STATE OF ILLINOIS
ILLINOIS COMMERCE COMMISSION

Northern Illinois Gas Company	**)**	
d/b/a Nicor Gas Company	**)**	
	)	
	)	**Docket No. 13-0549**
Application pursuant to Section 8-104 of	**)**	
the Public Utilities Act for Consent to and	**)**	
Approval of an Energy Efficiency Plan	**)**	

Exhibit 1.4 of
Geoffrey C. Crandall

On Behalf of

Environmental Law and Policy Center

January 21, 2014

ComEd Residential Saturation / End-Use, Market Penetration & Behavioral Study

Prepared for:

ComEd

Prepared by:

Opinion Dynamics Corporation
230 Third Avenue
Third Floor
Waltham, MA 02451
(617) 492-1400

With Subcontractors:

Vermont Energy Investment Corporation

Mad Dash Field Services

April 2013

TABLE OF CONTENTS

TABLES

FIGURES

1. INTRODUCTION

ComEd contracted with the Opinion Dynamics team to complete a comprehensive end-use saturation and penetration study of its residential, and key commercial and industrial customer segments, and conduct a behavioral analysis designed to identify energy waste associated with inefficient behavioral practices. 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 by end-use that disaggregate current energy usage into three components: 1) efficient usage, 2) energy waste associated with the use of inefficient technologies, and 3) energy waste due to behaviors.

This report presents the analysis of electricity usage and waste, as well as summary penetration and saturation results, for residential customers. This report is organized as follows:

- **Section 2: Summary of Key Penetration and Saturation Results.** This section presents the penetration and saturation data collected in the mail 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. Sections 5 through 10 are organized by end-use. Section 11 present an overview of other electric equipment not included in this analysis. Section 12 provides general characteristics of ComEd's customers and their homes.
  - Section 5: Lighting
  - Section 6: Cooling
  - Section 7: Electric Space Heating
  - Section 8: Electric Water Heating
  - Section 9: Major Appliances
  - Section 10: Electronics and Computing
  - Section 11: Other Electric Equipment
  - Section 12: General Home and Customer Characteristics

The summary data tables included in Sections 5 through 12 present penetration and saturation data crossed by the following three variables:

1. **Home Type:** The customer's home type is based on Question A2 of the mail survey ("Is your home…"). Home types are grouped as follows:
   - Single family: (1) Mobile home; (2) Single family detached residence; (3) Single family attached residence, e.g., a townhouse.
   - Multi-family: (4) Apartment or condominium.
2. **Electricity Usage, by Home Type:** Electricity usage is based on 2011 ComEd billing data. Within each home type, residential customers are divided into three usages groups:
   - High: Customers accounting for the top one-third of electricity usage, within each home type.
   - Medium: Customers accounting for the middle one-third of electricity usage, within each home type.
   - Low: Customers accounting for the bottom one-third of electricity usage, within each home type.
3. **Heating Fuel, by Home Type:** The heating fuel is based on ComEd's residential rates. Within each home type, residential customers are divided into two groups:
   - Electric heat includes rates: B90, B91, H90, H91, R90, and R91.
   - Non-electric heat includes rate classes: B70, B71, H70, H71, R70, and R71.

Each summary table also presents the total number of occupied homes. These numbers are slightly lower than the number of ComEd residential accounts and reflect the fact that some homes are vacant. Because vacant homes have no or only minimal electricity usage, they should not be included when extrapolating the usage and waste results to the population.

Where fewer than 30 people 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 3 of this report presents more detail about the number of responses for each question as well as significant differences between comparison groups.

Appendix 1

Appendix 1 is the technical appendix. It provides a detailed discussion of the usage and waste calculations for the following end-uses:

- Lighting
- Cooling
- Electric Space Heating
- Electric Water Heating
- Major Appliances
- Electronics and Computing

Each section presents our technical approach to estimating 1) current electricity usage, 2) technology waste, and 3) behavioral waste. The final section of this appendix contains a description of how assumptions about building shell insulation and duct sealing were developed. These are important inputs into the cooling and electric space heating analyses.

Appendix 2

Appendix 2 contains the primary data collection instruments used for this effort, i.e., the 2012 Residential Energy Use Survey (or "mail survey") and the On-Site Data Collection instrument.

Appendix 3

Appendix 3 contains the detailed mail survey results. Each section in Appendix 3 begins with the survey questions, as seen by the responding customer in the mail survey. Mail survey data in Appendix 3 has been adjusted by site visit results if 1) the same information was collected in both data collection efforts and 2) site visit results were significantly different from mail survey results (at 95% confidence) for the same set of respondents. The Methodology section provides more information about the mail survey adjustment process and the variables that were adjusted.

2. Summary of Key Penetration and Saturation Results

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

- **Penetration:** A percentage representing the proportion of customers that have one or more particular appliance (or other piece of equipment). It is calculated by dividing the number of customers with one or more of an appliance (or other piece of equipment) by the total number of customers responding to that question.
- **Saturation:** A percentage representing how many of a particular appliance (or other piece of equipment) exists among all customers. It is calculated by dividing the total number of a particular appliance (or other piece of equipment) by the total number of customers responding to that question. This percentage is at least equal to, but generally higher than the corresponding penetration of a particular appliance, because some households will have more than one of the appliance.

Table 2-1 presents the penetration and saturation data collected in the 2012 Residential 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

Appliance/Equipment	Penetration			Saturation		
	All	SF	MF	All	SF	MF
Lighting[S]						
Incandescent	99%	100%	98%	3,620%	4,738%	1,688%
CFL	85%	90%	75%	1,090%	1,333%	684%
Fluorescent tube lighting	64%	72%	49%	460%	653%	128%
Halogen	47%	50%	40%	344%	365%	309%
LED	5%	7%	3%	37%	57%	4%
Cooling						
Central air conditioning units	73%	87%	46%	81%	97%	51%
Programmable thermostats	44%	47%	35%	-	-	-
Window units	30%	18%	52%	53%	32%	91%
Space and Water Heating						
Electric space heating (primary fuel)	10%	4%	24%	-	-	-
Any electric space heating	33%	28%	42%	-	-	-
Electric water heating	8%	6%	13%	-	-	-

Table 2-1. 2012 Penetration and Saturation (cont.)

Appliance/Equipment	Penetration			Saturation		
	All	SF	MF	All	SF	MF
Major Appliances						
Clothes washer (private use)	80%	98%	47%	87%	106%	50%
Electric clothes dryer (private use)	25%	26%	23%	26%	27%	23%
Refrigerator	100%	100%	100%	134%	149%	107%
Secondary refrigerator	30%	42%	7%	-	-	-
Standalone freezer	31%	40%	13%	32%	42%	13%
Electric cooktop	23%	19%	30%	23%	20%	30%
Electric oven	29%	26%	33%	34%	33%	34%
Dishwasher	67%	75%	54%	68%	75%	54%
Electronics and Computing [A]						
Television	98%	99%	96%	252%	286%	187%
CRT TV	51%	57%	41%	90%	104%	64%
Flat screen LCD TV	61%	64%	56%	107%	121%	80%
Flat screen LED TV	21%	22%	18%	31%	34%	25%
Flat screen plasma TV	13%	14%	12%	17%	19%	15%
Projection TV	6%	8%	3%	7%	10%	3%
Cable/satellite box with DVR	59%	64%	49%	93%	106%	67%
Stand-alone cable/satellite box	43%	46%	37%	72%	83%	52%
DVR separate from cable/satellite box	14%	14%	14%	17%	18%	15%
Video game player	44%	47%	38%	59%	64%	51%
Home theater system [B]	23%	25%	18%	30%	33%	25%
Digital TV converter box [B]	40%	44%	32%	66%	74%	49%
DVD or VCR player [B]	62%	65%	58%	85%	89%	77%
Stereo, CD player, iPod, or MP3 player [B]	59%	60%	56%	88%	93%	78%
TV streaming device [B]	22%	21%	24%	31%	29%	34%
Desktop computer	57%	64%	43%	69%	80%	48%
Laptop/Tablet	64%	66%	62%	103%	110%	91%
Cordless phone (landline) and/or answering machine	62%	71%	45%	100%	119%	63%
Cell phone charger	93%	93%	92%	168%	176%	153%
Printer, fax, scanner, copier, or multifunction device	68%	74%	56%	80%	90%	60%
Copier	19%	22%	14%	20%	24%	14%
DSL/cable modem, WiFi routers, or home network	73%	76%	67%	88%	93%	77%

Table 2-1. 2012 Penetration and Saturation (cont.)

Appliance/Equipment	Penetration			Saturation		
	All	SF	MF	All	SF	MF
Other Electric Equipment [A]						
Electronic household air cleaner/humidifier	36%	31%	27%	42%	49%	30%
Dehumidifier	23%	34%	5%	25%	37%	5%
Hot tub/whirlpool	13%	17%	6%	13%	17%	6%
Electric-powered exercise equipment	15%	22%	3%	16%	23%	3%
Aquarium	10%	12%	6%	11%	14%	7%
Water bed	1%	2%	<1%	1%	2%	<1%
Well and/or sump pump	36%	54%	3%	46%	68%	3%
Microwave [B]	98%	99%	97%	128%	131%	125%
Toaster oven [B]	44%	44%	44%	59%	59%	59%
Electric cooking appliances (griddle, waffle iron, Panini press, etc.) [B]	28%	29%	26%	37%	39%	35%
Slow cooker [B]	27%	31%	19%	29%	34%	21%
Electric kettle [B]	7%	7%	7%	9%	8%	10%
Breadmaker [B]	3%	4%	2%	4%	5%	2%
Coffee maker [B]	62%	69%	49%	92%	103%	70%
Rice maker [B]	9%	8%	12%	12%	10%	15%
Air compressor [B]	9%	13%	1%	10%	14%	1%
Pools						
Pool	7%	9%	4%	-	-	-
Pool pump	5%	8%	1%	6%	8%	1%

Source: 2012 ComEd Residential Mail Survey; 2012 Residential Site Visits

[A] Question asked about appliances/equipment <u>used</u> in home.
[B] Question asked about appliances/equipment used <u>more than once a week</u>.
[S] All lighting data presented in this table is based on site visits.

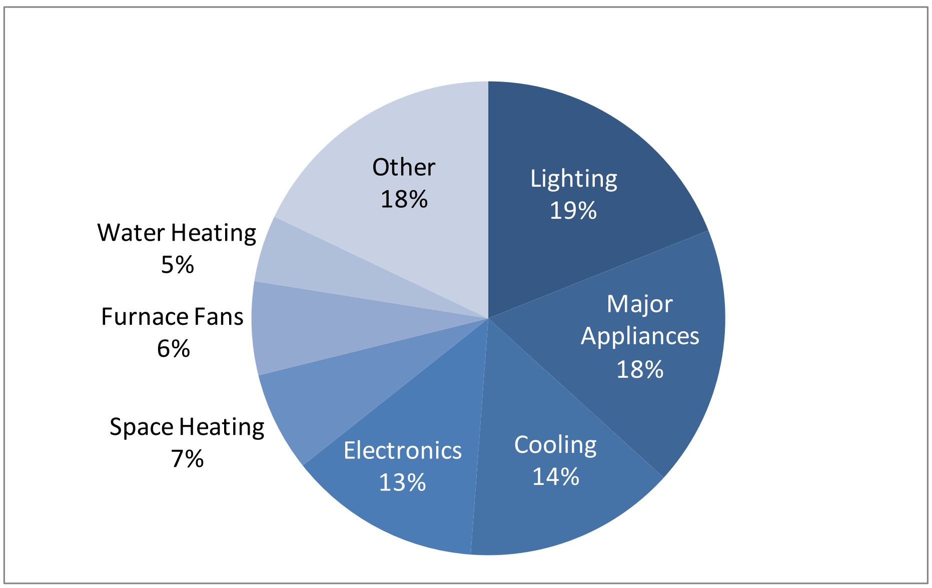
3. Summary of Electricity Usage and Waste

Our usage and waste analysis includes the end-uses that account for the majority of electricity usage among ComEd's residential customers. For each end-use, we assessed current electricity usage as well as key categories of technology and behavioral waste. In this analysis, we did not attempt to quantify every possible source of waste; rather, we focused on those categories that have the potential to provide significant savings from addressing waste.

Sections 5 through 10 of this report present detailed results for each end-use included in this analysis. This section brings together the individual end-use results and provides a high-level summary of our findings.

Overall, the analyzed end-uses account for 82% of ComEd's residential electricity usage. Not surprisingly, the top end-uses are lighting (19%), major appliances (18%), cooling (14%), and consumer electronics (13%).

Figure 3-1. Summary of Residential Energy Usage by End-Use



These usage numbers align fairly closely with 2010 EIA estimates of U.S. Residential Electricity Consumption by End-Use, which estimate 22% of usage for space cooling, 17% of usage for appliances, and 14% of usage for lighting.

In terms of waste, lighting still shows the greatest opportunities to reduce technology waste, which accounts for 64% of current usage, by switching to CFLs. Cooling has the greatest opportunities to reduce behavioral waste, which accounts for 38% of current usage, mainly by increasing temperature setpoints.

Table 3-1 presents the usage and waste results, across key analyzed end-uses.

Table 3-1. Summary of Usage and Waste Results

	Key Analyzed End-Uses[A]					
	Lighting	Major Appliances [B]	Cooling	Consumer Electronics[C]	Electric Space Heating	Electric Water Heating
% of Residential Usage	19%	18%	14%	13%	7%	5%
End-Use Penetration	100%	100%	94%	100%	33%	8%
kWh Per HH *(with End-Use)*	1,661	1,560	1,351	1,153	1,829	4,943
kWh Per HH *(All HH)*	1,661	1,560	1,267	1,153	596	398
Total Annual GWh	5,528	5,189	4,215	3,837	1,982	1,323
% Efficient Usage	25%	*	37%	*	85%	73%
% TW (before BW)	64%	*	33%	*	13%	17%
% BW (after TW)	11%	*	30%	*	2%	9%
% BW (before TW)	30%	*	38%	*	3%	10%
% TW (after BW)	45%	*	26%	*	13%	17%
GWh TW (before BW)	3,536	862	1,402	919	261	228
GWh BW (after TW)	603	78	1,273	78	39	124
GWh BW (before TW)	1,662	101	1,587	161	50	132
GWh TW (after BW)	2,477	838	1,087	836	250	219

Source: Usage and Waste Analysis
[A] This table does not include furnace fans, for which we estimated current usage, but not waste.
[B] Usage results include electric cooking appliances.
[C] Usage results include set top boxes.
[D] Waste percentages for these end-uses are not shown since they include a variety of different types of equipment.

4. METHODOLOGY

Key activities in support of the Residential Saturation/End-use, Market Penetration, and Behavioral Study included extensive primary data collection, monitoring, and engineering analysis of six electric end-uses. The following sections present details about each of these activities.

4.1 Primary Data Collection

The primary data collection activities for this effort included a mail survey with 4,414 residential customers and in-home visits at 297 homes. This section describes the sampling and weighting methodologies associated with these two activities.

4.1.1 Mail Survey

The 2012 Residential Energy Use Survey consisted of a mail/internet survey of ComEd residential customers. The mail survey was designed to collect comprehensive penetration and saturation data on electricity using equipment as well as information about customers' use of this equipment, i.e., their behaviors.

