




COMMONWEALTH EDISON BASELINE STUDY

Submitted to:
Jim Fay, Energy Efficiency Planning & Measurement

Prepared by:

Itron

1111 Broadway
Suite 1800
Oakland, CA 94607

www.itron.com/consulting

With Assistance from:

ERC
ENERGY RESOURCES CENTER

TREND TECH ENERGY SERVICES

GHE Green Home Experts

August 14, 2020


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1 INTRODUCTION

Commonwealth Edison Company (ComEd) contracted with a team of consultants led by Itron to conduct a comprehensive end-use research, market penetration, and potential study of its residential, commercial, and industrial customer segments. The core project goals and research objectives of this study (as stated in the RFP) were delineated as follows:

- Collect detailed energy utilization characteristics from a representative sample of ComEd's customer base for as many critical market segments and sub-segments as possible
- Use the new primary data collected to develop energy utilization distributions across key end uses and market segments and sub-segments
- Develop a trend analysis of the market penetration of select high-efficiency technologies based on new primary data collection, ComEd's previous saturation studies, and other sources
- Estimate the economic potential of energy efficiency across key end uses and market segments
- Identify and characterize the incremental cost-effective potential that exists beyond the current program participation and expected market trends
- Provide a concise summary of the key findings related to current end-use energy consumption, technology saturation, and cost-effective savings potential across market segments in the context of historical and expected evolution of key technology markets over time
- Deliver all primary and secondary data collected for the study in an easy-to-manipulate format that allows combination with other internal and external datasets

To meet these research objectives, the overall project was organized into the following top-level tasks, as illustrated in Figure 1-1 below:

- Task 1: Research and Data Collection,
- Task 2: Market Penetration Study,
- Task 3a: Energy Utilization Distributions,
- Task 3b: Economic Potential, and
- Task 4: Analysis of ComEd's Energy Efficiency Markets.

Note that Figure 1-1 also illustrates that the Itron team bifurcated Task 2 into two parallel sub-activities: a top-down assessment of energy efficiency market penetration trend in ComEd's service territory based

on secondary sources and a bottom-up assessment of those trends based on a "no program" market adoption forecast using Dunsky Energy Consulting's potential model.

FIGURE 1-1: INTERRELATION OF HIGH-LEVEL PROJECT TASKS AND SCOPE OF THIS REPORT

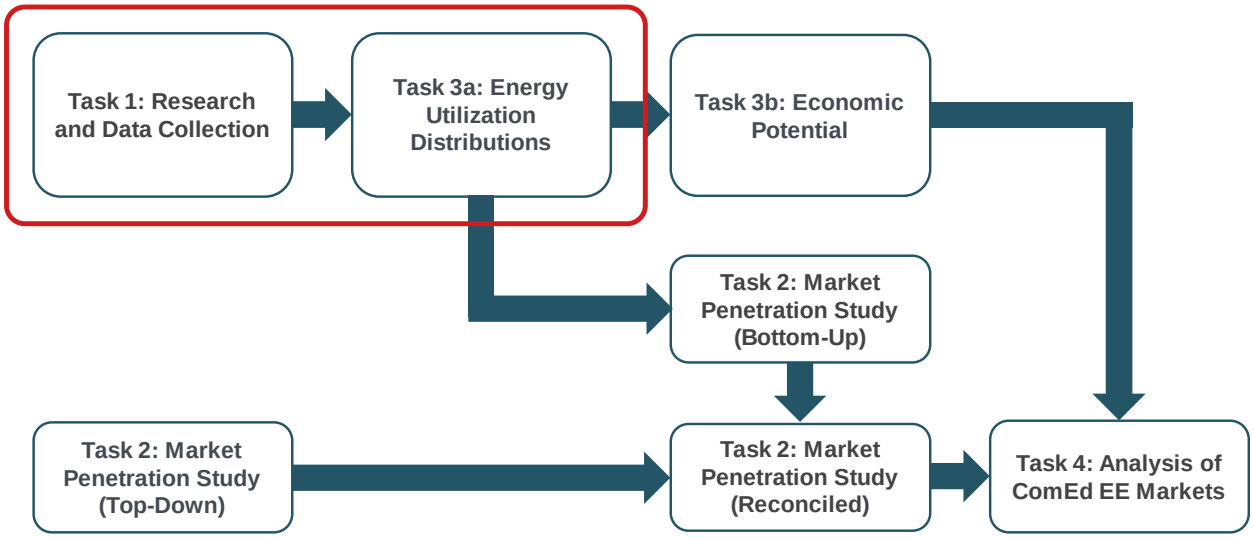


Figure 1-1 also illustrates the scope of this report, i.e. presentation of the methods, results, and key findings of Task 1 (Research and Data Collection) and Task 3a (Energy Utilization Distributions). A second report will present the results of Task 2 (Market Penetration Study), Task 3b (Economic Potential), and Task 4 (Analysis of ComEd's Energy Efficiency Markets).

The remainder of this report is organized as follows:

- Section 2 – Overview of Data Collection Approach,
- Section 3 – Residential Data Collection Methods,
- Section 4 – Residential Baseline Results,
- Section 5 – Commercial Data Collection Methods, and
- Section 6 – Commercial Baseline Results.

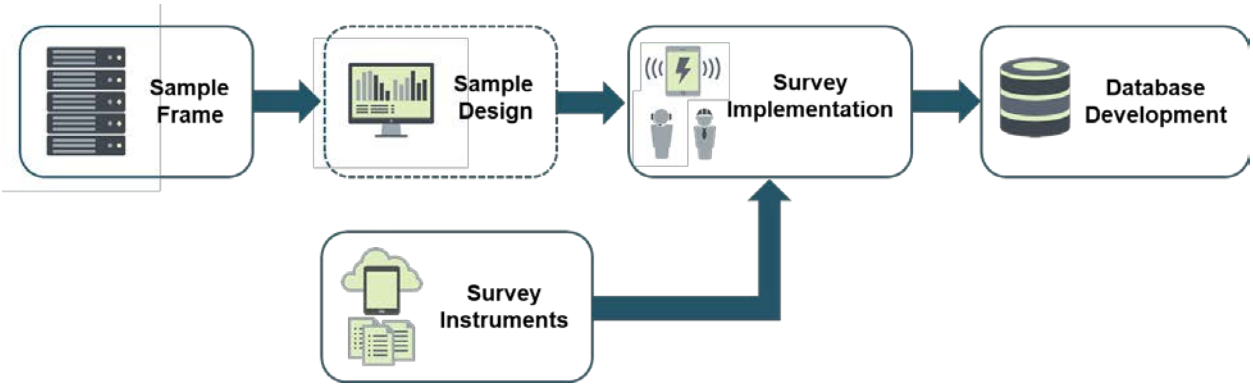
This report also includes the following technical appendices:

- Appendix A – Residential Web Survey Instrument, and
- Appendix B – Commercial On-Site Survey Instrument.

2 OVERVIEW OF DATA COLLECTION APPROACH

This section provides a high-level overview of the primary data collection approach used for Task 1. When conducting any type of primary data collection to establish statistically representative estimates of baseline end-use equipment saturation and efficiency, there are five key steps that are common no matter what specific survey mode or approach is used, as illustrated in Figure 2-1 below.

FIGURE 2-1: OVERVIEW OF KEY STEPS IN CONDUCTING DATA COLLECTION SURVEYS



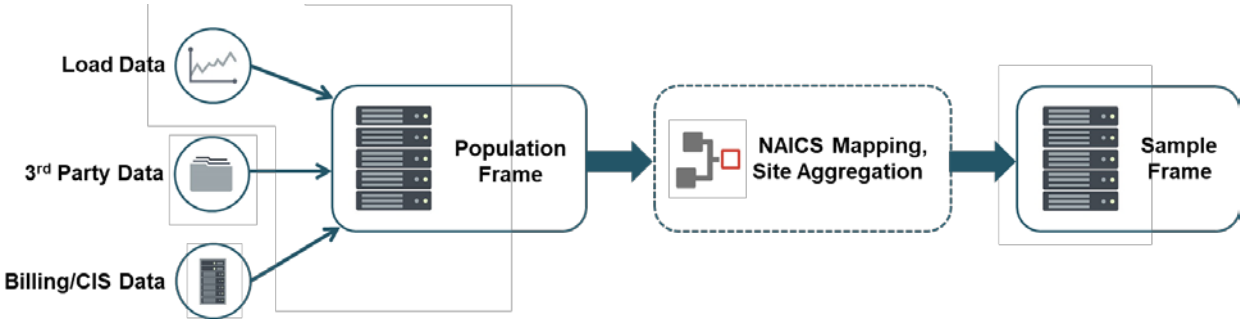
As the figure shows, the first step is to develop a sample frame, i.e. a comprehensive database of a given customer population from which a representative sample of customers will be drawn for recruitment into the data collection surveys. The second step is to design the sampling strategy, otherwise known as sample design, wherein one chooses the customer characteristics around which to develop a statistically representative sample. In the case of energy efficiency-relates studies, such characteristics often include building type, business type, and size. In parallel with sample design, one develops the survey instrument itself, whether it be a telephone-based survey script, a web site, or and electronic or hardcopy survey form. Once the sample frame, sample design, and survey instrument are fully developed, one then implements the survey. Finally, the collected data are organized into a central database, cleaned, and expanded (i.e. weighted) and aggregated to produce the final population estimates.

For this engagement, all of our primary data collection activities followed these same core steps. And while the specific sample designs, survey modes, and survey instruments were tailored to each sector, we used a common sample frame for our residential, commercial, and industrial surveys – which describe in more detail below.

2.1 SAMPLE FRAME DEVELOPMENT

The ultimate success of any large-scale, primary data collection effort (no matter what data collection methods are employed) begins with the quality and accuracy of the foundational data that describe the population of interest, otherwise known as the "population frame" (see Figure 2-2 below). The population frame directly determines the sampling variables and, in turn, the specific segments for which statistically valid results can be developed. In this sense, the depth and accuracy of the population frame plays a central role in the overall quality and value of the sample-based results.

FIGURE 2-2: SAMPLE FRAME DEVELOPMENT



For this engagement, the Itron Team was uniquely positioned with respect to being able to develop a complete and high-quality population frame at very little cost. This was due to Itron's recent acquisition of Silver Spring Networks (SSN), who provides ComEd's smart meter data collection management and analysis solutions, including a data analytics platform known as *Operations Optimizer*. The primary use cases of this analytics platform are centered on AMI operations, grid operations, revenue assurance, and customer programs (including DSM). As such, Operations Optimizer currently houses all of ComEd's monthly billing data (back to 2007), hourly interval data (back to 2010), and up-to-date CIS data for 3.97 million of ComEd's interval metered customers and ~268,000 of ComEd's non-interval metered customers. As Figure 2-2 above shows, these data represent the core components of the population frame required for the baseline study. Operations Optimizer also includes three other data dimensions that added significant depth and value to the population frame in the context of this study:

- **Comprehensive NAICS codes and employee counts for all nonresidential accounts**. Many utility CIS systems contain incomplete and inaccurate NAICS codes. Operations Optimizer comes packaged with complete NAICS information and employee counts from SalesGenie, which are validated on a rolling, continual basis by SSN support staff. This allows for accurate segmentation by business type. Employee counts provide an alternate metric for business size and a proxy for occupancy.

- **Site aggregation for all nonresidential accounts**. Unlike for residential accounts, nonresidential accounts do not necessarily equate to unique sites, buildings, or customers. This necessitates

the "creation" of individual sites by aggregating individual accounts and meters to develop a site-based sample frame and the sampling plan. Operations Optimizer has built-in site aggregation algorithms, which made site-level consumption data immediately available to the Itron Team.

- **Assessor data for most residential accounts**. For residential customers, Operations Optimizer comes packaged with county assessor data for all of Cook County (roughly 65% of ComEd's total residential population). These data provide precise data on the year built, square footage, and number of rooms and avoids the need to collect self-reported estimates of those variables.

Using custom extracts from Operations Optimizer as the population frame, we then conducted several layers of data attrition to develop the final sample frame. The core objective of this data attrition process was to ensure that the sample frame only included accounts for which we had reasonably complete data in terms of customer characteristics, contact information, and recent electricity consumption.

For the residential sector, the specific data attrition criteria used were:

- At least 11 months of bills in 2017 and 6 months of bills in 2018
- Unreasonably small (<100 ft2) or large building floor area (>10,000 ft2) for customers classified as residential but likely to be nonresidential
- Missing low-income eligibility flag

Table 2-1 summarizes the results of the applying these data attrition screens and the resulting sample frame for the residential sector.

TABLE 2-1: RESIDENTIAL SAMPLE FRAME

	Frame
N Active Accounts	3,657,914
Incomplete kWh in 2017 (less than 11 months of bills OR <2 kWh/day)	1,413,306
Incomplete kWh in 2018 (less than 6 months of bills)	437,474
Pop with at least 11 months of bills in 2017 and 6 months in 2018	1,807,134
Address-based SF/MF flag:	
% 2017 kWh Single Family	76%
% 2017 kWh Multi Family	24%
Sqft<100 or >10,000	677,364
Frame with reasonable kWh and sqft data	1,129,770
No low-income eligibility flag	38,334
Frame with reasonable kWh and sqft data and LI-eligibility data	**1,091,436**
% 2017 kWh Single Family	83%
% 2017 kWh Multi Family	17%

For the commercial and industrial sectors, the specific data attrition criteria used were:

- At least 11 months of bills in 2017 and 6 months of bills in 2018
- Customers with 3 or more active accounts, so as to avoid over-contacting during survey implementation
- Missing or duplicate phone numbers
- Missing NAICS codes
- Customers with demand greater than 10 MW

Note that the final criterion above reflects the fact that customers in Illinois with demand greater than 10 MW are not obligated to pay into the state of Illinois' general energy efficiency fund and therefore not eligible to receive incentives from utility programs in the state. ComEd requested that we remove these accounts from the sample frame in order to align our sample design with their program-eligible customer population. Also note that nearly all of ComEd's 10+ MW customers were removed from the

sample frame when we applied the screens for customers with 3 or more active accounts, accounts with duplicate phone numbers, and accounts with missing phone numbers.[1]

Table 2-1 summarizes the results of the applying these data attrition screens and the resulting sample frame for the commercial and industrial sectors.

TABLE 2-2: NONRESIDENTIAL SAMPLE FRAME

	Frame
N Active Accounts	399,879
Customer IDs w/ 3+ Accounts	143,946
N missing phone	23,841
N duplicate phone	56,947
Balance of NR Accounts	175,145
Incomplete kWh in 2017 (less than 11 months of bills OR <2 kWh/day)	56,627
Incomplete kWh in 2018 (less than 6 months of bills)	18,745
Remaining accounts with demand >10 MW	78
Pop with at least 11 months of bills in 2017 and 6 months in 2018	99,695
No NAICS/SIC	9,481
NR Population with known Sector and fairly complete 2017 kWh usage	**90,214**
% 2017 kWh Commercial	79%
% 2017 kWh Industrial	21%

2.2 OVERVIEW OF SECTOR-SPECIFIC DATA COLLECTION APPROACHES

In order to address the challenges and opportunities unique to each sector, we developed different data collection approaches for ComEd's residential, commercial, and industrial sectors, respectively. Below, we provide a high-level overview of and rationale for these sector-specific data collection approaches. In-depth documentation of these sector-specific methods is provided in subsequent sections of this report.

[1] To be clear, the data attrition associated with customers with 3 or more accounts and accounts with duplicate phone numbers removed the duplicate accounts in order to avoid over-contacting the same customers during the survey recruitment process. In contrast, accounts with missing phone numbers were completely removed from our sample frame.

2.2.1 Multi-Modal Surveys of Residential Customers

For residential customers, our core approach was centered on leveraging web-based surveys to reduce cost and greatly increase sample size. Web surveys are very low cost compared to telephone, mail, or on-site surveys. Standard web surveys (and telephone surveys) are well-suited for collecting reliable data on certain high-level variables such as the number of occupants, floor area, rent vs. own, and whether residents pay directly for cooling and heating their homes. Standard web surveys are also capable of collecting reasonably accurate binary information about equipment ownership (i.e. have/do not have a dishwasher).

However, standard web surveys are not well-suited for collecting deeper levels of end-use equipment characteristics (technology type, capacity, efficiency) with a reasonable level of accuracy due to a lack of consumer knowledge and/or user recall error. Unfortunately, it is exactly this type of detailed equipment data that is required to accurately assess the market shares of energy efficient equipment and the cost-effectiveness of energy efficiency measures, i.e. energy efficiency potential. Until now, acquiring such deep end-use equipment characteristic data required sending field engineers to customer premises to record make/model data for key end-use technologies, a.k.a. on-site surveys. This process, however, is time-consuming, expensive, and results in highly constrained sample sizes – due to limited research budgets.

To overcome this fundamental tradeoff between sample size and depth of data collection, Itron has developed a unique multi-modal data collection approach. The two key aspects of our approach are:

- Using mass mailings of postcards to recruit customers into the web survey; and
- Optimizing the web survey for mobile devices.

The first aspect is designed to address the fact that most utilities have incomplete email addresses for their customers. The second aspect – optimization for mobile devices – is what enables our approach to generate "on-site quality baseline information" at the cost and scale of telephone surveys. Optimizing for mobile allows the web survey to leverage device mobility (to conduct guided, room-by-room lighting inventories, for example)[2] and take direct advantage of the technologies that are standard on today's mobile devices, including **cameras** for taking photos and **location services**.

2 Technically speaking, it is possible to conduct room-by-room lighting inventories via standard telephone surveys. However, mobile web surveys can provide deep "hand holding" in terms of clickable tips and example images that telephone surveys simply cannot provide – resulting in more accurate and meaningful data.

Specifically, our mobile-optimized web surveys are designed to limit "self-report" style questions to only those variables that customers know with a high degree of accuracy (e.g. number of occupants, home size, rent vs. own, etc.). To collect detailed equipment characteristics, participants are asked to take and upload photos of the **nameplate** on each major piece of end-use equipment, i.e. the metal badge or sticker that contains the equipment's make and model number. Itron then uses image recognition to extract the make/model data from each nameplate image and then cross-references those make/model numbers against an extensive database of make/model-level equipment performance data to append **model-specific information on rated annual consumption, rated efficiency, rated capacity, and other key performance parameters**.[3] Itron also uses the geotag data in each photo to verify that each photo was taken at the customer's actual service address.

From a participant perspective, this approach reduces the time required to complete the survey and reduces the probability of data entry error. From a utility perspective, the resulting make/model-level data, coupled with room-by-room lighting inventories produce nearly the same depth and accuracy of data collection produced by on-site surveys but at scale of telephone and web surveys.

2.2.2 On-Site Surveys of Commercial Customers

For commercial customers, the lowest-cost approach to collect energy-efficiency information is telephone surveys. However, as is the case with telephone surveys of residential customers, telephone surveys of commercial customers are not well-suited for collecting deeper levels of end-use equipment characteristics (technology type, capacity, efficiency) with a reasonable level of accuracy due to the complexity of end-use energy equipment and systems in commercial buildings. To address this challenge, we used a more traditional on-site survey approach using a team of locally based field engineers and an extensive on-site survey instrument developed by Itron. While such on-site surveys are clearly more expensive (on a per-complete basis) than mail- or telephone-based surveys, no proven alternatives exist that can provide the same depth of information (i.e., value) with minimal uncertainty at commercial customer sites with complex and heterogenous systems. These on-site surveys were designed to collect make/model-level information on equipment holdings, along with information on business hours, operation schedules, and control settings.

To ensure that the on-site survey effort was as cost-effective as possible, the Itron Team included Trend Tech Energy Services, the Energy Resources Center (ERC) at the University of Illinois, and Green Home

[3] Based on data available from the U.S. DOE's Compliance Certification Database, the California Energy Commission's Modernized Appliance Efficiency Database, the U.S. EPA's Energy Star Qualified Product List, the Consortium for Energy Efficiency's Qualified Product List, manufacturer spec sheets, and web searches.

Experts (GHE) who provided qualified, locally-based field engineers to conduct the on-site primary data collection surveys at commercial customer sites.

2.2.3 Program Tracking and EM&V Data Mining of Industrial Customers

In Itron's experience, industrial customer on-site surveys can be significantly riskier (compared to on-site surveys at commercial or residential premises) in terms of the high costs associated with on-site data collection and the limited value of those data for developing a representative characterization of end-use consumption and energy-efficiency opportunities for the industrial sector as a whole. This dynamic is due to the heterogeneity of industrial processes and equipment compared to commercial businesses, even within a given industrial subsector (e.g. fabricated metals). Moreover, these cost/value tradeoffs are exacerbated when samples are limited in size (e.g. 3-10 points per segment).

At the same time, Itron had access to two rich primary data sets:

- End-use and measure-level results from the 2012 Baseline Study, which included 527 telephone surveys and 121 on-site surveys of industrial customers, and
- Customer-level program tracking and evaluation data from ComEd's Custom and Industrial Systems (IS) programs from PY4 (2011) through PY9 (2017).[4]

Given the availability of these two primary data sets, Itron proposed (and ComEd approved) supplementing those data with: 1) a small set of in-depth interviews with industrial plant managers and EE investment decision-makers in ComEd's territory, and 2) national-level data from the 2014 Manufacturing Energy Consumption Survey (MECS) – in lieu of conducting new primary data collection for this study.

After assembling the data above and reviewing them in detail, we then developed a potential modeling approach that we believe provided meaningful and grounded estimates of savings potential from industrial programs in the near term. At the highest level, we bifurcated the estimation of industrial potential between that from deemed measures (specifically lighting) and that from custom measures. For custom measures, we then developed a top-down approach to estimate potential. Our overall industrial potential modeling approach is documented in detail as part the second report from this engagement which provides the complete documentation and results for Task 3b (Economic Potential) and Task 4 (Analysis of ComEd's Energy Efficiency Markets).

[4] PY9 was a 19-month program as part of FEJA-mandated transition to calendar year program cycles.

3 RESIDENTIAL DATA COLLECTION METHODS

In this section, we present a detailed overview of each step in our data collection approach for ComEd's residential sector, including sample design, survey implementation, and final survey disposition. The results from this data collection effort are presented later in Section 4.

3.1 MULTI-MODAL SURVEY APPROACH

For residential customers, our core approach was centered on leveraging web-based surveys to reduce cost and greatly increase sample size. Web surveys are very low cost compared to telephone, mail, or on-site surveys. Standard web surveys (and telephone surveys) are well-suited for collecting reliable data on certain high-level variables such as the number of occupants, floor area, rent vs. own, and whether residents pay directly for cooling and heating their homes. Standard web surveys are also capable of collecting reasonably accurate binary information about equipment ownership (i.e. have/do not have a dishwasher). However, standard web surveys are not well-suited for collecting deeper levels of end-use equipment characteristics (technology type, capacity, efficiency) with a reasonable level of accuracy due to a lack of consumer knowledge and/or user recall error. Unfortunately, it is exactly this type of detailed equipment data that is required to accurately assess the market shares of energy efficient equipment and the cost-effectiveness of energy efficiency measures, i.e. energy efficiency potential. Until now, acquiring such deep end-use equipment characteristic data required sending field engineers to customer premises to record make/model data for key end-use technologies, a.k.a. on-site surveys. This process, however, is time-consuming, expensive, and results in highly constrained sample sizes – due to limited research budgets.

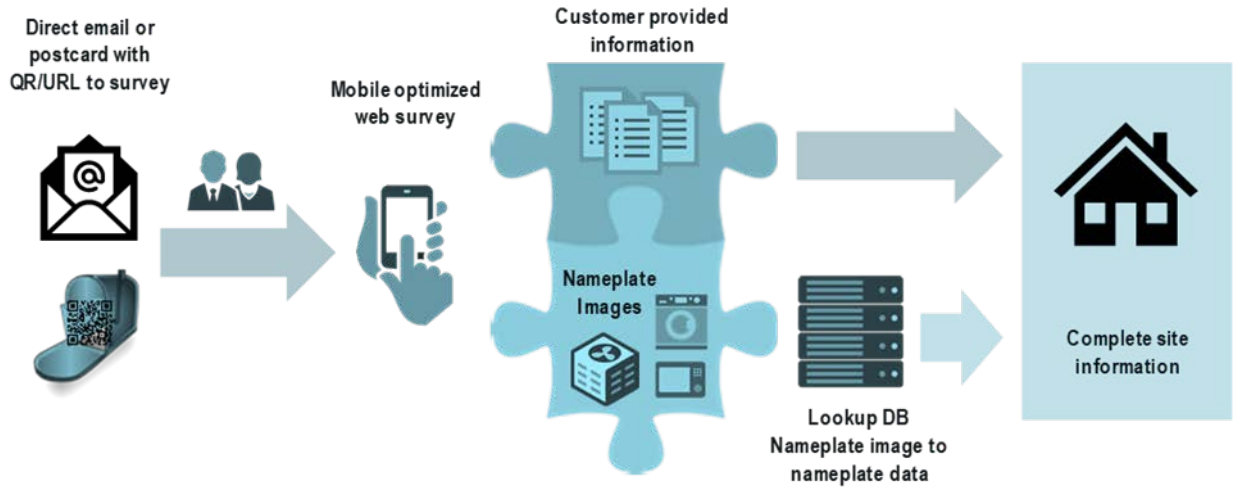
To overcome this fundamental tradeoff between sample size and depth of data collection, Itron has developed a unique multi-modal data collection approach (illustrated in Figure 3-1 below). The two key aspects of our approach are:

- Using mass mailings of postcards to recruit customers into the web survey; and
- Optimizing the web survey for mobile devices.

The first aspect is designed to address the fact that most utilities have incomplete email addresses for their customers. Using billing address data, customers were mailed postcards that advertised the opportunity to participate in the survey in exchange for a $25 Amazon.com gift card (once the survey has been completed and submitted) and a unique participant identification code required to launch the survey. Further details about the postcard mailers are provided in Section 3.4.

The second aspect – optimization for mobile devices – is what enables our approach to generate "on-site quality baseline information" at the cost and scale of telephone surveys. Optimizing for mobile allows the web survey to leverage device mobility (to conduct guided, room-by-room lighting inventories, for example)[1] and take direct advantage of the technologies that are standard on today's mobile devices, including **cameras** for taking photos and **location services** (in the form of geotag data).

FIGURE 3-1: MULTI-MODAL DATA COLLECTION APPROACH



Specifically, our mobile-optimized web surveys are designed to limit "self-report" style questions to only those variables that customers know with a high degree of accuracy (e.g. number of occupants, home size, rent vs. own, etc.). To collect detailed equipment characteristics, participants are asked to take and upload photos of the **nameplate** on each major piece of end-use equipment, i.e. the metal badge or sticker that contains the equipment's make and model number. Itron then uses image recognition to extract the make/model data from each nameplate image and then cross-references those make/model numbers against an extensive database of make/model-level equipment performance data to append **model-specific information on rated annual consumption, rated efficiency, rated capacity, and other key performance parameters**.[2] Itron also uses the geotag data in each photo to verify that each photo was taken at the customer's actual service address.

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[2] Based on data available from the U.S. DOE's Compliance Certification Database, the California Energy Commission's Modernized Appliance Efficiency Database, the U.S. EPA's Energy Star Qualified Product List, the Consortium for Energy Efficiency's Qualified Product List, manufacturer spec sheets, and web searches.

From a participant perspective, this approach reduces the time required to complete the survey and reduces the probability of data entry error. From a utility perspective, the resulting make/model-level data, coupled with room-by-room lighting inventories produce nearly the same depth and accuracy of data collection produced by on-site surveys but at scale of telephone and web surveys.

3.2 SAMPLE DESIGN

For this type of end-use energy baseline study, we use a stratified sample design in order to isolate specific customer populations of interest and their equipment holdings (and related end-use energy consumption). For this study, we had a range of possible stratification variables at our disposal, and ComEd identified the following stratification variables as being of highest relevance to their research objectives and portfolio planning needs:

- Whole-home consumption (High, Medium, Low)
- Building type (SFD, MFD)
- Location (Chicago, Suburban, Other)
- Low-income program-eligible (LI, non-LI)

The whole-home consumption variable was developed based on customer-specific annual kWh consumption from ComEd's billing data. Customers were rank ordered from highest to lowest annual kWh consumption. The top third were assigned to the "High" category, the middle third were assigned to the "Medium" category, and the bottom third were assigned to the "Low" category.

The building type variable was based on county assessor data available in the sample frame. We used Google Maps (street view) to manually verify these building type designations for a small sample of accounts. Based on the findings of this verification, we modified the original building type flags in the sample frame with the following adjustments: 1) any address with an apartment or unit number was considered a multi-family building; and 2) any address with multiple accounts was considered a multi-family building.

The location variable (Chicago, Suburban, and Other) was provided by ComEd. These variables were developed by ComEd staff based on population density data at the census-track level from the US Census Bureau. **The low-income eligible variable** was also provided by ComEd via an outside consulting firm (Elevate Energy) that had previously developed those variables for ComEd as part of a separate research project. Elevate calculated the share of homes at or below 80% of "area median income" (AMI) at the

census track level (roughly 10 square blocks) using data from the US Census Bureau. The "80% of AMI" value is a generally accepted proxy for "low income" and is roughly twice the federal poverty line.

In order to apply these income data for this study, we had to determine a threshold value (in terms of the share of homes in a given census track at or below 80% AMI) that provided the best characterization of ComEd's low-income eligible customer population. The choice of which threshold value to use is both critical and somewhat arbitrary. In order to make an informed choice of which threshold value to use, we complied independent estimates of the total low-income eligible population in Illinois to use as benchmarks. The two most relevant estimates we identified indicated that ~40% of households in the state of Illinois have incomes twice the federal poverty line (roughly equivalent to 80% of AMI) and that ~50% of students in the state are eligible to receive free school lunches (which is based on household income roughly equivalent to 80% of AMI).[3,4] Based on these benchmarks, we chose a threshold value of >=43% of homes at or below 80% AMI within a given census track to establish our low-income eligibility flag. This threshold value results in ~40% of ComEd's total residential customer population being characterized as LI-eligible, which is consistent with available independent estimates.

Applying the stratification variables above to the sample frame results in the distribution of customers shown in Table 3-1 below.

TABLE 3-1: DISTRIBUTION OF RESIDENTIAL CUSTOMERS BY SAMPLE STRATIFICATION VARIABLES

	>=43% HH at 0.8 AMI (LI)	Chicago	Suburb	Other	Total	Share of Frame:
Single Family					**807,799**	**74%**
- High kWh	No	13,344	182,734	9,624		
	Yes	23,055	44,780	955		
- Med kWh	No	12,934	157,651	5,761		
	Yes	29,444	60,007	897		
- Low kWh	No	13,065	141,899	5,249		
	Yes	35,813	69,577	1,010		
Multi-Family					**283,637**	**26%**
- High kWh	No	15,463	17,370	896		
	Yes	47,330	15,224	234		
- Med kWh	No	13,557	13,286	277		
	Yes	50,127	16,258	109		
- Low kWh	No	14,619	12,234	165		
	Yes	48,291	18,107	90		

[3] https://datausa.io/profile/geo/illinois/#category_housing

[4] https://www.illinoisreportcard.com/state.aspx?source=studentcharacteristics&source2=lowincome&Stateid=IL

The final sample design was based on a "robust" proportional allocation approach, where the total target sample (5,000 completes) is first allocated across building types (SFD, MFD) based strictly on the relative customer populations. The sample was then further allocated evenly across location (Chicago, Suburban, Other) and whole-home consumption (High, Medium, Low).[5] Finally, the sample was then allocated proportionally within each cell to low-income eligible and not low-income eligible based on the relative customer population in that cell. The final sample design is show in Table 3-2 below.

TABLE 3-2: FINAL SAMPLE DESIGN FOR RESIDENTIAL DATA COLLECTION SURVEYS

	>=43% HH at 0.8 AMI (LI)	Chicago	Suburb	Neither	Total	Share of Completes
Single Family					**3,738**	**75%**
- High kWh	No	140	275	370		
	Yes	275	140	45		
- Med kWh	No	141	275	370		
	Yes	275	141	46		
- Low kWh	No	140	275	370		
	Yes	275	140	45		
Multi-Family					**1,262**	**25%**
- High kWh	No	65	95	60		
	Yes	124	94	21		
- Med kWh	No	65	95	18		
	Yes	125	95	9		
- Low kWh	No	65	94	12		
	Yes	124	95	6		

3.3 MOBILE-OPTIMIZED WEB SURVEY INSTRUMENT

In parallel with the development of the sample design, we developed the web survey instrument in close collaboration with our web survey vendor Survox, Inc. (now part of Enghouse Interactive). The instrument included several features to optimize the survey for completion on mobile devices:

[5] Note one exception was that the MFD sample was allocated on a 2:2:1 basis across location (Chicago, Suburban, Other) due to the MFD/Other strata having a significantly smaller customer population compared to the MFD/Chicago and MFD/Suburban strata (only 1% and 2% of MFD/Chicago and MFD/Suburban, respectively).

- Automatic sizing to mobile device screen dimensions,
- Clickable pop-up screens to provide explanatory text and example images on demand, while keeping question length to a minimum,
- Access to the device's camera to allow for taking and uploading photos, and
- Access to the device's location services to allow photos to be geotagged.

The web survey instrument was skinned with ComEd's Energy Efficiency Program graphics and color scheme (per ComEd's branding guidelines) and linked to a ComEd-hosted vanity URL (with re-direct Survox's production URL), so that participants had a fully ComEd-branded experience. The instrument also allowed participants to pause and resume the survey on demand.

The survey itself was structured to begin with a short battery of high-level questions on home and occupant characteristics, followed by batteries on central systems (HVAC and water heating) and laundry appliances. The survey then began a room-by-room walk-through of the participant's home, with a focus on collecting data on kitchen appliances, lighting, room HVAC, and water fixtures. The survey concluded with a section on exterior lighting, entertainment technology, and a battery of marketing questions used by ComEd for customer segmentation research. It is important to note that this overall survey structure was explicitly designed to ensure that the highest-priority data types were collected towards the beginning of the survey so that even partially completed surveys provided usable data.

Due to the length and complexity of the web survey, we pre-tested the survey with a group of 20 ComEd and Itron staff – some of whom were directly involved in the project and some of whom were not. We collected feedback from each pre-tester, which drove refinements in the survey's skip patterns, question order, question wording, keyed data entry methods, photo-taking and uploading functionality, pause and resume functionality, and overall survey length and flow. An MS Word version of final web survey instrument provided in Appendix A.

3.4 POSTCARD DESIGN

For the postcard mailers sent to ComEd customers, Itron developed the initial concept and messaging in compliance with ComEd's (and Amazon's) branding standards and guidelines. We then made a series of refinements in collaboration with ComEd's Marketing Group. The final postcard design is shown below in Figure 3-2 and Figure 3-3.

FIGURE 3-2: FINAL POSTCARD DESIGN (FRONT)

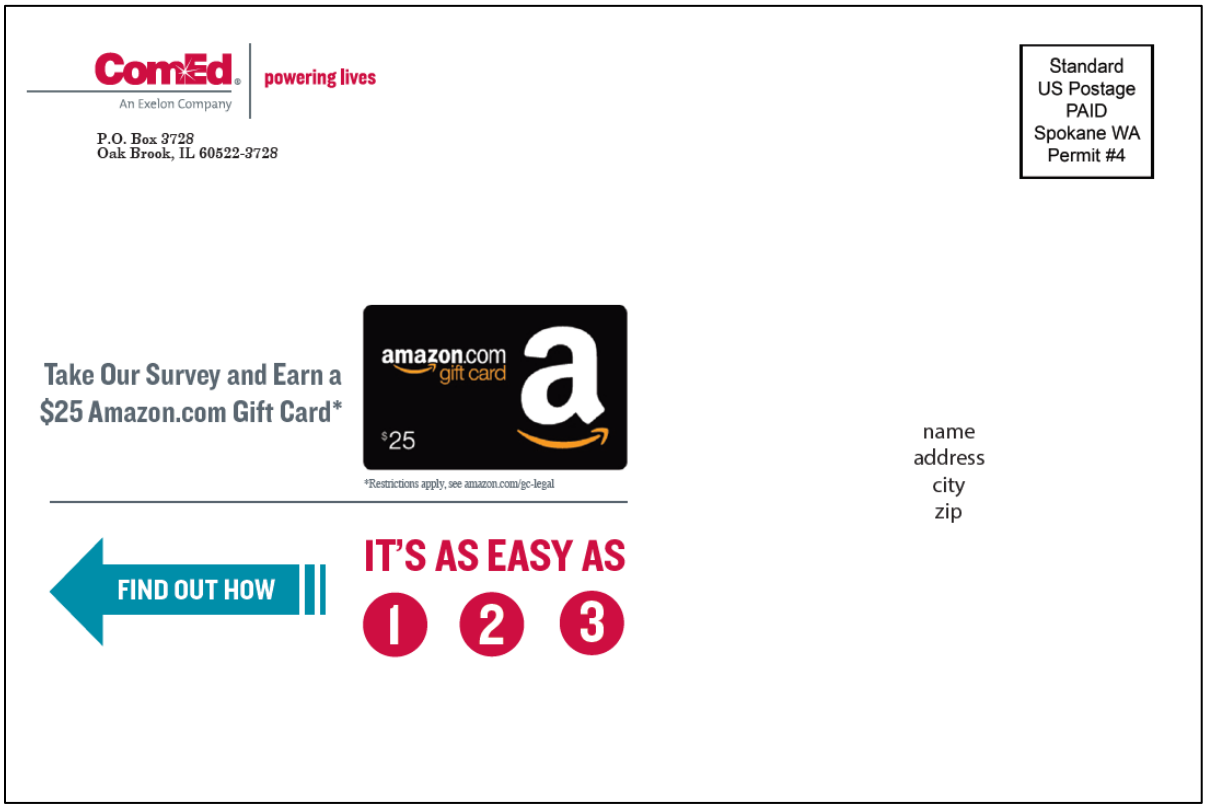
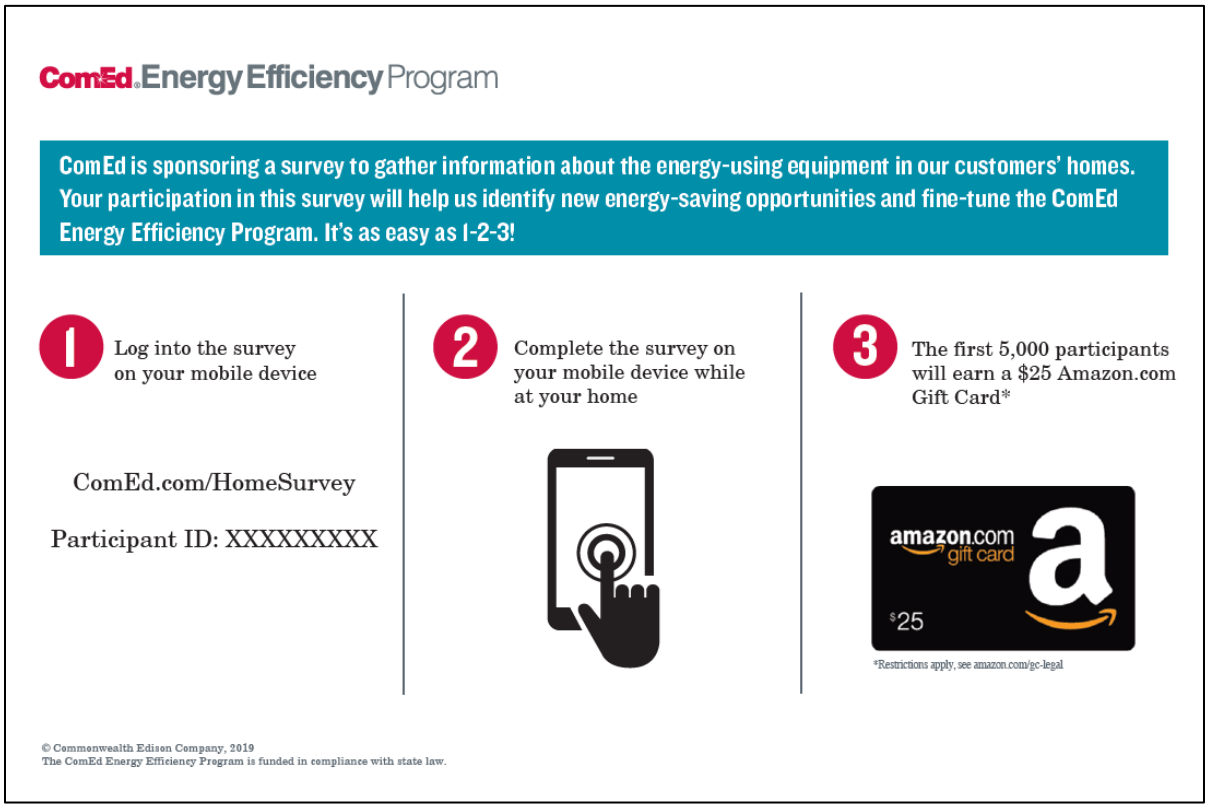


FIGURE 3-3: FINAL POSTCARD DESIGN (BACK)



3.5 SURVEY IMPLEMENTATION

Once the sample design, survey instrument, and postcard design were finalized, we then implemented the survey in two waves – an initial wave of 5,000 postcards, followed by a second wave of 30,000 postcards.[6] Splitting the survey implementation into two waves allowed Itron to conduct a small sample of on-site verification surveys (as requested by ComEd) to validate the accuracy of the data collected via the mobile-optimized web survey. See Box 3-1 for details on the methods and results of these on-site verifications.

As customers completed the web survey, we processed the survey responses on a daily basis in order to: 1) determine eligibility for and issue participation incentives, and 2) process customer-provided equipment nameplate images. The overall workflow used for this process is summarized in Figure 3-4 below. To determine eligibility for participation incentives, we first used geotagged data to validate that

[6] In our initial planning, we assumed a response rate of 15%. This response rate would in turn require a total of 35,000 postcards produced and mailed in order to get 5,000 click-ins to the web survey.

the survey was completed at a given customer's service address. All participants that completed the entire survey and passed this location validation step were then emailed their participation incentives in the form of a unique Amazon.com gift card redemption code.

In parallel, customer-provided the nameplate images were processed through Itron's image recognition algorithms to identify equipment-specific model numbers. As Figure 3-4 shows, these extracted model numbers were then cross-referenced against Itron's extensive make/model lookup library to append a variety of equipment-specific characteristics such as vintage, rated capacity, and rated efficiency. As a final step, the data derived from the nameplate images were merged with the self-reported data collected in the rest of the web survey to provide complete site information for a given premise.

Box 3-1: On-Site Verification Surveys

During the first wave of the web survey, participants were offered an additional $50 gift card incentive to allow Itron field staff to visit their homes and verify three key aspects of our mobile-optimized web survey: 1) self-reported technology ownership by type (i.e. forced-air vs. ductless HVAC), 2) model numbers derived from nameplate images, and 3) lighting socket counts.

In total, we conducted 48 on-site verification surveys with wave 1 participants, which produced the following findings:

- 97% of self-reported of ownership by technology type verified as correct.
- 94% of the model numbers read by our back-office processes verified as correct.
- Self-reported lighting sockets were under-reported by 15%, with halogen and incandescent A-lamps accounting for the majority of under-reported sockets.

FIGURE 3-4: SURVEY DATA PROCESSING WORKFLOW

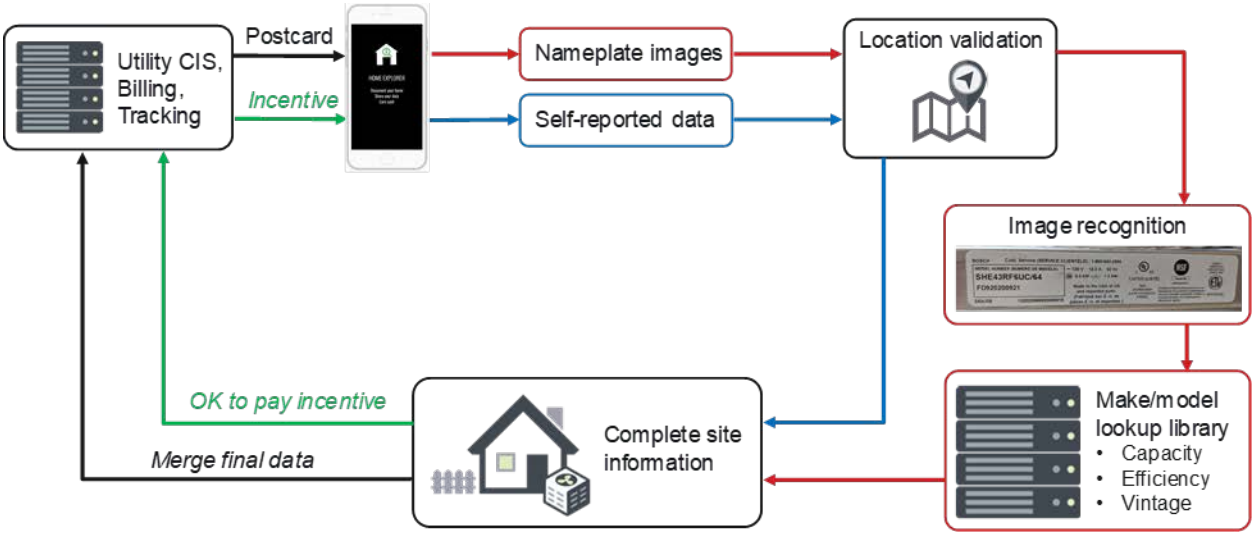


Table 3-3 shows the final disposition of the web survey by survey stratum. As the table shows, the 35,000 postcard mailers resulted in just over 2,000 click-ins to the web survey – for an overall participation rate

of just over 5%. While this participation rate was below the rate we assumed in our initial planning, ComEd expressed satisfaction with the overall number of survey participants and depth of the analytic dataset, and we collectively decided not to pursue additional waves of postcard mailers.

TABLE 3-3: FINAL WEB SURVEY DISPOSITION

Stratum	Building Type	Location	Usage	Low-Income Eligible	Postcards	Click-ins
11	SFD	Chicago	H	N	980	51
12	SFD	Chicago	H	Y	1,925	92
13	SFD	Chicago	M	N	987	79
14	SFD	Chicago	M	Y	1,925	100
15	SFD	Chicago	L	N	980	53
16	SFD	Chicago	L	Y	1,925	116
21	SFD	Suburban	H	N	1,925	145
22	SFD	Suburban	H	Y	980	53
23	SFD	Suburban	M	N	1,925	187
24	SFD	Suburban	M	Y	987	62
25	SFD	Suburban	L	N	1,925	136
26	SFD	Suburban	L	Y	980	44
31	SFD	Other	H	N	2,590	189
32	SFD	Other	H	Y	315	21
33	SFD	Other	M	N	2,590	182
34	SFD	Other	M	Y	322	26
35	SFD	Other	L	N	2,590	125
36	SFD	Other	L	Y	315	13
41	MFD	Chicago	H	N	455	24
42	MFD	Chicago	H	Y	868	38
43	MFD	Chicago	M	N	455	25
44	MFD	Chicago	M	Y	875	40
45	MFD	Chicago	L	N	455	24
46	MFD	Chicago	L	Y	868	32
51	MFD	Suburban	H	N	665	39
52	MFD	Suburban	H	Y	658	24
53	MFD	Suburban	M	N	665	53
54	MFD	Suburban	M	Y	665	21
55	MFD	Suburban	L	N	658	29
56	MFD	Suburban	L	Y	665	14
61	MFD	Other	H	N	420	18
62	MFD	Other	H	Y	147	7
63	MFD	Other	M	N	126	3
64	MFD	Other	M	Y	63	1
65	MFD	Other	L	N	84	2
66	MFD	Other	L	Y	42	2
TOTAL					**35,000**	**2,070**

Table 3-4 shows the final disposition of the nameplate images collected through the web survey. As the table shows, just under 3,000 nameplate images were submitted by survey participants, and we were able to match 71% of those nameplate images to unique make/model in our lookup library. Note that this overall match rate includes images that were unusable for purposes of identifying the unit's model number. Unusable images generally fell into three categories: overly blurry images, nameplates that were illegible due to wear/age, and images that were not of the unit's nameplate (often just the brand badge on the front of the unit). Within just usable images, we were able to match 93% of those images to unique make/model numbers in our lookup library.

