Summary of Key Penetration and Saturation Results

End Use/Equipment Type	Penetration			Saturation (Mean # Equipment Type)		
	Total	Com	Ind	Total	Comm	Ind
Incandescent Exit Signs	30%	29%	47%	--	--	--
CFL Exit Signs	23%	23%	16%	--	--	--
LED Exit Signs	41%	41%	35%	--	--	--
Cooling Equipment						
Packaged and Split Systems	81%	81%	86%	3.4	3.4	3.2
Room A/C Units	26%	27%	22%	5.0	5.2	*
Chillers	4%	3%	6%	0.1	0.1	*
Ventilation						
Ventilation (All Types)	82%	81%	93%	--	--	--
Ventilation Hoods	36%	35%	47%	1.3	1.2	1.7
Fans	50%	51%	49%	4.7	4.5	6.5
Dust Collection System	17%	0%	37%	--	--	--
Demand Controlled Ventilation	1%	1%	2%	--	--	--
Motors						
Overall Motors	32%	25%	78%	4.3	3.1	18.3
AC Induction Motors	26%	20%	69%	3.9	3.1	14.4
DC Brushed Motors	3%	1%	20%	0.3	*	2.3
DC Brushless Motors	0%	0%	0%	0.0	*	*
Stepper Motors	1%	0%	10%	0.0	*	*
Refrigeration						
Standing Refrigerator or Freezer	18%	19%	7%	1.3	1.4	*
Refrigerated Display Cases	6%	6%	0%	12.2[e]	12.9[e]	*
Walk-in Coolers	11%	12%	5%	348.9[f]	317.0[f]	*
Walk-in Freezers	6%	7%	4%	283.0[f]	242.6[f]	*
Refrigerated Vending Machines	4%	4%	3%	0.5	0.5	0.1
Ice Machines	4%	4%	0%	0.5	0.5	*
Office Equipment						
Computers (All Types)	92%	92%	95%	10.1	10.2	7.1
Desktops	89%	89%	92%	7.8	7.9	6.2
Laptops	54%	55%	43%	2.3	2.4	0.9
Imaging Equipment[g]	92%	92%	94%	4.2	4.1	4.8
Televisions	31%	32%	21%	3.3	3.4	1.2
Retail Registers/POS Terminals	11%	12%	4%	0.7	0.7	0.0
Servers	29%	30%	21%	--	--	--

*Denotes fewer than 30 observations

[a] Lighting refers to indoor overhead hardwired lighting unless specified

[b] T8 linear fluorescent lights include T8 Plus lights
[c] T5 linear fluorescent lights include T5 High Output (T5HO) lights
[d] HID Lighting includes metal halide, high pressure sodium, and mercury vapor bulbs
[e] Linear feet
[f] Square feet
[g] Imaging equipment includes printers, copy machines, scanners, and multi-function devices

3. SUMMARY OF ELECTRICITY USAGE AND WASTE

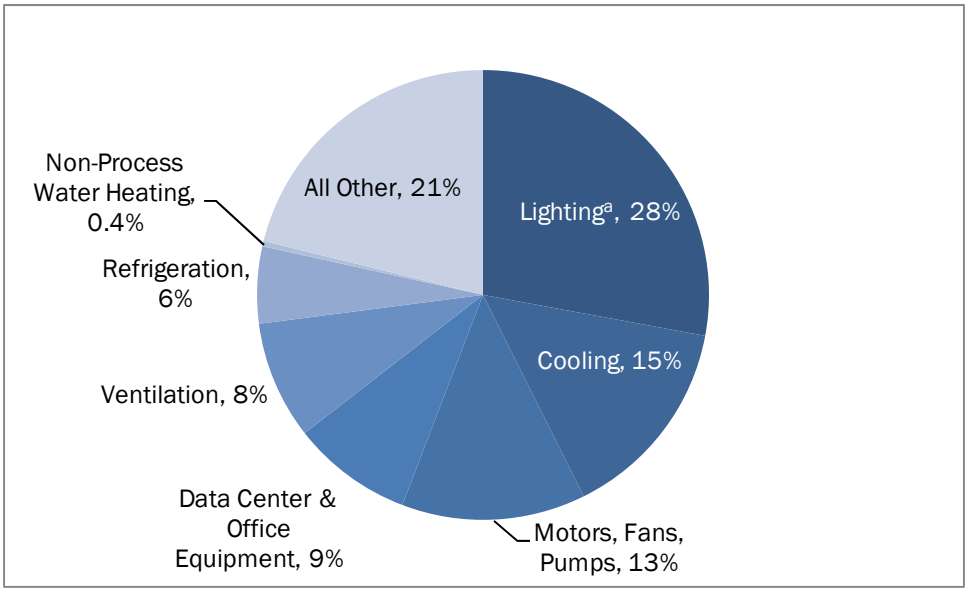
Our usage and waste analysis includes the end uses that account for the majority of electricity usage among the ComEd customers within commercial and industrial segments targeted by this study. (See Section 4 for details on the segments included.) For each end use, we assessed current electricity usage as well as key categories of technology and behavioral waste. Throughout this study, energy "waste" refers to the amount of electricity that is currently being used, but does not need to be used given (a) reasonable expectations for equipment upgrades that all customers could make today, (b) reasonable behavioral or operational changes that customers could make today, and still meet their operating needs. More specific definitions of technological and behavioral waste are provided in Section 4.2.1. In this analysis, we did not attempt to quantify every possible source of electricity waste; rather, we focused on those categories that have the potential to provide significant savings from addressing waste.

Sections 6 through 12 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.

Figure 3-1 summarizes the total electricity usage by C&I customers in the ComEd service territory by end use. Overall, the analyzed end uses account for 78% of the C&I electricity usage for the segments in scope. The top end uses are interior lighting (28%), cooling (15%), motors/fans/pumps (13%)[1], office equipment (9%), ventilation (8%), and refrigeration (6%).

[1] Usage and waste for motors, fans and pumps is calculated for both Commercial and Industrial customers. This category excludes motors used in HVAC for fans, blowers, and compressors.

Figure 3-1. Summary of Commercial and Industrial Energy Usage by End Use



a=Interior lighting only
Source: Usage and waste analysis

These usage numbers align fairly closely with 2003 EIA estimates of U.S. Commercial and Manufacturing Sectors Electricity Consumption by End Use, which estimates that across the country, 36% of usage is for lighting (interior and exterior), 12% for cooling, 10% for refrigeration, 10% for ventilation, 8% for industrial motors, 5% for office equipment and 18% for all other.

Table 3-1 summarizes the total electricity usage by commercial and industrial customers in the ComEd service territory for the individual end uses under study. The table shows the shares of end use electricity usage for each commercial segment and industrial rate class group. Lighting, cooling, and motors account for the three largest shares of usage for both the commercial and industrial sectors, but with lighting representing the largest commercial end use and motors composing the largest end use among industrial customers. Other end uses make up smaller shares of the total electricity usage with the exception of a few industry-specific equipment types, such as office equipment in the office segment and refrigeration in the food services and grocery and convenience store segments.

Table 3-1. Summary of Electricity Usage of Individual End Use by Commercial Segment and Industrial Rate Class Group

	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
No. of Identifiable ComEd Customers	300,230	168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230	15,675	12,377	2,282	1,016
Usage Summary															
Lighting[a]	28%	31%	30%	32%	49%	17%	37%	25%	33%	27%	29%	17%	28%	18%	13%
Cooling	15%	15%	15%	22%	17%	7%	5%	7%	21%	23%	15%	11%	12%	17%	8%
Ventilation	8%	9%	8%	19%	8%	12%	9%	4%	16%	4%	6%	7%	8%	8%	7%
Motors, Fans, Pumps	13%	7%	3%	4%	5%	5%	2%	7%*	7%*	7%*	14%	38%	37%	42%	47%
Refrigeration	6%	6%	1%	1%	3%	40%	3%	24%	5%+	2%	5%	1%	3%+	1%+	0%
Office Electronics	9%	10%	21%	12%+	4%	2%	5%	1%+	6%	5%	5%	3%	9%	3%+	2%+
Non-Process Hot Water	0.4%	0.4%	0.5%	0.4%	0.2%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.2%	0.9%	0.2%	0.2%
All Other	21%	22%	21%	10%	13%	16%	39%	32%	12%	32%	25%	23%	2%	11%	23%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: may not sum to 100% due to rounding
* End use percentage defaults to sector average due to low sample size
+ At least 1 type of equipment within end use defaults to sector average due to low sample size
a=Interior lighting only

In terms of waste, refrigeration and lighting show the greatest opportunities to reduce technological waste by upgrading to newer, more efficient equipment. Technological waste accounts for 38% and 35% of current usage for these end uses, respectively. Lighting also has the greatest opportunities to reduce behavioral waste, which accounts for 36% of current usage, mainly by improving and optimizing lighting controls.

Table 3-2 presents the usage and waste results, across all analyzed end uses.

Table 3-2. Summary of Usage and Waste Results

	Analyzed End Uses					
	Lighting	Cooling	Ventilation	Refrigeration	Motors	Office Equipment
% of C&I Usage	28%	15%	8%	6%	13%	9%
End-Use Penetration	100%	64%	82%	25%	32%	93%
kWh Per Business *(with end -use)*	36,394	29,781	13,475	39,863*	54,049	22,433*
kWh Per Business *(All in-scope businesses)*	36,394	19,199	11,018	7,181	20,482	11,311
Total Annual MWh	10,926,461	5,764,059	3,308,014	2,155,858	5,117,542	3,395,989
% Efficient Usage[a]	42%	63%	89%	59%	94%	42%
% TW (before BW)[b]	35%	29%	11%	38%	6%	42%
% BW (after TW)[c]	23%	9%	0%	3%	0%	16%
% BW (before TW)	36%	12%	0%	8%	0%	23%
% TW (after BW)	23%	26%	10%	33%	6%	35%
MWh TW (before BW)	3,802,392	1,661,246	353,309	818,900	291,991	1,417,598
MWh BW (after TW)	2,543,488	497,550	15,149	72,681	16,433	563,814
MWh BW (before TW)	3,882,878	682,822	17,031	181,816	17,631	797,457
MWh TW (after BW)	2,463,002	1,475,974	351,426	709,765	290,793	1,183,955

Source: Usage and Waste Analysis

[a] Defined as the percentage of current kWh usage that would be used if technology and behavior were "efficient" (per this study). The remaining component of current kWh is considered waste (per this study).

[b] This row displays the percentage of current kWh usage that is technological waste, if we assess technological waste assuming current behaviors (i.e., before assessing behavioral waste). TW = "Technological Waste" and BW = "Behavioral Waste".

[c] This row displays the percentage of current kWh usage that is behavioral waste, if we assess behavioral waste assuming current equipment (i.e., before assessing technological waste). BW = "Behavioral Waste" and TW = "Technological Waste".

*This is an average value for a business that has all types of equipment within the end use. For refrigeration, this would include two types of refrigeration (walk-in refrigeration and refrigerated cases), and for office equipment, this would include nine types of equipment (PCs, notebooks, servers, printers, multi-function devices, copiers, scanners, cash registers and televisions).

4. METHODOLOGY

Key activities in support of the Commercial and Industrial Saturation/End Use, Market Penetration, and Behavioral Study included extensive primary data collection, monitoring, and engineering analysis of electricity end uses. This section describes each of these activities in detail.

4.1 Primary Data Collection

The primary data collection activities for this effort included a telephone survey with 1,666[2] C&I customers, on-site audits at 347 businesses, and lighting and occupancy metering at 70 businesses. This subsection describes the sampling and weighting, data collection, and adjustment methodologies associated with these activities.

4.1.1 Telephone Survey

The telephone survey collected 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 aimed at building owners, business owners, and facility managers with knowledge of energy-using equipment at the business. We also used the telephone survey to recruit a subset of survey respondents for on-site audits and metering. We implemented the survey from our call center between July 5 and September 12, 2012, and completed 1,666 interviews. On average, the survey took 22.5 minutes to complete. Our response rate was 3.8%.

The survey primarily focused on the end uses of lighting, cooling, ventilation, refrigeration, motors, office equipment, water heating, compressed air, cooking, and process heating and drying. The survey also included questions about each business's demographics and important energy characteristics of each facility, such as hours of operation. The telephone survey instrument is presented in Appendix 3. To maintain a reasonable length, the survey only asked customers about their top four end uses. Also, some less frequently encountered end uses, or end uses known to be significant for certain sectors, were prioritized for some sectors. For example, we included questions about refrigeration and commercial kitchen equipment in surveys of the grocery and food service segments; office equipment was prioritized in surveys of office buildings; and compressed air and motors were prioritized in surveys for industrial customers.

Sample Design

Our sampling unit was the commercial or industrial business account. As of January 2012, there were 341,824 C&I accounts in ComEd's service territory. A portion of these accounts were out of scope or inappropriate for this study and, therefore, were dropped, resulting in a sample frame of 190,392 C&I accounts. As shown in Table 4-1, 151,432 accounts were removed for the following reasons:

[2] Due to segment reclassification and removal of public sector customers and other out of scope customers, the total number of telephone surveys used in the analysis was 1,519.

- Vacant premises (Criteria 1, 2)
- Premises with insufficient 2011 data needed for analysis (Criteria 3, 4)
- Accounts associated with customer having more than two accounts (Criterion 5)
- Duplicate or invalid phone numbers that cannot be contacted (Criteria 6, 7)

Table 4-1. Records Dropped Prior to Sampling

Criteria for Dropping Records	Number of Records Dropped*
1. Accounts with 2011 annual usage = 0	5,425
2. Accounts with less than 2 kWh average daily usage in 2011	16,539
3. Accounts in service only after May 2011	18,177
4. Accounts with less than 2 kWh average daily use in 3 or more summer months (May-Sept) in 2011	8,698
5. Accounts in excess of 2 per unique customer	42,673
6. Accounts with missing or invalid phone number	4,812
7. Accounts with duplicate phone number	55,108
TOTAL RECORDS DROPPED	**151,432**

** Drops are sequential.*

The primary objective of the sample design was to administer the survey to enough customers within each segment to conduct analysis at the segment level whenever possible. Secondary objectives were: 1) to have a distribution of business types and sizes to enable us to "roll up" findings to a sector level (commercial or industrial), and 2) to have a large enough pool of completed phone interviews to recruit site visit participants.

Our sample design employed a stratified random sampling approach, with strata based on business segments and customer rate classes. The segments and rate classes were determined following discussions with ComEd and our review of the customer data and are described below.

Our target number of completed surveys was 1,800. We set quotas for 10 commercial segments and 14 industrial segments. The initial assignment included 70 completes in each segment (to meet a minimum precision level of 10% at 90% confidence), except for those industrial segments where the number of feasible completes (assuming a completion rate of 10-15%) was less than 70. For these sparsely populated industrial segments, we attempted to survey a census of the businesses. Any additional interviews were to be distributed among the segments proportional to each segment's electricity use, thereby increasing the overall statistical precision of the results.

Within each segment, we stratified accounts by rate class[3], and sampled in proportion to the total annual electricity use each rate class contributes to the segment total. For example, if warehouse accounts in the 100-400kW rate class contribute 25% of total warehouse kWh, but only 6% of total warehouse customers, we aimed to complete interviews with 25% of warehouses in the 100-400 kW rate class.

[3] Rate classes are provided in Table 4-5.

Customers with missing segment information in the ComEd customer database comprised 32% of C&I customers and 19% of electricity use. We sampled these customers in proportion to their contribution to overall electricity use (i.e., we attempted to place approximately 20% of calls to survey customers with missing segment information). These customers were classified into the appropriate segment, based on their responses to the business segment module in the survey.

C&I Segment Classification

The telephone survey covered private sector (non-governmental) C&I ComEd customers within each major sector (i.e., commercial and industrial). To best meet ComEd's analysis and planning needs for C&I efficiency programs, we grouped customers into business segments of like business types, and excluded businesses considered outside of the commercial and industrial sectors (e.g., agriculture, mining, transportation, construction). In grouping, we developed a series of rules (described in detail in the following subsection) starting with the SIC and NAICS classifications provided by ComEd. We performed the classification for the ComEd C&I database as a whole (to guide sampling), and verified the segment assignment of phone survey respondents following the survey. The final sectors and segments included and excluded from the analysis are shown in Table 4-2.

Table 4-2. Segments within Sectors

Commercial	Industrial	Not included in analysis (Out of Scope)
• Office Buildings • Health Services • Retail • Food Service • Warehouse • Grocery/Convenience • Non-Public Education • Lodging/Hospitality • All Other Commercial	• Industrial Machinery • Fabricated Metals • Printing • Electronics/Instrumentation • Paper/Lumber/Furniture • Food (Industrial) • Rubber/Plastics • Chemicals • Stone/Clay/Glass • Primary Metals • Transportation Equipment • Apparel/Textiles • Petroleum • Misc. Manufacturing	• Agriculture • Forestry • Fishing • Mining • Construction • Transportation • Communication • Utilities • Housing

Customer Population Segment Assignment Rules

We applied a series of rules for assigning businesses to C&I segments both before and after the survey. The steps we used in classifying customers into the appropriate segments are outlined below.

Customer database segment assignment before sampling and surveying

Before constructing the sample and conducting customer interviews, we identified the most appropriate segment for each customer based on SIC and NAICS combinations. These initial segment classifications allowed us to develop quotas for each segment. Some commercial and industrial facilities have a mix of functions, and we developed several rules to consistently assign businesses to a single segment. Specifically, we:

1) Used SIC/NAICS rules provided by ComEd
2) Combined grocery stores and convenience stores based on discussion with ComEd
3) Combined several industrial segments based on discussion with ComEd
4) Identified customer classes within 'All Other Commercial' group (using customer name) that could be part of one of our other analysis segments
5) Identified customer classes that were in the industrial sector, but not in a specific segment that could be part of one of our other analysis segments (using customer name)

As described above, we did not reduce the original sample frame numbers, but did rearrange the sample frame numbers within specific segments.

