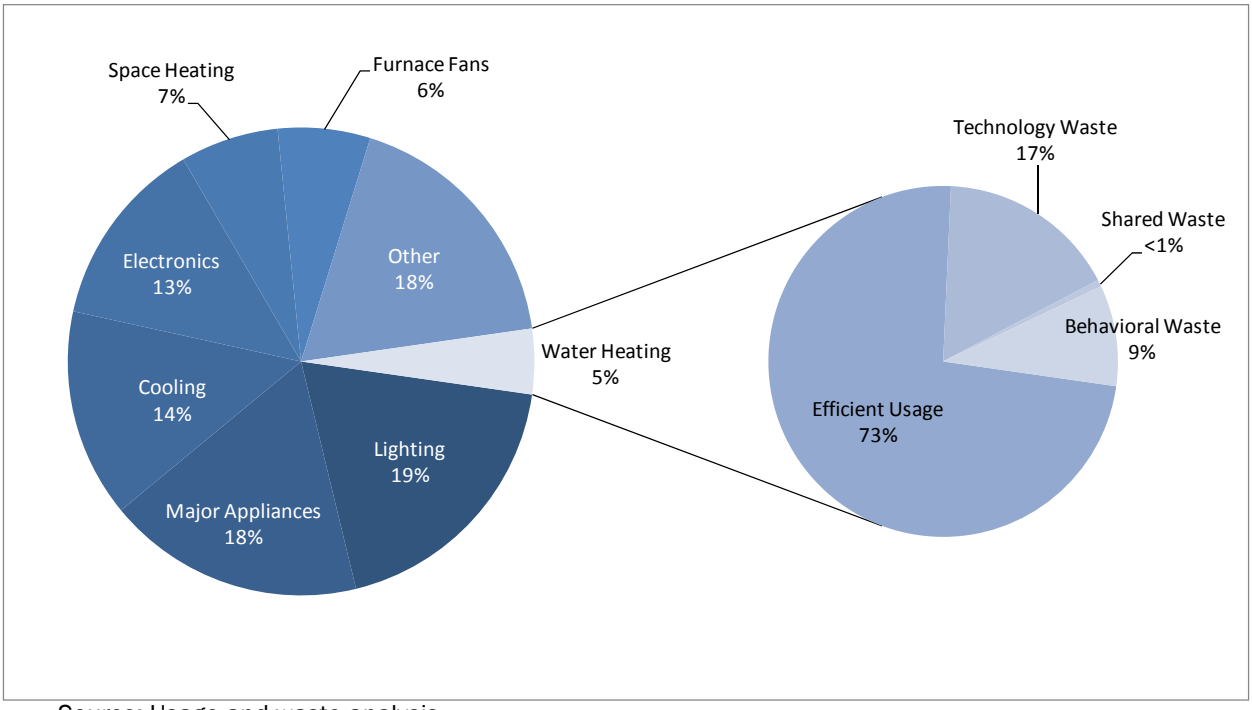
8. Electric Water Heating

Electric water heaters are used by 8% of households in ComEd's service territory. Overall, they account for approximately 5% of total residential electricity usage in ComEd's service territory. However, this share is much larger among households that have an electric water heater (36%). We estimate that technology and behavioral waste associated with electric water heaters accounts for approximately 17% and 9%, respectively, of current usage (if technology waste is addressed first).

Figure 8-1 shows the contribution of electric water heaters to overall residential electricity usage (pie chart on the left) and the breakout of electric water heater usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right).[13]

Figure 8-1. Usage and Waste Analysis – Electric Water Heaters



Source: Usage and waste analysis

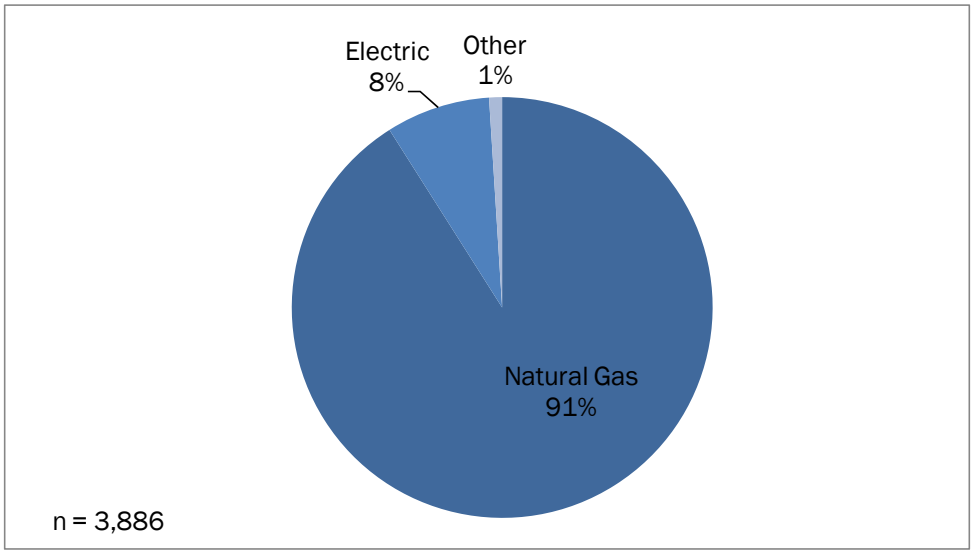
8.1 Water Heater Characteristics

The majority of ComEd's residential customers use natural gas water heaters (91%). Electric water heaters are relatively uncommon with only 8% of customers using one. Electric water

[13] Note that "Efficient Usage" represents the residual usage taking into account only the waste categories included in this analysis. If additional waste categories were identified and quantified, efficient usage might be smaller than presented here.

heaters are more common in multi-family homes (16%) compared to single family homes (6%).

Figure 8-2. Penetration of Electric Water Heaters



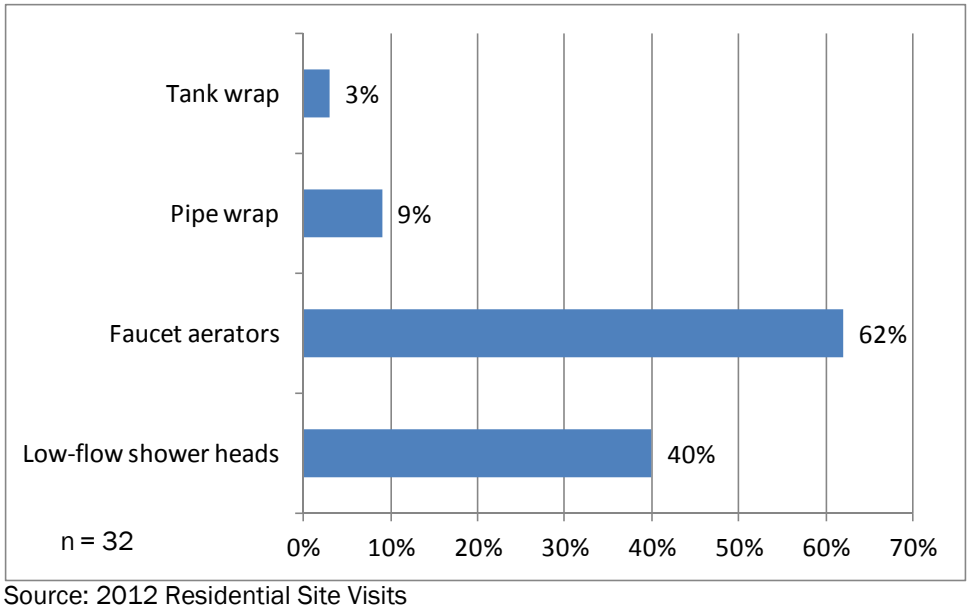
Source: 2012 ComEd Residential Mail Survey

Most electric water heaters in ComEd's service territory are storage water heaters (93%); 7% are tankless electric water heaters.

Few households with electric water heaters have tank wrap (3%) or pipe wrap (9%) that would reduce the energy requirement to keep the water at the desired set point. A larger percentage has faucet aerators (62%) or low flow shower heads (40%) that would reduce the water flow.[14]

[14] Note that these percentages are based on site visits which surveyed 32 homes with electric water heaters. Self-reported numbers from the mail survey showed a higher share of customers with tank wrap (24%) and low-flow shower heads (46%). These self-reported numbers are likely an over-estimate. However, the site visits did not include a sufficient sample of electric water heaters to make a statistically valid adjustment to the self-reported numbers.

Figure 8-3. Penetration of Water Heater Insulation and Flow Reduction Measures



Source: 2012 Residential Site Visits

The majority of households (68%) reports having a medium set point (126-135°F) for their water heater. Twenty-two percent report a low set point (120-125°F) while 10% report a high set point (136-140°F). Notably, 46% of all respondents did not know their set point.

Table 8-2 at the end of this chapter provides key penetration and saturation information about electric water heaters in ComEd's service territory.

8.2 Usage and Waste Analysis: Electric Water Heaters

The usage and waste analysis for electric water heaters is based on site visit data. The analysis includes 32 electric water heaters observed at the 297 site visit homes.

The amount of electricity used by an electric water heater is a function of 1) daily hot water usage, 2) the difference in temperature between water heater set point and incoming water temperature, and 3) the water heater energy factor. The age and the efficiency of the water heater are not considered in these calculations because electric resistance heating is approximately 100% efficient and no significant degradation in efficiency takes place as the heater ages.

We estimate hot water usage for four end-uses: clothes washers, dishwashers, showers, and faucets. In general, hot water usage for each end-use is estimated based on the number of occupants, the number of "events" (e.g., showers or loads of laundry) per day, the gallons of water used per event, and the percentage of hot water used in each event. We derived the number of occupants, the number of events per person per day, and the share of hot water usage for showers from the mail survey; all other inputs into the water usage analysis are based on secondary sources (e.g., ENERGY STAR or the Illinois TRM).

Water heater set points are also derived from the mail survey, while the water heater energy factor is a function of tank size and type (storage or on-demand), which were collected during the site visits.

This analysis includes three sources of technology waste for electric water heaters: 1) no storage tank insulation, 2) no pipe insulation, and 3) excess water usage due to lack of low-flow shower heads and faucet aerators. We also estimated waste associated with extra hot water usage due to inefficient clothes washers and dishwashers. These categories of waste are not included in the results for electric water heaters but are discussed in the appliance chapter.

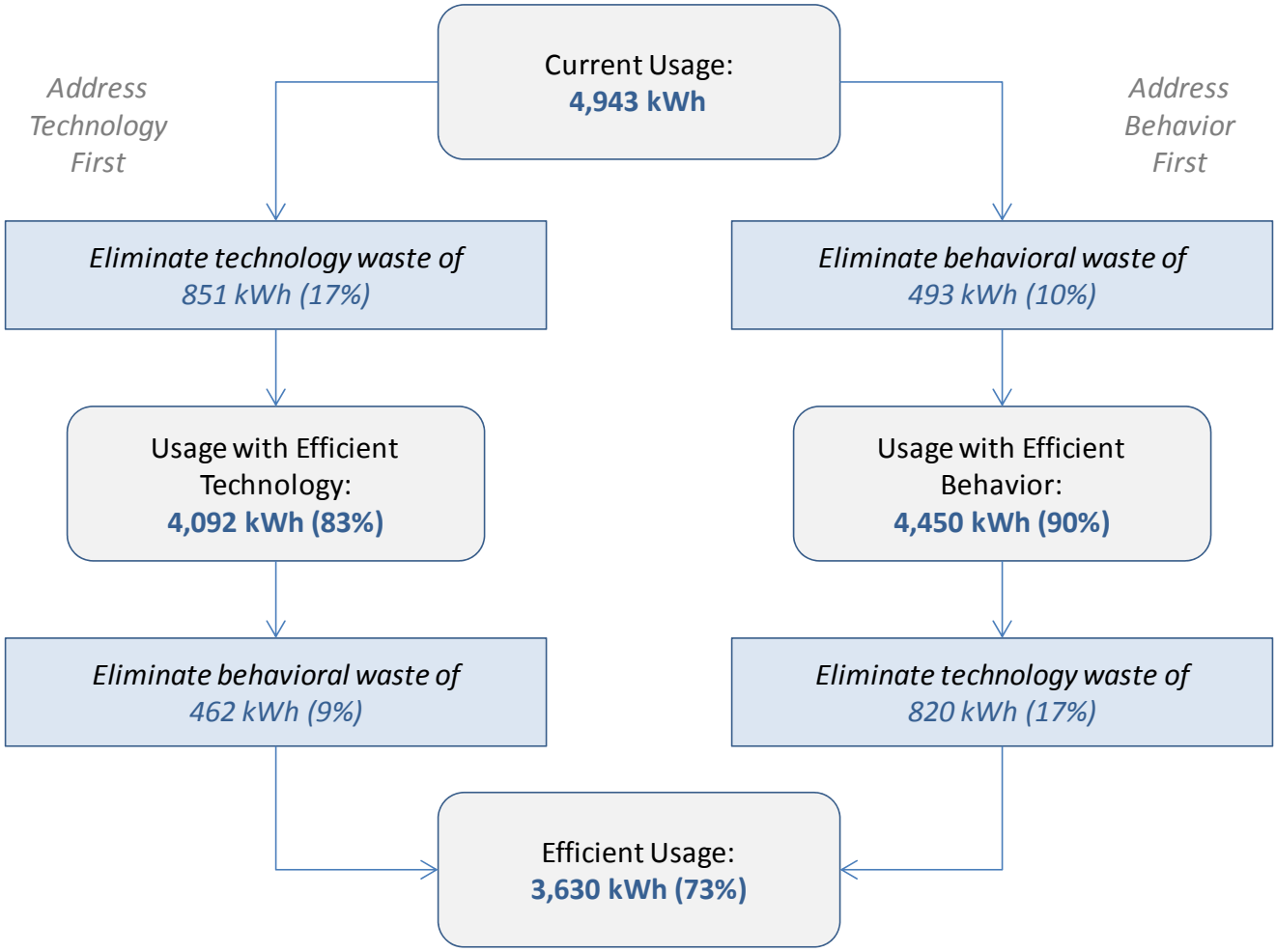
Behavioral waste for electric water heaters is associated with high temperature set points. We also estimated behavioral waste associated with excessive hot water use due to 1) customers washing an excessive percentage of clothes washer loads with hot water and 2) customers running partial dishwasher loads. As with technology waste, these categories of waste are not included in the results for electric water heaters but are discussed in the appliance chapter.

Overall, electric water heaters account for approximately 5% of total residential electricity usage in ComEd's service territory. However, this share is much larger among households that have an electric water heater (36%). Each household with an electric water heater uses an average of 4,943 kWh per year for water heating. There is substantial potential for energy savings from installing tank and pipe wrap as well as low flow shower heads and faucet aerators: If these measures were installed in all homes that do not already have them, 17% of water heater electricity use could be saved. The majority of these savings come from low flow shower heads (33%) and faucet aerators (34%); the potential savings from pipe wrap (19%) and tank wrap (13%) are smaller.

There is also substantial savings potential from reducing water heater temperature set points: Mail survey results show that most households do not use an efficient water heater set point. We estimate that about 10% of current water heater usage could be saved if these customers reduced their set point to a low setting of 120-125°F (9% if technology upgrades took place first).

Figure 8-4 shows the average annual per household energy usage and savings potential associated with electric water heaters (for households that have them). The figure shows estimated usage and savings when addressing technology waste, behavioral waste, or both.

Figure 8-4. Technological and Behavioral Potential – Electric Water Heaters



Source: Usage and waste analysis

The following table presents the same usage and waste information, including 1) average per household results for households with an electric water heater, 2) average per household results for all households, and 3) total usage and waste results for ComEd's residential population.

Table 8-1. Summary of Electric Water Heating Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF[A]	MF[A]	Total	SF[A]	MF[A]	Total	SF[A]	MF[A]
	Penetration:	8%	5%	15%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	4,943			398			1,323,479		
	Efficient Usage	3,630			292			971,977		
	% Efficient Usage	*73%*			*73%*			*73%*		
	Waste	1,313			106			351,502		
	% Waste	*27%*			*27%*			*27%*		
Technology First	Technology	851			68			227,834		
	Technology %	*17%*			*17%*			*17%*		
	Behavioral	462			37			123,668		
	Behavioral %	*9%*			*9.3%*			*9.3%*		
Behavior First	Behavioral	493			40			132,045		
	Behavioral %	*10%*			*10%*			*10%*		
	Technology	820			66			219,457		
	Technology %	*17%*			*17%*			*17%*		

Source: Usage and waste analysis
[A] The incidence of electric water heaters was too small to estimate usage and waste by single family and multi-family homes.

Table 8-2. Summary of Water Heating Data

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Primary water heating fuel [A]													
Natural gas	91%	94%	83%	95%	94%	88%	92%	80%	51%	23%	95%	26%	90%
Electric	8%	6%	16%	5%	5%	10%	7%	19%	49%	76%	5%	74%	9%
Other	1%	1%	9%	<1%	1%	2%	1%	1%	<1%	1%	1%	<1%	1%
Age of electric water heater													
<5 years	45%	47%	42%	48%	49%	44%	*	42%	47%	47%	47%	50%	31%
5-10 years	36%	37%	34%	38%	35%	37%	*	38%	27%	32%	38%	26%	42%
11+ years	20%	17%	25%	14%	17%	20%	*	20%	26%	21%	15%	23%	27%
Type of electric water heater[S]													
Storage	93%	*	*	*	*	*	*	*	*	*	*	*	*
Tankless	7%	*	*	*	*	*	*	*	*	*	*	*	*
Water heater has insulation blanket/tank wrap [S]	3%	*	*	*	*	*	*	*	*	*	*	*	*
Water heater has pipe insulation [S]	9%	*	*	*	*	*	*	*	*	*	*	*	*
Have low-flow showerheads [S]	40%												
Have faucet aerator [S]	62%	*	*	*	*	*	*	*	*	*	*	*	*
Water heater temp. setting													
Low (120-125°F)	22%	22%	22%	31%	11%	21%	*	*	19%	26%	21%	24%	20%
Medium (126-135°F)	68%	70%	63%	68%	77%	67%	*	*	66%	63%	73%	59%	68%
High (136-140°F)	10%	8%	15%	1%	11%	12%	*	*	15%	10%	7%	17%	12%

Source: 2012 ComEd Residential Mail Survey; 2012 Residential Site Visits
[A] All subsequent results only include households with electric water heaters.
[S] Data based on site visits.
* Insufficient number of responses.