The survey was sent to 18,000 homes in April 2012. To enhance recognition and response rates, all written communications with customers were conducted on specially-designed stationery, displaying the ComEd logo. The cover letter included a reference to a website and a personal identification number (PIN), and offered customers the option to complete the survey on-line instead of by mail. The cover letter also announced a drawing of ten $100 gift cards among respondents who returned the completed survey by the specified deadline.

About two and four weeks later, respectively, two reminder mailings – one postcard and one mailing containing another copy of the survey booklet – were sent to customers who had not yet returned a completed survey.

Sample Design

As of January 2012, there were 3,407,717 residential accounts in ComEd's service territory. The sample frame consisted of 2,971,612 residential accounts. Dropped from the population were:

- Accounts with less than 2 kWh average daily usage in 2011
- Accounts with less than 2 kWh average daily usage in three or more summer months (May-Sept) in 2011
- Accounts where the customer moved into the premise after May 2011

Dropping these accounts removed vacant premises and premises with insufficient 2011 summer data needed for analysis. The remaining records were grouped by home type (single family, multi-family).

Table 4-1. Mail Survey Sample Frame

Home Type	# of Records	% of Records	% of Usage
Single Family	2,063,884	69%	81%
Multi-Family	907,728	31%	19%
TOTAL	2,971,612	100%	100%

Source: 2011 ComEd Billing Data

The target number of completed surveys was 3,000. To achieve this number we sent out 18,000 survey booklets, assuming a response rate of approximately 17%.

The sampling approach was a stratified random sample within each of two home type groups (single family, multi-family), in proportion to their representation in the population of residential accounts. The following table presents the quota for the outgoing survey sample and the expected number of completed surveys for the two groups.

Table 4-2. Mail Survey Targets

Home Type	% of Records	Quota	Expected Completes
Single Family	69%	12,500	2,125
Multi-Family	31%	5,500	935
TOTAL	100%	18,000	3,060

Within each of the two home type groups, we sampled households in proportion to their electricity usage. To this end, we ranked households within each home type group by their average daily usage (in kWh) and divided them into three usage groups – high, medium, and low – each comprising one third of total electricity usage for each group. Because of the very wide range of usage in the "high" group, we then divided that group into very high usage (the top 5% of electricity usage) and high usage (the remaining 28% of the top third).[1]

[1] We also considered stratifying the sample by electric heat and non-electric heat, within the single family and multi-family home type groups. However, sample sizes were too small in many of the electric heat usage subgroups. In addition, most electric heat households fall into the "very high" usage group under our current sampling approach. As such, electric heat household were oversampled, resulting in a sufficient number of completed surveys for our analysis.

Table 4-3. Distribution of Households by Usage Groups

Home Type	Usage Group	% of Usage (within Group)	# of Households	% of HH (within Group)	Usage Range (Ave Daily kWh)	Mean Usage (Ave Daily kWh)
Single Family	Very high	5%	23,156	1%	88 – 1,843	125
	High	28%	314,539	15%	40 – 88	52
	Medium	33%	603,510	29%	26 – 40	32
	Low	33%	1,122,679	54%	2 – 26	17
Multi-Family	Very high	5%	8,556	1%	58 – 1,782	81
	High	28%	113,673	13%	25 – 58	35
	Medium	33%	248,839	27%	14 – 25	19
	Low	33%	536,660	59%	2 – 14	9
Total			2,971,612		2 – 1,843	24

Source: 2011 ComEd Billing Data

This approach of sampling households in proportion to their electricity usage resulted in an oversample of the high and very high usage groups. For example, 1% of single family households account for 5% of electricity usage (see table above). These households represented 5% of the single family sample, even though they only represent 1% of single family households. This approach provided us with more data on customers who have higher usage and therefore an assumed higher potential for savings. The following table summarizes the distribution of mailed surveys and the expected number of completed surveys among the eight home type/usage groups. The expected number of completed surveys assumes a response rate of 17%.

Table 4-4. Mail Survey Quota by Usage Groups

Home Type	Home Type Quota	Usage Group	% of Usage (within Group)	Quota	Expected Completes
Single Family	12,500	Very high	5%	620	105
		High	28%	3,540	602
		Medium	33%	4,170	709
		Low	33%	4,170	709
Multi-Family	5,500	Very high	5%	280	48
		High	28%	1,560	265
		Medium	33%	1,830	311
		Low	33%	1,830	311
Total	18,000			18,000	3,060

Summary of Survey Statistics

Overall, we received 4,452 responses to the survey, 3,728 by mail and 724 via the Internet. Of these, 38 responses were either duplicates or largely incomplete and could not be included in the analysis, leaving a total of 4,414 usable responses. Overall, 2% of mailed surveys were undeliverable (1% for single family homes and 5% for multi-family homes). The resulting overall response rate, calculated as the number of completed surveys divided by the number of deliverable surveys, was 25%. Given this response rate, we greatly exceeded the target number of completes.

Table 4-5 summarizes these survey statistics.

Table 4-5. Summary of Mail/Internet Survey Responses

	TOTAL	Single Family	Multi-Family
Total Mailed	18,000	12,500	5,500
Completed Survey – Mail	3,728	2,815	913
Completed Survey – Internet	724	512	212
Completed Survey – Total	4,452	3,327	1,125
Undeliverable – Number	354	105	249
Undeliverable – Percent	2%	1%	5%
Response Rate	25%	27%	21%

Weighting

To ensure that mail survey results are representative of ComEd's population of residential customers, we developed and applied weights. We developed these weights in a two-step process, as described below.

Development of Sample Weights

We first developed sample weights that correct for the fact that we oversampled multi-family and high usage households. We estimated these weights for each sample stratum by dividing the stratum's share of the population by the stratum's share of the sample. For example, Stratum 2 (high usage single family homes) represents 11% of the population but 21% of the mail survey responses. The weight for this stratum is calculated as 11% divided by 21%, or approximately 0.52. This means that the survey responses of customers in this stratum are weighted down. In other words, each response only counts about half, compared to a stratum with a weight of 1.

Table 4-6. Mail Survey Sample Weights

Stratum	Home Type	Usage Group	Population		Sample		Sample Weight
			Count	%	Count	%	
1	SF	Very high usage	23,156	0.8%	149	3.4%	0.231
2	SF	High usage	314,539	11%	907	21%	0.515
3	SF	Medium usage	603,510	20%	1,146	26%	0.782
4	SF	Low usage	1,122,679	38%	1,123	25%	1.485
5	MF	Very high usage	8,556	0.3%	43	1.0%	0.296
6	MF	High usage	113,673	4%	252	6%	0.670
7	MF	Medium usage	248,839	8%	369	8%	1.002
8	MF	Low usage	536,660	18%	425	10%	1.876
		TOTAL	2,971,612	100%	4,414	100%	

Development of Post-Stratification Weights

Post-stratification is a technique used to adjust or correct survey information. It is used when (1) survey respondents are not representative of the population from which they were selected, i.e., some subgroups of interest are over-represented and some are under-represented; and (2) over-represented subgroups are different from under-represented subgroups. In order to conduct post-stratification, information is required on both the percentage of the population and the percentage of the respondents that fall into the subgroups of interest (or strata). It is important that the strata available for the population are the same as the strata available for survey respondents. In addition, data to assign survey respondents into the strata must be available for *all* survey respondents; if survey responses to stratification variables are missing, responses have to be imputed.

We determined the need for post-stratification by comparing survey responses with known statistics about the population. We compared the survey data across core demographic and household characteristics with 2010 U.S. Census data for all Illinois counties in ComEd's service territory. This comparison found that homes with older heads-of-household are over-represented in our survey responses relative to the population. Since customers of different ages likely vary in their ownership and use of certain electricity using equipment, we developed an age-based post-stratification weight. This weight is calculated the same way as the sample weight, by dividing the stratum's share of the population by the stratum's share of the sample. It should be noted that to determine the stratum's share of the sample, we first apply the sample weights.

Table 4-7. Mail Survey Post-Stratification Weights

	Population		Sample		
Age	Count	%	Count	%	Weight
Under 34 years	710,946	20%	396	9%	2.218
35 to 44 years	689,248	20%	564	13%	1.510
45 to 54 years	766,547	22%	871	20%	1.088
55 to 64 years	619,872	18%	1,050	24%	0.730
65 years +	714,981	20%	1,448	33%	0.611
Missing Response			84		1.000
TOTAL	3,501,594		4,414		

Adjustment of Mail Survey Data

We used information from the in-home visits to adjust certain mail survey responses. In general, we considered for adjustment items that are technical in nature and often difficult for customers to report correctly, e.g., questions about equipment age or ENERGY STAR rating or questions about the customer's type of windows. We did not consider for adjustment items that cannot be observed during in-home visits (such as questions about behavior) or simple equipment counts that customers generally report correctly (with the exception of light bulbs). We also did not adjust questions with low incidence in the in-home sample.

We first conducted a Pearson's chi-squared test for questions considered for adjustment. Only if the test showed that mail survey responses are significantly different from on-site observations, did we include the question for adjustment.

Below are the survey questions we adjusted, by report section. The number in parentheses indicates the question number in the mail survey (see Appendix 2 for the final mail survey instrument).

- B. Central Air Conditioning/Cooling
  - Age of central air conditioner (B4)
  - ENERGY STAR rating of CAC (B5)
  - Have programmable thermostat (B6)
- C. Window Air Conditioning
  - ENERGY STAR rating of window unit (C3a)
- D. Insulation and Ventilation
  - Attic/top floor ceiling is insulated (D1)
  - Exterior walls are insulated (D2)
  - Type of windows (D3)
- F. Water Heating
  - Water heater fuel type (F1)
- G. Appliances
  - Age of clothes washer (G3)
  - Fuel type of clothes dryer (G6)
  - ENERGY STAR rating of primary refrigerator (G10a)
  - Age of primary refrigerator (G11)
  - Age of primary stand-alone freezer (G14)
  - ENERGY STAR rating of dishwasher (G18)
  - Age of dishwasher (G19)
- H. Entertainment and Technology
  - Use of smart strips (H6)
- J. Lighting
  - Number of bulbs inside the home (J1)
  - Percentage of indoor bulbs that are CFLs (J2)
  - Number of bulbs outside the home (J3)
  - Percentage of outdoor bulbs that are CFLs (J4)
  - Have bought a screw-in LED (J5)

Adjustment Methodology

We used the ratio adjustment method to adjust the mail survey responses for the items listed above.[2] This method first develops an adjustment factor, based on the value of the 245 nested in-home visits and the value from the survey responses of the same 245 households.[3] The adjustment factor is then multiplied by the value from the survey responses for all 4,414 households. The values to be adjusted can be either a mean or a proportion.

Figure 4-1 shows this two-step ratio adjustment method.

Figure 4-1. Ratio Adjustment Algorithm

Step 1: $$Adjustment\ Factor = \frac{\overline{X}_o}{\overline{Y}_o}$$

Step 2: $$\overline{Y}_{sa} = Adjustment\ Factor * \overline{Y}_s$$

Where:

X_o = mean/proportion from the 245 nested in-home visits
Y_o = mean/proportion from the survey responses for the 245 households with in-home visits
Y_{sa} = adjusted mean/proportion for the item
Y_s = mean/proportion from the survey responses for all 4,414 households

Consider the following example:

The in-home visits found that 42% of homes have a programmable thermostat. By contrast, the mail survey responses provided by the same 245 households reported that 78% have a programmable thermostat. Using these values, we first developed the adjustment factor for programmable thermostats, as follows:

Have Programmable Thermostat: $$Adjustment\ Factor = \frac{42\%}{78\%} = 0.54$$

Do not Have Programmable Thermostat: $$Adjustment\ Factor = \frac{58\%}{22\%} = 2.62$$

Of all mail survey respondents, 2,241 reported that that they have a programmable thermostat and 676 reported that they do not (valid n=2,917). Multiplying these responses by the adjustment factor yields:

[2] Judith T. Lessler and William D. Kalsbeek. Nonsampling Error in Surveys. 1992. p. 269.

[3] The adjustment excludes the 52 non-nested in-home site visits because we do not have complete mail survey data for these customers. See also the discussion of sampling for the in-home site visits below.

Have Programmable Thermostat: *Adjusted Value = 2,241 * 0.54 = 1,210 or 41%*

Do not Have Programmable Thermostat: *Adjusted Value = 676 * 2.62 = 1,768 or 59%*

When adjusting proportions, a final adjustment step is necessary. When the data is categorical data, as in the example above, each category is adjusted separately. As a result, in many cases, the total number of responses no longer sums to the correct valid "n". To correct for this, when adjusting categorical data in this report, we adjusted the base of our results.

Precision of Results

Overall, the precision of mail survey results is approximately 2.0% at a 95% confidence level for single family homes and 2.5% at a 95% confidence level for multi-family homes. However, for equipment with low incidence in the population (e.g., central air conditioning in multi-family homes), the precision is lower for follow-up questions about equipment characteristics or behaviors. In addition, precision levels are lower for questions with many incomplete or incorrect responses.

4.1.2 In-Home Visits

We conducted a total of 297 in-home visits with ComEd residential customers. The in-home visits were designed to collect data to verify mail survey responses and to collect additional, more technical data that we did not include in the mail survey as customers generally find it difficult to report. In addition, we used the in-home visits to install monitoring equipment at a subset of site visit homes (see also Section 4.2, Metering below).

The site visits took place between June and October 2012. To compensate customers for their efforts, we offered an incentive of $75 for site visits without monitoring and $200 for site visits with monitoring.

Sample Design

The target number of site visits was 300. This included 150 metered and 150 non-metered site visits, and 200 total site visits in single family residences and 100 in multi-family residences.

Table 4-8. Site Visit and Metering Quotas by Home Type

Home Type	Non-Metered	Metered	TOTAL
Single Family	125	75	200
Multi-Family	25	75	100
TOTAL	150	150	300

The sampling approach was a stratified random sample within each of two home type groups (single family, multi-family), in proportion to their representation in the population.

Within each of the two home type groups, we also sampled households in proportion to their electricity usage, similar to the sampling method used for the mail survey. The approach was the same for metered and unmetered site visits, i.e., we applied proportions of usage within the group to metered and non-metered quotas.

This approach of sampling households in proportion to their electricity usage resulted in an oversample of the high and very high usage groups. This approach provided us with more data on customers who have higher usage and therefore a higher potential for savings.

The in-home visits were originally designed as a nested sample, i.e., we set out to draw the sample of site visit homes from the population of mail survey respondents. However, for some of the quota groups, we were not able to reach our target number of visits from among the mail survey respondents. In particular, we had difficulty meeting the quota for metering in the lower usage multi-family homes as it was sometimes physically impossible to install the metering equipment. As such, we recruited additional site visit homes from among customers to whom we had sent a mail survey, but who did not return it. These customers were asked to complete a shortened version of the mail survey, focusing on behavioral questions, at the time of the site visit.