Phone survey respondent segment assignment after phone surveys

We asked customers to verify and correct their segment assignment (as needed) through the survey. We also examined the segment assignments resulting from the telephone surveys to ensure that customers' responses were consistent with the rules-based classification we developed for the customer database. For example, if the customer reported that they manufactured toothbrushes, we looked at the segment that similar manufacturers (based on name) fell into in the customer database (e.g., Miscellaneous Manufacturing, Electronics/Instrumentation, or Rubber/Plastics). We then re-classified the telephone survey respondents' segment to align as closely as possible with rules that had been established for the customer database. Specifically, we:

1) Determined the segment assignment most aligned with customer database rules through examination of (a) phone survey responses such as business type, space types, equipment, and (b) secondary data (the assigned SIC and NAICS codes, company websites, press releases, photographs of the facility)
2) Removed public sector customers based on customer name (91 respondents)
3) Removed any other out-of-scope customers (26 respondents)
4) Exclude site visit recruits who did not complete the survey (30 respondents)

The resulting 1,519 surveys formed the basis of our phone survey analysis.

Customer database segment assignment after telephone surveys

After conducting this reclassification, we revisited segment assignments in the customer database to determine if we needed to adjust any of the SIC or NAICS-based rules to reflect what we learned about customers in the telephone survey and subsequent research. We also created rules to identify public sector customers. We conducted this analysis to develop a sample frame that aligned with the telephone survey sample that could be used for weighting and extrapolation. Specifically, we:

1) Examined trends in reclassification to identify SIC/NAICS combinations that followed a similar pattern
2) Modified and re-applied SIC/NAICS segment rules for a select set of SIC/NAICS if a trend could be identified from phone respondent reclassification work
3) Developed and applied rules for identifying and removing public sector customers (based on SIC, NAICS, and keywords)
4) Examined the final segment distribution of telephone survey respondents with missing SIC/NAICS to determine if further adjustments to the sample frame were needed

This last adjustment further refined the sample frame segment-specific numbers using our improved rule-based system. We only removed data points that were public sector and, therefore, out of scope. We did not adjust segment-specific numbers in the sample frame based on the distribution of telephone respondents with missing SIC and NAICS.[4] The public sector adjustment reduced the size of the final sample frame for analysis from 190,392 to 183,687.

Table 4-3 and Table 4-4 present the final Commercial and Industrial segments, respectively, used in this study and briefly describe the types of businesses that fall within each segment. Please note that each segment is also defined by multiple unique combinations of SIC and NAICS codes that are not shown here.

[4] There were a few differences between the segment distribution of respondents with unknown SIC and NAICS (n=194) and the segment distribution within the sample frame. The magnitude of the differences, however, was not large and we know that other factors such as non-response bias and decision-maker screening criteria account for some of the differences observed in the response rate between segments. Therefore, we did not adjust the sample frame based on the segment distribution of the 194 customers with missing SIC and NAICS.

Table 4-3. Definition of Commercial Segments

Segment	Definition	Examples of Types of Businesses in the Segment
Office Buildings	Any business that is conducted in an office setting, including the headquarters of retail manufacturing businesses	Law firms, architectural firms, headquarters of retailers, consulting companies, retail banks[5]
Health Services	Inpatient and Outpatient health services	Hospitals, nursing homes, in-patient treatment centers, dentists' offices, outpatient mental health services, dermatologists, primary care physician offices
Retail	Businesses that sell things other than prepared food and groceries	Home improvement stores, jewelry stores, clothing stores, office supply stores
Food Service	Businesses that prepare and serve food as their main function	Restaurants, bars, bakeries, delis, ice cream stores
Warehouse	Any establishment that stores goods and has no manufacturing capabilities and little or no retail space.	Warehouses of all types, self storage facilities, junk yards
Grocery/ Convenience	Businesses that sell food where most of the food is pre-packaged.	Supermarkets, corner stores, gas stations
Non-Public Education	Businesses that have classroom space and whose goal is to educate	Non-public elementary, middle, and high schools, colleges and universities, pre-schools, libraries, day care, beauty colleges, training centers for continuing education, teachers and tutors working from home offices
Lodging/ Hospitality	Businesses that provide living space. This segment excludes educational establishments such as universities or boarding schools	Hotels, motels, assisted and supportive living, correctional facilities, condos and apartment buildings (common space only), camp sites with cabins
All Other Commercial	Commercial endeavors that do not fit in any of the above categories	Auto mechanics, houses of worship, car washes, auto body shops, car dealerships, movie theatres, parks, camp sites without cabins, museums, fraternal lodges, community centers, recreation centers, laundromats, golf clubs, bowling centers

[5] It was not possible to distinguish between retail banks and bank offices based on SIC or NAICS codes. Therefore, for consistency, we grouped all into the office buildings segment.

Table 4-4. Definitions of Industrial Segments

Segment	Definition	Examples of Types of Businesses/Products Manufactured in the Segment
Industrial Machinery	Facilities that make machines that are used to produce other products	Machines used in assembly lines, or any other type of machine
Fabricated Metals	Facilities that manufacture metal in pre-defined shapes	Sheet metal, metal furniture, metal tools such as screws, welding
Printing	Facilities that create printed documents	Facilities that print books, wedding invitations, screen printing of textiles, retail establishments that make photo copies
Electronics/ Instrumentation	Facilities that manufacture electronics or instruments	Computers, electrical panels, other electronic devices, and instruments used in the medical field
Paper/ Lumber/ Furniture	Facilities that produce paper produces, lumber products, and furniture, excluding metal and plastic furniture	Paper, lumber, products made of lumber, cabinets, furniture that is not made solely of metal or plastic, wood, paper, or cardboard based packaging
Food (Industrial)	Industrial facilities that produce food in mass quantities	Facilities that produce food in mass quantities for consumption in a location other than the one in which they are being produced
Rubber/Plastics	Facilities that make plastic or rubber items	Rubber bands, plastic furniture such as plastic lawn chairs, toothbrushes, plastic toys, plastic packaging
Chemicals	Facilities that make chemicals or chemical products	Industrial chemicals, lawn fertilizer, biodiesel fuel, bonding agents, dyes, paint, food-grade chemicals
Stone/Clay/ Glass	Facilities that produce products that are made of stone, clay, or glass	Cement, paving, lenses, mirrors, minerals
Primary Metals	Facilities that refine raw material to become usable metal	Steel, iron, and other metals
Transportation Equipment	Facilities that make transportation equipment	Trains, trucks, cars, airplanes. This segment does not include those who fix cars such as mechanics and auto body shops.
Apparel/ Textiles	Facilities that make apparel and textiles	Clothes, sheets, drapes, and other textiles
Petroleum	Facilities that refine petroleum	Petroleum, fuel, lubricants
Miscellaneous Manufacturing	Facilities that manufacture products that are defined by NAICS as miscellaneous manufacturing	Signs, brushes, brooms, dental labs, facilities that produce more than 2 items each of which is in a different sector

C&I Rate Class Rules

The rate classes used in this analysis are based on 2011 ComEd billing data. Within each sector, commercial and industrial customers were divided into four groups as shown in Table 4-5.

Table 4-5. Rate Class Groups

Rate Class Group	Rate Class
Less than 100 kW	B72, B73, B92, B93, H73, R72, R73
100 – 400 kW	B74, B94, H74, R74
400 kW – 1 MW	B75, B95, H75, R75
Greater than 1 MW	A76, H76, H77, R76, R77

Summary of Telephone Survey Statistics

Table 4-6 presents the final dispositions for the telephone survey. The response rate was 3.8% (computed as the number of completed interviews divided by the number of eligible respondents). The cooperation rate was 7.9% (computed as the number of completed interviews divided by the total number of eligible sample units actually contacted).

Table 4-6. C&I Customer Survey Disposition

Disposition	Number
Completed Interviews (I)	1,666[6]
Eligible Non-Interviews	31,120
Refusals (R)	*17,831*
Mid-Interview terminate (R)	*1,463*
Respondent never available (NC)	*11,287*
Language Problem (NC)	*539*
Not Eligible (e)	11,603
Fax/Data Line	*845*
Duplicate Number	*126*
Non-Working	*6,954*
Wrong Number	*1,763*
Business, government office, other organization	*1,617*
No eligible respondent	*298*
Unknown Eligibility Non-Interview (U)	14,639
Not Dialed/Worked	*0*
No Answer	*5,362*
Answering Machine	*8,864*
Busy	*280*
Call Blocking	*133*
Total Contacts in Sample	59,028
Response Rate	.038
Cooperation Rate	.079

Table 4-7 shows final numbers of phone survey completes and on-site audit completes for each segment. Despite attempting to call all customers in our sample frame for many segments, we were not able to complete 1,800 telephone surveys as initially anticipated. Though we attempted a census of eligible customers in most segments, completes per segment were often below the desired numbers needed to provide information at the desired confidence level of 90% and precision level of 10%[7]. Furthermore, because the phone survey asked each respondent about no more than four electricity end uses (to increase response rates and reduce survey fatigue), there were fewer responses about most end uses than the overall number of responses.

Anticipating fewer eligible accounts in the industrial segments, we oversampled industrial customers relative to their proportion of the eligible customer base (8%) and their proportion of total annual usage in eligible segments (19%). As shown in Table 4-7, industrial

[6] 1,666 represents the total number of phone surveys completed. Subsequent reclassification reduced the total number of surveys in the scope of the study to 1,519.

[7] A general rule of thumb for proportions in population sizes larger than 500 is that 67 independent sample points are needed to achieve 90% confidence with 10% precision (the criteria established by ComEd). A sample size of 50 can yield 90% confidence at 12% precision (or 80% confidence with 9% precision, and a sample size of 30 can achieve 90% confidence with 15% precision (or 80% confidence with 12% precision).

customers comprised 35% of both phone interviews and on-site audits. Nevertheless, the limited number of end uses asked about per respondent, combined with the low numbers of completed surveys in most industrial segments, resulted in fewer than 20 telephone survey completes per industrial segment for many end uses.

Table 4-7. Phone and On-Site Audit Completes by Segment

Segment	Phone Survey		On-site Audits		ComEd Customers (in Baseline Study segments)	
	n	Percent Completes	n	Percent Completes	Percent of Customers	Percent of Annual Use (MWh)
Office Buildings	165	10.9%	18	5.2%	27.0%	18.2%
Hospitals/Health Services	127	8.4%	23	6.6%	9.4%	7.2%
Retail	113	7.4%	27	7.8%	12.0%	8.5%
Food Service	155	10.2%	47	13.5%	8.3%	6.7%
Warehouse	155	10.2%	26	7.5%	4.8%	6.6%
Grocery/Convenience	54	3.6%	14	4.0%	2.5%	5.8%
Education	56	3.7%	13	3.7%	1.7%	4.7%
Lodging/Hospitality	55	3.6%	20	5.8%	0.6%	3.6%
Other Commercial	112	7.4%	38	11.0%	25.2%	15.9%
Industrial Machinery	92	6.1%	26	7.5%	1.7%	2.6%
Fabricated Metals	140	9.2%	30	8.6%	1.2%	3.3%
Printing	71	4.7%	19	5.5%	1.0%	1.7%
Electronics/Instrumentation	47	3.1%	14	4.0%	0.9%	2.3%
Paper/Lumber/Furniture	24	1.6%	3	0.9%	0.6%	1.6%
Food Industrial	26	1.7%	3	0.9%	0.6%	3.6%
Rubber/Plastics	38	2.5%	8	2.3%	0.4%	3.2%
Chemicals	21	1.4%	7	2.0%	0.3%	1.2%
Stone/Clay/Glass	18	1.2%	2	0.6%	0.3%	0.4%
Primary Metals	8	0.5%	1	0.3%	0.3%	1.2%
Transportation Equipment	9	0.6%	1	0.3%	0.2%	0.4%
Apparel/Textiles	4	0.3%	2	0.6%	0.2%	0.2%
Petroleum	3	0.2%	1	0.3%	0.1%	0.1%
Misc. Manufacturing	26	1.7%	4	1.2%	0.8%	0.8%
Total	**1,519**	**100%**	**347**	**100%**	**100%**	**100%**
Commercial Sector	992	65%	226	65%	91%	77%
Industrial Sector	527	35%	121	35%	9%	23%

The limited sample sizes for industrial end uses by segment meant that we could not with confidence report on the end-use profile of most industrial segments. Therefore, we needed to aggregate responses further, to create reporting groups with larger sample sizes (of both phone survey and site visit data). This could be done by combining segments or by reporting at a rate class level. We determined that reporting at a rate class level, rather than combining segments, was preferable for the following reasons:

- Facilities within individual industrial segments were found to have a high degree of heterogeneity in the types of products, processes, facility size, and age, making it difficult to characterize how electricity was used and efficiency levels within industry segments. Aggregating individual segments would only increase the amount of variation found within combined segments. The existing 14 industrial segments cannot be bundled much further because of functional dissimilarities.
- The phone survey data show that less variation exists within industrial rate classes than within individual industrial segments, indicating that we can better characterize penetration and saturation within an industrial rate class than within an industrial segment.
- The phone survey data show significant differences in efficiency level of equipment between rate classes that would be lost in segment-level summaries.
- With segment-based reporting, penetration, and saturation, numbers would be more reflective of the equipment and operational profile of smaller customers, who make up the bulk of each segment, and obscure the equipment and operational profile of larger customers.

The largest rate class in this study (Greater than 1 MW) includes 25 respondents. Because 25 completes is not sufficient for reporting end use results for this rate class for the industrial sector, we combined customers in the 400 kW – 1 MW class and Greater than 1 MW class to create one "400 kW and higher" group for the industrial sector.

For the commercial sector, most segments had sufficient numbers of phone survey responses to allow reporting of penetration at the segment level.

As shown in Table 4-8, we summarized the survey results for commercial customers by each of nine commercial sector segments, and for industrial customers by each of three rate class groups.

Table 4-8. Analytical Groupings for Commercial and Industrial Sectors and Number of Survey Completes

Commercial Sector	
Segment	**n**
Office Buildings	165
Hospitals/Health Services	127
Retail	113
Food Service	155
Warehouse	155
Grocery/Convenience	54
Non-Public Education	56
Lodging/Hospitality	55
All Other Commercial	112
Commercial Total	**992**

Industrial Sector	
Rate Class Group	**n**
Less than 100 kW	316
100-400 kW	138
Greater than 400 kW	73
Industrial Total	**527**

4.1.2 Telephone Survey Data Weighting and Adjustments

The telephone survey data presented in this report are weighted and adjusted using the data collected during on-site audits. We have also adjusted several key survey questions using other sources when respondents could not accurately provide answers. We describe the data adjustments generally in the sections below and in more detail in each of the end-use technical appendices.

Telephone Survey Weighting

We employed separate weighting schemes for penetration and saturation reporting than for the usage and waste analysis to address different analysis constraints and objectives. For penetration and saturation reporting, where the goal is reporting the percentage of all customers within a group that have a type of equipment (or the number that they have), we used stratum weights that accounted for differences in customer *counts* between groups in our sample versus the population. For usage and waste analysis, where the goal is reporting the proportion of energy use within a group that is attributable to each end use, we use "usage-based" stratum weights that accounted for different *amounts of energy* that each stratum contributes to their group total. Penetration and saturation weighting is described in this section, and usage and waste weighting is described in the following section.

Penetration and Saturation findings presented in this report are weighted to account for the following factors:

1) Differences in the distribution of customer counts by rate classes within our sample compared with the sample frame (i.e., customer base), since we attempted to oversample large accounts (with demand greater than 100 kW) to inform the usage and waste analysis

2) Differences in the distribution of customer counts by segment within the commercial sector, to account for oversampling some segments to achieve the desired level of confidence and precision within each segment

3) Differences in the distribution of customer counts by sector within the sample, to account for oversampling industrial customers to ensure representation from all industrial segments.

As the basis for weighting, we used the sample frame of all accounts in the 2011 customer population with (1) a known segment (i.e., known SIC and/or NAICS) and (2) a segment that is in the scope of the study. The size of the sample frame is 183,687 accounts, from a 2011 customer population of 341,824 customers. We removed 116,543 customers with missing SIC and NAICS information from the sample frame, and 41,594 out-of-scope customers (due to their segment or public sector status).[8] The commercial sample frame contains 168,012 accounts and the industrial sample frame contains 15,675 accounts. As discussed above, we developed segment classification rules through multiple stages, including modifications after the phone survey effort to align SIC and NAICS rules with phone survey respondent classification (to the extent possible).

We weighted commercial sector and industrial sector findings differently due to differences in reporting requirements and the sampling approach.

Commercial: Phone survey data are reported at a segment level for commercial segments, with a sector-level summary.

- Within each segment, data are weighted by customer rate class to align with the proportion of accounts within each rate class of each segment in the commercial sample frame. If the sample contained less than 10 respondents in a given rate class, the rate class was combined with a contiguous rate class and weights were calculated for the combined rate classes. In most cases, these within-segment rate class weights resulted in customers in the smallest rate class (<100 kW) weighted upward, and all other customers weighted downward.

- To develop sector-level values, we applied additional weights to align the proportion of accounts within each segment in the completed commercial survey sample with the same proportions in the commercial sample frame.

Industrial: Phone survey data are reported at the rate class level for three rate class groups, with a sector-level summary.

- Within each rate class, industrial segment data are not weighted. While there is a slight difference in the distribution of segments within each rate class (and for the industrial sample overall) compared with the industrial sample frame, the sample design had

[8] This sample frame is different than that presented earlier in this chapter because we removed public sector customers following telephone survey completion.

minimal influence on these differences. Due to the relatively small number of accounts in industrial segments compared with survey goals, we made a census attempt in nearly all industrial segments—i.e., we called every customer in the sample frame for the segment and completed as many interviews as possible. Additionally, sample sizes in many cases are too small to apply weights. Therefore, we did not apply segment weights to the industrial sector telephone survey data.

- To estimate sector-level penetration and saturation, we applied weights to align the proportion of accounts within each of the three rate class groups of the industrial customers in the sample with the distribution in the industrial sample frame.

All Commercial & Industrial Customers: Phone survey data are reported for all Commercial & industrial customers combined.

- To estimate penetration and saturation for all customers, we applied weights to align the proportion of accounts within each sector in the sample with the same distribution in the sample frame.

We evaluated final weights in both sectors for undesirable unequal weighting effects and found none.[9]

Telephone Survey Weighting for Usage and Waste Analysis

The key metrics in the Commercial & Industrial usage and waste analysis are proportions – specifically, electricity usage and waste as a proportion of each customer's annual electricity use. We first calculated proportions of usage and waste for each customer, for each end use (data permitting), and then calculated weighted averages to represent the percentage of energy used by each segment or rate class that is drawn by each end use.

The objective of the usage and waste analysis was to construct an energy profile for each segment, rate class or sector that reflects how much kWh is consumed by each end use. Therefore, larger facilities (who consume relatively more energy in their segment or sector) should be given slightly more weight, as their energy use patterns have a greater influence on the energy use of any ComEd segment or sector overall. Therefore we developed usage-based stratum weights that account for the proportion of energy use that each ComEd sub-group (a segment or rate class) contributes to the total energy use of the analysis group (a segment, rate class or sector).