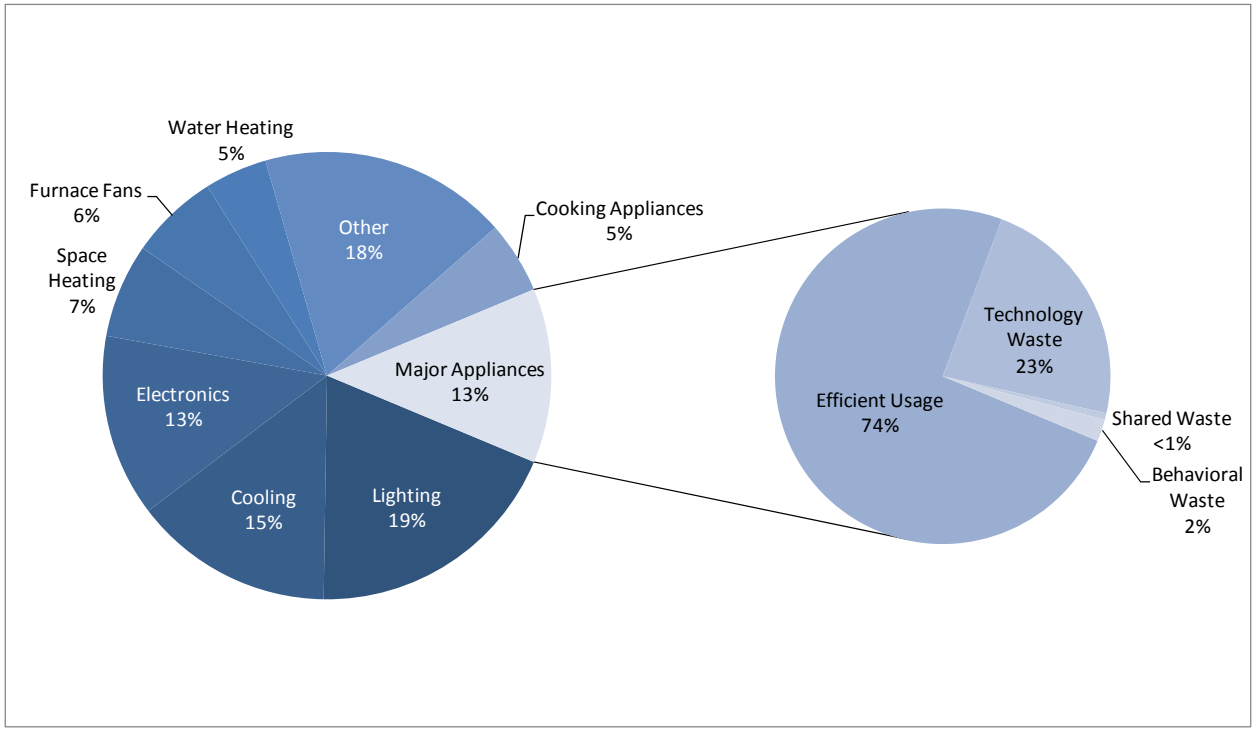
9. MAJOR APPLIANCES

Our analysis of major appliances includes refrigeration equipment (refrigerators and freezers), laundry equipment (washers and electric dryers), and dishwashers. Overall, major appliances account for approximately 13% of total residential electricity usage. Each household uses an average of 1,104 kWh per year to operate major appliances. Refrigerators account for the majority of this usage (68%). We estimate that technology and behavioral waste associated with major appliances accounts for approximately 23% and 2%, respectively, of current usage (if technology waste is addressed first).

In addition, we assessed current usage of cooking appliances (electric ovens and ranges as well as microwaves). These appliances account for an additional 5% of current usage.

Figure 9-1 shows the contribution of appliances to overall residential electricity usage (pie chart on the left) and the breakout of appliance usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right). Shared waste refers to the portion of waste that can be addressed by either technologies or behavior changes, depending on which is addressed first.[15]

Figure 9-1. Usage and Waste Analysis – Overall Appliances



Source: Usage and waste analysis

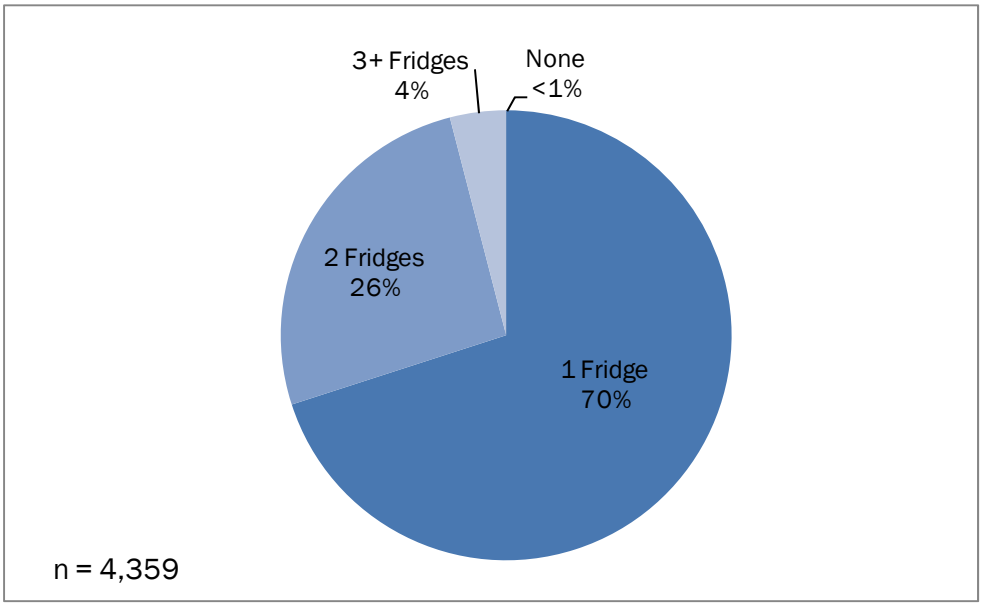
[15] Note that "Efficient Usage" represents the residual usage taking into account only the waste categories included in this analysis. If additional waste categories were identified and quantified, efficient usage might be smaller than presented here.

9.1 Refrigerators and Freezers

9.1.1 Refrigerator Characteristics

Refrigerators are found in nearly every home in ComEd's service territory. Less than one percent of residential customers do not have a refrigerator in their home. Most customers (70%) only have one refrigerator, 26% have two refrigerators, and 4% of customers have three or more.

Figure 9-2. Refrigerator Saturation



Source: 2012 ComEd Residential Mail Survey

Approximately half (49%) of refrigerators in ComEd territory are the traditional top freezer - bottom fridge type, almost all without a through the door icemaker. Another 29% are side-by-side, and 12% are bottom freezer - top fridge. Only 4% are single door refrigerators. Overall, 25% of refrigerators have a through the door ice maker.

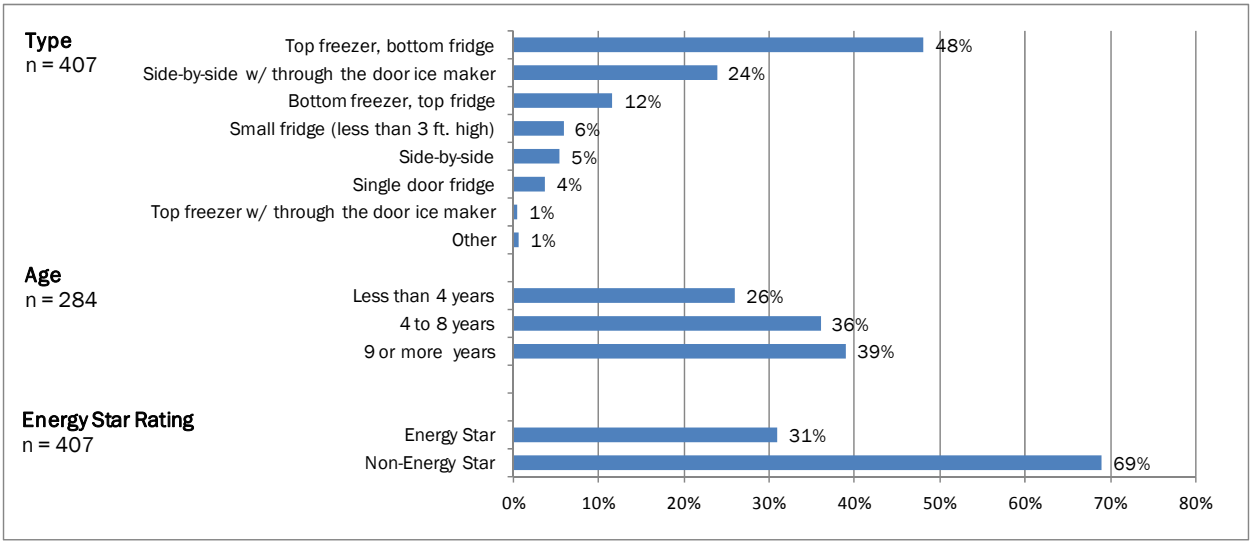
ComEd customers' refrigerators vary widely in age. The largest share of refrigerators (39%) is 9 years old or older. A quarter of refrigerators (26%) are less than 4 years old, and the remaining 36% are between 4 and 8 years old.[16]

Just under one third (31%) of refrigerators in ComEd service territory are ENERGY STAR models.[17]

[16] Note that refrigerator age could not be determined for 30% of the units observed during site visits.

[17] We considered a refrigerator to be ENERGY STAR rated if there was visible evidence of such a rating on the unit, e.g., a sticker or information on the nameplate. As a result, our reported percentage of ENERGY STAR units might be an underestimate.

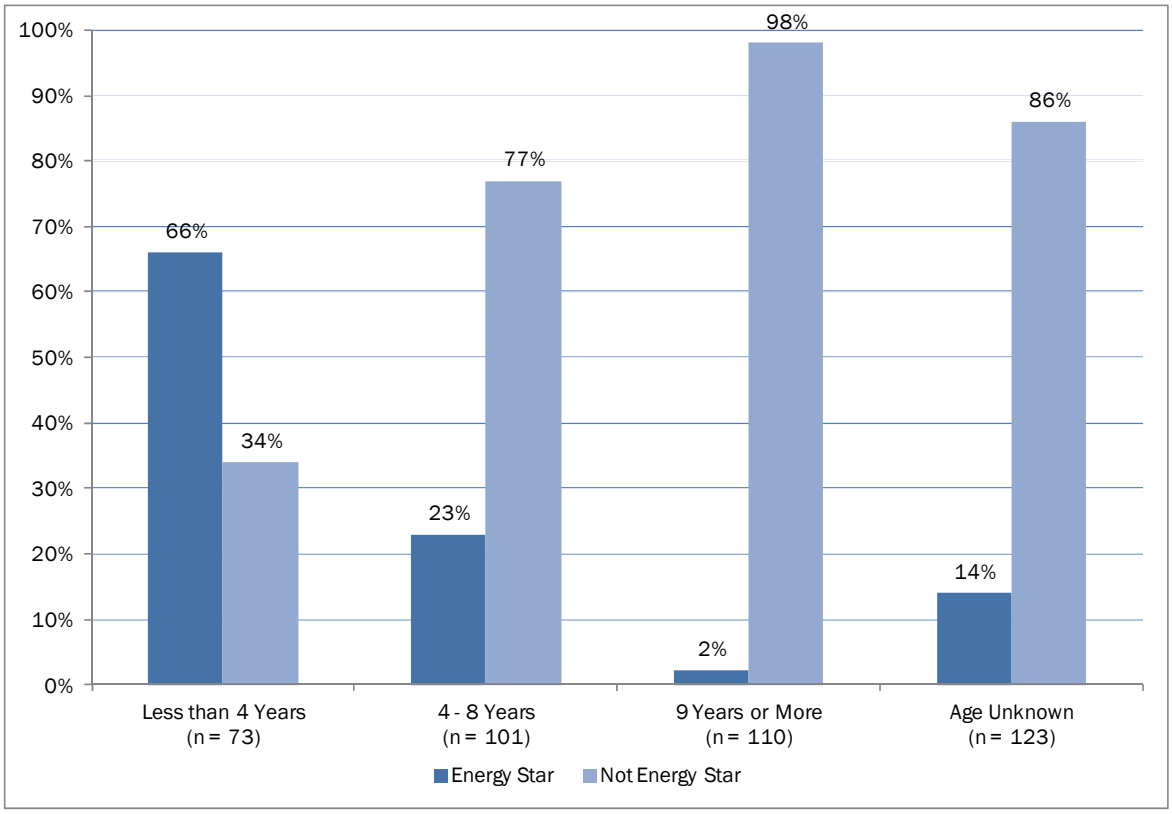
Figure 9-3. Key Refrigerator Characteristics



Source: 2012 Residential Site Visits

There is a distinct relationship between refrigerator age and ENERGY STAR: Only 2% of refrigerators 9 years or older are ENERGY STAR models, while 66% of refrigerators that are less than 4 years old are ENERGY STAR rated.

Figure 9-4. Refrigerator Age and ENERGY STAR

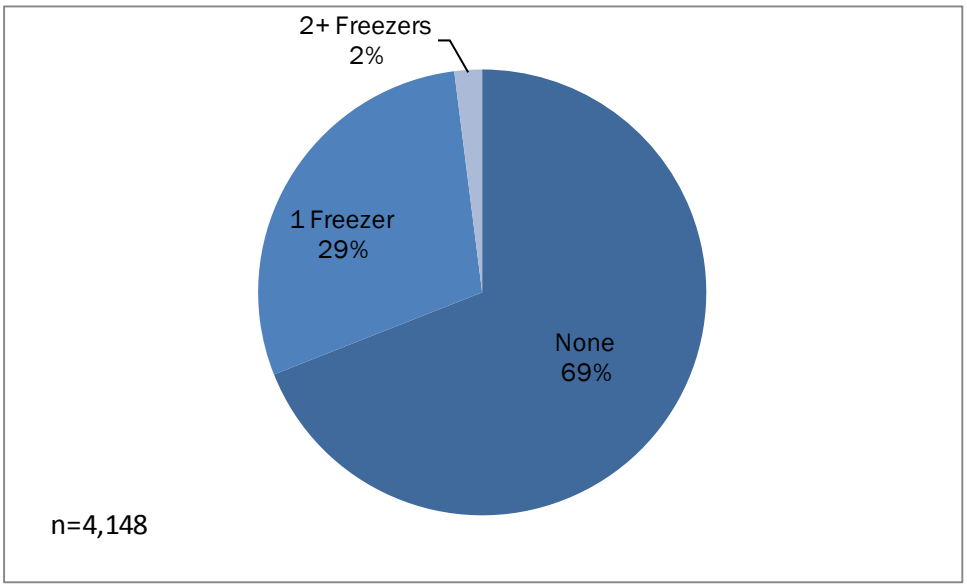


Source: 2012 Residential Site Visits

9.1.2 Freezer Characteristics

Slightly less than one third of ComEd customers (31%) have stand-alone freezers. The majority (69%) of ComEd customers do not own a separate freezer unit.

Figure 9-5. Freezer Saturation



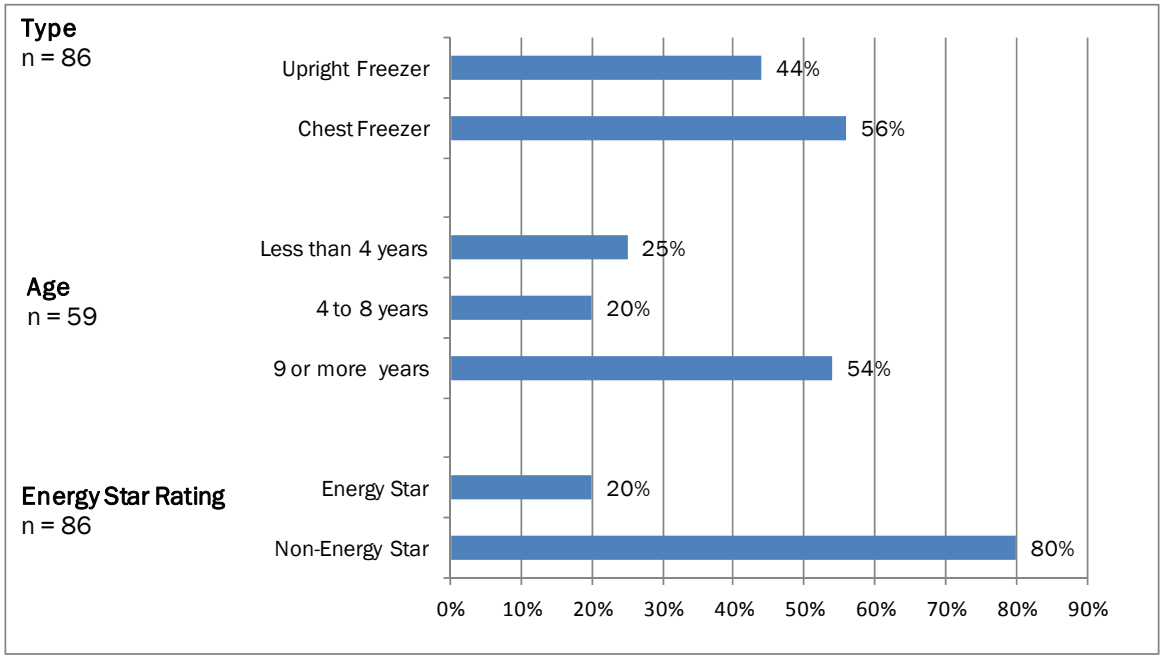
Source: 2012 ComEd Residential Mail Survey

Fifty-six percent of freezers in ComEd territory are chest freezers, while 44% are upright. More than half of all freezers (54%) are 9 years old or older.[18] Only 20% of freezers in ComEd service territory are ENERGY STAR models.[19]

[18] Note that freezer age could not be determined for 31% of the units observed during site visits.