Table 4-9. Site Visit Quotas by Home Type and Usage Group

Home Type	Usage Group	% of Usage (within Home Type)	Sample Frame	Site Visit Quota		
				Non-Metered	Metered	Total
Single Family	Very high	5%	149	6	4	10
	High	28%	907	36	21	57
	Medium	33%	1,146	42	25	67
	Low	33%	1,123	42	25	67
Multi-Family	Very high	5%	43	1	4	5
	High	28%	252	7	21	28
	Medium	33%	369	8	25	33
	Low	33%	425	8	25	33
Total			4,414	150	150	300

Summary of Site Visit Statistics

Overall, we conducted 297 site visits, 187 in single family homes and 110 in multi-family homes. Of these, 137 included metering and 160 did not include metering. In addition, 245 of the 297 site visits were nested, i.e., from within the population of mail survey respondents, while 52 were non-nested.

Table 4-10 summarizes these statistics.

Table 4-10. Summary of In-Home Visits

	TOTAL	Single Family	Multi-Family
Total Number of In-Home Visits	297	187	110
With Metering	137	72	65
No Metering	160	115	45
Nested	245	179	66
Non-Nested	52	8	44

Weighting

To ensure that on-site results are representative of ComEd's population of residential customers, we developed and applied weights. We used the same two-step process that was used for the mail survey. However, in order to ensure proper sample proportions, we added an additional step, discussed below.

Development of Sample Weights

We first developed sample weights that correct for the fact that we oversampled multi-family and high usage households. We estimated these weights for each sample stratum by dividing the stratum's share of the population by the stratum's share of the sample.

Table 4-11. Site Visit Sample Weights

Stratum	Home Type	Usage Group	Population		Sample		Sample Weight
			Count	%	Count	%	
1	SF	Very high usage	23,156	0.8%	11	3.7%	0.210
2	SF	High usage	314,539	11%	48	16.2%	0.655
3	SF	Medium usage	603,510	20%	68	22.9%	0.887
4	SF	Low usage	1,122,679	38%	60	20.2%	1.870
5	MF	Very high usage	8,556	0.3%	5	1.7%	0.171
6	MF	High usage	113,673	4%	32	10.8%	0.355
7	MF	Medium usage	248,839	8%	35	11.8%	0.711
8	MF	Low usage	536,660	18%	38	12.8%	1.411
		TOTAL	2,971,612	100%	297	100.0%	

Development of Post-Stratification Weights

As with the mail survey, we compared demographics of site visit participants with those of the population and found that homes with older heads-of-household are over-represented in our site visits. To correct for this, we developed an age-based post-stratification weight. This weight is calculated the same way as the sample weight, by dividing the stratum's share of the population by the stratum's share of the sample. It should be noted that to determine the stratum's share of the sample, we first apply the sample weights.

Table 4-12. Site Visit Post-Stratification Weights

Age	Population		Sample		Weight
	Count	%	Count	%	
Under 34 years	710,946	20%	34	11%	1.785
35 to 44 years	689,248	20%	45	15%	1.281
45 to 54 years	766,547	22%	44	15%	1.475
55 to 64 years	619,872	18%	70	24%	0.743
65 years +	714,981	20%	102	35%	0.590
Missing Response			2		1.000
TOTAL	3,501,594		297		

Restoring Single Family/Multi-Family Home Proportions

When we applied post-stratification weights for the site visits, the distribution of the sample between single family and multi-family homes slightly changed from its original proportions. To preserve the proper proportion of single family homes to multi-family homes we took a third step and applied a final factor to our post-stratification weights. This factor was 1.036 for single family homes and 0.939 for multi-family homes.

4.2 Metering

In support of our usage and waste analysis, we conducted three types of metering activities: 1) circuit-level monitoring of electricity usage, 2) monitoring of lighting use and occupancy, and 3) measurement of room temperature. These are described in the sections below.

We sampled for all metering activities as part of the sampling for site visits. In general, we attempted to deploy eMonitors, loggers, and temperature sensors in 150 homes, 75 single family and 75 multi-family, distributed evenly across the high, medium, and low usage groups (see also Section 4.1.2 above).[4]

Table 4-13 summarizes the number of homes for which we obtained the different types of metering data.

Table 4-13. Number of Homes with Metering

	TOTAL	Single Family	Multi-Family
Any Metering	137	72	65
eMonitors	130	69	61
Light/Occupancy Loggers	132	68	64
Temperature Sensors	118	63	55

[4] The target for valid metered site visits is 70 per home type. We deployed metering equipment in 10 additional homes to account for any meter failure or interruptions (e.g., logger recording or transmission failure, or unexpected absence of participants during metering period).

Weighting

Similar to the site visits, we developed and applied weights for the metering data, using a three-step process.

Development of Sample Weights

We first developed sample weights that correct for the fact that we oversampled multi-family and high usage households. We estimated these weights for each sample stratum by dividing the stratum's share of the population by the stratum's share of the sample.

Table 4-14. Metering Sample Weights

Stratum	Home Type	Usage Group	Population		Sample		Sample Weight
			Count	%	Count	%	
1	SF	Very high usage	23,156	0.8%	3	2.2%	0.356
2	SF	High usage	314,539	11%	20	14.6%	0.725
3	SF	Medium usage	603,510	20%	26	19.0%	1.070
4	SF	Low usage	1,122,679	38%	23	16.8%	2.250
5	MF	Very high usage	8,556	0.3%	1.0	0.7%	0.394
6	MF	High usage	113,673	4%	23	16.8%	0.228
7	MF	Medium usage	248,839	8%	27	19.7%	0.425
8	MF	Low usage	536,660	18%	14	10.2%	1.767
		TOTAL	2,971,612	100%	137	100.0%	

Development of Post-Stratification Weights

We then compared demographics of metering participants with those of the population and found that homes with older heads-of-household are over-represented in our metering. To correct for this, we developed an age-based post-stratification weight. This weight is calculated the same way as the sample weight, by dividing the stratum's share of the population by the stratum's share of the sample. As before, to determine the stratum's share of the sample, we first apply the sample weights.

Table 4-15. Metering Post-Stratification Weights

Age	Population		Sample		Weight
	Count	%	Count	%	
Under 34 years	710,946	20%	16	12%	1.679
35 to 44 years	689,248	20%	27	20%	0.998
45 to 54 years	766,547	22%	25	18%	1.199
55 to 64 years	619,872	18%	27	20%	0.887
65 years +	714,981	20%	41	30%	0.681
Missing Response			2		1.000
TOTAL	3,501,594		137		

Restoring Single Family / Multi-Family Home Proportions

When we applied post-stratification weights for the metered sites, the distribution of the sample between single family and multi-family homes slightly changed from its original proportions. To preserve the proper proportion of single family homes to multi-family homes we took a third step and applied a final factor to our post-stratification weights. This factor was 1.033 for single family homes and 0.983 for multi-family homes.

4.2.1 eMonitors

The eMonitor is an in-home energy management system sold by Powerhouse Dynamics. It allows homeowners to monitor the energy usage on every circuit of their home, enabling them to assess where most of the electricity is used, and potentially wasted.

As part of our usage and waste analysis, we deployed eMonitors in close to 150 homes. We attempted to monitor all electricity usage in each home, both on the electrical mains (providing total household usage) and for each individual circuit, for a period of two weeks. For each circuit, we also collected detailed information on the types of equipment that was connected to the circuit. In general, major equipment, such as central air conditioning systems and electric water heaters, is serviced by a dedicated circuit, allowing us to determine the electric usage for the equipment and to observe operating patterns. Other types of equipment, such as electronics, lighting, and smaller appliances, are generally on mixed circuits, making a determination of what is on at a given time difficult.

Our deployment of eMonitors was designed to support our usage and waste analysis and to develop load profiles for those types of equipment that tend to be on their own circuit.

4.2.2 Light and Occupancy Loggers

We deployed combination light and occupancy loggers in the same homes that received an eMonitor. For most of these homes, we deployed loggers in two rooms, generally the living room and the kitchen. The purpose of this metering activity was to assess behavioral waste associated with leaving the lights on when the room is not occupied. It should be noted that while the loggers captured the total time that lights were on, this effort was not designed to determine hours of use. Because of the limited extent of our metering – for a two-week period in any one home and within a relatively narrow period of time (June through September) – these results cannot be considered representative of lighting usage in ComEd's service territory, or even for the sampled customers.

The analysis of logger data involved several data verification steps. We removed loggers from analysis based on the following criteria:

- The logger captured less than 10 days of lighting data.
- The logger showed excessive flickering of monitored lights, defined as four or more one hour time periods where the lights turned on/off more than an average of 10 times per hour.
- The logger showed occupancy activity but no light between 8 p.m. and 6 a.m.

- The logger showed a high percentage of lights turning on or off without accompanying occupancy.

We calculated behavioral waste, by type of home, as the percentage of lighting run time during which the room was unoccupied. We developed percentages for different “time-out” periods, indicated by how long after occupancy the lights could remain on before counting the lighting usage as waste. We chose a time-out period of 15 minutes (which reflects a typical setting that could be expected for an occupancy sensor)—that is, if a room is left vacant for 15 consecutive minutes or less, we would not consider it waste if the lights were still on. After 15 minutes of a room being vacant, we consider a light left on as behavioral waste.

The lighting section in the technical appendix provides further detail about our methodology for estimating behavioral waste as well as the results of this analysis.

4.2.3 Temperature Measurements

We deployed temperature/humidity sensors in the same homes that received eMonitors and light/occupancy loggers. These sensors were generally placed near the thermostat of the central air conditioning unit, if present. For homes without central air conditioning, we placed the sensors near a room air conditioning unit.

This metering effort was designed to verify self-reported temperature setpoints from the mail survey and to refine our estimate of current central air conditioning usage. For each monitored home, we calculated the average temperature over the monitoring period for each of the six mail survey time periods (i.e., 6 a.m. – 9 a.m., 9 a.m. – 12 p.m., 12 p.m. – 4 p.m., 4 p.m. – 7 p.m., 7 p.m. – 10 p.m., and 10 p.m. – 6 a.m.). Using these average temperatures as setpoints, we estimated the actual equivalent full load hours (EFLH) for each household central air conditioning system. Comparing this to the EFLH based on self-reported setpoints provided us with a realization rate that we applied to all site visit households.

The cooling section in the technical appendix provides further detail about our methodology for estimating EFLH as well as the results of this analysis.

4.3 Usage and Waste Analysis

Our usage and waste analysis includes the end-uses that account for the majority of electricity usage among ComEd’s residential customers. The technical appendix provides detailed information about the analysis for each end-use. This section explains our general approach to estimating current usage, technology waste, and behavioral waste and presents the graphical representations of usage and waste used in this report. This section also summarizes the types of technology and behavioral waste included in our analysis.

4.3.1 Estimating Current Usage and Waste

The usage and waste analysis for all end-uses begins with an assessment of current usage. For most end-uses, we use engineering algorithms to estimate current usage. Where possible, these usage estimates are grounded in information obtained through end-use monitoring. The analysis is generally based on the site visit homes but utilizes a host of information collected not only during the site visits, but also through the mail survey and our metering efforts. Since our primary data collection could not cover all aspects of technology and behavior for all end-uses, we often supplement our primary data with secondary data. Where possible, we use information specific to ComEd's customers, e.g., assumptions from the Illinois TRM.

In some cases, there is missing information in the primary data, e.g., when a mail survey respondent left a question blank or if an on-site auditor could not assess certain equipment characteristics. We generally fill in this information with default values that we develop either from the mail survey or the site visits. Depending on the type of question and the number of valid responses that we received, we might develop one default value for the entire sample, we might develop separate default values for single family and multi-family homes, or we might develop default values by other key equipment characteristics, such as ENERGY STAR rating.

After estimating current usage, we estimate technology waste. For most end-uses, we assessed savings opportunities associated with upgrading to a more efficient model, generally an ENERGY STAR model (or equivalent level of efficiency). Other types of technology waste could be eliminated by adding insulation or a tank wrap or by sealing ducts. Technology waste can be developed directly, or it can be inferred, e.g., by estimating the usage of an efficient piece of equipment and subtracting that usage from the current usage. In many cases, we use the latter approach as the engineering algorithms often contain a term for technology efficiency that can be substituted with a more efficient level.

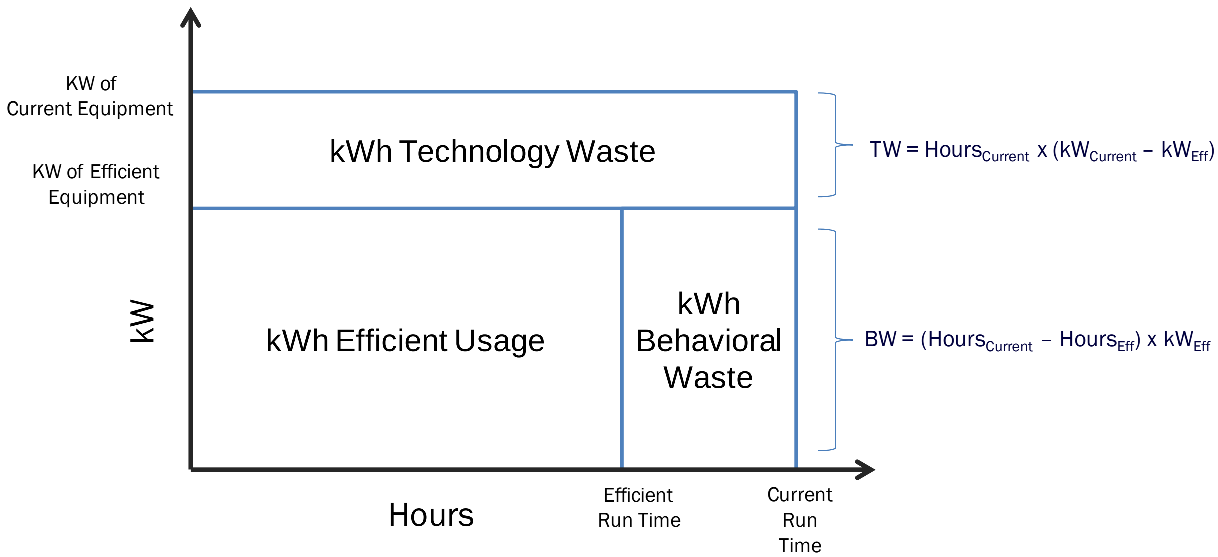
Behavioral waste for many end-uses is associated with longer than necessary run times, either as a result of inefficient temperature setpoints or by having equipment on when not using it (e.g., TVs or lights). Other types of behavioral waste vary by type of equipment. Similar to technology waste, behavioral waste can be developed directly, or it can be inferred, e.g., by estimating the usage with efficient run times and subtracting that usage from the current usage.

The magnitude of behavioral waste depends on whether it is addressed *before* or *after* addressing technology waste. To allow for flexibility in using our results, we estimate behavioral waste both ways. When it is addressed *before* technology waste, changes in behavior are applied to current technology parameters; when it is addressed *after* technology waste, changes in behavior are applied to efficient technology parameters.

The following graphic illustrates current usage, for a given end-use, and its disaggregation into technology waste, behavioral waste, and "efficient usage," i.e., the residual usage once both technology waste and behavioral waste have been addressed. The area of the rectangle represents total current energy consumption for the end-use, which is determined by the energy demand of the installed equipment (y-axis) and the baseline run time (x-axis). Reductions in the area of the rectangle equate to a reduction in usage. The green shaded area across the top of the rectangle represents the share of current consumption that can be considered technology waste. By switching to more efficient equipment, less wattage is required, and the area of the rectangle is reduced. The blue shaded area on the right side of the rectangle represents the share of current consumption that can be considered behavioral waste. By changing behavioral or operational practices in a way that reduces equipment run time, the area of the rectangle is again reduced. The remaining (white) area, after technology waste and behavioral waste are subtracted, constitutes the efficient usage of efficient equipment.