Usage and waste findings presented in this report are weighted to account for the following factors:

1) Differences in the distribution of the customer count of each rate class group within a segment of our sample compared with the proportion of energy each rate class group contributes to the segment in the sample frame (i.e., customer base).

2) Differences in the distribution of the customer count of each segment within a sector of our sample compared with the proportion of energy each segment contributes to the analysis

[9] A weighting scheme with a high standard deviation of weights relative to the mean weight can yield undesirable results by allowing some customer responses too much influence on the direction of results of their group (e.g., sector). The weighting schemes described above were tested to ensure they would not exhibit undesirable unequal weighting effects.

group in the sample frame (i.e., customer base). As mentioned above, we oversampled some segments to achieve the desired level of confidence and precision within each segment.

3) Differences in the distribution of the customer count of each sector within our sample compared with the proportion of energy each sector contributes to the analysis group in the sample frame (i.e., customer base). We purposefully oversampled industrial customers to ensure representation from all industrial segments.

For an example of factor (1), Office segment customers in the "less than 100 kW" rate class group comprised 73% of survey completes, yet they consume only 29% of energy use among all of ComEd's non-public Office customers. They would be given a weight of 0.4 (29% / 73%) when calculating the weighted average of lighting as a percentage of annual kWh among the Office segment.[10] For an example of factor (3), Commercial customers comprised 65% of survey completes, yet they consume 77% of energy use among all of ComEd's non-public C&I customers. They are given a weight of 1.2 (77% / 65%) when calculating the weighted average of lighting as a percentage of annual kWh among all ComEd customers.

We used the same sample frame described above as the basis for weighting. The commercial sample frame contains 168,012 accounts and the industrial sample frame contains 15,675 accounts. As discussed above, we developed segment classification rules through multiple stages, including modifications after the phone survey effort to align SIC and NAICS rules with phone survey respondent classification (to the extent possible).

We weighted commercial sector and industrial sector findings differently due to differences in reporting requirements and the sampling approach. For both sectors, we collapsed rate classes such that customers in the "less than 100 kW" rate class formed one rate class group, and customers in any rate class "greater than 100 kWh" formed a second rate class group.

Commercial: Phone survey data are reported at a segment level for commercial segments, with a sector-level summary.

- To develop segment-level results, usage and waste proportions are weighted by customer rate class group to align with the proportion of annual kWh that each rate class group in the commercial sample frame contributes to total annual kWh of the segment. In all cases, these within-segment rate class weights resulted in customers in the smallest rate class (<100 kW) weighted downward, and all other customers weighted upward.
- To develop sector-level values, we applied additional weights to align the distribution of customers by segment with the proportion of annual kWh that each segment in the commercial sample frame contributes to total annual kWh of the sector.

[10] For further illustration: Assume our sample consists of exactly two Office customers. Customer 1 is in the small rate class, and lighting is 40% of the customer's annual kWh. The 47,300 ComEd Office customers with a rate class < 100 kWh contribute 29% of annual kWh for the Office segment. Customer 2 is in the large rate class group and lighting is only 20% of the customer's annual kWh. The 2,231 ComEd Office customers with a rate class > 100 kWh contribute 71% of annual kWh for the Office segment. The segment's weighted average proportion of lighting would be calculated as (40% x 29%) + (20% x 71%) = 25.8%.

Industrial: Phone survey data are reported at the rate class group level for three rate class groups, with a sector-level summary.

- To develop rate class results, we first developed segment groups, with the four largest segments (Industrial Machinery, Fabricated Metals, Printing, Electronics/Instrumentation) forming their own groups, and all other industrial customers forming a fifth segment group. Within each segment, usage and waste proportions are weighted by customer rate class to align with the proportion of annual kWh that each rate class in the commercial sample frame contributes to total annual kWh of the segment. In all cases, these within-segment rate class weights resulted in customers in the smallest rate class (<100 kW) weighted downward, and all other customers weighted upward.
- To develop sector-level values, we applied additional weights to align the distribution of customers by segment group with the proportion of annual kWh that each segment group in the industrial sample frame contributes to total annual kWh of the sector.

All Commercial & Industrial Customers: Phone survey data are reported for all commercial and industrial customers combined.

- To estimate penetration and saturation for all customers, we applied weights to align the proportion of accounts within each sector in the sample with the proportion of annual kWh that each sector in the sample frame contributes to total annual kWh of the sample frame

We evaluated final weights in both sectors for undesirable unequal weighting effects and found none.

Manual Adjustments

Our initial review of the survey data revealed that there were several key survey questions for which many respondents could not accurately provide answers. Whenever possible, we used other data sources to adjust these data, as described below.

Square Footage

We asked each customer about the size of their business in square feet. Obtaining accurate values for square footage was essential to the analysis as it was to be used for lighting and HVAC use and waste analyses. Although interviewers were instructed to prompt respondents to give their best estimate, 16% of customers were still unable to estimate the square footage of their business. To find the square footage of these properties, we used public property records, as well as aerial and satellite photographs along with a web-based application designed to obtain the square footage of a building from these photos.

We also compared the square footage reported by customers completing the telephone survey to the square footage reported by site auditors. About a quarter of sites that we visited reported a square footage that differed from the auditor's square footage by more than 20%. In these cases, we typically applied the square footage collected during the site audit.

Multiple Accounts

Customer accounts were the basis for our sample frame and for the weights we applied. However, for usage and waste analysis, it is important to understand total energy usage and demand for the facility that the respondent described to us (and that we audited on-site). While most of the ComEd customers we spoke with had a single electric account, some had multiple accounts. The multiple account adjustments described below were performed for the usage and waste analysis but did not influence our sample frame or weights.

In cases of a business holding multiple accounts, we asked the customers to answer the survey questions for the account we called about, and if they could not answer for the specific account, to respond for the single building/address. If a single building or address had multiple accounts and the respondent answered for multiple accounts, we used the customer database to identify the additional accounts and linked annual consumption of these accounts to the survey respondent.

After carrying out these adjustments, we found that additional manual changes were necessary for the purposes of the usage and waste analysis. Some customers have more than one account associated with a subject property, but the accounts have different customer telephone numbers. These customers would not have been asked if they had more than one account. We also found that some customers reported only having one electric account for their business, but in reality they had multiple accounts.

To identify such discrepancies between the survey responses and the associated electric accounts, we analyzed survey responses for which the reported square footage seemed very high or very low given the electricity use and demand of the known accounts linked to the property. We used secondary research to define a reasonable range of watts per square foot (W/ft^2) for the customer classes in the study (e.g., a range between 2 W/ft^2 and 18 W/ft^2). By identifying and looking at cases that were outside of the expected range, we identified additional businesses that either misreported square footage or had not earlier been identified as having multiple electric accounts supplying energy to their business. In these cases, the square footage or account information were adjusted, as necessary.

We did not adjust the sample frame or weights based on this information to ensure that extrapolation from the sample to sample frame remained at the account level. The improvements in customer information were used to improve the energy usage and waste analysis.

4.1.3 On-site Audits

The 347 on-site audits were designed to collect data to verify the telephone survey responses and to collect more detailed and technical data that customers are generally unable to report on during a telephone survey. Based on the responses and the verified site data for the same set of customers, we were able to develop adjustment ratios that we applied back to the entire set of survey respondents. We also collected energy use and behavioral information from these facilities. The objective of this data collection was to not only gather information about the saturation and penetration of different types of equipment, but also to understand how the equipment is being used and how energy is wasted in C&I facilities. In addition, we used the on-site audits to install lighting monitoring equipment at a subset of 70 sites (see also Section 4.1.4, Metering below).

Initially, we aimed to complete 210 site audits under this study. We also sought to leverage data gathered through an additional 200 site audits completed as part of the potential study[11], which would allow us to increase the depth of measure and efficiency saturation data at the segment and rate class levels. We used the same site data collection instrument for both studies thus allowing us to use these results to the benefit of both efforts. With a limited uncalled sample available for the potential study site audit recruiting effort, we offered the potential study recruits a $100 incentive to compensate customers for their time and effort and to increase our recruitment rates. Despite this effort, the lower than anticipated survey response rate and 17 sites being identified as out of scope by the auditors, resulted in full audit data sets from 347 C&I facilities. Table 4-9 shows the number of site audit completes by commercial sector and industrial rate class group.

Table 4-9. Analytical Groupings for Commercial and Industrial Sectors and Number of Site Audit Completes

Commercial Sector	
Segment	**n**
Office Buildings	18
Hospitals/Health Services	23
Retail	27
Food Service	47
Warehouse	26
Grocery/Convenience	14
Non-Public Education	13
Lodging/Hospitality	20
All Other Commercial	38
Commercial Total	**226**

Industrial Sector	
Rate Class Group	**n**
Less than 100 kW	63
100-400 kW	43
Greater than 400 kW	15
Industrial Total	**121**

Our team of qualified technicians conducted the site audits between July and November 2012. They entered facility data using tablet computers and a comprehensive Excel-based data collection instrument. The data collection instrument covered the following topics:

[11] Concurrent to this C&I Saturation/End Use, Market Penetration and Behavioral Study, the Opinion Dynamics team conducted a separate Commercial Market DSM Potential Study that utilized much of the penetration and saturation data collected and analyzed in this study.

- Site characteristics
- Building characteristics
- Building envelope
- Business hours
- Compressed air
- Cooking equipment
- Electronics, computers, servers
- Electronics - Printers
- HVAC - air handler system
- HVAC - chillers
- HVAC - controls
- HVAC - unitary
- HVAC - ventilation
- Indoor lighting
- Motors
- Maintenance
- Open industrial
- Refrigeration
- Refrigeration: Walk-in coolers/freezers
- Refrigeration systems
- Wastewater treatment
- Water heating

Appendix 3 presents the final on-site audit data collection instrument.

Site Audit Weighting

The site audit data was used as the basis for saturation rates, adjustments to penetration rates, and developing assumptions for missing values required for usage and waste analysis. To account for differences in segment, rate class and sector between the site auditing sample frame, we developed a stratum-based weighting scheme similar to the penetration and saturation weighting scheme described above for Telephone Survey Penetration and Saturation Reporting.

Site audit findings are weighted to account for the following factors:

4) Differences in the distribution of the customer count of each rate class group within a segment of our sample compared with the same distribution within the sample frame

5) Differences in the distribution of the customer count of each segment within a sector of our sample compared with the same distribution within the sample frame

6) Differences in the distribution of the customer count of each sector within our sample compared with the same distribution within the sample frame

We used the same sample frame described above as the basis for weighting. The commercial sample frame contains 168,012 accounts and the industrial sample frame contains 15,675 accounts. As discussed above, we developed segment classification rules through multiple stages, including modifications after the phone survey effort to align SIC and NAICS rules with phone survey respondent classification (to the extent possible).

The weighting rules for site audits are described below. For both sectors, we collapsed rate classes such that customers in the “less than 100 kW” rate class formed one rate class group, and customers in any rate class “greater than 100 kWh” formed a second rate class group.

Commercial:

- Within each segment, data are weighted by customer rate class group to align with the proportion of accounts within each rate class group of each segment in the sample

frame. If any rate class (within a segment) had less than 10 site audit participants, this weight is not applied.

- Within each sector, data are weighted by customer segment to align with the proportion of accounts within each segment of the commercial sample frame.

Industrial: We first developed segment groups, with the four largest segments (Industrial Machinery, Fabricated Metals, Printing, Electronics/Instrumentation) forming their own groups, and all other industrial customers forming a fifth segment group.

- Within each segment group, data are weighted by customer rate class group to align with the proportion of accounts within each rate class group of each segment in the sample frame. If any rate class (within a segment) had less than 10 site audit participants, this weight is not applied.
- Within each sector, data are weighted by customer segment to align with the proportion of accounts within each segment group of the industrial sample frame

To estimate penetration and saturation for all customers, we applied weights to align the proportion of accounts within each sector in the sample with the same distribution in the sample frame.

We evaluated final weights in both sectors for undesirable unequal weighting effects and found none.

4.1.4 Metering

In support of our usage and waste analysis, we initially sought to monitor energy use in key areas of each facility using the Powerhouse Dynamics monitoring package. This package includes a central data logger, current transformers (CTs), and software with the ability to monitor up to 24 separate variables at a time with the primary objective of monitoring the largest electricity uses of large refrigeration systems, space cooling, and lighting. The use of this equipment would depend upon an adequate number of facilities with these end uses being monitored directly from a single electrical panel, or wirelessly (using the facility's wireless router) with a signal being sent to the central data logger from remote equipment throughout the facility.

After conducting numerous on-site audits, we identified relatively few facilities with the necessary conditions of: 1) the target end uses on dedicated circuits (with the exception of cooling), 2) a single electrical panel containing each end use's circuits, or 3) adequate wireless signals accessible throughout the facility. Our alternative to this multichannel approach was to monitor one or two of the priority end uses when feasible. However, we found very few facilities with qualifying refrigeration systems that were willing or able to allow us to monitor their systems, and we only identified a sufficient number of candidate cooling systems for monitoring after a significant portion of the cooling season had elapsed.

Ultimately, we focused monitoring efforts on refining the use and waste estimates for the largest electricity end use: lighting. By deploying a combination light and occupancy loggers, we were able to assess both hours of use and behavioral waste associated with leaving the lights on in a space when the space is not occupied. The purpose of this metering activity

was twofold: first, to compare the hours of use using logger measurements to the auditor-reported data (and thereby develop an adjustment factor for usage and waste analysis), and second, to assess behavioral waste associated with leaving the lights on when the room is not occupied.

We deployed combination light and occupancy loggers in a total of 70 commercial locations. Lighting use and occupancy were metered in each business for an average of 20 days between the months of September and November. For most of these businesses, we deployed loggers in five space types: conference rooms/classrooms, dining areas, hallways/stairwells, offices, and storage areas.

Hours of Use Analysis

The hours of use analysis included a detailed analysis of light and occupancy logger data. The analysis of logger data involved several data verification steps. Logger data was aggregated by day, including measure of the number of hours the lights were on, and how many times the lights were turned on and off (called flickers). We removed full days from logger data based on the following criteria:

- Federal holidays
- All cases of lights being turned off occurred when the logger showed that the space was unoccupied, which may indicate that loggers were picking up changes in daylight rather than lights being turned on/off
- Excessive flickering that may indicate loggers were picking up changes in daylight rather than lights being turned on/off, defined as:
    - 1 or more hours where the lights turned on/off more than 10 times per hour, or
    - 4 or more hours where the lights turned on/off more than 5 times per hour.
- A combination of one of the excessive flickering criteria as well as light turned on/off when unoccupied 50% of the time.

We then spot-checked the included days for occupancy and lighting patterns.

- We used the cleaned logger data to create an “average week” for each logger, aggregating daily data by day of the week. Data were filled in for missing days of the week with average hours of use from days with the same schedule of operating hours. We then removed full loggers from the analysis based on the following criteria:
    - Less than 7 full days of logger data
    - Previously eliminated logger data for 3 or more days of the week
    - Missing data for the auditor’s estimate of operating hours per week
    - The logger reported no lighting run time

Occupancy and Waste Analysis

The second purpose of deploying light and occupancy loggers was to assess behavioral waste as the percentage of lighting run time during which the room was unoccupied. This analysis was completed separately, and slightly different data validation rules were used than from the hours of use analysis.

We removed full days from logger data based on the following criteria:

- Federal holidays
- Three-quarters (75%) or more of instances of lights being turned off occurred when the logger showed that the space was unoccupied
- Excessive flickering, defined as:
  - 1 or more hours where the lights turned on/off more than 10 times per hour and less than 200 daily occupancy changes.
  - 7 or more hours where the lights turned on/off more than 5 times per hour and less than 10 daily occupancy changes.

We removed full loggers from the analysis based on the following criteria:

- Less than 7 full days of logger data
- The logger was monitoring lights that were already on occupancy sensors
- The logger reported no lighting run time

We calculated the percentage of behavioral waste by space type, as well as overall. We used a typical timeout period of 15 minutes—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.

Meter Data Weighting and Adjustments

To arrive at a measured average hours of use estimate, we weighted the sample using the percentage of fixtures by space type of the sample, compared to the percentage of fixtures by space type of all monitored facilities. To correct for the difference between auditor-reported hours of use and measured hours of use, we used a ratio of the two values to create an adjustment factor that was applied to the sample.

We calculated behavioral waste percentages by overlaying two weighting schemes that account for (and adjust) the business segment as well as the type of space. First, we developed weights that control for the proportion of total wattage by space type of the sample compared to the proportion of total wattage by space type of all 70 monitored facilities. Second, we applied the site audit stratum weights (described above) that adjust for business segment for commercial and rate class group for industrial.

4.2 Usage and Waste Analysis

Our usage and waste analysis includes the end uses that account for the majority of electricity usage among the in-scope ComEd C&I customers. Specifically, we quantified electricity use and waste for the following end uses:

- Interior lighting
- Cooling
- Ventilation
- Refrigeration
- Motors, fans and pumps[12]
- Office equipment and data centers
- Non-process water heating

[12] Note that this category includes motors, fans and pumps for both commercial and industrial customers. However, it excludes HVAC fans.

Other end uses primarily comprise known end uses for which we did not quantify electricity use and waste because we expected them to comprise a relatively small portion of C&I electricity use. These include: exterior lighting, cooking, space heating, compressed air, process cooling, process heating, miscellaneous plug loads, industrial processes, and wastewater treatment.

This section explains our general approach to estimating current usage, technological waste, and behavioral waste including adjustments made to the use and waste estimates. It summarizes the types of technological and behavioral waste included in our analysis, and introduces the graphical representations of usage and waste used throughout this report. The technical appendix provides more detailed information about the analysis for each end use.

4.2.1 Estimating Current Usage and Waste

The usage and waste analysis for all end uses begins with an assessment of current electricity usage. For most end uses, we use engineering algorithms to estimate current usage. The analysis is generally based on the data collected during site audits, but utilizes a host of information collected not only during the site audits, but also through the telephone 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.[13]

In some cases, information was missing from the primary data (e.g., when a telephone survey respondent was not able to answer a question, an on-site auditor could not assess certain equipment characteristics), or there was not a sufficient number of observations. We generally fill in this information with default values that we develop either from the telephone survey or the site audits. Depending on the type of question and the number of valid responses that we received, we may either: 1) develop one default value for the entire sample, 2) develop separate default values for one or more segments or rate classes, or 3) develop default values by other key facility or equipment characteristics, such as number of employees or equipment age.