[19] We considered a freezer to be ENERGY STAR rated if there was visible evidence of such a rating on the unit, e.g., a sticker or information on the nameplate. As a result, our reported percentage of ENERGY STAR units might be an underestimate.

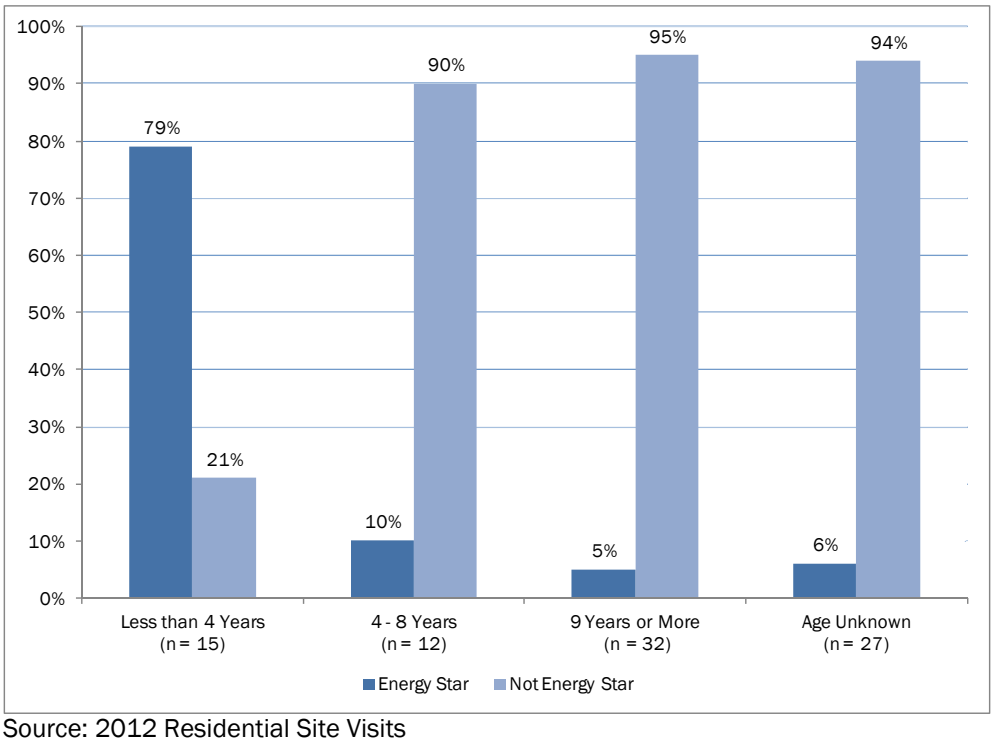
Figure 9-6. Key Freezer Characteristics



Source: 2012 Residential Site Visits

As with refrigerators, there is a relationship between freezer age and ENERGY STAR status: Only 5% of freezers 9 years or older and 10% of freezers between 4 and 8 years old are ENERGY STAR models. However, 79% of freezers that are less than 4 years old are ENERGY STAR.

Figure 9-7. Freezer Age and ENERGY STAR



Source: 2012 Residential Site Visits

Table 9-5 at the end of this chapter provides key penetration and saturation information about refrigerators and freezers in ComEd's service territory.

9.1.3 Usage and Waste Analysis: Refrigerators and Freezers

The usage and waste analysis for refrigerators and freezers is based on site visit data. The analysis includes 407 refrigerators and 86 freezers observed at the 297 site visit homes.

The amount of electricity used by refrigerators and freezers is a function of the unit's type, volume, and age, and whether the unit is ENERGY STAR rated. For non-ENERGY STAR refrigerators and freezers, we estimated usage based on the current Federal minimum efficiency standards, by type. We then made age-based adjustments to reflect the fact that the Federal minimum standard has changed over the lifetime of the units observed in our study. For ENERGY STAR units, we estimated usage as a percentage of the Federal minimum standard, based on the ENERGY STAR criteria at the time the unit was manufactured.

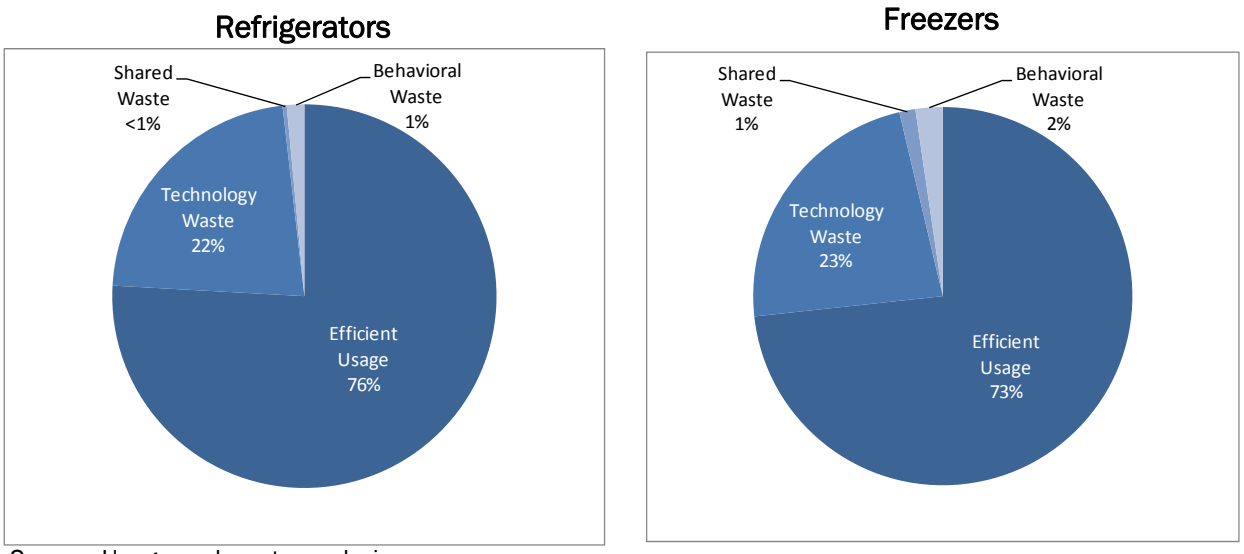
Technology waste for refrigerators and freezers is defined as the difference between the estimated usage of the current unit and the usage of an equivalent efficient unit. Efficient units are new ENERGY STAR units of the same type and volume as the current unit. Current ENERGY STAR criteria (as of April 28, 2008) require refrigerators to be at least 20% more efficient and freezers to be at least 10% more efficient than the federal minimum standard. We therefore estimate efficient usage to be 80% and 90%, respectively, of the usage of an equivalent non-ENERGY STAR refrigerator or freezer.

Behavioral waste for refrigeration is associated with freezers and secondary refrigerators that were found to be empty or nearly empty at the time of the site visit. For these units, the entire energy usage is considered to be behavioral waste.

Refrigeration used by ComEd's residential customers accounts for approximately 9% of total residential electricity usage. Each household uses an average of 910 kWh per year for refrigeration. There is substantial potential for energy savings from upgrading to more efficient technologies: If all existing standard efficiency and older model ENERGY STAR refrigerators and freezers were replaced with a new ENERGY STAR model, 23% of refrigeration electricity use could be saved. Behavioral savings potential is more limited as only 3% of freezers and refrigerators were considered wasteful because of their level of fullness. We estimate that elimination of these units would save an additional 2% of the current total refrigeration usage.

By equipment type, refrigerators account for 83% of total refrigeration usage. We estimate that 24% of current refrigerator usage is waste, compared to 27% for freezers. Figure 7-3 compares the break-down of usage and waste shares for refrigerators and freezers.

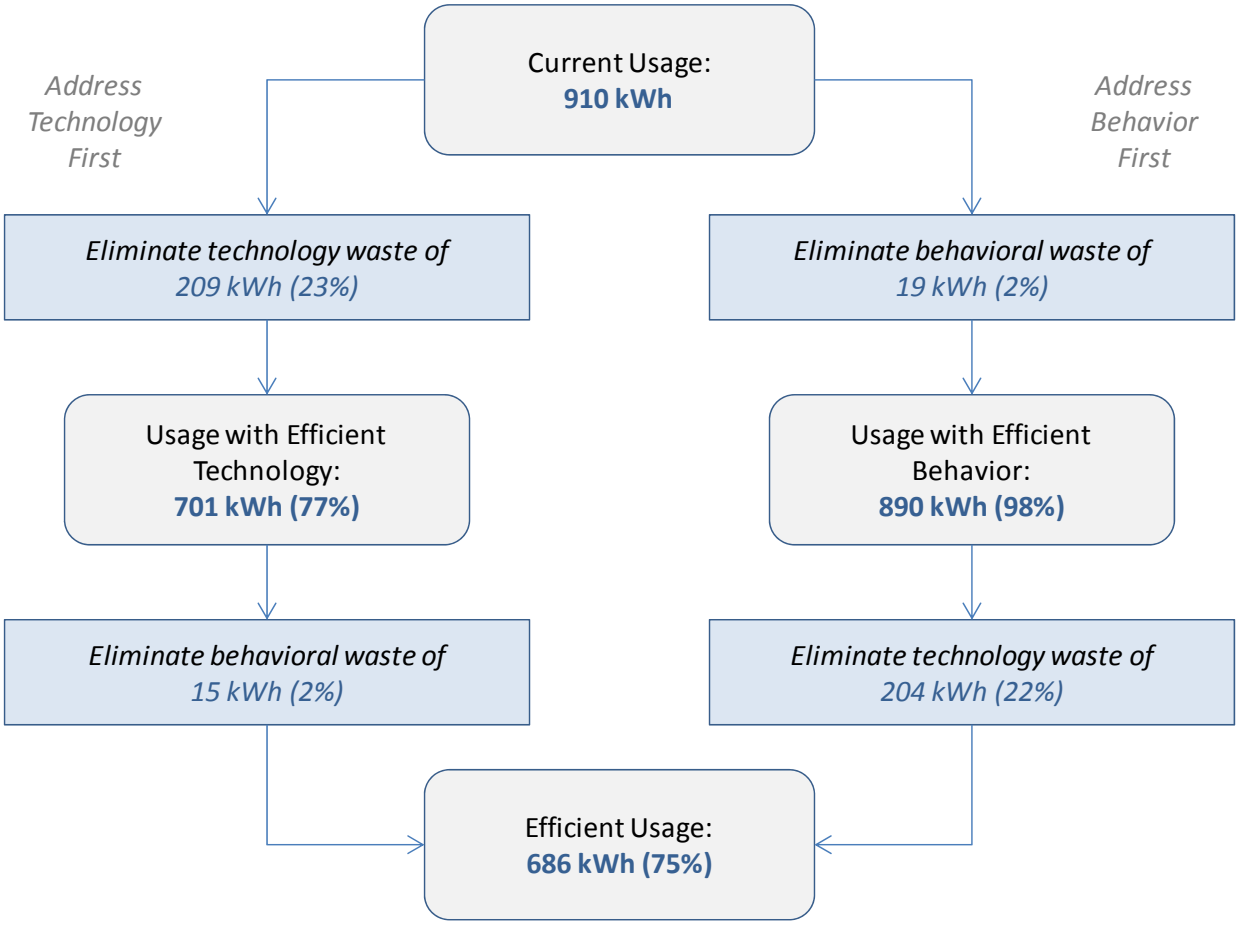
Figure 9-8. Usage and Waste Analysis by Equipment



Source: Usage and waste analysis

Figure 9-9 shows the average annual energy usage and savings potential for households that have refrigeration equipment. The figure shows estimated refrigeration usage and savings when addressing technology waste, behavioral waste, or both.

Figure 9-9. Technological and Behavioral Potential – Refrigeration



Source: Usage and waste analysis

9.2 Clothes Washers and Dryers

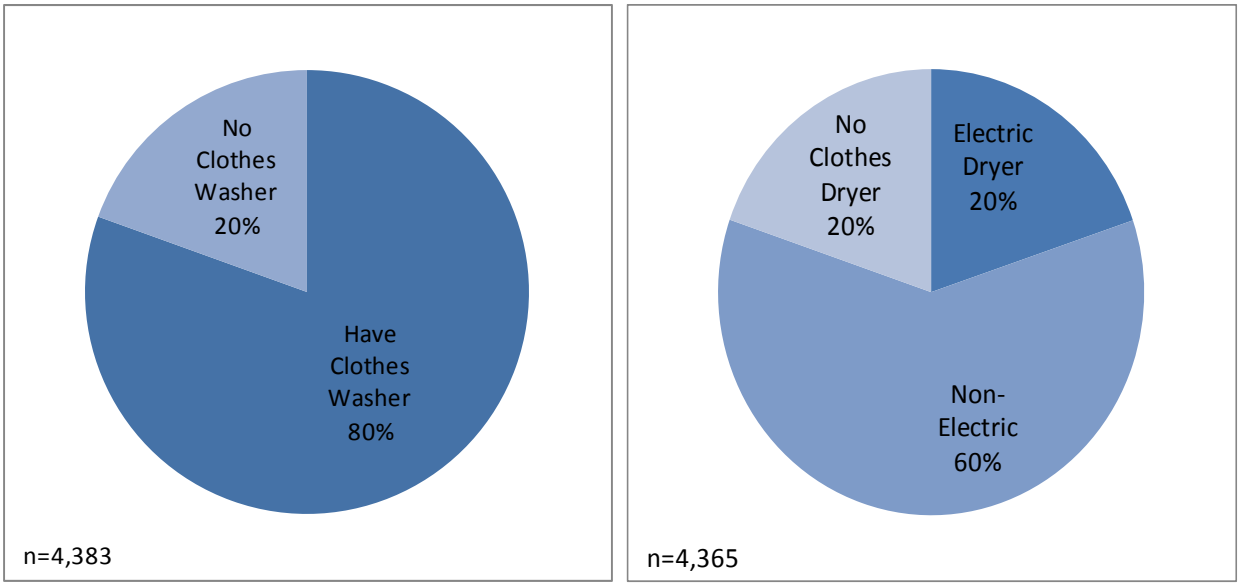
9.2.1 Washer and Dryer Characteristics

Four out of five ComEd customers (80%) have a clothes washer in their home. Nearly all single family homes (98%) have a clothes washer, while just under half of multi-family homes (47%) have one.[20]

Similarly, 80% of ComEd customers have a clothes dryer in their home. Again, nearly all single family homes (97%) have one, while just under half of multi-family homes (47%) have one. Three quarters of clothes dryers in ComEd territory (75%) are fueled by natural gas or propane, while 25% are powered by electricity. (Taking into account dryer penetration, this translates into 20% of all households having an electric dryer.) Multi-family homes more often have electric models (42%) compared to single family homes (21%).

[20] Clothes washers located in common areas for shared used are excluded from this analysis.

Figure 9-10. Clothes Washer and Dryer Penetration



Source: 2012 ComEd Residential Mail Survey

Three quarters of clothes washers (76%) are of the top loading type, while 24% are front loading. Based on the site visits, we estimate that 32% of clothes washers are ENERGY STAR rated.[21]

The largest share of clothes washers in ComEd's territory (40%) are between five and nine years old. One-quarter are less than five years old, and 16% are 20 or more years old.

On average, households wash 1.1 hot water loads, 2.3 warm water loads, and 2.4 cold water loads per week.

9.2.2 Usage and Waste Analysis: Clothes Washers and Dryers

The usage and waste analysis for clothes washers and dryers is based on a combination of site visit, mail survey, and secondary data. The analysis includes 228 clothes washers observed at the 297 site visit homes. Fifty-two of these homes have an electric dryer.

Current energy usage of clothes washers and electric dryers is determined by first estimating the energy requirements associated with the full laundry cycle (i.e., the electrical energy consumption of the washer and the dryer as well as the hot water energy consumption of the washer) and then determining the share of overall usage that is washer and dryer electrical usage. Overall laundry energy usage is based on the clothes washer type (front loading or top loading), its capacity (estimated based on age), the number of loads washed per year, and the washer's efficiency level.

[21] We considered a clothes washer to be ENERGY STAR rated if there was visible evidence of such a rating on the unit, e.g., a sticker or information on the nameplate. As a result, our reported percentage of ENERGY STAR units might be an underestimate.

Technology waste for the laundry cycle is defined as the difference between the usage of the installed laundry equipment and the usage of laundry equipment where an efficient washer is substituted for the current unit.

Behavioral waste for clothes washers is associated with an above-average share of hot water usage. We only considered this source of waste if the customer has an electric water heater. Because this type of waste is associated with hot water usage and because electricity requirements for current hot water usage are captured in the water heater analysis, we do not formally include the potential for waste reduction in this analysis. However, we do quantify it and discuss it below.[22]

We did not estimate behavioral waste associated with dryers.