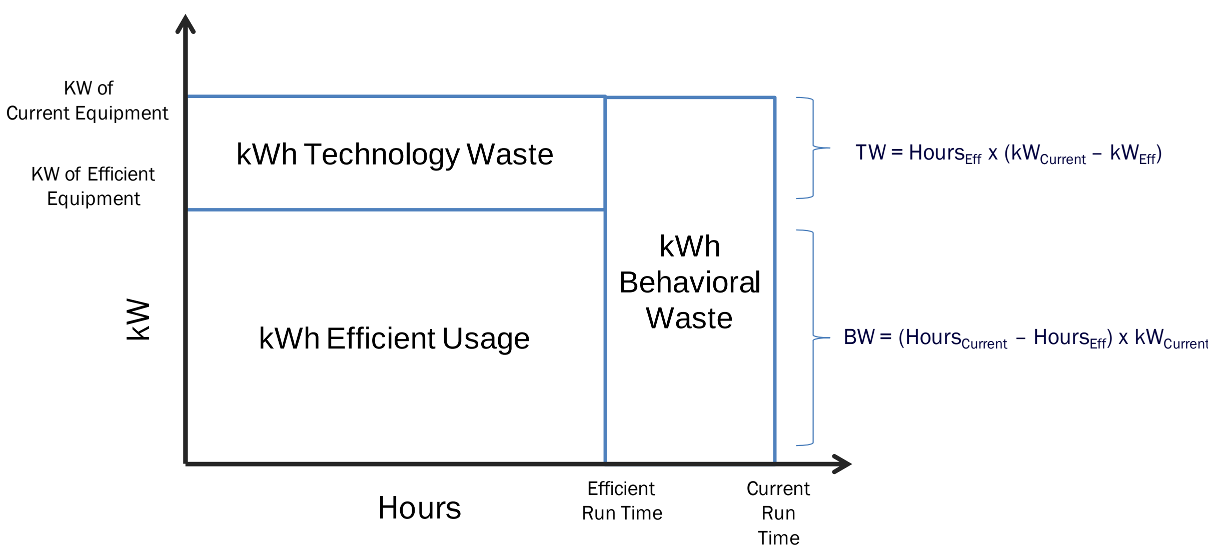
It should be noted that the residual, "efficient usage" is only efficient given the waste categories that we included in our analysis. Since there are many sources of waste for every end-use, inasmuch as other categories of waste exist, efficient usage would be further reduced. As such, the estimate of efficient usage should be considered a maximum value.

Figure 4-2. Usage and Waste Diagram – Addressing Technology Waste First



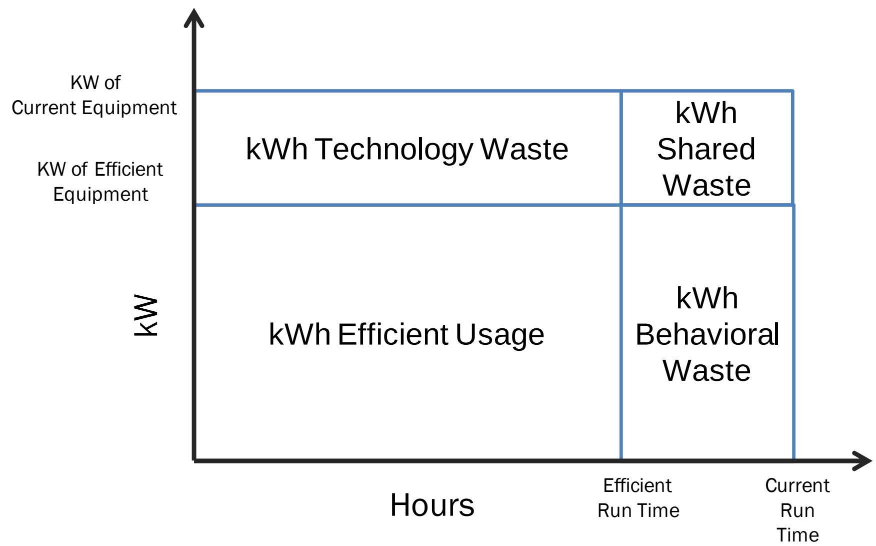
The graphic above shows definitions of waste if technology waste is addressed before behavioral waste. The magnitude of both types of waste changes, if behavioral waste is addressed first, as presented in the following graphic.

Figure 4-3. Usage and Waste Diagram – Addressing Behavioral Waste First



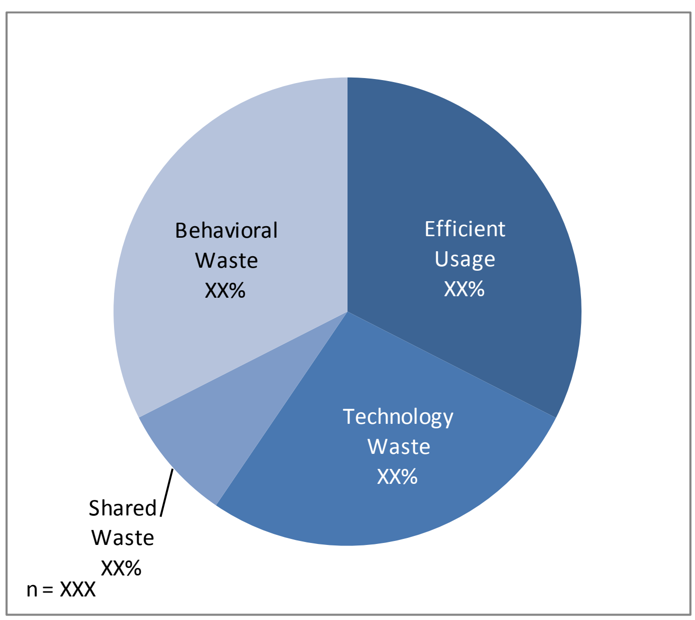
The difference between the two estimates of behavioral waste (and the two estimates of technology waste) can be considered "shared" waste, i.e., waste that is part of either technology waste or behavioral waste, depending on which is addressed first.

Figure 4-4. Usage and Waste Diagram – Showing Shared Waste



To facilitate assessment of the relative size of the four sources of energy consumption, this report uses pie charts, as shown below, instead of the rectangles. However, the terminology corresponds to the concepts presented above.

Figure 4-5. Usage and Waste Pie Chart



4.3.2 Summary of Waste Categories Included in this Report

This analysis focused on the key residential end-uses and major categories of technology and behavioral waste. The following tables summarize the categories of technology waste and behavioral waste, respectively, that are included in this analysis.

Table 4-16. Technology Waste Categories Included in Analysis

End-use/Equipment	Description
Lighting	• Upgrade incandescent and halogen bulbs to CFLs
Cooling	
Central AC	• Upgrade to new ES unit (SEER=14.5) • Seal unsealed duct joints / insulate uninsulated ducts • Insulate uninsulated surface areas
Room AC	• Upgrade to new ES unit (various EER ratings)
Electric Space Heating	• Upgrade to new ES unit (HSPF=8.2; heat pumps only) • Seal unsealed duct joints / insulate uninsulated ducts • Insulate uninsulated surface areas
Electric Water Heating	• Insulate uninsulated storage tank • Insulate uninsulated pipes • Install low-flow shower heads/aerators
Major Appliances	
Refrigerators	• Upgrade to new ES unit (20% more efficient than Federal Standard)
Stand-Alone Freezers	• Upgrade to new ES unit (10% more efficient than Federal Standard)
Laundry Equipment	• Upgrade clothes washer to new ES unit (MEF 2.0)
Dishwasher	• Upgrade dishwasher to new ES unit
Consumer Electronics	
Televisions	• Upgrade to new ES unit (LCD, LED, or plasma unit of the same size)
Video Game Systems	• Upgrade to more efficient unit
Computers	• Upgrade CRT monitors to LCD monitors

Table 4-17. Behavioral Waste Categories Included in Analysis

End-use/Equipment	Description
Lighting	• Turn off lights when room not occupied (15 minute time-out period)
Cooling	
Central AC	• Perform annual system maintenance • Increase temperature setpoints (78°F when home; 82°F when asleep; 85°F when away)
Room AC	• None estimated
Electric Space Heating	• Reduce temperature setpoints (68°F when home; 60°F when away)
Electric Water Heating	• Reduce temperature setpoint to 120°F
Major Appliances	
Refrigerators	• Unplug empty/nearly empty secondary fridge
Stand-Alone Freezers	• Unplug empty/nearly empty freezer
Laundry Equipment	• Eliminate excessive hot water use (% hot water usage > average)*
Dishwasher	• Use “no heat dry” function • Eliminate partial loads
Consumer Electronics	
Televisions	• Turn off TV when not watching
Video Game Systems	• None estimated
Computers	• None estimated

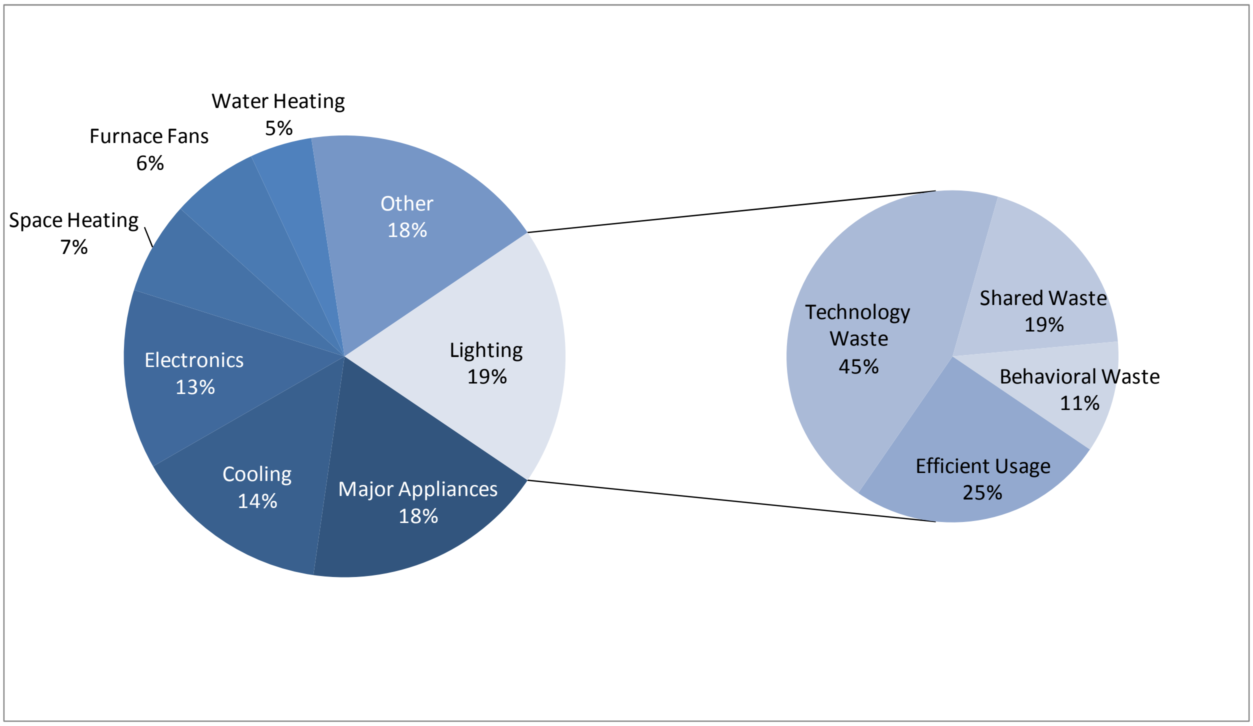
* Behavioral waste was quantified but not included in appliance analysis because waste is associated with electric water heaters.

5. Lighting

Lighting is used by all households in ComEd's service territory and accounts for approximately 19% of total residential electricity usage. Each household uses an average of 1,661 kWh per year to light their home. We estimate that technology and behavioral waste associated with lighting accounts for approximately 64% and 11%, respectively, of current usage (if technology waste is addressed first).

Figure 5-1 shows the contribution of lighting to overall residential electricity usage (pie chart on the left) and the breakout of lighting usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right).[5]

Figure 5-1. Usage and Waste Analysis – Lighting



Source: Usage and waste analysis

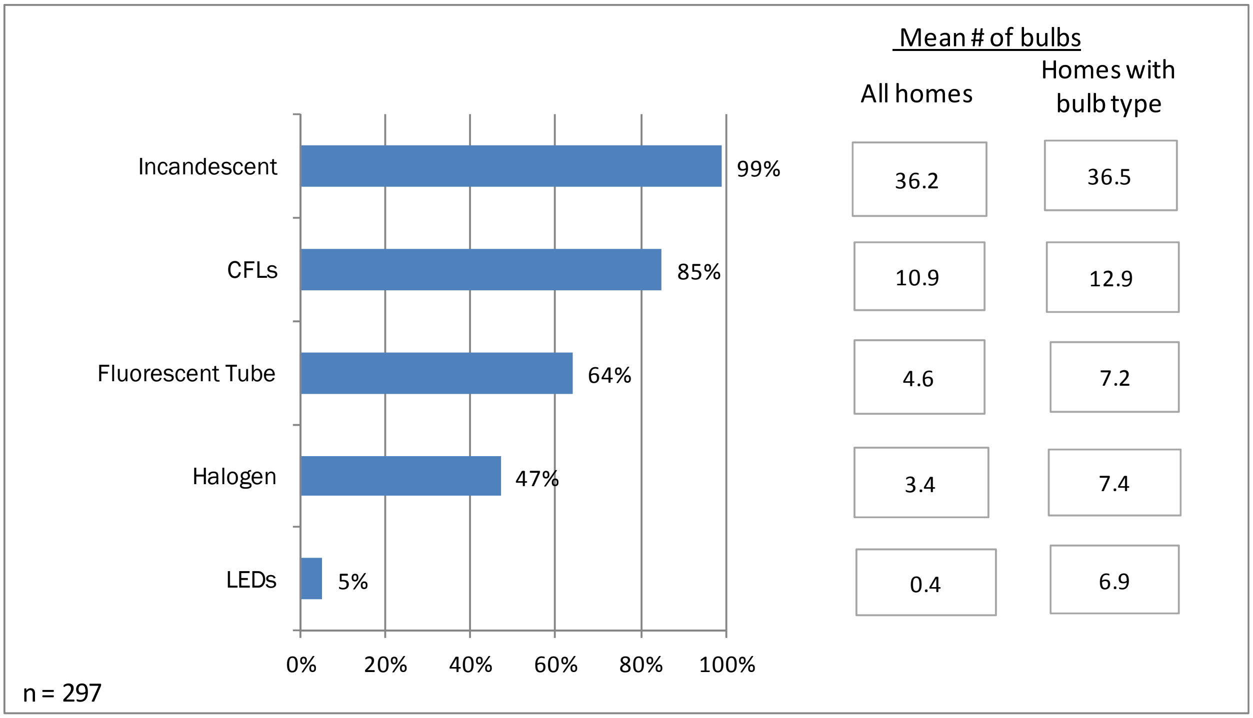
5.1 Lighting Characteristics

All of ComEd's residential customers use lighting in their homes. Incandescent lighting remains the most commonly used lighting technology. Almost all customers (99%) have at least one incandescent bulb installed in their home, and the average residential household has 36 incandescent bulbs. CFLs are the second most commonly used lighting technology,

[5] 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.

with 85% having at least one CFL installed and an average of 11 CFLs per home. LEDs are still rare, with only 5% of household having one or more LEDs in their home.