TABLE 3-4: FINAL NAMEPLATE IMAGE DISPOSITION

End-Use Technology	Nameplate Images Submitted	Nameplate Images Matched	% Submitted Nameplate Images Matched	% Usable Nameplate Images Matched
Central AC & Heat Pumps	597	376	63%	88%
Water Heaters	47	20	43%	67%
Refrigerators	876	660	75%	97%
Freezers	116	63	54%	91%
Dishwashers	470	373	79%	94%
Clothes Washers	636	481	76%	93%
Clothes Dryers	194	131	68%	89%
Room AC	62	28	45%	80%
Total	**2,998**	**2,132**	**71%**	**93%**

As can be expected, not all participants provided nameplate images – either at all or for specific types of equipment.[7] In anticipation of this outcome, the survey included batteries of questions on self-reported equipment age, physical size, and product features. These questions were specifically designed to allow us to backfill equipment-specific efficiency (and sometimes capacity) characteristics based on historical federal minimum efficiency standards in cases where nameplate images were not provided.

Table 3-5 shows the number of equipment-specific efficiency records that were backfilled in this manner, and the resulting size of the final equipment-level efficiency dataset that we were able to develop from the survey (over 4,500 records). Overall, we were able to develop equipment-specific efficiency characteristics for just under 80% of all participants that stated they owned that type of equipment

[7] Participants that did not submit nameplate images were asked to provide the main reason for not doing so. The most frequent reasons given were inability to access the unit (e.g. AC compressors located on a roof or behind a locked gate) or inability to locate the nameplate on the unit.

through a combination of nameplate image matching and backfilling based on self-reported characteristics and historical minimum efficiency standards.

TABLE 3-5: FINAL EQUIPMENT-LEVEL ENERGY EFFICIENCY DATASET

End-Use Technology	Total Self-Reported Ownership	Nameplate Images Matched	Unmatched Nameplate Images Backfilled w/Code Baseline	No Nameplate Image Submitted Backfilled w/Code Baseline	Total EE Records (matched + backfilled)
Central AC & Heat Pumps	1,366	376	53	791	1,220
Water Heaters	92	20	10	50	80
Refrigerators	1,286	660	22	252	934
Freezers	240	63	6	109	178
Dishwashers	648	373	22	175	570
Clothes Washers	1,114	481	34	474	989
Clothes Dryers	302	131	16	97	244
Room AC	648	28	7	255	290
Total	**5,696**	**2,132**	**170**	**2,203**	**4,505**

4 RESIDENTIAL BASELINE RESULTS

In this section, we present the results of our residential data collection. We start with reviewing some high-level housing characteristics and then present key findings for each of the major residential end-uses by segment.

Note that the results presented below were weighted before summing, averaging, and calculating other results metrics. Specifically, the raw survey results were weighted according to the number of respondents in a given sample stratum relative to the number of premises in that stratum in the population. This approach is sometimes referred to as "site weighting". Due to the nature of the web survey designed for this study, we were able to record responses from participants that completed the entire survey as well as from participants that only completed a portion of the survey. As such, we developed separate weights for each section of the survey. The complete set of weights that we used to expand the results from each sample stratum and each survey section are provided in a separate data deliverable.

Note also that for reporting purposes, we aggregated the results for 'Other' and 'Suburban' geographic strata. This was done primarily due to the very small number of completed surveys in the individual 'Other' sample strata. Importantly, however, the results for 'Other' segment tracked very closely with those for 'Surburban' segment.

4.1 HOME CHARACTERISTICS

Figure 4-1 shows the average size of homes (in square feet) in ComEd's service territory for each major residential customer segment. As the figure shows, the average size of single-family dwellings (SFDs) is significantly higher than the average size of multi-family dwellings (MFDs) – 1,856 ft^2 vs. 1,372 ft^2, respectively. Similarly, the average size of non-low income-eligible (non-LI) homes is significantly higher than the average size of low-income-eligible (LI) homes – which reflects the lower share of MFDs in the non-LI segment compared to the share of MFDs in LI homes. Overall, differences in average home size correlate strongly with differences in the average number of rooms across segments (primarily bedrooms and bathrooms). Interestingly, differences in average home size also appear to correlate strongly with differences in home ownership rates across segments, as shown in Figure 4-2.

FIGURE 4-1: AVERAGE HOME SIZE

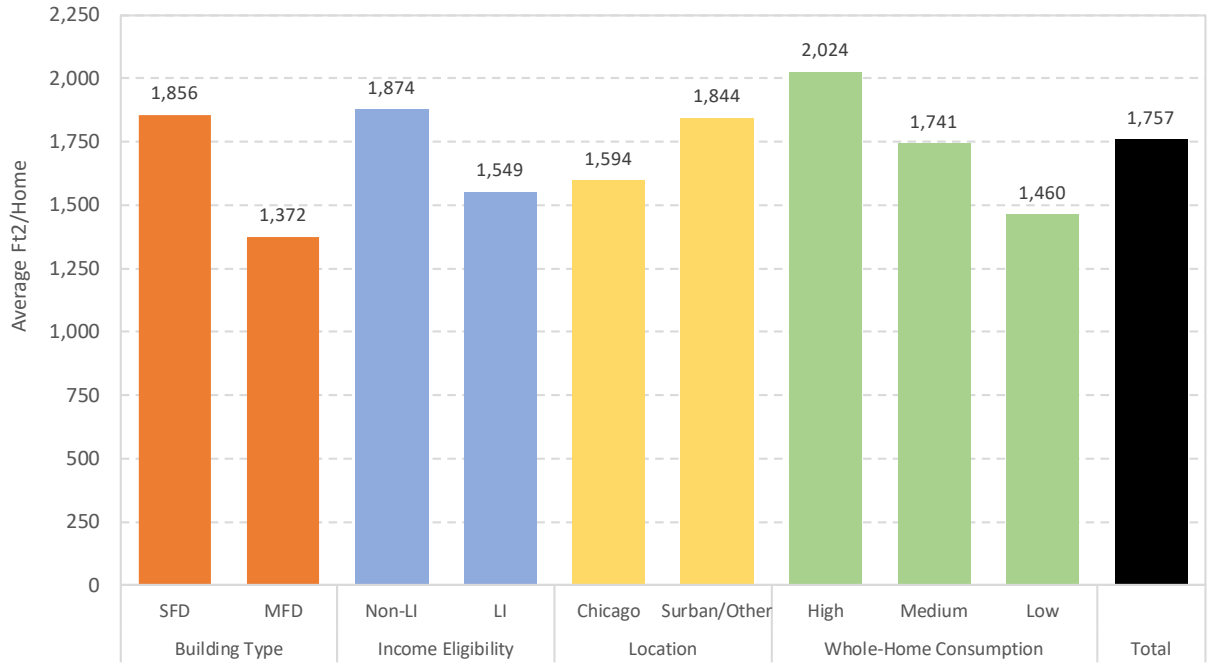


FIGURE 4-2: SHARES OF HOME OWNERSHIP

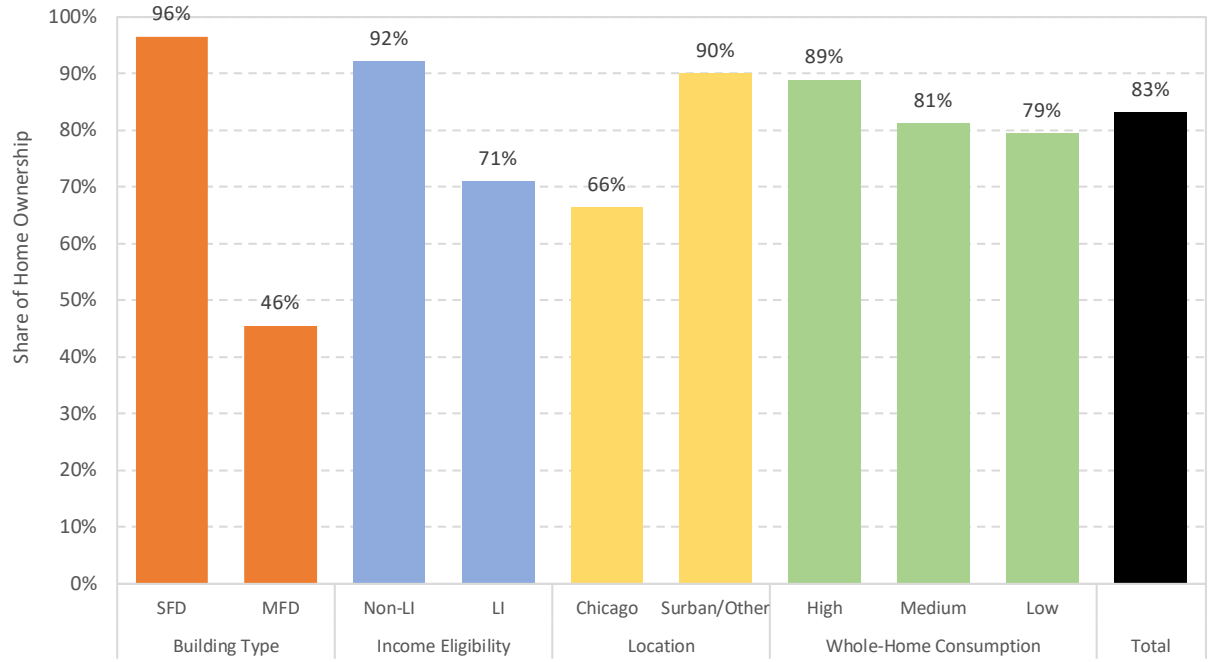
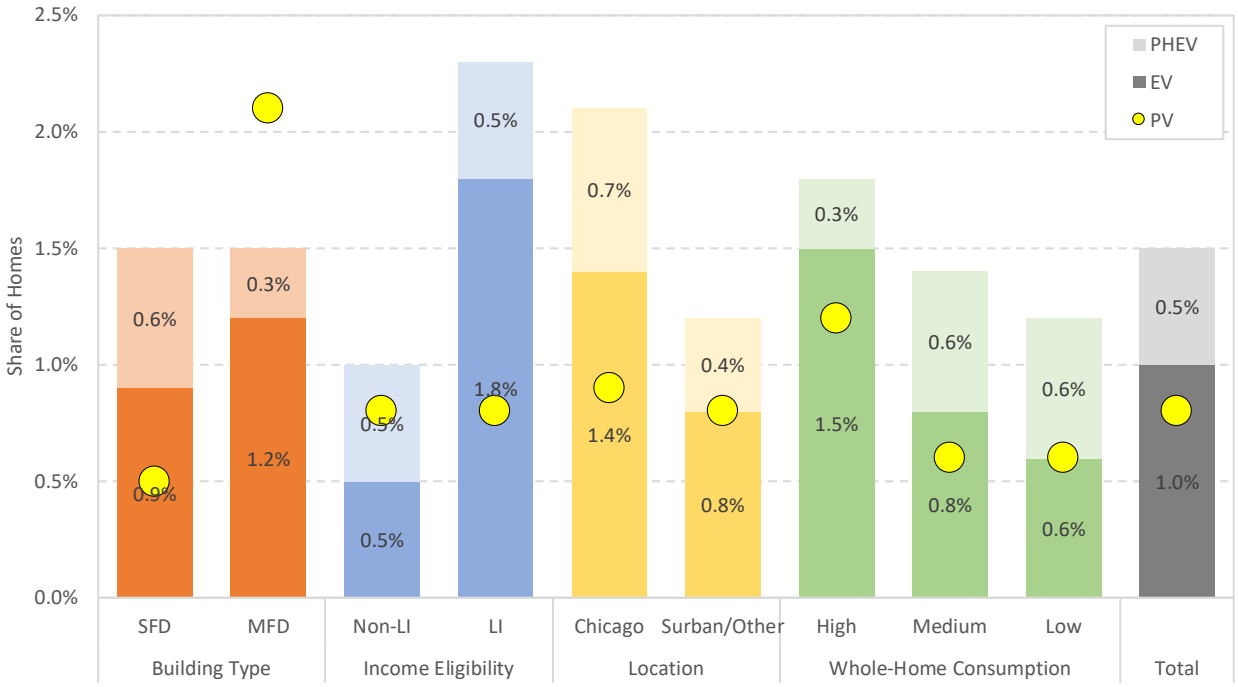


Figure 4-3 shows the penetration of plug-in electric vehicles (PHEV), all-electric vehicles (EV), and solar photovoltaic (PV) systems owned by ComEd's residential customers. Overall, ownership of PHEV, EV, and PV among ComEd's residential customers is still low – at or below 1% total market share for each. As might be expected, EV ownership is highest among homes in Chicago and high-consumption homes. In contrast, the survey results indicate that EV ownership is highest (in terms of market share) among LI homes and PV ownership is highest (in terms of market share) among MFD homes – both of which are somewhat counter-intuitive results.

FIGURE 4-3: ELECTRIC VEHICLE AND SOLAR PV PENETRATION



4.2 BUILDING ENVELOPE

The significant limitation of our multi-modal survey approach is related to collecting high-quality data on building envelope. Most customers, even homeowners, do not know the R-values of their insulation. Moreover, the presence and thickness of insulation are difficult to observe directly, and we believe it is unreasonable to ask survey participants to climb into their attics, drill holes in their walls, climb into crawl spaces, and otherwise directly observe the presence of insulation in their homes.[1] As such, we limited the web survey to asking about building envelope characteristics that customers know with a

[1] These barriers are also present and largely insurmountable when conducting on-site surveys. The one exception is attic insulation, which on-site surveyors can often readily observe, assuming attic access is a non-issue.

reasonable degree of certainty or can otherwise observe readily. Specifically, these characteristics were: 1) the prevailing window type at their home, and 2) whether (and what kind of) major insulation work has been conducted at their home in the last 5 years.

Figure 4-5 shows the distribution of prevailing residential window types in ComEd's service territory. As the figure shows, the vast majority of homes have all or mostly double- or triple-pane windows. However, it is notable that nearly a quarter of all homes in ComEd's territory still have all or mostly single-pane windows – with the highest shares in MFD and LI homes. Similarly, the share of homes that have recently had insulation work completed is lowest among in MFD and LI homes (see Figure 4-6).

FIGURE 4-4: PREVAILING WINDOW TYPE

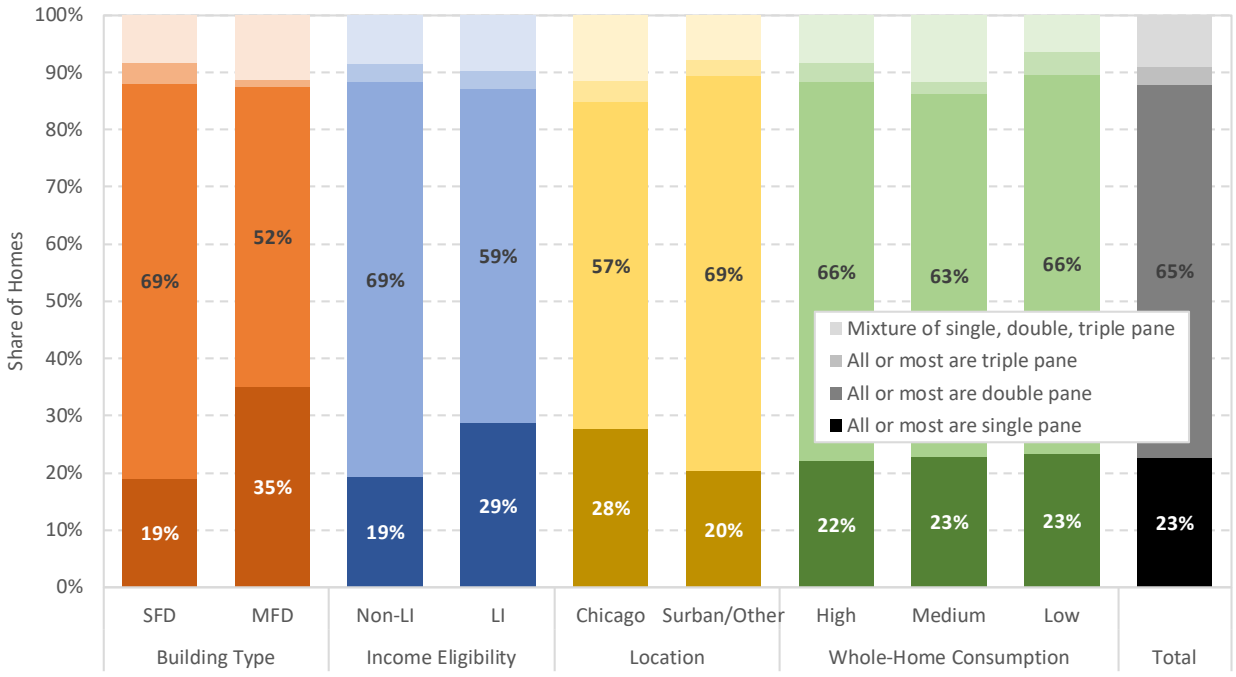
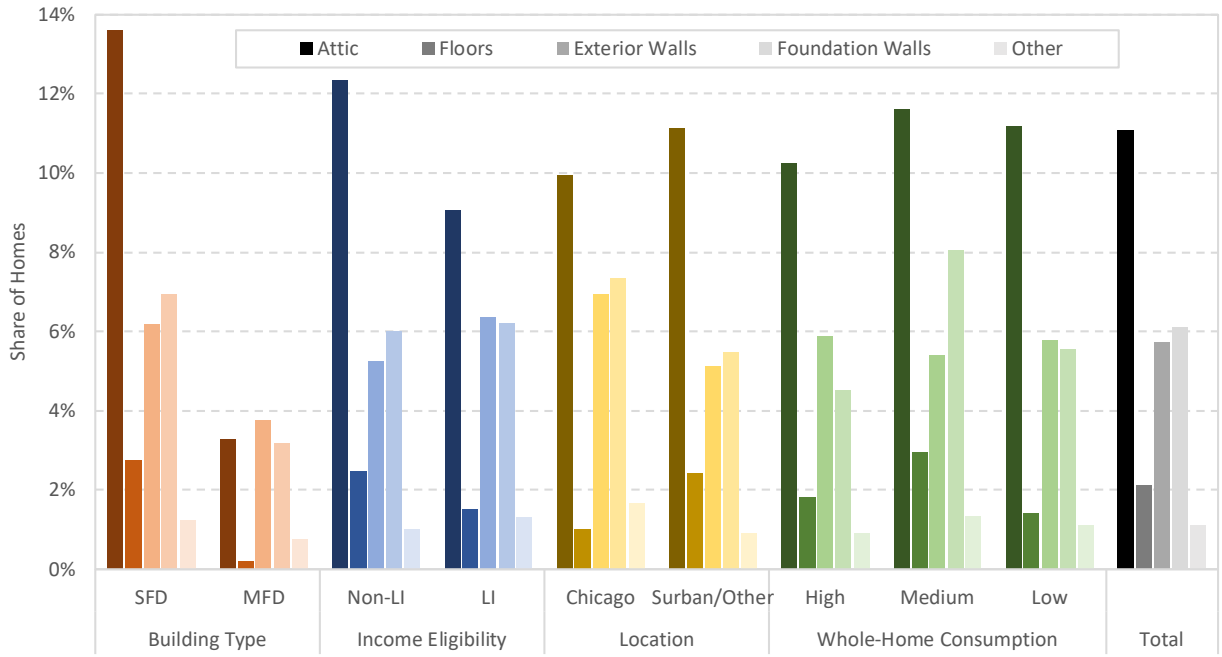


FIGURE 4-5: SHARES OF HOMES WITH RECENT INSULATION WORK BY TYPE



Another key take-away from Figure 4-6 is that the frequency of attic insulation interventions is significantly higher than any other type of insulation intervention. This makes intuitive sense from the perspective of feasibility and cost. Attic insulation retrofits are relatively inexpensive and tend to be feasible do-it-yourself projects, whereas floor and wall insulation retrofits are major efforts that are costly, disruptive, and often bundled with larger home renovation projects.

The web survey also collected similar information on whether any air sealing work (i.e. window and door sealing) has been conducted at the participant's home in the last 5 years. Overall, 14.5% of participants reported having done window and/or door sealing work in their homes in the last 5 years. These results did not vary significantly across customer segments with the exception of low- and medium-consumption homes, who reported slightly higher frequency of having air sealing work done at their homes compared to other customer segments.

4.3 SPACE COOLING

Below we present the key results for space cooling based on the baseline survey, as well as the results of a dedicated analysis of total space cooling consumption based on a load disaggregation analysis using customer-specific billing data.

4.3.1 Central Cooling

Figure 4-1 shows the saturation of central cooling in ComEd's service territory by technology and customer segment. The overall saturation of central cooling is nearly 80%, with the highest saturation occurring in Suburban, non-LI, SFD homes. As the figure shows, nearly all central cooling systems in ComEd's territory are forced-air split systems. Central air-source heat pumps are a subset of forced-air split systems, but very few of these technologies were observed in the survey (<2%). Similarly, the saturation of ductless mini-split systems, ground-source heat pumps, and other central cooling technologies is less than 2% each.

FIGURE 4-6: SATURATION OF CENTRAL COOLING BY TECHNOLGY

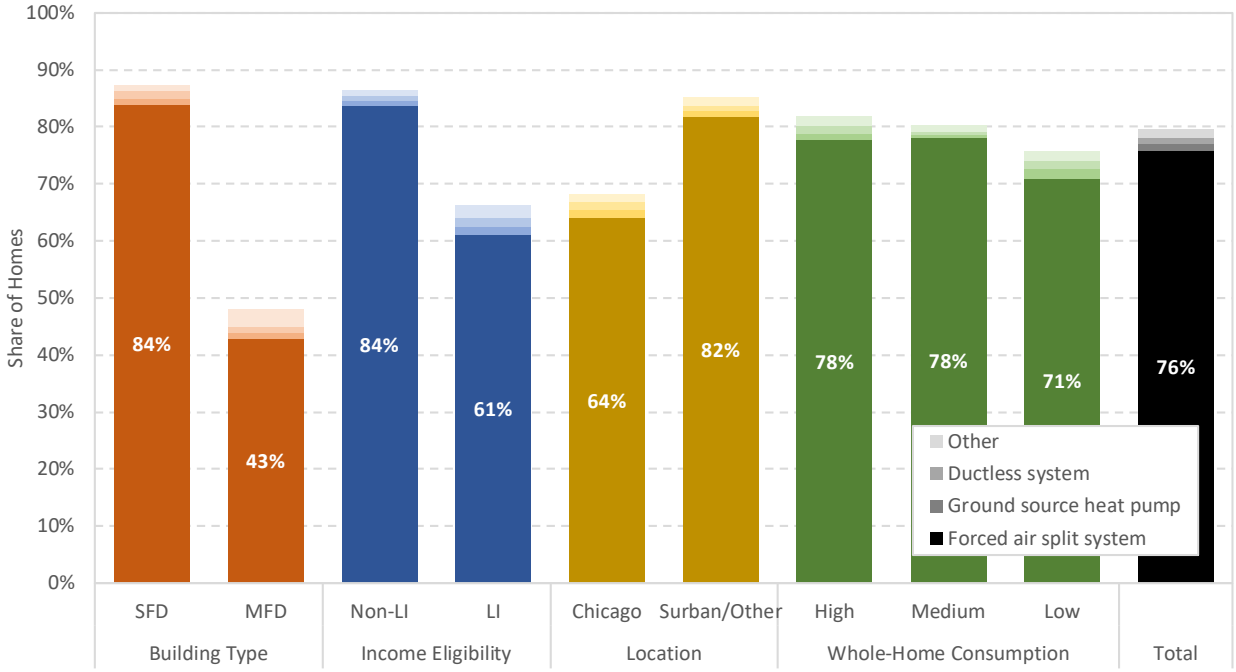


Figure 4-7 shows the distribution of central cooling system capacity per home in ComEd's service territory (in tons cooling per home). As the figure shows, the distribution of central cooling system capacity is skewed slightly left, with the majority of units having a capacity less than 3 tons but a significant tail to the right of the distribution with system capacities in excess of 6 tons.

FIGURE 4-7: DISTRIBUTION OF CENTRAL COOLING SYSTEM CAPACITY PER HOME

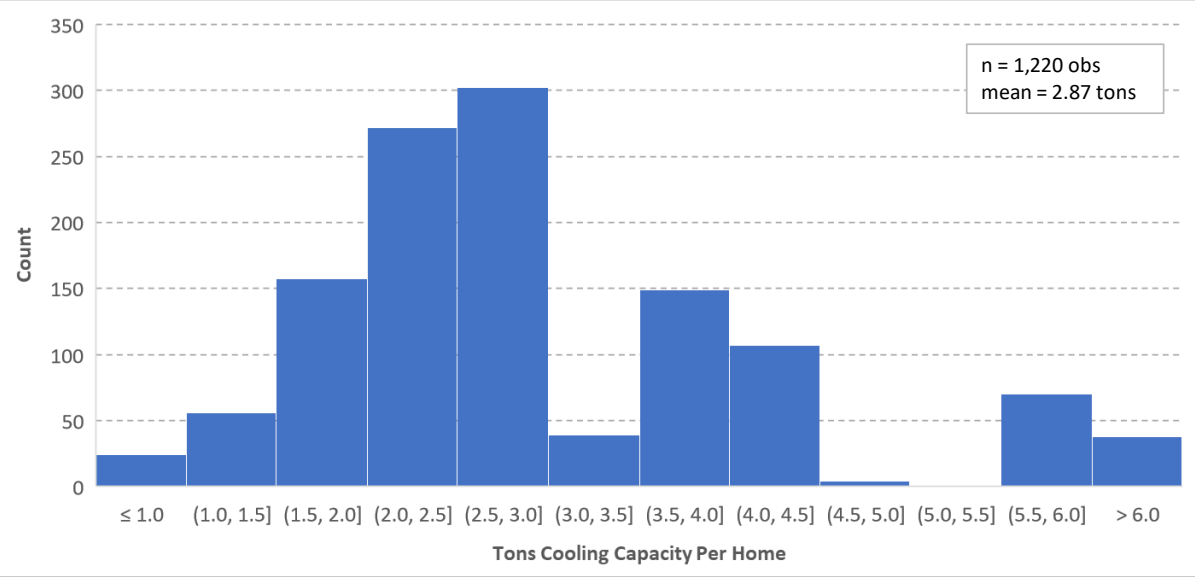


Figure 4-8 shows the average capacity of central cooling systems in ComEd's territory by customer segment. When viewed in comparison with Figure 4-1, the magnitude of cooling system capacity correlates strongly with home size, and the largest average system sizes are found in segments with the highest square footage, i.e. high-consumption, non-LI, and Suburban homes.

FIGURE 4-8: AVERAGE CENTRAL COOLING SYSTEM CAPACITY PER HOME

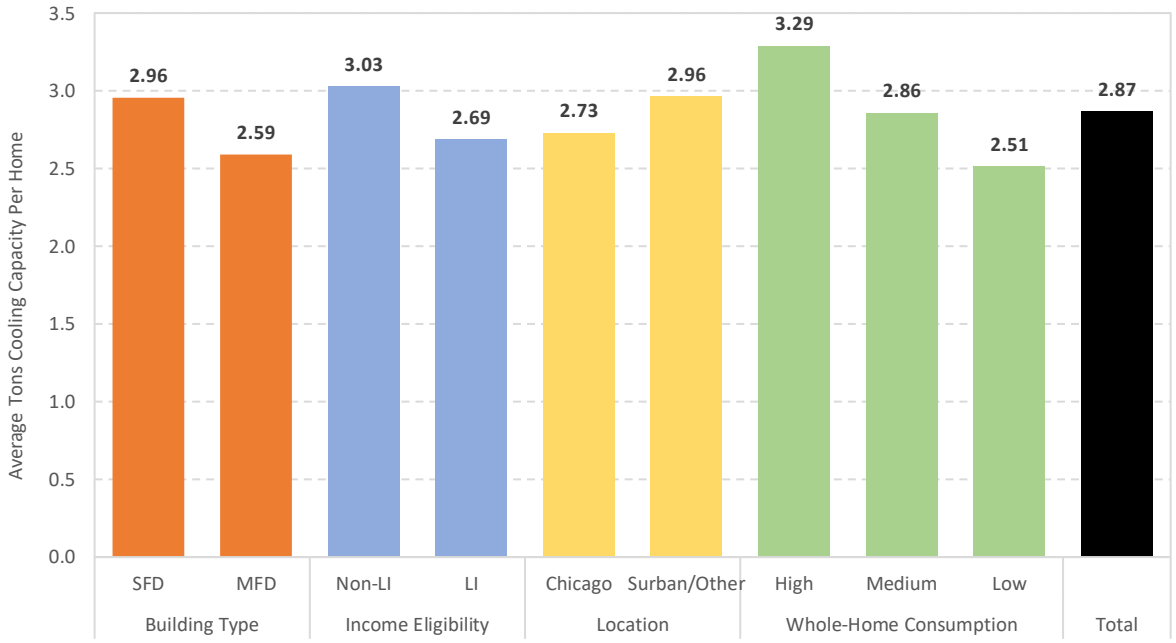


FIGURE 4-9: DISTRIBUTION OF CENTRAL COOLING SYSTEM RATED EFFICIENCY

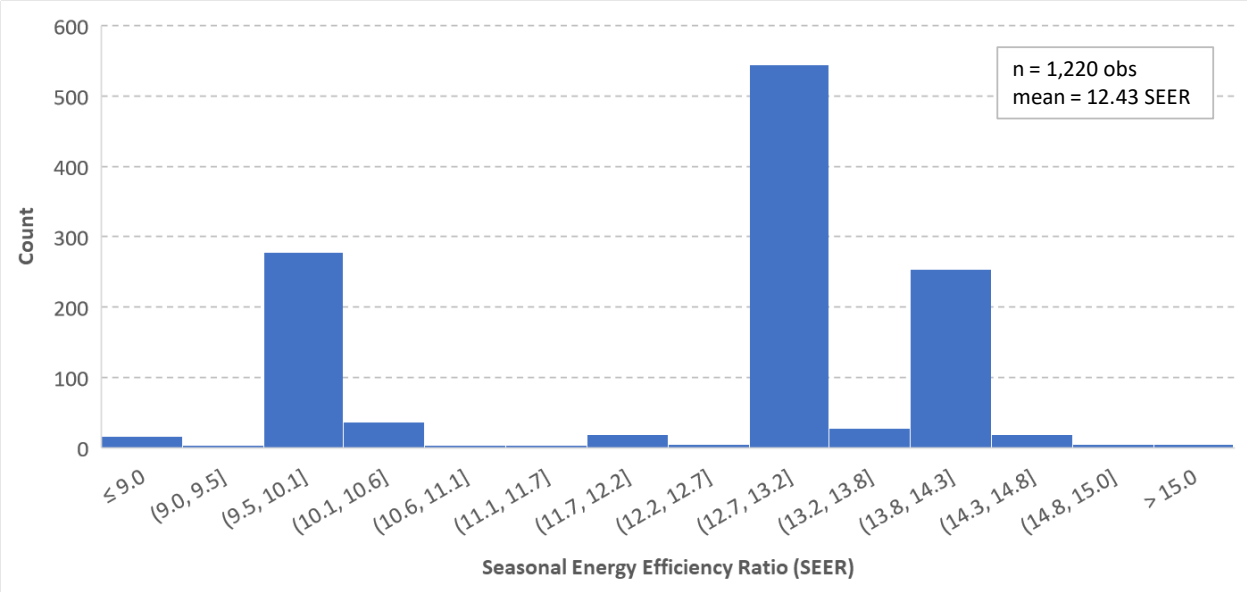
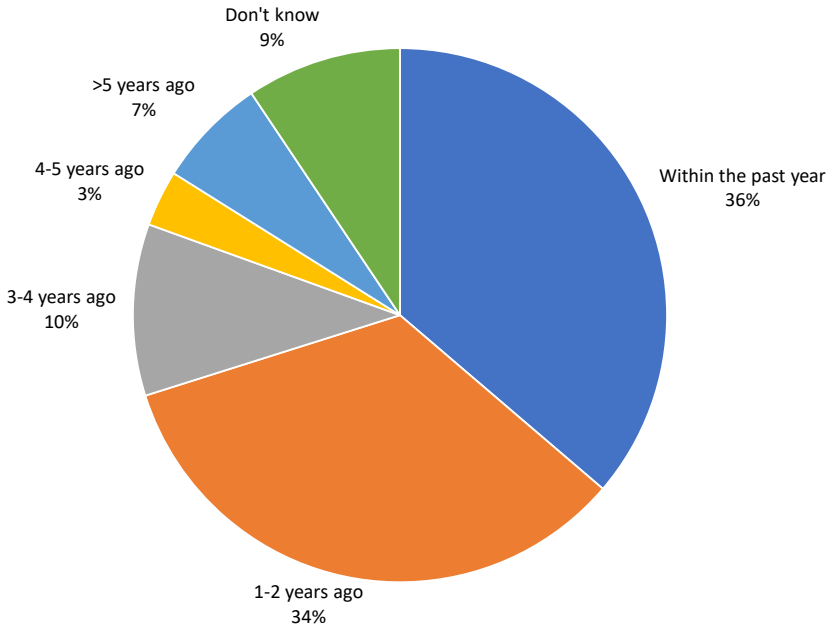


Figure 4-9 above shows the distribution of rated system efficiency (expressed as Seasonal Energy Efficiency Ratio or SEER) of central cooling systems in ComEd's service territory. As the figure shows, the distribution of rated system efficiency is concentrated around the historical minimum code levels that have been enforced for central air conditioning systems since 1992 (10 SEER, 13 SEER, and 14 SEER), with an overall average of 12.4 SEER for all units observed. From an energy efficiency potential perspective, it should be noted that the share of units rated below 13 SEER is 30%, and the vast majority of those units are 10 SEER. From a market transformation perspective, it should be noted that the share of units rated 14 SEER or above is 13%.

Figure 4-10 below shows the frequency of recent central cooling system repair, which indicates that 70% of ComEd customers that have central cooling have had maintenance conducted within the past two years – a surprisingly large share that would indicate that maintenance-related energy savings measures represent a relatively small program opportunity for ComEd going forward.

FIGURE 4-10: CENTRAL COOLING SYSTEM MAINTENANCE



4.3.2 Room Cooling

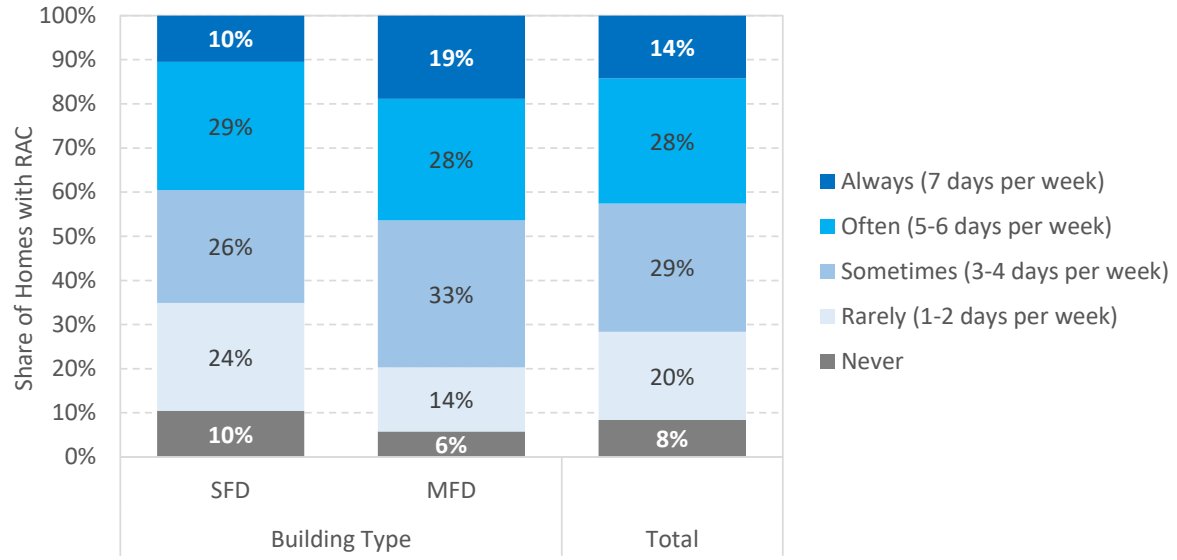
Table 4-1 summarizes a few of the key results for room air conditioners (RACs). As the table shows, the overall saturation of RACs among ComEd's residential customers is 18%, with the saturation within MFD homes significantly higher (40%). Apart from this higher saturation in MFDs, however, the average rated efficiency of RACs is remarkably similar across customer segments, with an overall average of 10.3 SEER. Similarly, the average age of RACs is also remarkably similar across segments, with nearly half of all RAC units less than 6 years old.

TABLE 4-1: ROOM AIR CONDTIONER SATURATION, EFFICIENCY, AND AGE

Segment	Saturation	Average Rated EER	Share of Units <6 years old
SFD	10%	10.16	49%
MFD	40%	10.44	49%
Total	18%	10.32	49%

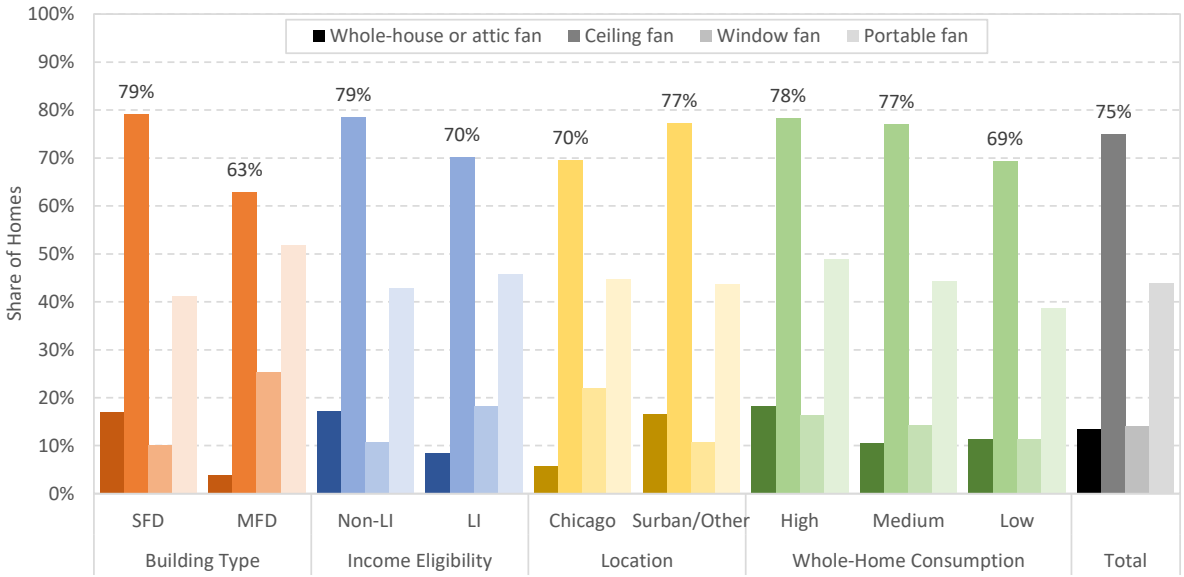
Figure 4-11 summarizes the usage patterns for RACs in ComEd's residential sector. Overall, just over 40% of RACs are operated at least 5 days per week during the cooling season, with slightly more frequent usage of RACs in MFD homes.

FIGURE 4-11: ROOM AIR CONDITIONERS USAGE DURING COOLING SEASON



Apart from RACs, the other major category of room cooling technologies common in residential homes is fans, including whole-house fans, ceiling fans, window fans, and portable fans. Figure 4-12 shows the saturation of these types of fans among ComEd's residential customers. As the figure shows, the saturation of ceiling fans is remarkably high across all customer segments, averaging 75% saturation overall. In contrast, the saturation of whole-home fans and window fans is still fairly low in comparison, with both technologies having less than 15% saturation overall.

FIGURE 4-12: SATURATION OF FANS USED FOR ROOM COOLING



4.3.3 Space Cooling Utilization Analysis

While our multi-modal survey design provides deep insights into the capacity and rated efficiency of residential CAC and RAC units, total electricity consumption for space cooling is also impacted by several important factors unrelated to unit capacity and efficiency, namely building envelope performance (construction material, insulation levels, infiltration levels, etc.) and customer behavior (occupancy, temperature setpoints/schedules, thermostat override habits, etc.). As a result, customer-level space cooling consumption tends to vary more widely than any other major electric end use.

Because of this wide distribution of customer-level consumption, analyzing the cost-effectiveness of space cooling energy efficiency measures in aggregate can therefore introduce significant "aggregation bias", particularly in the context of estimating the cost-effective potential for energy efficiency. Aggregation bias occurs when average values of measure savings for high-level customer segments (e.g. SFD, MFD) imply that a given measure is not cost-effective, when in fact that measure is cost-effective for a significant portion of the eligible population due to a wide distribution of measure savings. In this sense, aggregation bias can result in systematic under-estimation of the size of the cost-effective energy efficiency resource – particularly for space cooling measures. Indeed, aggregation bias has been a common (and valid) criticism of traditional energy efficiency potential studies, where cost-effectiveness is typically calculated based on segment-level averages.

For this study, ComEd expressed a strong interest in using data collection and analysis approaches designed to minimize aggregation bias wherever possible. For most of the major residential end uses, our multi-modal data collection approach allows us to characterize the distribution of end-use energy consumption based on large samples of equipment-specific rated capacity and efficiency data. For space cooling, however, we augmented our rich primary data set with a dedicated analysis designed to characterize the distribution of space cooling energy consumption in ComEd's service territory.[2] This analysis was composed of two main steps – load disaggregation and cluster analysis – the output of which was a segmentation scheme designed to minimize aggregation bias for space cooling measures that will be applied during the estimation of economic potential in the next phase of this study.

Load Disaggregation

As mentioned earlier in Section 2, ComEd currently uses Itron's *Operations Optimizer* data analytics platform to manage its AMI operations. Operations Optimizer also includes a load disaggregation module. Load disaggregation is a technique where whole-home consumption data are combined with

[2] Space heating consumption also varies widely for largely the same reasons that space cooling varies widely. However, since electric space heating is not prevalent in ComEd's service territory, we chose not to expend project resources on conducting a similar analysis for space heating.

local weather data and sometimes building characteristics and equipment data to isolate the loads associated with individual end uses. For weather-dependent loads like space cooling, this is commonly done through statistical regression of whole-home consumption against cooling degree-days or other measures of outdoor temperature. Operations Optimizer combines statistical regressions of whole-home consumption and weather with physics-based calculations that take into a given premise's square footage and building vintage (available from tax assessor data) to estimate the load associated with space cooling.

For this project, we temporarily enabled the load disaggregation module in Operations Optimizer on a one-time basis in order to generate estimates of space cooling loads for each of the customers that responded to our web survey. Importantly, we also modified the load disaggregation algorithm in Operations Optimizer to use the customer-specific central AC system capacity and rated SEER values as inputs (rather than imputed values, per the default approach). This modified load disaggregation algorithm in turn produced estimates of customer-specific space cooling consumption that are calibrated to actual total customer load, home square footage, building vintage, and the capacity and SEER rating of the specific cooling equipment installed at a given premise.

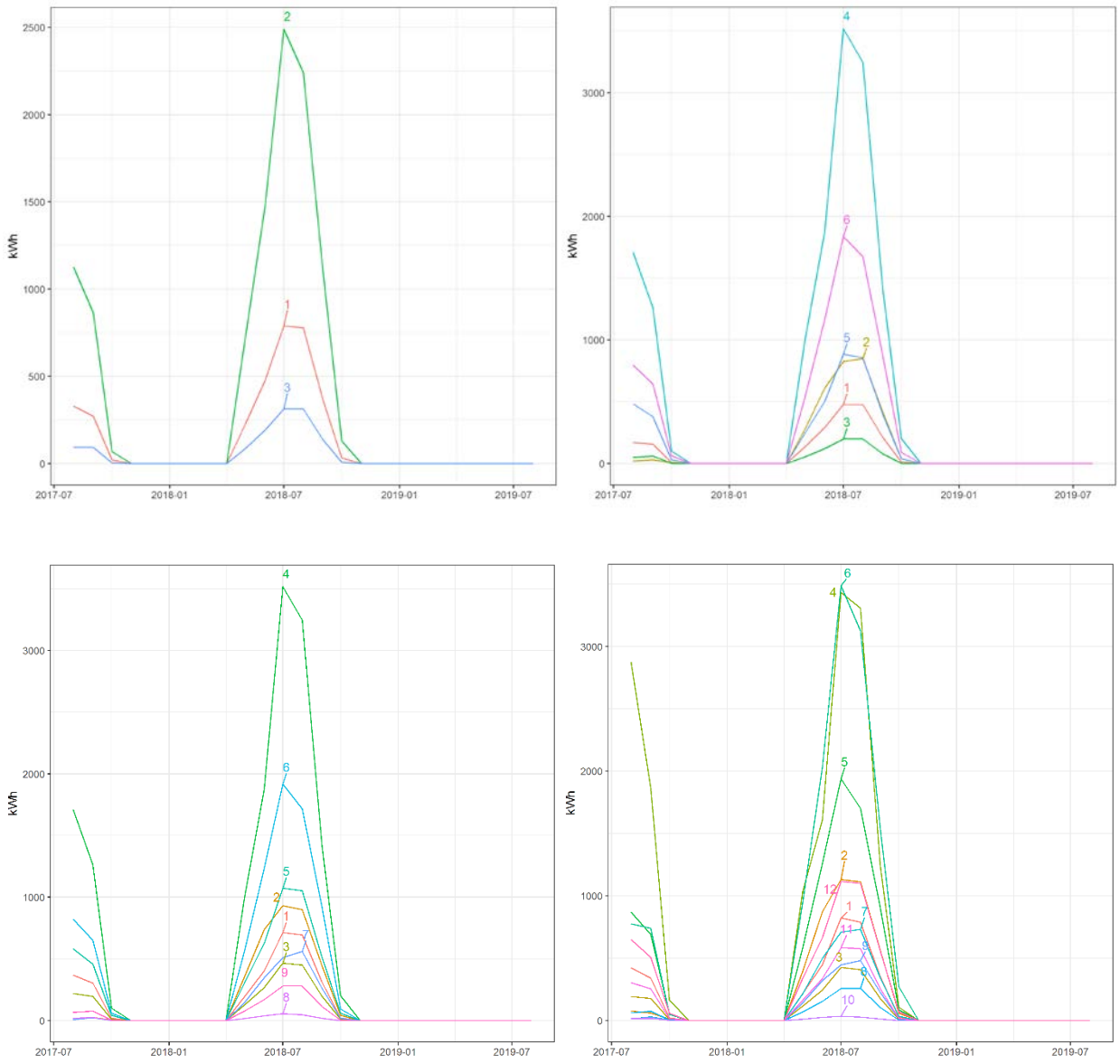
In total, we used this modified load disaggregation algorithm to generate space cooling consumption estimates for 1,277 individual customers in ComEd's service territory.

Cluster Analysis

As expected, the range of space cooling consumption estimates generated by Operations Optimizer was wide, ranging from less than 500 kWh/year to over 10,000 kWh/yr. With these estimates in hand, our next objective was to examine the distribution of space cooling consumption and identify the best way to group customers such that the aggregate results for those groups adequately reflected the full distribution of per-home space cooling consumption.

To do this, we used a k-means clustering analysis – which is an analytic method that groups individual observations into a set number of clusters by finding the shortest distance (or difference) between an individual observation and the mean of a given cluster. Figure 4-13 show the results of clustering analysis for 3, 6, 9, and 12 clusters, where each line is a cluster showing the average monthly space cooling consumption for that cluster over the summer months of 2018.

FIGURE 4-13: K-MEANS CLUSTER ANALYSIS RESULTS



Segment Definitions for Potential Modeling

Again, the primary objective of the clustering analysis was to provide a data-driven basis upon which to define segments for potential modeling that minimized aggregation bias for space cooling measures. However, the final potential modeling segments also needed to be designed with an eye towards the other aspects of potential modeling beyond just cost-effectiveness analysis, namely adoption modeling where it is vital to group customers with similar market adoption behaviors and barriers. From a

practical point of view, we also needed to limit the total number of potential modeling segments to 12 or less to fit within the constraints of the Dunsky Energy Efficiency Potential Model.