Laundry equipment used by ComEd's residential customers (including washer and dryer, but excluding hot water) accounts for approximately 0.8% of total residential electricity usage. Each household with laundry equipment uses an average of 122 kWh per year for laundry. However, for households with an electric dryer, usage is substantially higher, averaging 345 kWh.[23] By equipment type, clothes washers account for 36% of total laundry electric usage, while electric dryers account for 64%. These numbers reflect the higher usage of electric dryers but their lower penetration, compared to clothes washers (which are all electric).

The potential for energy savings from upgrading to more efficient technologies is rather small overall: If all existing clothes washers were replaced with an efficient model, 25% of laundry energy usage, or approximately 30 kWh per household with laundry equipment, could be saved.

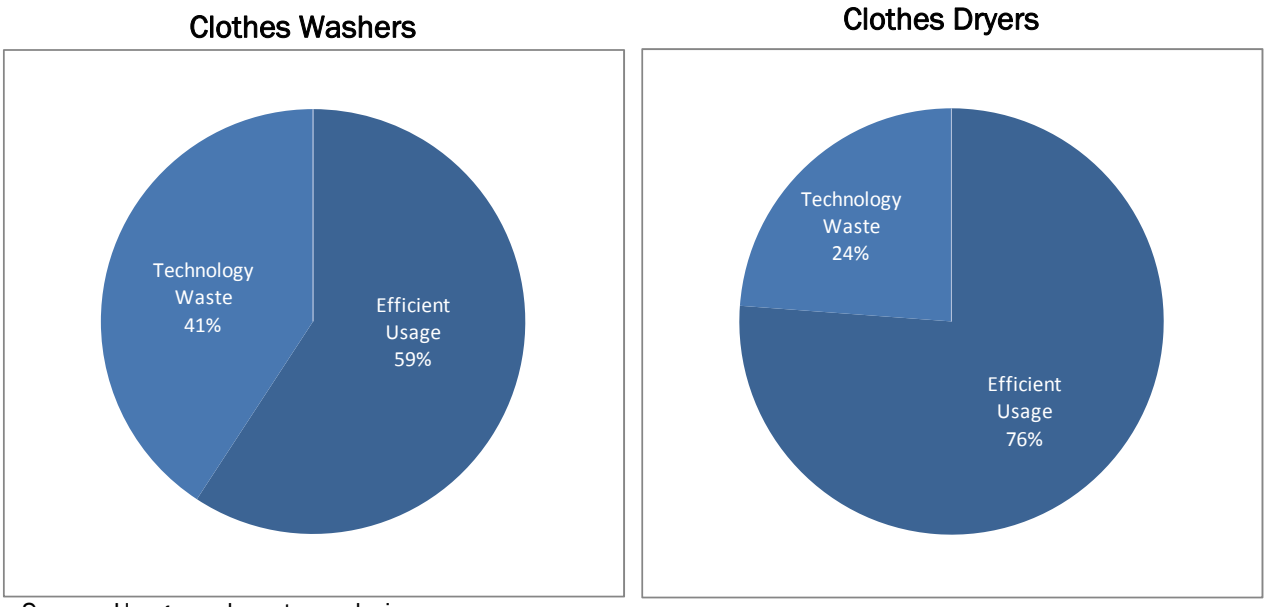
While behavioral waste from reducing clothes washer hot water usage is not formally included in the analysis of laundry equipment waste, we did quantify potential savings: We estimate that customers with an electric water heater use approximately 600 kWh per year for laundry (including washer, dryer, and hot water). Average usage for these customers is higher compared to all customers with laundry equipment due to the extra water heating requirement of the electric water heater. In addition, customers with an electric hot water heater also tend to have an electric dryer. These customers could save 90 kWh a year, or 15%, by reducing the amount of hot water used to wash their laundry, given their current water heater configuration (i.e., whether or not they have tank wrap or pipe wrap). This number would decrease to 49 kWh if their system was first upgraded with tank wrap and pipe wrap.

Figure 9-11 compares the break-down of usage and waste shares for clothes washers and dryers.

[22] Including this waste in the clothes washer waste analysis would provide misleading results since energy usage associated with hot water requirements are not included for *current* usage.

[23] This estimate is lower than some values available from secondary sources. The main factor accounting for this difference is the lower average number of dryer loads (232 per year, among site visit homes) reported by ComEd customers, compared to assumptions used in other estimates.

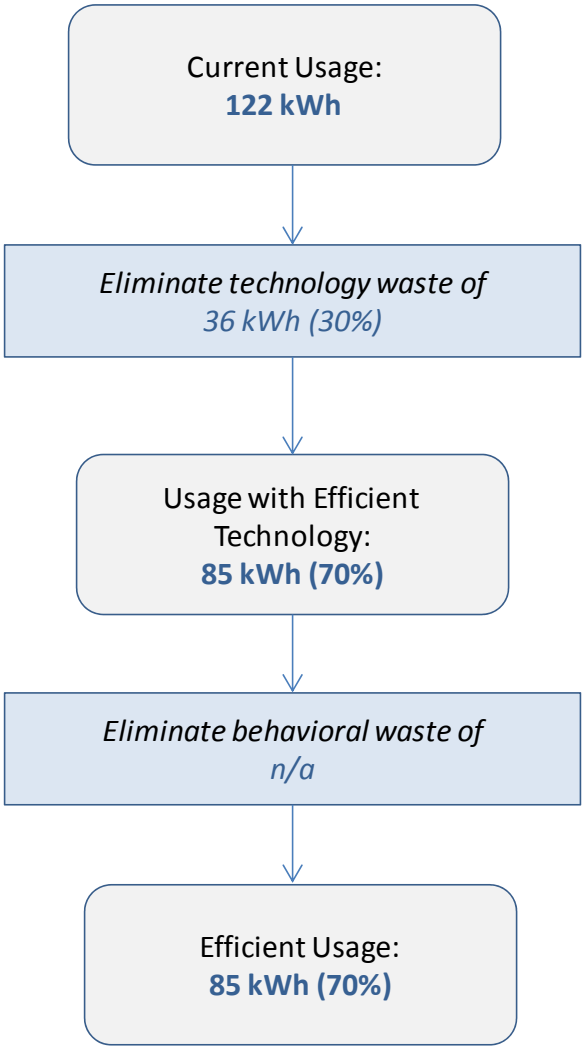
Figure 9-11. Usage and Waste Analysis by Equipment



Source: Usage and waste analysis

Figure 9-12 shows the average annual per household energy usage and savings potential associated with laundry as a whole. The figure shows estimated usage and savings when addressing technology waste, behavioral waste, or both. These numbers represent a typical household with laundry equipment.

Figure 9-12. Technological and Behavioral Potential – Laundry



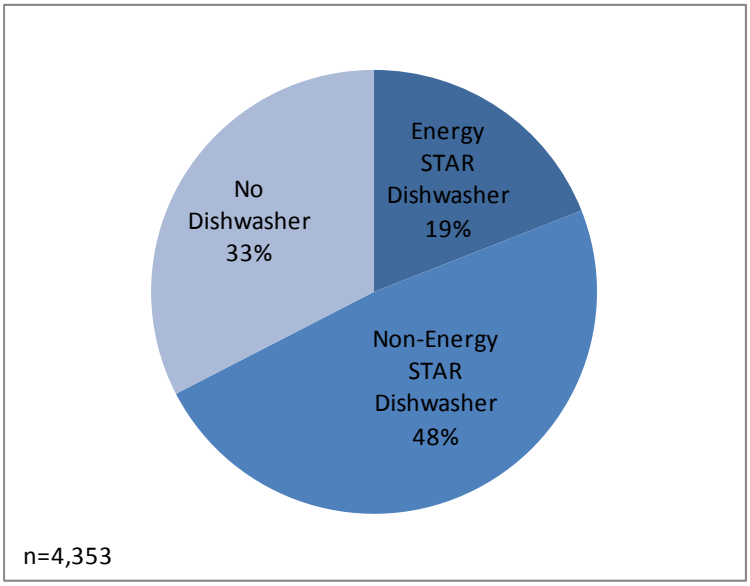
Source: Usage and waste analysis

9.3 Dishwashers

9.3.1 Dishwasher Characteristics

Two thirds of ComEd customers (67%) have dishwashers installed in their homes. Three quarters of single family homes (75%) have at least one dishwasher, while just over half of multi-family homes (54%) have one. Approximately one quarter (28%) of dishwashers in ComEd's service territory are ENERGY STAR rated.[24] Taking into account dishwasher penetration, this translates into 19% of all households having an ENERGY STAR rated dishwasher.

Figure 9-13. Penetration of Dishwashers



Source: 2012 ComEd Residential Mail Survey

Fairly even shares of dishwashers are less than five years old (33%), between five and nine years old (31%), and between 10 and 19 years old (30%); 5% are over 20 years old.

On average, households run 2.7 full dishwasher loads and 0.5 partial loads per week. Almost four in five customers (79%) report never running a partial dishwasher load.

9.3.2 Usage and Waste Analysis: Dishwashers

The usage and waste analysis for dishwashers is based on a combination of site visit, mail survey, and secondary data. The analysis includes 227 dishwashers observed at the 297 site visit homes.

The amount of electricity a dishwasher uses is a function of the unit's efficiency level (i.e., if it is ENERGY STAR rated), whether the unit has a "no-heat dry" function and the customer uses it, and the number of cycles the unit runs per year. ENERGY STAR rating and presence

[24] For dishwashers, the ENERGY STAR rating is based on the mail survey, adjusted by site visit observation.

of a “no-heat dry” function are based on site visits; usage of the “no-heat dry” function and the number of cycles per year are based on the mail survey.

Technology waste for dishwashers is defined as the difference between the usage of the current unit and the usage of an equivalent ENERGY STAR unit.

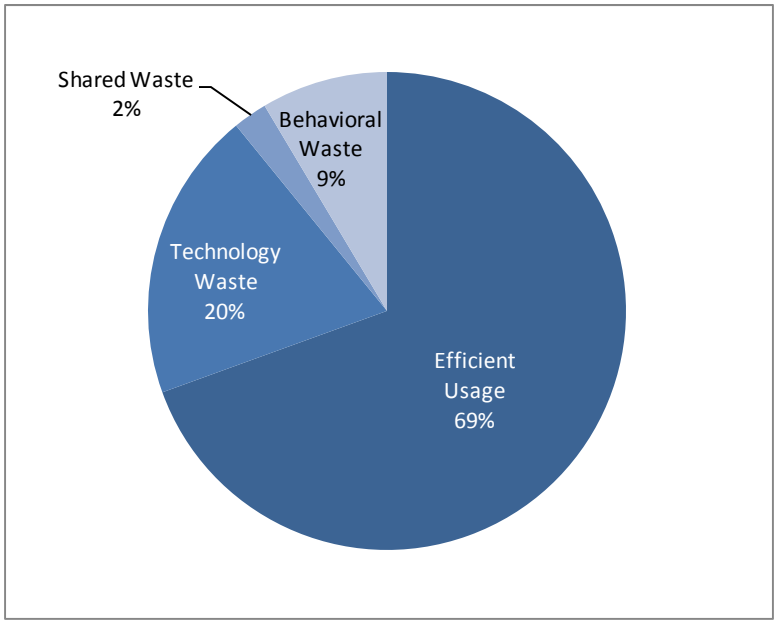
This analysis includes behavioral waste for dishwashers from two sources: waste associated with having a “no-heat dry” function but not using it, and waste associated with running the dishwasher to wash only a partial load (for the purposes of our analysis, a partial load was considered to be a dishwasher that was half full).

Dishwasher use by ComEd’s residential customers accounts for approximately 1% of total residential electricity usage. Each household with a dishwasher uses an average of 137 kWh per year running their dishwasher. Upgrading all existing dishwashers to ENERGY STAR models would save approximately 22% of current usage. Using the “no-heat dry” function and running fewer dishwasher loads by waiting until the dishwasher is full would save approximately 11% in electric operating costs (9% if technology waste is addressed first).

Additional behavioral waste associated with running partial loads exists for customers that have an electric water heater. These customers would save on water heating costs if they eliminated partial loads. Similar to clothes washers, we do not formally include water heating savings in this dishwasher analysis. However, we estimate the potential electricity savings associated with reduced electric water usage to be approximately 25 kWh per year based on the current water heater configuration (i.e., whether or not tank wrap or pipe wrap is present). This number would decrease to 16 kWh if their system was first upgraded with tank wrap and pipe wrap.

Figure 9-14 summarizes the breakout of dishwasher usage into efficient usage, technology waste, behavioral waste, and “shared waste”. Shared waste refers to the portion of waste that can be addressed by either technologies or behavior changes, depending on which is addressed first.

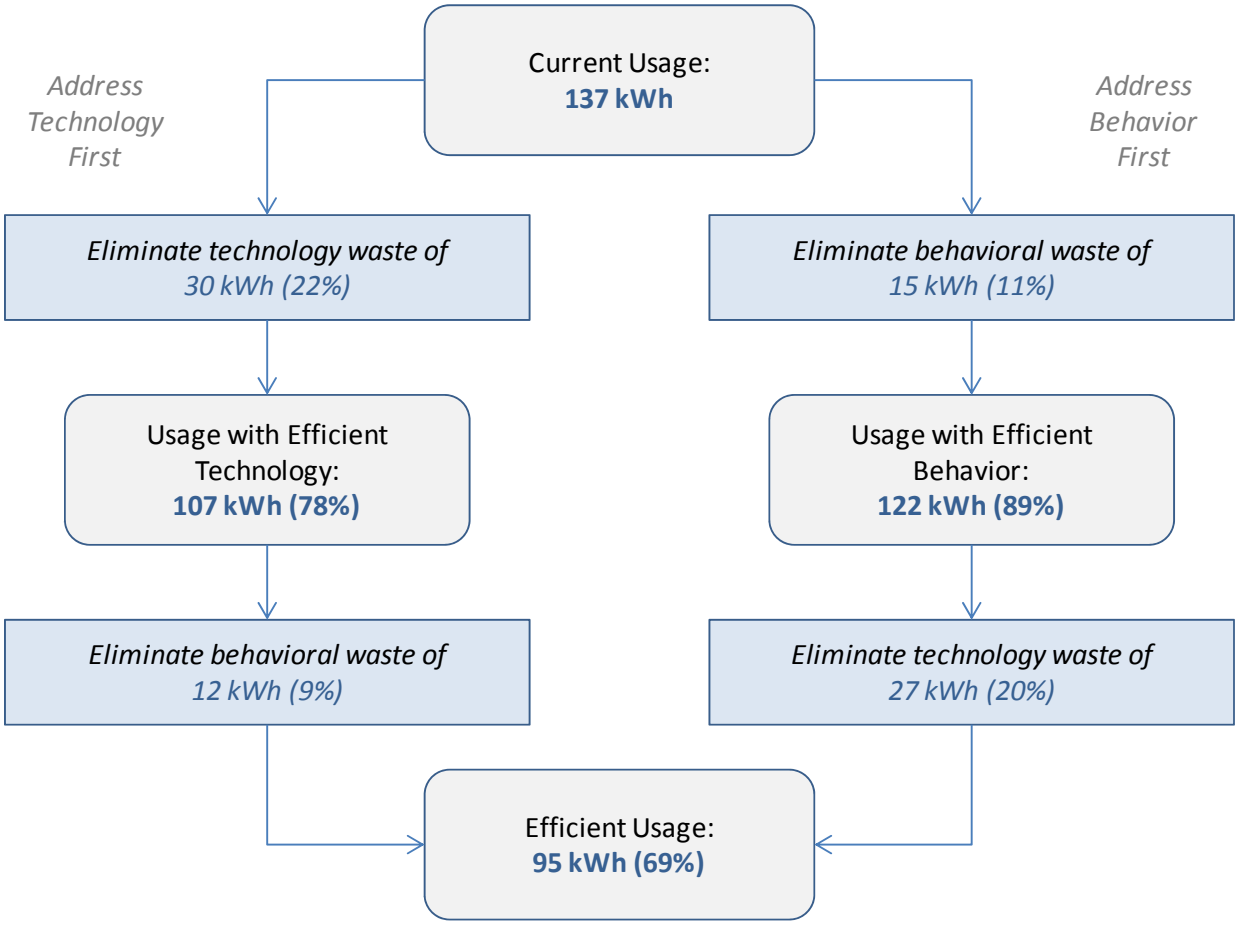
Figure 9-14. Usage and Waste Analysis – Dishwashers



Source: Usage and waste analysis

Figure 9-15 shows the average annual per household energy usage and savings potential associated with dishwashers. The figure shows estimated usage and savings when addressing technology waste, behavioral waste, or both. These numbers represent a typical home with a dishwasher.

Figure 9-15. Technological and Behavioral Potential – Dishwashers



Source: Usage and waste analysis

The three tables at the end of this chapter present the same usage and waste information for refrigeration equipment, laundry equipment, and dishwashers, respectively. The tables show 1) average per household results for households with each appliance type, 2) average per household results for all households, and 3) total usage and waste results for ComEd's residential population. The tables present these results in aggregate and for single family and multi-family homes.

9.4 Electric Cooking Appliances

We also quantified current usage for major electric cooking appliances, i.e., electric ovens, electric ranges, and microwaves. We did not estimate waste associated with these appliances since they account for a relative small share of overall usage.

Current usage estimates for electric cooking appliances are based on penetration results from the mail survey and per unit energy usage assumptions from secondary sources. Overall, we estimate that electric ovens and ranges and microwaves account for 5% of current usage.