Figure 5-2. Penetration and Saturation of Lighting, by Type



Source: 2012 Residential Site Visits

Table 5-2 at the end of this chapter provides key penetration and saturation information about lighting in ComEd's service territory.

5.2 Usage and Waste Analysis: Lighting

The amount of electricity a light bulb uses is a function of the bulb's wattage and the amount of time it is turned on. We estimated electricity usage for all bulbs found in site visit homes. The site visits collected information on the quantity of bulbs as well as each bulb's technology (e.g., incandescent, CFL, fluorescent, halogen, LED), shape, wattage, socket type (pin-based, standard screw-based, specialty screw-based), control type (on/off, 3-way, dimmable, motion sensor), and room location in the home. Hours of use are based on secondary information and were assigned by room type.[6]

Technology waste for lighting is estimated for all installed incandescent and halogen bulbs and is defined as the difference between the usage of the current bulb and the usage of an equivalent CFL. We used the ENERGY STAR general assumption that a CFL uses 25% of the electricity used by an equivalent incandescent or halogen bulb.

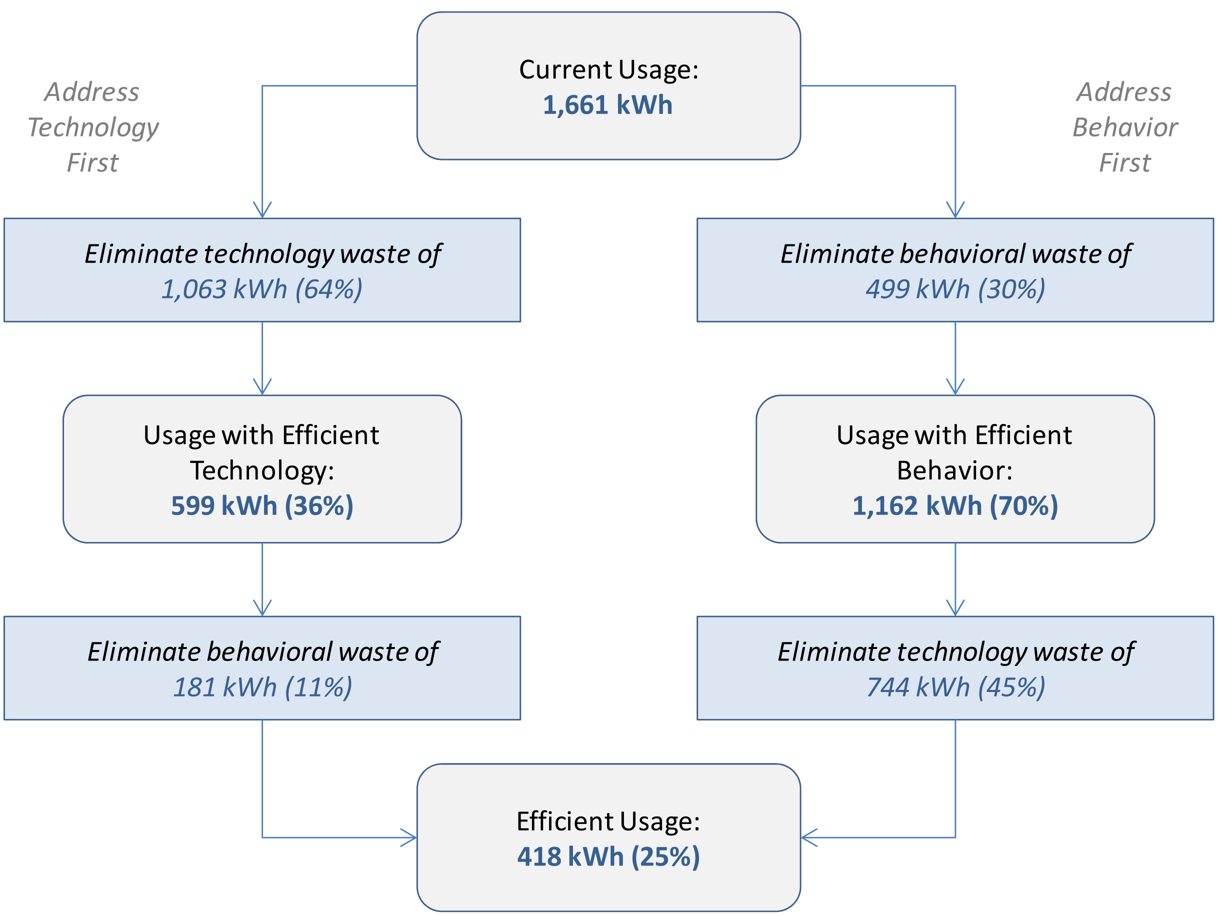
[6] While we deployed light and occupancy loggers in support of the behavioral waste analysis, this effort was not designed to determine hours of use. As a result, our analysis of current usage uses does not rely on logger data.

Behavioral waste for lighting is associated with lights left on when the room is not occupied. This is based on 96 light and occupancy loggers deployed in living rooms and kitchens of 79 homes. Our analysis used a 15-minute time-out period, meaning that the first 15 consecutive minutes of no occupancy, when the lights are still on, are not counted as waste. We estimated behavioral waste by applying the weighted average waste percentage (i.e., the percentage of lighting usage associated with unoccupied rooms) to total indoor household lighting usage. This analysis assumes that the waste percentages observed in living rooms and kitchens are representative of other types of rooms.

Lighting used by ComEd's residential customers accounts for 19% of total residential electricity usage. Each household uses an average of 1,661 kWh per year for lighting. There is substantial potential for energy savings from upgrading to more efficient technologies: If all existing incandescent and halogen lamps were replaced with CFLs, 64% of lighting electricity use could be saved. Behavioral savings potential is also substantial: We estimate that not leaving lights on when rooms are unoccupied would save an additional 11% of the current total lighting usage (30% if behavioral waste was addressed first).

Figure 5-3 shows the average annual per household energy usage and savings potential associated with lighting. The figure shows estimated usage and savings when addressing technology waste, behavioral waste, or both.

Figure 5-3. Technological and Behavioral Potential – Lighting



Source: Usage and waste analysis

The following table presents the same usage and waste information, both in aggregate and for single family and multi-family homes. The table shows 1) average per household results and 2) total usage and waste results for ComEd's residential population.

Table 5-1. Summary of Lighting Usage and Waste

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)[A]			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	1,661	2,145	763				5,528,352	4,639,783	888,570
	Efficient Usage	418	541	188				1,390,007	1,170,789	219,218
	% Efficient Usage	*25%*	*25%*	*25%*				*25%*	*25%*	*25%*
	Waste	1,244	1,604	575				4,138,345	3,468,994	669,351
	% Waste	*75%*	*75%*	*75%*				*75%*	*75%*	*75%*
Technology First	Technology	1,063	1,373	486				3,535,725	2,969,622	566,102
Technology First	*Technology %*	*64%*	*64%*	*64%*				*64%*	*64%*	*64%*
Technology First	Behavioral	181	231	89				602,620	499,371	103,249
Technology First	*Behavioral %*	*11%*	*11%*	*12%*				*10.9%*	*10.8%*	*11.6%*
Behavior First	Behavioral	499	634	249				1,661,746	1,371,798	289,948
Behavior First	*Behavioral %*	*30%*	*30%*	*33%*				*30%*	*30%*	*33%*
Behavior First	Technology	744	970	326				2,476,599	2,097,195	379,404
Behavior First	*Technology %*	*45%*	*45%*	*43%*				*45%*	*45%*	*43%*

Source: Usage and waste analysis
[A] Because the penetration of lighting is 100%, overall per household values are identical to those of households with lighting.

Table 5-2. Summary of Lighting Data[S]

	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
Mean number of light bulbs													
Total	56.7	72.7	29.0	54.4	84.1	104.0	27.7	31.0	30.0	56.6	73.1	24.3	29.7
Inside the house	53.2	67.5	28.5	50.5	78.6	95.7	27.2	30.5	29.5	53.6	67.8	24.2	29.1
Outside the house	3.5	5.2	0.5	3.9	5.5	8.3	0.5	0.5	0.5	3.0	5.3	0.1	0.5
Have incandescent lighting	99%	100%	98%	100%	100%	100%	98%	100%	91%	100%	100%	91%	99%
Mean number of incandescent light bulbs [A]													
Total	36.5	47.4	17.2	35.6	54.1	68.2	17.2	17.4	17.1	36.0	47.6	14.8	17.6
Inside the house	34.2	43.9	17.0	32.7	50.8	63.2	17.0	17.1	17.0	34.1	44.2	14.7	17.3
Outside the house	2.3	3.4	0.3	2.9	3.3	5.0	0.2	0.3	0.1	1.9	3.5	0.1	0.3
Percentage of bulbs that are incandescent	63%	65%	56%	66%	65%	65%	58%	55%	47%	55%	66%	48%	57%
Have CFLs	85%	90%	75%	90%	89%	90%	73%	79%	79%	52%	90%	71%	76%
Have non-spiral CFLs	36%	46%	18%	37%	59%	50%	14%	23%	38%	3%	47%	13%	19%
Mean number of CFLs [A]													
Total	12.9	14.8	9.1	13.4	16.2	16.5	7.9	9.8	12.0	6.6	14.9	9.4	9.0
Inside the house	11.9	13.4	8.8	12.5	14.4	14.5	7.7	9.6	11.5	5.9	13.5	9.3	8.7
Outside the house	1.0	1.4	0.2	0.9	1.8	2.0	0.2	0.2	0.5	0.7	1.4	0.1	0.3
Percentage of bulbs that are CFLs	23%	20%	27%	22%	19%	16%	25%	27%	36%	5%	20%	32%	26%
Have fluorescent tube lighting	64%	72%	49%	70%	71%	80%	50%	43%	59%	57%	72%	56%	48%
Mean number of fluorescent tube lamps [A]	7.2	9.1	2.6	5.4	11.8	13.8	2.7	2.5	2.5	14.2	9.0	2.1	2.7
Percentage of bulbs that are fluorescent tubes	7%	8%	6%	7%	8%	10%	7%	4%	6%	8%	8%	8%	4%

	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 halogen lighting	47%	50%	40%	36%	62%	70%	40%	23%	38%	71%	50%	39%	41%
Mean number of halogen lamps [A]	7.4	7.3	7.6	5.0	6.6	11.4	7.7	7.9	6.7	10.3	7.2	6.0	7.9
Percentage of bulbs that are halogen	6%	4%	8%	3%	6%	6%	8%	10%	8%	30%	4%	9%	8%
Have LEDs	5%	7%	3%	4%	12%	6%	1%	7%	0%	5%	7%	0%	3%
Mean number of LEDs [A]	6.9	8.2	1.4	10.6	7.6	5.7	1	1.6	0	26	7.9	0	1.4
Percentage of bulbs that are LEDs	<1%	1%	<1%	1%	1%	<1%	<1%	<1%	0%	1%	1%	0%	<1%
Have occupancy sensors													
Inside the house	15%	15%	2%	13%	16%	21%	2%	4%	0%	26%	15%	0%	2%
Outside the house	19%	21%	1%	16%	24%	27%	2%	0%	0%	26%	21%	0%	1%
Have dimmers (indoors)	47%	60%	25%	49%	71%	72%	19%	32%	34%	34%	61%	30%	24%
Have timers													
Inside the house	19%	20%	2%	21%	19%	20%	0%	4%	6%	14%	20%	0%	2%
Outside the house	9%	11%	1%	12%	11%	8%	0%	3%	0%	0%	11%	0%	1%

Source: 2012 Residential Site Visits
[S] All lighting data presented in this table is based on site visits.
[A] Based on households with this type of light bulb.

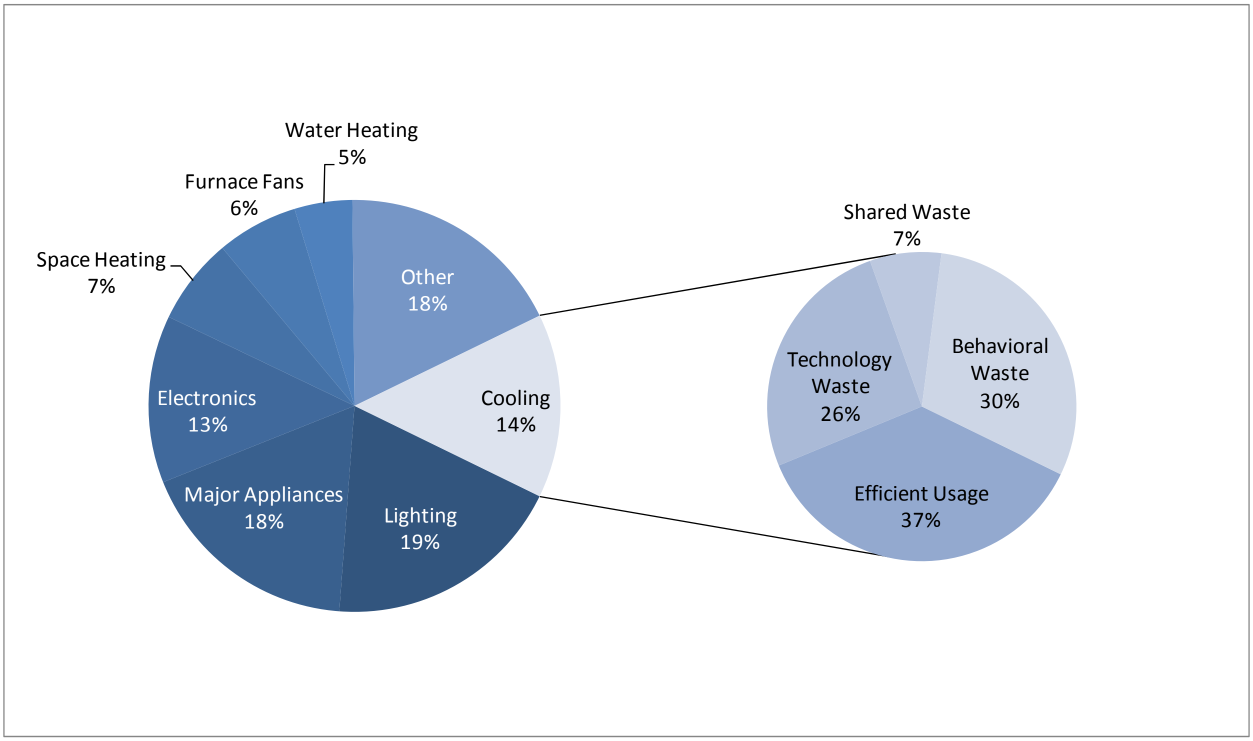
6. COOLING

Our analysis of cooling includes central air conditioning and room air conditioning. Almost every home in ComEd service territory (94%) has some type of air conditioning system to cool their home. Almost three quarters (73%) of households have central air conditioning, while 30% have room air conditioning (4% have both).