With the clustering results in hand, the first step was to examine the customer characteristics within each cluster and identify the mix of characteristics that describe the majority of customers in a given cluster. From the clustering results, it became clear that certain physical characteristics such as CAC system capacity, SEER, and building vintage were not associated with clusters in a manner one would expect based purely on an engineering perspective, i.e. some homes with large, inefficient CAC systems were in the lower-consumption clusters, while some homes with small, highly efficient CAC systems were in the higher-consumption clusters. While such results may appear counter-intuitive at first blush, they more likely reflect the influence of differences in customer behavior and building envelope performance – for which we had limited data available at the individual customer level. Our best proxy for customer behavior was the high, medium, and low whole-home consumption flags.

In total, we identified the following as the variables that most differentiated each main cluster (and were available for this study):

- Building type (SFD, MFD)
- Whole-home consumption (H, M, L)
- Home size (less than 2,000 ft^2, greater than or equal to 2,000 ft^2)
- Low-income program eligibility (LI, non-LI)

These variables combine to produce 24 segments. However, after examining the average space cooling consumption in each of the segments defined by these variables, we collapsed several segments with either very small customer populations, similar average space cooling consumption, and/or similar market adoption barriers. The final set of 11 modeling segments that we defined for the potential study phase of this project were as follows:

- SFD-H-<2Kft2-nonLI
- SFD-M-<2Kft2-nonLI
- SFD-L-nonLI
- MFD-M-nonLI
- SFD-H->2Kft2-nonLI
- SFD-M->2Kft2-nonLI
- MFD-H-nonLI
- MFD-L-nonLI
- SFD-<2Kft2-LI
- MFD-LI
- SFD->2Kft2-LI

4.4 CENTRAL HEATING

Figure 4-14 show the saturation of central space heating by technology and fuel. As the figure shows, nearly all homes in ComEd's service territory have central heating of some kind, with 99% of SFD homes and 73% of MFD homes having central heating (93% overall). The figure also shows that gas furnaces are the dominant space heating technology used (70% of all homes), followed by gas boilers (9%). Conversely, electric baseboard heating and air-source heat pumps have very small market shares (<2% each) among ComEd's residential customers.[3] Across customer segments, the most significant variation in space heating technology saturation is between SFD and MFD homes, where the saturation of boilers in MFDs is significantly higher than in SFD homes (13% vs. 8%, respectively).

FIGURE 4-14: SATURATION OF CENTRAL HEATING BY TECHNOLOGY AND FUEL

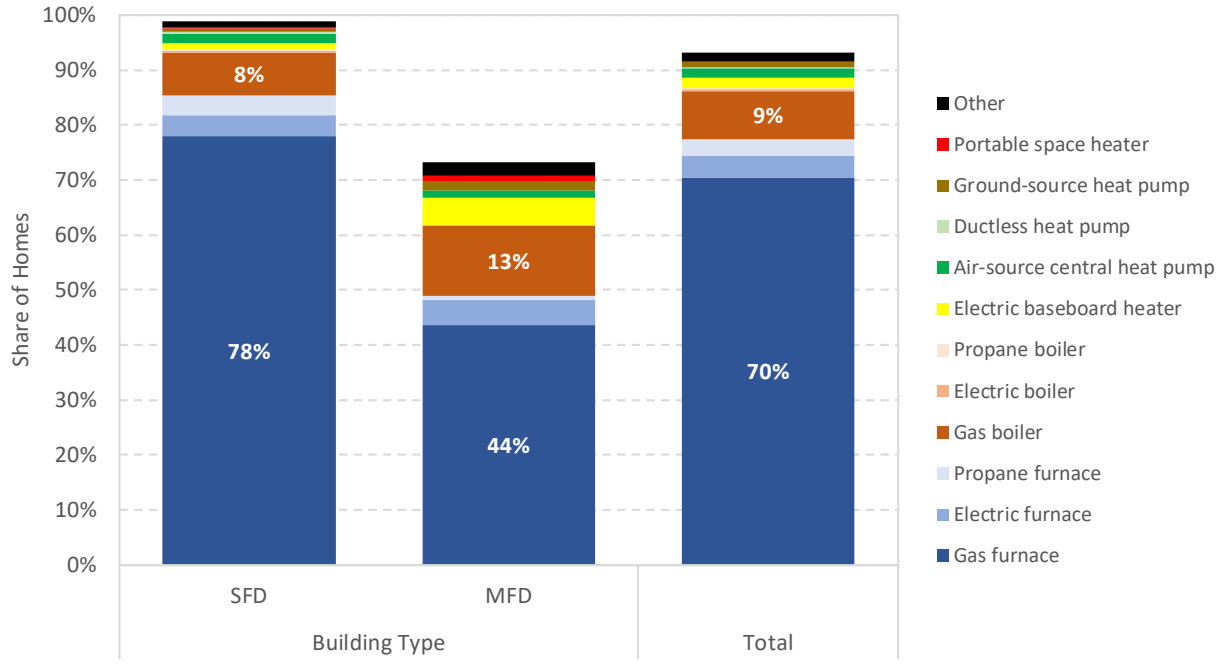
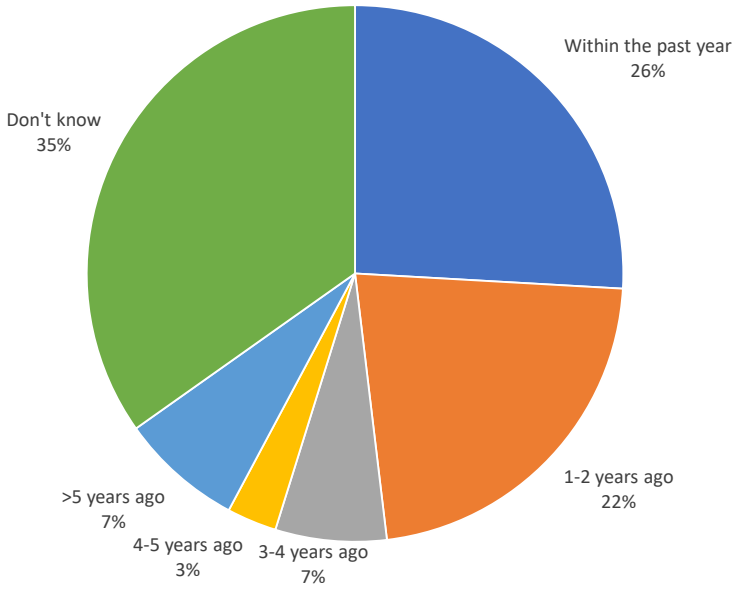


Figure 4-15 below shows that 48% of ComEd customers that have central heating have had maintenance conducted within the past two years. This result contrasts sharply with the self-reported maintenance habits for space cooling systems, where 70% of ComEd customers reported having conducted maintenance on their space cooling systems within the past two years. However, given the very small share of electric central heating systems in ComEd's territory, this result does not necessarily indicate a significant energy saving opportunity for ComEd programs going forward.

[3] Due to the low saturation of heat pumps in ComEd's territory, the small number of air-source heat pumps observed did not support statistically representative estimates of capacity or coefficient of performance (COP).

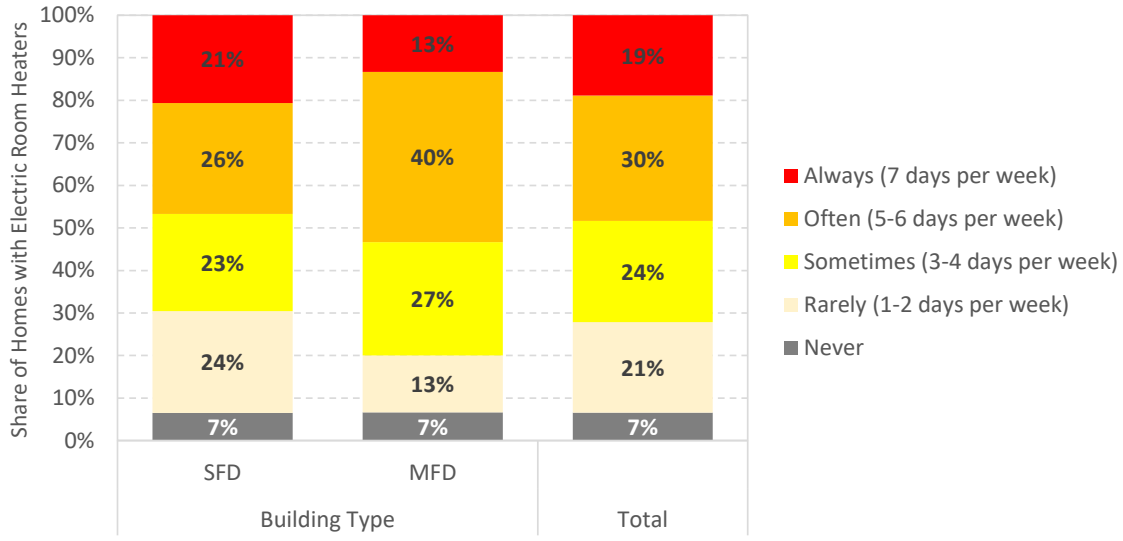
FIGURE 4-15: CENTRAL SPACE HEATING MAINTENANCE



4.5 ROOM HEATING

The saturation of portable electric space heaters among ComEd's residential customers is 14% overall, with a slightly higher saturation in MFD homes compared to SFD homes (17% vs. 12%, respectively). Figure 4-16 shows that nearly half of homes with portable electric space heaters use them at least 5 days per week during heating season, with slightly more frequent usage in MFD homes than SFD homes.

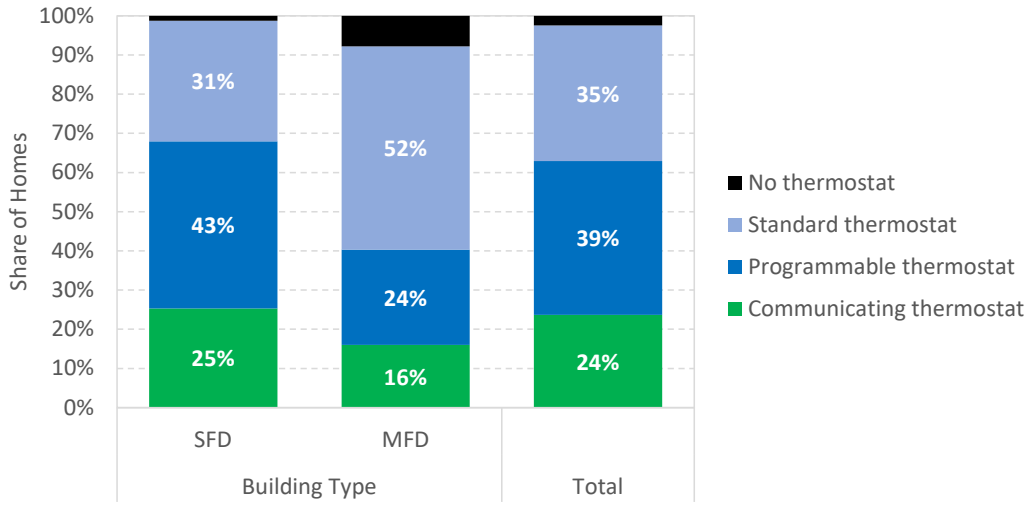
FIGURE 4-16: ROOM HEATING USAGE DURING HEATING SEASON



4.6 THERMOSTATS

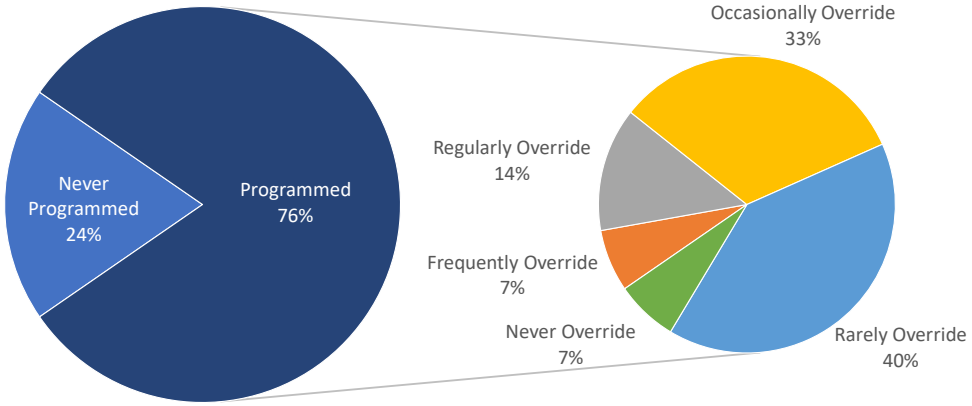
Figure 4-17 shows that very few homes in ComEd's territory do not have any thermostat, and 35% of homes still have only standard (non-programmable) thermostats. This result is more accentuated in MFD homes, where 8% do not have any thermostat and 52% have only standard thermostats. Communicating thermostats (e.g. Nest, Ecobee, etc.) currently have a 24% market share overall.

FIGURE 4-17: SATURATION OF THERMOSTATS BY TYPE



For customers with programmable or communicating thermostats, we also asked about programming habits, since the presence of a thermostat does not necessarily translate to optimal use of HVAC systems. Figure 4-18 shows that 24% of respondents reported that they have never programmed their thermostats. The figure also shows that among those that have programmed their thermostats, 21% reported that they frequently or regularly override the temperature and/or schedule settings.

FIGURE 4-18: FREQUENCY OF OVERRIDING PROGRAMMED THERMOSTAT SETTINGS



4.7 WATER HEATING

Figure 4-19 shows the fuel shares for residential water heating in ComEd's territory. As with central heating, gas is the dominant water heating fuel among ComEd's residential customers, and electric water heating accounts for only 9% of the total market. Figure 4-19 also shows that among homes with electric water heating, greater than 75% of those systems are electric storage water heaters. Figure 4-20 shows that the share of electric water heaters with insulation is fairly low (7% and 17%, respectively).

FIGURE 4-19: WATER HEATING FUEL SHARES

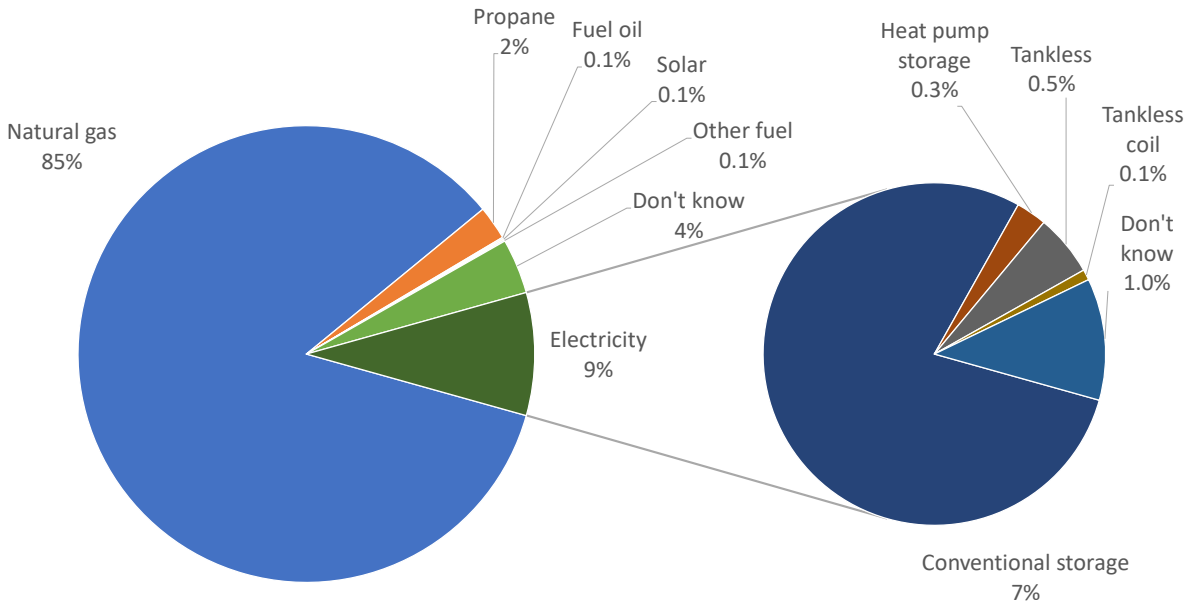
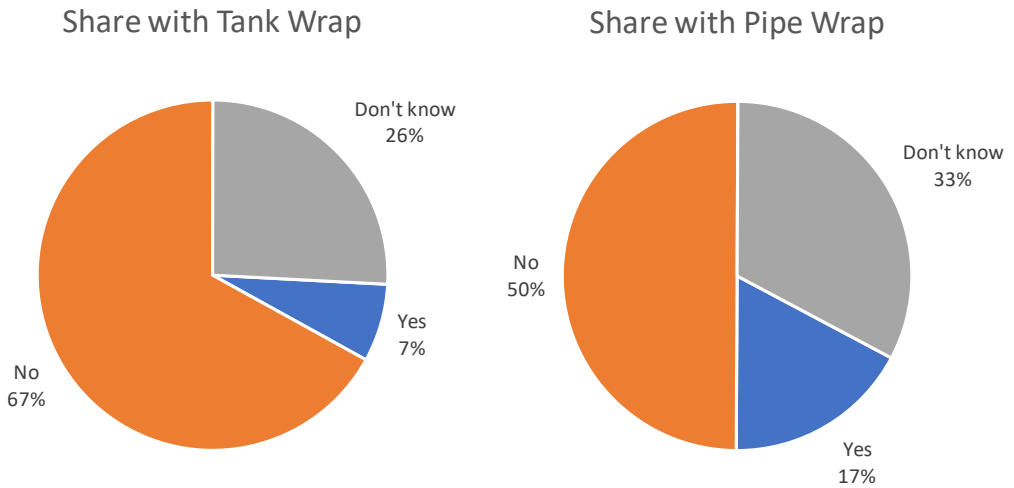


FIGURE 4-20: SHARES OF ELECTRIC WATER HEATERS WITH INSULATION MEASURES



4.8 LAUNDRY APPLIANCES

Figure 4-21 shows that the overall saturation of clothes washers among ComEd's residential customers is 93% but only 62% in MFD homes – which is consistent with the existence of shared laundry facilities in some MFD homes. Front-loading clothes washers account for just under a third of all observed units.

FIGURE 4-21: SATURATION OF CLOTHES WASHERS BY TYPE

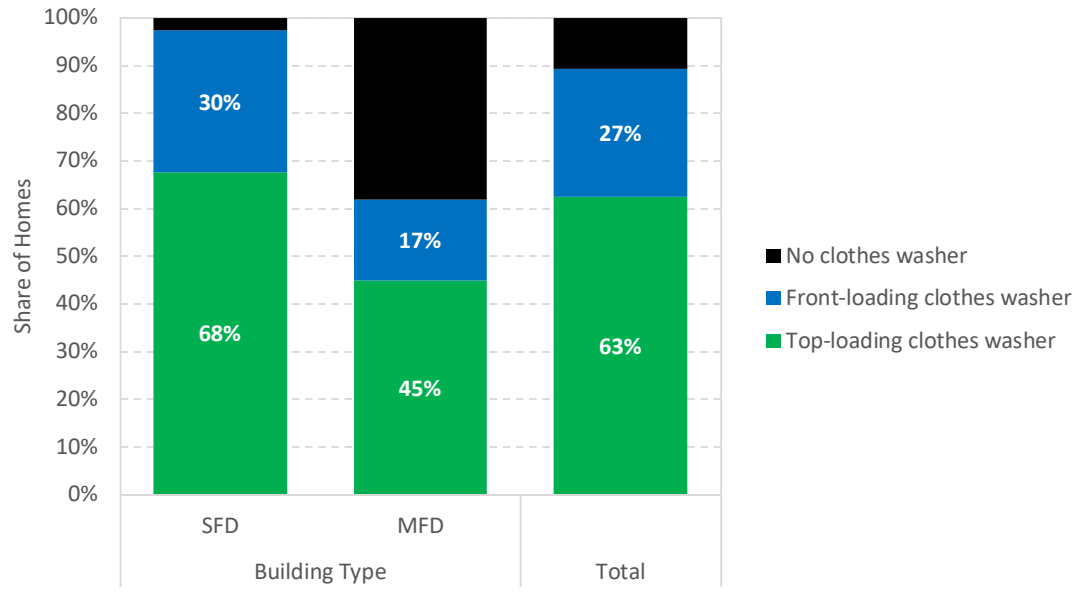


FIGURE 4-22: DISTRIBUTION OF CLOTHES WASHER RATED EFFICIENCY (MODIFIED ENERGY FACTOR)

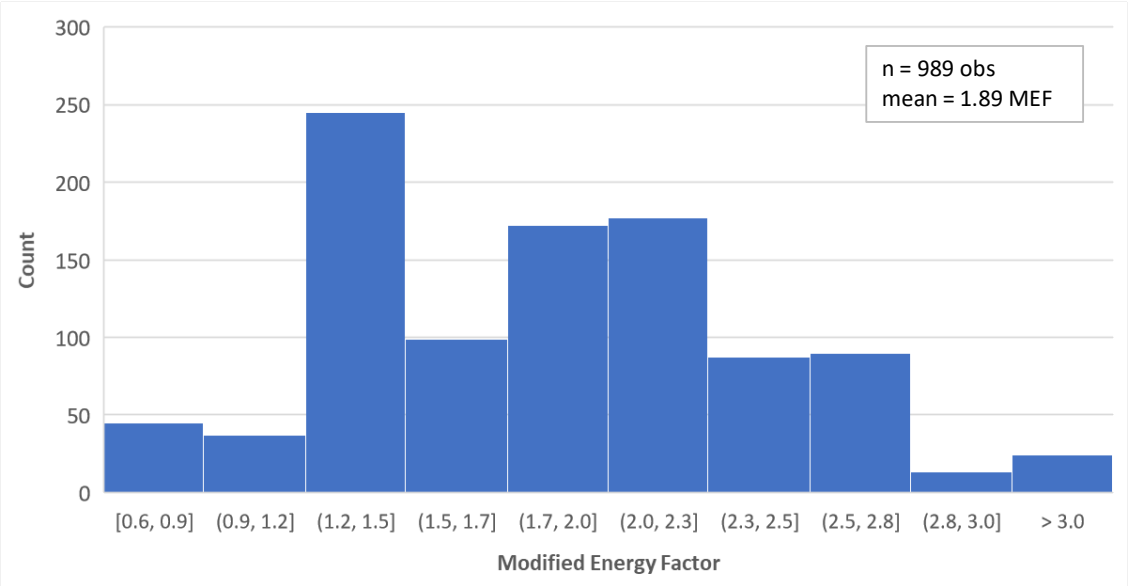


Figure 4-22 above shows the distribution of clothes washer rated efficiency (expressed as Modified Energy Factor or MEF). As the figure shows, clothes washer efficiency largely follows a normal distribution, with a mean value of 1.89 MEF and values as low as 0.6 MEF and as high as 3.0 MEF. The key exception to note, however, is a relatively high concentration of units with rated MEFs between 1.2 and 1.5. which was the federal minimum efficiency standard from 2011 through 2018.

Figure 4-23 below shows the saturation of clothes dryers among ComEd's residential customers by type. As the figure shows, natural gas clothes dryers enjoy a majority market share in ComEd's territory, accounting for 57% of the total residential market. The figure also shows that clothes dryer ownership is significantly higher in Suburban homes compared to homes in Chicago, and clothes dryers that use bottled gas (e.g. propane) have a non-zero market share in Suburban homes as well. This latter result is perhaps a reflection of the relative availability of natural gas service in the more rural parts of ComEd's service territory.

FIGURE 4-23: SATURATION OF CLOTHES DRYERS BY FUEL AND TYPE

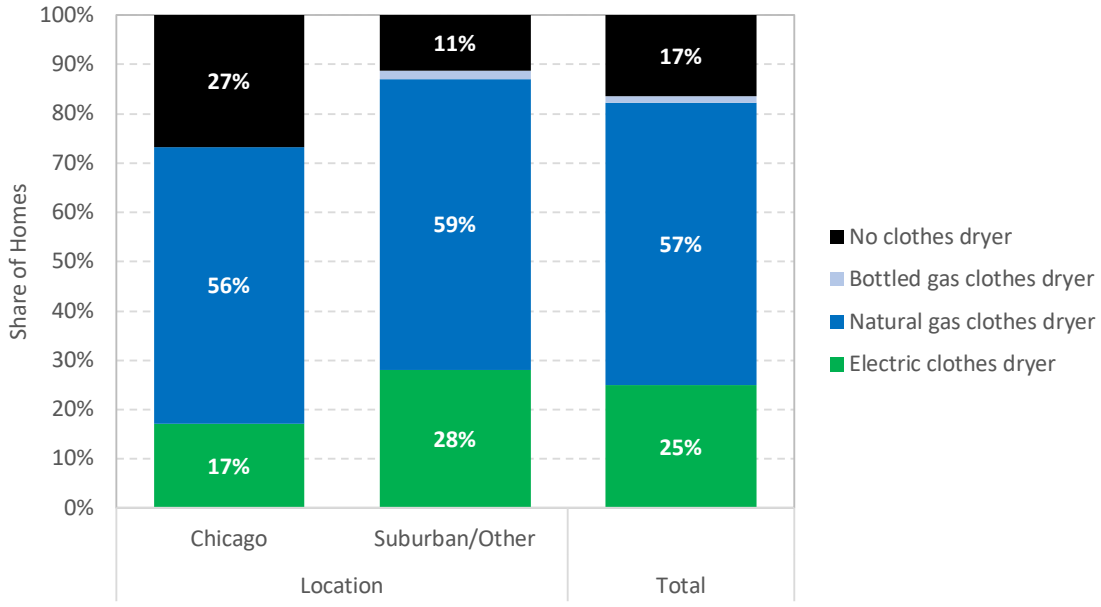
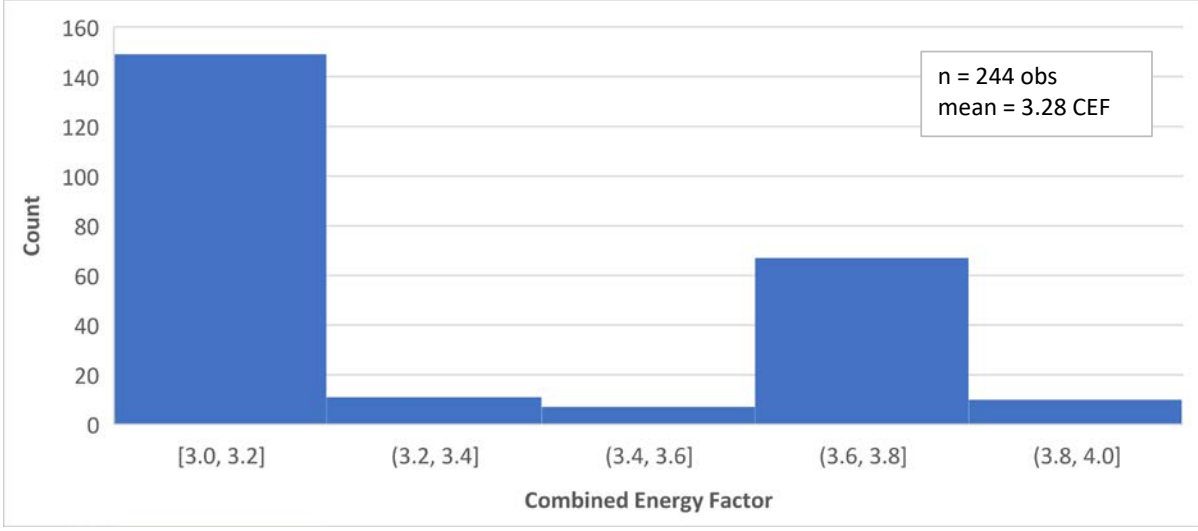


Figure 4-24 below shows the distribution of clothes dryers rated efficiency (expressed as Combined Energy Factor or CEF) for the electric clothes washers observed in the survey. As the figure shows, the distribution of rated efficiency is strongly bimodal around the two historical federal minimum efficiency standards (3.01 CEF and 3.72 CEF).

FIGURE 4-24: DISTRIBUTION OF CLOTHES DRYER RATED EFFICIENCY (COMBINED ENERGY FACTOR)



4.9 KITCHEN APPLIANCES

Figure 4-25 below shows the saturation of refrigerators among ComEd's residential customers, as well as the relative share of home with multiple refrigerators. As the figure shows, the share of homes with more than one refrigerator is just over 20%. As can be expected, the SFD, non-LI, and Suburban customer segments have slightly higher shares of homes with more than one refrigerator.

FIGURE 4-25: SATURATION OF REFRIGERATORS

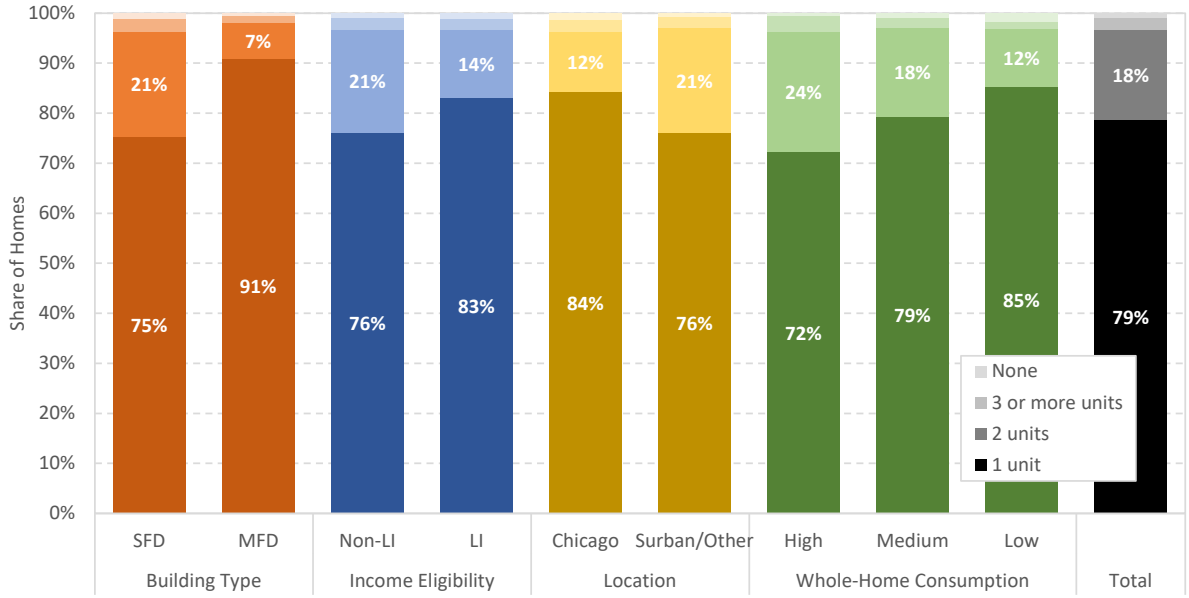


Figure 4-26 below shows the distribution of rated annual consumption for refrigerators observed in our survey. As the figure shows, rated annual consumption appears to follow a roughly bi-modal distribution, with the highest concentration of units centered around the maximum energy consumption levels reflected in the 2001 federal efficiency standard (i.e. the 475-520 kWh/year bucket).

FIGURE 4-26: DISTRIBUTION OF REFRIGERATOR RATED ANNUAL CONSUMPTION (KWH/YR)

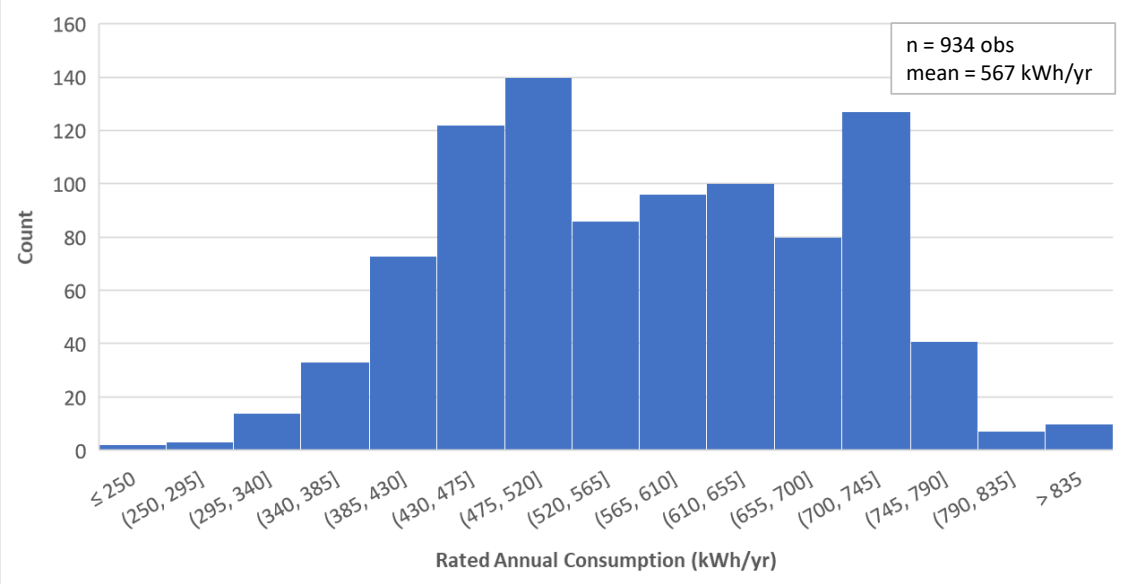


Figure 4-27 below shows the saturation of stand-alone freezers among ComEd's residential customers, and Figure 4-28 below shows the distribution of rated annual energy consumption for stand-alone freezers observed in our survey. As the figures show, the overall saturation of stand-alone freezers is just over 20%, with stand-alone freezers more prevalent in the SFD, Suburban, and high whole-home consumption customer segments and very few homes with multiple stand-alone freezers (<2% overall). Additionally, the figures show that the distribution of rated annual energy consumption for stand-alone freezers observed in our survey is skewed to the left, with the highest concentration of units centered around the 2001 federal energy efficiency standard level (i.e. the 445-531 kWh/year bucket in Figure 4-28) and a mean of 460 kWh/year.

FIGURE 4-27: SATURATION OF STAND-ALONE FREEZERS

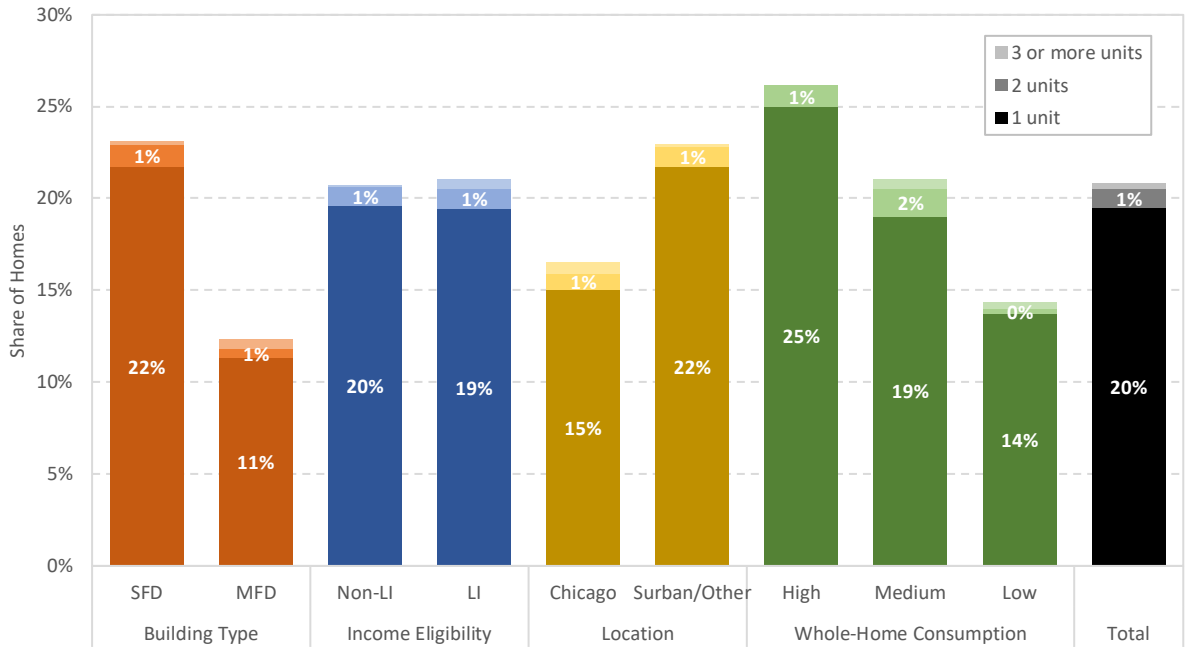


FIGURE 4-28: DISTRIBUTION OF STAND-ALONE FREEZER RATED ANNUAL CONSUMPTION (KWH/YR)

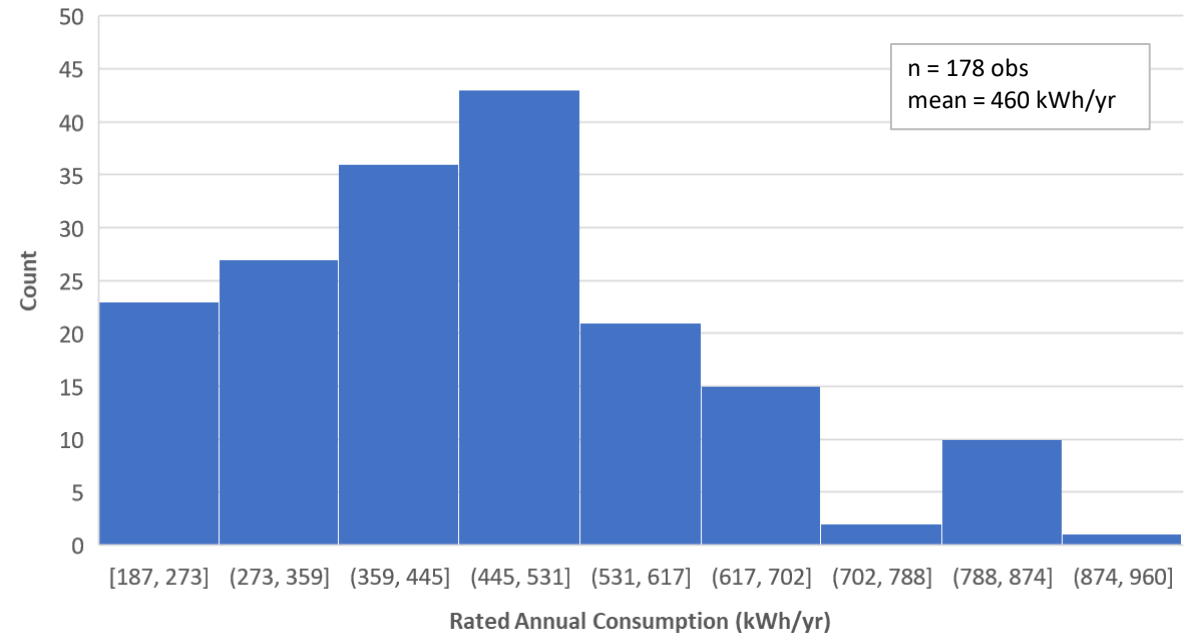


Figure 4-29 shows the saturation of dishwashers among ComEd's residential customers is 62% overall, with the highest saturation occurring in the SFD, non-LI, and Suburban customer segments. Figure 4-30

shows the distribution of the rated annual consumption of the dishwashers observed in our survey, which is tightly concentrated around the three previous federal efficiency standard levels.

FIGURE 4-29: SATURATION OF DISHWASHERS

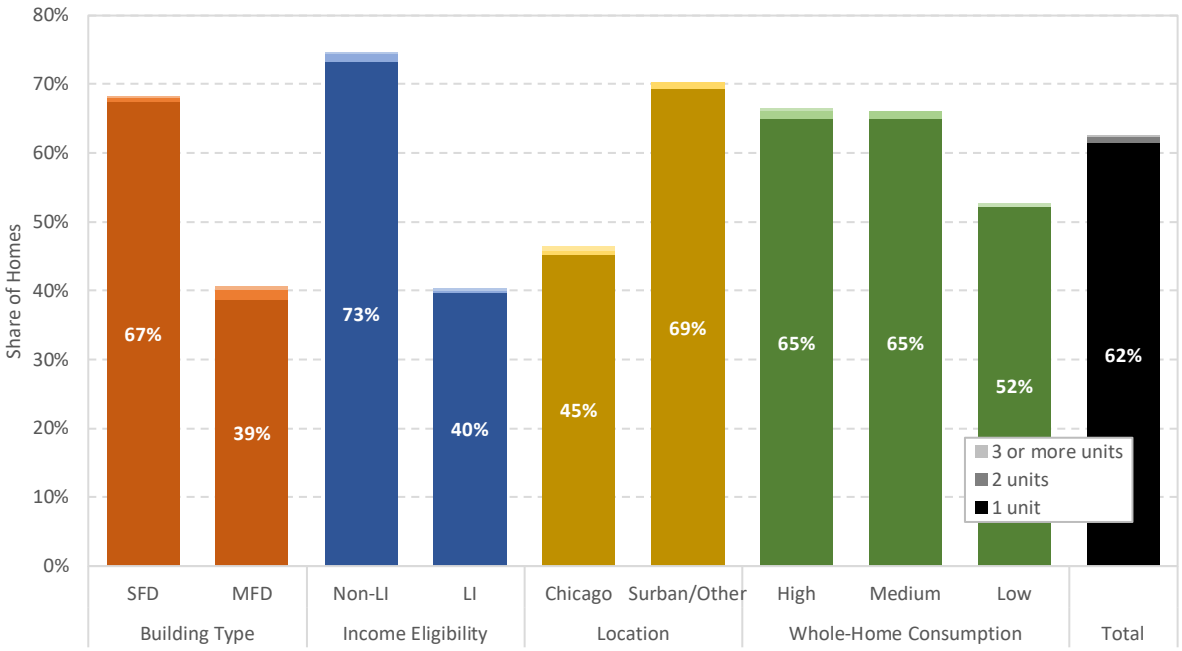
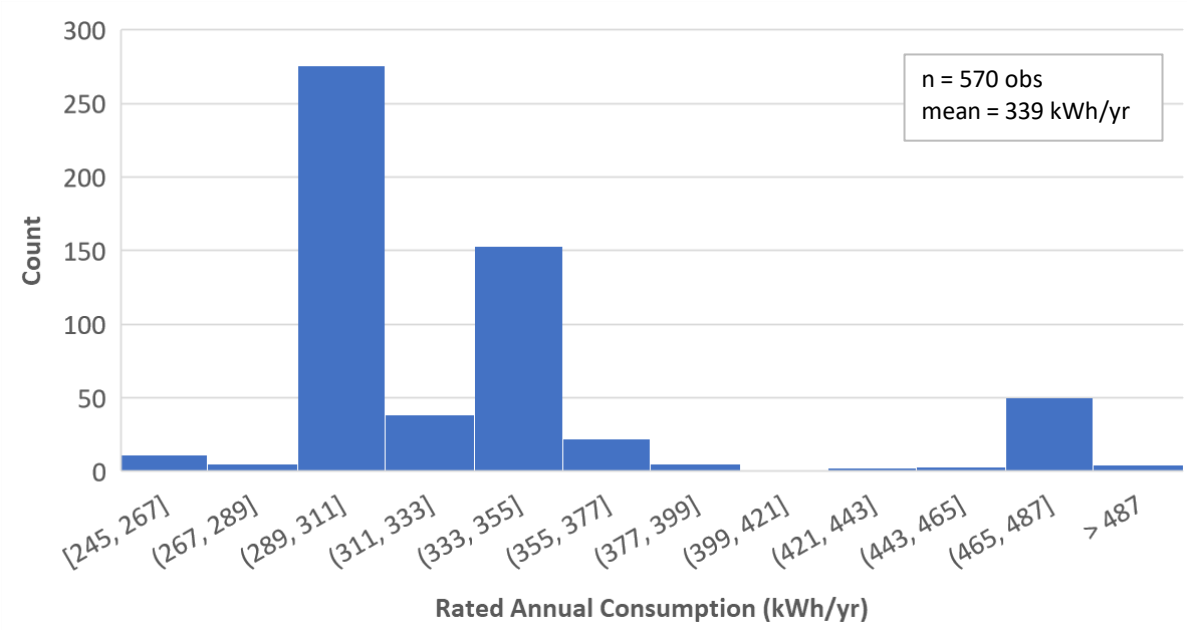


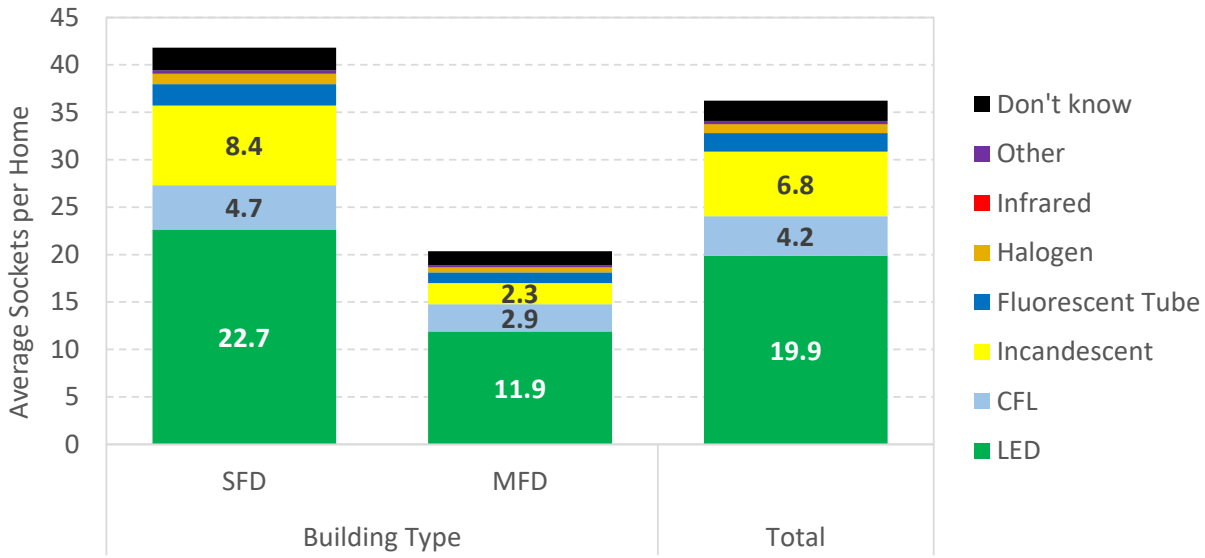
FIGURE 4-30: DISTRIBUTION OF DISHWASHER RATED ANNUAL CONSUMPTION (KWH/YR)



4.10 INTERIOR LIGHTING

Figure 4-31 shows the average number of interior lighting sockets by lighting technology. There are several key take-aways from this figure. First, there are roughly twice as many interior lighting sockets on average in SFD homes compared to MFD homes, even though SFDs are only ~35% larger on average than MFD homes. This result reflects a significantly higher average number of interior lighting sockets per square foot of floor area in SFD compared to MFD (0.022 sockets/ft^2 vs. 0.014 sockets/ft^2, respectively). Second, the penetration of LED lamps in residential interior lighting is just over 50% - which is a massive and remarkable change from the saturation of LED lamps estimated in ComEd's 2012 baseline study (<1%). This result indicates that the residential interior lighting market has undergone a rapid transformation away from both incandescents (whose 2012 market share was 63%, now 19%) and CFLs (whose 2012 market share was 23%, now 12%).

FIGURE 4-31: AVERAGE NUMBER OF INTERIOR LIGHTING SOCKETS BY TECHNOLOGY



At ComEd's request, the survey also collected data on lamp shape (e.g. standard A-lamps vs. reflector lamps, etc.) in addition to technology type in order to characterize the size of the addressable residential lighting market after January 1, 2020 when new federal efficiency standards for general service lighting are schedule to take effect (stemming from the 2007 Energy Independence and Security Act). These new standards will not apply to "specialty" lamps (e.g. globe, candelabra, and other decorative lamp types) and are thus of particular interest to utility program planners going forward.

Figure 4-32 below shows, the vast majority of residential interior lighting lamps are standard shape, with specialty lamps accounting for 11% of all sockets. Within specialty lamps, over half of these lamps are

already LED, but over 30% are incandescent – indicating a non-negligible post-EISA program opportunity. Furthermore, there is evidence that incandescent specialty lamps will continue to be purchased by customers in the absence of programmatic support going forward, as shown in Figure 4-33, underscoring a case for continuing utility program incentives, education, or both going forward.