After estimating current usage, we estimate technological waste. For most end uses, we assessed savings opportunities associated with upgrading to more efficient equipment, where "more efficient equipment" was defined as CEE Tier 3 (if widely available for ComEd market), CEE Tier 2, or the current ENERGY STAR version of equipment.[14] Other types of technological waste could be eliminated by adding additional energy saving measures such as variable frequency drives (VFDs), or demand controlled ventilation. Technological waste can be developed directly, or it can be inferred, e.g., by estimating the electricity usage of an efficient piece of equipment and subtracting that usage from the current usage. In many

[13] State of Illinois Energy Efficiency Technical Reference Manual. Final as of September 14th, 2012. Effective June 1st, 2012.

[14] Where possible, efficient equipment thresholds align with program guidelines. There were no requirements for cost-effectiveness when defining the efficient case. Appendix 1 of this study contains all detailed technical definitions of waste thresholds.

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.

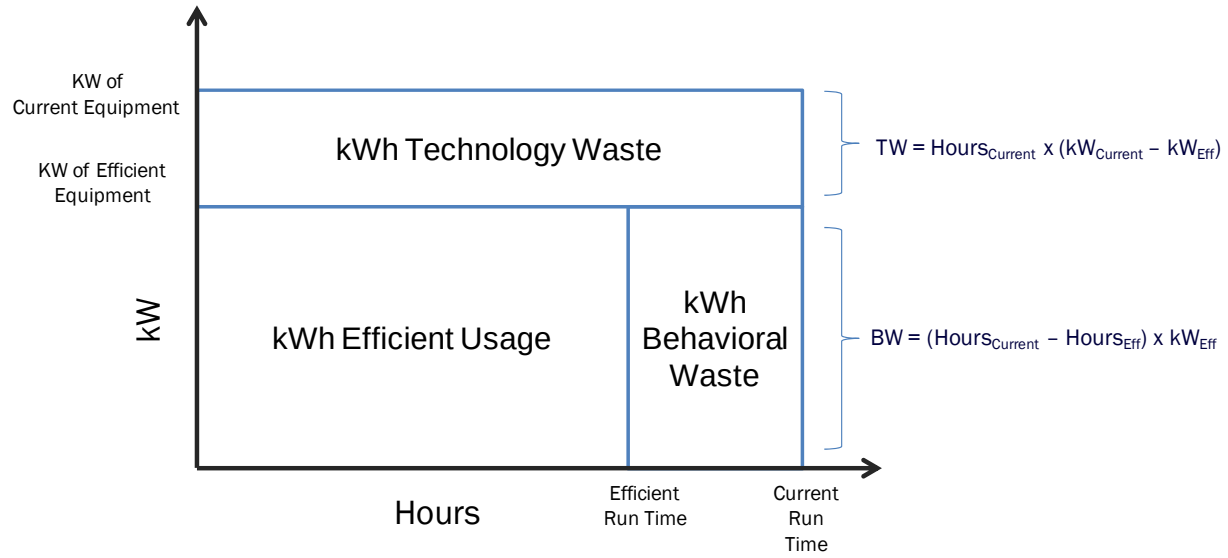
Behavioral waste for many end uses is associated with longer than necessary run times, either as a result of inefficient temperature setpoints or by having equipment on when not using it (e.g., lights or computers). Other types of behavioral waste vary by type of equipment. Similar to technological waste, 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 technological waste. To allow for flexibility in using our results, we estimate behavioral waste both ways. When it is addressed *before* technological waste, changes in behavior are applied to current technology parameters; when it is addressed *after* technological waste, changes in behavior are applied to efficient technology parameters.

The following graphic illustrates current usage, for an end use, and its disaggregation into technological waste, behavioral waste, and "efficient usage," i.e., the residual usage once both technological waste and behavioral waste have been addressed. The larger 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 technological 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 technological waste and behavioral waste are subtracted, constitutes the efficient usage of efficient equipment.

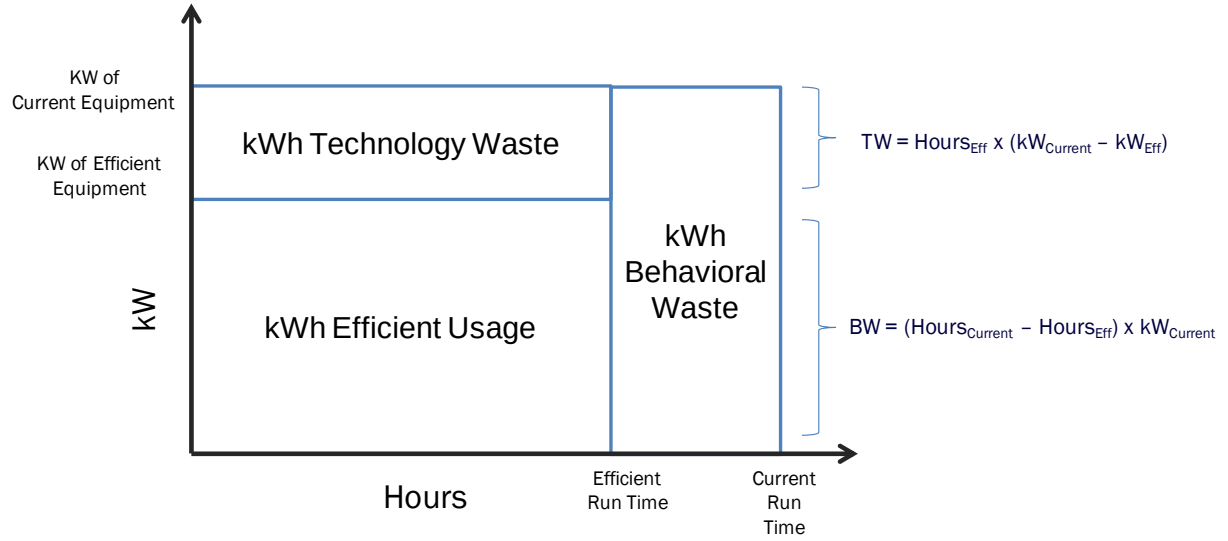
It should be noted that the residual, "efficient usage" is only efficient given the waste categories that we included in our analysis. Since there are many sources of waste for every end use, inasmuch as other categories of waste exist, efficient usage would be further reduced. As such, the estimate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

Figure 4-1. Usage and Waste Diagram—Addressing Technological Waste First



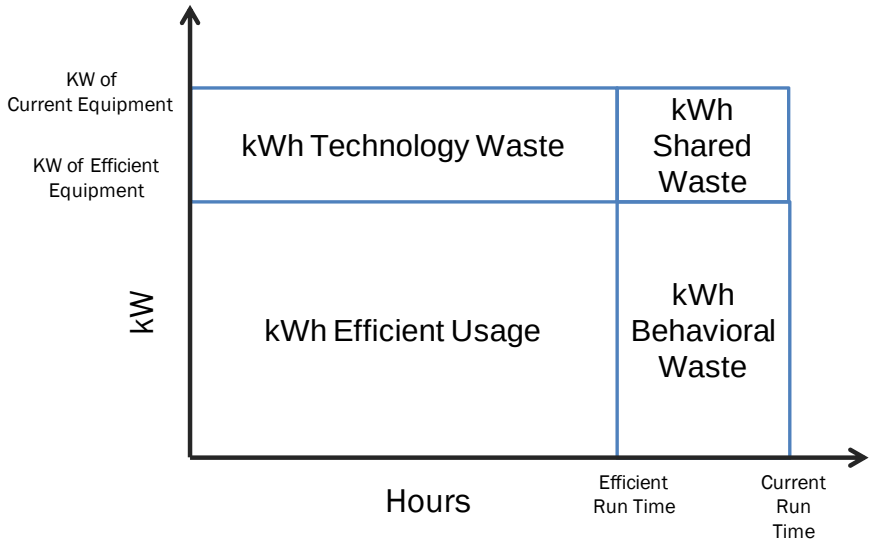
The graphic above shows definitions of waste if technological waste is addressed before behavioral waste. The magnitude of both types of waste changes, if behavioral waste is addressed first, is presented in the following graphic.

Figure 4-2. Usage and Waste Diagram—Addressing Behavioral Waste First



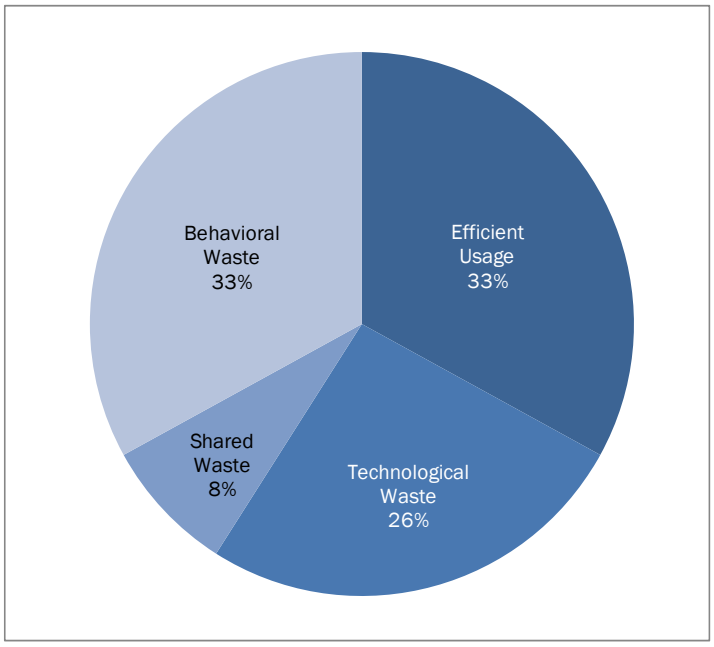
The difference between the two estimates of behavioral waste (and the two estimates of technological waste) can be considered "shared" waste, i.e., waste that is part of either technological waste or behavioral waste, depending on which is addressed first.

Figure 4-3. 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 4-4. Example Usage and Waste Pie Chart



This analysis focused on the key C&I end uses and major categories of technological and behavioral waste. The categories of technological waste and behavioral waste that are included in this analysis are summarized in Table 4-10 and Table 4-11, respectively.

Table 4-10. Technological Waste Categories Included in Analysis

End use/Equipment	Description
Lighting	• Upgrade high efficient lighting
Cooling	
Packaged/Split Systems	• Upgrade to new efficient system[a]
Chillers	• Upgrade to new efficient system, according to ComEd incentive qualification standards
Room AC	• Upgrade to new efficient unit, according to ComEd incentive qualification standards
Ventilation	• Installing variable frequency drives in air handling units • Use demand controlled ventilation (where applicable)
Motors	• Install variable frequency drives (where feasible) • Upgrade to new efficient motor
Refrigeration	
Standing Refrigerators/Freezers	• Upgrade to ENERGY STAR unit
Display Cases	• Upgrade to new efficient cases • Install LED lighting (where applicable) • Install occupancy sensors for lighting (where applicable) • Install electronically commutated (EC) evaporator fan motors • Install door heater controls (where applicable)
Walk-In Coolers/Freezers	• Install strip curtains • Install automatic door closers • Install electronically commutated (EC) evaporator fan motors • Install evaporator fan motor control • Allow floating head pressure control • Install door heater controls (where applicable)
Office Equipment	
Computers	• Upgrade to ENERGY STAR laptop • Replace all monitors with ENERGY STAR flat screen monitor
Imaging Equipment[b]	• Upgrade to ENERGY STAR unit
Servers	• Upgrade to more efficient servers • Upgrade computer room air conditioning equipment
Televisions	• Upgrade to ENERGY STAR television
Retail Register	• Upgrade to new efficient units

[a] 15 SEER for systems below 5.4 tons, 12.2 EER for system 5.4-20 tons, 10.6 EER for systems above 20 tons
[b] Imaging equipment includes standalone printers, standalone copy machines, standalone scanners, and multi-function devices

Table 4-11. Behavioral Waste Categories Included in Analysis

End use/Equipment	Description
Lighting	• Turn off lights when not in use for given task • Implement multiple methods of lighting controls
Cooling	• Maintain packaged or split systems regularly (at least every 30 months) • Increase occupied temperature setpoints (77°F for commercial; 82°F for industrial) • Increase unoccupied temperature setpoints (85°F for commercial and industrial)
Ventilation	• Reduce ventilation when not needed based on facility operations and production (industrial sector only)
Motors	• Perform regular maintenance of motors • Maintain or improve efficiency standards for motors through purchasing newer, more efficient motors rather than rewinding
Refrigeration	• Set refrigerators to 38°F and freezers to 0°F
Office Equipment	
Computers	• Turn off or switch to power saver mode when idle • Power down computers outside of business hours
Imaging Equipment[a]	• Optimize power management settings
Servers	• Virtualization (i.e., consolidation) • Power management improvements
Televisions	• Turn off television outside of business hours
Retail Registers	• Turn off register/POS terminal when not in use

[a] Imaging equipment includes standalone printers, standalone copy machines, standalone scanners, and multi-function devices

4.2.2 Adjustments to Penetration and Saturation Values

We adjusted penetration and saturation rates developed from the phone survey data to account for three types of errors that may cause bias in unadjusted phone survey results.[15] The three types of adjustments are described below.

End Use Category Adjustment

This adjustment accounts for self-report error in the end use penetration rate from phone survey questions that serve as "gateways" to more detailed equipment questions. For example, customers were asked whether they had "stand-alone commercial refrigeration." If they answered that they did not have this equipment, they were not asked specific questions

[15] A fourth type of potential bias is self-selection among phone survey respondents, if customers with greater interest in energy efficiency and management were more likely to respond to the survey. Survey sampling, recruitment and design attempted to minimize this bias.

about this type of refrigeration later in the survey, which could have refreshed their memory about certain types of refrigeration they may have that did not immediately come to mind when initially asked. The adjustment ratio is calculated by comparing end-use category penetration rates between phone survey respondents and the audit results at the same facilities.

Specific Equipment Adjustment

This adjustment accounts for self-report error in the specific type of equipment that is asked—for example, customers' self-report of having T8 linear fluorescent lamps, or a specific type of motor. This adjustment is only used when it is clear that the site visits were able to comprehensively audit all of the equipment types on site. For example, laptop computers may be difficult for auditors to count accurately if they are used outside of the office a portion of the day; therefore, we did not adjust these phone survey responses. For categorical variables (i.e., penetration rates) the adjustment ratio is calculated by comparing penetration rates of specific equipment between site audit respondents and the same phone survey respondents. For continuous variables (i.e., saturation rates) the adjustment ratio is calculated by comparing average counts of specific equipment or average values of equipment characteristics (e.g., motor HP) between site visit respondents and the same phone survey respondents.

Equipment Selection Bias Adjustment

This adjustment accounts for non-random selection of equipment modules. Each phone survey respondent was asked about only four end uses, even if their facility had more. Consequently, customers with more end uses such as motors, refrigeration, and compressed air were less likely to be asked about end uses such as lighting, cooling, ventilation, and computer electronics. Therefore, we might expect slightly different penetration and saturation rates among customers who have an end use but were not asked specific questions about it, compared with customers who have the end use and were asked about it. The adjustment ratio is calculated by comparing site visit penetration or saturation rates among customers who have the end use and were asked about it by phone, and customers who have the end use, but were not asked specific questions about the type of equipment over the phone.

To determine if each of the adjustments above was necessary to report a penetration or saturation rate, we first examined results of statistical tests. If the statistical test revealed a significant difference in the penetration or saturation rate (where applicable) at a confidence level of 95% (two-tailed), we performed an adjustment. The details of this process are described below.

4.2.3 Adjustments to Usage and Waste Values

Usage and waste algorithms are applied to both telephone and site visit data. For more end use algorithms, the site visit data contains more detailed and more complete information on equipment characteristics, such as quantity, age, capacity, and type. Both instruments collected detailed information on business characteristics, such as operating hours, production hours, the types (and sizes) of different spaces at the facility, number of employees, and penetration of equipment end uses. Therefore the engineering algorithms

can be applied to both sets of data, though adaptations (and assumptions) are required to apply the engineering algorithms to the phone survey data.

The phone survey provides the basis for usage and waste analysis at the segment or rate class level, because of the larger sample size of each analysis group (compared to the site visits). Because the phone survey responses may be less complete and potentially biased (in the ways listed above), phone survey usage and waste results must be adjusted to align directionally, if not proportionally, with what we aligned on site. The nested sample design allows for comparative analysis of engineering-based results applied to customers who completed both the telephone survey and site visit process. By comparing usage and waste percentages among an identical group of customers for whom we can apply the engineering algorithms to the phone survey data independently of the site visit data, as well as applying the algorithms to the phone survey data, we generate adjustment ratios for the following percentages:

- Baseline kWh as a percentage of annual kWh
- Total Waste kWh as a percentage of Baseline kWh
- Total technological savings (taken before behavioral savings) as a percentage of total waste
- Remaining behavioral savings (taken after technological) as a percentage of total waste
- Total behavioral savings (taken before technological savings) as a percentage of total waste
- Remaining technological savings (taken after behavioral) as a percentage of total waste

These adjustment ratios can then be applied to segment- or rate-class level weighted averages. The adjustment process accounts for a variety of discrepancies that arise between phone survey and site visit data, including non-systematic discrepancies. The engineering algorithm process is designed to develop assumptions than can correct for any systematic differences in self-report, such as hours of use of lighting, computer mode settings, or linear feet of refrigeration. However, many discrepancies we observed are not as systematic – square feet of the facility, equipment counts, equipment size, and even business hours. Because these biases can be upward or downward, we did not adjust many individual inputs in usage and waste analysis (e.g., computer counts) because such an adjustment – that might help correct one person – could inflate the results of another person, with cascading implications for usage & waste. Therefore we relied on an end-use-specific, aggregate adjustment process to both (a) pinpoint places where algorithm assumptions could be improved, and (b) develop an adjustment factor to apply to phone result.