Overall, cooling accounts for approximately 14% of total residential electricity usage. Each household with cooling equipment uses an average of 1,351 kWh per year to operate cooling equipment. Central air conditioning accounts for the vast majority of this usage (93%). We estimate that technology and behavioral waste associated with cooling accounts for approximately 33% and 30%, respectively, of current usage (if technology waste is addressed first).

Figure 6-1 shows the contribution of cooling to overall residential electricity usage (pie chart on the left) and the breakout of cooling into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right).[7]

Figure 6-1. Usage and Waste Analysis – Cooling



Source: Usage and waste analysis

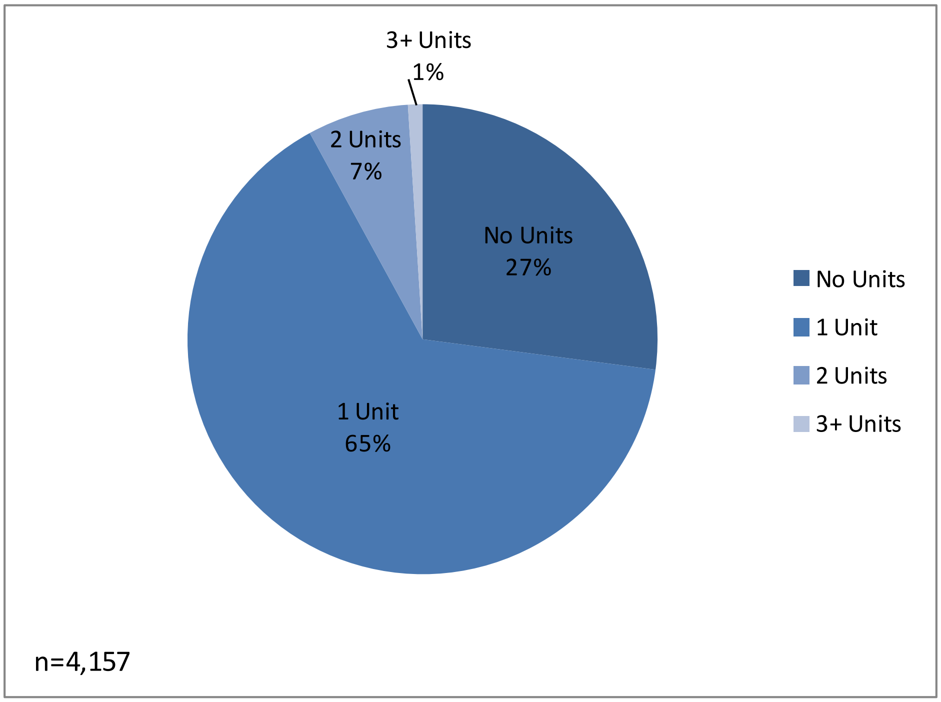
[7] Note that "Efficient Usage" represents the residual usage taking into account only the waste categories included in this analysis. If additional waste categories were identified and quantified, efficient usage might be smaller than presented here.

6.1 Central Air Conditioning

6.1.1 Central Air Conditioning Characteristics

Almost three quarters of customers in ComEd service territory (73%) have central air conditioning in their homes. However, there is a significant difference between single family and multi-family homes: less than half of multi-family homes (46%) have central air conditioning, compared to 87% of single family homes. Of those with central air conditioning, most customers (89%) have only one unit.

Figure 6-2. Central Air Conditioner Saturation



Source: 2012 ComEd Residential Mail Survey

Nearly half of units in ComEd territory (42%) are sized under 3 tons. Thirty-eight percent of units are sized at exactly 3 tons, and the remainder (20%) are larger units of over 3 tons.[8] The vast majority of units (93%) are under an efficiency level of 14 SEER, the current ENERGY STAR standard. The mean age of central air conditioning units is 10 years.

Approximately one-quarter (26%) of ComEd customers have a service contract for regular maintenance on their central air conditioning system, and less than half of customers (46%) have had their system serviced within the past year.

Less than half of ComEd customers (44%) have a programmable thermostat, although two thirds of customers (67%) with a programmable thermostat reported having it programmed to adjust temperature automatically depending on the time of day.

[8] Note that central air conditioner tonnage could not be determined for 28% of units observed during site visits.

Table 6-3 at the end of this chapter provides key penetration and saturation information about central air conditioning units in ComEd's service territory.

6.1.2 Usage and Waste Analysis: Central Air Conditioning

The usage and waste analysis for central air conditioning is based on mail survey, site visit, and secondary data. The analysis includes 251 central air conditioning units observed at the 297 site visit homes.

The amount of electricity a central air conditioning unit uses is a function of the system's efficiency level, system capacity, and the number of hours of use. We collected system capacity and efficiency levels through the site visits and subsequent model number lookups. Where we were unable to collect this information, we estimated characteristics based on unit age, unit type, ENERGY STAR status of the unit, and home type. Hours of use are based on self-reported temperature setpoints that we adjusted with on-site temperature measurements.

We calculated three categories of technology waste for central air conditioning units: unit efficiency, duct sealing and insulation, and building shell. The algorithms account for interactive effects among these categories.

Behavioral waste for central air conditioning units is calculated for two categories of waste: lack of system maintenance and thermostat setpoints being lower than the setpoints recommended by ComEd and ENERGY STAR. Setpoint waste is calculated by developing a ratio of efficient EFLH (equivalent full load hours) to current household EFLH, given self-reported occupancy patterns.

Overall, central air conditioning used by ComEd's residential customers accounts for approximately 14% of total residential electricity usage. Each household with a central air conditioning system uses an average of 1,620 kWh per year to operate the system.

There is significant potential for energy savings in central air conditioning. If technology waste was addressed first, more than one third of current usage (35%) could be saved by upgrading central air conditioning systems, duct systems, and home insulation.[9] If technology waste was addressed individually, unit efficiency, duct sealing and insulation, and building shell improvements would account for 20%, 8%, and 12% respectively of current usage (however, note that due to interactive effects, these percentages are not additive).

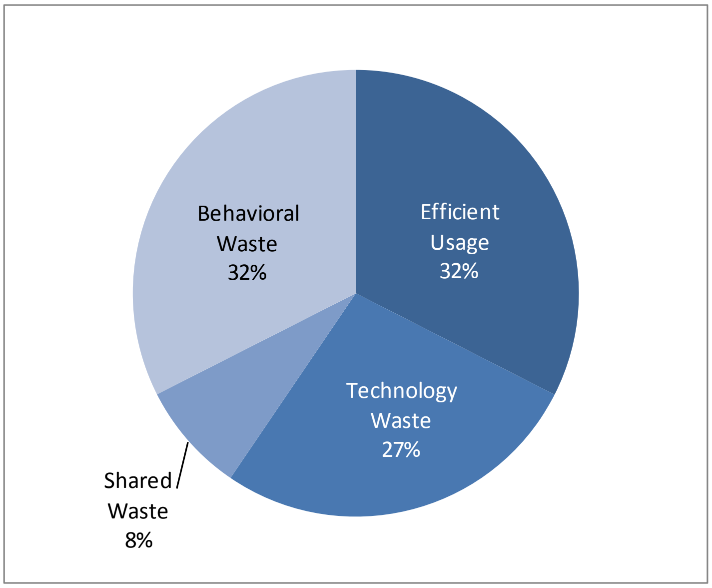
Behaviorally, 41% of current cooling usage could be saved if ComEd's customers raised their cooling setpoints to ComEd/ENERGY STAR recommended levels of 78°F when the home is occupied during waking hours, 82°F when the home is occupied during sleep hours, and 85°F when the home is unoccupied. Potential savings from raising setpoints would be 32% if technology upgrades took place first. If both sources of waste could be completely

[9] Note that the analysis of insulation improvements is limited to adding insulation to uninsulated surfaces. The analysis did not include adding insulation to surfaces that already have some amount of insulation. Therefore, the reduction in usage from insulation improvements is a conservative estimate.

addressed, an average efficient household would use only 526 kWh per year to operate their central air conditioning system, approximately one third (32%) of current usage.

Figure 6-3 summarizes the breakout of central air conditioning usage into efficient usage, technology waste, behavioral waste, and "shared waste."

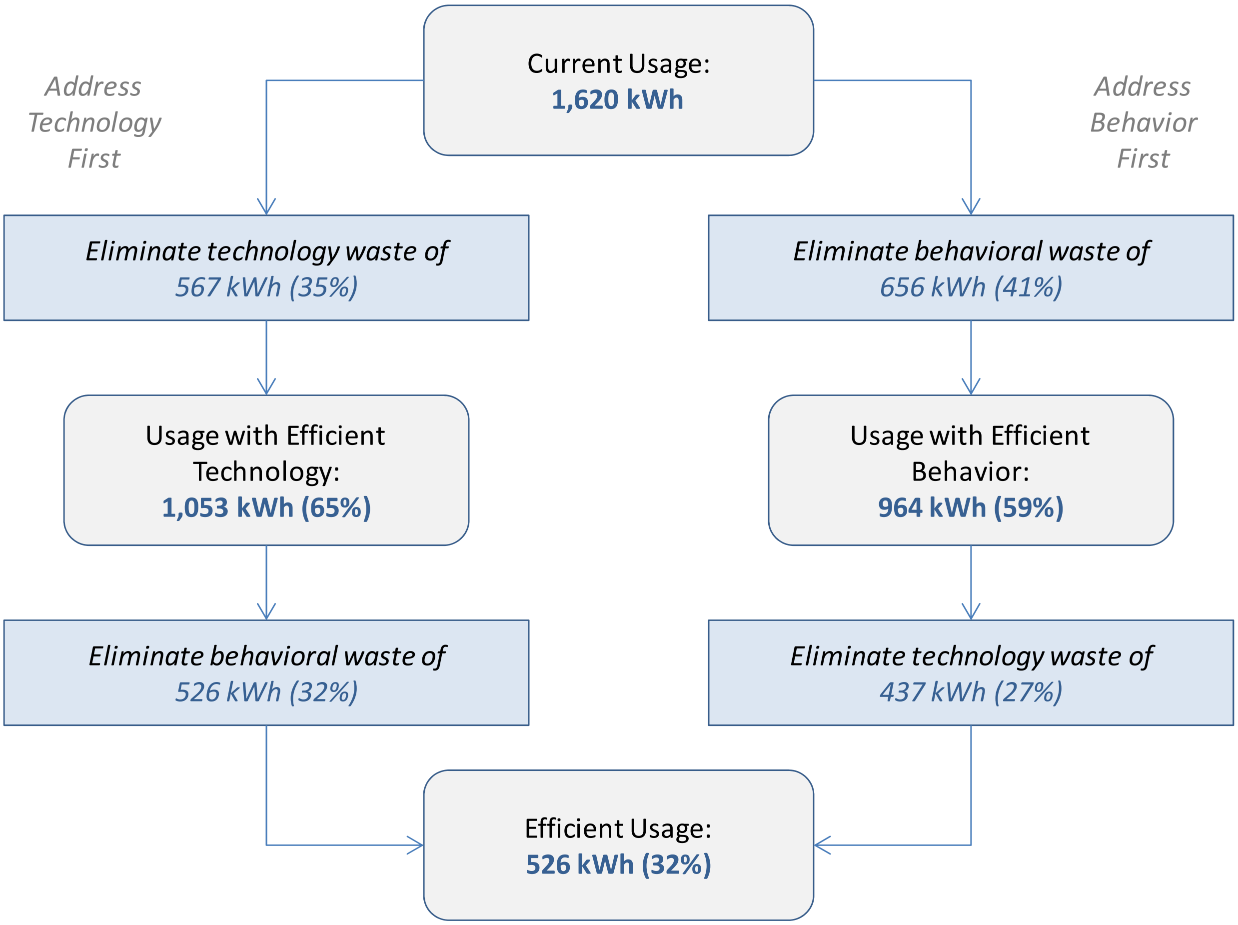
Figure 6-3. Usage and Waste Analysis – Central Air Conditioning



Source: Usage and waste analysis

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

Figure 6-4: Technological and Behavioral Potential – Central Air Conditioning

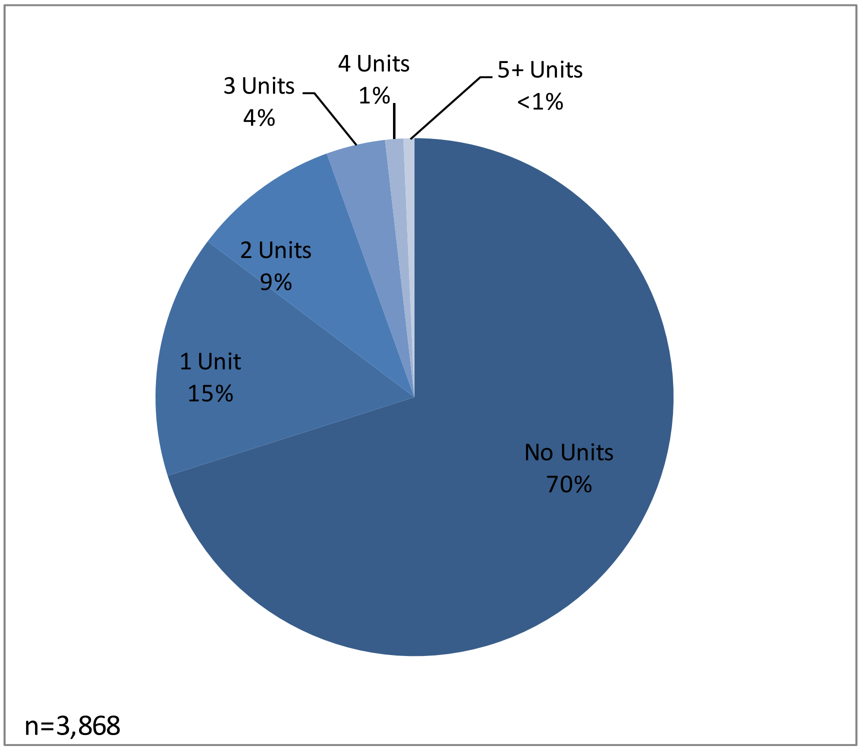


Source: Usage and waste analysis

6.2 Room Air Conditioning

6.2.1 Room Air Conditioning Characteristics

Figure 6-5. Room Air Conditioner Saturation



Source: 2012 ComEd Residential Mail Survey

Three out of ten customers in ComEd's service territory (30%) use window or wall air conditioning units. As with central air conditioning, there is a significant difference between single family and multi-family homes: only 18% of single family homes use window or wall unit air conditioning, compared to over half (52%) of multi-family homes.

Thirty-eight percent of room air conditioners are small units, 6,000 BTU/h or under (0.5 tons or less), while 62% are over 6,000 BTU/h.[10] Approximately one third of units (35%) are ENERGY STAR rated.

The majority of room air conditioners (55%) are units less than 5 years of age – 26% are between 5 and 9 years of age, and 19% are 10 or more years of age.

Table 6-4 at the end of this chapter provides key penetration and saturation information about room air conditioning units in ComEd's service territory.

[10] BTU/h could not be determined for approximately 50% of room air conditioners observed during site visits.

6.2.2 Usage and Waste Analysis: Room Air Conditioning

The usage and waste analysis for room air conditioners is based on a combination of site visit, mail survey, and secondary data. The analysis includes 125 units observed at 297 site visit homes.