FIGURE 4-32: AVERAGE NUMBER OF INTERIOR LIGHTING SOCKETS BY TECHNOLOGY AND LAMP SHAPE

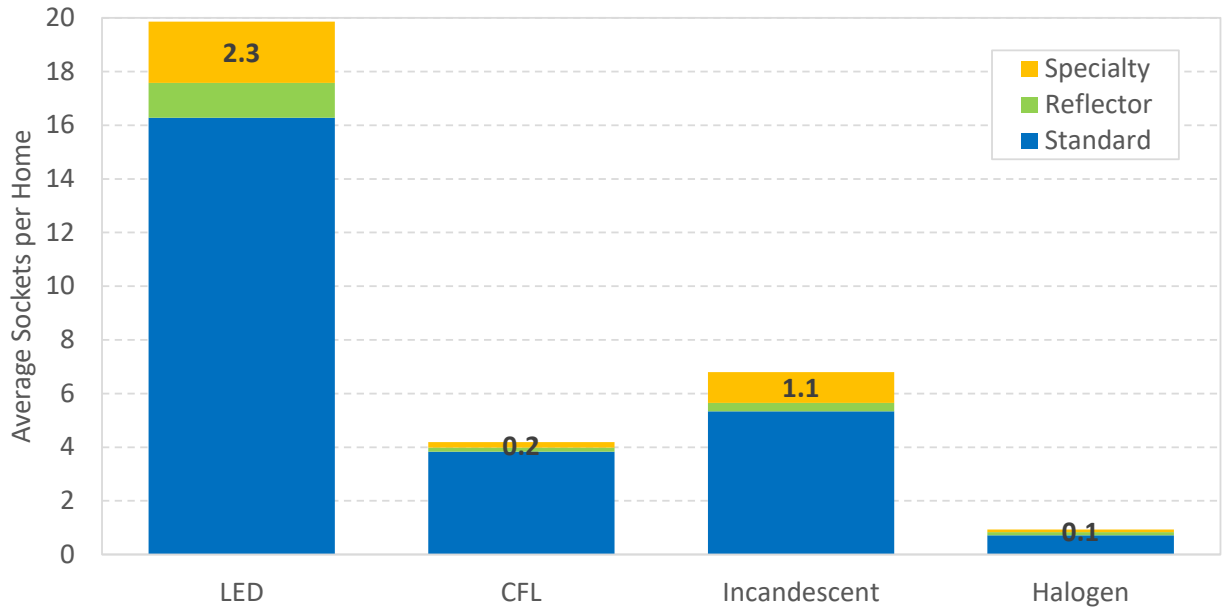
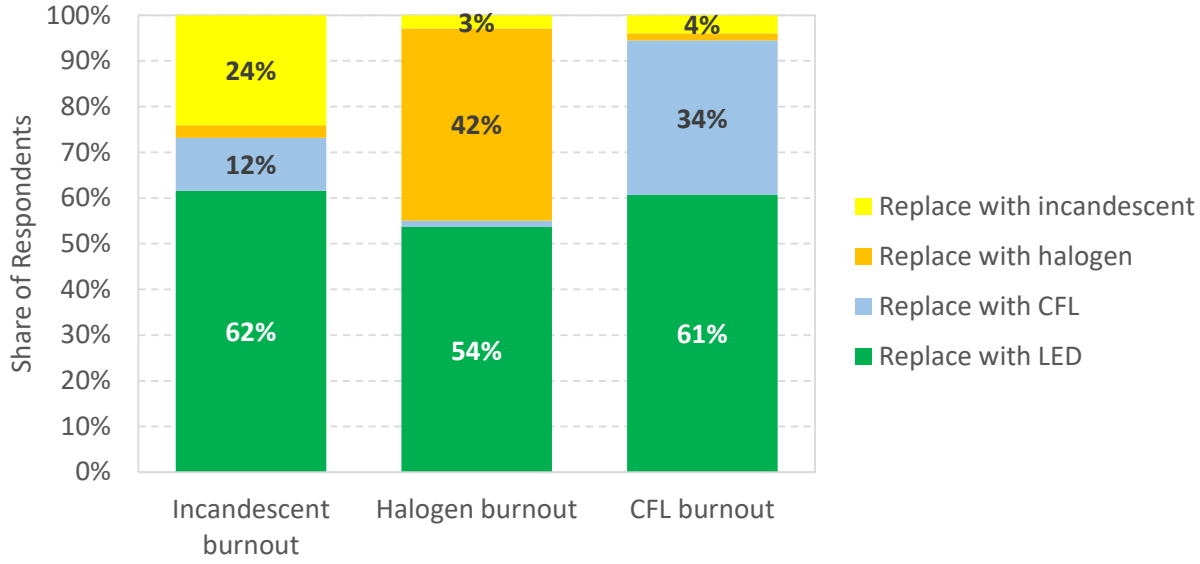


FIGURE 4-33: REPLACE ON BURNOUT PLANS FOR INTERIOR LIGHTING



4.11 EXTERIOR LIGHTING

In our effort to minimize the overall length of the web survey (with an eye toward respondent fatigue), we focused on the exterior lighting questions on characterizing the size of the replacement market, i.e. exterior lighting sockets with incandescent or halogen lamps. As such, we did not collect data specifically on exterior lighting sockets with LED or CFL lamps specifically, and we assumed that exterior lighting sockets not populated with incandescent or halogen lamps have either LED or CFL lamps installed, since the use of linear fluorescent lamps for exterior residential lighting is negligible and infrared lamps are only used in interior applications (mostly bathrooms).

Table 4-2 shows that the market share of LED and CFL lamps in the residential exterior lighting market is similar to that in the residential interior lighting market – roughly 50% overall – with incandescent and halogen lamps accounting for the other half of the installed base. The table also shows that roughly half of exterior incandescent and halogen lamps are not controlled by either timers or motion sensors.

TABLE 4-2: AVERAGE NUMBER OF EXTERIOR LIGHTING SOCKETS BY TECHNOLOGY AND CONTROL TYPE

	Average Number of Sockets per Home		Share of Incandescent or Halogen Sockets Controlled…	
	LED or CFL	Incandescent or Halogen	…by Timers	…by Motion Sensors
SFD	2.3	2.5	22%	20%
MFD	1.8	1.4	29%	28%
Total	2.2	2.3	23%	20%

4.12 DEHUMIDIFIERS AND AIR PURIFIERS

Figure 4-34 below shows the saturation of air purifiers, dehumidifiers, and humidifiers in ComEd's residential sector. As the figure shows, the overall saturation of these technologies is relatively low (8%, 10%, and 8%, respectively), with dehumidifiers having a significantly higher saturation in SFD homes compared to MFD homes (16% vs. 2%, respectively). However, Figure 4-35 shows that where customers have air purifiers or dehumidifiers, they tend to use these technologies fairly frequently. As the figure shows, the majority of air purifiers are plugged in nearly year-round. Dehumidifier usage is not as frequent in comparison, but over 75% of customers with dehumidifiers report having their units plugged in at least 7 months out of the year.

FIGURE 4-34: SATURATION OF AIR PURIFIERS, DEHUMIDIFIERS, AND HUMIDIFIERS

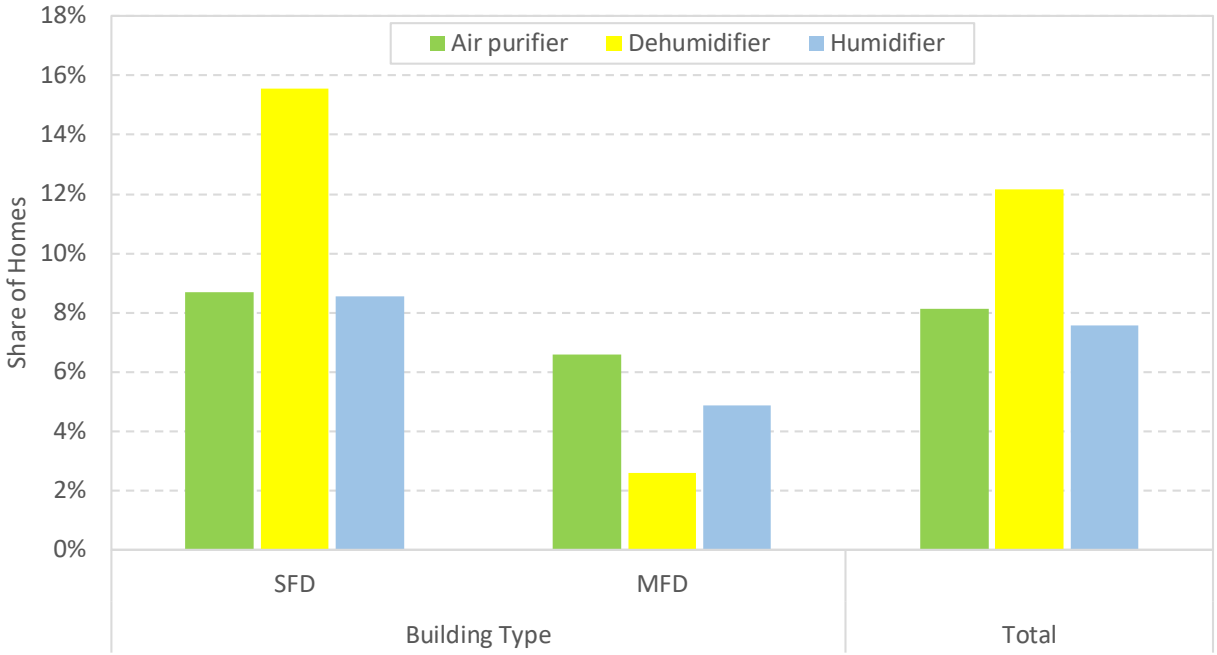
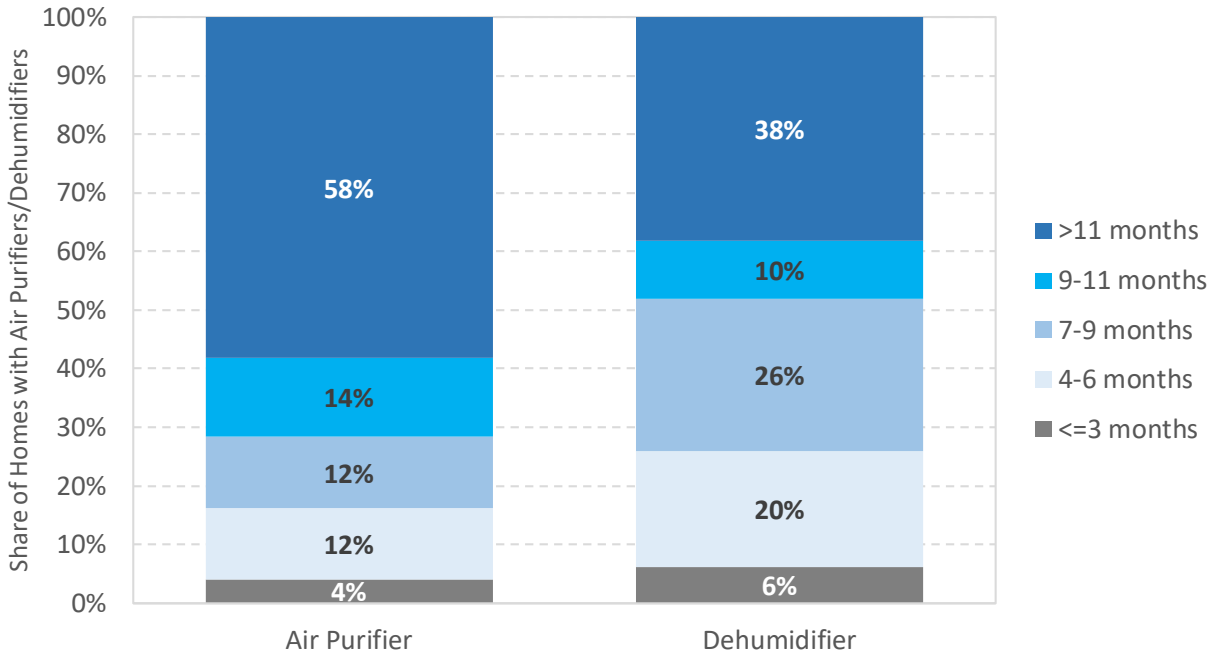


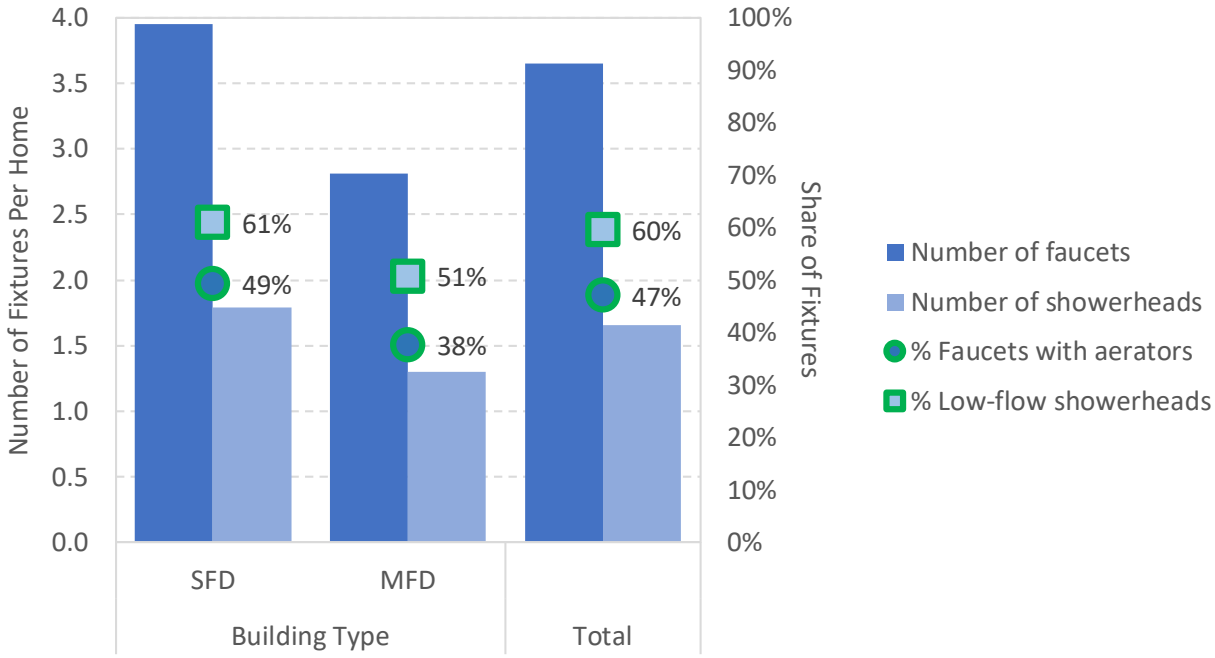
FIGURE 4-35: AIR PURIFIER AND DEHUMIDIFIER USAGE



4.13 WATER FIXTURES

Figure 4-36 shows the average number of faucets and showerheads per home in ComEd's residential sector, along with the saturation of the associated energy efficiency measure for that type of fixture (i.e. aerators for faucets and low-flow showerheads). As the figure shows, the saturation of these water efficiency measures is significant in ComEd's territory. These results are largely consistent with those from the 2012 baseline study, which may indicate that that particular market is stagnant or otherwise stable.

FIGURE 4-36: AVERAGE NUMBER OF WATER FIXTURES AND SATURATION OF WATER EFFICIENCY MEASURES



4.14 CONSUMER ELECTRONICS

Finally, our web survey also collected a rich dataset on the ownership and operation of consumer electronics and entertainment equipment. Below we highlight the results for two specific energy efficiency opportunities of particular interest to ComEd – smart strips and voice-activate devices.

Figure 4-37 shows the saturation of Tier 1/Tier 2 smart strips among ComEd's residential customers. As the figure shows, smart strip saturation is already significant despite the relative newness of the technology – over 30% overall. The vast majority of these smart strips are connected to television systems or home office/computer systems.

FIGURE 4-37: SATURATION OF SMART STRIPS AND SYSTEMS CONTROLLED IN THOSE HOMES

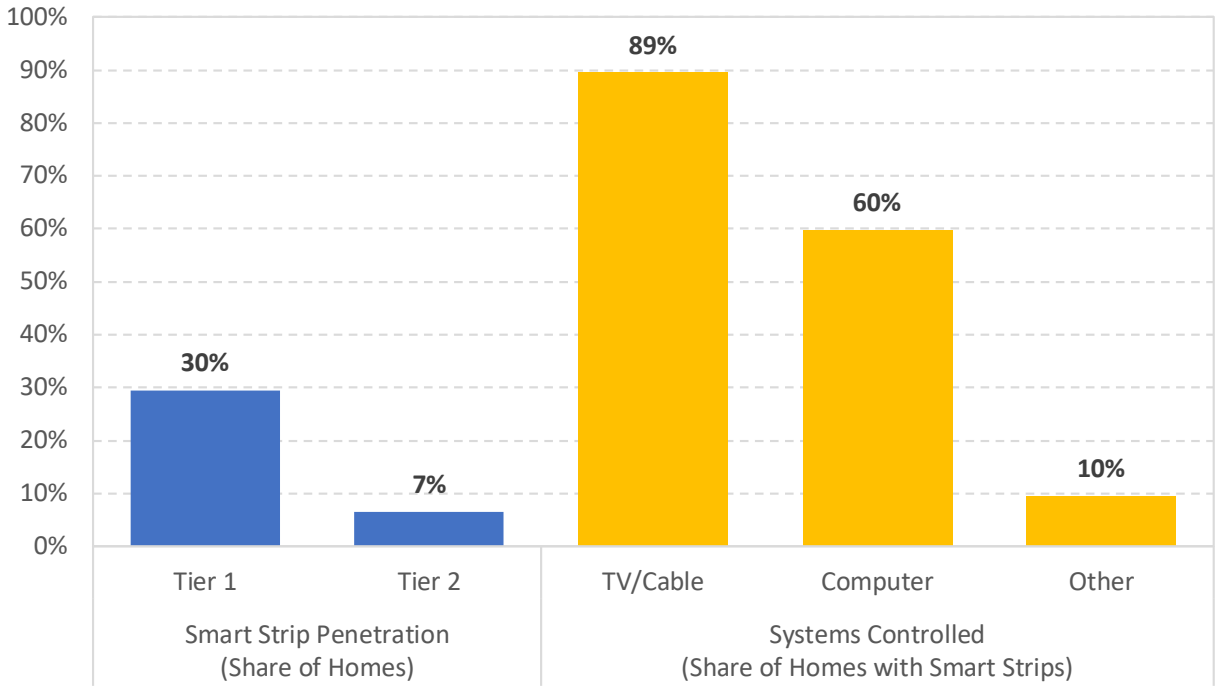


FIGURE 4-38: SATURATION OF VOICE-ACTIVATED DEVICES AND SYSTEMS CONTROLLED IN THOSE HOMES

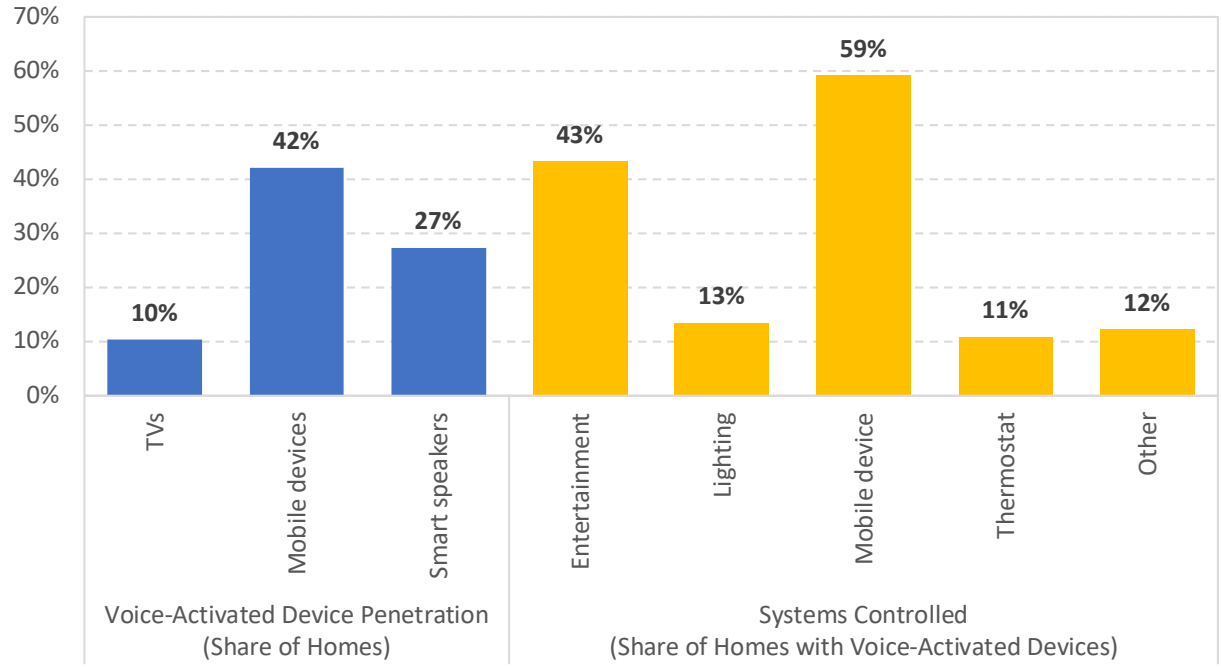


Figure 4-38 above shows the saturation of voice-activated devices among ComEd's residential customers. "Voice-activated mobile devices" refers to regular usage of Siri, OK Google, and similar voice-based services available on smart phones. "Smart speakers" refers to Amazon Echo, Google Home, and similar stand-alone voice-activated hardware products. As the figure shows, voice-activated services via mobile devices and smart speakers are already used by a significant portion of the residential market in ComEd's territory (42% and 27%, respectively). These voice-activated services are mostly used for controlling the mobile device itself (Siri, Hey Google, etc.), but a significant share of homes that use voice-activated services use those services to control lighting systems (13%) and HVAC systems (11%). The overall penetration of voice-controlled HVAC and lighting among ComEd's residential customers is 5% and 3%, respectively.

4.15 COMPARISON TO 2012 BASELINE STUDY & KEY FINDINGS

While many of the key results presented above can be readily and adequately interpreted in isolation, others are best viewed in comparison to those from the previous residential baseline study conducted for ComEd in 2012. Below we present the key comparisons to the 2012 baseline study results and highlight the key findings. Note that due to differences in methodologies and sample sizes, the tables below only show comparisons that we believe are legitimate, apples-to-apples comparisons.

Table 4-3 below presents a comparison of the lighting inventory results from the 2012 and 2019 baseline studies – shown as socket saturations by technology type (i.e. share of sockets occupied by incandescents, CFLs, LEDs, etc.). Note that this table includes interior and exterior lighting sockets aggregated together, which was the lowest common denominator between the two studies that allowed for an applies-to-apples comparison.

TABLE 4-3: COMPARISON OF KEY LIGHTING RESULTS BETWEEN 2012 AND 2019 BASELINE STUDIES

End-Use/Technology	Metric	2012 Baseline Study			2019 Baseline Study		
		All	SFD	MFD	All	SFD	MFD
Lighting							
Incandescent	Share of all sockets	65%	66%	60%	19%	20%	11%
CFL	Share of all sockets	20%	19%	24%	12%	11%	14%
Linear Fluorescent	Share of all sockets	8%	9%	5%	5%	5%	6%
Halogen	Share of all sockets	6%	5%	11%	3%	3%	3%
LED	Share of all sockets	1%	1%	0%	55%	54%	58%

As the table shows, there has been a large and dramatic shift in the lighting technologies that residential customers in ComEd's territory use in their homes. In 2012, incandescent lamps were the dominant technology (65% of all sockets), with CFLs coming in a distant second (20%). A mere seven years later, LEDs have become the dominant residential lighting technology, accounting for 55% of lighting sockets. This growth in LED market share has come at the expense of both incandescents and CFLs, with incandescents now accounting for less than 20% and CFLs only 12%. Comparatively, linear fluorescent and halogen lamps have somewhat maintained their relative market shares in residential homes – albeit minor shares overall. This level of market transformation in such a short period of time is remarkable. While the global LED market has undergone a rapid and steady improvement in price, performance, and choice, the results shown in Table 4-3 above also include the impacts of ComEd's upstream residential LED programs which have sold roughly 27 million lamps to ComEd customers since 2012.[4]

Table 4-4 presents a comparison of the key results for heating and cooling equipment from the 2012 and 2019 baseline studies. For space heating and water heating, the table shows that there is very little, if any, evidence that ComEd's residential customers are actively fuel-switching away from natural gas and towards electricity. Indeed, the heat pump market appears to be stable at 2% share among residential customers. For space cooling, the overall saturation of CACs appears to be steady. However, there is some evidence that the efficiency of the installed stock of CACs is improving gradually. The only summary metric for CAC efficiency from the 2012 baseline study is the share of systems with a SEER rating below 14. We developed the same metric based on data for collected for this study, which shows that share of CAC systems with a SEER rating below 14 has declined slightly, from 93% in 2012 to 87% in 2019 – indicating an overall increase in the average efficiency of residential CAC systems.

[4] Source: Itron (2019), "ComEd Residential Lighting Discounts Program and Holiday Light Exchange Program Impact Evaluation Report, CY2018".

TABLE 4-4: COMPARISON OF KEY HEATING & COOLING RESULTS BETWEEN 2012 AND 2019 BASELINE STUDIES

End-Use/Technology	Metric	2012 Baseline Study			2019 Baseline Study		
		All	SFD	MFD	All	SFD	MFD
Space Cooling							
Central air conditioner	Share of all homes	73%	87%	46%	80%	87%	48%
…<14 SEER	Share of all CAC systems	93%	-	-	87%		
Window air conditioner	Share of all homes	30%	18%	52%	18%	10%	40%
Space Heating							
Primary electric space heating	Share of all homes	10%	4%	24%	9%	8%	13%
…Electric baseboard	Share of all homes	6%	-	-	2%	1%	5%
…Electric furnace	Share of all homes	3%	-	-	4%	4%	5%
…Heat pump	Share of all homes	2%	-	-	2%	2%	1%
Portable electric space heating	Share of all homes	24%	23%	24%	14%	12%	17%
Water Heating							
Electric water heating	Share of all homes	8%	6%	13%	9%	8%	11%
Water heater tank wrap	Share of all homes	3%	-	-	7%		
Hot water pipe wrap	Share of all homes	9%	-	-	17%		
Faucet aerators	Share of all homes	62%	-	-	47%	49%	38%
Low-flow showerheads	Share of all homes	40%	-	-	60%	61%	51%

Table 4-5 presents a comparison of the key results for appliances from the 2012 and 2019 baseline studies. While the overall saturation of major residential appliances appears mostly unchanged, the table also shows a significant decline in the number of secondary refrigerators, secondary stand-alone freezers, and dehumidifiers (see also the results for room air conditioners in Table 4-4 above). The saturation of all those equipment types declined by 30-50% from 2012 levels – a significant change that is well beyond the error band of the estimates from both studies and likely reflects the influence of ComEd's long-standing appliance recycling program.

TABLE 4-5: COMPARISON OF KEY APPLIANCE RESULTS BETWEEN 2012 AND 2019 BASELINE STUDIES

End-Use/Technology	Metric	2012 Baseline Study			2019 Baseline Study		
		All	SFD	MFD	All	SFD	MFD
Laundry Appliances							
Clothes washers	Share of all homes	80%	98%	47%	90%	98%	62%
...Top loading	Share of all homes	61%	74%	36%	63%	68%	45%
…Front loading	Share of all homes	19%	26%	24%	27%	30%	17%
Electric clothes dryers	Share of all homes	25%	26%	23%	25%	27%	17%
Kitchen Appliances							
Refrigerator	Share of all homes	100%	100%	100%	99%	99%	100%
Secondary refrigerator	Share of all homes	30%	42%	7%	20%	24%	9%
Standalone freezer	Share of all homes	31%	40%	13%	21%	23%	21%
Dishwasher	Share of all homes	67%	75%	54%	63%	68%	41%
Dehumidifiers & Air Purifiers							
Air purifier/humidifier	Share of all homes	36%	31%	27%	16%	18%	12%
Dehumidifier	Share of all homes	23%	34%	5%	12%	16%	3%

In addition to these key longitudinal findings, there are also several key stand-alone findings based on the results previously presented that are worth highlighting as well.

As shown previously, our multi-modal data collection approach allowed us to characterize the distribution of the rated capacity and efficiency of several kinds of major appliances (see Figures 4-22, 4-24, 4-26, 4-28, and 4-30) . A key finding from these data collectively is that the appliance efficiency is generally concentrated around the federal minimum energy efficiency standards that have been in effect over different parts of the past 20+ years. However, it is worth noting that each appliance type has a slightly different distribution around these historical standards that is worth considering explicitly. For laundry appliances, the highest concentration of rated energy efficiency is around the standard level that was effective during the early 1990s. For refrigerators and freezers, the highest concentration of rated energy efficiency is around the standard level that was effective during the early 2000s. For dishwashers, the highest concentration of rated energy efficiency is around the standard levels that were effective during the early 2010s. These patterns reflect the relative age of these appliance stocks – the majority of installed laundry appliances are from early 1990s, the majority of refrigerators and stand-alone freezers are from the early 2000s, and the majority of dishwashers are from the early 2010s. This means that we should expect the highest near-term stock turnover (and energy efficiency opportunity) to come from laundry appliances – relative to the other major appliances – since those

units that date from the early 1990s can be expected to be retired and replaced sooner than those purchased in the early 2000s or early 2010s.

The final set of stand-alone results worth highlighting are those for the newest technologies in the residential market, namely communicating thermostats, smart power strips, and voice-activated devices. The penetration of each of these new technologies is significant, especially considering that these products have only become widely available since the previous baseline study was conducted. Communicating thermostats have achieved 24% market share, smart power strips have achieved 37% market share, and voice-activated smart speakers have achieved 30% market share. The highly dynamic nature of these markets needs to be considered in stark contrast to the much slower market for other residential end-use technologies. Despite the fact that these systems currently only control a very small portion of ComEd's overall residential electricity load, the potential and probability for these technologies to influence of much larger percentage of load in the very near future is significant.

5 COMMERCIAL DATA COLLECTION METHODS

In this section, we present a detailed overview of each step in our data collection approach for ComEd's commercial sector, including sample design, survey implementation, and final survey disposition. The results from this data collection effort are presented later in Section 6.

5.1 ON-SITE SURVEY APPROACH

For commercial customers, the lowest-cost approach to collect energy-efficiency information is telephone surveys. However, as is the case with telephone surveys of residential customers, telephone surveys of commercial customers are not well-suited for collecting deeper levels of end-use equipment characteristics (technology type, capacity, efficiency) with a reasonable level of accuracy. This is due to the complexity and diversity of end-use equipment and systems in commercial buildings (compared to residential buildings) and a general lack of knowledge among employees and tenants about the technical characteristics of their end-use equipment. To address this challenge, we used a more traditional on-site survey approach using a team of locally based field engineers and a comprehensive on-site survey instrument developed by Itron. While such on-site surveys are clearly more expensive (on a per-complete basis) than mail- or telephone-based surveys, no proven alternatives exist that can provide the same depth of information (i.e., value) with minimal uncertainty at commercial customer sites with complex and heterogenous systems. These on-site surveys were designed to collect make/model-level information on equipment holdings, along with information on business hours, operation schedules, and control settings.

To ensure that the on-site survey effort was as cost-effective as possible, the Itron Team included Trend Tech Energy Services, the Energy Resources Center (ERC) at the University of Illinois, and Green Home Experts (GHE) who provided qualified, locally-based field engineers to conduct the on-site primary data collection surveys at commercial customer sites.

5.2 SAMPLE DESIGN

Like in the residential sector, we used a stratified sample design in order to isolate specific customer populations of interest and their equipment holdings (and related end-use energy consumption). For this study, ComEd identified building type as the stratification variable of highest relevance to their research objectives and portfolio planning needs. To develop indicators of building type for ComEd's commercial customer population, we used the customer-level NAICS codes available from Operations Optimizer and mapped each customer to one of the following twelve building types:

- Office
- Food Service
- Public Administration
- Healthcare
- Education
- Religious
- Retail
- Lodging
- Services
- Grocery
- Entertainment
- Wholesale

In addition to this building-type segmentation, ComEd also requested sub-dividing the Education and Public Administration segments into "public" and "private" segments, based on the definitions of "public" and "private" established in Illinois' Future Energy Jobs Act (FEJA). This additional segmentation was intended to allow ComEd to examine whether energy efficiency baselines and savings potential for those FEJA-defined segments are significantly different from the rest of their commercial customer base.

Finally, as end-use equipment and operations are known to vary widely depending on the size of a commercial premise, we also examined the range and distribution of per-premise annual kWh consumption within each building type in order to identify where additional segmentation by size would be warranted. Specifically, we developed ratios of the standard deviation (of per-premise annual kWh consumption) to the mean value for a given building type. This provided an indicator of how widely or tightly distributed energy consumption is on a per-premise basis within a given building type – where very wide distributions would indicate a need to sub-divide that segment by size in order to minimize potential aggregation bias. This analysis indicated that the widest distributions of per-premise energy consumption occur in five building types in ComEd's service territory: Office, Retail, Health, Education, and Public Administration. In order to sub-divide those five building types by size, we rank-ordered customers by per-premise consumption and then assigned the top third into a "Large" customer segment, the middle third into a "Medium" customer bucket, and the bottom third into a "Small" customer segment.

In total, we defined 28 strata for the commercial on-site surveys, as shown in Table 5-1 below. The final sample design was based on a "robust" proportional allocation approach, where the total target sample (450 completes) is first allocated to each building-type stratum based strictly on relative share of annual kWh usage, and then rounded to the nearest multiple of 5. This approach prevents the smallest segments from being assigned 1 or 2 sample points and guarantees a minimal level of potential variation when randomly selecting sites within each stratum. Within Office, Retail, Health, "Public" Education, "Private" Education, "Public" Public Administration, and "Private" Public Administration, we further allocated sample into L/M/S-size strata using the same robust proportional allocation approach.

It should be noted that the sample design shown in Table 5-1 was not designed or intended to produce statistically representative results at the individual stratum level. Indeed, given the overall sample size for the commercial on-site surveys (450 completes), Itron and ComEd were keenly aware that this survey effort would only be able to produce statistically representative results at higher levels of aggregation (e.g. 3-4 segments, rather than 28). Rather, the primary objective of the final sample design was to ensure that the survey captured the full range of end-use equipment ownership and operations for the most important building types of programmatic interest to ComEd.

TABLE 5-1: DISTRIBUTION OF COMMERCIAL CONSUMPTION BY BUILDING TYPE AND FINAL SAMPLE DESIGN

Building Type	% 2017 kWh	N Sample
Office	16.4%	80
Large		*27*
Medium		*27*
Small		*26*
Health	9.3%	40
Large		*13*
Medium		*14*
Small		*13*
Retail	10.1%	50
Large		*17*
Medium		*17*
Small		*16*
"Public" Education	8.2%	45
Large		*15*
Medium		*15*
Small		*15*
"Private" Education	3.5%	20
Large		*7*
Medium		*7*
Small		*6*
"Public" Public Admin	8.5%	45
Large		*15*
Medium		*15*
Small		*15*
"Private" Public Admin	5.2%	25
Large		*8*
Medium		*9*
Small		*8*
Food Service	6.1%	30
Grocery/Convenience	4.3%	20
Lodging	4.5%	20
Entertainment	2.7%	10
Religious	1.5%	5
Services	2.6%	15
Wholesale	8.9%	45
TOTAL		**450**

5.3 SURVEY INSTRUMENT

For this study, Itron adapted a comprehensive on-site data collection survey instrument previously developed for the 2012 Commercial Saturation Survey (CSS), funded by the California Public Utilities Commission. Specifically, we adapted the CSS instrument to focus on the specific data elements of most interest to ComEd, while balancing survey length, ease of use, and comprehensiveness. The final on-site data collection survey instrument developed for this study is provided in Appendix B. The main sections and data elements included in the instrument are summarized below:

- **General premise information** – occupancy, floor area, EV chargers, pool facilities, etc.
- **Electric accounts and meters** – to verify ComEd records and account-to-premise mapping
- **Building-level operations schedules** – weekly, seasonal, holidays
- **Building-level controls** – control type, systems controlled
- **Activity Areas** – area designations for defining floor space and lit/conditioned space
- **On-site power generation** – PV, CHP, back-up generators
- **HVAC inventory** – technology type, efficiency, capacity, fan quantity, type, horsepower, controls
- **Lighting inventory** – counts and wattage by technology, shape, and length; controls, ballast type
- **Food service equipment inventory** – counts by technology type and Energy Star qualification
- **Office equipment inventory** – counts by technology type and Energy Star qualification
- **Data centers inventory** – location, size, PUE, ventilation system type, cooling system type
- **Refrigeration system inventory** – system type, compressor horsepower, temperature range, evaporator fan motor type and controls, lighting types
- **Water heating and fixtures inventory** – technology type, fuel type, efficiency, system capacity, water fixture counts
- **Compressed air systems inventory** – technology type, weekly run-time, capacity, control type, nozzle counts and characteristics

We also included several data elements that were specifically requested by ComEd to address specific high-priority program and portfolio design issues. These data elements included:

- T12 lamps in storage,

- Replacement plans for T12/magnetic ballast fixtures upon burnout,
- Food service equipment procurement practices, and
- Compressed air leak repair practices.

Once the on-site survey instrument was fully developed, Itron conducted a 2-day training workshop with the on-site survey team (Itron, ERC, Trend Tech, and GHE). This training workshop included a classroom-based overview of the instrument, as well as in-field pre-testing of the instrument and data collection protocols at actual customer sites. The workshop concluded with a final half-day classroom session to review the results and lessons learned from the in-field pre-tests.

5.4 SURVEY IMPLEMENTATION

Once the sample design and survey instrument were finalized, we then implemented the commercial on-site survey in four main steps: 1) mailing of advance notification letters, 2) telephone recruitment, 3) conducting the site visit, and 4) back-office QA/QC and data entry.

In the first step, we developed an advanced notification letter to the customers randomly selected to participate within each survey stratum. These advanced notification letters were intended to help establish the legitimacy of the survey effort from the customer's perspective, explain the value of the research to ComEd's commercial customers, and thereby increase the probability of participation. We developed the content and format of these notification letters in collaboration with ComEd staff and consistent with ComEd's branding and communications guidelines. The final notification letters were printed on ComEd letterhead and signed by the ComEd project sponsor.

In parallel to the production and mailing of these notification letters, we notified the ComEd account representatives for the customers that were selected for recruitment so that they could anticipate questions from their customers – and reinforce the legitimacy of our survey.

After allowing enough time for the advanced notification letters to arrive at customer premises, we then began telephone-based recruitment using a third-party call center and a recruitment script developed by Itron. The primary objectives of the recruitment script were to:

- Advertise the $35 Amazon.com gift card participation incentive,
- Identify and speak with the specific staff that could authorize participation,
- Secure agreement to participate, and

- Collect contact information for the customer staff that would host our field surveyors.

For customers that were successfully recruited, our assigned field surveyor would then schedule the actual on-site visit directly with the appropriate customer contact. After completion of each site visit, the completed survey form would then undergo a back-office QA/QC review to ensure adequate completion, internally consistent entries, and identify entries that need to be corrected/verified with the assigned field surveyor. Following this QA/QC process, each data element in the completed survey forms was entered into a custom-built an MS Access database for weighting and analysis.

The final disposition of the commercial on-site surveys is shown in Table 5-2.

TABLE 5-2: FINAL ON-SITE SURVEY DISPOSITION

Strata	Building Type	Size	Target Completes	Recruited	Sites Dropped[1]	Surveyed
1	Office	L	27	41	18	23
2	Office	M	27	39	19	20
3	Office	S	26	45	13	20
4	Food	All	30	39	12	27
5	Grocery/Convenience	All	20	33	8	20
6	Health	L	13	21	9	12
7	Health	M	14	22	12	10
8	Health	S	13	21	11	10
9	Retail	L	17	22	5	17
10	Retail	M	17	22	5	17
11	Retail	S	16	23	5	11
12	Education - Public	L	15	25	9	16
13	Education - Public	M	15	25	10	15
14	Education - Public	S	15	23	6	17
15	Education - Private	L	7	9	2	7
16	Education - Private	M	7	11	4	7
17	Education - Private	S	6	12	8	4
18	Lodging	All	20	30	14	16
19	Entertainment	All	10	14	4	10
20	Public Admin - Public	L	15	22	7	15
21	Public Admin - Public	M	15	24	9	15
22	Public Admin - Public	S	15	23	11	12
23	Public Admin - Private	L	8	11	6	5
24	Public Admin - Private	M	9	14	8	6
25	Public Admin - Private	S	8	12	5	7
26	Religious	All	5	8	3	5
27	Services	All	15	19	4	15
28	Wholesale	All	45	53	11	42
TOTAL			**450**	**663**	**238**	**401**

[1] These sites were initially recruited via telephone but did not result in a completed on-site survey, due to a change in willingness to participate, appointments that were not honored by the customer, or an inability to schedule the site visit with the on-site contact.

6 COMMERCIAL BASELINE RESULTS

In this section, we present the results of our commercial data collection. We start with reviewing the impact of removing customers with demand >10 MW on the average size of the commercial customers in our sample frame. We then present key findings for each major commercial end use by segment.

Note that the results presented below were weighted before summing, averaging, and calculating other summary metrics. Specifically, the raw survey results were weighted according to their respective shares of 2017 kWh electricity consumption in a given sample stratum. This approach is sometimes referred to as "energy weighting". Also note that although our sample design included 28 individual strata, we aggregated those strata to 12 segments for reporting purposes (and for developing inputs for the potential study). Finally, the results presented below focus on the key findings for major commercial end uses. The complete set of weights used to expand the results to the segment and population levels, along with the complete set of expanded survey results, are provided in a separate data deliverable.

6.1 IMPACT OF REMOVING CUSTOMERS WITH DEMANDS >10 MW

Wherever possible, we compare results to those from 2012 commercial baseline study in order to identify any longitudinal trends. However, unlike our earlier comparisons to the 2012 residential baseline study results (see Section 4.15), we cannot make strict apples-to-apples comparisons of our commercial baseline results. This is due to removing commercial customers with demand >10 MW from our sample frame. Recall that ComEd requested that we remove these accounts from the sample frame in order to align our sample design with the fact that customers in Illinois with demand >10 MW are not obligated to pay into the state of Illinois' general energy efficiency fund and therefore not eligible to receive incentives from utility programs in the state (as a result of recently enacted FEJA legislation).

ComEd provided list of specific customers to exclude from our sample frame based on this criterion. This list included just over 1,400 nonresidential accounts, of which 618 were commercial accounts in the scope of the on-site surveys.[1] As Table 6-1 below shows, these 618 commercial accounts accounted for 22% of total kWh electricity consumption in ComEd's commercial sector in 2017. At the segment level, removing these >10 MW customers had the largest impact on the Retail, Office, Education, and Health segments, where removing these large customers reduced the total "in scope" electricity consumption by 55%, 23%, 17%, and 12%, respectively. These impacts are significant, as this filter removed the largest customers (and buildings) in ComEd's commercial customer population from the scope of this baseline study.

[1] Per discussions with ComEd during project kickoff, certain commercial segments were excluded from the scope of our on-site surveys, including Construction, Mining, Utility-own consumption, and Transportation.

TABLE 6-1: IMPACT OF REMOVING CUSTOMERS WITH DEMANDS >10 MW

	Population		>10 MW Customers		
Segment	Number of Active Accounts	2017 GWh Consumption	Number of Active Accounts	2017 GWh Consumption	% 2017 GWh Compared to Pop
Office	108,088	10,790	327	2,465	23%
Food Service	22,456	2,666	36	205	8%
Grocery	7,495	2,042	3	1	0%
Convenience	676	38	1	0	0%
Health	30,817	3,969	103	459	12%
Retail	55,382	10,790	44	5,925	55%
Education	9,444	3,935	38	673	17%
Lodging	4,317	1,135	2	1	0%
Warehouse	877	251	2	0	0%
Entertainment	6,402	1,013	3	0	0%
Public Admin	13,230	4,078	14	107	3%
Religious	8,003	457	2	0	0%
Services	25,414	1,023	28	6	1%
Wholesale	11,316	2,808	15	271	10%
TOTAL COM	**303,917**	**44,995**	**618**	**10,112**	**22%**

It is critical to keep the impact of removing these large commercial customers in mind when interpreting the results shown in the remainder of this section, specifically with regards to the results for Office and Retail (and to a lesser extent Health and Education) – both as stand-alone results and when compared to the results from the 2012 baseline study.

6.2 COMMERCIAL PREMISE CHARACTERISTICS

Figure 6-1 shows the distribution of floor area per premise surveyed by segment. As the figure shows, the largest premises surveyed for this study were in the Colleges and Lodging segments, where 30% and 10% of those premises, respectively, were over 100,000 ft^2. Overall, only 3% of the premises surveyed had square footage of at least 100,000 ft^2, and 10% had square footage between 100,000 and 25,000 ft^2. The majority of surveyed premises had square footage between 25,000 and 2,500 ft^2 (54%), with just over a third having square footage less than 2,500 ft^2.

This distribution of surveyed premise size is a direct reflection of the >10 MW customer filter summarized above, which had the effect of removing the largest customers in the Office, Retail, Health, and Education segments from our sample frame.

FIGURE 6-1: DISTRIBUTION OF SURVEYED COMMERCIAL SQUARE FOOTAGE BY SEGMENT

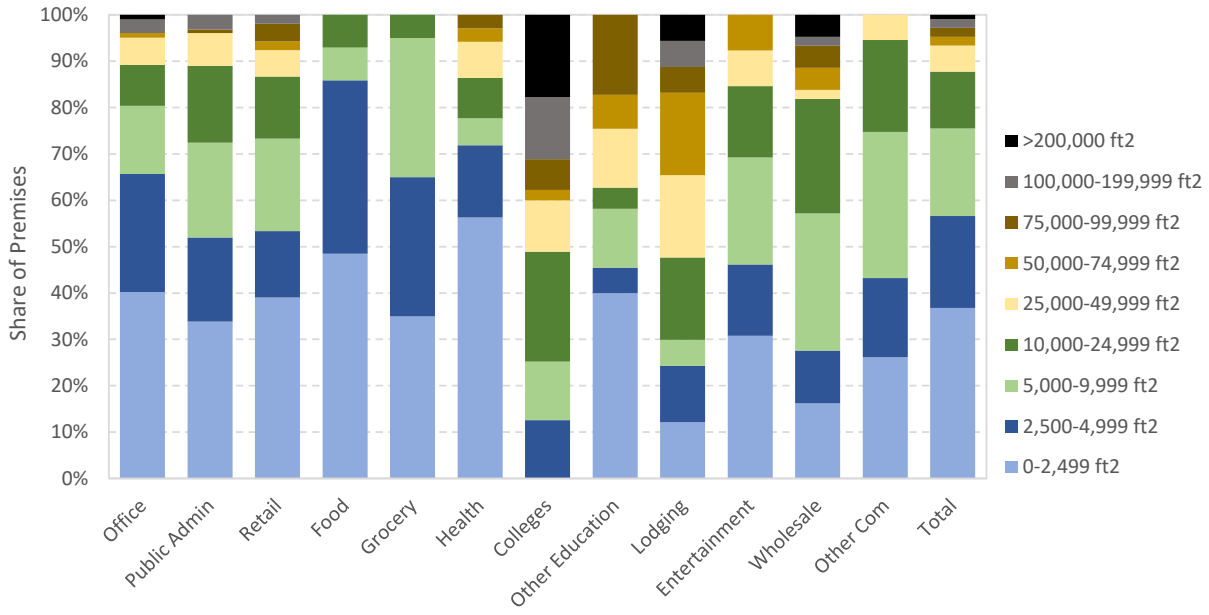


Table 6-1 summarizes several premise-level characteristics observed as part of the on-site surveys. As the table shows, we observed very few commercial premises with compressed air systems. Again, this results likely reflects the absence of very large commercial buildings from our sample frame, which tend to have a higher frequency of compressed air systems used for pneumatic controls. Similarly, we observed very few premises with electric vehicle charging stations or on-site generation – characteristics that are more closely associated with very large commercial buildings.

