little difference in the amount of time spent away from the apartment during the study period between residents of properties with in-unit laundry facilities versus those with common area laundry facilities.

FIGURE 12: Days and Numbers of Residents Away from Home During Study

Absent from Home	Type of Laundry Facilities	
	Common Area	In-Unit
Yes*	64%	55%
No	36%	45%
TOTAL	100%	100%
Average Number of Days Out of Apartment*	4.47	4.52
Average Number of People Out of Apartment	0.55	1.14

* Differences between respondents from common area versus in-unit properties were NOT statistically significant $p < 0.05$.

A question on the survey asked respondents (if applicable) why they did not use the washing machines in their apartment buildings. Each of the following explanations was cited by just over a third of the residents of properties with common area laundry rooms who did not use them: the cost of doing laundry, the condition of the laundry room, and the small load-capacity of the machines. Small load-capacity was the most frequently given reason by residents of properties with in-unit laundry facilities to explain why they did not use them.

FIGURE 13: Reasons Some Residents Did Not Use On-Site Machines

Reasons	Type of Laundry Facilities*	
	Common Area	In-Unit
Condition of laundry room	38%	not asked
Cost	38%	not asked
Small load-capacity	35%	38%
Preference for other location	27%	0%
Condition or type of laundry equipment	24%	25%
Laundry done at relative's or friend's	22%	13%
Machines rarely available	4%	not asked
Other	24%	38%

* Responses total more than 100% because residents could give multiple reasons.

Residents were asked to rank the condition of their laundry equipment. Those residents with common area laundry facilities ranked 68% of the equipment as “good” or “excellent” where as 85% of residents with in-unit machines ranked them as “good” or “excellent”.

Verifying Laundry-Water Use Estimates

In order to confirm the estimates of laundry-water use obtained through water meters, additional information was gathered about the use of the machines in common area facilities by obtaining the records on the number of coins vended during the study period. The time period when the meters were on the washing machines and the time period for which coin vending information was available was not identical, but the two time periods did overlap.

The metered observations, coin observations and self-reported information were all compared. Of course, the unit of analysis for the coin data and self-reported data is cycles or loads. For the meter observations, the unit of analysis is gallons of water. In order to convert these into comparable units of analysis, information about the average number of gallons used per cycle for the machines on these properties was obtained from manufacturers. For the common area machines, the manufactures indicated that 32 gallons of water were

used per cycle. For the in-unit machines, the manufactures stated that 43.5 gallons of water were used per cycle. Thus, to convert the meter observations into loads, the total number of gallons of water per unit per week was divided by the appropriate number of gallons per cycle. To convert the coin observations and self-reported data into gallons per unit per week, the number of loads was multiplied by the appropriate number of gallons per cycle.

Figures 14 & 15 show the comparison of estimates of on-site laundry use by the three data collection methods for the common area properties, and for the meter observations and survey data for the in-unit properties. For common area properties, the figures are quite similar for coin and meter observations. It appears that residents with common area machines may overestimate their use of the facilities somewhat, or perhaps they underestimated the amount of laundry done off-site. For those with in-unit facilities, the meter observations and self-reported information are quite similar (see Figure 15).

FIGURE 14: Laundry-Water Use by Data Collection Method (On-Site) per Apartment Unit per Week

		Type of Laundry Facilities			
		Common Area		In-Unit	
		Gallons	Cycle/Loads	Gallons	Cycles/Loads
California	Meter Observations	77.43	2.42	340.44	7.83
	Coin Observations	72.04	2.25	–	–
	Self-Report (Survey)	89.62	2.80	331.70	7.63
Georgia	Meter Observations	44.48	1.39	208.52	4.79
	Coin Observations	39.45	1.23	–	–
	Self-Report (Survey)	64.15	2.00	161.70	3.72
Oregon	Meter Observations	77.42	2.42	141.33	3.25
	Coin Observations	60.78	1.90	–	–
	Self-Report (Survey)	101.46	3.17	173.31	3.98
Texas	Meter Observations	41.16	1.29	201.81	4.64
	Coin Observations	36.15	1.13	–	–
	Self-Report (Survey)	82.30	2.57	199.81	4.59
Total	Meter Observations	57.31	1.79	221.43	5.09
	Coin Observations	52.11	1.63	–	–
	Self-Report (Survey)	88.00	2.75	215.87	4.96