Current energy usage of room air conditioners is a function of the unit's capacity, efficiency level, and the number of hours of use. We estimated efficiency level based on site visit observations of the unit's age, ENERGY STAR status, and capacity. Hours of use are based on default values from the TRM.

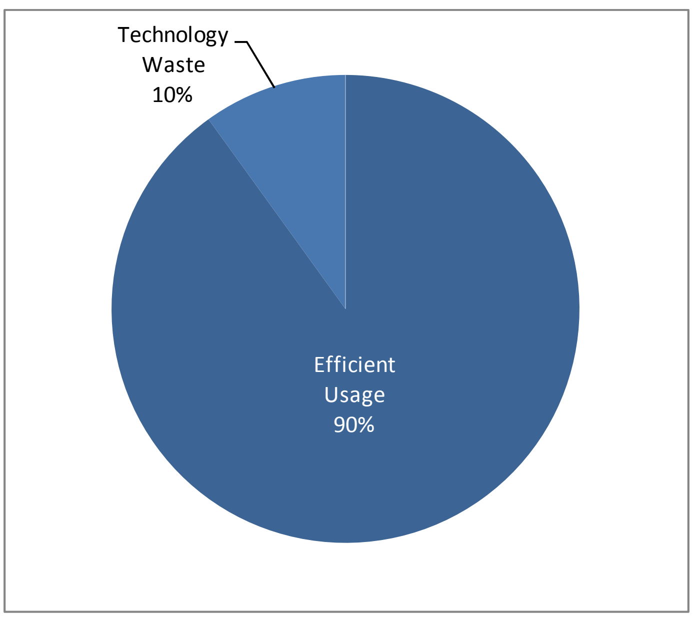
Technology waste for room air conditioners is defined as the difference between the estimated usage of the current unit and the usage of an equivalent efficient unit. Efficient units are new ENERGY STAR units of the same capacity as the current unit.

No behavioral waste was calculated for room air conditioners.

Room air conditioner use by ComEd's residential customers accounts for approximately 1% of total residential electricity usage. Each household with a room air conditioner uses an average of 299 kWh per year running their room air conditioner. Upgrading inefficient existing room air conditioning units to ENERGY STAR models would save approximately 10% of current usage.

Figure 6-6 summarizes the breakout of room air conditioner usage into efficient usage and technology waste.

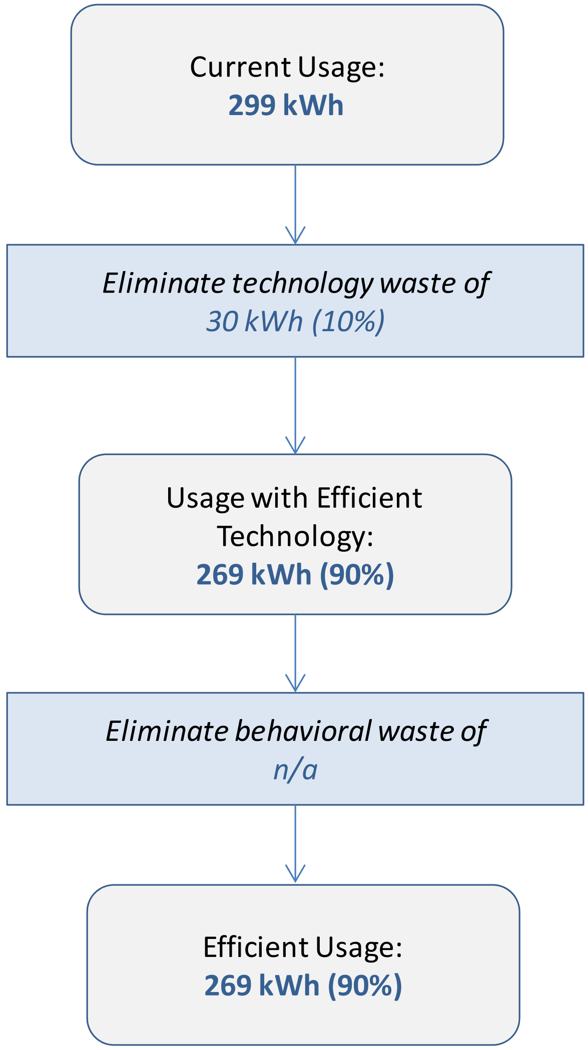
Figure 6-6. Usage and Waste Analysis – Room Air Conditioners



Source: Usage and waste analysis

Figure 6-7 shows the average annual energy usage and savings potential for households that have room air conditioners. The figure shows estimated cooling usage and savings when addressing technology waste.

Figure 6-7. Technological and Behavioral Potential – Room Air Conditioners



Source: Usage and waste analysis

The following two tables present the same usage and waste information for central air conditioning and room air conditioning, respectively. The tables show 1) average per household results for households with each type of air conditioning, 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.

Table 6-1. Summary of Central Air Conditioning 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:	73%	87%	46%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	1,620	1,720	1,270	1,178	1,496	586	3,919,004	3,235,969	683,035
	Efficient Usage	526	625	301	383	544	139	1,273,598	1,175,662	162,091
	% Efficient Usage	*32%*	*36%*	*24%*	*32%*	*36%*	*24%*	*32%*	*36%*	*24%*
	Waste	1,094	1,095	969	795	953	447	2,645,406	2,060,307	520,944
	% Waste	*68%*	*64%*	*76%*	*68%*	*64%*	*76%*	*68%*	*64%*	*76%*
Technology First	Technology	567	584	446	413	508	206	1,372,851	1,098,296	239,695
	Technology %	*35%*	*34%*	*35%*	*35%*	*34%*	*35%*	*35%*	*34%*	*35%*
	Behavioral	526	511	523	382	445	241	1,272,556	962,010	281,250
	Behavioral %	*32%*	*30%*	*41%*	*32%*	*30%*	*41%*	*32%*	*30%*	*41%*
Behavior First	Behavioral	656	659	645	477	574	298	1,587,247	1,240,429	346,817
	Behavioral %	*41%*	*38%*	*51%*	*41%*	*38%*	*51%*	*41%*	*38%*	*51%*
	Technology	437	436	324	318	379	150	1,058,160	819,877	174,127
	Technology %	*27%*	*25%*	*25%*	*27%*	*25%*	*25%*	*27%*	*25%*	*25%*

Source: Usage and waste analysis

Table 6-2. Summary of Room Air Conditioning 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:	30%	18%	52%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	299	279	311	89	50	162	296,480	107,395	189,085
	Efficient Usage	269	267	294	80	48	153	267,195	102,846	178,339
	% Efficient Usage	*90%*	*96%*	*94%*	*90%*	*96%*	*94%*	*90%*	*96%*	*94%*
	Waste	30	12	18	9	2	9	29,284	4,549	10,746
	% Waste	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*
Technology First	Technology	30	12	18	9	2	9	29,284	4,549	10,746
	Technology %	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*
	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	-	-	-	-	-	-	-	-	-
Behavior First	Behavioral	-	-	-	-	-	-	-	-	-
	Behavioral %	-	-	-	-	-	-	-	-	-
	Technology	30	12	18	9	2	9	29,284	4,549	10,746
	Technology %	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*	*10%*	*4%*	*6%*

Source: Usage and waste analysis

Table 6-3. Summary of Central Air Conditioning 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 central air cooling [A]	73%	87%	46%	83%	92%	91%	35%	61%	62%	58%	88%	56%	45%
Mean number of CAC units	1.1	1.1	1.1	1.0	1.1	1.3	1.1	1.1	1.2	1.1	1.1	1.1	1.1
Mean age of primary unit	10.1	10.3	9.2	10.4	10.2	9.9	9.4	8.5	9.9	*	10.3	11.7	8.8
Size of primary unit [S]													
<3 tons	42%	36%	*	50%	32%	19%	*	*	*	*	37%	*	*
3 tons	38%	41%	*	36%	47%	41%	*	*	*	*	41%	*	*
>3 tons	20%	23%	*	14%	21%	40%	*	*	*	*	22%	*	*
Unit is <SEER 14 [S]	93%	93%	*	95%	93%	88%	*	*	*	*	93%	*	*
Unit has ECM fan [S]	6%	8%	0%	3%	15%	8%	*	*	*	*	8%	*	0%
Cool entire house	85%	83%	93%	82%	84%	84%	91%	95%	90%	86%	83%	88%	93%
Have progr. thermostat	44%	47%	35%	43%	49%	55%	28%	47%	34%	27%	47%	29%	36%
Thermostat is programmed [B]	67%	69%	61%	66%	73%	69%	59%	66%	54%	*	69%	48%	63%
Set thermostats at <78°F during summer													
6am – 9am	80%	80%	82%	75%	83%	87%	78%	85%	86%	*	80%	81%	82%
9am – 12pm	77%	77%	76%	73%	82%	83%	70%	80%	82%	*	77%	75%	76%
12 pm – 4pm	79%	79%	79%	74%	83%	83%	72%	84%	84%	*	79%	76%	79%
4pm – 7pm	84%	84%	86%	80%	87%	88%	79%	91%	91%	*	84%	87%	86%
7pm – 10pm	86%	85%	88%	82%	88%	89%	82%	92%	93%	*	85%	88%	88%
10pm – 6am	82%	82%	84%	79%	84%	86%	80%	87%	86%	*	82%	81%	84%
Have service contract	26%	25%	28%	23%	26%	28%	30%	27%	29%	20%	25%	33%	28%
Serviced CAC within last year	46%	46%	48%	41%	47%	53%	49%	44%	54%	*	45%	47%	48%

Source: 2012 ComEd Residential Mail Survey; 2012 Residential Site Visits
[A] All subsequent questions were only asked of households with central air cooling.
[B] Asked of households with a programmable thermostat.
[S] Data based on site visits.
* Insufficient number of responses

Table 6-4. Summary of Window Air Conditioning 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
Use window units [A]	30%	18%	52%	20%	15%	16%	59%	43%	44%	51%	17%	53%	52%
Mean number of window units used in summer	1.8	1.8	1.8	1.7	1.8	2.0	1.7	1.8	1.9	*	1.8	1.6	1.8
Unit is ENERGY STAR [B]	35%	37%	33%	33%	47%	41%	32%	44%	22%	*	38%	16%	36%
Age of window unit [B]													
<5 years	55%	57%	53%	57%	53%	60%	53%	57%	46%	46%	58%	43%	55%
5-9 years	26%	30%	24%	29%	31%	30%	24%	26%	23%	35%	29%	27%	24%
10+ years	19%	14%	22%	14%	16%	10%	23%	17%	31%	18%	13%	31%	21%
How often is the unit turned on in the summer months? [B]													
Not used at all	1%	1%	1%	2%	<1%	1%	1%	1%	1%	0%	1%	1%	1%
Turned on a few times each summer	35%	40%	31%	46%	35%	28%	34%	24%	26%	62%	39%	37%	30%
Turned on quite a bit	44%	43%	45%	38%	50%	48%	43%	45%	54%	33%	44%	42%	46%
Turned on just about all summer	20%	16%	23%	14%	14%	22%	22%	30%	19%	5%	17%	21%	24%

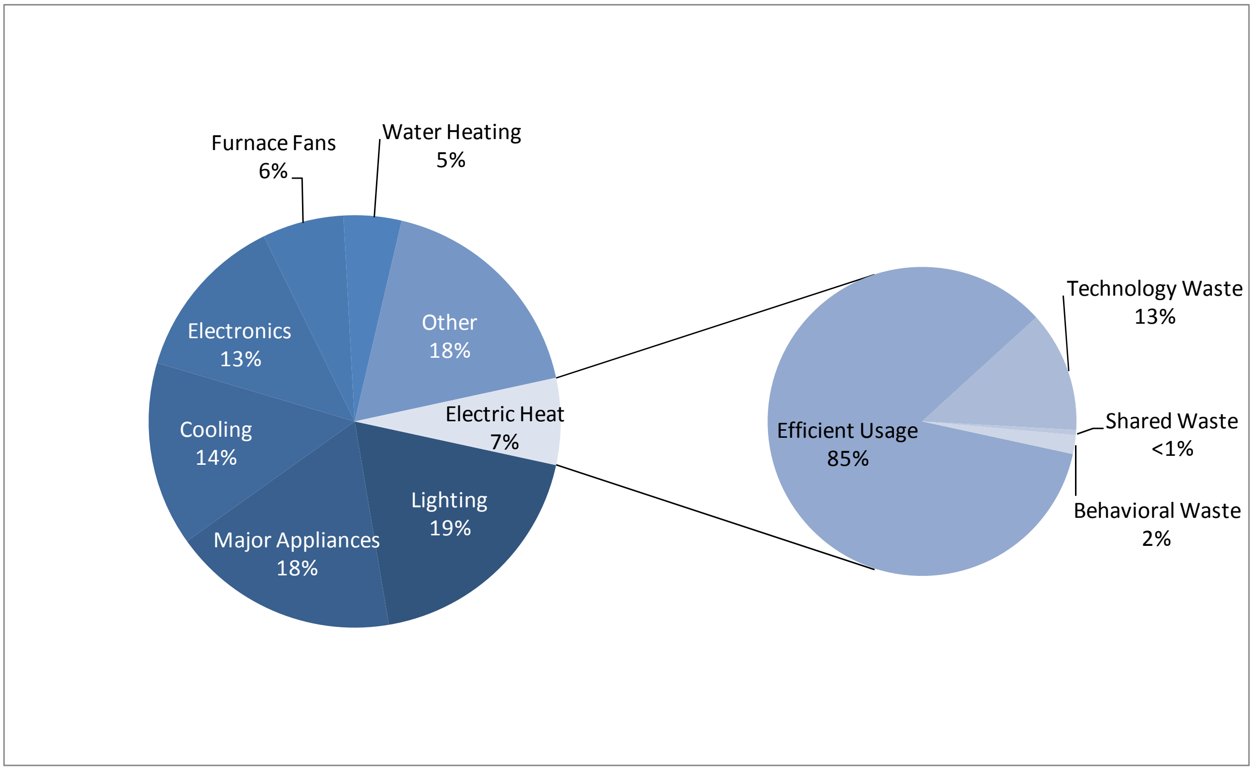
Source: 2012 ComEd Residential Mail Survey
[A] All subsequent questions were only asked of households with window air cooling.
[B] Based on all window units used in home.
* Insufficient number of responses.

7. Electric Space Heating

Electric space heating is used by approximately 33% of households in ComEd's service territory. Overall, electric heating accounts for approximately 7% of total residential electricity usage. Each household with electric space heating uses an average of 1,829 kWh per year to heat their home. We estimate that technology and behavioral waste associated with electric heating accounts for approximately 13% and 2%, respectively, of current usage (if technology waste is addressed first).