TABLE 6-2: PREMISE-LEVEL CHARACTERISTICS AND PRACTICES

Metric	Share of Premises
Use Compressed Air	1.0%
Practice Strategic Energy Management	1.0%
Building Retro-commissioned within Last 10 Years	3.0%
Electric Vehicle Charging Stations	2.0%
On-Site Generation (any kind)	4.2%
On-Site Solar PV	3.2%
On-Site Backup Generation	0.5%

6.3 LIGHTING

Figure 6-2 shows the saturation of interior lighting technologies by segment – in terms of the share of interior lighting fixtures occupied by each major lighting technology (e.g. linear fluorescent, CFL, LED, etc.). As the figure shows, linear fluorescent lighting is the dominant interior lighting technology in most commercial segments – particularly in segments with the highest average floor area per premise (Colleges, Other Education, and Public Admin). A key exception to this is the Lodging segment, where non-linear LEDs (i.e. screw-based LEDs) account for the largest share of interior lighting fixtures, followed by CFLs. The penetration of the highest efficiency linear lighting technology – linear LEDs (sometimes referred to as TLEDs) – is still low overall in the commercial sector, accounting for only 5% of all interior fixtures and 9% of all linear fixtures). The penetration of linear LEDs is highest in the Entertainment segment (39% of all fixtures; 64% of all linear fixtures).

Compared to the 2012 baseline results, the saturation of non-linear LEDs, linear LEDs, and CFLs have all increased significantly – at the expense of linear fluorescents and incandescents. However, the decrease in linear fluorescent saturation compared to 2012 also reflects the impact of removing >10 MW customers from the sample frame. Nonetheless, the increased saturation of both linear and non-linear LEDs likely reflects a real change in the lighting commercial market since 2012.

FIGURE 6-2: SATURATION OF INTERIOR LIGHTING BY TECHNOLOGY AND SEGMENT

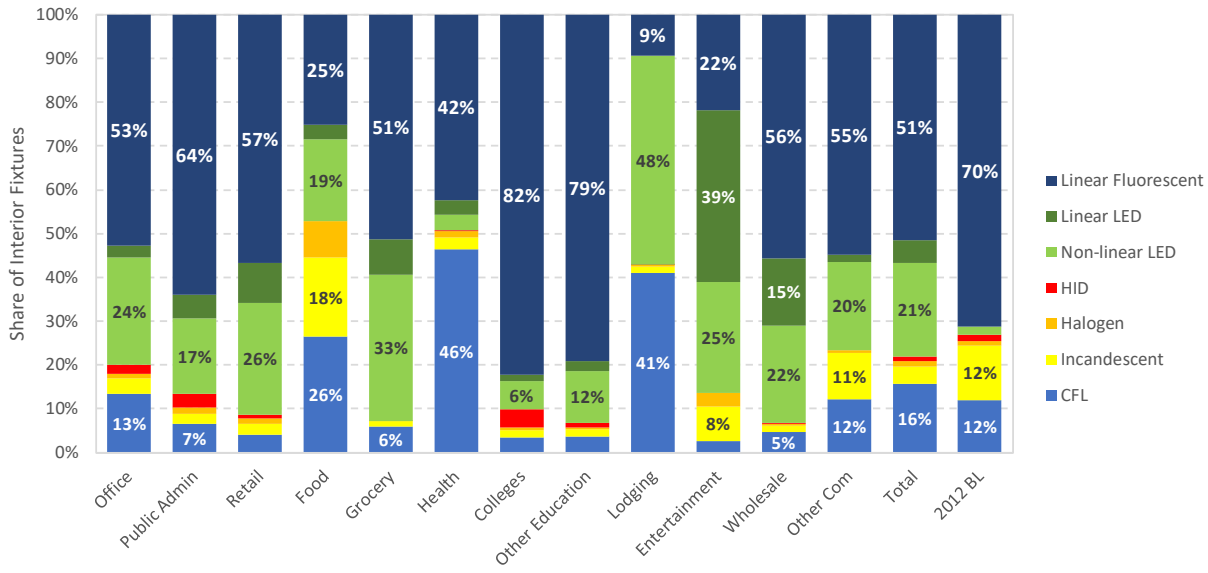
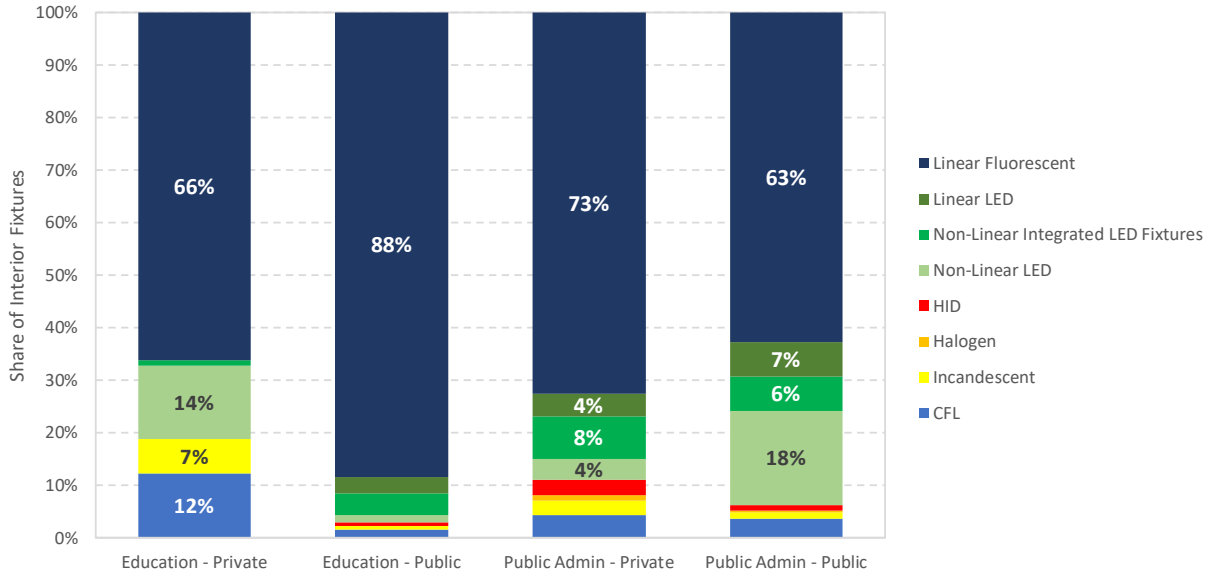


Figure 6-3 compares the saturation of interior lighting technologies between the "Public" and "Private" sub-segments of Education and Public Administration. As the figure shows, linear lighting fixtures

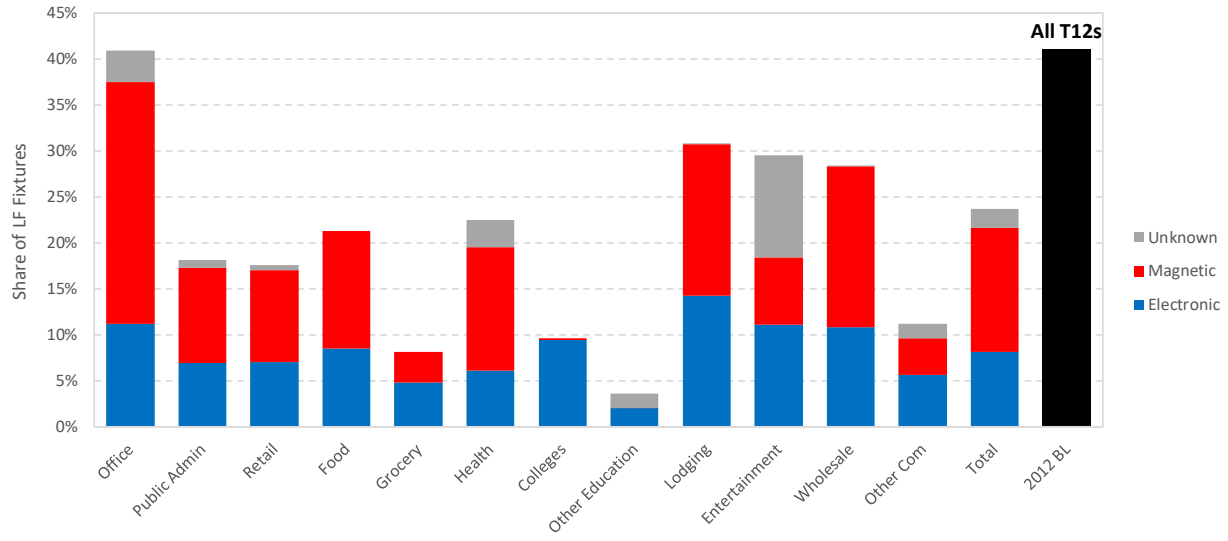
(fluorescent and LED) are the dominant interior lighting technology in these segments. The share of linear LEDs (within linear fixtures) is slightly higher in the "Public" Education and "Public" Public Administration segments compared to their "Private" counterparts, but only marginally. Among screw-based fixtures, LED and CFL lamps occupy for the majority of screw-based fixtures – similar to the overall commercial results. In this light, perhaps the most important take-away from this comparison is that the opportunity for linear LEDs in "Public" Education is significantly higher than in "Private" Education and both Public Administration segments.

FIGURE 6-3: COMPARISON OF INTERIOR LIGHTING TECHNOLOGY SATURATION, PUBLIC VS. PRIVATE



Given the dominance of linear fluorescent fixtures in commercial buildings, ComEd was interested in further decomposing the linear fluorescent fixture baseline by lamp and ballast type – in particular the remaining installed stock of the most inefficient linear fluorescent lamps, T12s. Figure 6-4 below shows the share of T12 fixtures among all linear fluorescent fixtures by ballast type and segment. Overall, 24% of linear fluorescent fixtures observed were T12 fixtures, with over half of those T12 fixtures operating on magnetic ballasts (a highly inefficient legacy ballast technology). Compared to the results in 2012, the saturation of T12s appears to have declined significantly (41% to 24%). However, T12s still represent a significant share of the installed linear fluorescent stock in ComEd, particularly in the Office segment.

FIGURE 6-4: SATURATION OF T12 LINEAR FLUORESCENT FIXTURES BY BALLAST TYPE AND SEGMENT



For customers with T12 fixtures, we also solicited self-reported replacement plans for T12 lamps and ballasts upon burnout, which are summarized in Figure 6-5 below. Interestingly, over half of respondents stated that they plan to replace burned out T12 lamps with new T12 lamps, rather than upgrade those fixtures to T8s, T5s, or TLEDs. Indeed, at sites with T12 fixtures and magnetic ballasts, those customers reported having an average of 6.5 T12 lamps in storage at the premise.

In contrast, over 60% of respondents stated that they plan on upgrading their T12 fixtures to T8, T5, or linear LED fixtures upon burnout of the magnetic ballast. These findings indicate that the remaining T12 fixture stock will likely transform to higher efficiency fixtures largely as a function of remaining useful life of magnetic ballasts. From a program design perspective, these findings indicate a potentially fruitful early replacement opportunity.

FIGURE 6-5: SELF-REPORTED T12 LAMP AND BALLAST REPLACEMENT PLANS

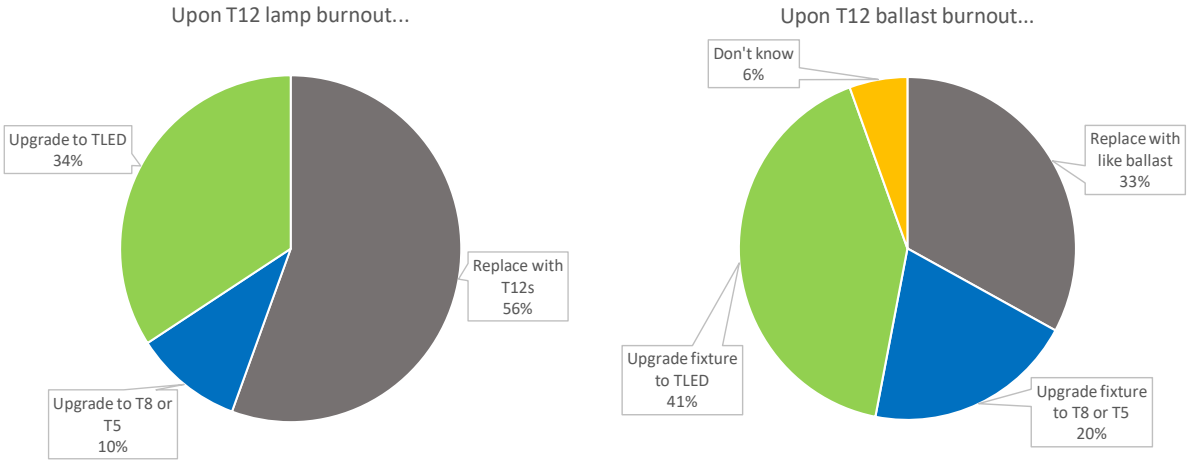
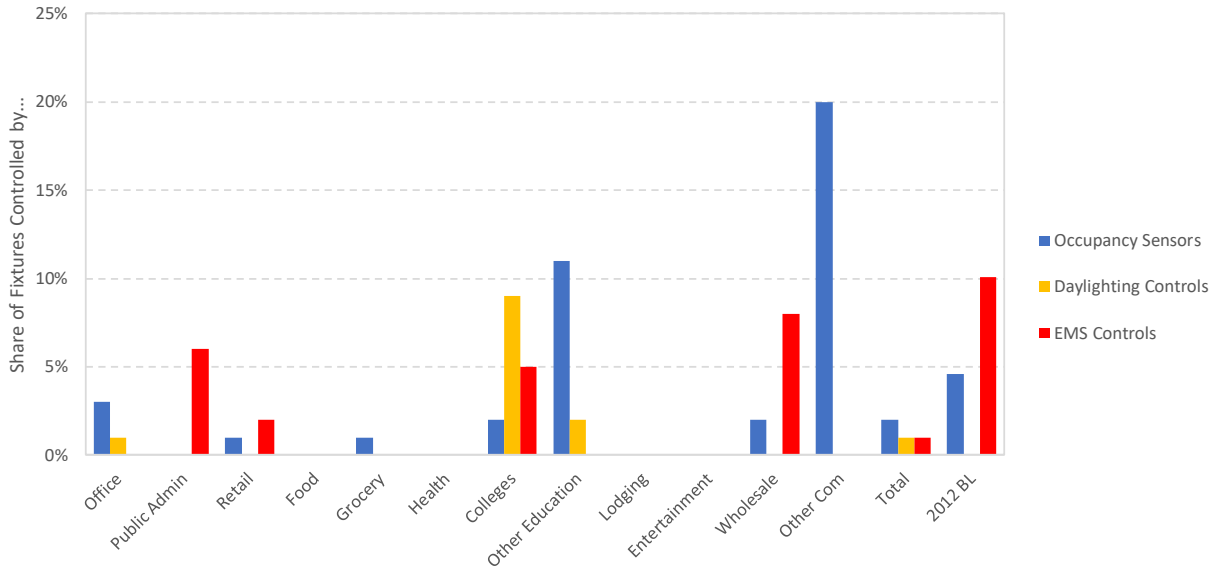


Figure 6-6 shows the saturation of interior lighting controls by segment. As the figure shows, the segments with highest average square footage per premise also tend to have the highest saturation of lighting controls, i.e. Colleges, Other Education, Public Admin, Offices, and Wholesale. The exceptions to this are the Lodging segment (where we observed very few lighting controls) and the Other Commercial segment (where we observed the highest relative saturation of occupancy sensors). Compared to the 2012 baseline study, the saturation of interior lighting controls is lower. However, this likely reflects the impact of removing >10 MW customers from our sample frame, rather than a distinct market trend.

FIGURE 6-6: SATURATION OF INTERIOR LIGHTING CONTROLS BY SEGMENT



6.4 SPACE COOLING

Figure 6-7 below shows the average installed cooling capacity "density", i.e. average tons of cooling capacity per 1,000 square feet of floor space, by segment. As the figure shows, the Colleges, Other Education, and Food Service segments have the highest relative density of space cooling capacity (5.1-4.6 tons per 1,000 ft2) – more than twice the level in the Other Commercial, Entertainment, and Wholesale segments.

FIGURE 6-7: AVERAGE COOLING CAPACITY DENSITY BY SEGMENT (TONS/1,000 FT2)

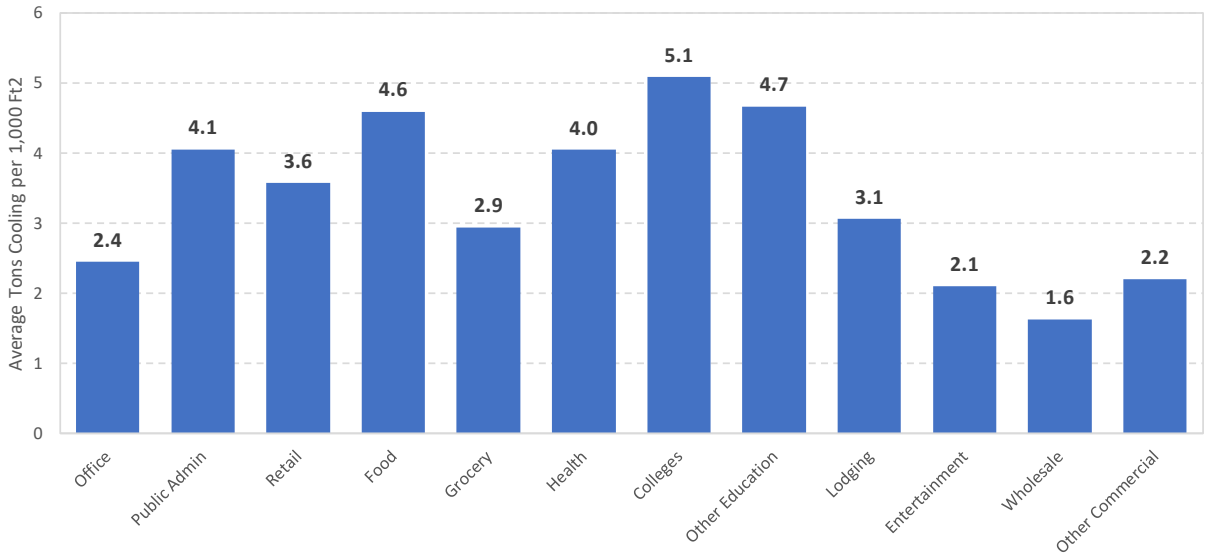


Figure 6-8 shows the saturation of cooling technologies by segment – in terms of the share of total installed capacity from each cooling technology. As the figure shows, the saturation of individual cooling technologies varies significantly across commercial segments in ComEd. In Retail, Food, Entertainment, Wholesale, and Other Commercial, packaged AC systems account for nearly all space cooling capacity. In contrast, chillers account for 58% of cooling capacity in Public Administration, and built-up DX systems account for 60% of cooling capacity in Offices. Interestingly, Figure 6-9 shows that the "Private" sub-segments of Education and Public Administration are cooled mostly with packaged and split AC systems, whereas their "Public" counterparts are cooled mostly using chillers and built-up DX systems.

FIGURE 6-8: SATURATION OF COOLING CAPACITY BY TECHNOLOGY AND SEGMENT

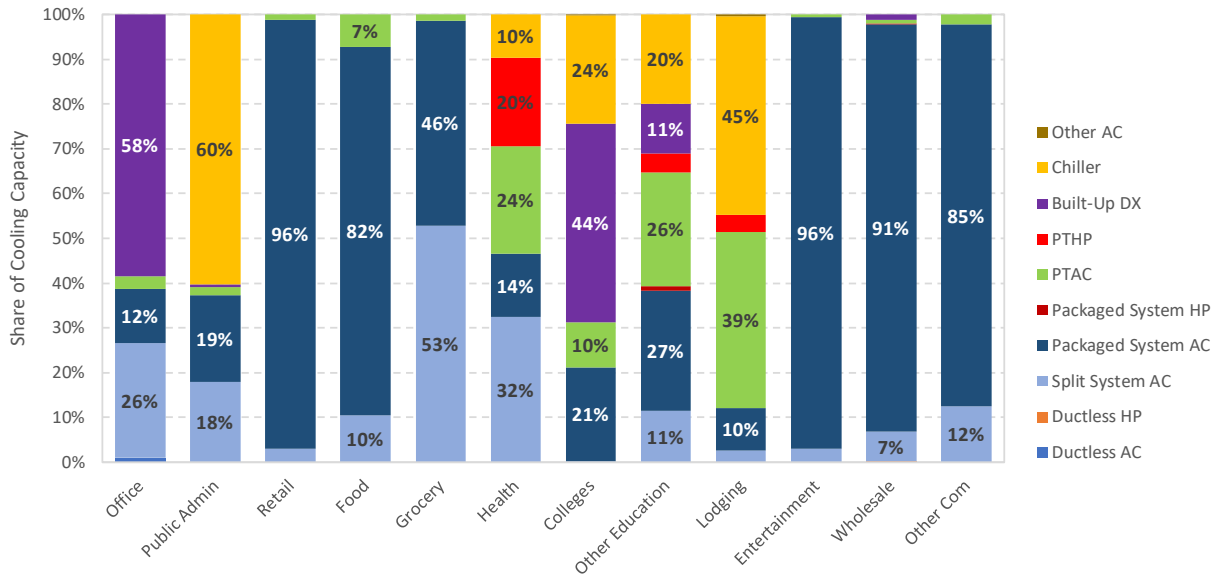


FIGURE 6-9: COMPARISON OF COOLING TECHNOLOGY SATURATION, PUBLIC VS. PRIVATE

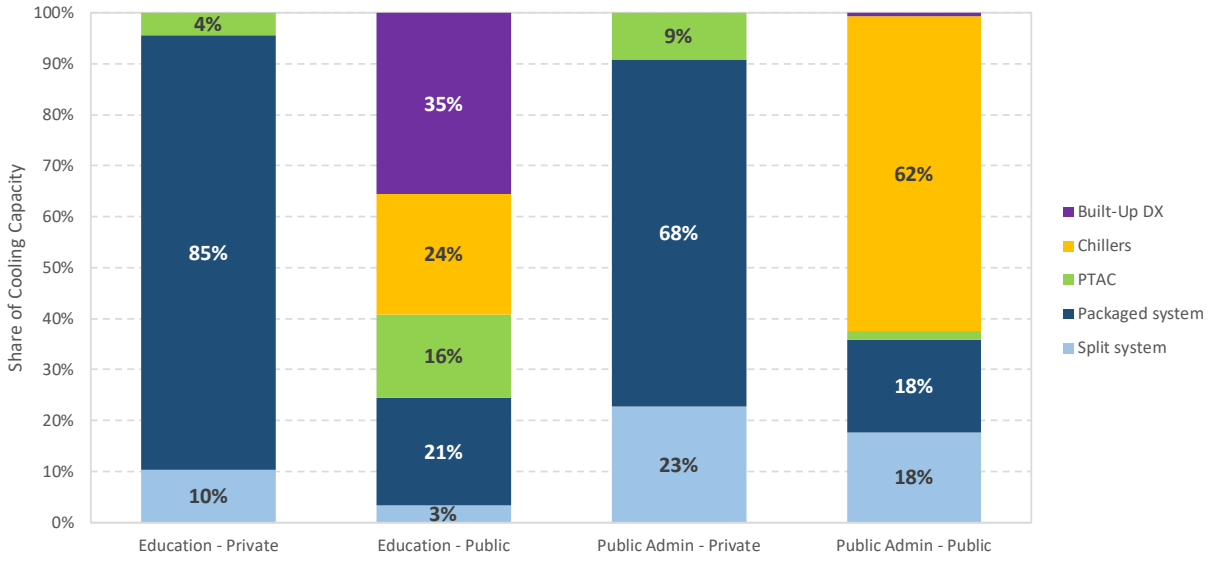


Figure 6-1 shows the average rated efficiency of the split and packaged AC units that were observed in the on-site surveys by segment – in terms of Energy Efficiency Ratio (EER).[2] As the figure shows, the overall

[2] Small residential-size split systems are rated in Seasonal Energy Efficiency Ratio (SEER). We converted SEER to EER using engineering algorithms in order to calculate average EER across all split and packaged systems.

average EER of split and packaged systems among ComEd's commercial customers is estimated to be 10.7 EER, with the Health, Public Administration, and Office segments having the highest average EER (11.3, 11.2, and 11.1, respectively) and Other Commercial having the lowest average EER (9.9). The most striking comparison in Figure 6-10, however, is the significant increase in overall average efficiency (across all commercial segments) compared to the same result from the 2012 baseline study (10.7 EER compared to 8.0 EER).

FIGURE 6-10: AVEARGE RATED EFFICIENCY OF SPLIT AND PACKAGED AC UNITS BY SEGMENT

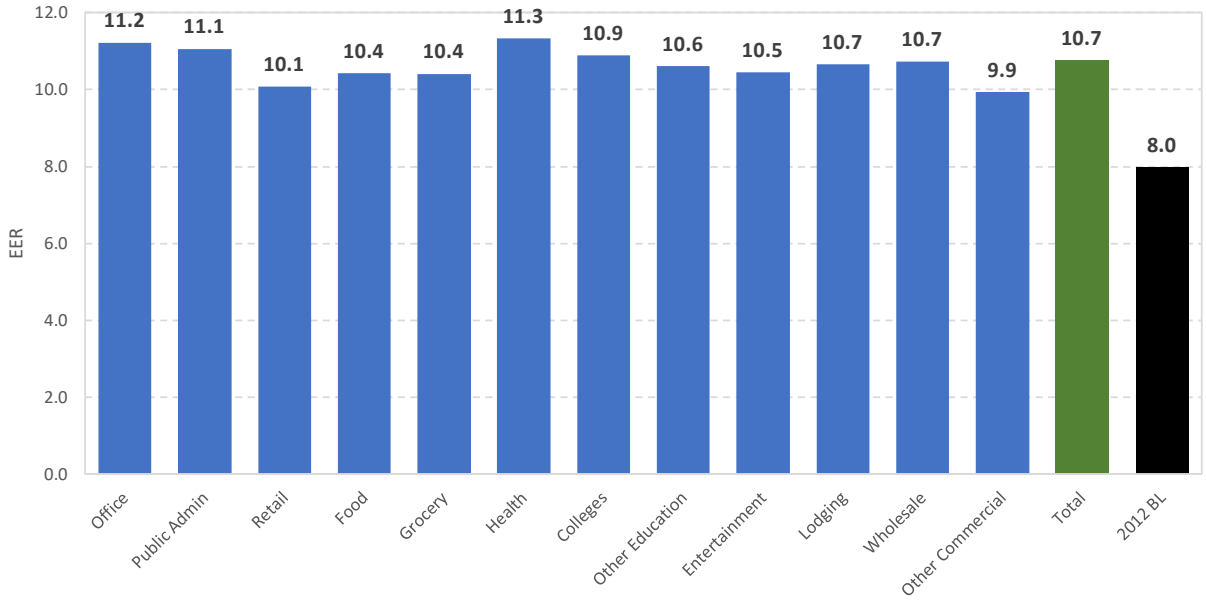


Figure 6-11 below shows the saturation of cooling controls by technology and segment – expressed as the share of installed cooling capacity controlled by a given control technology. With the exception of the Office segment, the figure shows that the segments with the highest shares of chillers and built-up DX systems also have the highest penetration of Energy Management Systems (EMS). Outside of those segments, the dominant cooling control technology used is programmable thermostats, with a significant share of installed cooling capacity still being controlled manually (i.e. standard thermostats and manually controlled setpoints).

FIGURE 6-11: SATURATION OF COOLING CONTROLS BY TECHNOLOGY AND SEGMENT

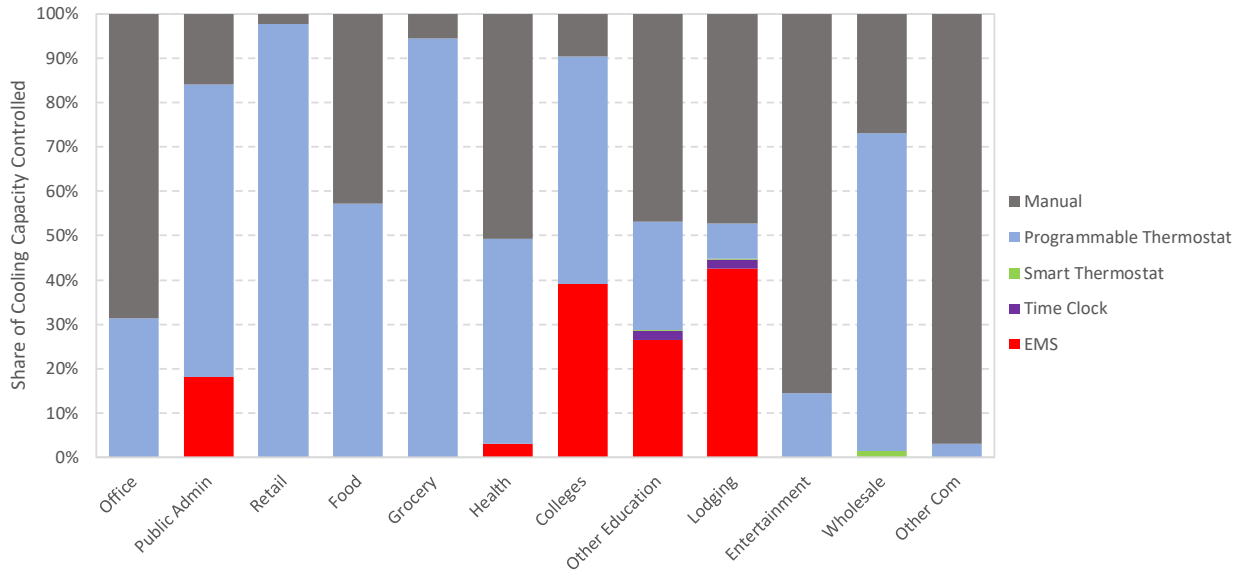
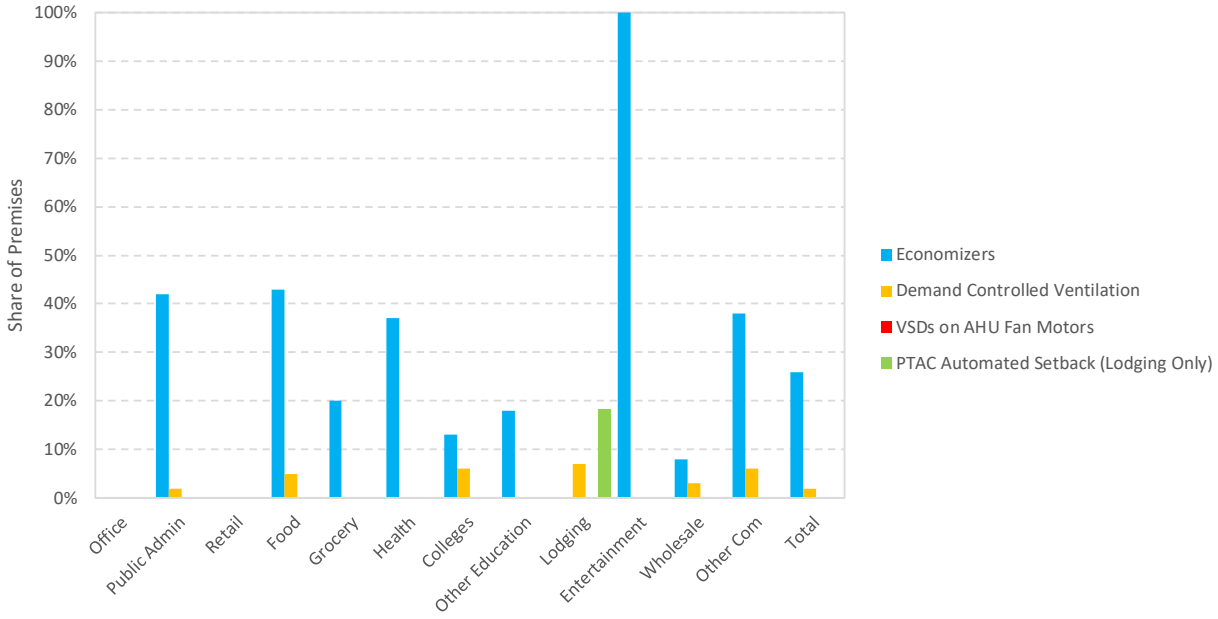


Figure 6-12 shows the saturation of HVAC energy efficiency measures by segment – in terms of the share of premises with a given measure installed. As the figure shows, while the use of economizers is significant across most sectors (particularly Entertainment), the use of other HVAC energy efficiency measures such as demand-controlled ventilation, variable-speed drives on air handlers, and automated setback for PTAC units is minor overall.

FIGURE 6-12: SATURATION OF HVAC ENERGY EFFICIENCY MEASURES BY TECHNOLOGY AND SEGMENT



6.5 SPACE HEATING

Figure 6-13 shows the primary space heating fuel shares for space heating in commercial buildings in ComEd's service territory by segment. As the figure shows, natural gas is by far the dominant space heating fuel across all commercial segments, with the key exception of the Lodging segment, where electricity is the dominant space heating fuel. In segments where electric space heating is present, electric furnaces account for nearly all electric space heating capacity, with heat pumps and resistance heating accounting for minor overall shares of electric space heating capacity (see Figure 6-14).

FIGURE 6-13: SPACE HEATING FUEL SHARES BY SEGMENT

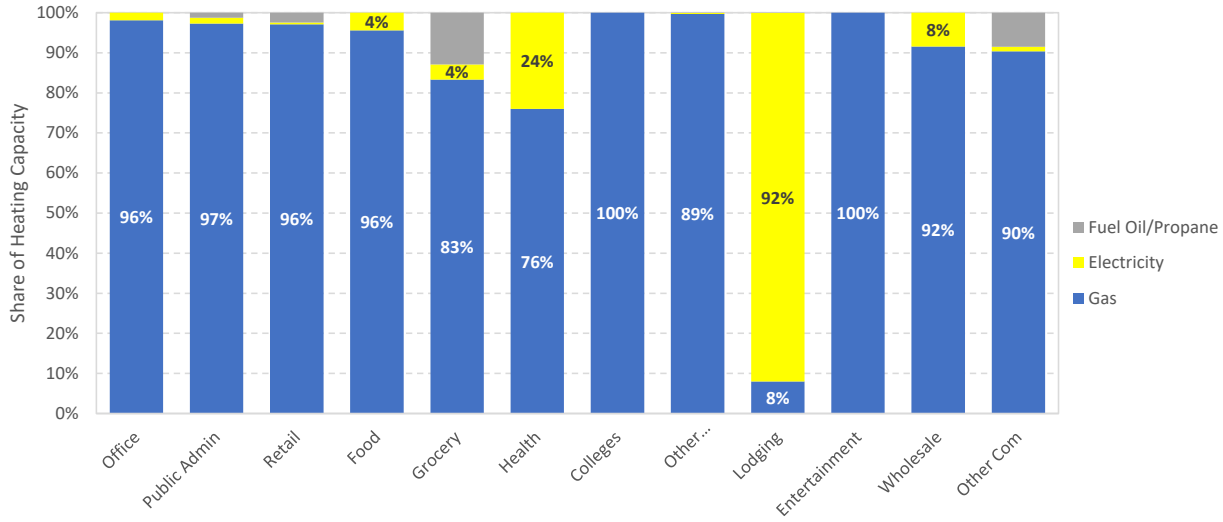


FIGURE 6-14: SATURATION OF ELECTRIC SPACE HEATING BY TECHNOLOGY AND SEGMENT

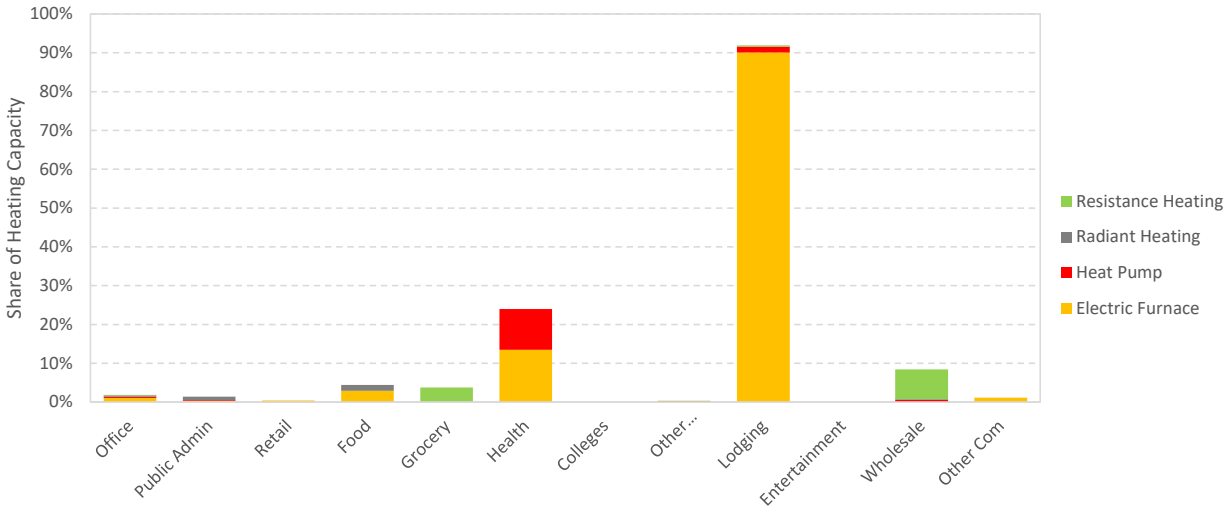
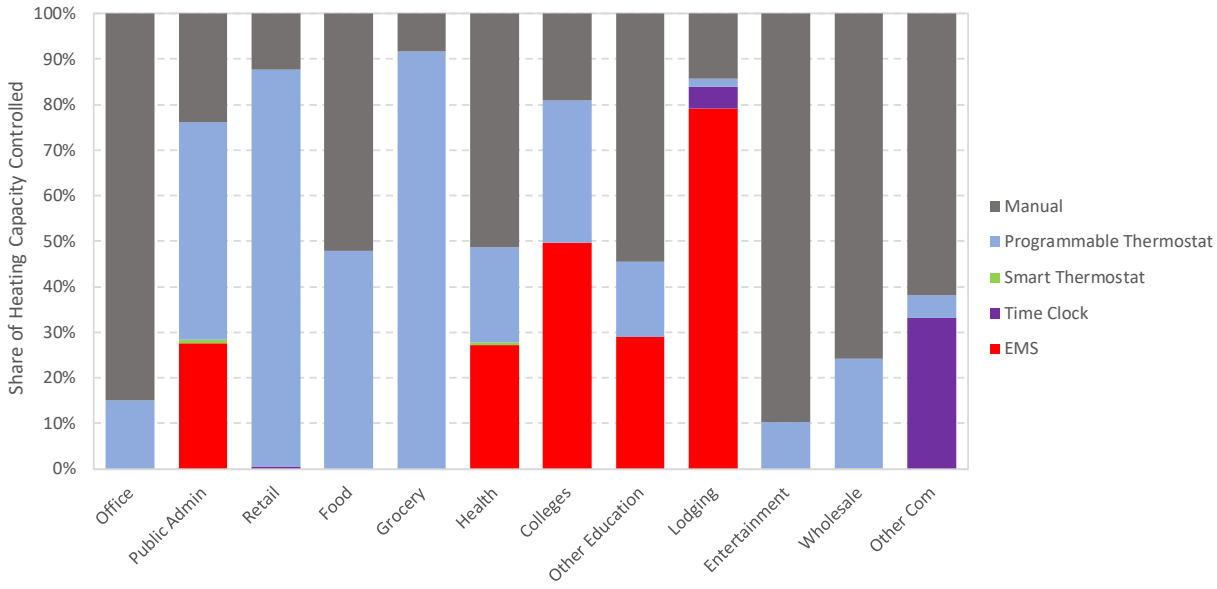


Figure 6-15 shows the saturation of space heating controls by technology and segment. As the figure shows, the saturation of EMS systems and programmable thermostats to control space heating is similar, although slightly higher, than the saturation of those systems to control space cooling (see Figure 6-11). Given that most commercial electric space heating is concentrated in the Lodging segment (Figure 6-13) and nearly all of that heating capacity in Lodging comes from electric furnaces (Figure 6-14) and is already controlled by EMS (Figure 6-15), there appears to be very little opportunity for electric energy savings from commercial space heating energy efficiency measures in ComEd's territory.

FIGURE 6-15: SATURATION OF SPACE HEATING CONTROLS BY TECHNOLOGY AND SEGMENT



6.6 WATER HEATING

Similar to space heating, the primary fuel used for water heating in ComEd's commercial buildings is also natural gas. Unlike space heating, however, electric water heating is also present in significantly quantities across all commercial segments, as shown in Figure 6-16 below. Indeed, buildings that use electricity or both electricity and natural gas for water heating account for more than 50% of premises in some segments, such as Public Administration, Retail, and Wholesale. In contrast, electric water heating is present in less than 20% of premises in the Food, Colleges, and Lodging segments.

At sites with electric water heating, the most common water heating technology observed by far was electric storage water heaters. However, as Figure 6-17 below shows, boilers provide hot water for just under half of sites with electric water heating in Colleges, and instantaneous water heaters provide hot

water for more than half of sites with electric water heating in the Lodging segment. Instantaneous water heaters also provide small but significant shares of water heating in the Office, Retail, Grocery, Health, and Other Commercial segments.

FIGURE 6-16: WATER HEATING FUEL SHARES BY SEGMENT

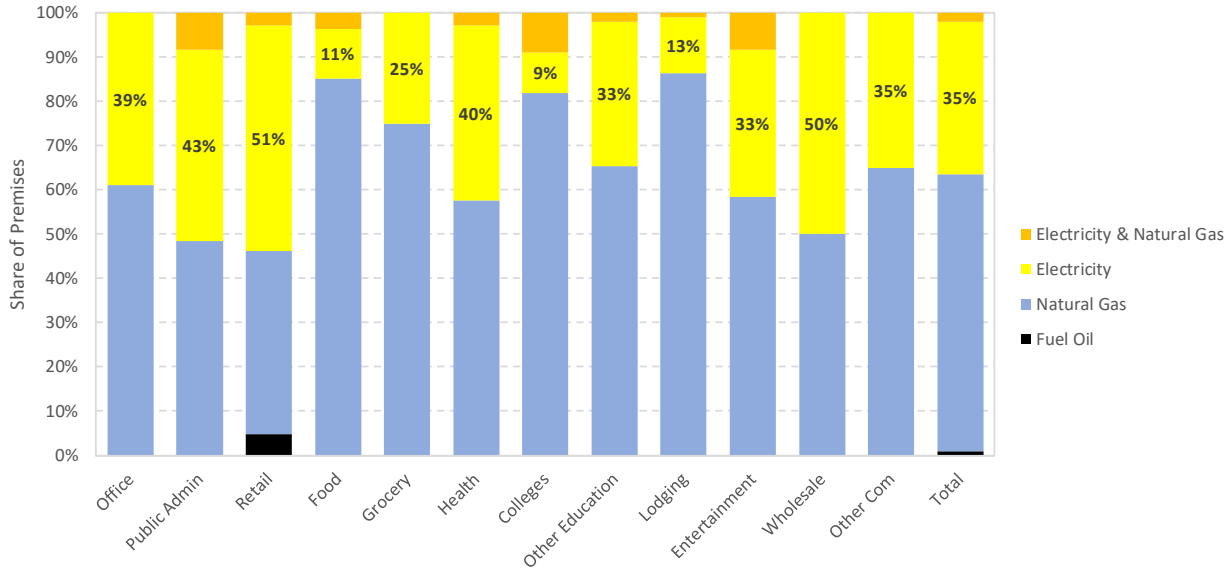
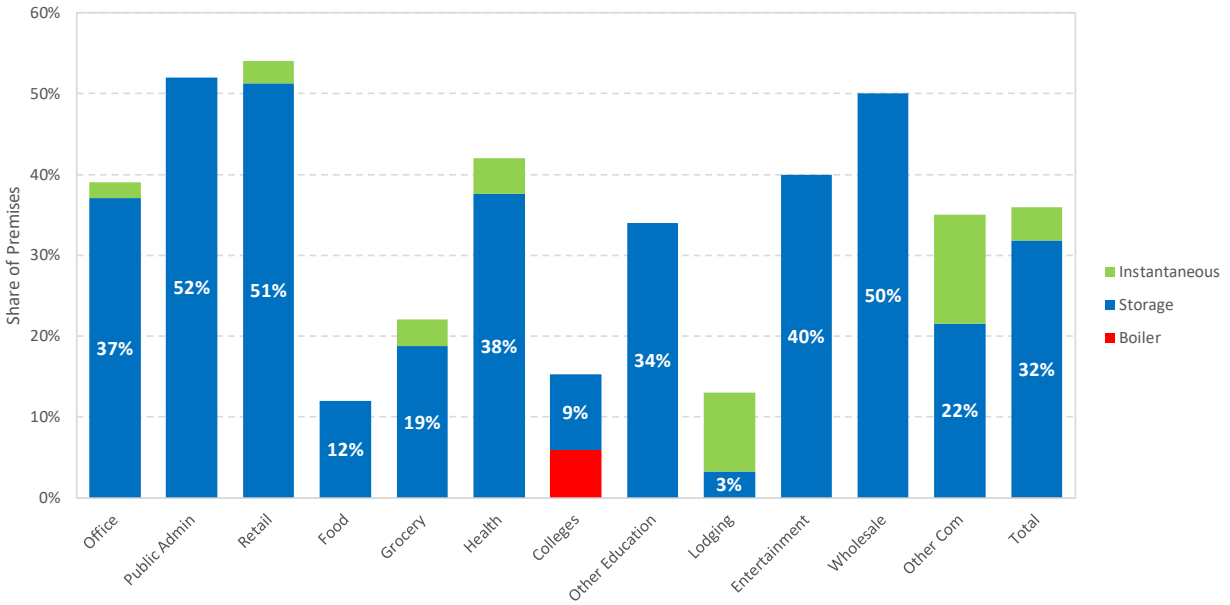


FIGURE 6-17: SATURATION OF ELECTRIC WATER HEATING BY TECHNOLOGY AND SEGMENT



6.7 REFRIGERATION

The dominant form of commercial refrigeration in terms of energy consumption is remote refrigeration, where the refrigerated unit contains the evaporator, but the condensers and compressors are located in a separate space (usually outdoors). There are two main categories of remote refrigeration – systems where a rack of condensers and compressors serve multiple refrigeration units (which we refer to as 'remote refrigeration') and systems where specific compressor and condensers are dedicated to single refrigeration units (which we refer to as 'remote condensing unit'). Both types of systems serve premises that have large refrigeration capacity requirements such as grocery stores and refrigerated warehouses. In contrast, self-contained refrigeration units include all three components (evaporators, compressors, and condensers) all in the same housing and are typically used at premises that have smaller capacity requirements, such as convenience stores and restaurants. Figure 6-18 and Figure 6-19 show the distribution of walk-in cooler/freezer volume (in ft3) and refrigerated display case length (in linear ft) by system type and segment in ComEd's commercial sector.