Table 9-1 summarizes penetration values for electric cooking equipment and our estimates of annual per unit usage, average annual usage per household in ComEd's service territory, and the share of each appliance of overall household electricity usage.

Table 9-1. Cooking Appliance Current Usage

Appliance	Penetration	Annual Usage per Unit (kWh)	Annual Usage per HH (kWh)	Share of Overall HH Usage
Electric Ovens	29%	440	128	1.5%
Electric Ranges	23%	536	123	1.4%
Microwaves	98%	209	205	2.3%

Source: 2012 ComEd Residential Mail Survey; 2001 RECS (http://www.eia.gov/emeu/recs/recs2001/enduse2001/enduse2001.html)

Table 9-2. Summary of Refrigeration Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	100%	100%	100%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	910	1,074	605	910	1,074	605	3,026,463	2,322,000	704,464
	Efficient Usage	686	802	470	686	802	470	2,282,660	1,735,482	547,177
	% Efficient Usage	*75%*	*75%*	*78%*	*75%*	*75%*	*78%*	*75%*	*75%*	*78%*
	Waste	224	271	135	224	271	135	743,803	586,517	157,286
	% Waste	*25%*	*25%*	*22%*	*25%*	*25%*	*22%*	*25%*	*25%*	*22%*
Technology First	Technology	209	251	131	209	251	131	694,904	541,796	153,108
	Technology %	*23%*	*23%*	*22%*	*23%*	*23%*	*22%*	*23%*	*23%*	*22%*
	Behavioral	15	21	4	15	21	4	48,899	44,721	4,178
	Behavioral %	*1.6%*	*1.9%*	*0.6%*	*1.6%*	*1.9%*	*0.6%*	*1.6%*	*1.9%*	*0.6%*
Behavior First	Behavioral	19	27	5	19	27	5	64,816	59,324	5,492
	Behavioral %	*2.1%*	*2.6%*	*0.8%*	*2.1%*	*2.6%*	*0.8%*	*2.1%*	*2.6%*	*0.8%*
	Technology	204	244	130	204	244	130	678,987	527,193	151,794
	Technology %	*22%*	*23%*	*22%*	*22%*	*23%*	*22%*	*22%*	*23%*	*22%*

Source: Usage and waste analysis

Table 9-3. Summary of Laundry Equipment Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	77%	94%	44%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	122	122	120	93	115	53	309,966	248,352	61,614
	Efficient Usage	85	85	87	65	80	38	217,134	172,633	44,501
	% Efficient Usage	*70%*	*70%*	*72%*	*70%*	*70%*	*72%*	*70%*	*70%*	*72%*
	Waste	36	37	33	28	35	15	92,831	75,719	17,112
	% Waste	*30%*	*30%*	*28%*	*30%*	*30%*	*28%*	*30%*	*30%*	*28%*
Technology First	Technology	36	37	33	28	35	15	92,831	75,719	17,112
	Technology %	*30%*	*30%*	*28%*	*30%*	*30%*	*28%*	*30%*	*30%*	*28%*
	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Behavior First	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
	Technology	36	37	33	28	35	15	92,831	75,719	17,112
	Technology %	*83%*	*82%*	*87%*	*83%*	*82%*	*87%*	*83%*	*82%*	*87%*

Source: Usage and waste analysis

Table 9-4. Summary of Dishwasher Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	74%	80%	61%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	137	155	95	101	124	58	336,449	268,922	67,528
	Efficient Usage	95	107	67	70	86	41	233,733	185,920	47,813
	% Efficient Usage	*69%*	*69%*	*71%*	*69%*	*69%*	*71%*	*69%*	*69%*	*71%*
	Waste	42	48	28	31	38	17	102,716	83,002	19,714
	% Waste	*31%*	*31%*	*29%*	*31%*	*31%*	*29%*	*31%*	*31%*	*29%*
Technology First	Technology	30	35	19	22	28	12	73,931	60,132	13,799
	Technology %	*22%*	*22%*	*20%*	*22%*	*22%*	*20%*	*22%*	*22%*	*20%*
	Behavioral	12	13	8	9	11	5	28,785	22,869	5,915
	Behavioral %	*9%*	*9%*	*9%*	*9%*	*9%*	*9%*	*9%*	*9%*	*9%*
Behavior First	Behavioral	15	17	11	11	13	7	36,586	28,874	7,713
	Behavioral %	*11%*	*11%*	*11%*	*11%*	*11%*	*11%*	*11%*	*11%*	*11%*
	Technology	27	31	17	20	25	10	66,129	54,128	12,002
	Technology %	*20%*	*20%*	*18%*	*20%*	*20%*	*18%*	*20%*	*20%*	*18%*

Source: Usage and waste analysis

Table 9-5. Summary of Appliance Data

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Have a clothes washer	80%	98%	47%	98%	98%	99%	40%	56%	54%	94%	98%	33%	49%
Washer type													
Top loading washer	76%	76%	77%	82%	73%	61%	79%	76%	71%	77%	76%	75%	77%
Front loading washer	24%	24%	23%	18%	27%	39%	21%	24%	29%	23%	24%	25%	23%
Age of washer													
<5 years	25%	25%	23%	24%	25%	29%	25%	21%	23%	19%	25%	18%	24%
5-9 years	40%	37%	49%	34%	41%	42%	47%	50%	53%	48%	37%	65%	47%
10-19 years	20%	21%	16%	21%	22%	17%	16%	16%	15%	16%	21%	9%	16%
20+ years	16%	17%	12%	20%	13%	12%	12%	13%	9%	17%	17%	8%	12%
Have a clothes dryer	80%	97%	47%	97%	98%	98%	41%	56%	53%	94%	97%	30%	50%
Dryer fuel													
Natural gas	68%	72%	49%	74%	72%	67%	56%	49%	29%	16%	73%	1%	54%
Electricity	32%	27%	51%	25%	27%	32%	44%	51%	71%	83%	26%	99%	46%
Propane	1%	1%	0%	1%	1%	2%	0%	0%	0%	2%	1%	0%	0%
Number of refrigerators													
0	<1%	<1%	<1%	<1%	0%	<1%	<1%	<1%	0%	0%	<1%	0%	<1%
1	70%	57%	93%	72%	45%	32%	94%	92%	90%	72%	57%	97%	93%
2	26%	36%	6%	26%	47%	49%	5%	7%	6%	24%	36%	3%	6%
3 or more	4%	6%	1%	2%	8%	18%	<1%	<1%	4%	5%	6%	<1%	1%
Primary fridge is ENERGY STAR	31%	38%	19%	37%	41%	38%	17%	23%	21%	23%	39%	15%	20%
Age of primary refrigerator													
<4 years	20%	20%	19%	20%	21%	19%	19%	19%	21%	16%	20%	21%	19%
4-11 years	56%	53%	61%	52%	54%	55%	62%	60%	56%	55%	53%	57%	61%
12-19 years	10%	10%	9%	10%	11%	10%	9%	8%	9%	9%	10%	9%	8%
20+ years	15%	17%	12%	18%	14%	16%	11%	12%	14%	21%	16%	14%	11%

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
Have stand-alone freezer	31%	40%	13%	31%	47%	52%	10%	14%	20%	51%	39%	10%	13%
Age of primary stand-alone freezer													
<5 years	29%	27%	45%	30%	26%	23%	50%	37%	44%	*	27%	*	46%
5-9 years	30%	30%	28%	26%	34%	32%	26%	31%	27%	*	30%	*	27%
10-19 years	29%	30%	23%	32%	28%	31%	21%	26%	22%	*	30%	*	22%
20+ years	12%	13%	5%	12%	13%	14%	3%	6%	7%	*	13%	*	5%
Have dishwasher	67%	75%	54%	67%	82%	86%	44%	65%	75%	60%	75%	65%	52%
Dishwasher is ENERGY STAR	28%	32%	18%	31%	32%	34%	20%	17%	17%	20%	32%	15%	19%
Age of dishwasher													
<5 years	33%	33%	33%	34%	32%	35%	33%	35%	32%	31%	33%	31%	34%
5-9 years	31%	30%	36%	27%	31%	33%	36%	37%	35%	32%	30%	32%	37%
10-19 years	30%	32%	24%	33%	33%	29%	25%	22%	26%	28%	32%	25%	24%
20+ years	5%	5%	6%	6%	4%	3%	6%	6%	6%	9%	5%	12%	5%
Have…													
Electric oven	29%	26%	33%	20%	28%	44%	25%	32%	73%	88%	25%	93%	23%
Electric range	23%	19%	30%	17%	18%	27%	22%	28%	71%	87%	17%	93%	20%
Microwave	98%	99%	97%	99%	98%	98%	96%	97%	98%	100%	99%	98%	96%

Source: 2012 ComEd Residential Mail Survey
* Insufficient number of responses.

10. Electronics and Computing

Our analysis of consumer electronics includes televisions, video game systems, and computers. Overall, these three categories of consumer electronics account for approximately 9% of total residential electricity usage. Each household uses an average of 824 kWh per year to operate these electronics. Televisions account for a majority of this usage (53%). We estimate that technology and behavioral waste associated with consumer electronics accounts for approximately 34% and 3%, respectively, of current usage (if technology waste is addressed first).[25]

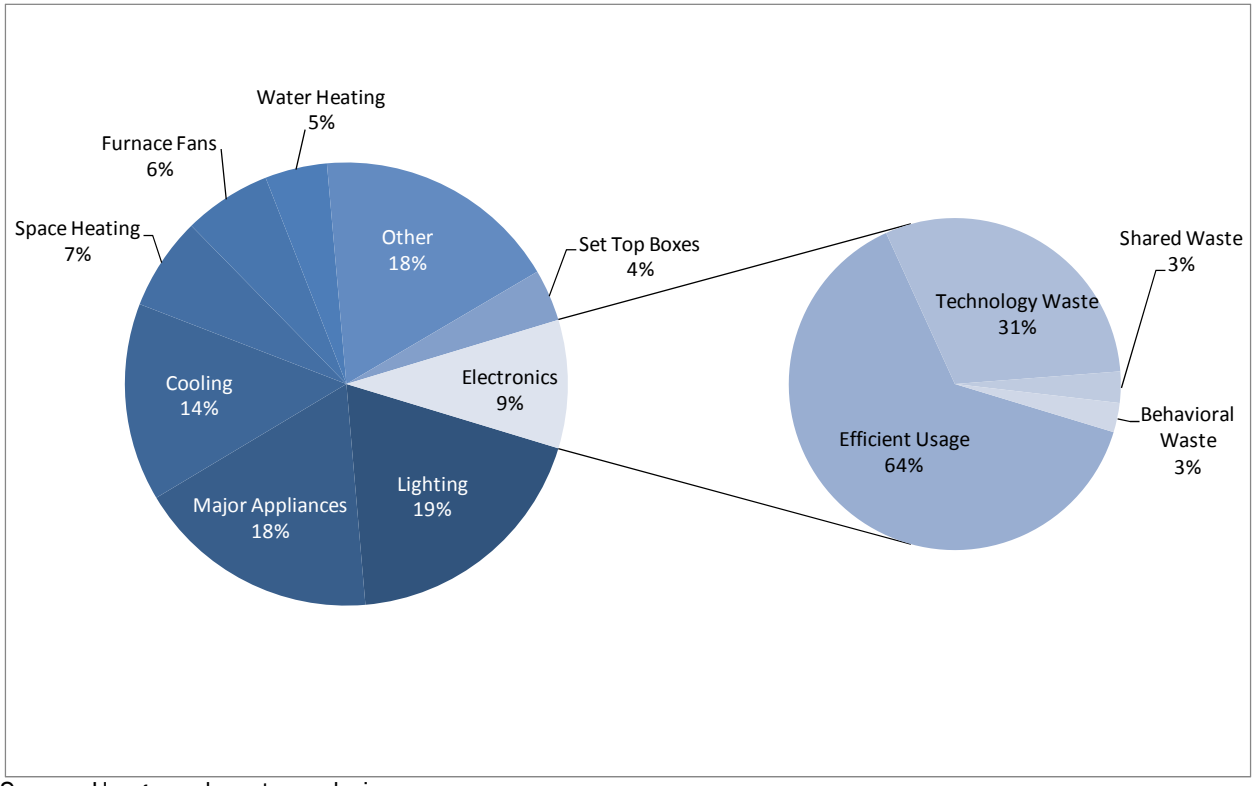
In addition, we assessed current usage of set top boxes. These units account for approximately 4% of total residential electricity usage.

Figure 10-1 shows the contribution of consumer electronics to overall residential electricity usage (pie chart on the left) and the breakout of consumer electronics usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right). Shared waste refers to the portion of waste that can be addressed by either technologies or behavior changes, depending on which is addressed first.[26]

[25] Behavioral waste in this analysis only includes waste for televisions; we did not estimate behavioral waste for computers and video game systems.

[26] Note that "Efficient Usage" represents the residual usage taking into account only the waste categories included in this analysis. If additional waste categories were identified and quantified, efficient usage might be smaller than presented here.

Figure 10-1. Usage and Waste Analysis – Consumer Electronics



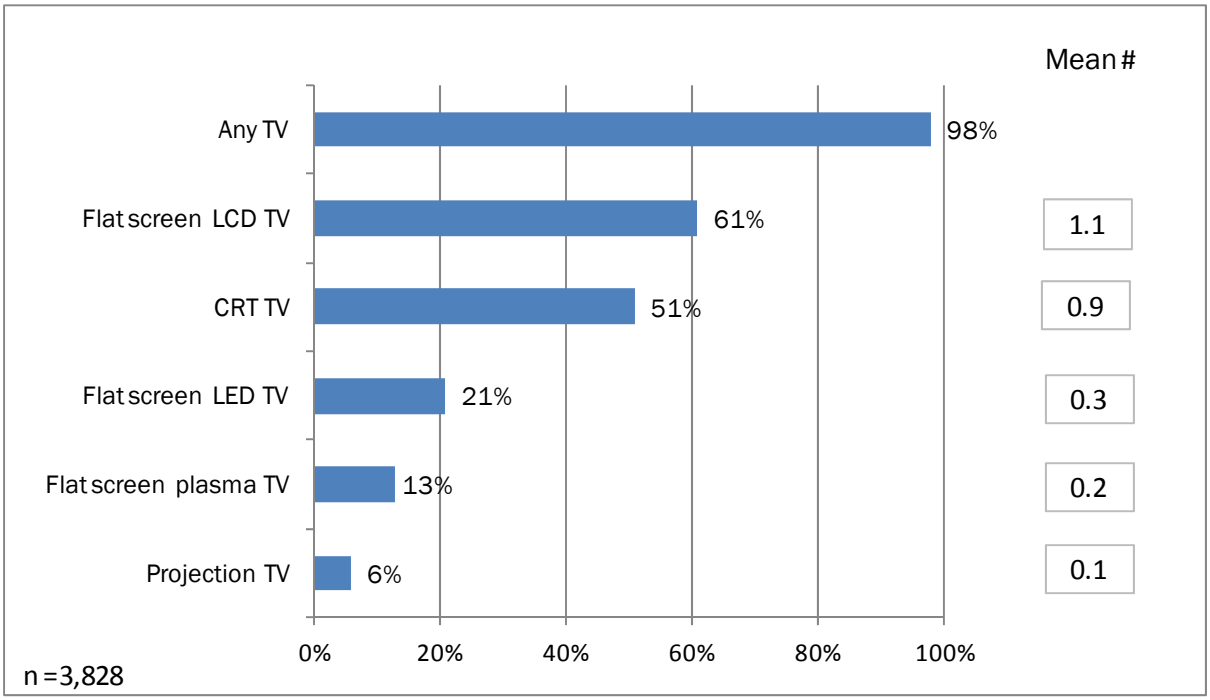
Source: Usage and waste analysis

10.1 Televisions

10.1.1 Television Characteristics

TVs are nearly ubiquitous among ComEd's residential customers: 99% of single family customers and 96% of multi-family customers use them in their homes. The most common types of TV are flat screen LCDs, with 61% of households using at least one, followed by CRTs (51%). On average, ComEd residential customers use 2.5 TVs in their homes.

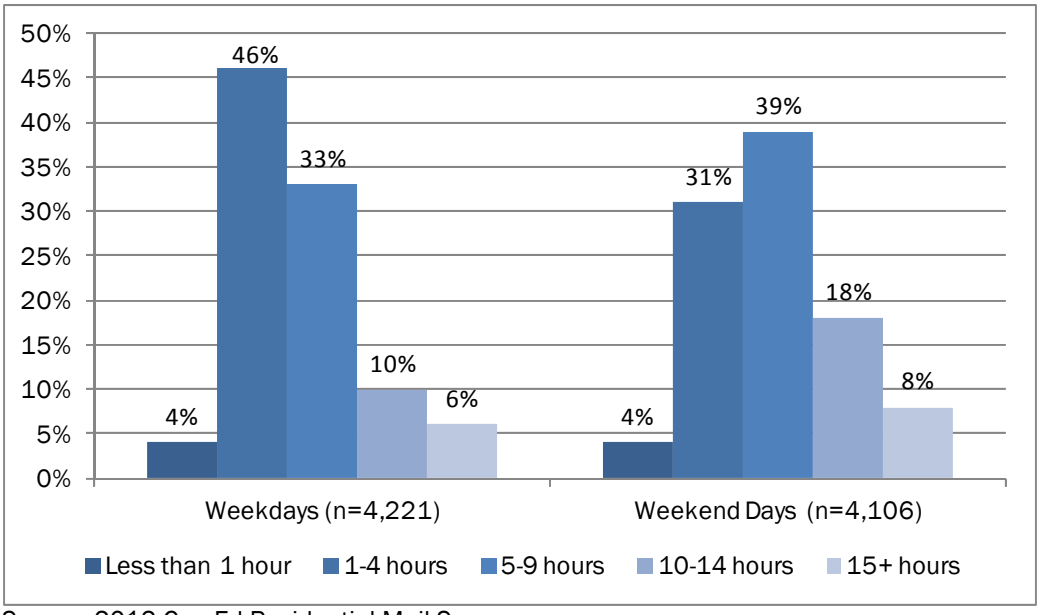
Figure 10-2. Penetration and Saturation of TVs, by Type



Source: 2012 ComEd Residential Mail Survey

ComEd customers use their TVs extensively: single family customers have theirs turned on an average of 4.0 hours on weekdays and 4.8 hours on weekend days. Not surprisingly, primary TVs are turned on more frequently (6.0 hours per weekday and 7.3 hours per weekend day) compared to secondary TVs (2.6 hours per weekday and 3.1 hours per weekend day).