Figure 7-1 shows the contribution of electric space heating to overall residential electricity usage (pie chart on the left) and the breakout of heating usage into efficient usage, technology waste, behavioral waste, and "shared waste" (pie chart on the right).[11]

Figure 7-1. Usage and Waste Analysis – Electric Space Heating



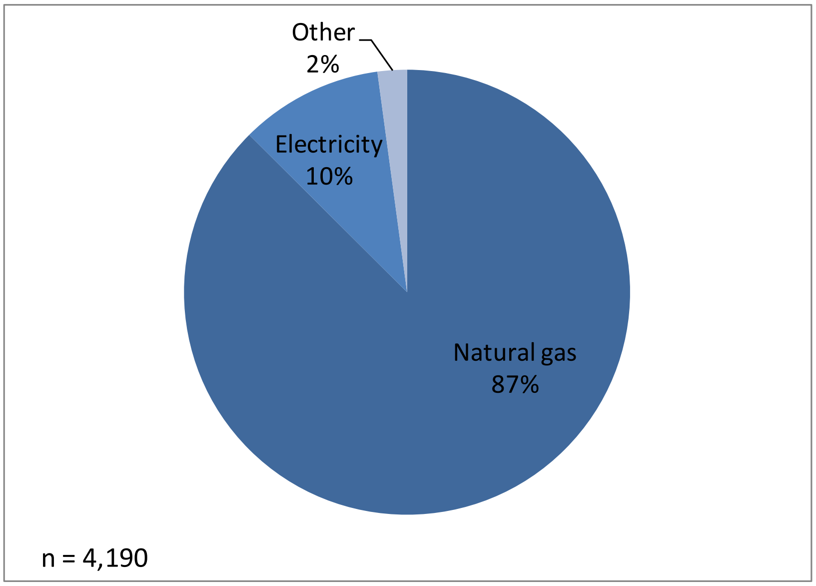
Source: Usage and waste analysis

[11] 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.

7.1 Electric Heating Characteristics

The vast majority of ComEd households use natural gas as their primary heating fuel. Ten percent use electricity and 2% use another heating fuel, such as propane or oil. In addition, 22% of customers use electricity as a secondary heating fuel.

Figure 7-2. Primary Electric Heat Penetration



Source: 2012 ComEd Residential Mail Survey

Electric baseboards are the most common type of primary electric heating system (55%); fewer households use electric furnaces (28%) or heat pumps (17%). Most customers who use electric heat (either as a primary or secondary fuel source) also have one or more portable space heaters (72%).

Table 7-3 at the end of this chapter provides key penetration and saturation information about electric heat in ComEd's service territory.

7.2 Usage and Waste Analysis: Electric Heating

The usage and waste analysis for electric heating is based on site visit, mail survey, and billing data. The analysis includes 40 primary and 58 secondary electric heating systems observed at the 297 site visit homes.

The current usage analysis for electric heating is based on billing data. We estimate current usage as the incremental usage of each home during the primary heating months (November through March) relative to the usage during the shoulder months (May and October). We excluded the summer months from this analysis of incremental winter usage as cooling energy usage would make an assessment of heating load impossible.

We considered households to use electricity as their *primary* heating source if 1) the site visit determined that there was no other primary heating source (such as a natural gas boiler or furnace) and 2) the mail survey indicated that electric heat was the primary fuel source (or the response was missing). We considered households to use electricity as their *secondary* heating source if the mail survey indicated that they used electricity to heat any spaces in their home, but the household was not flagged as using electricity as their primary heating fuel.

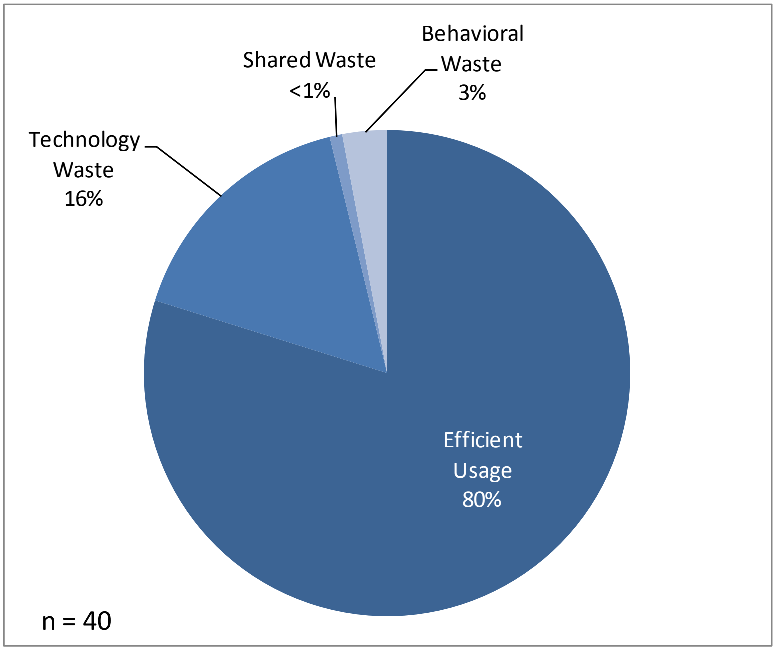
Technology waste for primary electric heating is calculated for three categories of waste: heat pump efficiency, duct sealing and insulation, and building shell.[12] The algorithms account for the interactive effects among these categories. For secondary electric heating, we only considered technology waste associated with building shell.

Behavioral waste is estimated for primary electric heat and is associated with thermostat setpoints higher than the setpoints recommended by ENERGY STAR and ComEd. It is calculated by developing a ratio of efficient EFLH (equivalent full load hours) to current household EFLH, given self-reported occupancy patterns.

Overall, electric heat used by ComEd's residential customers accounts for approximately 7% of total residential electricity usage. This share is much larger among households that use electricity as a primary (36%) or secondary (10%) heating fuel. Each household with primary electric heat uses an average of 3,815 kWh per year for home heating; each household with secondary electric heat uses an average of 897 kWh per year. There is some potential for energy savings from upgrading to more efficient technologies: If all possible technological sources of primary electric heat waste were addressed, 17% of current electric heat usage could be saved. Behaviorally, 3% of current primary electric heat usage could be saved if ComEd's customers lowered their heating setpoints (4% if technology upgrades took place first).

[12] Note that the analysis of insulation improvements is limited to adding insulation to uninsulated surfaces. The analysis did not include adding insulation to surfaces that already have some amount of insulation. Therefore, the reduction in usage from insulation improvements is a conservative estimate.

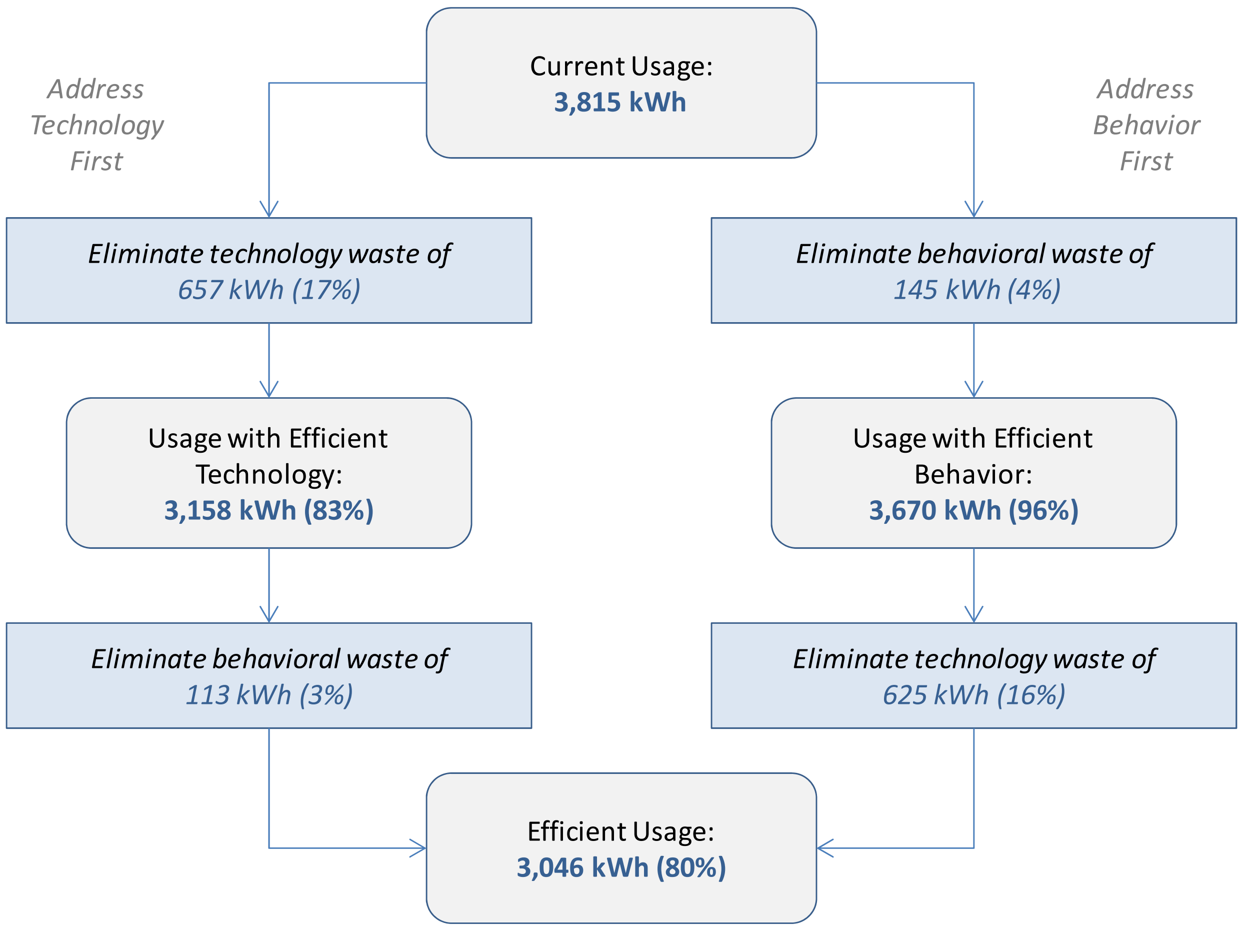
Figure 7-3. Usage and Waste Analysis – Primary Electric Heating



Source: Usage and waste analysis

Figure 7-4 shows the average annual energy usage and savings potential for households that have primary electric heating. The figure shows estimated electric heating usage and savings when addressing technology waste, behavioral waste, or both.

Figure 7-4. Technological and Behavioral Potential – Primary Electric Heating



Source: Usage and waste analysis

The two tables at the end of this chapter present the same usage and waste information for primary electric heat and secondary electric heat, respectively. The tables show 1) average per household results for households with electric heat, 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 separately for single family and multi-family homes (where sample sizes allow).

7.3 Furnace Fans

In addition to electric space heating, we also quantified current electricity usage for fans associated with non-electric central forced air heating systems. While these non-electric heating systems do not use electricity to generate heat, they do use electricity to distribute the heat throughout the home.

Current usage associated with furnace fans is based on site visit information for 204 homes with non-electric central forced air systems. It is a function of fan effective wattage (based on assumptions from secondary sources) and equivalent full load run hours (calculated from setpoints reported in the mail survey).

Overall, we estimate that 70% of households in ComEd's service territory have fans associated with non-electric furnaces. These account for 6% of current usage among all ComEd households and for approximately 8% of usage among households with a furnace fan.

Table 7-1. Summary of Electric Heat Usage and Waste – Primary

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF[A]	MF	Total	SF[A]	MF	Total	SF[A]	MF
	Penetration:	10%	2%	25%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	3,815		3,451	397		877	1,320,482		1,021,640
	Efficient Usage	3,046		2,762	317		702	1,054,176		817,836
	% Efficient Usage	*80%*		*80%*	*80%*		*80%*	*80%*		*80%*
	Waste	769		688	80		175	266,306		203,804
	% Waste	*20%*		*20%*	*20%*		*20%*	*20%*		*20%*
Technology First	Technology	657		616	68		157	227,258		182,436
	Technology %	*17%*		*18%*	*17%*		*18%*	*17%*		*18%*
	Behavioral	113		72	12		18	39,048		21,369
	Behavioral %	*3%*		*2%*	*3%*		*2%*	*3%*		*2%*
Behavior First	Behavioral	145		98	15		25	50,109		29,091
	Behavioral %	*4%*		*3%*	*4%*		*3%*	*4%*		*3%*
	Technology	625		590	65		150	216,197		174,713
	Technology %	*16%*		*17%*	*16%*		*17%*	*16%*		*17%*

Source: Usage and waste analysis
[A] The incidence of primary electric space heating was too small to estimate usage and waste for single family homes.

Table 7-2. Summary of Electric Heat Usage and Waste – Secondary

		Per HH (with Equipment; kWh)			Per HH (Overall; kWh)			Total ComEd Population (MWh)		
		Total	SF	MF[A]	Total	SF	MF[A]	Total	SF	MF[A]
	Penetration:	22%	27%	14%	*No. of Occupied Homes in ComEd Service Territory (thousands):*			3,327	2,163	1,165
	Current Usage	897	1,024	444	199	273	62	661,251	589,567	71,684
	Efficient Usage	866	1,003	377	192	267	52	638,435	577,491	60,944
	% Efficient Usage	*97%*	*98%*	*85%*	*97%*	*98%*	*85%*	*97%*	*98%*	*85%*
	Waste	31	21	67	7	6	9	22,816	12,076	10,740
	% Waste	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*
Technology First	Technology	31	21	67	7	6	9	22,816	12,076	10,740
	Technology %	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*
	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	31	21	67	7	6	9	22,816	12,076	10,740
	Technology %	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*	*3%*	*2%*	*15%*

Source: Usage and waste analysis
[A] The incidence of secondary electric space heating was too small to estimate usage and waste for multi-family homes.

Table 7-3. Summary of Electric 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 space heating fuel													
Natural gas	87%	94%	74%	96%	96%	85%	83%	73%	33%	14%	96%	4%	85%
Electric	10%	4%	24%	2%	2%	10%	14%	25%	67%	81%	2%	95%	13%
Other	2%	2%	2%	1%	2%	5%	3%	2%	<1%	5%	2%	1%	2%
Primary Heating System Type [A,S]													
Baseboard heating	55%	*	*	*	*	*	*	*	*	*	*	*	*
Electric furnace	28%												
Heat pump	17%	*	*	*	*	*	*	*	*	*	*	*	*
Home uses electric heat (primary or non-primary)	33%	28%	42%	23%	29%	38%	33%	43%	76%	88%	27%	96%	33%
Home uses portable space heater [B]	72%	83%	57%	85%	85%	77%	66%	60%	37%	50%	85%	29%	71%
Mean number of portable space heaters [C]	1.5	1.5	1.5	1.4	1.6	1.8	1.5	1.5	1.9	1.6	1.5	1.9	1.5
Set thermostats >69°F during winter [B]													
6am – 9am	41%	37%	47%	31%	44%	40%	46%	49%	44%	31%	38%	46%	47%
9am – 12pm	38%	35%	43%	33%	34%	40%	43%	45%	39%	31%	35%	40%	44%
12 pm – 4pm	38%	35%	43%	33%	36%	39%	43%	45%	40%	33%	36%	40%	44%
4pm – 7pm	50%	48%	53%	45%	51%	49%	52%	55%	53%	38%	48%	48%	55%
7pm – 10pm	51%	46%	59%	41%	49%	50%	60%	59%	56%	39%	46%	55%	61%
10pm – 6am	32%	25%	43%	22%	28%	27%	44%	46%	39%	22%	25%	44%	43%

Source: 2012 ComEd Residential Mail Survey; 2012 Residential Site Visits
[A] Asked of households that use electricity as their primary space heating fuel.
[B] Asked of households that use electric heat.
[C] Asked of households that use portable space heaters.
[S] Data based on site visits.
* Insufficient number of responses.