FIGURE 6-18: DISTRIBUTION OF WALK-IN COOLER/FREEZER VOLUME (FT3) BY SEGMENT

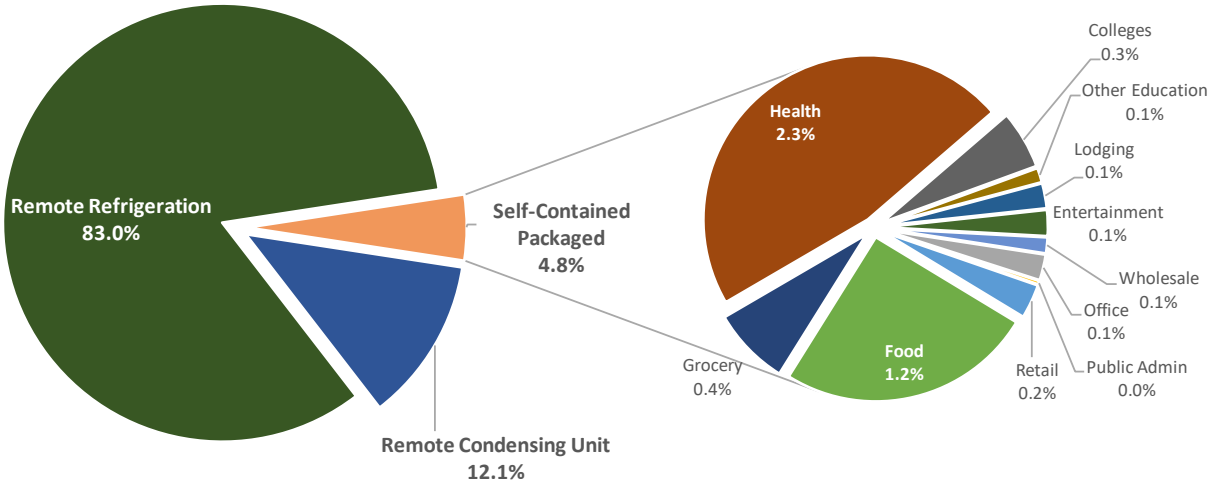
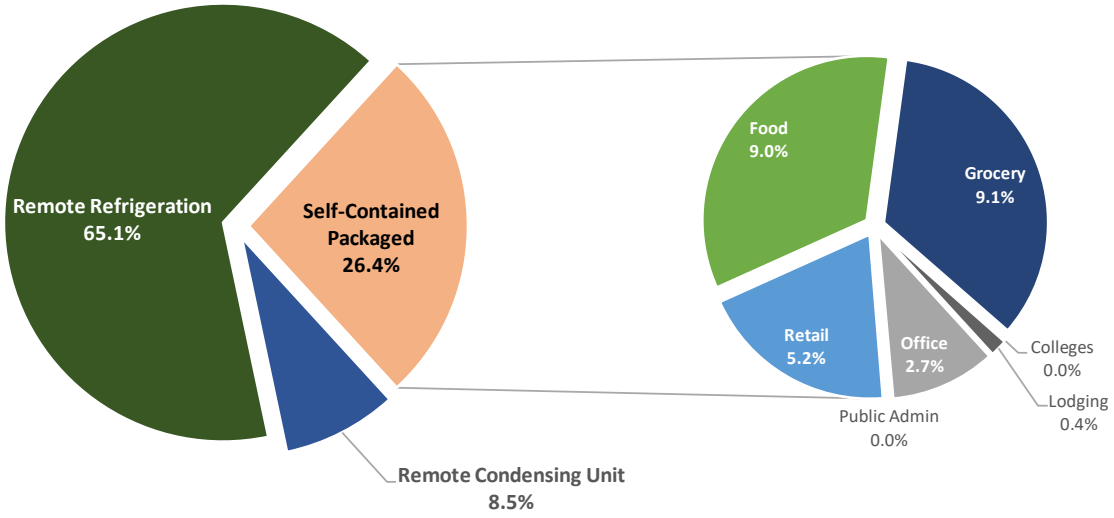


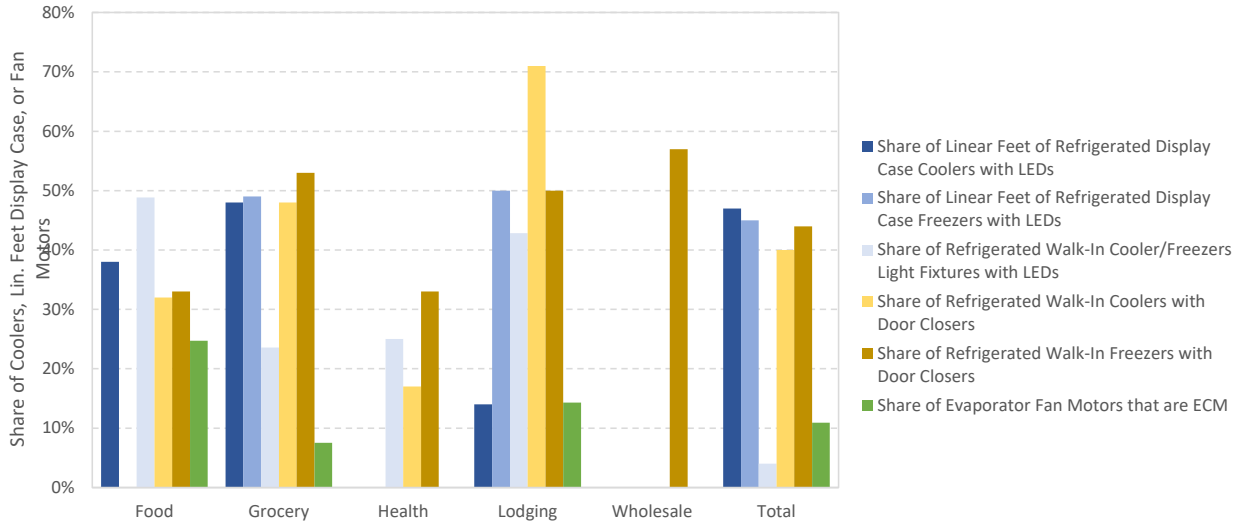
FIGURE 6-19: DISTRIBUTION OF REFRIGERATED DISPLAY CASE LENGTH (LINEAR FT) BY SEGMENT



While walk-in coolers/freezers and display cases served by remote refrigeration and remote condensing systems are almost exclusively concentrated in ComEd's Wholesale and Grocery segments, Figure 6-18 and Figure 6-19 above show that self-contained packaged units are used across a wider cross-section of commercial segments, including Health, Retail, Offices, Colleges, and Lodging.

Figure 6-20 below shows the saturation of select energy efficiency measures applicable to commercial refrigeration by technology and segment. As the figure shows, the saturation of LEDs used in refrigerated display cases I fairly high compared to the saturation of LEDs for general service lighting (see Figure 6-2). This result is in line with expectations, however, since refrigerated spaces were one of the applications that led early adoption of LEDs, given the benefits of reduced heat loss from LED lamps on total refrigeration load. The saturation of automatic door closers is also significant (particularly in the Lodging segment) but is still less than 50% overall for both walk-in coolers and walk-in freezers. Lastly, Figure 6-20 shows that the saturation of electrically-commutated motors (ECMs) used in evaporator fans – while significant in the Food segment – is still minor overall (just over 10%), representing a potentially significant opportunity for program-driven savings going forward.

FIGURE 6-20: SATURATION OF REFRIGERATION ENERGY EFFICIENCY MEASURES BY TECHNOLOGY AND SEGMENT



6.8 FOOD SERVICE

Figure 6-21 shows the density of food service equipment, expressed as the average number of units per 10,000 ft2 of floor area by fuel, equipment type, and segment. As the figure shows, the Food, Grocery, and Entertainment segments have significantly higher densities of food service equipment compared to other commercial segments. Across all equipment types, Figure 6-21 shows a fairly even split between gas and electric equipment in terms of average number of units per 10,000 ft2.

FIGURE 6-21: AVERAGE NUMBER OF UNITS PER 10,000 FT2 BY FUEL AND EQUIPMENT TYPE

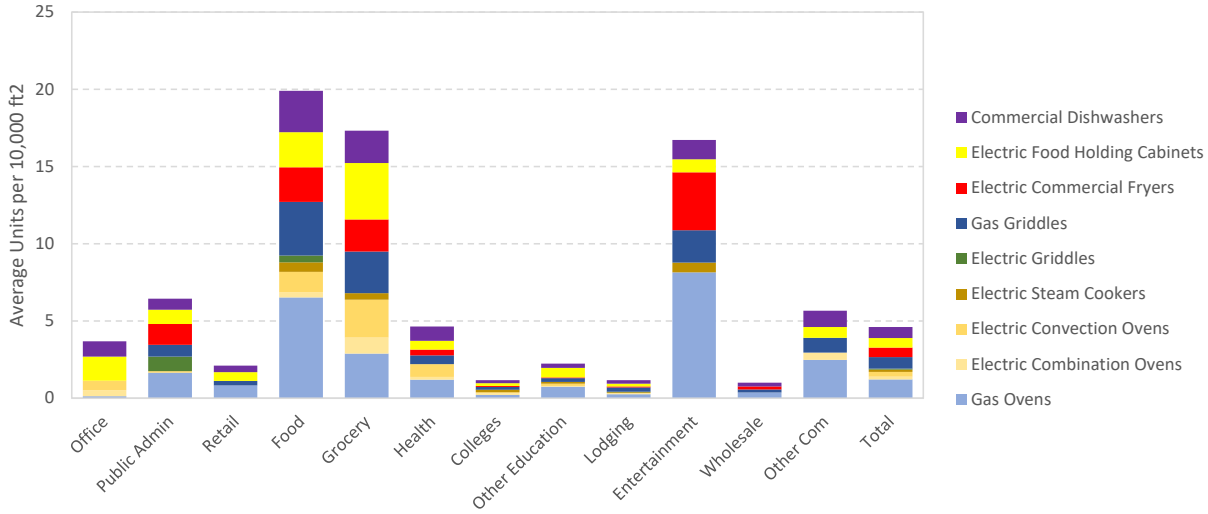
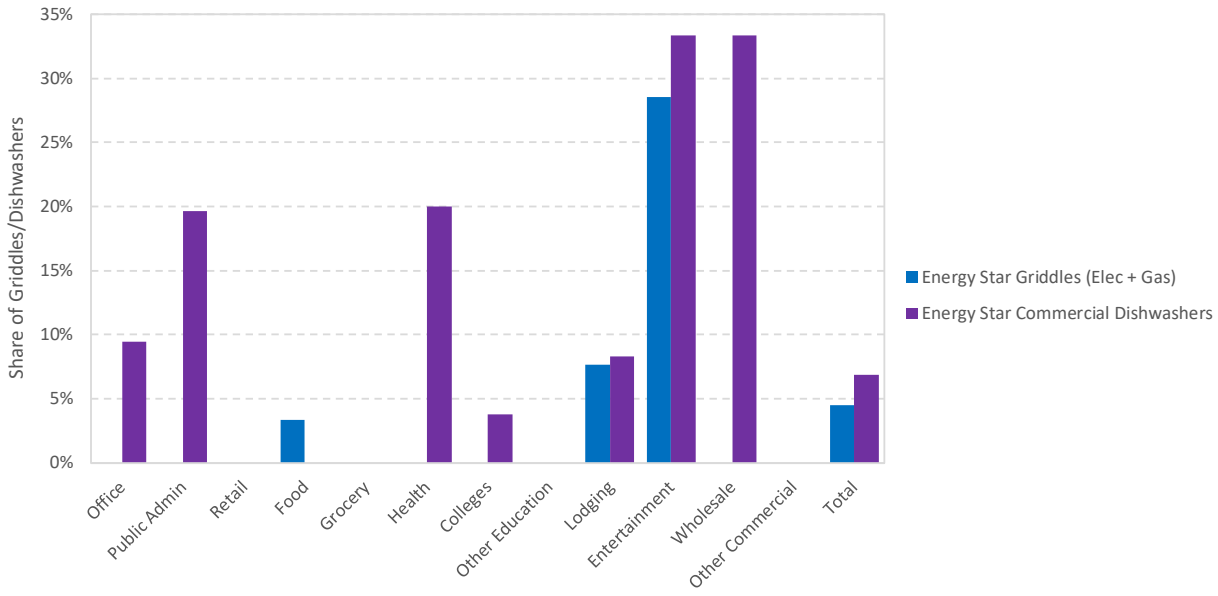


Figure 6-22 below shows the saturation of select energy efficiency measures applicable to commercial food service equipment by technology and segment. As the figure shows, the saturation of Energy Star griddles and commercial dishwashers varies significantly across segments, from zero in Grocery to over 25% in Entertainment. The overall saturation of Energy Star griddles and commercial dishwashers, however, is quite low. This result is consistent with results from other jurisdictions across North America and is thought to reflect the unique markets barriers related to energy efficiency in the food service sector.

FIGURE 6-22: SATURATION OF FOOD SERVICE ENERGY EFFICIENCY MEASURES BY TECHNOLOGY AND SEGMENT

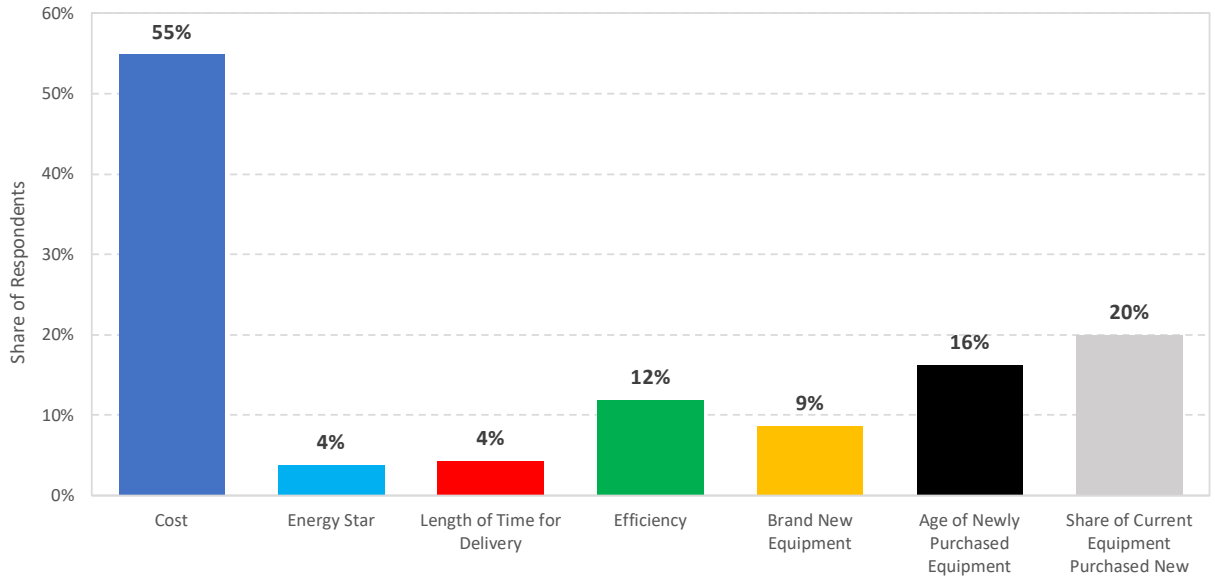


In particular, the adoption of new, high-efficiency food service equipment (with or without programmatic support) is faced with the unique challenge of competing against a robust market for used food service equipment. Unlike HVAC equipment which tends to stay in place at a given premise after a change of ownership, food service equipment is often removed and sold back to equipment distributors. In this sense, new, high-efficiency food service equipment must overcome not just higher incremental costs compared to new, standard-efficiency equipment but also compared to used equipment.

When designing our on-site surveys, we discussed this specific market barrier with ComEd, who expressed a desire to collect some quantitative data on this issue as part of this study. As such, the survey included a set of interview questions focused on equipment purchase criteria for premises where food service equipment was present. Figure 6-23 presents the key results of those interview questions below. As the figure shows, first cost was by far the most important purchase criteria reported, with efficiency and new equipment cited as important criteria for only 12% and 9% of respondents, respectively. Indeed, on average, respondents reported that only 20% of their current equipment stock was purchased new. These

results reinforce the importance of this particular market barrier for high-efficiency food service programs and highlight the need for program designs that can account for a robust secondary equipment market.

FIGURE 6-23: SELF-REPORTED EQUIPMENT REPLACEMENT PURCHASE CRITERIA



6.9 KEY FINDINGS

Below we present the key findings from the commercial on-site surveys with respect to the most significant changes to the end-use baselines compared to 2012 (where possible) and the efficiency opportunities and challenges going forward. As noted in the beginning of this chapter, removing customers with demand greater than 10 MW from the sample frame had a significant impact on the baseline results in comparison to the previous baseline study conducted in 2012. This impact was largest impact in the Retail, Office, Education, and Health segments, where removing >10 MW customers reduced the total "in scope" annual electricity consumption by 55%, 23%, 17%, and 12%, respectively. As a result, the number of direct comparisons and longitudinal assessments that are possible are limited. That said, the baseline data collected for this study set the foundation for ComEd's post-FEJA commercial program and portfolio design going forward.

Below we present the key findings and take-aways for each major commercial end use.

Lighting

- **The saturation of LEDs has increased significantly since 2012 – from 2% of fixtures to 27%.** The segments with the highest saturation of LEDs are Lodging (largely medium, screw-based LEDs) and Retail and Grocery (largely linear LEDs). This increase in LED saturation came mostly at the expense of incandescent lighting, whose share of total fixtures declined significantly since 2012 (from 12% to 4%). These changes are similar to the changes in residential lighting since 2012, with the key exception that the share of CFLs in commercial lighting actually grew slightly, whereas CFL saturation has declined in the residential sector.

- **The saturation of T12 fixtures has declined since 2012 – from 41% of all linear fluorescent fixtures to 24% – but remains significant, particularly in the Office segment (>40%).** Importantly, more than half of those remaining T12 fixtures use magnetic ballasts, which is a legacy ballast technology that appears to be preventing customers from upgrading to more efficient lamp and ballast technologies. Indeed, over half of customers that still use T12 fixtures reported that they plan to replace burned out T12 lamps with new T12 lamps, as long as the magnetic ballasts continue to function. In contrast, two-thirds of customers currently using T12 fixtures report that they intend to upgrade those fixtures to T8, T5, or TLED fixtures upon burnout of the existing T12 ballast.

- **The efficient lighting opportunity in the "public" Education segment is almost exclusively associated with linear LEDs.** A comparison of the FEJA-defined "public" versus "private" sub-segments of Education revealed that nearly 90% of the interior lighting fixtures in the "public" Education sub-segment are linear fluorescent fixtures. This indicates that the energy efficiency opportunity in that sub-segment going forward is almost exclusively linear LEDs.

HVAC

- **Split and packaged DX systems are the dominant central cooling technologies in the Retail, Food, Grocery, Entertainment, Wholesale, and Other Commercial.** In these segments, split and packaged DX systems account for over 90% of installed cooling capacity. These segments are also generally the segments with the lowest average floor area per premise.

- **In contrast, chillers and built-up DX systems account for large shares of installed cooling capacity in Colleges, Other Education, Lodging, Office, and Public Administration.** This finding is consistent with the large relative average size of premises in these segments (and corresponding large cooling system requirements). Notably, the "private" sub-segments of Education and Public Admin are cooled mostly with split and packaged DX systems, but their "Public" counterparts are cooled mostly with chillers and built-up DX systems.

- **The average efficiency of split and packaged DX systems increased significantly since 2012 – from 8.0 EER to 10.8 EER.**

- **Natural gas provides the vast majority of central space heating in ComEd's territory – over 90% of heating capacity is fueled by natural gas.** There two notable exceptions to this – the Health

segment, where electricity provides 24% of heating capacity, and the Lodging segment, where electricity provides 92% of heating capacity. From a technology perspective, electric furnaces provide nearly all of the electric space heating in Lodging and roughly half of electric heating in Health, with the remainder provided by heat pumps.

- **EMS systems are used to control significant shares of central cooling and heating capacity in the Public Administration, Health, Colleges, Other Education, and Lodging segments.** In the other commercial segments, however, little to no HVAC controls were observed beyond programmable thermostats.

- **The use of economizers in commercial HVAC systems is widespread, but the saturation of other add-on HVAC efficiency measures – beyond programmable thermostats – is low.**

Water Heating

- **Like in space heating, natural gas fuels the majority of commercial water heating capacity in ComEd's territory (65%), but to a lesser extent than space heating.**

- **At sites with electric water heating, the most common technology observed was electric storage water heaters (88% of sites), although there are some important variations in electric water heating technology across segments.** In the Lodging segment, instantaneous water heaters account for more than half of sites with electric water heating. Instantaneous water heaters also provide small but significant shares of water heating in the Office, Retail, Grocery, Health, and Other Commercial segments. In Colleges, electric boilers provide hot water for just under half of sites with electric water heating.

Commercial Refrigeration

- **Remote refrigeration systems are concentrated almost exclusively in refrigerated warehouses (Wholesale) and grocery stores (Grocery).** These large, complex systems that are best suited for retrofit, upgrade, and/or optimization through custom rebate programs.

- **Self-contained packaged refrigeration is present across a more diverse array of commercial segments, including Health, Food, Retail, and Offices.** These technologies account for significant shares of refrigerated display case capacity in ComEd's **territory** and are suitable to target either via deemed rebate programs, custom rebate programs, or both.

- **The use of LEDs in refrigerated display cases is quickly becoming standard practice.** Nearly 50% of refrigerated display case lighting – in terms of share of linear feet – is now LED lighting in ComEd's territory. While there is no benchmark available from the 2012 **baseline** study for comparison, this particular result in consistent with the dynamics of the LED market over the last decade, where early adoption of LEDs first occurred in applications with the largest co-benefits. In the case of refrigerated display case lighting, LEDs provide not only more efficient lighting but also reduced refrigeration load from lower heat loss.

- **The saturation of electrically commutated motors (ECMs) used in evaporator fans is still minor overall (just over 10%).** While the saturation of ECMs is significantly higher in the Food segment (25%), the low overall saturation of ECMs in ComEd's territory represents a potentially significant opportunity for program-driven savings going forward.

Food Service

- **The overall saturation of Energy Star griddles and commercial dishwashers is low – only 4% and 7% of observed units, respectively.**

- **Interviews revealed strong evidence of significant barriers to adoption of new, Energy Star-qualified food service equipment.** First cost was noted as the most important purchase criterion for over half of respondents, while efficiency was cited as an important purchase criterion by only 12% of respondents. Moreover, only 16% of respondents said that the age of new equipment was an important purchase criterion – a finding that is consistent with the existence of a robust market for used equipment in the food sector. Indeed, respondents reported that on average only 20% of their current equipment stock was purchased new. These results highlight the need for program designs that can account for a robust secondary equipment market.

APPENDIX A RESIDENTIAL SURVEY INSTRUMENT

Note that there are many terms in the survey that were also clickable links to pop-up screens that provided additional explanatory text and images. For this appendix, we hid the pop-up screen content in the survey instrument document itself to improve readability (pages 1-55 of Appendix A) and attached a separate output of just the pop-up screen content (pages 56-99 of Appendix A).

1 RESIDENTIAL SURVEY INSTRUMENT

[LANDING PAGE]

Please enter the participant ID number on the mailer you received – including the dashes – and then press the start button.

Participant ID: [RECORD]

[WELCOME PAGE]

Thank you for participating in ComEd's Home Energy Survey! Some things to know before you begin:

- The survey is designed to be completed on a mobile device.
- You may take a break from the survey at any time. If you exit the survey, you can return to where you left off by using the same link and participant ID number provided on the mailer sent to you.
- To be eligible for the $25 Amazon.com Gift Card, you must complete the entire survey, including the requested photos.

P1 Your Name: [RECORD]

Enter the email address where the Amazon.com Gift Card should be sent.

P2 Email Address: [RECORD]

(Your email address will be collected for use by ComEd only. It will not be shared for third-party use.)

[SHOW NEW PAGE]

QC_GEO Geolocation services will be used to verify your location. You must fill out this survey at <CUST_ADDRESS>. Is this your address?

1 Yes
2 No

[IF "No", SHOW FOLLOWING TEXT, THEN QUIT SURVEY & RE-ROUTE TO LOGIN-SCREEN]: You may have entered an incorrect participant ID. Please try again.

[SHOW NEW PAGE]

When you select "next" at the bottom of this page a pop-up screen will appear that asks you to enable location services.

Location services must be enabled to be eligible for the $25 Amazon.com Gift card. By clicking the check-box below you indicate your understanding of this requirement.

1 Yes, I understand that location services must be enabled for eligibility to receive a $25 Amazon.com Gift Card [Make This Response A CHECK BOX] [Must click to advance]

[POP UP REQUEST TO ENABLE LOCATION SERVICES AFTER RESPONDENT HITS "next"]

1.1 YOUR HOME AND LIFESTYLE

A1 Which best describes the ownership of this home?

1 Own, either with a mortgage or outright
2 Rent/Lease

A2 Is your home…

1 A single-family detached house
2 A townhouse, duplex, or row house
3 An apartment or condominium
4 A manufactured home (mobile or trailer)

A3 Approximately how many square feet of living space does your home have, including bathrooms, foyers and hallways? *(Exclude garages and other unfinished spaces)*

1 Less than 250
2 250 - 500
3 501 - 750
4 751 - 1,000
5 1,001 - 1,250
6 1,251 - 1,500
7 1,501 - 2,000
8 2,001 - 2,500
9 2,501 - 3,000
10 3,001 - 4,000
11 4,001 - 5,000
12 More than 5,000

A4 How many of the following rooms does your home have? *(Leave blank if 0)*

a Bedrooms [RECORD #]
b Bathrooms [RECORD #]
c Kitchens [RECORD #]

d Living/Family Rooms [RECORD #]

e Dens/Offices [RECORD #]

f Dining Rooms [RECORD #]

[ASK IF A2 <> "An apartment or condominium" or "A manufactured home (mobile or trailer)"]

A9 Do you have a garage?

1 Yes

2 No

[ASK IF A2 <> "An apartment or condominium" or "A manufactured home (mobile or trailer)"]

A5 Do you have a finished or unfinished basement?

1 No Basement

2 Unfinished basement

3 Finished basement

[SET TOTAL_ROOMS = SUM(A4a-A4g)+[1 if A9=="Yes"] + [1 if A5 <> "No Basement"]]

A6 Do you have an electric vehicle at your home?

1 Yes, I have an electric vehicle

2 Yes, I have a plug-in hybrid

3 I have a hybrid vehicle that does NOT need to be charged

4 No

[ASK IF A6 = "Yes, I have an electric vehicle" OR "Yes, I have a plug-in hybrid"]

A6a What type of charger do you use to charge your vehicle at home? Chargers can be Level 1, Level 2, or Level 3.

0 None, I do not charge my vehicle at home.

1 Level 1 charger

2 Level 2 charger

3 Level 3 charger

98 I charge my vehicle at home, but I don't know the type of charger used

A7 Do you have a solar PV system at your home?

1 Yes

2 No

A8 Have you received a Home Energy Report from ComEd within the last 5 years?

1 Yes

2 No

O9 How many people, including yourself, usually live in this home? *(Exclude anyone away more than half the year)* [RECORD]

O10 Please indicate the number of people in each age range that usually live in this home *(including yourself).*

Age Range	# People in Age Range
a. 5 and under	[Record #]
b. 6 to 17	[Record #]
c. 18 to 34	[Record #]
d. 35 to 54	[Record #]
e. 55 to 64	[Record #]
f. 65 and over	[Record #]

[Check sum of O10 = O9 response]

1.2 SPACE COOLING

B0 Do you pay for central air conditioning for your home?

1 Yes
2 No, it is part of my rent/condo fee
3 No, do not have central air conditioning in my home

[IF B0 = "No, it is part of my rent/condo fee", SKIP TO E0]
[IF B0 = "No, do not have central air conditioning in my home" SKIP TO E0]

B2

[SHOW IF PRIMARY:] What is the PRIMARY central air conditioning system in your home? The most common types of central air conditioners are forced air split systems, ground source heat pumps, and ductless systems.

[SHOW IF SECONDARY:] Do you have SECONDARY central air conditioning system(s)? If so, please indicate the type(s). The most common types of central air conditioners are forced air split systems, ground source heat pumps, and ductless systems.

[Show: Radio button allowing a single choice for Primary. Show multi-select check boxes for allow multiple selections for Secondary]

	1. Primary	2. Secondary
a. Forced air split system		
b. Ground source heat pump		
c. Ductless system		
d. Other, specify: [RECORD] *(exclude window/room air conditioners)*		

[IF B2_Primary and B2_Secondary <> (a. forced air split system OR c. ductless system), THEN SKIP TO E0]

B6 When was the last time you or somebody else performed maintenance on your primary cooling system?

1 Within the past year
2 1-2 years ago
3 3-4 years ago
4 More than 5 years ago
98 Don't know

B3 How many outdoor compressors does your [IF a only, show: "forced air split system" IF c only, show: "ductless system", IF a and c show: "forced air split system and ductless system"] use?

1 1 [DON'T SHOW IF a and c]
2 2
3 3
4 4 or more

[Loop through (B4_cc#) for each cooling unit (up to 4), per answer to B3]

[SHOW IF B3>1 and #=1] It looks like you have multiple outdoor compressors in your home.
[SHOW IF B3>1 and #=1] Let's discuss the outdoor compressor of your [IF b2_primary = a SHOW: forced air split system] [IF b2_primary = a SHOW: ductless system] first.
[SHOW IF B3>1 and #=1 and (B2_Primary & B2_Secondary = a or c)] If your [IF b2_primary = a SHOW: forced air split system] [IF b2_primary = a SHOW: ductless system] has multiple compressors, answer questions regarding the most used compressor first.

B4_cc# How old is this central air conditioning **UNIT (<#>)**?

1 Less than 5 years
2 5-13 years
3 14-27 years
4 Over 27 years
98 Don't know

[END LOOP]

[Loop through (B7_cc#-B11_cc#) for each cooling unit (up to 4), per answer to B3]

[SHOW IF B3=1 and #=1] We will now ask you to take a picture of the model information on the nameplate found on the outdoor compressor of your central air conditioning system.
[SHOW IF B3>1 and #=1] We will now ask you to take a picture of the model information on the nameplate found on each outdoor compressor of your central air conditioning system.

[SHOW IF B3>1 and #=1] Take a photo of the outdoor compressor of your [IF b2_primary = a SHOW: forced air split system] [IF b2_primary = a SHOW: ductless system] first.

[SHOW IF B3>1 and #=1 and (B2_Primary & B2_Secondary = a or c)] If your [IF b2_primary = a SHOW: forced air split system] [IF b2_primary = a SHOW: ductless system] has multiple compressors, take a photo of the most used compressor first.

B7_cc# The outdoor unit is usually mounted on a concrete slab on the ground next to your home or potentially on an exterior wall if you have a ductless system. The nameplate is a sticker or metal badge that contains the make/model information and should be in plain view on the side of the outdoor unit (<#>).

1 Ready to take photo of **UNIT (<#>)**
2 I am not able to take a photo

[ASK IF B7_cc# = 1]
B8_cc# Are there barcodes included on the nameplate on **UNIT (<#>)**?

1 Yes
2 No

[ASK IF B8_cc# = Yes]
B9_cc# Take a photo of the barcode(s) found on the nameplate of **UNIT (<#>)**:

1) Tap “BROWSE” or “CHOOSE FILE” (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap “UPLOAD”
4) Wait until upload is complete and tap “NEXT” when instructed
   [TAKE PHOTO]

[ASK IF B7_cc# = 1]

B10_cc# Take a photo of the model number found on the nameplate of **UNIT (<#>)**:

- [SHOW IF UPLOADED PHOTO IN B9_cc#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR B10_cc#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF B7_cc# = 2]

B11_cc# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of **UNIT (<#>)**.

0 I changed my mind, I will take a photo of the nameplate
1 I don't know where the central AC unit is located
2 I cannot access the central AC unit
3 I cannot find the nameplate on the central AC unit
4 Other, specify: [RECORD]

[IF B11_cc# = 0, Go back to B8_cc#]
[END LOOP]

1.3 SPACE HEATING

E0 Do you pay to heat your home?

1 Yes
2 No, it is part of my rent/condo fee
3 No, do not have a heating system

[IF E0 = "No, it is part of my rent/condo fee", SKIP TO F0]

[IF E0 = "No, do not have a heating system" SKIP TO F0]

E3 [SHOW IF PRIMARY:] What is the PRIMARY heating system in your home? The most common types of heating systems are furnaces, air-source heat pumps, ground-source heat pumps, ductless heat pumps, boilers, baseboard heaters, and portable space heaters.

[SHOW IF SECONDARY:] Do you have SECONDARY heating system(s)? If so, please indicate the type(s). The most common types of heating systems are furnaces, air-source heat pumps, ground-source heat pumps, ductless heat pumps, boilers, baseboard heaters, and portable space heaters.
[Show: Radio button allowing a single choice for Primary. Show multi-select check box to allow multiple selections for Secondary]

	1. Primary	2. Secondary
a. Forced air furnace		
d. Air-source central heat pump		
f. Ground-source heat pump		
e. Ductless heat pump		
b. Boiler (hot water or steam)		
c. Electric baseboard heaters		
h. Other, Specify: [RECORD] (exclude portable space heaters)		

[ASK IF E3_primary = a, b, h]

E1 What is the primary fuel source used to heat your home?

1 Natural gas
2 Electricity
3 Oil
4 Propane
5 Other, specify: [OPEN]

[IF E3_primary = c, d, e, f THEN set primary_heat = "Electricity",
ELSE Set primary_heat = <E1_response>]

[IF primary_heat <> Electricity THEN SKIP TO F0]

E4 How old is your primary heating system?

1 Less than 5 years
2 5-13 years
3 14-27 years

4 Over 27 years
98 Don't know

E6 When was the last time you or somebody else performed maintenance on your primary heating system?

1 Within the past year
2 1-2 years ago
3 3-4 years ago
4 4-5 years ago
5 More than 5 years ago
98 Don't know

[IF primary_heat <> Electricity, SKIP TO F0]

[ASK IF E3_Primary = d. Air source central heat pump
OR E3_Primary = e. Ductless Heat pump, ELSE SKIP TO F0]

[IF (B2_Primary or B2_Secondary = a. forced air split system AND E3_Primary = d. air source central heat pump)
OR (B2_Primary or B2_Secondary = c. ductless system AND E3_Primary = e. Ductless Heat Pump)
THEN SKIP TO F0]

E8 We now need you to take a photo of the model information on the nameplate on your heat pump unit. The nameplate is a sticker or metal badge that contains the make/model information and is located on the outside of the unit or on the inside of the access door.

1 Ready to take photo
2 I am not able to take a photo

[ASK IF E8 = 1]

E9 Are there barcodes included on the nameplate?

1 Yes
2 No

[ASK IF E9= Yes]

E10 Take a photo of the barcode(s) found on the nameplate:

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
    - Avoid taking the photo at an angle

- Make sure the barcode is clear and in focus

3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed
   [TAKE PHOTO]

[ASK IF E8 = 1]

E11 Take a photo of the model number name found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN E10] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR E11]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed
   [TAKE PHOTO]

[ASK IF E8 = 2]

E12 Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the nameplate on your heat pump system.

0 I changed my mind, I will take a photo of the nameplate
1 I don't know where the heat pump is located
2 I cannot access to the heat pump
3 I cannot find the nameplate on the heat pump
4 Other, specify: [RECORD]

[IF E12 = 0, Go back to E9]

1.4 WATER HEATING

F0 Do you pay for hot water at your residence?

1 Yes
2 No, it is part of my rent/condo fee

[SKIP TO D1, IF F0 <> "Yes"]

F2 What fuel does your primary water heater use? The most common fuels used for water heating are natural gas, electricity, propane, oil, and solar.

1 Natural gas
2 Electric
3 Propane
4 Oil
5 Solar
6 Other, specify: [RECORD]
98 Don't know

[SKIP TO D1, IF F2 <> "Electric"]

F3 What is the typical temperature setting of your water heater?

1 Low (below 130F)
2 Medium (130-150F; standard factory setting)
3 High (over 150F)

F4 How old is your water heater?

1 Less than 5 years
2 5-15 years
3 More than 15 years
98 Don't know

F6 What type of water heater does your home use? The most common types are types of water heaters are conventional storage, heat pump storage, indirect storage, tankless, and tankless coil.

[ONLY SHOW Indirect storage IF E3_primary OR E3_secondary = a. forced air furnace OR b. boiler]
[ONLY SHOW Tankless Coil IF E3_primary OR E3_secondary = a. forced air furnace OR b. boiler]

1 Conventional storage
2 Heat pump storage
3 [SHOW IF E3_primary OR E3_secondary = a. forced air furnace OR b. boiler] Indirect storage *(combined with furnace or boiler)*

4 Tankless

5 [SHOW IF E3_primary OR E3_secondary = a. forced air furnace OR b. boiler] Tankless coil *(combined with furnace or boiler)*

98 Don't know

[Ask IF F6 <> 4 or 5, ELSE SKIP TO F9]

F7 Does your water heater tank have an added insulation blanket or tank wrap?

1 Yes

2 No

98 Don't know

[ASK IF F7 = Yes]

F7a Please take a photo of the tank insulation on your primary water heater. *(Please try to capture the full height and width of the tank in the photo)*

[TAKE PHOTO]

[ASK IF F6 <>98, ELSE SKIP TO F14]

F9 Now we will need you to take a picture of the model information on the nameplate found on your primary water heater. The nameplate is a sticker or metal badge that contains the make/model information and is located on the outside of the unit. If you have a storage water heater, the nameplate may be covered by insulation.

1 Ready to take photo

2 I am not able to take a photo

[ASK IF F9 = 1]

F10 Are there barcodes included on the nameplate?

1 Yes

2 No

[ASK IF F10= Yes]

F11 Take a photo of the barcode(s) found on the nameplate:

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF F9 = Ready to take photo]

F12 Take a photo of the model number found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN F11] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR F12]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF F9 = I am not able to take a photo]

F13 Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the water heater nameplate.

0 I changed my mind, I will take a photo of the nameplate
1 I don't know where my primary water heater is located
2 I cannot have access my primary water heater
3 I cannot find the nameplate on my primary water heater
4 The nameplate is covered by insulation
5 Other, specify: [RECORD]

[IF F13 = 0, Go back to F10]

F14 Are the water pipes that carry hot water from your water heater to your hot water fixtures insulated?

1 Yes
2 No
98 Don't know

[ASK IF F14 = Yes]

F14a Please take a photo of the pipe insulation near your water heater.

[TAKE PHOTO]

1.5 LAUNDRY

G1a How many clothes washers do you have in your home?

0 0
1 1
2 2
3 3 or more

[IF G1a = 0 SKIP TO G1b]

[ASK IF G1a = 1]

G1aa_single Is the clothes washer ATTACHED to a clothes dryer as part of a single washer/dryer unit?

1 Yes
2 No

[ASK IF G1a >1]

G1aa_multi Are any of the <G1a response> clothes washers ATTACHED to a clothes dryer as part of a single washer/dryer unit? If yes, indicate the number of clothes washer units configured in this way.

0 No, 0
1 1
2 2
3 3 or more [SHOW IF G1a = 3]

[IF G1a=0 THEN SET NUM_COMBO = 0
IF G1a=1 & G1aa_single = Yes THEN SET NUM_COMBO = 1
IF G1a=1 & G1aa_single = No THEN SET NUM_COMBO = 0
IF G1a>1 THEN SET NUM_COMBO = G1aa_multi]

[Loop through (G2_cw#-G10_cw#) for each clothes washer per answer to G1a, up to 3]

Please answer a few characteristic questions regarding each clothes washer in your home

G2_cw# Clothes washer <#> is a…

0 Top loading washer
1 Front loading washer

G3_cw# How old is clothes washer <#>?

2 Less than 2 years
3 2-4 years
4 5-12 years

5 13-15 years
98 16 years or more
99 Don't Know

G4_cw# How large is clothes washer <#>?
1 Compact
2 Standard
98 Don't know

G6_cw# We now need you to take a photo of the model information on the nameplate on your clothes washer <#>. The nameplate is a sticker or metal badge that contains the make/model information. Tap on the legends below for guidance on where to find the nameplate on your clothes washer. [SHOW IF NUM_COMBO>0: In washer/dryer single units, the nameplate may be found on the dryer only]

[SHOW IF G2_cw# = Top Loading Washer]

A | B | C | D

[SHOW IF G2_cw# = Front Loading Washer]

A | B | C | D

Would you like to…

1 Ready to take photo

3 I am not able to take a photo

[ASK IF G6_cw# = 1]

G7_cw# Are there barcodes included on the nameplate?

1 Yes

2 No

[ASK IF G7_cw#= Yes]

G8_cw# Take a photo of the barcode(s) found on the clothes washer nameplate:

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF G6_cw# = 1]

G9_cw# Take a photo of the model number found on the clothes washer nameplate:

- [SHOW IF UPLOADED PHOTO IN G8_cw#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR G9_cw#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch

2) Take the photo as close as possible while still capturing the entire model number
    - Avoid taking the photo at an angle
    - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF G6_cw# = 3]

G10_cw# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of clothes washer <#> nameplate.

0 I changed my mind, I will take a photo of the nameplate
1 I don't know where clothes washer <#> is located
2 I cannot access clothes washer <#>
3 I cannot find the nameplate on clothes washer <#>
4 Other, specify: [RECORD]

[IF G10_cw# = 0, Go back to G7_cw#]
[END LOOP]

G1b

[SHOW IF NUM_COMBO = 0] How many clothes dryers do you have in your home?
[SHOW IF NUM_COMBO >0] How many clothes dryers do you have in your home that are NOT ATTACHED to clothes washers?

0 0
1 1
2 2
3 3 or more

[IF G1b = 0 SKIP TO T1]
[Loop through (G11_cd#-G18_cd#) for each clothes dryer per answer to G1b, up to 3]
[SHOW IF NUM_COMBO>0] Please answer some questions about DETACHED clothes dryer <#>.

G11_cd# Clothes dryer <#> is a…

1 Electric dryer
2 Natural gas dryer
3 Bottled gas dryer (propane, butane, LPG)

[ASK IF G11_cd# = "Electric dryer" ELSE SKIP LOOP TO NEXT Clothes dryer or SKIP TO T1]]

G12_cd# How old is clothes dryer <#>?

1 Less than 5 years

2 5 years or more

98 Don't know

G14_cd# We now need you to take a photo of the model information on the nameplate on your clothes dryer <#>. The nameplate is a sticker or metal badge that contains the make/model information. Tap on the legend below for guidance on where to find the nameplate on your clothes dryer.

A | B | C | D

Would you like to…

1 Ready to take photo

3 I am not able to take a photo

[ASK IF G14_cd# = 1]

G15_cd# Are there barcodes included on the clothes dryer nameplate?

1 Yes

2 No

[ASK IF G15_cd#= Yes]

G16_cd# Take a photo of the barcode(s) found on the clothes dryer nameplate.

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
    - Avoid taking the photo at an angle

- Make sure the barcode is clear and in focus

3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF G14_cd# = 1]

G17_cd# Take a photo of the model number found on the clothes dryer nameplate:

- [SHOW IF UPLOADED PHOTO IN G16_cd#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR G17_cd#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF G14_cd# = 3]

G18_cd# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the clothes dryer <#> nameplate.

0 I changed my mind, I will take a photo of the nameplate
1 I don't know where clothes dryer <#> is located
2 I cannot access clothes dryer <#>
3 I cannot find the nameplate on clothes dryer <#>
4 Other, specify: [RECORD]

[IF G18_cd# = 0, Go back to G15_cd#]

1.6 THERMOSTATS

[ASK IF B0 = Yes or E0 = Yes, ELSE SKIP TO D1]

T1 What type of thermostat do you use in your home? The main types of thermostats are communicating, programmable, and standard.

1 Communicating thermostat
2 Programmable (non-communicating) thermostat
3 Standard thermostat
4 No thermostat

[ASK IF T1 = 1 or 2, ELSE SKIP TO D1]

T2 Does your thermostat have any of the following capabilities? *(Select all that apply)* [multi-select]

1 No [IF SELECT NO, do not allow selection of other options]
2 Occupancy/activity detection
3 Geo-fencing on a mobile device to determine arrival & departure to your home
4 Optimized schedule based on your historical, or population-specific, trends
5 Automatic response to weather data and forecasts

T3 Is your thermostat currently programmed with a set temperature schedule [IF T2<> No, THEN SHOW: or with other advanced features]?

[IF T2 <> No, THEN Multi-SELECT. ELSE SINGLE SELECT]

[IF T2<> No, THEN SHOW: (Select all that apply)]

1 Yes, set temperature schedule
2 Yes, with occupancy/activity detection [SHOW IF T2 = 2]
3 Yes, with geo-fencing [SHOW IF T2 = 3]
4 Yes, with optimized schedule based on historical, or population specific, trends [SHOW IF T2 = 4]
5 Yes, with automatic response to weather data and forecasts [SHOW IF T2 = 5]
6 No [IF SELECT NO, do not allow selection of other options]

[ASK IF T3 = 1]

T4 Do you have different temperature settings for certain periods (e.g., weekend, daytime, or nighttime)?

1 Yes
2 No

[ASK IF T3 <> No]

T5 How often do you manually override the programmed temperature of your thermostat?

1 Frequently *(At least once a day)*
2 Regularly *(3-5 times a week)*
3 Occasionally *(1-2 times a week)*
4 Rarely *(1-2 times a month)*
5 Never

[ASK IF T5<> Never]

T6 Select the primary reason why you manually override the programmed temperature of your thermostat.

1 Someone is at home at an unexpected time of day
2 My home is empty at an unexpected time of day
3 My home is not a comfortable temperature
4 Other, specify: [RECORD]

[ASK IF T2 = 2 or 3]

T7 Have you enabled your thermostat to detect when you are in your home and allow it to override any previously set temperature schedule?

1 Yes
2 No
3 I am not aware of this capability on my thermostat

[ASK IF T2 = 3 or 4]

T8 Have you enabled your thermostat to automatically bring your home to a desired temperature when it senses you are on your way home?

1 Yes
2 No
3 I am not aware of this capability on my thermostat

1.7 INSULATION AND VENTILATION

D1 Have you had any insulation work completed in your home in the last 5 years? *(Include new insulation and any upgrades to existing insulation)*

1 Yes
2 No
98 Don't know

[ASK IF D1 = Yes]

D2 In which areas of your home was insulation work completed? *(Select all that apply)* [multi-select]

1 Attic
2 Floors
3 Exterior walls – between living space and unheated garages, shed roofs, or storage areas
4 Exterior walls – foundation walls in heated basements or above ground level
5 Other, specify: [OPEN]

[ASK IF E3_primary = (a. forced air furnace OR d. air source central heat pump OR f. ground source heat pump)
OR E3_secondary = (a. forced air furnace OR d. air source central heat pump OR f. ground source heat pump)
OR B2_Primary = (a. forced air split system or b. Ground source heat pump)
OR B2_secondary = (a. forced air split system or b. Ground source heat pump)]

D3 Have you had any work done to test and seal air leaks in your **ventilation system** within the last 5 years? *(Include any work done to seal leaks, fix holes, or connect poorly connected ducts in your home)*

1 Yes
2 No
98 Don't know

D4 Did you have any work done to test and seal air leaks from your **windows and exterior doors** within the last 5 years? *(Include any work done to install weather stripping, door gaskets, caulking, or foam sealant)*

1 Yes
2 No
98 Don't know

D5 Do you use any of the following fans to cool your home in summer months? *(Check all that apply)* [multi-select]

1 Whole-house or attic fan
2 Ceiling fan
3 Window fan
4 Portable fan
5 No

D6 Choose the statement that best describes the windows in your home.

1 All or most are single pane
2 All or most are double pane
3 All or most are triple pane
4 Mixture of single, double, triple pane

1.8 ROOM BY ROOM

[SHOW FOR 1st ROOM ONLY: We will now begin a walk-through tour of your home starting in your [IF A4c >1 show: MAIN] KITCHEN. As you enter each room of your home, continue filling out the survey. Enter information about each room as you move through your home.

Let's get started.]

[SHOW FOR ALL ROOMS AFTER 1st: Let's move into the next room.]

[Loop through R1 through Ar12 (sections 1.6.1 through 1.6.8) , until all rooms have been visited]
[Throughout this room-by-room loop, append room # at the end of the question #. For instance, R1 becomes R1_room1, R1_room2, R1_room3, etc. Similarly, K10 becomes K10_room1, K10_room2, K10_room3, etc.]

[IF 1st ROOM ASK R_First, ELSE ASK R1]
R_First

1 I am in the kitchen and ready to continue [THIS MUST BE SELECTED TO ADVANCE]

[IF 1st ROOM THEN Set <R1 Response>= Kitchen, SKIP TO R2]

[Show response options to R1 based on responses from A4 and rooms already visited. As visit the # of rooms indicated in A4 reduce the options shown in R1. E.g., if 2 bedrooms were indicated in R1, after 2 bedrooms were visited through the R1 room-by-room loop, remove "Bedroom" as an option from R1]

R1 What type of room are you in now?

1 Bathroom
2 Bedroom
3 Kitchen
4 Living/Family Room
5 Office/Den
6 Dining
7 Garage [SHOW IF A9="yes"]
8 Basement [SHOW IF A5<>"no basement"]
9 Other indoor space [RECORD]

R2 Does the <R1 Response> have:

[SHOW: Radio-button allowing a single selection for each row]

	1. Yes	2. No

Light bulbs in sockets *(including free standing lamps, ceiling fixtures, and recessed ceiling fixtures)*		
Refrigeration equipment *(refrigerators, freezers)* [DON'T SHOW IF R1 = Bathroom or Bedroom]		
Kitchen/cooking appliances [DON'T SHOW IF R1 = Bathroom or Bedroom]		
Room heating, cooling, or air quality equipment *(portable space heaters, room AC, humidifiers, dehumidifiers, air purifiers)*		
Water fixtures *(sinks, showers, toilets)*		

Refrigeration

[Ask if R2b =Yes, ELSE SKIP TO K1]

H1a How many **refrigerators** does this <R1 Response> have?