Figure 10-3. Hours of TV Usage – Primary TV



Source: 2012 ComEd Residential Mail Survey

10.1.2 Usage and Waste Analysis: Televisions

The usage and waste analysis for televisions is based on mail survey, site visit, and secondary data. The analysis includes 859 televisions observed at the 297 site visit homes.

The amount of electricity a TV uses is a function of the power draw (in on and off states) and the amount of time it is turned on. Power draw, in turn, is a function of 1) TV type, 2) screen size, and 3) efficiency level. For each TV type (CRT, LCD, LED, Plasma, and Projection), we estimated electricity usage for all TVs found in site visit homes. The site visits collected information on the type, size, and efficiency level of each unit; the mail survey collected information on the number of hours TVs are turned on during weekdays and during weekend days.

Technology waste for TVs is defined as the difference between the usage of the current unit and the usage of the equivalent efficient unit. Efficient units are new ENERGY STAR LCD, Plasma, or LED TVs (based on ENERGY STAR v5.3) with the same diagonal as the current unit.

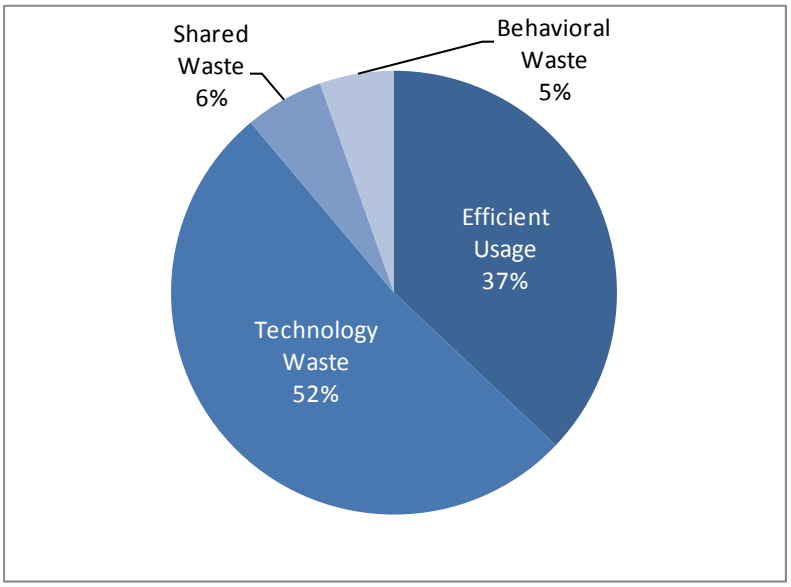
Behavioral waste for TVs is associated with the amount of time that units are turned on when nobody is watching. Expected hours that TVs are watched is based on secondary data and reflects national averages. These hours are specific to weekdays and weekend days and to the age of the head of household.

TVs used by ComEd's residential customers account for approximately 5% of total residential electricity usage. Each household with a television uses an average of 441 kWh per year for TVs. There is substantial potential for energy savings from upgrading to newer, more efficient technologies: If all existing non-ENERGY STAR or old ENERGY STAR TVs were replaced with new ENERGY STAR flat screen technologies of the equivalent size, 58% of TV electricity use could be saved. This potential is related to ENERGY STAR status and

technology type: Less than 40% of TVs are ENERGY STAR rated (including current and previous ENERGY STAR standards), and over 50% of homes have at least one CRT. Behavioral savings potential is more limited: We estimate that about half of residential customers could save energy by turning off their TVs when not watching. This could save about 11% of TV usage (5% if technology upgrades took place first).

Figure 10-4 shows the breakout of TV usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right). Shared waste refers to the portion of waste that can be addressed by either technologies or behavior changes, depending on which is addressed first. The figure shows that efficient usage accounts for only 37% of total current usage. If technologies are addressed first, 58% of usage can be saved by upgrading to newer, more efficient TVs. If behavior is addressed first, 11% can be saved by turning off TVs when not watching.

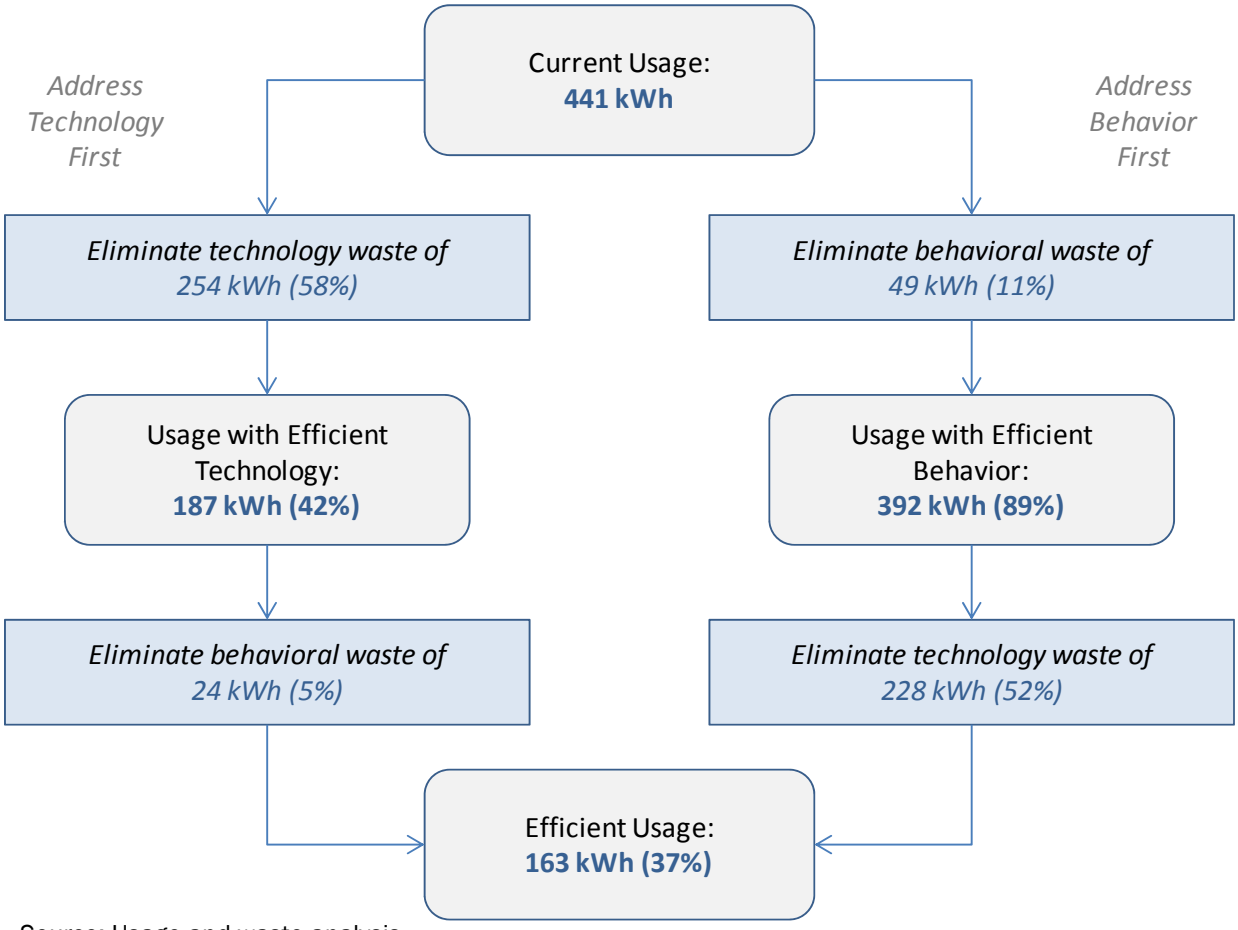
Figure 10-4: Usage and Waste Analysis – TVs



Source: Usage and waste analysis

Figure 10-5 shows the average annual per household energy usage and savings potential associated with TVs. The figure shows estimated usage and savings when addressing technology waste, behavioral waste, or both.

Figure 10-5: Technological and Behavioral Potential – TVs



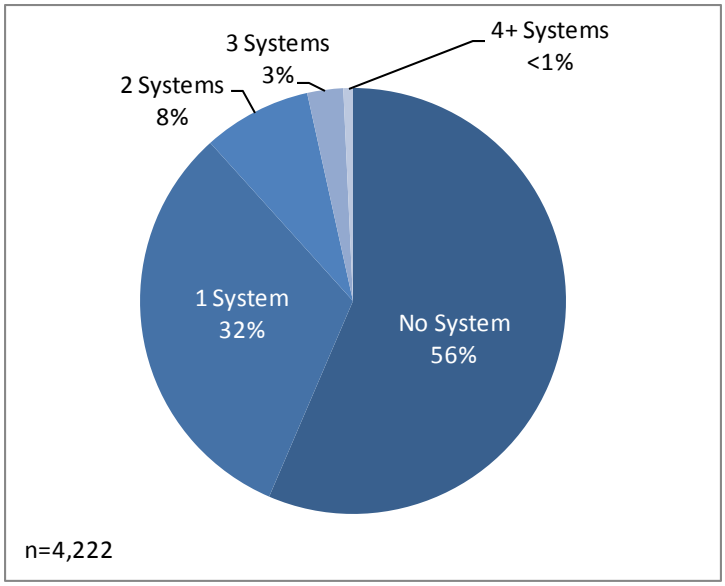
Source: Usage and waste analysis

10.2 Video Game Systems

10.2.1 Video Game System Characteristics

Video game systems are relatively common among ComEd's residential customers: 47% of single family customers and 38% of multi-family customers use them in their homes. Approximately a quarter (27%) of homes with a video game system have more than one.

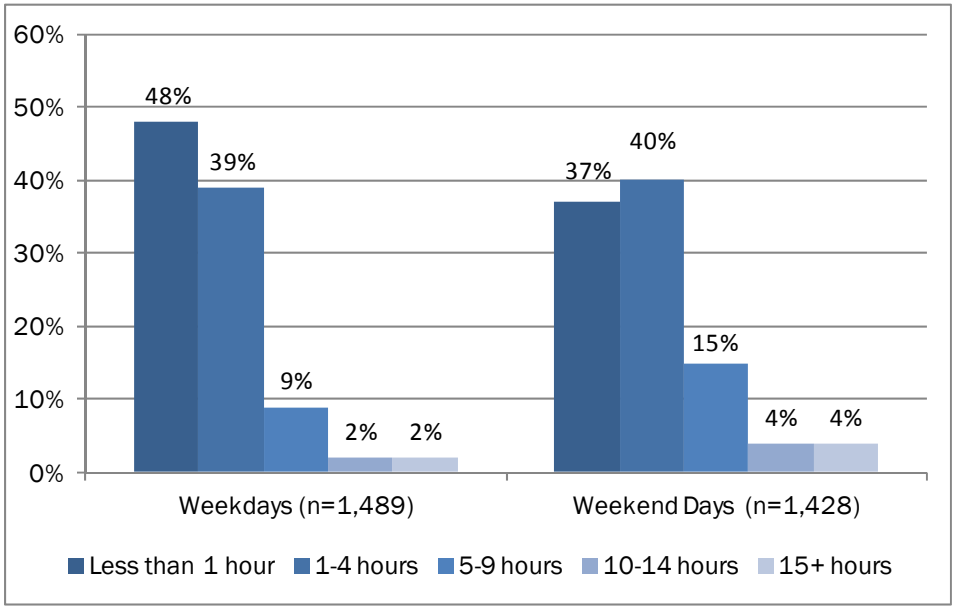
Figure 10-6. Video Game System Saturation



Source: 2012 ComEd Residential Mail Survey

On average, video game players are in use for 2.5 hours on weekdays and 3.4 hours on weekends.

Figure 10-7. Hours of Video Game Player Usage



Source: 2012 ComEd Residential Mail Survey

10.2.2 Usage and Waste Analysis: Video Game Systems

The usage and waste analysis for video game systems is based on mail survey responses and secondary data.

The amount of electricity a video game system uses is a function of the power draw (in active, idle, and off states) and the amount of time it is in each of these states of usage. The mail survey collected information on the number of hours each unit is in active mode. However, our data collection efforts did not include detailed information on the type of video game systems customers own. Since electricity usage of video game systems differs by model, we calculated default values for each of the three usage modes, based on an average of power draw values for the most common video game systems in the market, weighted by the market share of each system. Our analysis included the 2005, 2007, and 2010 revisions of the Xbox 360, the 2006, 2007, and 2010 revisions of the Playstation 3, and the Nintendo Wii.

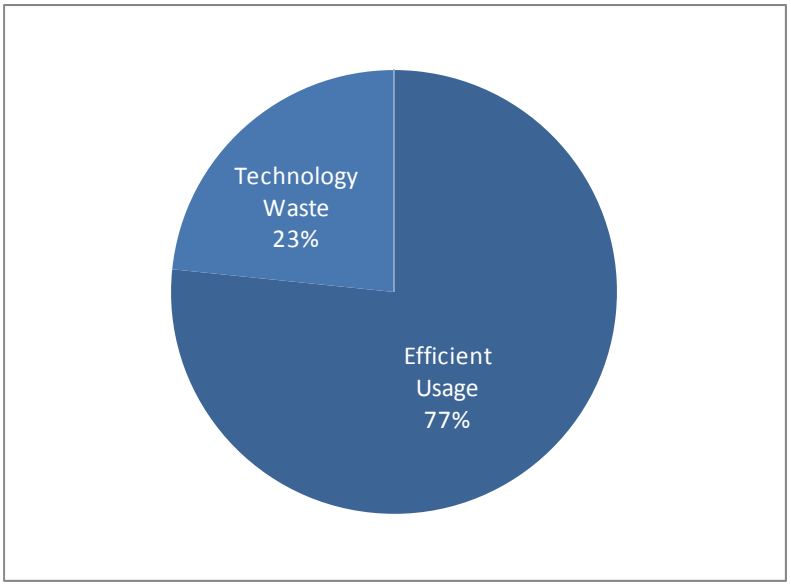
Technology waste includes waste from usage of inefficient video game systems. While there is no ENERGY STAR standard for video game systems, new revisions tend to be more efficient than older ones. Thus our analysis of technology waste compared usage of current units to usage of newer revisions.

Behavioral waste was not calculated for video game systems.

Video game systems used by ComEd's residential customers account for approximately 1% of total residential electricity usage. Each household with a video game system uses an average of 215 kWh on video games. There is limited potential for energy savings from upgrading to newer, more efficient technologies: If existing inefficient video game systems were replaced with the most recent revision of each model, 23% of video game electricity use could be saved.

Figure 10-8 summarizes the breakout of video game systems usage into efficient usage and technology waste.

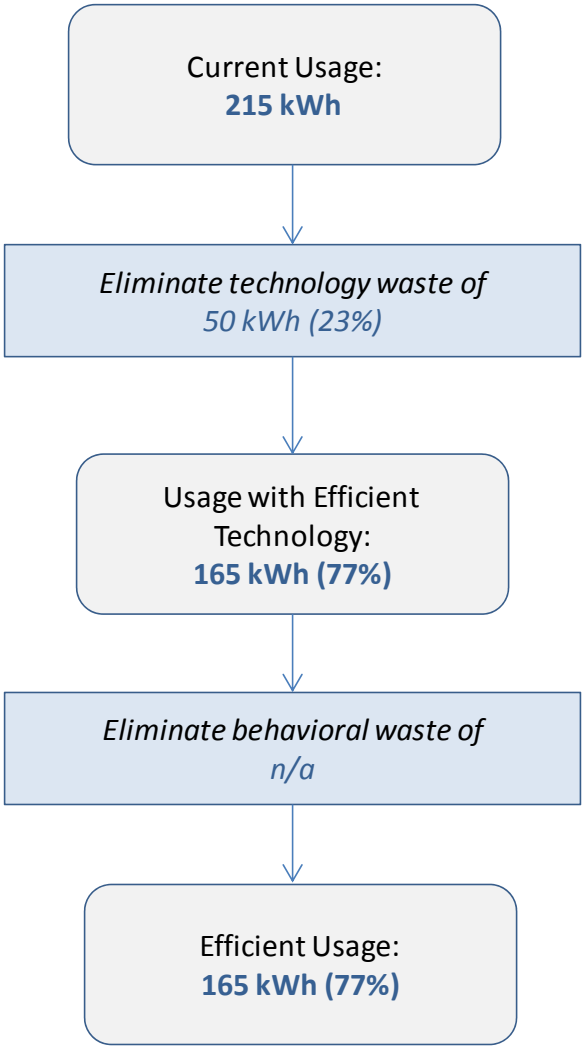
Figure 10-8. Usage and Waste Analysis – Video Game Systems



Source: Usage and waste analysis

Figure 10-14 shows the average annual per household energy usage and technology savings potential associated with video game systems.