The steps of the end-use-specific, aggregate usage and waste adjustment process are:

1. Apply engineering algorithms to all phone survey results and calculate usage and waste as a percentage of annual kWh

2. Apply engineering algorithms to all site visits results and calculate usage and waste as a percentage of annual kWh
3. For each end use, find all customers who have usage & waste estimates based on *both* their phone responses and the site audit data
4. Compare unweighted usage and waste percentages for this group of customers that have analogous results[16]
5. Develop the six adjustment ratios listed above based on the percent differences of each of the six key metrics between the site audit results and phone survey results
6. Apply adjustment ratios from this group to weighted average phone results from all analysis groups (segments, rate classes)

For example, there were 75 customers for whom we could calculate motors usage based on their site visit data (using a bottom-up, motor-by-motor approach) as well as the phone survey data (using segment- and rate-class level averages to fill in values of motor counts, horsepower or age that customers did not know). The engineering algorithms predicted that average annual motor use comprised 45% of annual kWh for these 75 customers using their site visit values, and comprised 52% of annual kWh using phone survey values. The average percentage difference of -12.5% can be applied to other segments and rate classes to adjust weighted average motors kWh as a proportion of annual facility kWh. For example, motor kWh among retail customers with motors was estimated at 32% using phone survey data, and adjusted to 28% using the aggregate, end-use-specific adjustment of -12.5%. This adjustment counts for a number of reporting differences – such as average motor horsepower, age, or not considering certain motor types when responding by phone – as well as any assumptions that were made to fill in missing values. A similar process can be applied to adjust waste percentages, which can account for more systematic differences such as over-reporting cooling set points (i.e., reporting a higher temperature set-point than observed) or over-reporting the use of computer energy-savings modes. In summary, this adjustment process enables site visit findings to be extrapolated to segment and rate class samples.

Technological and behavioral savings adjustments were applied to all end uses for which we calculated technological and behavioral savings. The usage adjustment was not applied to (a) ventilation, because the site visit methodology was only applicable to a subset of customers, or (b) motors for the largest rate class (> 400 kWh), because the phone survey methodology was different for this class (compared with the phone survey for all other segments and rate classes), therefore the same adjustment ratio would not apply.

[16] We compare unweighted results because this adjustment process aims to adjust for self-report error, which we do not expect to be systematically linked to segment or rate class across the variety of parameters under analysis.

5. GENERAL C&I CUSTOMER CHARACTERISTICS

The usage and waste analysis for each end use depended on the specific characteristics of ComEd's commercial and industrial customers. We use factors such as square footage of the facility, annual operating hours, and number of employees as inputs into various algorithms to calculate electricity usage for each end use. Table 5-1 shows characteristics of the customers' physical facilities while Table 5-2 shows the characteristics of the businesses, broken out by commercial segment and industrial rate class.

Table 5-1. Summary of Building Characteristics

	Total[17]	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
No. of ComEd Customers	300,230	168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230	15,675	12,377	2,282	1,016
Building Ownership (n=1,488)															
Own Building	43%	42%	33%	36%	38%	38%	40%	34%	62%	94%	56%	51%	47%	62%	79%
Lease/Rent Building	57%	58%	67%	64%	62%	62%	60%	66%	38%	6%	44%	49%	53%	38%	21%
Business Occupies More than One Building (n=1,513)	11%	11%	9%	6%	16%	3%	11%	14%	18%	11%	14%	18%	85%	76%	54%
Age of Building (n=1,221)															
2 to 9 Years	5%	6%	7%	12%	2%	9%	7%	8%	6%	17%	2%	4%	4%	4%	8%
10 to 19 Years	11%	11%	14%	11%	13%	9%	14%	7%	7%	7%	10%	11%	11%	10%	18%
20 to 29 Years	15%	15%	20%	21%	9%	15%	21%	20%	11%	19%	10%	16%	16%	19%	18%
30 to 39 Years	14%	14%	19%	11%	12%	11%	13%	14%	7%	7%	12%	14%	14%	18%	8%
40 to 49 Years	13%	13%	10%	16%	8%	10%	14%	4%	10%	16%	18%	17%	18%	15%	18%
More Than 50 Years	41%	41%	31%	29%	56%	47%	30%	47%	59%	34%	47%	37%	38%	33%	29%
Building Type (n=867)															
Standalone	78%	78%	74%	74%	71%	75%	79%	72%	89%	93%	83%	80%	77%	92%	86%
1 Shared Wall	12%	12%	18%	15%	12%	13%	11%	18%	5%	4%	9%	13%	15%	3%	8%
2 Shared Walls	9%	9%	8%	11%	17%	11%	10%	10%	6%	3%	6%	6%	6%	5%	6%
Other	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%	1%	0%	0%
Avg. Number of Stories	2.59	2.70	4.60	2.14	2.03	2.02	1.18	2.15	2.08	6.90	1.69	1.22	1.21	1.28	1.38

[17] This includes 116,543 ComEd customers with unknown SIC and NAICS, but excludes 41,594 who are an out-of-scope segment or public sector.

	Total[17]	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
(n=1,396)															
Area of Building[a] (n=1,368)															
0 to 2,499 Sqft	36%	38%	50%	50%	35%	42%	14%	46%	22%	17%	25%	15%	19%	1%	0%
2,500 to 4,999 Sqft	24%	25%	24%	29%	28%	36%	14%	25%	16%	3%	23%	17%	21%	0%	3%
5,000 to 9,999 Sqft	17%	16%	12%	13%	12%	16%	20%	15%	16%	10%	24%	19%	23%	3%	0%
10,000 to 49,999 Sqft	17%	15%	11%	5%	18%	5%	35%	9%	27%	40%	21%	38%	34%	68%	22%
50,000 to 99,999 Sqft	3%	3%	1%	1%	3%	0%	10%	3%	6%	10%	3%	7%	2%	22%	27%
100,000 Sqft or More	3%	3%	1%	2%	4%	0%	7%	2%	14%	21%	3%	4%	0%	7%	48%

[a] Square footage estimates were adjusted based on site visits and other sources

Table 5-2. Summary of Business Characteristics

	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
No. of ComEd Customers	300,230	168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230	15,675	12,377	2,282	1,016
Year Round Operation (n=1,516)	97%	97%	100%	100%	99%	98%	97%	95%	85%	99%	94%	98%	98%	99%	100%
Mean Operating Hours per Week (n=1,496)	61.7	62.0	52.8	55.0	62.2	89.4	55.6	97.8	57.5	149.7	61.1	58.2	52.3	70.8	102.4
Days Open per Week (n=1,518)															
Less than 5 days/week	4%	4%	3%	12%	3%	1%	3%	0%	8%	0%	4%	2%	2%	3%	1%
5 days/week	46%	44%	74%	50%	16%	2%	76%	5%	57%	2%	33%	73%	74%	76%	53%
More than 5 days/week	50%	52%	23%	38%	80%	97%	21%	95%	35%	98%	63%	25%	24%	21%	45%
Number of Employees (n=1,480)															
1-4 Employees	38%	38%	35%	34%	46%	25%	32%	47%	16%	23%	46%	31%	38%	3%	1%
5-9 Employees	28%	28%	30%	35%	22%	24%	27%	31%	14%	29%	28%	24%	29%	7%	1%
10-24 Employees	20%	19%	20%	18%	19%	32%	24%	9%	28%	12%	15%	23%	23%	33%	8%
25-99 Employees	11%	11%	12%	9%	10%	18%	15%	4%	28%	19%	6%	17%	8%	49%	43%
100 or More Employees	4%	4%	3%	4%	3%	1%	2%	8%	13%	17%	6%	5%	1%	8%	46%

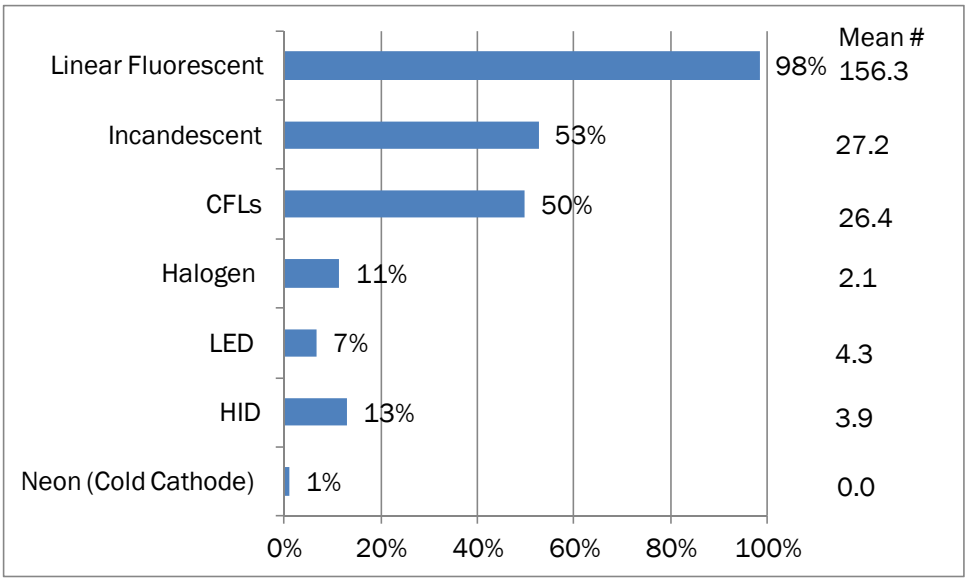
6. LIGHTING

Summary

Figure 6-1 presents the penetration and saturation of interior lighting equipment[18] among commercial customers in ComEd's service territory. The vast majority (98%) of commercial customers have linear fluorescent lighting installed in their businesses. Incandescent bulbs and CFLs are present in 53% and 50% of commercial businesses, respectively. Other lighting types, such as halogen bulbs, LEDs, and HID bulbs, can be found in less than a quarter of businesses as these are used in more specialized applications.

On average, ComEd customers in commercial segments have 225 working light fixtures. Linear fluorescent lights, incandescent bulbs, and CFLs are the most commonly installed fixture types, in terms of the number of fixtures per business.

Figure 6-1. Penetration and Saturation of Interior Lighting Fixtures among Commercial Customers



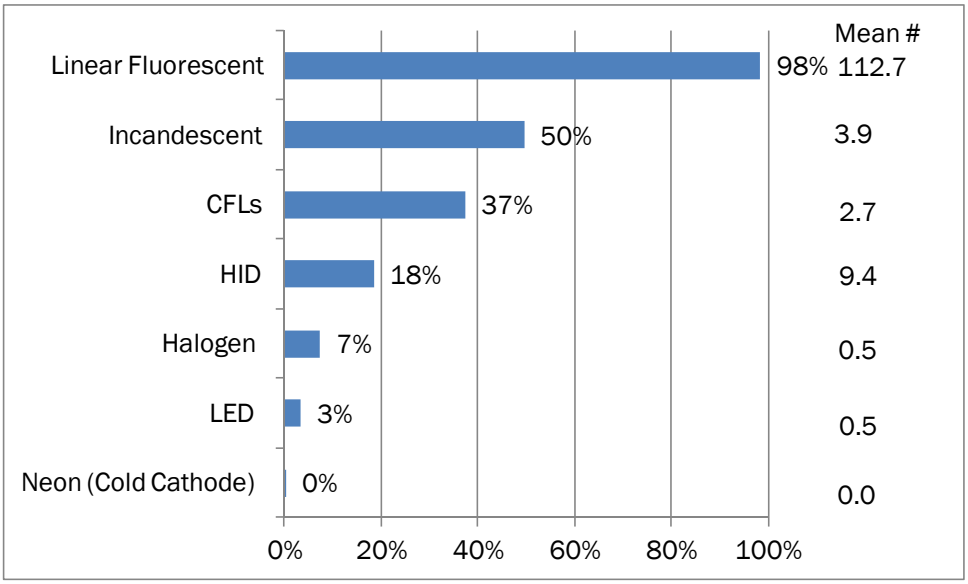
Source: Phone survey and site visits

Figure 6-2 shows the penetration and saturation of interior lighting equipment among industrial customers in ComEd's service territory. Nearly all (94%) industrial customers have linear fluorescent lights in their business. Similar to commercial customers, incandescent bulbs (37%) and CFLs (27%) represent the next most commonly present lighting types with other lighting types installed in 20% of businesses or less.

On average, ComEd customers in the industrial sector have 133 working light fixtures. Linear fluorescent lights are by far the most commonly installed fixture types.

[18] Lighting in this analysis refers to interior lighting. Exterior lighting was not quantified.

Figure 6-2. Penetration and Saturation of Interior Lighting Fixtures among Industrial Customers



Source: Phone survey and site visits

Table 6-1. Summary of Lighting Penetration and Saturation by Commercial Segment and Industrial Rate Class

Lighting	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
No. of Identifiable ComEd Customers	300,230	168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230	15,675	12,377	2,282	1,016
All Lighting															
Mean Number of Light Fixtures in Business	216.8	224.6	-	-	-	-	-	-	-	-	-	133.4	-	-	-
Percentage of Customers that Have Linear Fluorescent Lights in Business	98%	98%	99%	99%	98%	96%	99%	96%	100%	96%	98%	98%	99%	98%	93%
Mean Number of Linear Fluorescent Fixtures per Business	152.6	156.3	-	-	-	-	-	-	-	-	-	112.7	-	-	-
Percentage of Customers that Have CFLs in Business	46%	47%	41%	53%	53%	64%	23%	43%	56%	90%	45%	35%	34%	37%	45%
Mean Number of CFL Fixtures per Business	24.4	26.4	-	-	-	-	-	-	-	-	-	2.7	-	-	-
Percentage of Customers that Have Incandescent Bulbs in Business	50%	50%	46%	47%	51%	62%	31%	30%	50%	75%	55%	47%	46%	53%	56%
Mean Number of Incandescent Bulb Fixtures per Business	25.2	27.2	-	-	-	-	-	-	-	-	-	3.9	-	-	-
Percentage of Customers that Have HID Bulbs in Business[a]	13%	12%	8%	7%	16%	13%	15%	7%	15%	31%	17%	18%	15%	34%	28%
Mean Number of HID Bulb Fixtures per Business[a]	3.9	3.4	-	-	-	-	-	-	-	-	-	9.4	-	-	-
Percentage of Customers that Have Halogen Bulbs in Business	11%	11%	8%	13%	12%	20%	8%	9%	14%	18%	11%	7%	6%	9%	9%
Mean Number of Halogen Bulb Fixtures per Business	1.9	2.1	-	-	-	-	-	-	-	-	-	0.5	-	-	-

Lighting	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
Percentage of Customers that Have LED Lights in Business	6%	6%	6%	6%	5%	9%	3%	9%	9%	15%	6%	3%	3%	5%	8%
Mean Number of LED Light Fixtures per Business	4.0	4.3	-	-	-	-	-	-	-	-	-	0.5	-	-	-
Percentage of Customers that Have Neon (Cold Cathode) Lights in Business	1%	1%	0%	0%	1%	3%	0%	2%	0%	1%	1%	0%	0%	0%	0%
Mean Number of Neon (Cold Cathode) Light Fixtures per Business	0.0	0.0	-	-	-	-	-	-	-	-	-	0.0	-	-	-
Linear Fluorescent Lights															
Percentage of Customers that Have T12 Linear Fluorescent Lights in Business	66%	65%	64%	75%	76%	73%	65%	69%	57%	78%	54%	71%	72%	73%	55%
Mean Number of T12 Linear Fluorescent Light Fixtures per Business	63.0	64.2	-	-	-	-	-	-	-	-	-	50.3	-	-	-
Percentage of Customers that Have T10 Linear Fluorescent Lights in Business	2%	2%	2%	1%	1%	1%	1%	*	*	0%	2%	1%	1%	0%	0%
Mean Number of T10 Linear Fluorescent Light Fixtures per Business	0.0	0.0	-	-	-	-	-	-	-	-	-	0.0	-	-	-
Percentage of Customers that Have T8 Linear Fluorescent Lights in Business[b]	57%	58%	62%	59%	60%	55%	45%	*	*	69%	53%	56%	52%	61%	83%
Mean Number of T8 Linear Fluorescent Light Fixtures per Business[b]	71.7	73.0	-	-	-	-	-	-	-	-	-	58.0	-	-	-
Percentage of Customers that Have T5 Linear Fluorescent Lights in	11%	10%	8%	11%	6%	5%	26%	*	*	5%	13%	12%	9%	21%	24%

Lighting	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
Business[c]															
Mean Number of T5 Linear Fluorescent Light Fixtures per Business[c]	17.8	19.1	-	-	-	-	-	-	-	-	-	4.0	-	-	-
Lighting Controls															
Percentage of Customers with only Manual Lighting Controls	78%	77%	-	-	-	-	-	-	-	-	-	91%	-	-	-
Percentage of Customers with One Other Non-Manual Lighting Control Type in Additional to a Manual Control	14%	15%	-	-	-	-	-	-	-	-	-	8%	-	-	-
Percentage of Customers with Two or more Non-Manual Lighting Controls	4%	5%	-	-	-	-	-	-	-	-	-	0%	-	-	-
Percentage of Customers with Energy Management System	2%	3%	-	-	-	-	-	-	-	-	-	0%	-	-	-
Percentage of Light Fixtures that are Manually Controlled	78%	77%	-	-	-	-	-	-	-	-	-	96%	-	-	-
Percentage of Light Fixtures with Dimmer or Dual Level Switches	1%	1%	-	-	-	-	-	-	-	-	-	0%	-	-	-
Percentage of Light Fixtures with Timers	5%	5%	-	-	-	-	-	-	-	-	-	0%	-	-	-
Percentage of Light Fixtures with Occupancy Sensors	4%	5%	-	-	-	-	-	-	-	-	-	1%	-	-	-
Percentage of Light Fixtures with No Controls	2%	2%	-	-	-	-	-	-	-	-	-	3%	-	-	-
Percentage of Light Fixtures with Energy Management System	10%	10%	-	-	-	-	-	-	-	-	-	0%	-	-	-
Percentage of Light Fixtures on During	94%	94%	-	-	-	-	-	-	-	-	-	97%	-	-	-

Lighting	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
Business Hours															
Percentage of Light Fixtures on During Non-Business Hours	23%	23%	-	-	-	-	-	-	-	-	-	21%	-	-	-
Exterior Lighting[d]															
Percentage of Customers with Exterior Lighting Included in Electric Bill	51%	50%	30%	35%	59%	67%	55%	55%	62%	81%	66%	58%	51%	84%	96%
Percentage of Customers with Exterior Lighting - Surface Parking Lot Lights	61%	61%	62%	63%	61%	47%	59%	60%	78%	78%	63%	63%	54%	81%	96%
Percentage of Customers with Exterior Lighting - Parking Lot Lights	4%	4%	4%	5%	2%	2%	0%	0%	0%	6%	6%	1%	1%	0%	6%
Percentage of Customers with Exterior Lighting - Walkway and Entryway Lights	57%	55%	57%	55%	58%	68%	66%	57%	82%	89%	46%	69%	63%	82%	90%
Exit Signs															
Percentage of Customers that Have Exit Signs in Business	84%	84%	79%	89%	80%	94%	90%	88%	94%	90%	85%	88%	86%	95%	97%
Average Number of Exit Signs per Business	7.1	7.1	6.5	10.9	4.4	3.6	8.1	3.1	26.8	40.0	6.8	6.4	4.3	11.0	28.1
Percentage of Exit Sign Fixtures that are Incandescent	30%	29%	-	-	-	-	-	-	-	-	-	47%	-	-	-
Percentage of Exit Sign Fixtures that are CFL	23%	23%	-	-	-	-	-	-	-	-	-	16%	-	-	-
Percentage of Exit Sign Fixtures that are LED	41%	41%	-	-	-	-	-	-	-	-	-	35%	-	-	-

* Denotes fewer than 30 observations.