0 0
1 1
2 2
3 3 or more

[IF H1a = 0 then SKIP TO H1b]

[Loop through (H2_rf#-H14_rf#) for each refrigerator per answer to H1a, up to 3]

Please answer a few questions regarding the general characteristics of each refrigerator in your <R1 Response>

H2_rf# Refrigerator <#>

How old is this refrigerator?

1 Less than 6 years
2 6 to 18 years
3 19 or more years
98 Don't know

H3_rf# How many months per year is refrigerator <#> **unplugged**?

0 It is always plugged in
1 Less than 1 month
2 1-3 months
3 3-5 months

4 Over 5 months

H4_rf# What is the door-style of refrigerator <#>?

1 Single door
2 Top freezer - bottom refrigerator
3 Top refrigerator - bottom freezer
4 Side-by-side (refrigerator/freezer)

H5_rf# What is the approximate size of refrigerator <#>?

1 Compact
2 Small
3 Medium
4 Large
5 Very large
98 Don't know

H6_rf# How does refrigerator <#> defrost?

1 Automatic defrost (frost-free)
2 Manual defrost
98 Don't know

H7_rf# Does refrigerator <#> have a through-the-door ice and water dispenser?

1 Yes
2 No

H8_rf# Is refrigerator <#> freestanding or is it built-in?

1 Freestanding refrigerator
2 Built-in refrigerator
98 Don't know

H10_rf# We now need you to take a photo of the model information on the nameplate on your refrigerator <#>. The nameplate is a sticker or metal badge that contains the make/model information. Tap on the legend below for guidance on where to find the nameplate on your refrigerator.

A | B | C | D

Would you like to…

1 Ready to take photo

3 I am not able to take a photo

[ASK IF H10_rf# = 1]

H11_rf# Are there barcodes included on the nameplate?

1 Yes

2 No

[ASK IF H11_rf#= Yes]

H12_rf# Take a photo of the barcode(s) found on the nameplate:

1) Tap “BROWSE” or “CHOOSE FILE” (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap “UPLOAD”
4) Wait until upload is complete and tap “NEXT” when instructed

[TAKE PHOTO]

[ASK IF H10_rf# = 1]

H13_rf# Take a photo of the model number found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN H12_rf#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR H13_rf#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF H10_rf# = 3]

H14_rf# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the refrigerator <#> nameplate.

0 I changed my mind, I will take a photo of the nameplate
2 I cannot access refrigerator <#>
3 I cannot find the nameplate on refrigerator <#>
4 Other, specify: [RECORD]

[IF H14_rf# = 0, Go back to H11_rf#]
[END LOOP]

H1b How many **stand-alone freezers** does this <R1 Response> have?

0 0
1 1
2 2
3 3 or more

[If H1b = 0 SKIP TO K1]
[Loop through (H15_fz#-H24_fz#) for each freezer per answer to H1b, up to 3]
Please answer a few questions regarding the general characteristics each freezer in <R1 Response>

H15_fz# How old is freezer <#>?

1 Less than 6 years
2 6 to 18 years
3 19 or more years
98 Don't know

H16_fz# How many months per year is the freezer <#> unplugged?
0 0, it is always plugged in
1 Less than 1 month
2 1-3 months
3 3-5 months
4 Over 5 months

H17_fz# Indicate the style of freezer <#> …
1 Upright, frost-free (automatic defrost)
2 Upright, manual defrost
3 Chest
98 Don't know

H18_fz# What is the approximate size of freezer <#>?
1 Compact
2 Small
3 Medium
4 Large
98 Don't know

H20_fz# We now need you to take a photo of the model information on the nameplate on your freezer <#> . The nameplate is a sticker or metal badge that contains the make/model information. Tap on the legend below for guidance on where to find the nameplate on your freezer.

A | B | C

Would you like to…

1 Ready to take photo

3 I am not able to take a photo

[ASK IF H20_fz# = 1]

H21_fz# Are there barcodes included on the nameplate?

1 Yes

2 No

[ASK IF H21_fz#= Yes]

H22_fz# Take a photo of the barcode(s) found on the nameplate:

1) Tap “BROWSE” or “CHOOSE FILE” (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap “UPLOAD”
4) Wait until upload is complete and tap “NEXT” when instructed

[TAKE PHOTO]

[ASK IF H20_fz# = 1]

H23_fz# Take a photo of the model number found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN H22_fz#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR H23_fz#]

1) Tap “BROWSE” or “CHOOSE FILE” (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
    - Avoid taking the photo at an angle
    - Make sure the model number is clear and in focus
3) After taking the photo, tap “UPLOAD”
4) Wait until upload is complete and tap “NEXT” when instructed

[TAKE PHOTO]

[ASK IF H20_fz# = 3]

H24_fz# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the freezer <#> nameplate.

0 I changed my mind, I will take a photo of the nameplate
2 I cannot access freezer <#>
3 I cannot find the nameplate on freezer <#>
4 Other, specify: [RECORD]

[IF H24_fz# = 0, Go back to H21_fz#]
[END LOOP]

1.8.1 Food Preparation

[Ask if R2c =Yes, ELSE SKIP TO c1]

K1a How many DISHWASHERS does this <R1 Response> have?

0 0
1 1
2 2
3 3 or more

[IF K1a = 0 SKIP TO K1b]
[Loop through (K2_dw#-K9_dw#) for each dishwasher per answer to K1a, up to 3]

Please answer a few questions regarding the general characteristics each dishwasher in <R1 Response>

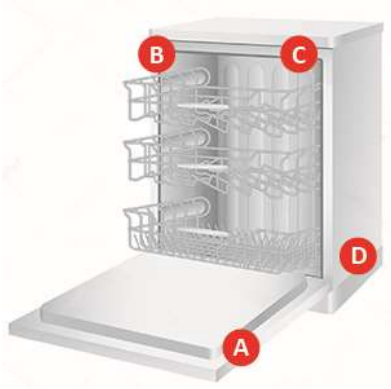
K2_dw# How old is dishwasher <#>?

1 Less than 6 years
2 6-8 years
3 9 years or more
98 Don't know

K3_dw# What size is dishwasher <#>?

1 Compact
2 Standard
98 Don't know

K5_dw# We now need you to take a photo of the model information on the nameplate on your dishwasher <#>. The nameplate is a sticker or metal badge that contains the make/model information. Tap on the legend below for guidance on where to find the nameplate on your dishwasher.



A | B | C | D

Would you like to…

1 Ready to take photo
3 I am not able to take a photo

[ASK IF K5_dw# = 1]

K6_dw# Are there barcodes included on the nameplate?

1 Yes
2 No

[ASK IF K6_dw#= Yes]

K7_dw# Take a photo of the barcode(s) found on the nameplate:

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
    - Avoid taking the photo at an angle

- Make sure the barcode is clear and in focus

3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF K5_dw# = 1]

K8_dw# Take a photo of the model number found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN K7_dw#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR k8_dw#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

[TAKE PHOTO]

[ASK IF K5_dw# = 3]

K9_dw# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of the dishwasher <#> nameplate.

0 I changed my mind, I will take a photo of the nameplate
2 I cannot access dishwasher <#>
3 I cannot find the nameplate on dishwasher <#>
4 Other, specify: [RECORD]

[IF K9_dw# = 0, Go back to K6_dw#]
[END LOOP]

K1b How many **cooktops**, **stovetops**, or **ranges** does this <R1 Response> have?

0 0
1 1
2 2
3 3 or more

[ASK IF K1b=1]

K10aa Is the **cooktop** in this room **electric**?

1 Yes

2 No

[ASK IF K1b>1]

K10ab Of the <K1b> **cooktops** in this room, how many are **electric**?

0 0

1 1

2 2 [SHOW IF K1b >1]

3 3 or more[SHOW IF K1b >2]

K1c How many **ovens** does this <R1 Response> have?

0 0

1 1

2 2

3 3 or more

[ASK IF K1c=1]

K10ba Is the **oven** in this room **electric**?

1 Yes

2 No

[ASK IF K1c>1]

K10bb Of the <K1c> **ovens** in this room, how many are **electric**?

0 0

1 1

2 2 [SHOW IF K1c >1]

3 3 or more [SHOW IF K1c >2]

K1d How many **microwaves** does this <R1 Response> have?

0 0

1 1

2 2

3 3 or more

K11. Is there a **ventilation/exhaust fan** in this <R1 Response>?

1 Yes
2 No

1.8.2 Room HVAC

[ASK IF R2f = Yes, ELSE SKIP TO J1]

C1 How many of each of the following does this <R1 Response> have:

(If 0, leave blank)

a Room air conditioner *(window/portable/through-the-wall)* [RECORD]
b Portable **electric** space heater [RECORD]
c Air purifier/cleaner [RECORD]
d Dehumidifier [RECORD]
e Humidifier [RECORD]

[ASK IF C1b>0]

C2 How often do you **use** the electric portable space heater(s) during the heating season?

[SHOW: radio buttons that allow a single selection across the row]

[SHOW: # of rows that correspond to the # entered in C1b]

	0. Never	1. Rarely (Once a month)	2. Sometimes (once per week)	3. Often (2 to 4 days per week)	4. Always (5 to 7 days per week)
b_1. Portable electric space heater 1					
b_2. Portable electric space heater 2					
b_3. Portable electric space heater 3					

[IF C1d>0 or C1c>0]

C3 How many months per year are the following technologies **unplugged**:

[SHOW: radio buttons that allow a single selection across the row]

[SHOW: # of rows that correspond to the # entered in C1c and C1d, respectively]

	0. 0, always plugged in	1. Less than 1 month	2. 1-3 months	3. 3-5 months	4. 6-8 months	5. 9-12 months

c_1. Air purifier/cleaner 1						
c_2. Air purifier/cleaner 2						
c_3. Air purifier/cleaner 3						
d_1. dehumidifier 1						
d_2. dehumidifier 2						
d_3. dehumidifier 3						

[IF C1a = 0 SKIP TO J1]
[Loop through (C4_rc#-C13_rc#) for each room ac per answer to c1a, up to 6]

C5_rc# What type of room air conditioner do you have <#>? The most common types are window units, portable units, and through-the-wall units.

1 Window air conditioner or heat pump
2 Portable air conditioner or heat pump
3 Through-the-wall air conditioner or heat pump
4 Other, specify: [RECORD]

C6_rc# How old is room cooling unit <#>?

1 Less than 6 years
2 6-18 years
3 19 years or older
98 Don't know

C8_rc# How often is room cooling unit <#> turned on during the cooling season?

1 Never
2 Rarely (1-2 days per week)
3 Sometimes (3-4 days per week)
4 Often (5-6 days per week)
5 Always (7 days per week)

[ASK IF C5_rc# = 1 or 2, ELSE SKIP TO J1 (or C5_rc# if there are more #)]
C9_rc# We now need you to take a photo of the model information on the nameplate on your room cooling unit <#>. The nameplate is a sticker or metal badge that contains the make/model information. The name plate can be found on the inside of the access door.

Would you like to…

1 Ready to take photo

3 I am not able to take a photo

[ASK IF C9_rc# = 1]

C10_rc# Are there barcodes included on the nameplate?

1 Yes

2 No

[ASK IF C10_rc# = Yes]

C11_rc# Take a photo of the barcode(s) found on the nameplate:

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire barcode
   - Avoid taking the photo at an angle
   - Make sure the barcode is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

   [TAKE PHOTO]

[ASK IF C9_rc# = 1]

C12_rc# Take a photo of the model number found on the nameplate:

- [SHOW IF UPLOADED PHOTO IN C11_rc#] [CHECK BOX] Previous image already contains the model number [IF CHECKED, DO NOT REQUIRE PHOTO UPLOAD FOR C12_rc#]

1) Tap "BROWSE" or "CHOOSE FILE" (depending on your browser) and your camera will launch
2) Take the photo as close as possible while still capturing the entire model number
   - Avoid taking the photo at an angle
   - Make sure the model number is clear and in focus
3) After taking the photo, tap "UPLOAD"
4) Wait until upload is complete and tap "NEXT" when instructed

   [TAKE PHOTO]

[ASK IF C9_rc# = 3]

C13_rc# Getting photos of equipment model numbers is a critical aspect of this research, but we understand that it may not always be possible. Please select the reason why you are unable to take a photo of room cooling unit <#>.

2 I changed my mind, I will take a photo of the nameplate
6 I cannot access room cooling unit <#>
7 I cannot find the nameplate on room cooling unit <#>
8 Other, specify: [RECORD]

[IF C13_rc# = 0, Go back to C10_rc#]
[END LOOP]

1.8.3 Lighting

[Ask if R2a =Yes, ELSE SKIP TO L1]

J1 How many light bulbs are in sockets in the <R1 Response>? *(Include all light bulbs that can be turned on. Including those in free standing lamps, ceiling fixtures, and recessed ceiling lighting)*
[Record #]

[IF J1 = 0 SKIP TO L1]

J2 What kind of light bulbs are installed in this room? The most common types of indoor lights are LEDs, CFLs, incandescent, fluorescent tubes, halogens, and infrared. *(Select all the apply)*

[multi-select] [IF J1 =1, only allow a single-selection]

1 LED
2 CFL
3 Incandescent
4 Fluorescent Tube
5 Halogen
6 Infrared (i.e., Heat Lamp)
7 Other
98 Don't know

[ASK IF more than 1 choice selected for J2, ELSE SKIP TO J4]
[Allow blanks, treat as 0]

J3 How MANY of the <J1 Response> light bulbs are:

a [SHOW IF J2 =1] LED [RECORD #]

b [SHOW IF J2 =2] CFL [RECORD #]
c [SHOW IF J2 =3] Incandescent [RECORD #]
d [SHOW IF J2 =4] Fluorescent tube [RECORD #]
e [SHOW IF J2 =5] Halogen [RECORD #]
f [SHOW IF J2 =6] Infrared (i.e., heat lamp) [RECORD #]
g [SHOW IF J2 =7] Other [RECORD #]
h [SHOW IF J2 =98] Don't know [RECORD #]

[CHECK SUM(J3[x])=J1 Response]

[IF more than 1 choice selected for J2, THEN SET:
COUNT_LED = J3a, COUNT_CFL=J3b, COUNT_INC=J3c, COUNT_FLU=J3d, COUNT_HAL=J3e, COUNT_INF = J3f, COUNT_OTH = J3g, COUNT_DKN = J3h
ELSE IF only 1 choice was selected for J2, THEN SET:
COUNT_<AAA> = J1
COUNT_<XYZ> = 0
Where <AAA> corresponds to selection in J2 and XYZ corresponds to all options not selected in J2]

[LOOP THROUGH J4_<code> and J5_<code> for each of the 6 following (code, text) pairs = {(LED, LED), (CFL, CFL), (INC, INCANDESCENT), (HAL, HALOGEN), (OTH, OTHER TECHNOLOGY), (DKN, DON'T KNOW TECHNOLOGY)}]
[ASK IF COUNT_<code> is GREATER THAN 0]
J4_<code> How many of the <COUNT_<CODE>> <text> bulbs in this room are standard shape?

0 0
1 1
2 2 [SHOW IF COUNT_<CODE> IS GREATER THAN 1]
3 3 [SHOW IF COUNT_<CODE> IS GREATER THAN 2]
4 4 [SHOW IF COUNT_<CODE> IS GREATER THAN 3]
5 5 [SHOW IF COUNT_<CODE> IS GREATER THAN 4]
6 6 [SHOW IF COUNT_<CODE> IS GREATER THAN 5]
7 7 [SHOW IF COUNT_<CODE> IS GREATER THAN 6]
8 8 [SHOW IF COUNT_<CODE> IS GREATER THAN 7]
9 9 [SHOW IF COUNT_<CODE> IS GREATER THAN 8]
10 10 [SHOW IF COUNT_<CODE> IS GREATER THAN 9]
11 11 [SHOW IF COUNT_<CODE> IS GREATER THAN 10]
12 12 [SHOW IF COUNT_<CODE> IS GREATER THAN 11]
13 13 [SHOW IF COUNT_<CODE> IS GREATER THAN 12]
14 14 [SHOW IF COUNT_<CODE> IS GREATER THAN 13]
15 15 [SHOW IF COUNT_<CODE> IS GREATER THAN 14]

16 16 [SHOW IF COUNT_<CODE> IS GREATER THAN 15]
17 17 [SHOW IF COUNT_<CODE> IS GREATER THAN 16]
18 18 [SHOW IF COUNT_<CODE> IS GREATER THAN 17]
19 19 [SHOW IF COUNT_<CODE> IS GREATER THAN 18]
20 20 [SHOW IF COUNT_<CODE> IS GREATER THAN 19]
997 More than 20, specify: [RECORD #] [SHOW IF COUNT_<CODE> IS GREATER THAN 20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO COUNT_<CODE>]
998 Don't know

[SET COUNT_<CODE>_STANDARD = J4_<code>
IF J4_<code> = 998 THEN SET COUNT_<CODE>_STANDARD = 0
IF J4_<code> = 997 THEN SET COUNT_<CODE>_STANDARD = <J4 RECORDED_RESPONSE>]

[SET COUNT_<CODE>_Remaining = COUNT_<CODE> - COUNT_<CODE>_STANDARD]

[ASK J5_<code> IF COUNT_<CODE> IS GREATER THAN COUNT_<CODE>_STANDARD]

J5_<code> How many of the <COUNT_<CODE>_Remaining> <text> bulbs remaining in this room are reflectors?

0 0
1 1
2 2 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 1]
3 3 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 2]
4 4 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 3]
5 5 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 4]
6 6 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 5]
7 7 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 6]
8 8 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 7]
9 9 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 8]
10 10 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 9]
11 11 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 10]
12 12 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 11]
13 13 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 12]
14 14 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 13]
15 15 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 14]
16 16 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 15]
17 17 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 16]
18 18 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 17]

19 19 [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 18]
20 20 or more [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 19]
997 More than 20, specify: [RECORD #] [SHOW IF COUNT_<CODE>_Remaining IS GREATER THAN 20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO COUNT_<CODE>_Remaining]
998 Don't know

[LOOP TO NEXT <CODE>]

1.8.4 Water Related Equipment

[ASK IF R2g = Yes, ELSE SKIP TO AR1]

L1 How many of each of the following does this <R1 Response> have:

a Faucet [RECORD #]

b Showerhead [RECORD #] [ASK IF R1 <> Kitchen or Bedroom]

[ASK IF L1a > 0]

L2 What is the number of faucets with water-saving faucet aerators in the room?

0 0
1 1
2 2 [SHOW IF L1a > 1]
3 3 [SHOW IF L1a > 2]
4 4 [SHOW IF L1a > 3]
5 5 or more [SHOW IF L1a > 4]
98 Don't Know

[ASK IF L1b>0 AND R1 <> "Kitchen" or bedroom]

L3 What is the number of showerheads with water-saving showerheads in the room?

0 0
1 1
2 2 [SHOW IF L1b > 1]
3 3 [SHOW IF L1b > 2]
4 4 [SHOW IF L1b > 3]
5 5 or more [SHOW IF L1b > 4]
98 Don't Know

[ASK IF R1 <> “Kitchen”]

L4 Does this room have a ventilation fan?

3 Yes

4 No

98 Don't know

1.8.5 Additional Rooms

[IF # rooms visited so far is less than TOTAL_ROOMS, then BEGIN LOOP AGAIN AT R1]

Ar1 Are there any additional rooms in this home?

1 Yes

2 No

[IF Ar1 = Yes, BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4b > sum(R1 == bathroom)]

Ar2 You reported <A4b_Response> bathrooms, but only visited <sum(R1 == bathroom)>. Have you visited all bathrooms in your home?

1 Yes

2 No

[ASK IF AR2 = NO]

Ar2a Continue the tour through your home. Please visit the next bathroom.

1 Ok

2 I am not able to visit the remaining bathroom(s) in this home.

[IF Ar2a= "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar2a = 2]

Ar2b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next bathroom

[IF Ar2b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4a > sum(R1== bedroom)]

Ar3 You reported <A4a_Response> bedrooms, but only visited <sum(R1==bedroom)>. Have you visited all bedrooms in your home?

1 Yes

2 No

[ASK IF AR3 = NO]

Ar3a Continue the tour through your home. Please visit the next bedroom.

1 Ok

2 I am not able to visit the remaining bedroom(s) in this home

[IF Ar3a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar3a = 2]

Ar3b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next bedroom

[IF Ar3b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4c > sum(R1==kitchen)]

Ar4 You reported <A4c_Response> kitchens, but only visited <sum(R1==kitchen)>. Have you visited all kitchens in your home?

1 Yes

2 No

[ASK IF AR4 = NO]

Ar4a Continue the tour through your home. Please visit the next kitchen.

1 Ok

2 I am not able to visit the remaining kitchen(s) in this home.

[IF Ar4a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar4a = 2]

Ar4b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next kitchen

[IF Ar4b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4d > sum(R1==living/family room)]

Ar5 You reported <A4d_Response> living/family rooms, but only visited <sum(R1==living/family room)>. Have you visited all living/family rooms in your home?

1 Yes

2 No

[ASK IF AR5 = NO]

Ar5a Continue the tour through your home. Please visit the next living/family room.

1 Ok

2 I am not able to visit the remaining living/family room(s) in this home

[IF Ar5a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar5a = 2]

Ar5b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next living/family room

[IF Ar5b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4e > sum(R1==den/office)]

Ar6 You reported <A4e_Response> den/offices, but only visited <sum(R1==den/office)>. Have you visited all den/offices in your home?

1 Yes

2 No

[ASK IF AR6 = NO]

Ar6a Continue the tour through your home. Please visit the next den/office.

1 Ok

2 I am not able to visit the remaining den/office(s) in this home

[IF Ar6a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar6a = 2]

Ar6b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next den/office

[IF Ar6b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A4f > sum(R1==dining room)]

Ar7 You reported <A4f_Response> dining rooms, but only visited <sum(R1==dining room)>. Have you visited all dining rooms in your home?

1 Yes

2 No

[ASK IF AR7 = NO]

Ar7a Continue the tour through your home. Please visit the next dining room.

1 Ok

2 I am not able to visit the remaining dining room(s) in this home

[IF Ar7a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar7a = 2]

Ar7b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the next dining room

[IF Ar7b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A5 <> "No basement" and sum(R1 == basement)=0]

Ar8a You reported a basement in this home but have not visited one yet. Please visit the basement.

1 Ok

2 I am not able to visit the basement in this home

[IF Ar8a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar8a = 2]

Ar8b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the basement

[IF Ar8b = 2 BEGIN LOOP AGAIN AT R1]

[ASK IF AR1 = NO]

[ASK IF A9 ==YES and sum(R1 == garage)=0]

Ar9a You reported a garage in this home but have not visited one yet. Please visit the garage.

1 Ok

2 I am not able to visit the garage in this home

[IF Ar9a = "OK" BEGIN LOOP AGAIN AT R1]

[IF Ar9a = 2]

Ar9b If you do not visit all rooms in your home, you will not receive the full incentive.

1 I understand

2 Continue the tour with the garage

[IF Ar9b = 2 BEGIN LOOP AGAIN AT R1]

[END ROOM BY ROOM LOOP]

1.9 EXTERIOR LIGHTING

N1 Does your home have any outdoor lighting? *(If you live in an apartment or condominium, please answer for any outdoor lighting that you control)*

1 Yes

2 No

[IF N1 = No, SKIP TO NEXT SECTION]

N2 How many light bulbs are in sockets outside your home? *(Include all light bulbs that can be turned on)* [Record #]

[ASK IF N2>0, ELSE SKIP TO I1]

N3 How many of the <N2> exterior bulbs are incandescent OR halogen lamps?

0 0

1 1

2 2 [SHOW IF <N2> IS GREATER THAN 1]

3 3 [SHOW IF <N2> IS GREATER THAN 2]

4 4 [SHOW IF <N2> IS GREATER THAN 3]

5 5 [SHOW IF <N2> IS GREATER THAN 4]

6 6 [SHOW IF <N2> IS GREATER THAN 5]

7 7 [SHOW IF <N2> IS GREATER THAN 6]

8 8 [SHOW IF <N2> IS GREATER THAN 7]

9 9 [SHOW IF <N2> IS GREATER THAN 8]

10 10 [SHOW IF <N2> IS GREATER THAN 9]

11 11 [SHOW IF <N2> IS GREATER THAN 10]

12 12 [SHOW IF <N2> IS GREATER THAN 11]

13 13 [SHOW IF <N2> IS GREATER THAN 12]

14 14 [SHOW IF <N2> IS GREATER THAN 13]
15 15 [SHOW IF <N2> IS GREATER THAN 14]
16 16 [SHOW IF <N2> IS GREATER THAN 15]
17 17 [SHOW IF <N2> IS GREATER THAN 16]
18 18 [SHOW IF <N2> IS GREATER THAN 17]
19 19 [SHOW IF <N2> IS GREATER THAN 18]
20 20 [SHOW IF <N2> IS GREATER THAN 19]
997 More than 20, specify: [RECORD #] [SHOW IF <N2> IS GREATER THAN 20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO <N2>]
998 Don't know

[SET TEMP_EXT_INCHAL = N3
IF N3 = 998 THEN TEMP_EXT_INCHAL = ""
IF N3 = 997 THEN TEMP _EXT_INCHAL = <N3 RECORDED_RESPONSE>]

[ASK IF N3>0 AND N3 <> Don't Know, ELSE SKIP TO I1]

N7 How many of the <TEMP_EXT_INCHAL> exterior incandescent/halogen lamps are controlled by… **timers**?

0 0
1 1
2 2 [SHOW IF TEMP _EXT_INCHAL >1]
3 3 [SHOW IF TEMP _EXT_INCHAL >2]
4 4 [SHOW IF TEMP _EXT_INCHAL >3]
5 5 [SHOW IF TEMP _EXT_INCHAL >4]
6 6 [SHOW IF TEMP _EXT_INCHAL >5]
7 7 [SHOW IF TEMP _EXT_INCHAL >6]
8 8 [SHOW IF TEMP _EXT_INCHAL >7]
9 9 [SHOW IF TEMP _EXT_INCHAL >8]
10 10 [SHOW IF TEMP _EXT_INCHAL >9]
11 11[SHOW IF TEMP _EXT_INCHAL >10]
12 12 [SHOW IF TEMP _EXT_INCHAL >11]
13 13 [SHOW IF TEMP _EXT_INCHAL >12]
14 14 [SHOW IF TEMP _EXT_INCHAL >13]
15 15 [SHOW IF TEMP _EXT_INCHAL >14]
16 16 [SHOW IF TEMP _EXT_INCHAL >15]
17 17 [SHOW IF TEMP _EXT_INCHAL >16]
18 18 [SHOW IF TEMP _EXT_INCHAL >17]

19 19 [SHOW IF TEMP _EXT_INCHAL >18]
20 20 [SHOW IF TEMP _EXT_INCHAL >19]
997 More than 20, specify: [RECORD #] [SHOW IF TEMP _EXT_INCHAL >20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO TEMP _EXT_INCHAL]
998 Don't Know

N8 How many of the < TEMP_EXT_INCHAL> exterior incandescent/halogen lamps are controlled by… **motion sensors**?

0 0
1 1
2 2 [SHOW IF TEMP _EXT_INCHAL >1]
3 3 [SHOW IF TEMP _EXT_INCHAL >2]
4 4 [SHOW IF TEMP _EXT_INCHAL >3]
5 5 [SHOW IF TEMP _EXT_INCHAL >4]
6 6 [SHOW IF TEMP _EXT_INCHAL >5]
7 7 [SHOW IF TEMP _EXT_INCHAL >6]
8 8 [SHOW IF TEMP _EXT_INCHAL >7]
9 9 [SHOW IF TEMP _EXT_INCHAL >8]
10 10 [SHOW IF TEMP _EXT_INCHAL >9]
11 11[SHOW IF TEMP _EXT_INCHAL >10]
12 12 [SHOW IF TEMP _EXT_INCHAL >11]
13 13 [SHOW IF TEMP _EXT_INCHAL >12]
14 14 [SHOW IF TEMP _EXT_INCHAL >13]
15 15 [SHOW IF TEMP _EXT_INCHAL >14]
16 16 [SHOW IF TEMP _EXT_INCHAL >15]
17 17 [SHOW IF TEMP _EXT_INCHAL >16]
18 18 [SHOW IF TEMP _EXT_INCHAL >17]
19 19 [SHOW IF TEMP _EXT_INCHAL >18]
20 20 [SHOW IF TEMP _EXT_INCHAL >19]
997 More than 20, specify: [RECORD #] [SHOW IF TEMP _EXT_INCHAL >20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO TEMP _EXT_INCHAL]
998 Don't Know

N9 How many of the < TEMP_EXT_INCHAL> exterior incandescent/halogen lamps are controlled by… **photocells**?

0 0
1 1
2 2 [SHOW IF TEMP _EXT_INCHAL >1]

3 3 [SHOW IF TEMP _EXT_INCHAL >2]
4 4 [SHOW IF TEMP _EXT_INCHAL >3]
5 5 [SHOW IF TEMP _EXT_INCHAL >4]
6 6 [SHOW IF TEMP _EXT_INCHAL >5]
7 7 [SHOW IF TEMP _EXT_INCHAL >6]
8 8 [SHOW IF TEMP _EXT_INCHAL >7]
9 9 [SHOW IF TEMP _EXT_INCHAL >8]
10 10 [SHOW IF TEMP _EXT_INCHAL >9]
11 11[SHOW IF TEMP _EXT_INCHAL >10]
12 12 [SHOW IF TEMP _EXT_INCHAL >11]
13 13 [SHOW IF TEMP _EXT_INCHAL >12]
14 14 [SHOW IF TEMP _EXT_INCHAL >13]
15 15 [SHOW IF TEMP _EXT_INCHAL >14]
16 16 [SHOW IF TEMP _EXT_INCHAL >15]
17 17 [SHOW IF TEMP _EXT_INCHAL >16]
18 18 [SHOW IF TEMP _EXT_INCHAL >17]
19 19 [SHOW IF TEMP _EXT_INCHAL >18]
20 20 [SHOW IF TEMP _EXT_INCHAL >19]
997 More than 20, specify: [RECORD #] [SHOW IF TEMP _EXT_INCHAL >20] [CHECK RESPONSE IS LESS THAN OR EQUAL TO TEMP _EXT_INCHAL]
998 Don't Know

1.10 ENTERTAINMENT & TECHNOLOGY

I1 Select the type(s) of television you use in your home *(Choose all that apply)* [multi-select]
0 None [IF SELECTED, Don't allow other selections]
1 Projection television
2 LCD - Large *(>50 inches)*
3 LCD - Medium *(30-50 inches)*
4 LCD - Small *(<30 inches)*
5 Plasma - Large *(>50 inches)*
6 Plasma - Medium *(<50 inches)*
7 LED - Large *(>50 inches)*
8 LED - Medium *(30-50 inches)*
9 LED - Small *(<30 inches)*
10 OLED - Large *(>50 inches)*
11 OLED - Medium *(<50 inches)*

[IF I1 = None, SKIP TO I2]

[LOOP I1a_# THROUGH EACH RESPONSE SELECTED IN I1]

I1a_# How many <I1 response> do you use in your home?

1 1
2 2
3 3
4 4
5 5 or more

I2 Which of the following electronics do you use in your home *(Choose all that apply)* [multi-select]

0 None [IF SELECTED, Don't allow other selections]
1 Cable or satellite box with DVR [Don't Show If I1 = None]
2 Cable or satellite box without DVR [Don't Show If I1 = None]
3 Stand-alone DVR *(e.g., TiVo)* [Don't Show If I1 = None]
4 Gaming systems *(e.g., Xbox, PlayStation, Wii)*
5 Laptop or desktop customized for gaming *(i.e., with high-powered graphics cards)*
6 Laptop/tablet *(exclude those customized for gaming)*
7 Desktop computer *(exclude those customized for gaming)*
8 Stand-alone monitor for laptop or desktop display
9 TV streaming device *(to play internet content on TV)* [Don't Show If I1 = None]

[LOOP I2a_# THROUGH EACH RESPONSE SELECTED IN I2]

I2a_# How many <I2 response> do you use in your home?

1 1
2 2
3 3
4 4
5 5 or more

[ASK IF (I2 <> "Cable or satellite box with DVR" OR "Cable or satellite box without DVR")
AND I1 <> None]

I2aa Did you remove, or stop using, a cable or satellite box within the LAST 12 MONTHS?

1 Yes
2 No

[Loop through each TECH indicated in I2 = {GAMING SYSTEMS (e.g., Xbox, PlayStation, Wii), LAPTOPS OR DESKTOPS CUSTOMIZED FOR GAMING (i.e., with high-powered graphics cards) }]

I3 On average, how many hours per day are <TECH> turned on during…the weekdays and weekends? *(select 1 option per column)*

[SHOW: Radio buttons allowing one selection per column]

Hours	a. Weekday	b. Weekend
1. <1		
2. 1-4		
3. 5-9		
4. 10-14		
5. 15-19		
6. 20-24		

I6 Do you use "smart" power strips for home electronics?

1 Yes

2 No

98 Don't know

[ASK IF I6 = "Yes", ELSE SKIP TO I9]

I7 There are two types of smart power strips, Tier 1 and Tier 2. How many of each type of smart power strip do you use?

a Tier 1 [Record #]

b Tier 2 [Record #]

[Do not show Tier 1 option if I7a = 0, Do not show Tier 2 option if I7b = 0]

I8 What systems do you use the smart power strips for?

	1. Tier 1	2. Tier 2
a. Television/cable [Don't Show if I1 = None]		
b. Computing		
c. Other, specify: [Record]		

I9 How many voice-activated devices do you **use** in your home?

(If 0, leave blank)

a Voice activated TVs [Record #] [Don't Show if I1 = None]

b Mobile smart device *(e.g., Siri, "OK Google" on smartphones)* [Record #]

c Standalone voice-activated device *(e.g., Amazon Echo, Google Home)* [Record #]

[ASK IF I9a + I9b + I9c >0]

I9aa What system(s) do you control through voice-activated devices? *(Select all that apply)* [multi-select]

1 Thermostat
2 Lighting
3 Mobile device *(e.g., smartphone, tablet)*
4 Entertainment *(e.g., TV, music)*
5 Other, specify: [RECORD]

I10 Do you have the use of a swimming pool at your home?

1 Yes, and I pay for its energy use
2 Yes, but it is in a common area and I do not pay for its energy use
3 No pool

[ASK IF I10 = "Yes, and I pay for its energy use" ELSE SKIP TO O1]

I11 How is your pool heated?

1 Pool is not heated
2 Natural gas
3 Electricity
4 Solar heater (using solar collectors)
5 Bottled gas (propane, butane, LPG)
6 Other, specify: [Record]

I12 How many pool pumps do you have?

[RECORD #]
998 Don't know

[ASK IF I12 >0 and <> "don't know"]

I13 Indicate the quantity and type of pool pump(s) used in your home:

a. Single speed pool pump [RECORD #]
b. Dual speed pool pump [RECORD #]
c. Variable speed pool pump [RECORD #]
d. Don't know [RECORD #]

[Sum of I13 should equal response to I12]

[ASK IF J2 = CFL OR INCANDESCENT OR HALOGEN) in ANY ROOM OR (N3 = CFL OR INCANDESCENT OR HALOGEN)]

I14 Consider the following bulb type(s) used in your home. Upon burnout, what bulb-type will you likely use for replacement?

[Show I14a if J2 (in ANY ROOM) or N3 >0]

[Show I14b if J2 (in ANY ROOM) or N3 >0]

[Show I14c if if J2 (in ANY ROOM)]

[Allow only 1 selection for each row – radio button]

	Replace with…			
Upon burnout of…	1. Incandescent	2. Halogen	3. CFL	4. LED
a. Incandescent				
b. Halogen				
c. CFL				

1.11 MARKETING AND DEMOGRAPHICS

O1 How important would it be for you to have access to more information, tools, and services to help improve the energy efficiency in your home?

0 0 Not at all important
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 10 Very Important

O2 Have you done any of the following to save energy in your home in the last 3 months?

[SHOW: Radio button allowing one selection for each row]

	1. Yes	2. No
a. Adjusted your fridge setting so it isn't running too cold		
b. Used a power strip on unused electronics and chargers		

O3 How knowledgeable do you feel about specific programs and services offered by ComEd to help you manage your energy?

0 Know almost nothing about the topic
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 10 Know a great deal about the topic

O4 In the last three months, have you seen, read, or heard anything about ComEd's programs or activities designed to help customers manage energy costs or become more energy efficient?

1 Yes
2 No

O5 How much do you agree or disagree with: ComEd is a trustworthy source of information about saving energy?

1 Strongly disagree
2 Somewhat disagree
3 Neither agree nor disagree
4 Somewhat agree
5 Strongly agree

O6 Please indicate your level of interest in potential future ComEd programs.

[SHOW: Radio button allowing one selection for each row]

	1 Not at all interested	2 Not too interested	3 Neither interested nor uninterested	4 Somewhat interested	5 Very interested
a. A "community solar" system that is located remotely and managed by a third-party and allows you and your neighbors to pay a discounted rate for the portion of the electricity the system generates					
b. A rebate for a small table-top energy usage and cost display that shows your home's electricity usage and costs near real-time					

O7 How much do you agree or disagree with the following:

[SHOW: Radio buttons allowing one selection for each row]

	1 strongly disagree	2 somewhat disagree	3 neither agree nor disagree	4 somewhat agree	5 strongly agree
a. I have already done everything I can to save energy in my home					
b. It is too difficult to try to determine whether we will save money over time by buying the most energy efficient products					

O11 How likely would you be to participate in a ComEd program where you would receive a personalized energy report, mailed to your home or emailed to you, showing your home's energy use compared to the usage of similar homes in your area?

1 Definitely wouldn't participate
2 Probably wouldn't participate
3 Might or might not participate
4 Probably would participate
5 Definitely would participate
6 Current or past participant
98 Don't know

1.12 END

[Show in First Survey Round, ELSE SKIP TO END]

recruit_1 As part of this study, the research team will be visiting a small number of homes to verify the information provided through this survey. This on-site verification will take less than 30 minutes to complete. Customers that agree to an on-site verification will receive an additional $50 Amazon.com Gift Card upon completion of verification.

Are you interested in participating in this verification step and receiving an additional $50 Amazon.com Gift Card?

1 Yes
2 No

[ASK IF recruit_1 = "Yes"]

Thank you for your interest in an on-site verification visit!

The research team that will conduct these visits will contact you directly to schedule your appointment.

Please provide the best contact information for scheduling an in-home visit:

recruit_name Name: [RECORD NAME]
recruit_phone Phone: [RECORD Phone]

END **Thank you for completing ComEd's Home Survey!**

We greatly appreciate your time and participation. Upon verification of your responses a $25 Amazon.com Gift Card will be sent to: **<P2_Response>**

Main document changes and comments

Page 1-3: Commented [TM1] Ting, Michael 2/26/2019 5:42:00 PM

Level 1: Make this word a link to a pop-up with the following content:

Level 1 chargers take 8-15 hours for a full recharge and require only a standard 120v outlet.

Page 1-3: Commented [TM2] Ting, Michael 2/26/2019 5:43:00 PM

Level 2: Make this word a link to a pop-up with the following content:

Level 2 chargers take 3-8 hours for a full recharge and require a 240v outlet.

Page 1-3: Commented [TM3] Ting, Michael 2/26/2019 5:44:00 PM

Level 3: Make this word a link to a pop-up with the following content:

Level 3 chargers take 20 minutes to 1 hour for a full recharge and are also known as DC Fast Chargers.

Page 1-3: Commented [TM4] Ting, Michael 2/25/2019 3:15:00 PM

Home Energy Report: Make these words a link to a pop-up with the following text:

A personalized energy report, mailed to your home or emailed to you, showing your home's energy use compared to the usage of similar homes in your area.

Page 1-4: Commented [TM5] Ting, Michael 5/6/2019 10:26:00 AM

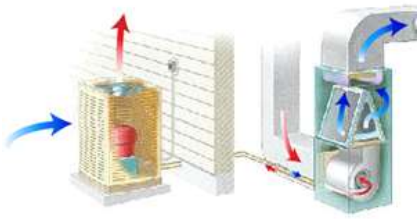
PRIMARY: Make this word a link to a pop-up with the following text:

Your PRIMARY system is the one that provides most or all of the space cooling for your home during the summer and is often controlled by your thermostat.

Page 1-4: Commented [RL6]	Robinson, Lauren	2/14/2019 4:26:00 PM

Forced air split system: Make this word a link that triggers a pop-up with the following text & image:

Forced-air split systems cool air and use a blower motor and a system of air ducts to distribute cool air throughout the house. These systems are also often called "split" systems because the compressor is located outdoors, usually mounted on the ground. Split systems include AC-only systems and heat pumps.



Page 1-4: Commented [RL7]	Robinson, Lauren	2/14/2019 4:27:00 PM

Ground source heat pump: Make this word a link that triggers a pop-up with the following text:

Ground-source heat pump systems work similarly to split systems in that they cool air and use a blower motor and a system of air ducts to circulate cool air throughout the house. In contrast to split systems, ground-source heat pumps do not use an outdoor condenser unit to produce the cool air. Instead they use loops of pipe buried in the ground. If your home is centrally cooled via a forced air system but no outdoor compressor is present, then it is a ground-source heat pump.

Page 1-4: Commented [RL8]	Robinson, Lauren	2/14/2019 4:28:00 PM

Ductless system: Make this word a link that triggers a pop-up with the following text & image:

Ductless systems (sometimes called "mini-splits") cool liquid refrigerant in an outdoor compressor, distribute that refrigerant to specific rooms through pipes, and then use heat exchangers and fans in small

wall- or ceiling-mounted indoor units to cool indoor air. Ductless systems include AC-only systems and heat pumps.

Page 1-4: Commented [TM9]	Ting, Michael	5/6/2019 10:28:00 AM

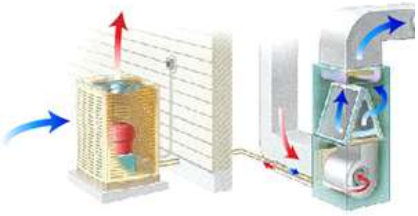
SECONDARY: Make this word a pop-up that contains the following text.

SECONDARY systems provide additional central air conditioning capacity to supplement your primary system or to serve as backup capacity. The most common secondary central air conditioning system are ductless systems used to supplement forced air systems. Note that portable air conditioners are NOT considered secondary central air conditioning systems.

Page 1-4: Commented [RL10]	Robinson, Lauren	2/14/2019 4:26:00 PM

Forced air split system: Make this word a link that triggers a pop-up with the following text & image:

Forced-air split systems cool air and use a blower motor and a system of air ducts to distribute cool air throughout the house. These systems are also often called “split” systems because the compressor is located outdoors, usually mounted on the ground. Split systems include AC-only systems and heat pumps.



Page 1-4: Commented [RL11]	Robinson, Lauren	2/14/2019 4:27:00 PM

Ground source heat pump: Make this word a link that triggers a pop-up with the following text:

Ground-source heat pump systems work similarly to split systems in that they cool air and use a blower motor and a system of air ducts to circulate cool air throughout the house. In contrast to split systems, ground-source heat pumps do not use an outdoor condenser unit to produce the cool air. Instead they use loops of pipe buried in the ground. If your home is centrally cooled via a forced air system but no outdoor compressor is present, then it is a ground-source heat pump.

Page 1-4: Commented [RL12]	Robinson, Lauren	2/14/2019 4:28:00 PM

Ductless system: Make this word a link that triggers a pop-up with the following text & image:

Ductless systems (sometimes called "mini-splits") cool liquid refrigerant in an outdoor compressor, distribute that refrigerant to specific rooms through pipes, and then use heat exchangers and fans in small wall- or ceiling-mounted indoor units to cool indoor air. Ductless systems include AC-only systems and heat pumps.

Page 1-5: Commented [TM13]	Ting, Michael	2/26/2019 5:47:00 PM

many : Make this word a link to a pop-up with the following content:

Larger homes may have more than one compressor to cool different parts of the home.

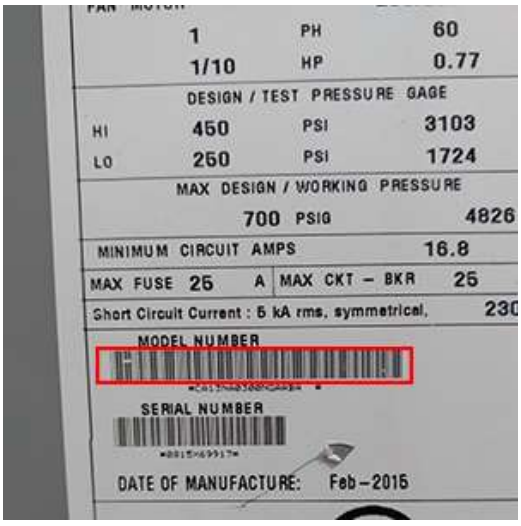
Page 1-6: Commented [TM14]	Ting, Michael	2/7/2019 3:15:00 PM

Nameplate: Make this word a link that triggers a pop-up with the following image:

Page 1-6: Commented [TM15]	Ting, Michael	2/26/2019 11:25:00 AM

barcode(s): Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.



If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-2: Commented [TM16]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-3: Commented [TM17]	Ting, Michael	5/6/2019 10:35:00 AM

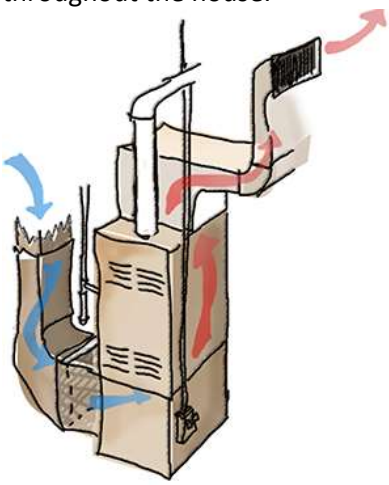
PRIMARY: Make this word a link to a pop-up with the following text:

Your PRIMARY system is the one that provides most or all of the space heating for your home during the winter and is often controlled by your thermostat.

Page 1-3: Commented [RL18]	Robinson, Lauren	2/14/2019 4:31:00 PM

Forced-air furnaces: Make this word a link that triggers a pop-up with the following text & image:

Forced-air furnaces heat air and use a blower motor and a system of air ducts to distribute warm air throughout the house.



Page 1-3: Commented [RL19]	Robinson, Lauren	2/14/2019 4:42:00 PM

Air-source heat pumps: Make this word a link that triggers a pop-up with the following text & image:

Air-source central heat pumps use an outdoor compressor unit and then a blower motor and a system of air ducts to circulate warm air throughout the house. These heat pump systems are also used for home cooling during the summer.

Page 1-3: Commented [TM20]	Ting, Michael	2/25/2019 3:44:00 PM

Ground source heat pumps: Make this word a link that triggers a pop-up with the following text:

Ground-source heat pumps work similarly to split systems in that they warm air and use a blower motor and a system of air ducts to circulate warm air throughout the house. In contrast to split systems, ground-source heat pumps do not use an outdoor condenser unit to produce the warm air. Instead they use loops of pipe buried in the

ground. If your home is centrally heated via a forced air system but no outdoor compressor is present, then it is a ground-source heat pump.

Page 1-3: Commented [RL21]	Robinson, Lauren	2/14/2019 4:42:00 PM

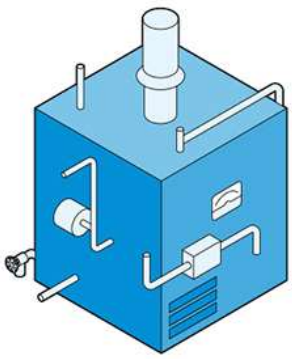
Ductless heat pumps: Make this word a link that triggers a pop-up with the following text & image:

Ductless heat pumps (sometimes called “mini-splits”) heat liquid refrigerant in an outdoor compressor, distribute that refrigerant to specific rooms through pipes, and then use heat exchangers and fans in small wall- or ceiling- mounted indoor units to cool indoor air. These systems are also used for home cooling during the summer.