FIGURE 15: Comparison of Estimates of Laundry-Water Use by Data Collection Method, Total

Data Collection Method	Gallons per Unit per Week		Ratio of In-Unit gallons to Common Area gallons	Cycles/Loads per Unit per Week		Ratio of In-Unit cycles/loads to Common Area cycles/loads
	Common Area	In-Unit		Common Area	In-Unit	
Meter Observations	69.13	227.11	3.29 times higher	2.16	5.22	2.42 times higher
Coin Observations	62.85	NA	NA	1.96	NA	NA
Self-Report (Survey)	106.15	221.41	2.09 times higher	3.32	5.09	1.53 time higher

Estimating Energy Usage from the Energy Guide

Differences in laundry patterns between residents of properties with common area washing machines and those with in-unit washing machines not only impacts water use, but also energy use. Using the information from the meters about the number of loads of laundry done per unit per week, estimates of differences in energy consumption patterns for laundry-use can also be concluded.

In order to calculate these estimates, information was needed about the energy used per washing machine per load. The year, make, and model of every washing machine metered in the study was recorded. The U.S. Government has mandated that all models manufactured after 1996 provide an Energy Guide showing the needed energy and energy costs per year associated with using the machine. Energy is listed in kWh and therms, depending on

the type of energy used. Since the washing machine models in the properties studied were manufactured before 1996, no Energy Guides were available for the models included in the study. Energy Guide information on 44 different models was gathered from four different manufacturers. An average energy use per load for electric hot water and gas hot water was calculated. These figures were then multiplied by the average number of loads per unit per week. For the common area laundry machines, energy use per load was known, and this was also multiplied by the average number of loads per unit per week.

While this study did not compare dryer efficiency of in-unit machines versus common area machines, it should be noted that 96% of domestic dryers used in in-apartment-unit applications are electric. Only 36% of commercial dryers are electric. According to the California Energy Commission, the cost of electricity needed to dry a typical load of laundry is twice the cost of gas needed to do the same.

FIGURE 16: Estimates of Laundry Use Energy Consumption

		Type of Laundry Facilities							
		Common Area				In-Unit			
		Cycle/Loads per Unit per Week	Estimated Energy Use			Cycle/Loads per Unit per Week	Estimated Energy Use		
per Cycle	per Week		per Year	per Cycle	per Week		per Year		
California	Electricity (in kWh)	2.26	1.048	2.368	123.16	7.74	2.139	16.559	861.05
	Gas (in therms)	2.26	0.049	0.111	5.79	7.74	0.107	0.824	42.87
Georgia	Electricity (in kWh)	3.50	1.048	3.668	190.74	4.93	2.139	10.547	548.45
	Gas (in therms)	3.50	0.049	0.173	8.97	4.93	0.107	0.525	27.31
Oregon	Electricity (in kWh)	2.65	1.048	2.777	144.41	3.39	2.139	7.252	377.13
	Gas (in therms)	2.65	0.049	0.131	6.79	3.39	0.107	0.361	18.78
Texas	Electricity (in kWh)	1.57	1.048	1.645	85.56	4.70	2.139	10.055	522.86
	Gas (in therms)	1.57	0.049	0.077	4.02	4.70	0.107	0.501	26.03
Total	Electricity (in kWh)	2.16	1.048	2.264	117.71	5.22	2.139	11.167	580.71
	Gas (in therms)	2.16	0.049	0.106	5.54	5.22	0.107	0.556	28.91



For more information, a copy of the Appendix, or additional copies of this study, the contact Multi-housing Laundry Association at 800-380-3652 or visit our web site at www.laundrywise.com.