[a] HID Lighting includes metal halide, high pressure sodium, and mercury vapor bulbs

[b] T8 Linear Fluorescent lights include T8 Plus lights

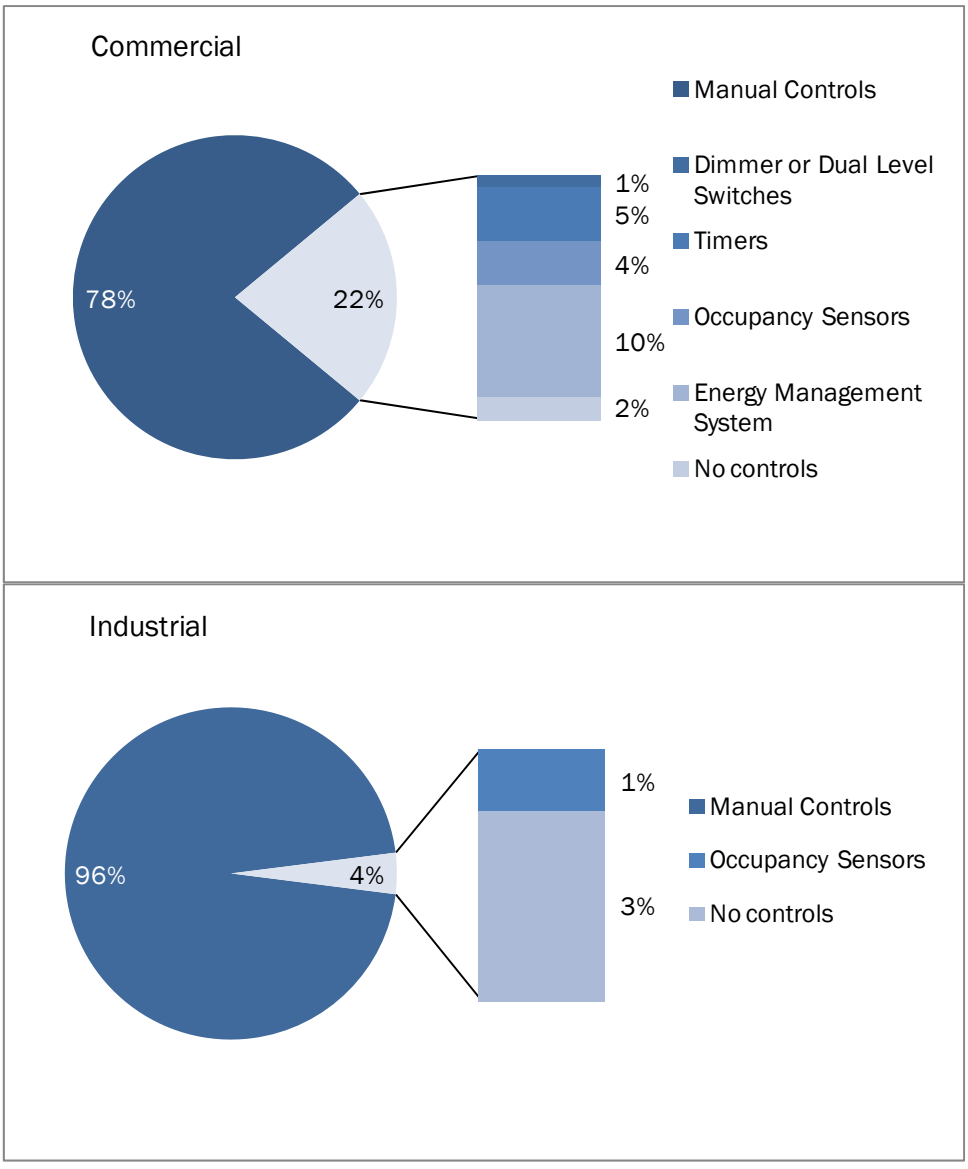
[c] T5 Linear Fluorescent lights include T5 High Output (T5HO) lights

[d] Penetration of exterior lighting types is based on the number of customers with outdoor lighting included in electric bill

Lighting Controls

As shown in Figure 6-3, the manual controls (on/off switches) control the majority of light fixtures for in both the commercial and industrial sectors. Only 4% of fixtures in commercial businesses use occupancy sensors, compared to 1% in industrial businesses.

Figure 6-3. Percentage of Light Fixtures by Control Type



Source: Phone survey and site visits

Usage and waste analysis

Electricity consumption for lighting depends on several technological and behavioral factors:

- Installed wattage, based on the square footage and baseline lighting power density and validated by using lighting/lamp types, wattage, and bulb counts, and

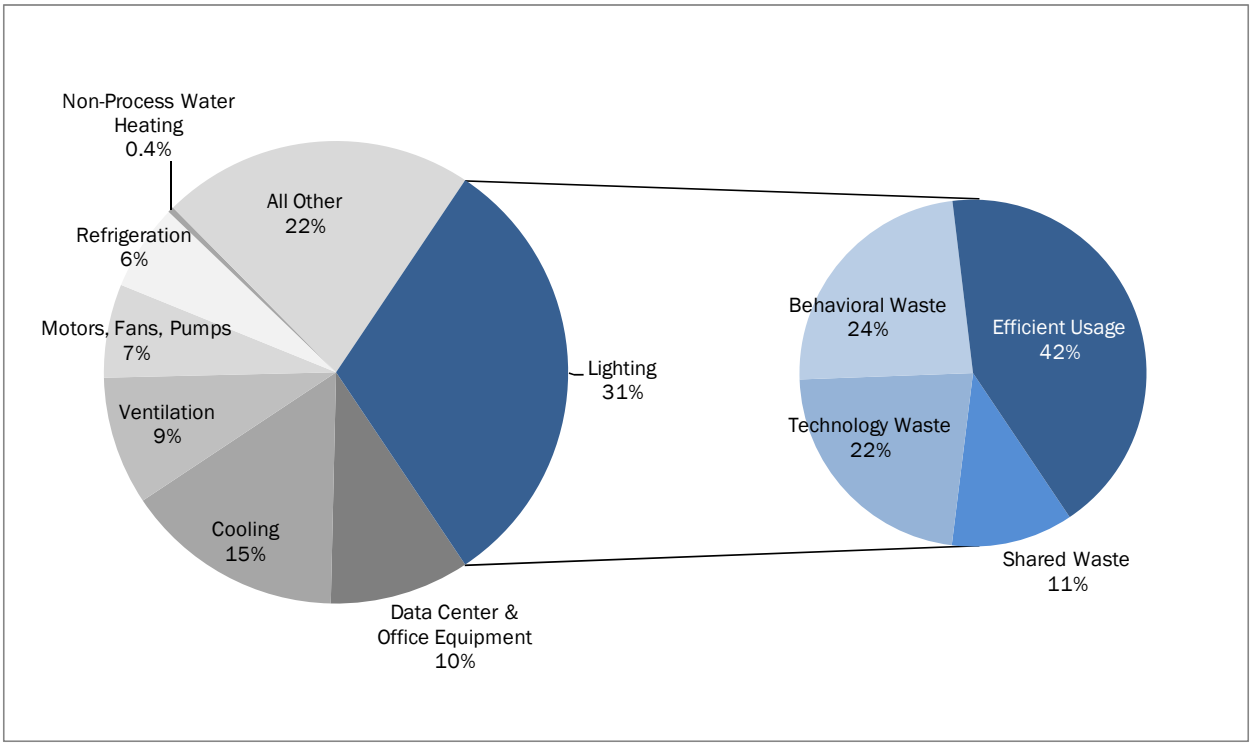
- The expected hours of use, determined by the percentage of lighting on during business operating hours and the percentage of lighting on during non-operating hours.

We define technological waste for lighting as the difference between the usage of installed lighting and the usage high efficiency lighting. Behavioral waste for lighting occurs when lights are used for longer than needed for a given task.

Commercial Sector

Figure 6-4 shows the contribution of interior lighting to overall commercial electricity usage (illustrated in the pie chart on the left) and the breakout of lighting usage into efficient usage, technological waste, behavioral waste, and "shared waste" (shown in the pie chart on the right). Shared waste refers to the portion of waste that can be addressed by either technology upgrades or behavior changes, depending on which is addressed first. The figure shows lighting accounts for 31% of overall electricity use in the commercial sector. Large opportunities for energy savings exist for lighting in the commercial sector, as efficient usage accounts for only 42% of total base electricity use for lighting. If technologies are addressed first, 34% of usage can be saved by upgrading to newer, more efficient equipment. If behavior is addressed first, 35% can be saved implementing energy-saving behaviors, such as turning off lights outside of business hours or using occupancy sensors.

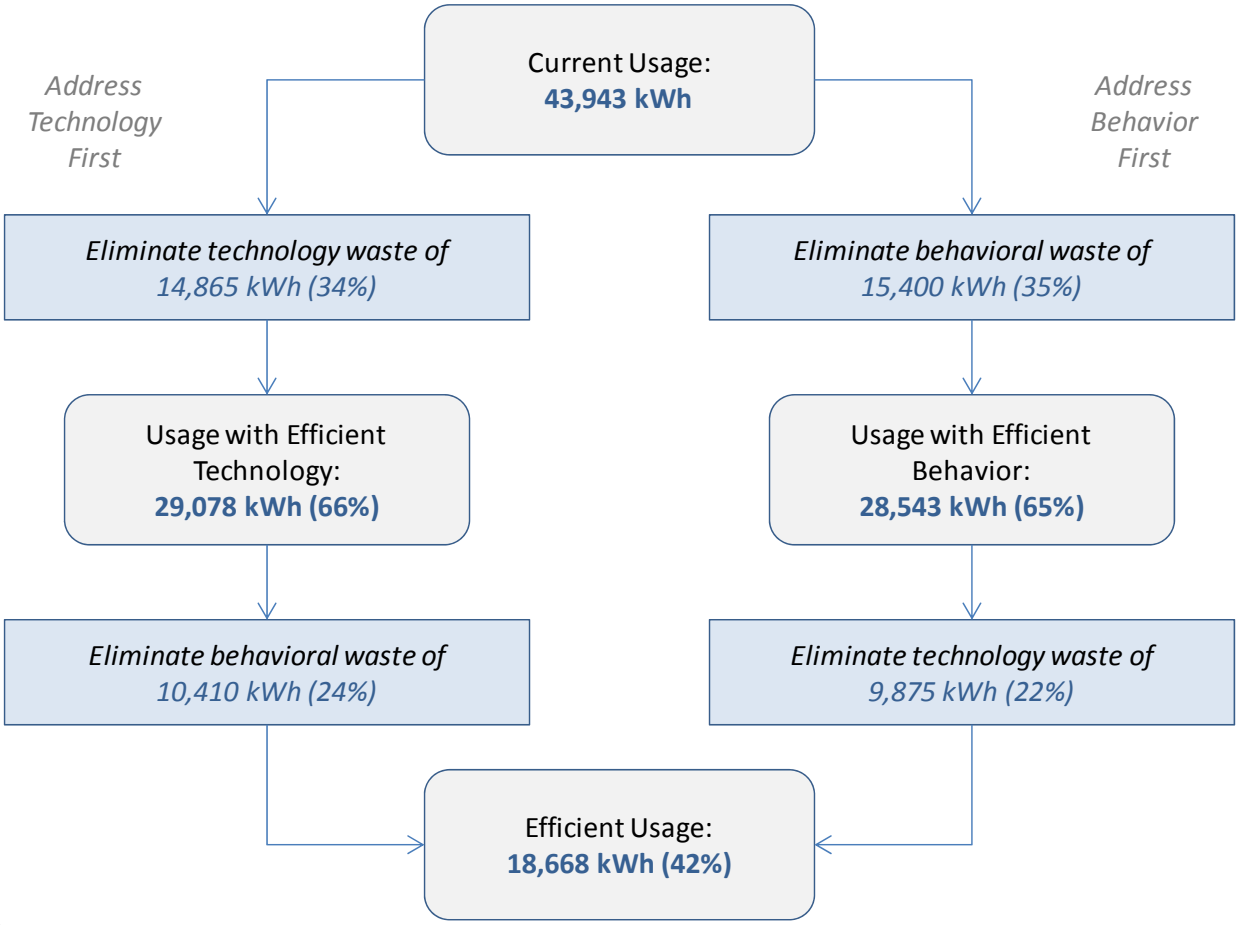
Figure 6-4: Usage and Waste Analysis for the Commercial Sector – Lighting



Source: Usage and waste analysis

Figure 6-5 shows the average annual energy usage and savings potential associated with lighting for the commercial sector. The figure shows estimated usage and technological and behavioral savings when addressing technological waste first or behavioral waste first.

Figure 6-5: Technological and Behavioral Potential for the Commercial Sector – Lighting



Source: Usage and waste analysis

Table 6-2 shows the average annual energy usage and savings potential associated with lighting for the commercial sector by segment. The table shows estimated usage and savings when addressing technological waste, behavioral waste, and both. Note that the data we provide in the figures and tables shows the percentage of equipment (or end use) usage and waste among all customers in the sector or sub-sector, including those who may not have the equipment.

Table 6-2. Technological and Behavioral Potential by Commercial Segment – Lighting

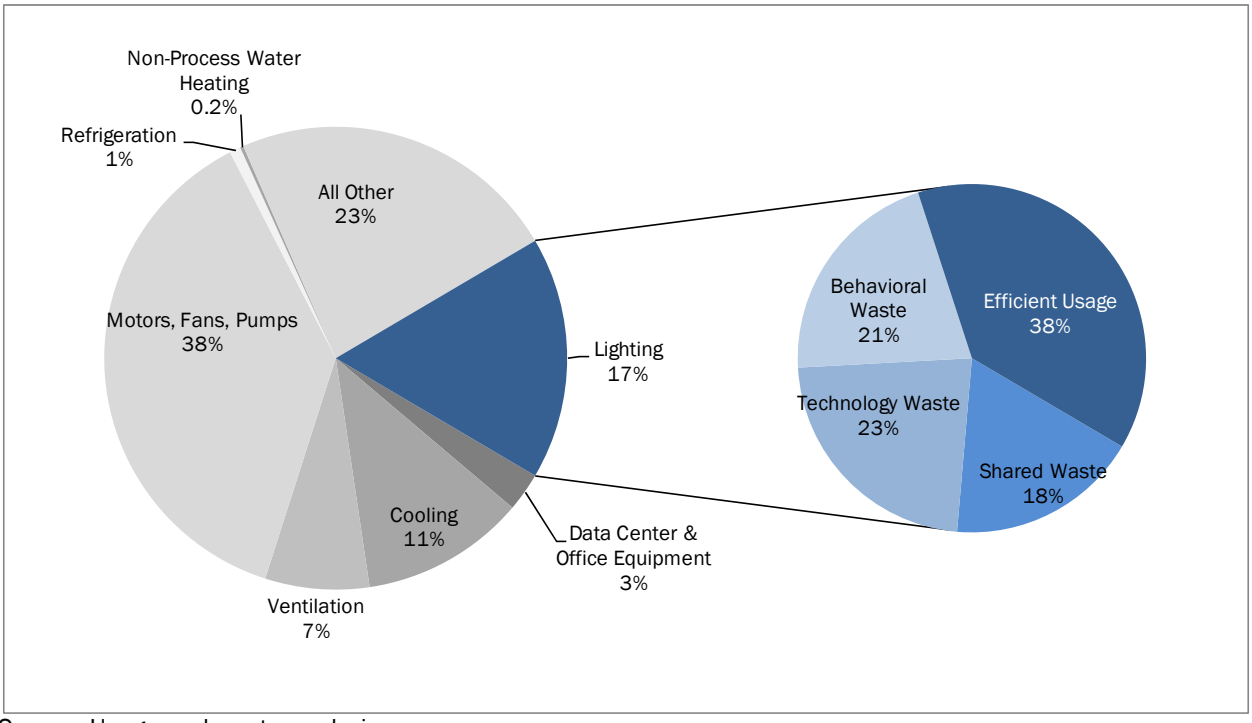
		Comm. Total	Office	Hosp / Health Svc	Retail	Food Svc	Ware-house	Groc / Conv	Education	Lodging	Other Comm.
Number of Identifiable Customers		168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230
Average Annual kWh		140,949	112,914	127,846	118,829	134,946	228,249	378,347	459,606	974,624	105,648
Sample (n)		962	158	126	108	155	150	53	54	54	104
Percentage That Have Equipment		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Usage & Waste Summary											
Avg Base Usage	% Annual kWh kWh	31% 43,943	30% 34,172	32% 40,577	49% 57,889	17% 23,505	37% 83,791	25% 93,747	33% 150,443	27% 259,763	29% 30,698
Avg Total Waste	% Base Usage kWh	58% 25,275	58% 19,760	60% 24,191	52% 30,069	60% 14,164	60% 50,381	51% 48,125	57% 85,602	61% 157,222	61% 18,612
Avg Efficient Usage	% Base Usage kWh	42% 18,668	42% 14,412	40% 16,385	48% 27,820	40% 9,340	40% 33,410	49% 45,622	43% 64,841	39% 102,541	39% 12,086
Address Technology First											
Avg Technological Waste	% Base Usage kWh	34% 14,865	33% 11,398	36% 14,644	25% 14,700	37% 8,764	38% 32,180	26% 23,958	35% 52,009	40% 102,865	39% 11,828
Avg Behavioral Waste	% Base Usage kWh	24% 10,410	24% 8,362	24% 9,547	27% 15,369	23% 5,401	22% 18,201	26% 24,167	22% 33,594	21% 54,357	22% 6,784
Address Behavior First											
Avg Behavioral Waste	% Base Usage kWh	35% 15,400	35% 12,005	37% 14,891	30% 17,631	37% 8,772	37% 31,387	30% 28,258	35% 52,327	38% 98,649	38% 11,593
Avg Technological Waste	% Base Usage kWh	22% 9,875	23% 7,755	23% 9,300	21% 12,439	23% 5,392	23% 18,994	21% 19,867	22% 33,276	23% 58,573	23% 7,019

Source: Usage and waste analysis

Industrial Sector

Figure 6-6 shows the average annual energy usage and savings potential associated with interior lighting for ComEd customers in the industrial sector. For this sector, efficient usage accounts for 38% of total base electricity use on lighting. Addressing technology first results in savings of 41% of usage, while addressing behaviors first saves 39%.