Figure 10-9.Technological and Behavioral Potential – Video Game Systems



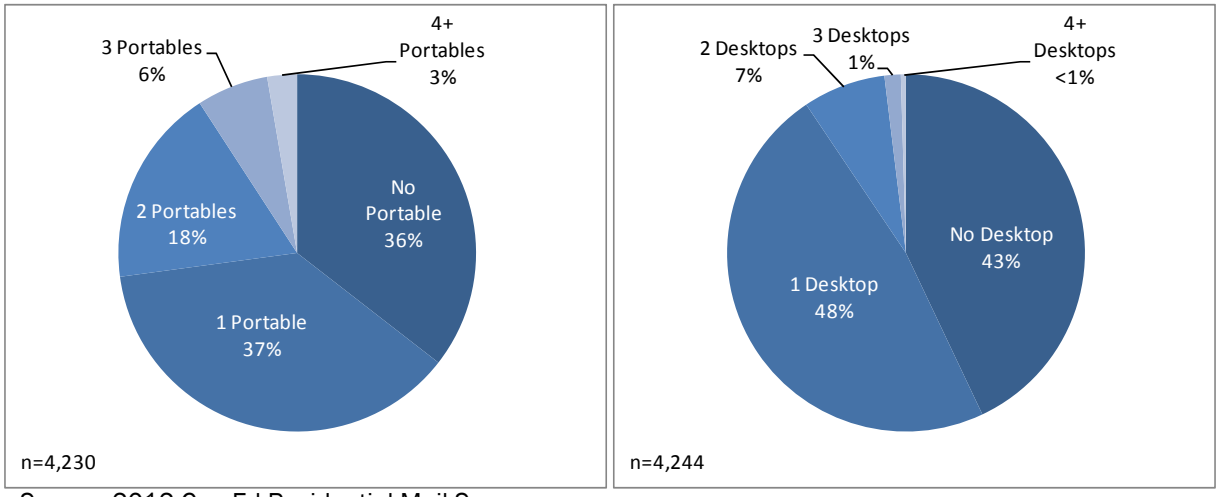
Source: Usage and Waste Analysis

10.3 Computers

10.3.1 Computer Characteristics

Computers are common among ComEd's residential customers: 87% of single family customers and 80% of multi-family customers use them in their homes. More homes have a laptop computer or tablet (64%) than a desktop computer (57%). On average, ComEd customers use 1.7 computers in their homes.

Figure 10-10. Portable and Desktop Computer Saturation

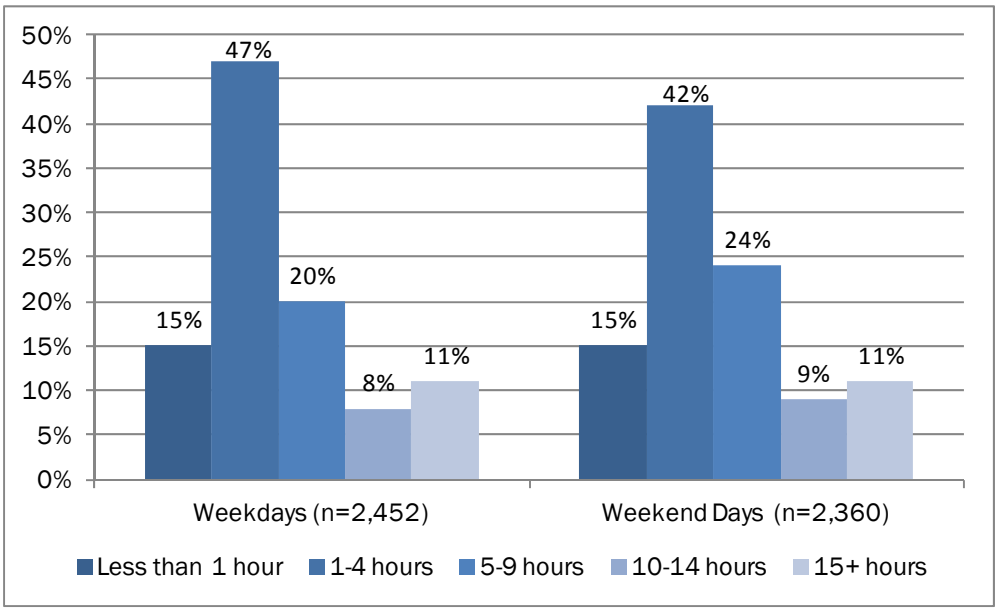


Source: 2012 ComEd Residential Mail Survey

Most desktops in ComEd territory (88%) are connected to an LCD (flat panel) monitor, with only a small minority (12%) using a CRT (tube) monitor. Approximately 8% of laptops in ComEd's service territory are connected to an external monitor, all of them to LCD flat panel monitors.

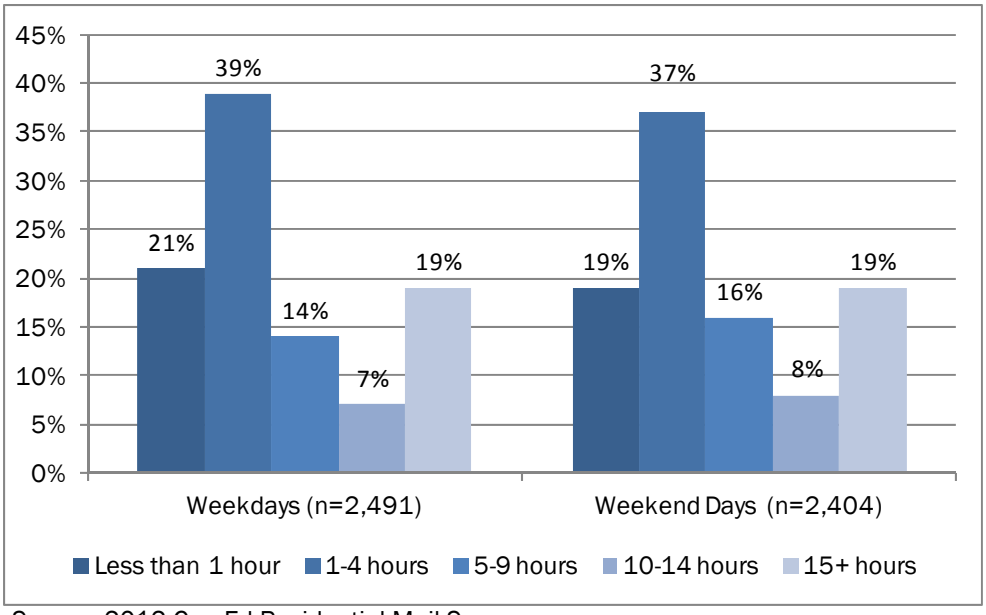
Customers' laptops and tablets are turned on for an average of 5.7 hours per day on weekdays and 6 hours per day on weekends; laptops are turned on 6.9 hours per day on weekdays and 7.3 hours per day on weekends.

Figure 10-11. Hours of Use – Laptops and Tablets



Source: 2012 ComEd Residential Mail Survey

Figure 10-12. Hours of Use – Desktops



Source: 2012 ComEd Residential Mail Survey

10.3.2 Usage and Waste Analysis: Computers

The usage and waste analysis for computers is based on mail survey, site visit, and secondary data. It includes 460 computers observed at the 297 site visit homes.

The amount of electricity a computer uses is a function of the power draw (in on, sleep, and off states) and the amount of time it is in these different states of usage. The mail survey collected information on the number of hours each computer is in active mode. Power draw values are from secondary sources and are defined by computer type.

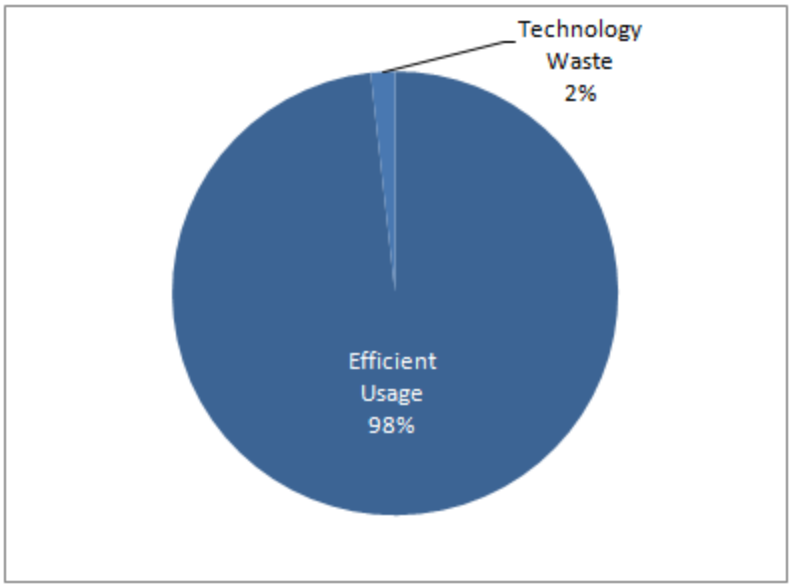
Technology waste includes waste from usage of in efficient CRT monitors. Efficient computer monitors were defined as LCD (flat panel) monitors.

Behavioral waste was not calculated for computer systems.

Computers used by ComEd's residential customers account for approximately 3% of total residential electricity usage. Each household with a computer uses an average of 381 kWh per year for computers. There is limited potential for energy savings from upgrading from CRT to LCD monitors: with only 12% of desktop monitors and 0% of laptop external monitors being CRT models, savings potential is only 2%.

Figure 10-13 summarizes the breakout of computer usage into efficient usage and technology waste.

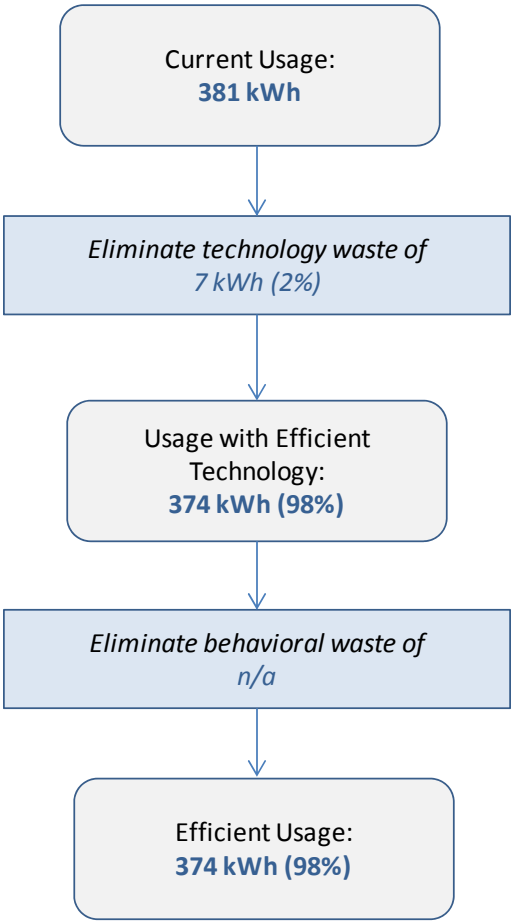
Figure 10-13. Usage and Waste Analysis - Computers



Source: Usage and waste analysis

Figure 10-14 shows the average annual per household energy usage and savings potential associated with computers. The figure shows estimated usage and savings when addressing technology waste.

Figure 10-14. Technological and Behavioral Potential – Computers



Source: Usage and waste analysis

The tables at the end of this chapter present the same usage and waste information for televisions, video game systems, and computers, respectively. The tables show 1) average per household results for households with each equipment type, 2) average per household results for all households, and 3) total usage and waste results for ComEd's residential population. The tables present these results in aggregate and for single family and multi-family homes.

10.4 Set Top Boxes

We also quantified current usage for set top boxes. We did not estimate waste associated with these units since they account for a relative small share of overall usage.

Current usage estimates for set top boxes are based on saturation results from the mail survey and per unit energy usage assumptions from secondary sources. Overall, we estimate that set top boxes account for 3.8% of current usage.

Table 10-1 summarizes penetration and saturation values for set top boxes, by type, and our estimates of annual per unit usage, average annual usage per household in ComEd's service territory, and the share of set top boxes of overall household electricity usage.

Table 10-1. Cooking Appliance Current Usage

Type of Set Top Box	Penetration	Saturation	Annual Usage per Unit (kWh)	Annual Usage per HH (kWh)	Share of Overall HH Usage
Box with DVR	59%	93%	221	206	
Stand-alone box	43%	72%	110	79	
Stand-alone DVR	14%	17%	275	47	
Total	84%	182%		331	3.8%

Source: 2012 ComEd Residential Mail Survey; Fraunhofer Center for Sustainable Energy Systems

Table 10-2. Summary of TV Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	99%	99%	98%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	441	490	348	435	487	339	1,447,939	1,052,935	395,005
	Efficient Usage	163	174	143	161	173	140	536,267	373,652	162,615
	% Efficient Usage	*37%*	*35%*	*41%*	*37%*	*35%*	*41%*	*37%*	*35%*	*41%*
	Waste	278	316	205	274	314	200	911,672	679,283	232,389
	% Waste	*63%*	*65%*	*59%*	*63%*	*65%*	*59%*	*63%*	*65%*	*59%*
Technology First	Technology	254	283	198	250	281	193	833,388	608,828	224,559
	Technology %	*58%*	*58%*	*57%*	*58%*	*58%*	*57%*	*58%*	*58%*	*57%*
	Behavioral	24	33	7	24	33	7	78,285	70,455	7,830
	Behavioral %	*5%*	*7%*	*2%*	*5%*	*7%*	*2%*	*5%*	*7%*	*2%*
Behavior First	Behavioral	49	67	15	48	67	14	161,374	144,885	16,488
	Behavioral %	*11%*	*14%*	*4%*	*11%*	*14%*	*4%*	*11%*	*14%*	*4%*
	Technology	228	249	190	225	247	185	750,299	534,398	215,901
	Technology %	*52%*	*51%*	*55%*	*52%*	*51%*	*55%*	*52%*	*51%*	*55%*

Source: Usage and Waste Analysis

Table 10-3. Summary of Video Game System Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	41%	45%	32%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	215	213	221	88	97	70	291,211	209,398	81,813
	Efficient Usage	165	163	170	67	74	54	223,131	160,137	62,994
	% Efficient Usage	*77%*	*76%*	*77%*	*77%*	*76%*	*77%*	*77%*	*76%*	*77%*
	Waste	50	50	51	20	23	16	68,080	49,261	18,819
	% Waste	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*
Technology First	Technology	50	50	51	20	23	16	68,080	49,261	18,819
	Technology %	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*
	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Behavior First	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
	Technology	50	50	51	20	23	16	68,080	49,261	18,819
	Technology %	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*	*23%*	*24%*	*23%*

Source: Usage and Waste Analysis

Table 10-4. Summary of Computer Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF	Total	SF	MF	Total	SF	MF
	Penetration:	79%	86%	64%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	381	378	387	299	326	249	994,774	704,384	290,390
	Efficient Usage	374	370	385	294	318	248	977,240	688,770	288,471
	% Efficient Usage	*98%*	*98%*	*99%*	*98%*	*98%*	*99%*	*98%*	*98%*	*99%*
	Waste	7	8	3	5	7	2	17,534	15,614	1,919
	% Waste	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*
Technology First	Technology	7	8	3	5	7	2	17,534	15,614	1,919
	Technology %	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*
	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Behavior First	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
	Technology	7	8	3	5	7	2	17,534	15,614	1,919
	Technology %	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*	*2%*	*2%*	*1%*

Source: Usage and Waste Analysis

Table 10-5. Summary of Consumer Electronics Data

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of ComEd Customers (thousands)	3,327	2,208	1,120	1,201	646	361	662	307	151	34	2,174	152	968
Home uses													
TV	98%	99%	96%	99%	100%	100%	95%	98%	100%	100%	99%	99%	96%
Video game player	44%	47%	38%	37%	55%	62%	31%	50%	41%	40%	47%	37%	38%
DVR	64%	68%	55%	60%	76%	81%	48%	65%	68%	65%	69%	51%	56%
Cable/satellite box	43%	46%	37%	43%	49%	52%	33%	40%	49%	48%	46%	44%	36%
Laptop/Tablet	64%	66%	62%	57%	74%	79%	58%	68%	64%	55%	66%	61%	62%
Desktop computer	57%	64%	43%	57%	70%	76%	39%	47%	50%	44%	65%	39%	43%
Mean number of TVs													
Total	2.5	2.9	1.9	2.5	3.1	3.6	1.6	2.1	2.4	2.2	2.9	1.9	1.9
Standard tube (CRT)	0.9	1.0	0.6	1.0	1.1	1.1	0.6	0.6	0.8	0.9	1.0	0.7	0.6
Flat panel LCD	1.1	1.2	0.8	1.0	1.3	1.7	0.7	0.9	1.0	0.8	1.2	0.8	0.8
Flat panel LED	0.3	0.3	0.2	0.3	0.4	0.4	0.2	0.3	0.3	0.4	0.3	0.2	0.2
Flat panel plasma	0.2	0.2	0.2	0.1	0.2	0.3	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Projection TV	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Mean hours turned on – per weekday													
Primary TV	5.9	5.8	6.1	5.7	6.0	6.0	5.9	6.1	6.7	5.7	5.8	6.4	6.0
Secondary TV	3.0	2.9	3.1	2.8	3.0	3.1	3.3	2.8	3.4	2.8	2.9	2.9	3.2
Tertiary TV	2.1	2.1	2.4	1.9	2.1	2.3	2.3	2.4	2.3	*	2.1	2.2	2.4
DVR	5.3	5.5	5.1	4.4	6.3	7.3	4.0	6.3	7.5	6.1	5.4	4.8	5.1
Video game player	2.5	2.4	3.0	2.2	2.3	2.7	3.5	2.3	3.3	*	2.4	3.5	2.9
Mean hours turned on – per weekend day													
Primary TV	7.2	7.1	7.4	6.9	7.4	7.5	7.2	7.6	7.7	6.7	7.2	7.7	7.4
Secondary TV	3.6	3.5	3.9	3.3	3.6	3.8	4.0	3.7	4.0	2.7	3.5	3.4	4.0
Tertiary TV	2.6	2.5	3.3	2.3	2.5	2.8	2.8	3.7	3.7	*	2.5	3.1	3.4
DVR	5.7	5.9	5.3	4.7	6.7	8.0	3.9	6.9	7.7	5.8	5.9	5.3	5.3

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
Video game player	3.4	3.2	4.0	2.9	3.2	3.7	4.5	3.4	3.7	*	3.2	3.8	4.0

Source: 2012 ComEd Residential Mail Survey

11. Other Electric Equipment

Our usage and waste analysis focused on those end-uses that account for a majority of ComEd's residential energy usage and had likely opportunities to reduce waste. We estimate that 82% of ComEd's current usage is associated with those analyzed end-uses, leaving a residual of 18%, which is comprised of "other" electric uses and equipment.