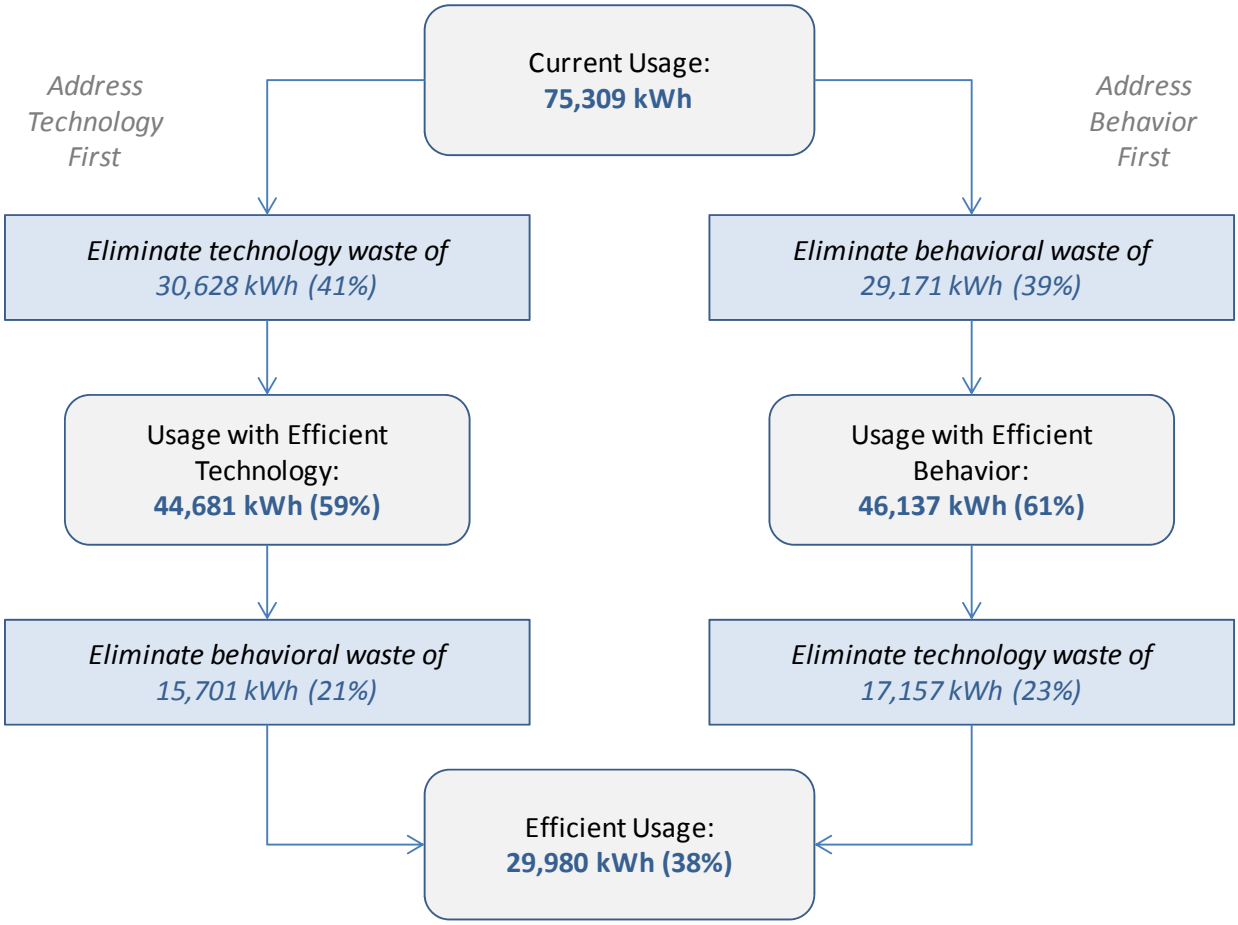
Figure 6-6: Usage and Waste Analysis for the Industrial Sector – Lighting



Source: Usage and waste analysis

Figure 6-7 shows the average annual energy usage and savings potential associated with lighting for the industrial sector. The figure shows estimated usage and technological and behavioral savings when addressing technological waste first or behavioral waste first.

Figure 6-7: Technological and Behavioral Potential for the Industrial Sector– Lighting



Source: Usage and waste analysis

Table 6-3 shows the average annual energy usage and savings potential associated with lighting for the industrial sector by rate class. The table shows estimated usage and savings when addressing technological waste, behavioral waste, and both.

Table 6-3. Technological and Behavioral Potential by Industrial Rate Class – Lighting

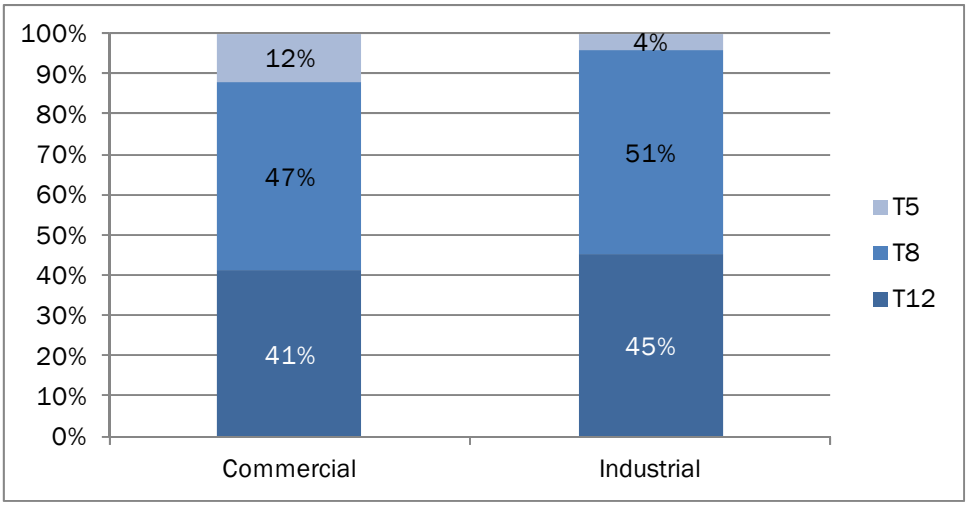
		Industrial Total	Less than 100 kW	100-400 kW	Greater than 400 kW
Number of Identifiable Customers		15,675	12,377	2,282	1,016
Average Annual kWh		444,425	50,339	568,641	4,966,218
Sample (n)		521	310	138	73
Percentage that have Equipment		100%	100%	100%	100%
Usage & Waste Summary					
Avg Base Usage	% Annual kWh	17%	28%	18%	13%
	kWh	75,309	14,200	100,714	636,718
Avg Total Waste	% Base Usage	62%	63%	62%	59%
	kWh	46,328	8,918	62,553	378,123
Avg Efficient Usage	% Base Usage	38%	37%	38%	41%
	kWh	28,980	5,282	38,161	258,595
Address Technology First					
Avg Technological Waste	% Base Usage	41%	40%	41%	42%
	kWh	30,628	5,729	41,011	265,066
Avg Behavioral Waste	% Base Usage	21%	22%	21%	19%
	kWh	15,701	3,189	21,542	121,841
Address Behavior First					
Avg Behavioral Waste	% Base Usage	39%	39%	39%	32%
	kWh	29,171	5,606	39,397	205,398
Avg Technological Waste	% Base Usage	23%	23%	23%	19%
	kWh	17,157	3,312	23,156	120,620

Linear Fluorescent Lighting

As shown in Table 6-1, nearly all commercial and industrial businesses have interior linear fluorescent lights, with at least 98% of customers in each segment or rate class having these lights.

As shown in Figure 6-8, T8 fixtures account for approximately half of all interior linear fluorescent fixtures installed in the ComEd service territory (47% in commercial segments and 51% in industrial segments). T12 fixtures represent similar, but smaller shares of installed linear fluorescent fixtures. Twelve percent of linear fluorescent light fixtures in the commercial sector are T5 types, while this type makes up only 4% of fixtures in the industrial sector. Note that less than 1% of all linear fluorescent fixtures are T10 fixtures.

Figure 6-8. Percentage of Installed Interior Linear Fluorescent Light Fixtures by Type



Source: Phone survey and site visits

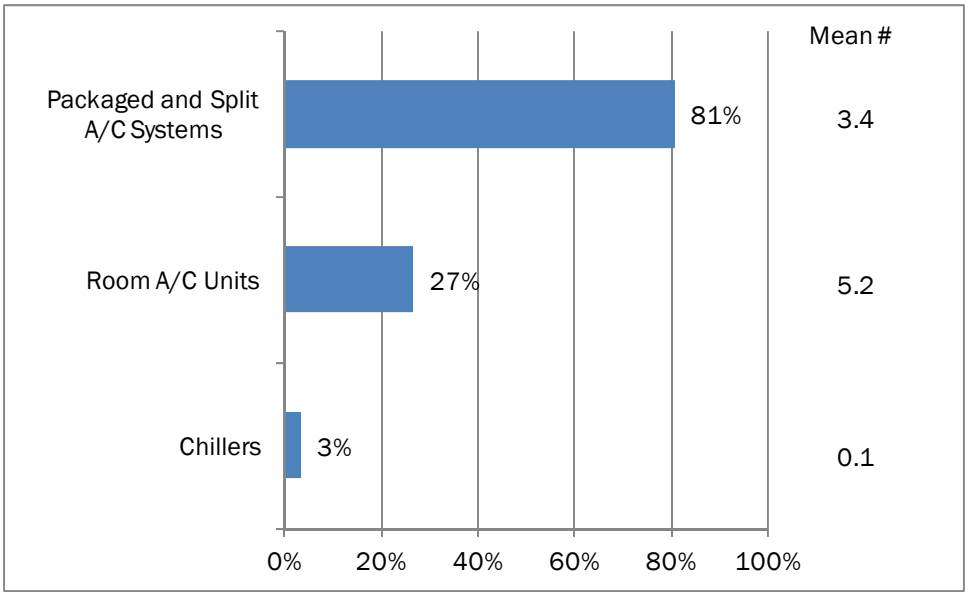
7. COOLING

Summary

Figure 7-1 shows the penetration and saturation of cooling equipment among commercial customers in ComEd's service territory. Overall, 92% of commercial customers have cooled spaces in their business. Over three-quarters (81%) of customers in commercial segments have a packaged or split cooling system. Twenty-seven percent of commercial customers have room air conditioning units (window or wall mounted units) and 3% have chillers.

On average, ComEd customers in commercial segments have 3.4 packaged/split cooling systems, 5.2 room air conditioner units, and 0.1 chillers.

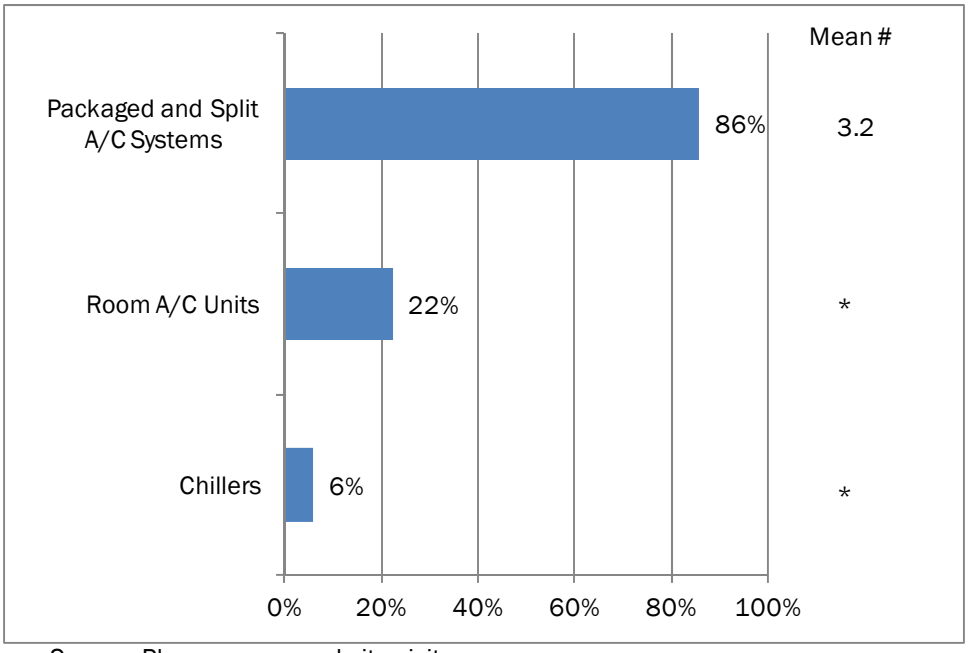
Figure 7-1. Penetration and Saturation of Cooling Equipment among Commercial Customers



Source: Phone survey and site visits

Figure 7-2 presents the penetration and saturation of cooling equipment among industrial customers in ComEd's service territory. Overall, 91% of ComEd customers in the industrial sector have cooled spaces in their business. Nearly nine tenths (86%) of industrial customers have packaged or split cooling systems, while 22% have window/wall units, and 6% have chillers. The average industrial customers has 3.2 packaged or split systems. We do not report the mean number of window/wall units and chillers due to the low number of observations.

Figure 7-2. Penetration and Saturation of Cooling Equipment among Industrial Customers



Source: Phone survey and site visits

Table 7-1. Summary of Cooling Equipment Penetration and Saturation by Commercial Segment and Industrial Rate Class

Cooling	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
No. of Identifiable ComEd Customers	300,230	168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230	15,675	12,377	2,282	1,016
Overall Cooling															
Percentage of Customers That Have Cooled Spaces	92%	92%	93%	91%	93%	99%	90%	98%	97%	96%	88%	91%	89%	95%	98%
Percentage of Customers with Cooling Controlled by Manual Thermostat	48%	48%	47%	53%	52%	52%	34%	57%	42%	55%	45%	46%	50%	34%	20%
Percentage of Customers with Cooling Controlled by Programmable Thermostat	55%	55%	55%	58%	50%	56%	68%	42%	53%	28%	55%	64%	63%	71%	61%
Percentage of Customers with Cooling Controlled by EMS	6%	6%	9%	5%	6%	1%	0%	7%	10%	9%	4%	3%	0%	6%	23%
Percentage of Customers with Cooling Controlled by Manual On/Off	2%	2%	1%	1%	2%	2%	2%	2%	4%	6%	2%	1%	1%	1%	1%
Percentage of Customers with Regularly Maintained Cooling Equipment	80%	80%	76%	83%	80%	90%	83%	*	87%	91%	75%	85%	82%	95%	*
Packaged and Split Cooling Systems															
Have Packaged/Split Systems in Business	81%	81%	78%	80%	85%	89%	87%	*	82%	68%	76%	86%	84%	93%	*
Mean Number of Packaged/Split Systems in Business	3.4	3.4	-	-	-	-	-	-	-	-	-	3.2	-	-	-
Mean Age of Packaged/Split Systems	12.1	12.0	-	-	-	-	-	-	-	-	-	13.6	-	-	-
Mean Rated Cooling Capacity of Packaged/Split Systems	7.9	8.0	-	-	-	-	-	-	-	-	-	7.5	-	-	-

Cooling	Total	Total Comm-ercial	Commercial Segment									Total Industrial	Industrial Rate Class		
			Office	Hosp/ Health Svc	Retail	Food Svc	Ware-house	Groc/ Conv	Education	Lodging	Other		<100 kW	100-400 kW	>400 kW
Room Air Conditioners															
Percentage of Customers That Have Room A/C Units in Business	26%	27%	23%	11%	29%	23%	9%	*	44%	64%	35%	22%	23%	12%	*
Mean Number of Room A/C Units in Business	5.0	5.2	*	*	*	*	*	*	*	*	*	*	*	*	*
Mean Age of Room A/C Units	6.8	6.7	*	*	*	*	*	*	*	*	*	*	*	*	*
Chillers															
Percentage of Customers That Have Chillers in Business	4%	3%	5%	5%	1%	1%	2%	*	10%	13%	3%	6%	3%	6%	*
Mean Number of Chillers in Business	0.1	0.1	*	*	*	*	*	*	*	*	*	*	*	*	*
Mean Age of Chillers	14.1	14.3	*	*	*	*	*	*	*	*	*	*	*	*	*
Mean Chiller Size (Tons)	348.0	373.6	*	*	*	*	*	*	*	*	*	*	*	*	*
Percentage of Customers with Chillers with Chilled Water Flow Controlled by VFD	47%	46%	*	*	*	*	*	*	*	*	*	*	*	*	*

* Denotes fewer than 30 observations.

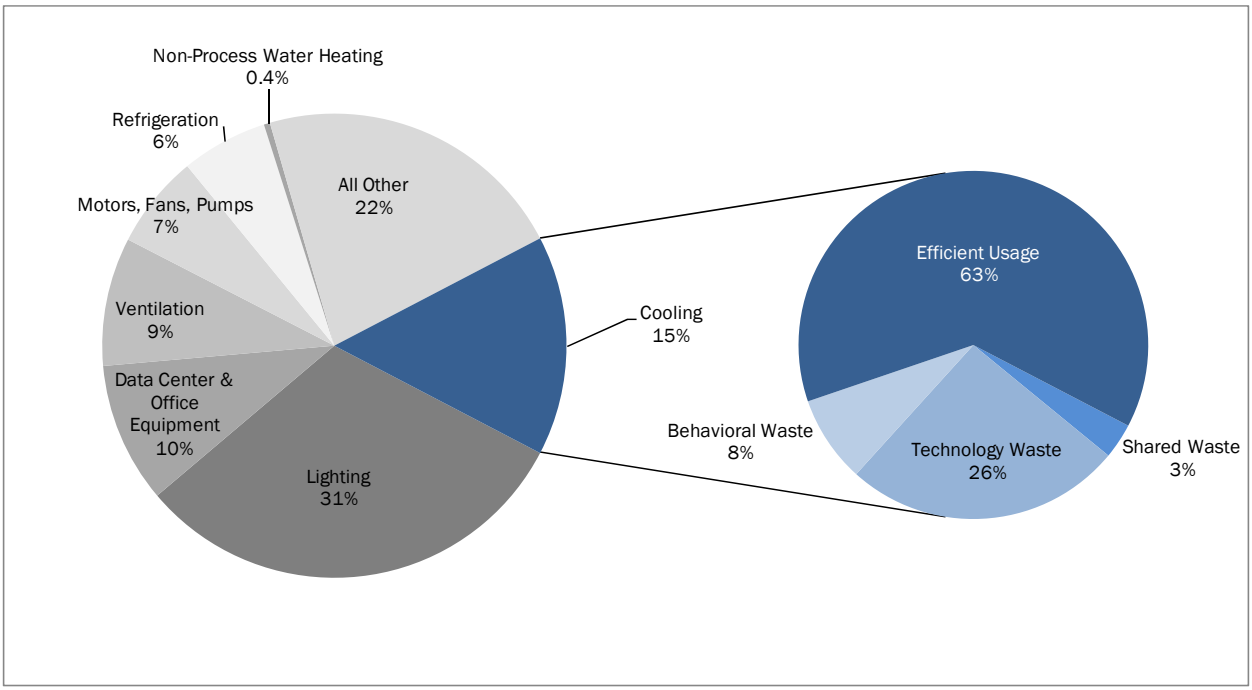
Usage and waste analysis

We use different algorithms to calculate the usage and waste of the different types of cooling equipment under study. Following the presentation of the usage and waste analyses for the commercial and industrial sectors, we provide the factors that feed into the calculation of each equipment type's usage and technological and behavioral waste.

Commercial Sector

Figure 7-3 shows the contribution of cooling equipment to overall commercial electricity usage (illustrated in the pie chart on the left) and the breakout of cooling equipment usage into efficient usage, technological waste, behavioral waste, and "shared waste" (shown in the pie chart on the right). Shared waste refers to the portion of waste that can be addressed by either technology upgrades or behavior changes, depending on which is addressed first. The figure shows cooling accounts for 15% of overall electricity use in the commercial sector. Efficient usage accounts for 63% of total base electricity use for cooling equipment. If technologies are addressed first, 29% of usage can be saved by upgrading to newer, more efficient equipment. If behavior is addressed first, 11% can be saved by changing temperature setpoints to more efficient levels during operation hours and non-operation hours.

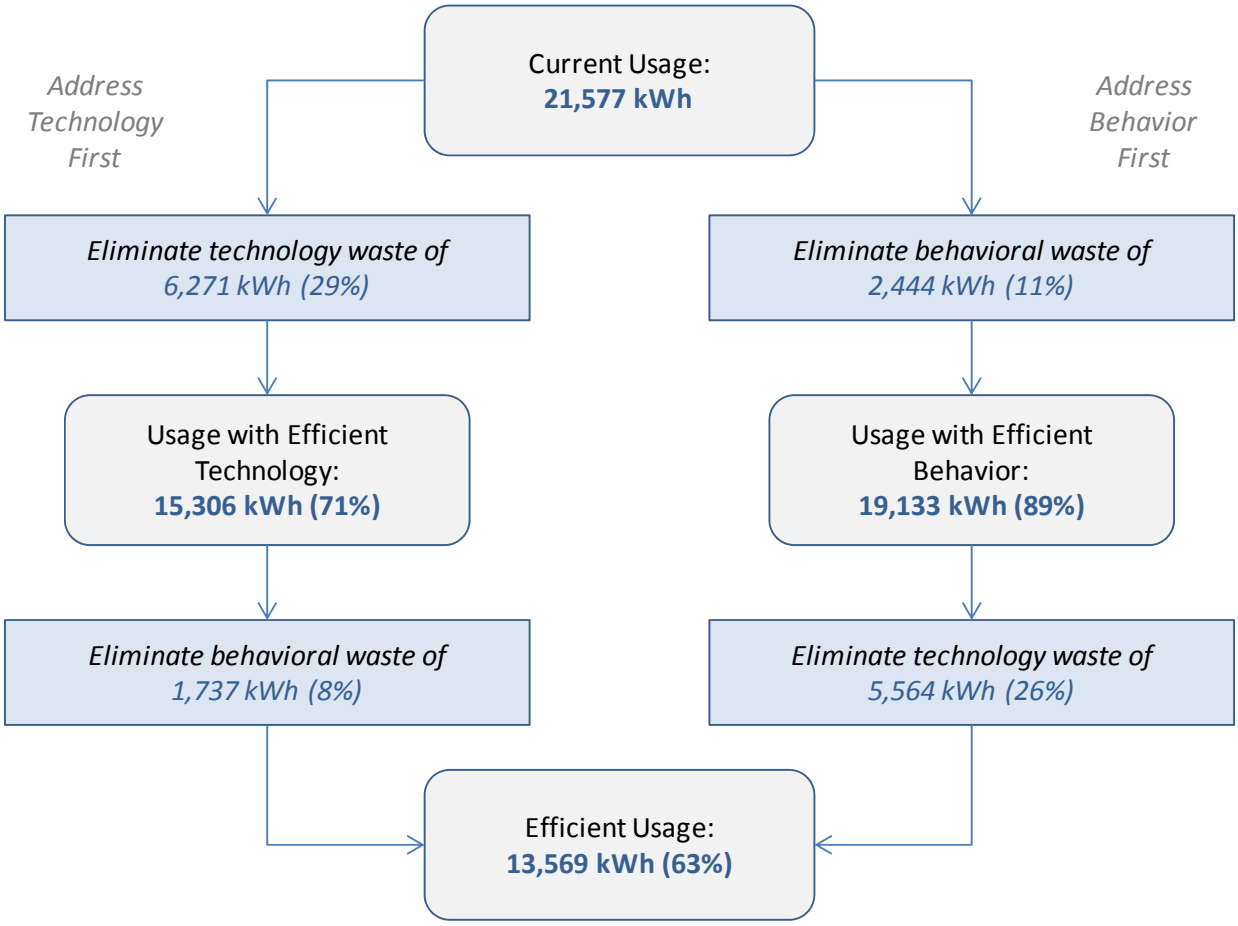
Figure 7-3: Usage and Waste Analysis for the Commercial Sector – All Cooling Equipment



Source: Usage and waste analysis

Figure 7-4 shows the average annual energy usage and savings potential associated with cooling for the commercial sector. The figure shows estimated usage and technological and behavioral savings when addressing technological waste first or behavioral waste first.

Figure 7-4: Technological and Behavioral Potential for the Commercial Sector – All Cooling Equipment



Source: Usage and waste analysis

Table 7-2 shows the average annual energy usage and savings potential associated with cooling equipment for the commercial sector by segment. The table shows estimated usage and savings when addressing technological waste, behavioral waste, and both. Note that the data we provide in the figures and tables shows the percentage of equipment (or end use) usage and waste among all customers in the sector or sub-sector, including those who may not have the equipment.

Table 7-2. Technological and Behavioral Potential by Commercial Segment – All Cooling Equipment

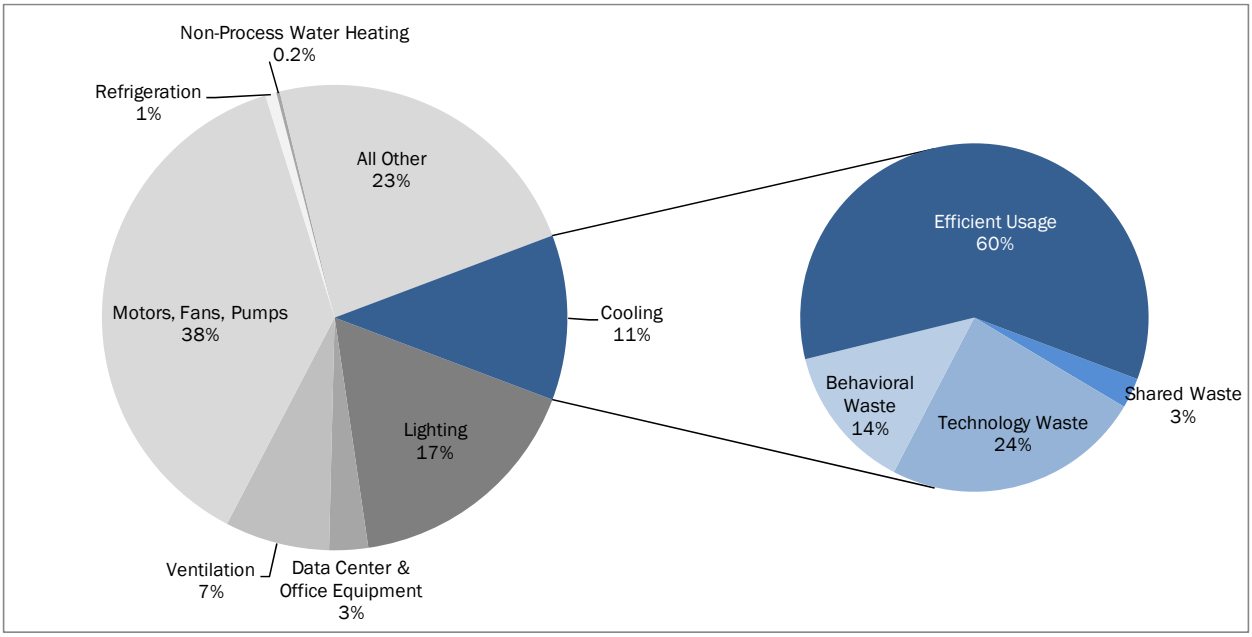
		Comm. Total	Office	Hosp / Health Svc	Retail	Food Svc	Ware-house	Groc / Conv	Education	Lodging	Other Comm.
Number of Identifiable Customers		168,012	49,531	17,344	21,968	15,184	8,817	4,664	3,136	1,138	46,230
Average Annual kWh		140,949	112,914	127,846	118,829	134,946	228,249	378,347	459,606	974,624	105,648
Sample (n)		651	115	92	70	112	76	29	42	47	68
Percentage That Have, Own/Maintain Own Cooling		64%	54%	60%	76%	74%	62%	82%	74%	86%	65%
Usage & Waste Summary											
Avg Base Usage	% Annual kWh kWh	15% 21,577	15% 17,443	22% 28,197	17% 19,923	7% 9,663	5% 11,893	7% 25,834	21% 98,316	23% 228,152	15% 16,348
Avg Total Waste	% Base Usage kWh	37% 8,008	39% 6,720	39% 10,860	37% 7,364	43% 4,180	47% 5,612	43% 11,106	34% 33,014	39% 87,910	32% 5,264
Avg Efficient Usage	% Base Usage kWh	63% 13,569	61% 10,723	61% 17,337	63% 12,559	57% 5,483	53% 6,281	57% 14,727	66% 65,302	61% 140,242	68% 11,084
Address Technology First											
Avg Technological Waste	% Base Usage kWh	29% 6,271	33% 5,706	28% 7,896	29% 5,754	34% 3,258	28% 3,286	27% 6,969	24% 23,503	25% 57,647	28% 4,580
Avg Behavioral Waste	% Base Usage kWh	8% 1,737	6% 1,014	11% 2,964	8% 1,610	10% 921	20% 2,326	16% 4,137	10% 9,511	13% 30,263	4% 684
Address Behavior First											
Avg Behavioral Waste	% Base Usage kWh	11% 2,444	11% 1,886	13% 3,682	11% 2,105	13% 1,285	25% 2,983	20% 5,285	12% 11,629	17% 38,294	6% 997
Avg Technological Waste	% Base Usage kWh	26% 5,564	28% 4,834	25% 7,178	26% 5,259	30% 2,894	22% 2,630	23% 5,822	22% 21,385	22% 49,616	26% 4,267

Source: Usage and waste analysis

Commercial Sector

Figure 7-5 shows the average annual energy usage and savings potential associated with all cooling equipment for ComEd customers in the industrial sector. For this sector, efficient usage accounts for 60% of total base electricity use on cooling equipment. Addressing technology first results in savings of 27% of usage, while addressing behaviors first saves 16%.

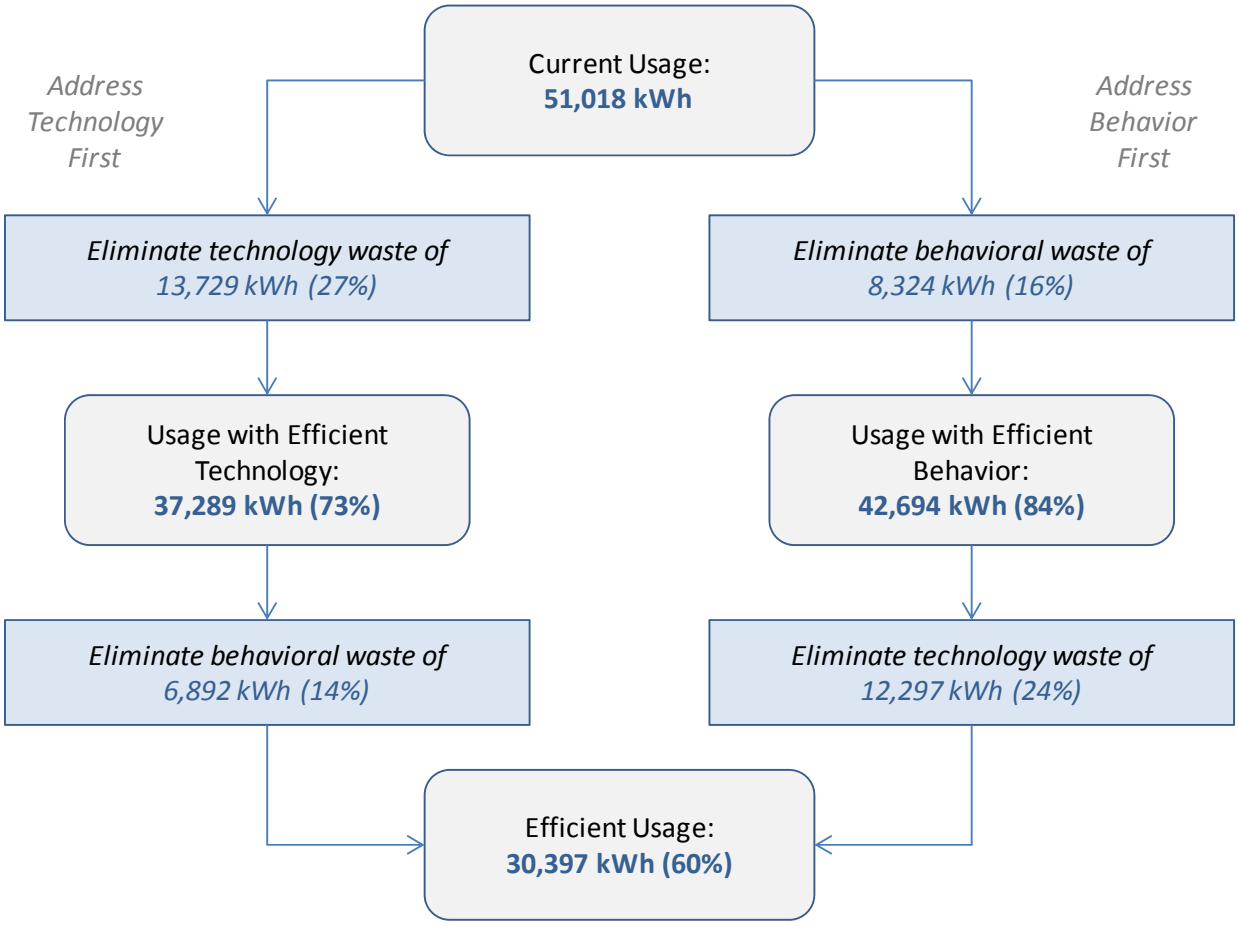
Figure 7-5: Usage and Waste Analysis for the Industrial Sector – All Cooling Equipment



Source: Usage and waste analysis

Figure 7-6 shows the average annual energy usage and savings potential associated with cooling for the industrial sector. The figure shows estimated usage and technological and behavioral savings when addressing technological waste first or behavioral waste first.

Figure 7-6: Technological and Behavioral Potential for the Industrial Sector– All Cooling Equipment



Source: Usage and waste analysis

Table 7-3 shows the average annual energy usage and savings potential associated with all cooling equipment for the industrial sector by rate class. The table shows estimated usage and savings when addressing technological waste, behavioral waste, and both.

Table 7-3. Technological and Behavioral Potential by Industrial Rate Class – All Cooling Equipment

		Industrial Total	Less than 100 kW	100-400 kW	Greater than 400 kW
Number of Identifiable Customers		15,675	12,377	2,282	1,016
Average Annual kWh		444,425	50,339	568,641	4,966,218
Sample (n)		215	130	49	36
Percentage That Have, Own/Maintain Own Cooling		70%	81%	72%	68%
Usage & Waste Summary					
Avg Base Usage	% Annual kWh	11%	12%	17%	8%
	kWh	51,018	6,059	96,730	374,111
Avg Total Waste	% Base Usage	40%	44%	41%	38%
	kWh	20,620	2,671	39,600	141,743
Avg Efficient Usage	% Base Usage	60%	56%	59%	62%
	kWh	30,397	3,388	57,130	232,368
Address Technology First					
Avg Technological Waste	% Base Usage	27%	34%	28%	23%
	kWh	13,729	2,035	26,641	86,617
Avg Behavioral Waste	% Base Usage	14%	10%	13%	15%
	kWh	6,892	636	12,959	55,126
Address Behavior First					
Avg Behavioral Waste	% Base Usage	16%	15%	16%	17%
	kWh	8,324	882	15,753	63,473
Avg Technological Waste	% Base Usage	24%	30%	25%	21%
	kWh	12,297	1,789	23,847	78,270

Source: Usage and waste analysis

Packaged and Split Systems

As shown in Table 7-1, penetration of packaged or split systems is 80% or higher among several commercial customers segments, including hospitals/health service, retail, food service, warehouse, and education. Penetration among industrial customers is above 80% for all rate classes.

Figure 7-7 shows that 46% of businesses in commercial segments with packaged or split cooling systems have economizers on at least one of these systems. Similarly, 52% of industrial customers have economizers on at least one of their packaged or split cooling systems.