Types of "other" equipment include various household appliances, such as humidifiers and dehumidifiers, exercise equipment, small kitchen appliances, and pool pumps. It also includes plug-load that we could not quantify.

Table 11-1 below summarizes the types of other electric equipment present in ComEd's service territory, for which we collected penetration and saturation information through the mail survey.

Table 11-1. Summary of Other Electric Equipment Data

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Home uses													
Air cleaner and/or humidifier	36%	41%	27%	36%	46%	50%	26%	27%	29%	28%	42%	28%	26%
Dehumidifier	23%	34%	5%	24%	41%	48%	4%	6%	10%	24%	34%	3%	6%
Electric-powered exercise equipment	15%	22%	3%	16%	25%	32%	2%	3%	9%	13%	22%	4%	3%
Aquarium	10%	12%	6%	8%	14%	19%	5%	8%	8%	6%	12%	8%	6%
Water bed	1%	2%	0%	2%	2%	2%		0%		4%	2%	0%	
Well and/or sump pump	36%	54%	3%	45%	58%	72%	2%	4%	3%	48%	54%	2%	3%
Home uses more than once a week													
Toaster oven	44%	44%	44%	43%	45%	45%	44%	44%	48%	34%	44%	48%	44%
Electric cooking appliances	28%	29%	26%	24%	33%	38%	25%	27%	28%	23%	29%	27%	26%
Slow cooker	27%	31%	19%	27%	34%	38%	18%	18%	21%	28%	31%	16%	19%
Electric kettle	7%	7%	7%	6%	7%	7%	6%	9%	8%	3%	7%	6%	7%
Breadmaker	3%	4%	2%	4%	4%	5%	2%	2%	5%	3%	4%	5%	2%
Coffee maker	62%	69%	49%	63%	74%	77%	43%	55%	60%	68%	69%	51%	49%
Rice maker	9%	8%	12%	8%	8%	8%	14%	7%	11%	3%	8%	6%	13%
Air compressor	9%	13%	1%	9%	16%	18%	1%	0%	1%	13%	13%	0%	1%
Home has a pool	7%	9%	4%	4%	11%	19%	3%	5%	4%	8%	9%	5%	3%
Pool heat													
Electricity	7%	4%	24%	2%	3%	7%	*	*	*	*	4%	*	*
Natural gas	32%	36%	4%	14%	35%	50%	*	*	*	*	36%	*	*
Propane	1%	1%			1%	1%	*	*	*	*	1%	*	*
Unheated	61%	59%	72%	84%	62%	42%	*	*	*	*	59%	*	*
Number of pool pumps													
0	9%	6%	*	13%	6%	2%	*	*	*	*	6%	*	*
1	85%	90%	*	87%	92%	90%	*	*	*	*	90%	*	*

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
2	5%	4%	*	0%	2%	7%	*	*	*	*	4%	*	*
3 or more	<1%	<1%	*	0%	0%	1%	*	*	*	*	<1%	*	*

Source: 2012 ComEd Residential Mail Survey
* Insufficient number of responses.

12. General Home and Customer Characteristics

Home and customer characteristics do not account for energy usage or waste, per se, but they are important inputs into many of our analyses. For example, most of our results are presented by single family and multi-family homes. Square footage is an important input for the central air conditioning analysis, and many of the default values for hot water usage are based on the number of occupants in the home.

In addition, information on the homes' shell, including insulation and windows, are key determinants of cooling and heating usage. They also contribute to waste and can present significant opportunities for savings, if improved.

The following three tables summarize mail survey responses to questions about key home and customer characteristics.

Table 12-1. Summary of Home Characteristics

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Own home	74%	92%	38%	91%	94%	93%	33%	42%	51%	81%	93%	40%	38%
Building type													
Mobile home	1%	2%	--	2%	1%	2%	--	--	--	5%	2%	--	--
Single family detached	56%	85%	--	82%	88%	91%	--	--	--	71%	85%	--	--
Single family attached	9%	13%	--	17%	10%	8%	--	--	--	24%	13%	--	--
Multi-family (Less than 5 units)	29%	--	29%	--	--	--	30%	30%	29%	--	--	13%	32%
Multi-family (5+ units)	71%	--	71%	--	--	--	70%	70%	71%	--	--	87%	68%
Home built													
2000-2012	15%	14%	16%	12%	16%	18%	13%	23%	16%	6%	14%	6%	18%
1970-1999	37%	37%	37%	33%	38%	45%	33%	36%	53%	52%	36%	65%	32%
1950-1969	25%	29%	17%	32%	28%	20%	19%	14%	15%	26%	29%	16%	17%
Before 1950	23%	20%	30%	23%	18%	16%	35%	27%	15%	17%	20%	12%	33%
Square footage of home													
Less than 500	4%	2%	8%	3%	1%	1%	10%	4%	4%	1%	2%	6%	8%
500-999	15%	6%	34%	9%	4%	2%	36%	32%	28%	10%	6%	40%	33%
1,000-1,499	27%	23%	35%	30%	19%	11%	34%	37%	36%	30%	23%	25%	36%
1,500-1,999	21%	26%	11%	31%	24%	17%	8%	15%	16%	21%	27%	18%	10%
2,000-2,499	13%	18%	4%	15%	23%	18%	3%	4%	9%	20%	18%	4%	4%
2,500-2,999	8%	11%	3%	7%	14%	16%	2%	4%	2%	10%	11%	1%	3%
3,000-3,499	4%	6%	1%	3%	8%	13%	1%	1%	3%	3%	6%	1%	1%
3,500 or more	6%	7%	4%	2%	6%	22%	5%	3%	3%	4%	7%	3%	5%
Mean number of bedrooms	2.6	3.1	1.8	2.9	3.2	3.5	1.6	1.9	2.0	2.7	3.1	1.6	1.8
Have finished basement	33%	42%	15%	34%	49%	56%	17%	14%	10%	31%	43%	2%	17%

Source: 2012 ComEd Residential Mail Survey

Table 12-2. Summary of Home Insulation & Ventilation Characteristics

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Home has attic/top floor insulation [A]	75%	75%	--	71%	78%	83%	--	--	--	84%	75%	--	--
Thickness of insulation													
0-3 inches	17%	17%	--	19%	17%	15%	--	--	--	*	18%	--	--
4-6 inches	45%	45%	--	47%	46%	39%	--	--	--	*	45%	--	--
7-10 inches	25%	25%	--	22%	25%	33%	--	--	--	*	25%	--	--
10+ inches	12%	12%	--	12%	13%	13%	--	--	--	*	12%	--	--
Home has exterior wall insulation	92%	94%	83%	93%	95%	97%	81%	83%	88%	98%	94%	86%	82%
Home windows													
All or most single pane	10%	6%	17%	7%	6%	5%	18%	17%	17%	10%	6%	18%	17%
All or most double pane	7%	8%	5%	9%	8%	8%	4%	5%	7%	9%	8%	6%	5%
Mixture of single and double pane	74%	75%	69%	73%	77%	80%	68%	72%	69%	73%	75%	73%	69%
All or most triple pane	1%	1%	1%	1%	1%	1%	1%	<1%	1%	2%	1%	<1%	1%
Home uses													
Whole-house or attic fan	12%	17%	3%	14%	20%	22%	3%	3%	6%	13%	17%	3%	3%
Ceiling fan	67%	75%	51%	71%	79%	80%	48%	57%	47%	70%	75%	41%	52%
Window fan	12%	12%	14%	12%	11%	10%	16%	9%	12%	9%	12%	11%	14%
Portable fan	49%	46%	54%	45%	48%	45%	55%	53%	50%	57%	46%	53%	54%
Any kitchen ventilation fan	68%	72%	60%	70%	71%	77%	53%	70%	69%	70%	72%	71%	58%
Any bathroom ventilation fan	74%	82%	59%	78%	84%	88%	50%	72%	75%	80%	82%	73%	57%

Source: 2012 ComEd Residential Mail Survey
[A] Applicable to single family homes only.

Table 12-3. Summary of Customer Characteristics

	Total	Home Type		Electric Usage						Rate Class			
		Single Family	Multi-family	Single Family			Multi-Family			Single Family		Multi-Family	
				Low	Med.	High	Low	Med.	High	Elec. Heat	Non-Elec.	Elec. Heat	Non-Elec.
No. of Occupied Homes in ComEd Service Territory (thousands)	3,327	2,163	1,165	1,176	632	354	689	319	157	33	2,129	158	1,017
Age of head-of-household													
Under 25 years	2%	1%	3%	2%	0%	0%	4%	2%	5%	2%	1%	7%	3%
25 to 34 years	18%	12%	31%	14%	10%	8%	31%	32%	28%	13%	12%	24%	32%
35 to 44 years	20%	19%	20%	15%	23%	25%	18%	26%	18%	18%	19%	15%	21%
45 to 54 years	22%	25%	16%	21%	27%	34%	16%	16%	15%	16%	25%	14%	16%
55 to 64 years	18%	20%	13%	20%	20%	19%	14%	12%	13%	21%	20%	12%	13%
65 years and over	20%	23%	16%	27%	19%	14%	17%	13%	21%	30%	23%	28%	14%
Highest education level													
Less than high school graduate/GED	5%	5%	6%	6%	3%	2%	7%	4%	6%	4%	5%	7%	6%
High school graduate/GED	15%	14%	16%	17%	11%	11%	17%	15%	14%	20%	14%	17%	16%
Some college/trade/ vocational school	24%	25%	23%	25%	27%	21%	22%	24%	24%	35%	25%	25%	22%
College degree	31%	31%	31%	30%	33%	33%	30%	33%	32%	30%	31%	31%	31%
Graduate or postgraduate degree	25%	25%	24%	22%	26%	32%	24%	23%	24%	11%	25%	21%	24%
Mean household income	$70k	$78k	$55k	$64k	$89k	$100k	$51k	$60k	$61k	$58k	$78k	$47k	$56k
Home is permanent year-round residence	99%	99%	99%	99%	100%	99%	99%	99%	98%	99%	99%	97%	99%
Mean number of occupants	2.64	2.89	2.18	2.50	3.12	3.63	2.02	2.35	2.46	2.20	2.90	1.94	2.21
Primary language is English	93%	95%	90%	92%	98%	99%	88%	92%	94%	96%	95%	94%	89%

Source: 2012 ComEd Residential Mail Survey

ComEd Commercial and Industrial Saturation / End Use, Market Penetration & Behavioral Study

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1. INTRODUCTION

This report presents the results of the commercial and industrial portion of the comprehensive end-use saturation, penetration, and behavioral study conducted for Commonwealth Edison (ComEd) by the Opinion Dynamics team. The overarching study covers ComEd's customers in both the residential sector and key commercial and industrial (C&I) segments and identifies electricity waste associated with inefficient technologies and behaviors. This report presents only commercial and industrial findings; residential findings are contained in a separate report. The goal of this research is to inform program planning efforts by identifying gaps in current program measure offerings and any energy efficient technologies that have achieved sufficient market saturation to warrant exclusion from programs in the future. The behavioral waste analysis further enhances program planning efforts by quantifying end-use specific savings that could be achieved through the adoption of programs designed to promote efficient behaviors. The combined analysis provides energy usage profiles for each end use that disaggregate current energy use into three components: 1) efficient use, 2) energy waste associated with the use of inefficient technologies, and 3) energy waste due to inefficient behaviors.

This report presents the analysis of electricity usage and waste as well as summary penetration and saturation results for the C&I sectors. It is organized as follows:

- **Section 2: Summary of Key Penetration and Saturation Results.** This section presents the penetration and saturation data collected in the telephone survey and adjusted, where necessary, by site visit results.
- **Section 3: Summary of Electricity Usage and Waste.** This section provides an overview of usage and waste across all end uses included in this study.
- **Section 4: Methodology.** This section presents information about our approaches to primary data collection, metering, and the overall usage and waste analysis. It includes details about our primary data sampling and weighting methodology, and defines key usage and waste concepts used throughout this report.
- **Sections 5 through 12:** These sections present the usage and waste analyses and summarize key penetration and saturation results. Section 5 provides general characteristics of ComEd's C&I customers. Sections 6 through 11 are organized by end use. Section 12 presents an overview of other electric equipment for which the usage and waste were not analyzed in this study.
    - Section 5: General C&I Customer Characteristics
    - Section 6: Lighting
    - Section 7: Cooling
    - Section 8: Ventilation
    - Section 9: Refrigeration
    - Section 10: Motors

- Section 11: Office Equipment
- Section 12: Other Energy Using Equipment

The summary data tables included in Sections 5 through 12 present penetration and saturation data crossed by commercial segment and industrial rate class. Each summary table also presents the total number of C&I customers within the scope of this study. (See Section 4, Methodology for a description of the C&I customers included in this study.) Where fewer than 30 businesses responded to a question, results are not shown in the summary data tables (denoted by "*") because differences between subgroups with less than 30 responses cannot be statistically detected. Appendix 2 presents more detail about the number of responses for each question as well as significant differences between comparison groups.

Also included in this report are the following three appendices presenting more detail on our data collection and analysis methods:

- **Appendix 1** is the technical appendix. It provides a detailed discussion of the usage, waste calculations, and assumptions for the following end uses:
  - Lighting
  - Cooling
  - Ventilation
  - Refrigeration
  - Motors
  - Office Equipment
  - Water Heating

Each section of the sections above presents our technical approach to estimating 1) current electricity use, 2) technological waste, and 3) behavioral waste.

- **Appendix 2** contains the detailed telephone survey results. Each section in Appendix 2 begins with the survey questions, as asked in the telephone survey. Telephone survey data in Appendix 2 is weighted, but is *not* adjusted by site visits results. Section 4 (Methodology) provides more information about the weighting process. Section 4 also contains more information about the telephone survey adjustment process and how variables were adjusted for penetration and saturation reporting in Sections 2, 3, 5-12. Sections 2, 3, 5-12 contain weighted and adjusted penetration and saturation results for many telephone survey questions.
- **Appendix 3** contains the primary data collection instruments used for this effort, which include the Telephone Survey Instrument and the Site Audit Data Collection Instrument.

2. Summary of Key Penetration and Saturation Results

A primary purpose of this study was to determine the penetration and saturation of commercial and industrial customers with key electricity using equipment. These two concepts are defined as follows:

- **Penetration:** A percentage representing the proportion of customers that have one or more particular piece of equipment. It is calculated by dividing the number of customers with one or more of the equipment types by the total number of customers responding to that question.
- **Saturation:** A mean representing how many of a particular piece of electricity-using equipment) exists among all customers. It is calculated by dividing the total number of each piece of equipment by the total number of customers responding to that question. Therefore, the saturation value includes customers who do *not* have the equipment, and it will be slightly lower than the mean count among those that *have* the equipment (if equipment penetration is less than 100%). The saturation value is at least equal to, but generally higher than the corresponding penetration of a particular equipment type, because many businesses will have more than one of each equipment type. The units-of-measure are typically equipment counts.

Table 2-1 presents the penetration and saturation data collected in the 2012 C&I Energy Use Survey and adjusted, where necessary, by site visit results. In some cases (footnoted), penetration and saturation data is sourced directly from site visit data.

Table 2-1. 2012 Penetration and Saturation

End Use/Equipment Type	Penetration			Saturation (Mean # Equipment Type)		
	Total	Com	Ind	Total	Comm	Ind
Lighting[a]						
Linear Fluorescent Light Fixtures	98%	98%	98%	152.6	156.3	112.7
T12 Linear Fluorescent Light Fixtures	66%	65%	71%	63.0	64.2	50.3
T10 Linear Fluorescent Light Fixtures	3%	3%	2%	0.0	0.0	0.0
T8 Linear Fluorescent Light Fixtures[b]	57%	58%	56%	71.7	73.0	58.0
T5 Linear Fluorescent Light Fixtures[c]	11%	10%	12%	17.8	19.1	4.0
CFL Fixtures	46%	47%	35%	24.4	26.4	2.7
Incandescent Bulb Fixtures	50%	50%	47%	25.2	27.2	3.9
HID Bulb Fixtures[d]	13%	12%	18%	3.9	3.4	9.4
Halogen Bulb Fixtures	11%	11%	7%	1.9	2.1	0.5
LED Light Fixtures	6%	6%	3%	4.0	4.3	0.5
Neon (Cold Cathode) Light Fixtures	1%	1%	0%	0.0	0.0	0.0
All Exit Signs	84%	84%	88%	7.1	7.1	6.4