Page 1-3: Commented [RL22]	Robinson, Lauren	2/14/2019 4:31:00 PM

Boilers: Make this word a link that triggers a pop-up with the following text & image:

Boilers heat water to provide hot water or steam that is then distributed through a series of pipes. Boilers are the heat sources for steam radiator systems, radiant floor/ceiling/wall heating systems, and hot water baseboards. Boilers can be mounted on the ground or on a wall.



Page 1-3: Commented [RL23] **Robinson, Lauren** **2/14/2019 4:32:00 PM**

Baseboard heaters: Make this word a link that triggers a pop-up with the following text & image:

Electric baseboard heaters are installed at the bottom of walls inside a conditioned space and heat air directly without the use of fans or blowers. Sometimes the electric power connection is visible.

Page 1-3: Commented [RL24] **Robinson, Lauren** **2/14/2019 4:44:00 PM**

Portable space heaters: Make this word a link that triggers a pop-up with the following text:

Portable space heaters are used to supplement existing heating systems. They can be moved from room to room and plug into wall sockets.

Page 1-3: Commented [TM25] **Ting, Michael** **5/6/2019 10:36:00 AM**

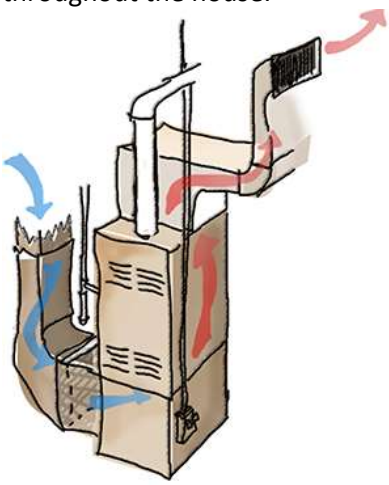
SECONDARY: Make this word a pop-up that contains the following text.

SECONDARY systems provide additional space heating capacity to supplement your primary system or to serve as backup capacity. The most common secondary central heating systems are ductless heat pumps or baseboard heaters used to supplement furnaces.

Page 1-3: Commented [RL26] **Robinson, Lauren** **2/14/2019 4:31:00 PM**

Forced-air furnaces: Make this word a link that triggers a pop-up with the following text & image:

Forced-air furnaces heat air and use a blower motor and a system of air ducts to distribute warm air throughout the house.



Page 1-3: Commented [RL27]	Robinson, Lauren	2/14/2019 4:42:00 PM

Air-source heat pumps: Make this word a link that triggers a pop-up with the following text & image:

Air-source central heat pumps use an outdoor compressor unit and then a blower motor and a system of air ducts to circulate warm air throughout the house. These heat pump systems are also used for home cooling during the summer.

Page 1-3: Commented [TM28]	Ting, Michael	2/25/2019 3:44:00 PM

Ground source heat pumps: Make this word a link that triggers a pop-up with the following text:

Ground-source heat pumps work similarly to split systems in that they warm air and use a blower motor and a system of air ducts to circulate warm air throughout the house. In contrast to split systems, ground-source heat pumps do not use an outdoor condenser unit to produce the warm air. Instead they use loops of pipe buried in the

ground. If your home is centrally heated via a forced air system but no outdoor compressor is present, then it is a ground-source heat pump.

Page 1-3: Commented [RL29]	Robinson, Lauren	2/14/2019 4:42:00 PM

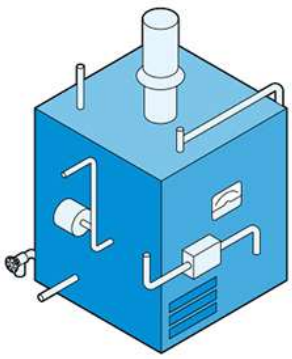
Ductless heat pumps: Make this word a link that triggers a pop-up with the following text & image:

Ductless heat pumps (sometimes called “mini-splits”) heat liquid refrigerant in an outdoor compressor, distribute that refrigerant to specific rooms through pipes, and then use heat exchangers and fans in small wall- or ceiling- mounted indoor units to cool indoor air. These systems are also used for home cooling during the summer.

Page 1-3: Commented [RL30]	Robinson, Lauren	2/14/2019 4:31:00 PM

Boilers: Make this word a link that triggers a pop-up with the following text & image:

Boilers heat water to provide hot water or steam that is then distributed through a series of pipes. Boilers are the heat sources for steam radiator systems, radiant floor/ceiling/wall heating systems, and hot water baseboards. Boilers can be mounted on the ground or on a wall.



Page 1-3: Commented [RL31]	Robinson, Lauren	2/14/2019 4:32:00 PM

Baseboard heaters: Make this word a link that triggers a pop-up with the following text & image:

Electric baseboard heaters are installed at the bottom of walls inside a conditioned space and heat air directly without the use of fans or blowers. Sometimes the electric power connection is visible.

Page 1-3: Commented [RL32]	Robinson, Lauren	2/14/2019 4:44:00 PM

Portable space heaters: Make this word a link that triggers a pop-up with the following text:

Portable space heaters are used to supplement existing heating systems. They can be moved from room to room and plug into wall sockets.

Page 1-3: Commented [TM33]	Ting, Michael	2/25/2019 3:00:00 PM

fuel source: Make this word a link to a pop-up with the following content:

Natural gas, oil, and propane furnaces have a large cylindrical vent (or “flue”) at the top of the unit to exhaust combustion gases outdoors. Oil and propane furnaces are connected to stand alone fuel tanks located next to the furnace. Electric furnaces and heat pumps lack exhaust flues.

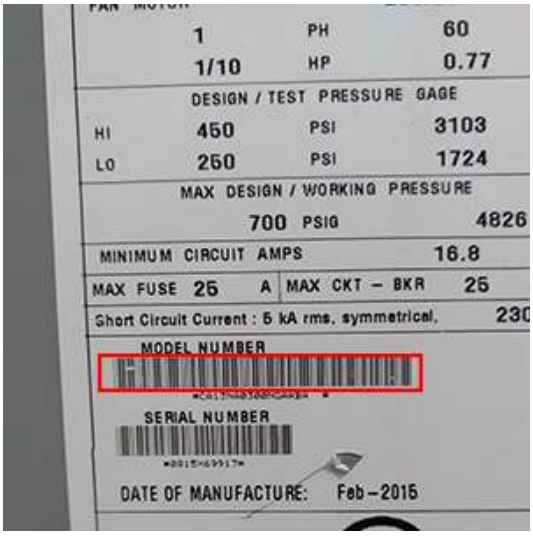
Page 1-4: Commented [TM34]	Ting, Michael	2/7/2019 3:15:00 PM

nameplate : Make this word a link that triggers a pop-up with the following image:

Page 1-4: Commented [TM35] **Ting, Michael** **2/26/2019 12:58:00 PM**

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.



If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-5: Commented [TM36] **Ting, Michael** **5/3/2019 2:49:00 PM**

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-6: Commented [RL37]	Robinson, Lauren	2/14/2019 4:49:00 PM

Natural gas: Make this word a link that triggers a pop-up with the following text & image:

Natural gas water heaters all have a large vent (or "flue") at the top of the unit to exhaust combustion gases that is typically 3-6" in diameter and noticeably wider than water pipes, gas pipes, or electrical connections.

Page 1-6: Commented [RL38]	Robinson, Lauren	2/14/2019 4:49:00 PM

Electricity: Make this word a link that triggers a pop-up with the following text:

Electric water heaters do not have a flue. They are connected to an electrical power line.

Page 1-6: Commented [RL39]	Robinson, Lauren	2/14/2019 4:50:00 PM

Propane: Make this word a link that triggers a pop-up with the following text:

Propane water heaters have flues like natural gas water heaters, but their gas lines are connected to a stand-alone propane tank located on the premises.

Page 1-6: Commented [RL40]	Robinson, Lauren	2/14/2019 4:50:00 PM

Oil: Make this word a link that triggers a pop-up with the following text:

Oil-fired water heaters use fuel oil to heat water and also have flues, but their hot water storage tanks are connected to an oil burner.

Page 1-6: Commented [RL41]	Robinson, Lauren	2/14/2019 4:50:00 PM

Solar: Make this word a link that triggers a pop-up with the following text:

Solar water heating systems include storage tanks and solar collectors.

Page 1-6: Commented [RL42]	Robinson, Lauren	2/14/2019 4:53:00 PM

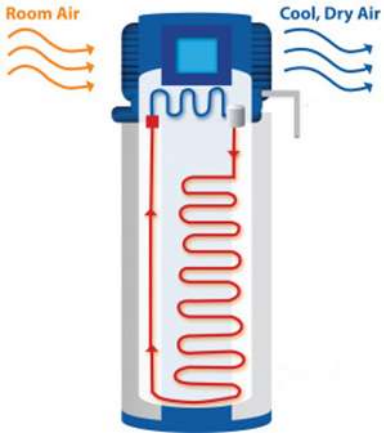
Conventional storage: Make this word a link that triggers a pop-up with the following text & image:

Conventional storage water heaters are large cylindrical tanks that are free-standing and sometimes strapped to a wall.

Page 1-6: Commented [RL43]	Robinson, Lauren	2/14/2019 4:54:00 PM

Heat pump storage: Make this word a link that triggers a pop-up with the following text & image:

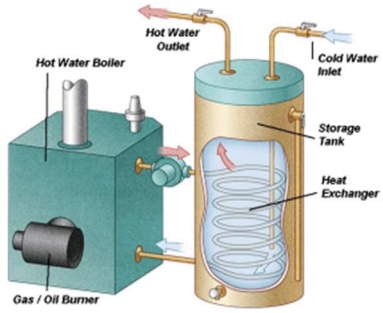
Heat pump storage water heaters look like electric resistance storage water heaters, except they have vents at the top of the unit and fans that pull surrounding air into the unit.



Page 1-6: Commented [RL44]	Robinson, Lauren	2/14/2019 4:55:00 PM

Indirect storage: Make this word a link that triggers a pop-up with the following text & image:

Indirect storage water heaters use the main furnace or boiler to heat a fluid that's circulated through a heat exchanger in the storage tank.



Page 1-6: Commented [RL45]	Robinson, Lauren	2/14/2019 4:54:00 PM

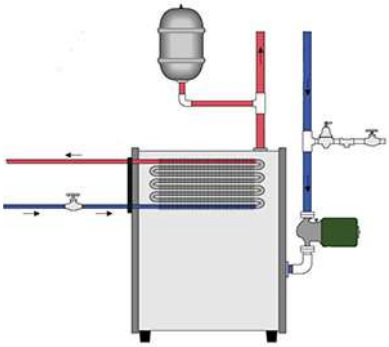
Tankless: Make this word a link that triggers a pop-up with the following text & image:

Tankless water heaters (also known as instantaneous or on-demand water heaters) are typically box-shaped units that are wall-mounted. They heat water directly without the use of a storage tank.

Page 1-6: Commented [RL46]	Robinson, Lauren	2/14/2019 4:55:00 PM

Tankless Coil: Make this word a link that triggers a pop-up with the following text & image:

Tankless coil water heaters are a kind of indirect system where the home's space heating system (a furnace or boiler) is used to heat water via a heat exchanger (a coil) but without a storage tank. These systems are readily identifiable when the water pipes that serve the kitchen and bathroom are observed entering and exiting a furnace or boiler and no storage tank is present.



Page 1-7: Commented [TM47]	Ting, Michael	2/7/2019 3:15:00 PM

nameplate Make this word a link that triggers a pop-up with the following image:

Page 1-7: Commented [TM48]	Ting, Michael	2/26/2019 12:59:00 PM

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-8: Commented [TM49]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-10: Commented [TM50]	**Ting, Michael**	**2/26/2019 10:06:00 AM**

large: Make the word “large” a link to a pop-up with the following text:

Compact clothes washers are quite small and are mostly comprised of portable units or purpose-built units for RVs.

If your unit is not portable and at least 21” deep and 36” tall, it is considered a **standard** size clothes washer.

Page 1-10: Commented [TM51]	**Ting, Michael**	**2/7/2019 3:15:00 PM**

nameplate Make this word a link that triggers a pop-up with the following image:

Page 1-10: Commented [TM52] **Ting, Michael** **2/8/2019 3:06:00 PM**

Top-Loading: A

Make this letter a link that triggers a pop-up with the following text:

“Inside the lid”

Page 1-10: Commented [TM53] **Ting, Michael** **2/8/2019 3:08:00 PM**

Top-Loading: B

Make this letter a link that triggers a pop-up with the following text:

“Along the top edge of the tub”

Page 1-10: Commented [TM54] **Ting, Michael** **2/8/2019 3:09:00 PM**

Top-Loading: C

Make this letter a link that triggers a pop-up with the following text:

“On the back of the unit, opposite the control panel”

Page 1-10: Commented [TM55] **Ting, Michael** **2/8/2019 3:10:00 PM**

Top-Loading: D

Make this letter a link that triggers a pop-up with the following text:

“On the side of the unit, near the lower front corner”

Page 1-11: Commented [TM56] **Ting, Michael** **2/8/2019 3:06:00 PM**

Front-Loading: A

Make this letter a link that triggers a pop-up with the following text:

“Along the door jamb”

Page 1-11: Commented [TM57] **Ting, Michael** **2/8/2019 3:08:00 PM**

Front-Loading: B

Make this letter a link that triggers a pop-up with the following text:

“Along the inside edge of the door”

Page 1-11: Commented [TM58] **Ting, Michael** **2/8/2019 3:09:00 PM**

Front-Loading: C

Make this letter a link that triggers a pop-up with the following text:

“On the back of the unit, opposite the control panel”

Page 1-11: Commented [TM59] **Ting, Michael** **2/8/2019 3:10:00 PM**

Front-Loading: D

Make this letter a link that triggers a pop-up with the following text:

“On the side of the unit, near the lower front corner”

Page 1-11: Commented [TM60] **Ting, Michael** **2/26/2019 1:00:00 PM**

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-11: Commented [TM61]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-13: Commented [TM62]	Ting, Michael	2/7/2019 3:15:00 PM

nameplate Make this word a link that triggers a pop-up with the following image:

Page 1-13: Commented [TM63]	Ting, Michael	2/8/2019 3:06:00 PM

A: Make this letter a link that triggers a pop-up with the following text:

“Along the door jamb”

Page 1-13: Commented [TM64]	Ting, Michael	2/8/2019 3:08:00 PM

B: Make this letter a link that triggers a pop-up with the following text:

“Along the inside edge of the door”

Page 1-13: Commented [TM65]	Ting, Michael	2/8/2019 3:09:00 PM

C: Make this letter a link that triggers a pop-up with the following text:

“On the side of the unit, near the lower front corner”

Page 1-13: Commented [TM66]	Ting, Michael	2/8/2019 3:10:00 PM

D: Make this letter a link that triggers a pop-up with the following text:

“On the back of the unit, opposite the control panel”

Page 1-13: Commented [TM67]	Ting, Michael	2/26/2019 1:01:00 PM

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-14: Commented [TM68]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-14: Commented [TM69] **Ting, Michael** **2/25/2019 3:59:00 PM**

Communicating: Make these words a link to a pop-up with the following content:

Communicating thermostats are able to communicate with your heating/cooling system through the web or a mobile app.

Page 1-14: Commented [TM70] **Ting, Michael** **2/25/2019 4:01:00 PM**

programmable: Make these words a link to a pop-up with the following content:

Programmable (non-communicating) thermostats allow you to set indoor temperature and on-off times, but only directly on the thermostat itself.

Page 1-14: Commented [TM71] **Ting, Michael** **2/25/2019 4:08:00 PM**

standard: Make these words a link to a pop-up with the following content:

Standard thermostats allow you to set indoor temperature but do not have the ability to program on-off times.

Page 1-17: Commented [TM72] **Ting, Michael** **2/26/2019 1:31:00 PM**

windows Make this word a link to a pop-up with the following content:

If you're not sure how many panes of glass are in your windows, hold a flashlight so it's shining directly through your window. You will see either one, two or three spots of light. Each spot of light represents one pane (or sheet) of glass.

Page 1-20: Commented [TM73] **Ting, Michael** **2/26/2019 10:20:00 AM**

size Make this word a link to a pop-up with the following content:

The most common type of **compact** refrigerator is the "mini fridge" that fits underneath counter tops and desks. Although uncommon, compact units can be up to 44" tall.

Small refrigerators are ~60" tall and 28" wide at most.

Medium refrigerators are ~66" tall and 30" wide at most.

Large refrigerators are also ~66" tall but generally 32" wide.

Very large refrigerators are up to 69" tall and at least 32" wide.

Page 1-20: Commented [RL74] **Robinson, Lauren** **5/15/2019 12:59:00 PM**

defrost Make this word a link to a pop-up with the following content:

Automatic Defrost – is always working. You don't need to do anything to manage the frost build up inside the unit. Most refrigerators on the market today have automatic defrost controls.

Manual Defrost - requires you to remove all of the food from your refrigerator and freezer, unplug the unit, and allow it to warm up to melt the frost inside the unit. This is done each time the unit develops a quarter-inch of ice build-up on the interior walls (on average, once a year).

Page 1-20: Commented [TM75]	Ting, Michael	2/26/2019 3:27:00 PM

freestanding Make this word a link to a pop-up with the following content:

Freestanding refrigerators stand on their own and slide into place next to cabinets or against a wall. Built-in refrigerators sit flush with kitchen cabinetry. They are typically less deep than freestanding refrigerators.

Page 1-21: Commented [TM76]	Ting, Michael	2/7/2019 3:15:00 PM

Nameplate: Make this word a link that triggers a pop-up with the following image:

Page 1-21: Commented [TM77]	Ting, Michael	2/8/2019 3:06:00 PM

A: Make this letter a link that triggers a pop-up with the following text:

“On the interior side wall or the ceiling, usually on the top level of the refrigerator”

Page 1-21: Commented [TM78]	Ting, Michael	2/8/2019 3:08:00 PM

B: Make this letter a link that triggers a pop-up with the following text:

“Behind the kick plate”

Page 1-21: Commented [TM79]	Ting, Michael	2/8/2019 3:09:00 PM

C: Make this letter a link that triggers a pop-up with the following text:

“On the interior rear wall, behind the crisper drawer”

Page 1-21: Commented [TM80]	Ting, Michael	2/8/2019 3:10:00 PM

D: Make this letter a link that triggers a pop-up with the following text:

“On door jamb near the upper corners or along the top”

Page 1-21: Commented [TM81]	Ting, Michael	2/26/2019 1:02:00 PM

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-22: Commented [TM82]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-23: Commented [RL83]	Robinson, Lauren	5/15/2019 1:00:00 PM

style Make this word a link to a pop-up with the following content:

Automatic Defrost – is always working. You don't need to do anything to manage the frost build up inside the unit.

Manual Defrost - requires you to remove all of the food from your freezer, unplug the unit, and allow it to warm up to melt the frost inside the unit. This is done each time the unit develops a quarter-inch of ice build-up on the interior walls (on average, once a year).

Page 1-23: Commented [TM84]	Ting, Michael	2/26/2019 10:42:00 AM

size Make this word a link to a pop-up with the following content:

Compact upright freezers are ~56” tall and 24” wide at most. Compact chest freezers are 33” tall and can be up to 21” deep and 37” wide.

Small upright freezers are ~60” tall and 28” wide at most. Small chest freezers are ~28” deep and up to 50” wide.

Medium upright freezers are ~60” tall and 30” wide at most. Medium chest freezers are up to 65” wide.

Large upright freezers are also over 64” tall at least 32” wide. Chest freezers in this size range are highly uncommon.

Page 1-23: Commented [TM85]	**Ting, Michael**	**2/7/2019 3:15:00 PM**

Nameplate: Make this word a link that triggers a pop-up with the following image:

Page 1-24: Commented [TM86]	**Ting, Michael**	**2/8/2019 3:06:00 PM**

A: Make this letter a link that triggers a pop-up with the following text:

“On the side of the unit, near the lower front corner”

Page 1-24: Commented [TM87]	**Ting, Michael**	**2/8/2019 3:08:00 PM**

B: Make this letter a link that triggers a pop-up with the following text:

“On the interior back or side wall, near the top”

Page 1-24: Commented [TM88]	Ting, Michael	2/8/2019 3:09:00 PM

C: Make this letter a link that triggers a pop-up with the following text:

“On the inside or along the inside edge of the door”

Page 1-24: Commented [TM89]	Ting, Michael	2/26/2019 1:02:00 PM

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-24: Commented [TM90]	Ting, Michael	5/3/2019 2:49:00 PM

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-26: Commented [TM91]	Ting, Michael	2/26/2019 11:08:00 AM

size Make this word a link to a pop-up with the following content:

Compact dishwashers are mostly comprised of counter-top models that up to 22” wide and no more than 18” tall.

Standard dishwashers are all at least 32” tall (“counter height”) and range from 15” wide to 36” wide.

Page 1-26: Commented [TM92]	Ting, Michael	2/7/2019 3:15:00 PM

Nameplate: Make this word a link that triggers a pop-up with the following image:

Page 1-26: Commented [TM93] **Ting, Michael** **2/8/2019 3:06:00 PM**

A: Make this letter a link that triggers a pop-up with the following text:

"Along the inside edge of the door"

Page 1-26: Commented [TM94] **Ting, Michael** **2/8/2019 3:08:00 PM**

B: Make this letter a link that triggers a pop-up with the following text:

"Along the door jamb"

Page 1-26: Commented [TM95] **Ting, Michael** **2/8/2019 3:09:00 PM**

C: Make this letter a link that triggers a pop-up with the following text:

"On the framing near the top of the unit"

Page 1-26: Commented [TM96] **Ting, Michael** **2/8/2019 3:10:00 PM**

D: Make this letter a link that triggers a pop-up with the following text:

"On side of the unit, near the lower front corner"

Page 1-26: Commented [TM97] **Ting, Michael** **2/26/2019 1:03:00 PM**

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-27: Commented [TM98] **Ting, Michael** **5/3/2019 2:49:00 PM**

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-30: Commented [RL99]	Robinson, Lauren	2/14/2019 5:03:00 PM

Window air conditioners and heat pumps : Make this word a link that triggers a pop-up with the following text & image:

Window air conditioners and heat pumps are a type of "packaged" system that includes the evaporator, condenser, compressor, and fans all in one unit that sits inside a window frame and cools one room. Window heat pumps are the same but can also provide heat during the winter.

Page 1-30: Commented [RL100]	Robinson, Lauren	2/14/2019 5:04:00 PM

Portable air conditioners and heat pumps : Make this word a link that triggers a pop-up with the following text & image:

Portable air conditioners and heat pumps are also packaged systems, but instead of sitting inside the window frame the unit sits in the room and a small exhaust tube is fed through the window.

Page 1-30: Commented [RL101] **Robinson, Lauren** **2/14/2019 5:05:00 PM**

Through-the-wall air conditioners and heat pumps: Make this word a link that triggers a pop-up with the following text & image:

Through-the-wall air conditioners and heat pumps are similar to window air conditioners and heat pumps but are permanently installed through dedicated sections of exterior walls. They are typically found in hotels or apartment buildings.

Page 1-31: Commented [TM102] **Ting, Michael** **2/26/2019 1:03:00 PM**

barcode(s) : Make this word a link to a pop-up with the following content:

If there are multiple barcodes, take a photo of the barcode associated the model number, not the serial number.

If you are unsure which barcode is for the model number, take a photo that includes all the barcodes.

Page 1-31: Commented [TM103] **Ting, Michael** **5/3/2019 2:49:00 PM**

model number: make this word a pop-up with the following content:

Be careful to identify and capture the **model number**, not the serial number. Model numbers are often preceded by abbreviations like “Mod. No.”, “Mod. Num.”, “MOD#”, or “M/N”. Serial numbers are often preceded by abbreviations like “Serial No.”, “Ser. Num.”, “SER#”, or “S/N”.

If you are unsure which number is the model number as which is the serial number, take a photo that includes both.

Page 1-32: Commented [RL104] **Robinson, Lauren** **2/14/2019 4:21:00 PM**

LED: Make this word a link that triggers a pop-up with the following text & image:

LEDs always have a component between the screw base and the glass enclosure, similar to CFLs. However, this middle component tends to be smaller and more discrete in LED lamps compared to CFLs. When the glass enclosure is clear, you can see the small LED chips that actually emit the light.

Page 1-32: Commented [RL105]	Robinson, Lauren	2/14/2019 4:20:00 PM

CFL: Make this word a link that triggers a pop-up with the following text & image:

CFLs consist of two or three tubular loops that are often visible. When the tubes are covered by a glass enclosure, they can look similar to incandescent bulbs. However, CFLs always have a bulky component between the screw base and the tubes (or glass enclosure) which contains the ballast.

Page 1-32: Commented [RL106]	Robinson, Lauren	2/14/2019 4:20:00 PM

Incandescent: Make this word a link that triggers a pop-up with the following text & image:

Incandescent lights are the historically standard for screw-based lighting sockets in residential homes. The key ways to tell if a lamp is incandescent are the presence of a small, thin filament (visible when the glass enclosure is clear) or when the glass enclosure continues all the way down to the screw base.

Page 1-32: Commented [RL107]	Robinson, Lauren	2/14/2019 4:22:00 PM

Fluorescent Tube: Make this word a link that triggers a pop-up with the following text & image:

Fluorescent tubes are also known as linear fluorescent lamps. These are most commonly used in commercial settings but are sometimes found in residential garages, basements, workshops, or hallways.

Page 1-32: Commented [RL108]	Robinson, Lauren	2/14/2019 4:22:00 PM

Halogen: Make this word a link that triggers a pop-up with the following text & image:

Halogen lamps can resemble incandescent lamps in that they contain a filament and have glass enclosures that continue all the way down to the base. However, the filament in halogens is larger and more complex

than in an incandescent. Halogen filaments can resemble “a lamp inside a lamp”. Halogens are most commonly used in recessed downlights and other applications that use directional, reflector lamps.

Page 1-32: Commented [RL109]	Robinson, Lauren	2/14/2019 4:23:00 PM

Infrared: Make this word a link that triggers a pop-up with the following text:

Infrared heat lamps use a special type of incandescent bulb for the primary purpose of heat production rather than to generate light (i.e., bathroom heat lamps).

Page 1-33: Commented [RL110]	Robinson, Lauren	2/14/2019 4:13:00 PM

Standard: Make this word a link that triggers a pop-up with the following text & image:

Standard shape lamps are also known as A-lamps and have the classic pear shape. The common twister or spiral-style CFL lamps are also considered standard shaped lamps, since they can be used interchangeably with A-lamps.

Page 1-34: Commented [TM111] **Ting, Michael** **5/6/2019 10:55:00 AM**

reflectors: make this word a link to a pop-up with the following text and image.:

Reflector lamps are also known as directional or parabolic lamps. These lamps are commonly used in recessed downlighting, track lighting, and pendant lighting fixtures.

Page 1-35: Commented [TM112] **Ting, Michael** **2/26/2019 6:05:00 PM**

faucet aerators Make this word a link to a pop-up with the following content:

Aerators are add-on devices that reduce the water usage by mixing air into the water stream.

Page 1-35: Commented [TM113] **Ting, Michael** **2/26/2019 6:06:00 PM**

showerheads Make this word a link to a po-up with the following content:

Water-saving showerheads use 2.5 gallons per minute or less and have been standard since 1993.

Page 1-40: Commented [RL114] **Robinson, Lauren** **2/14/2019 3:42:00 PM**

INCANDESCENT: Make this word a link that triggers a pop-up with the following text & image:

Incandescent lights are the historically standard for screw-based lighting sockets in residential homes. The key ways to tell if a lamp is incandescent are the presence of a small, thin filament (visible when the glass enclosure is clear) or when the glass enclosure continues all the way down to the screw base.

Page 1-40: Commented [RL115] **Robinson, Lauren** **2/14/2019 3:42:00 PM**

HALOGEN: Make this word a link that triggers a pop-up with the following text & image:

Halogen lamps can resemble incandescent lamps in that they contain a filament and have glass enclosures that continue all the way down to the base. However, the filament in halogens is larger and more complex than in an incandescent. Halogen filaments can resemble “a lamp inside a lamp”. Halogens are most commonly used in recessed downlights and other applications that use directional, reflector lamps.

Page 1-45: Commented [TM116] **Ting, Michael** **2/26/2019 6:15:00 PM**

"smart" Make this word a link to a pop-up with the following content:

Smart power strips automatically turn off the devices connected to it when a primary device is turned off.

Page 1-45: Commented [RL117] **Robinson, Lauren** **2/14/2019 4:04:00 PM**

Tier 1: Make this word a link that triggers a pop-up with the following text:

Tier 1 power strips control power based on a master switch. When the control device (e.g., a TV) is switched off, all the other outlets are automatically turned off as well.

Page 1-45: Commented [RL118]	Robinson, Lauren	2/14/2019 4:02:00 PM

Tier 2: Make this word a link that triggers a pop-up with the following text:

Tier 2 power strips use infrared technology to sense remote control signals, and/or motion sensing technology to sense occupancy in the room.

Header and footer changes

Text Box changes

Header and footer text box changes

Footnote changes

Endnote changes

APPENDIX B COMMERCIAL SURVEY INSTRUMENT

ComEd Baseline/Potential Study
On-Site Inventory Survey Form

General Site Information

Itron SiteID	xx
Building Type	xx

Business Name (CIS)	xx
Storefront Name	
Service Address	xx
CORRECTIONS TO SITE INFORMATION	
Revised Corp. (Multi-Site) Name	
Revised Business Name	
Revised Service Address	
Revised City	

Revised Zip	

Site Contact Information

PS Completion Date:	xx	Respondent:	xx	Title:	xx

	Contacted	Contact Name	Phone Number	Alternate Phone
Contact agreed to onsite survey	☐	xx	xx	
Contact knowlegeable about energy at factility	☐			
Other Site Contact	☐			

Note: Use the "Contacted" check box to indicate the actual contact(s) for the site visit.

Scheduling Notes/Special Instructions for On-site Visit:

xx

Ladder Required for Rooftop Access	xx
Length of Ladder Required	xx

Survey Tracking Information

Survey Company:		Assigned Surveyor(s) Initials:		
Survey Travel Mileage:	miles	Total Travel Time		hrs
Survey Duration (24 hr clock)	Start:	Survey Duration (24 hr clock)	End:	
Total Onsite Time	hrs	Total Time to Fill Out Survey Form		hrs

	Date:	Initials
Field survey completed:	__ __ / __ __ / __ __	__ __ __
Survey received from surveyor:	__ __ / __ __ / __ __	__ __ __
Initial QC check completed:	__ __ / __ __ / __ __	__ __ __
Survey sent back to surveyor (*if needed*):	__ __ / __ __ / __ __	__ __ __
Received from surveyor (*if needed*):	__ __ / __ __ / __ __	__ __ __
Itron QC completed:	__ __ / __ __ / __ __	__ __ __
Data entry completed:	__ __ / __ __ / __ __	__ __ __

Premise-Level General Information

PRIMARY BUSINESS TYPE CODE *(do not leave blank)*:		*(Use **3-number** codes from Business Type Table)*

Premise General Information

How many full-time equivalent employees work at this premise?			___	
What kind of premise is this? **B** = Single building **P** = Part of a building **CM** = Campus (*subsample*)	**SM** = Small multi-building (*survey all*) **OT** = Other *(describe in comments)*		B P CM	SM OT
What is the total occupied floor area of this premise?			_____ft^2	
-- If the premise has an enclosed parking garage, what is the floor area? (exclude from above ft^2)			_____ft^2	
How many buildings are part of this premise?				
What year was this building built?				

Pool	Is there a pool at the facility?	**Y N**			
	Pool Pump Quantity	___	Pool Pump HP	__	
Electric Vehicles	Does the facility have electric vehicle chargers?	**Y N**	Qty of Chargers	__	
	Is EV charger Energy Star Rated	**Y N**	Voltage	**DC 120V 240V**	
	Smart Charger Capable	**Y N**			

Other Information

All Facilities	Does your facility have Strategic Energy Management (SEM) protocols in place?	Y N	
	Has your facility participated in building retro-commissioning in the last 10 years?	Y N	
Lodging Facilities	How many guest rooms are at the facility?		
	Do PTAC/PTHP have automated setback?	Y N	
	Is keycard system present? (If so, circle all end-uses it controls)	Lighting HVAC NA	
Facilities with Food Service Equipment	What percentage of your food service equipment is purchased new as opposed to used?	____%	
	What factors are most important when purchasing additional or replacement food service equipment? *(circle all that apply)* **C** = Cost **ES** = Energy Star **T** = Length of time for delivery **EF** = Efficiency **N** = Brand New Equipment **A** = Age of newly purchased equipment **OT** = Other *(desc)*	C ES T EF N A OT: _____	
	Where do you typically shop for additional / replacement food service equipment?		
	How often do you have to replace your food service equipment?		

Electric Accounts and Meters

Utility / Provider ComEd Other_____				
Method of meter number verification: **B**=Verified Bills **M**=Verified Meter *(circle one)*				**B M**
Item #	**Meter Number:**	**Account Number:**	**Meter Status Code**	**Address** *(for multiple buildings only)*
1	**xx**	**xx**		
2				
3				
4				
5				

Meter Status Codes: **V** = Verified pre-populated meter **A** = Add meter that was found on site but not prepopulated here.
D = Delete meter that was listed here but not found onsite **NI** = Not verified meter – inaccessible: Explain in comments
OT = Other Situation: Explain in comments

*Comments:*_____
_____
_____
_____
_____

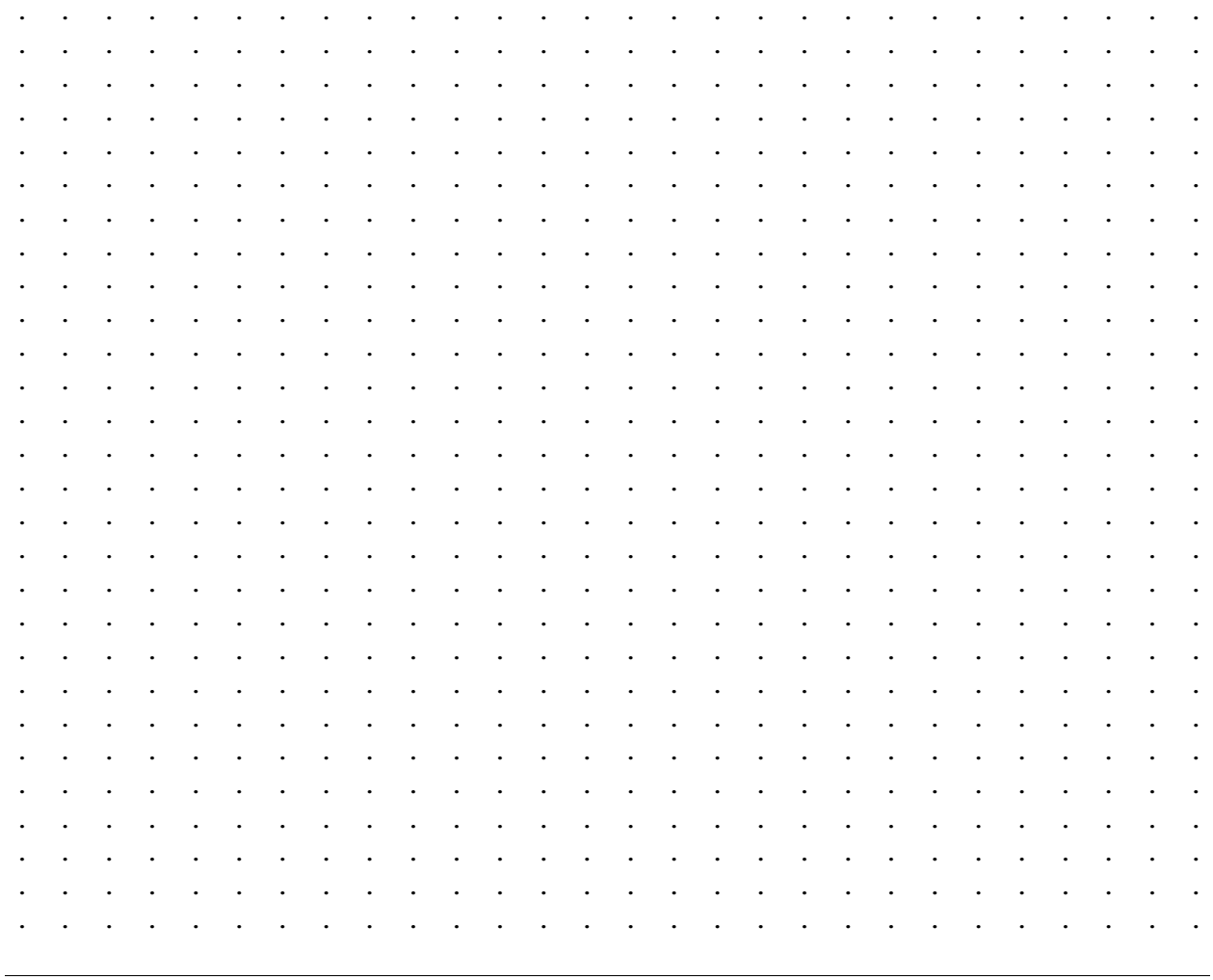
Shared Services/Electric Meters ☐ N/A

The shared service situation is: **N**= Needs explanation (use comment block) **P** = This site provides services or electricity to another site that was not part of the on-site survey. **R** = This site receives services or electricity from another site that was not part the on-site survey	**N P R**
The shared service impacts these utility services (circle all): **E**=Electricity **G**=Natural Gas **F**=Fuel Oil **L**=LPG **OT**=Other (describe in comments)	**E G F L OT**

Briefly describe the shared services and list the affected meters, if known: _____
_____
_____
_____
_____
_____

Premise/Site-Plan Sketch

This form is for the benefit of the field staff and the QC staff. It is not required to be filled out, can be substituted for building plans or building layouts, or not used at all for less complex facilities. It maybe useful for field staff to draw a layout of the building and make notes on the layout to assist with the survey.



Premise/Site-Plan sketch comments:

Premise/Site-Plan Sketch

Premise/Site-Plan sketch comments:

_____

_____

_____

_____

_____

_____

_____

_____

Building-Level Schedule Definitions

If different buildings have vastly different schedules, fill out a new page for the different buildings.

Building ID(s) Served *(List all that apply)*	
Number of Holidays per Year	

Primary Business Hours

*Define typical operation for <u>all</u> Day Types listed below and **specify hours in military time (00 to 24).** For partial (i.e. not full) operation days, also indicate the approximate % of full operation as Partial Op %.*

Day Type	Business Hours	Closed All Day?	Open 24 hrs?	% Partial Operation
Monday	from _____ to_____	☐	☐	
Tuesday	from _____ to_____	☐	☐	
Wednesday	from _____ to_____	☐	☐	
Thursday	from _____ to_____	☐	☐	
Friday	from _____ to_____	☐	☐	
Saturday	from _____ to_____	☐	☐	
Sunday	from _____ to_____	☐	☐	
Holidays	from _____ to_____	☐	☐	

Seasonal Operation Periods ☐ N/A

If the building does not operate at the typical business schedule, as listed above, then specify below which months are different. For example, if the building is closed for a week in December, December should show 75%. If the building is typically open 8am-5pm, but it is open for an additional 10 hours a week (2 hours per weekday) during the summer months (June, July, August), then those months should reflect ~ 120%.

Typical Schedule			
Month	**% of Primary Business Hours**	**Month**	**% of Primary Business Hours**
January		July	
February		August	
March		September	
April		October	
May		November	
June		December	

Holiday and Seasonal Operation Comments:

_____
_____
_____
_____
_____
_____

Building-Specific General Information

Building ID_____
(Use Letters to Specify)

BUILDING ACTIVITY TYPE CODE:		*(Use **2- letter** codes from Business Activity Type Lookup Table)*

Building/Suite General Information

Does this Building ID represent multiple buildings? *(like in the case of portable classrooms)*					**Y** **N**
Represented floor area of building/suite					_____ ft^2
Number of floors (not including basement)					
Is there a basement?					**Y** **N**
Daylighting controls used?					**Y** **N**
What year was the majority of the building survey area built?					
Is the Building LEED Certified?	Certified Silver Gold Platinum N UNK				
EMS / BAS	Is there an EMS/BAS **Y** **N**		EMS/BAS Used for DR?		**Y** **N**
	When was the EMS system installed? *(year)*	____	Year last updated?		____
	Which end uses does the EMS/BAS control? *(circle all that apply)* **IL** = Inside Lighting **OL** = Outside Lighting **HV** =HVAC units **CP** = Central Plant (chiller, boiler, etc.) **AX** = HVAC auxiliary pumps/fans **WH** = Domestic/Service Water heating **PR** = Process equipment *(describe)* **OG** = On-site generation **OT** = Other *(describe in comments)*				IL OL HV CP AX WH PR OG OT
	End/control point device type (*Circle all that apply – note predominant type in comments)*: **PN**= Pneumatic **E**=Electronic/DDC **OT** = Other (*describe*)				PN E OT
	Control Capability features (*Circle all that apply*): **B** = Basic Control (time & temp) **D** = Data Trending **O** =Optimized start/ stop **R** = Reset Optimization **DL**= Demand Limiting or load limiting				B D O R DL
	EMS is controlled and operated by: **O**=On-site Personnel **C**=Central headquarters (off site) **T**=External third-party **OT = Other**				O C T OT
If the building ID has multiple buildings/suites…	What is the total floor area of this building type?				_____ ft^2
	What % of the total floor area is heated or cooled of the surveyed building?				_____ %
	Total number of buildings of this building type				

Activity Area Definitions

Activity Area ID# Assignments *Identify an Area ID# for each distinct Activity Area type within the surveyed area. Indicate each area on the Site Plan sketch, Form 6. Also consider lighting system controls and operation when defining these areas.*

Conditioned Space Type Codes

CH = Cooled & Heated **CL** = Only Cooled **HT** = Only Heated N**U** = HVAC present but not used **RF** = Refrigerated **UN** = Unconditioned **OU** = Outside
OT = Other (describe in comments)

Area ID#	Building ID #	Activity Area Code	Surveyor's Description of Area	% of Total Represented Building Floor Area	Conditioned Space Type Code	Total Qty of this Area Actually Surveyed	Total Represented Qty of this Area Type On-site	End-Uses *NOT* Surveyed*	*Typical Lighting On-Hours per Day*	
									Weekday	*Weekend*
1								LT OF FS RF		
2								LT OF FS RF		
3								LT OF FS RF		
4								LT OF FS RF		
5								LT OF FS RF		
6								LT OF FS RF		
7								LT OF FS RF		
8								LT OF FS RF		
9								LT OF FS RF		
10								LT OF FS RF		
11								LT OF FS RF		
12								LT OF FS RF		
13								LT OF FS RF		
14								LT OF FS RF		
15								LT OF FS RF		
16								LT OF FS RF		
17								LT OF FS RF		
18								LT OF FS RF		
19								LT OF FS RF		
20								LT OF FS RF		
21								LT OF FS RF		
22								LT OF FS RF		
23								LT OF FS RF		
24								LT OF FS RF		
25								LT OF FS RF		

** Circle all end-uses that apply. Explain in comments why they were not surveyed.*

COMMENTS:

On-Site Power Generation ☐ N/A

Cogeneration, self-generation, solar cell/photovoltaic system, and emergency generators. Solar thermal (i.e. water heating) technologies are <u>not</u> recorded here.

		Item # __	Item # __
Emergency / Backup	Is this primarily an **e**mergency generator/backup system?	Y N	Y N
	-- How often is it tested? (e.g. once a month, twice a year)		
Currently Operational? (Yes, even if only down temporarily for maintenance)		Y N	Y N
- If NO, is this system permenantly out of service?		Y N	Y N
Serves: Specific Buildings (note Building IDs) or **EP** = Entire Premise			
Technology Type: **I**=Internal Combustion Engine **G**=Gas Turbine **M**=Microturbine **PV**=SolarArray/Photovoltaic **F**=Fuel Cell **W**=Wind **AES =** Advanced Energy Storage **O**=Other		I G M PV F W AES O	I G M PV F W AES O
Fuel Type (if applicable): **G**=Natural Gas **BG**=BioGas **NB**=Both NatGas&BioGas **D**=Diesel **F**=Fuel oil **GA**=Gasoline **O**=Other		G BG NB D F GA O	G BG NB D F GA O
Quantity of similar units:			
What is the unit's (or for PV plant's) generation capacity? (kW)			
System Operation			
FOSSIL-FUELED	**COGEN:** Use of heat generated (if applicable, select all that apply): **C**=Chilled water **D**=Domestic hot water **S**=Space Heat **P**=Pool **PR**=Process **N**=None **O**=Other	C D S P PR N O	C D S P PR N O
	Unit (s) used for utility Demand Response (DR) programs?	Y N	Y N
	Average operating hours per day (If seasonal, describe operation below)		
	Number of operating days per year		
	Annual Heat Capacity Output		
	Units		
Does system have Performance Metering/Monitoring?		Y N UNK	Y N UNK
PV Technology	Roof Mounted (**R**), Ground Mounted (**G**), or Carport (**C**)	R G C	R G C
	PV mounting type: **F**=Fixed **S**=Single axis **D**=Dual axis	F S D	F S D

Other Energy Services/Generation Notes: _____

_____

_____

_____

_____

_____

_____

HVAC Systems

HVAC NOT SURVEYED *(explain in comments)* ☐		**NO HVAC ONSITE** ☐		
	Item #	____	____	____
	Building ID *or* Area ID served			
	Distribution System Type: *See HVAC-CODES form*			
	Temperature control type:	M T E P SP	M T E P SP	M T E P SP
Cooling Equipment	**Cooling Equipment Type**	**N DX C E P OT UNK**	**N DX C E P OT UNK**	**N DX C E P OT UNK**
	Quantity of cooling units of this type			
	Year Installed *(or manufactured)*			
	Capacity Output **T**=Tons **k**=kBtuh *(circle one)*	**T k**	**T k**	**T k**
	Equipment Manufacturer Brand**			
	Model Number for unitary/split-system outdoor unit**			
	Model number for split-system coil**			
	Efficiency:			
	Units: EER, SEER, kW/Ton, IPLV			
Heating Equipment	**Heating Equipment Type**	**N F HP B ER RH BB P OT UNK**	**N F HP B ER RH BB P OT UNK**	**N F HP B ER RH BB P OT UNK**
	If Baseboard Heating (BB), Average Length of Heater	ft	ft	ft
	Quantity of heating units of this type			
	Fuel Type: **E** = Electricity **G** = Natural Gas **F** = Fuel Oil **P** = Propane **B** = Biomass **OT** = Other	**E G F P B OT**	**E G F P B OT**	**E G F P B OT**
	Year Installed *(or manufactured)*			
	Input Rating/Heating Capacity			
	Units of Input Rating (kW / kBtuh)	kW kBtuh	kW kBtuh	kW kBtuh
	Equipment Manufacturer **			
	Model Number**			
	Efficiency: (*enter as % for AFUE and* η)			
	Efficiency Units: **A**=AFUE **T**=Thermal η **H**=HSPF **C**=COP	A T H C	A T H C	A T H C

*** Record Make/Model Information only if other metrics like efficiency, capacity are not captured*

HVAC Inventory Comments:

_____
_____
_____
_____
_____
_____
_____

HVAC Systems *(cont.)*

Ventilation	**Item # (match to Table Above)**			___			___			___		
	Demand Controlled Ventilation (DCV)?			Y		N	Y		N	Y		N
	Economizer Type: DB = Dry Bulb **SE =** Single Enthalpy **DE** = Dual Enthalpy **OT** = Other **N** = None **UNK** = Unknown			DB OT	SE N	DE UNK	DB OT	SE N	DE UNK	DB OT	SE N	DE UNK
	% Outdoor Air (specify minimum if variable)											
	If 100% outdoor air, then Adsorbent Air Cleaners Present?			Y	N	N/A	Y	N	N/A	Y	N	N/A
	Air Handler Units	Total Number of AHU Surveyed										
		Total Number of AHU Represented										
		Return Fan	Fan Quantity									
			Average Horsepower									
			Is VSD Installed?	Y	N	UNK	Y	N	UNK	Y	N	UNK
			If no VSD, Year of Fan Motor									
		Supply Fan	Fan Quantity									
			Average Horsepower									
			Is VSD Installed?	Y	N	UNK	Y	N	UNK	Y	N	UNK
			If no VSD, Year of Fan Motor									
		Exhaust Fan	Fan Quantity									
			Average Horsepower									
			Is VSD Installed?	Y	N	UNK	Y	N	UNK	Y	N	UNK
			If no VSD, Year of Fan Motor									
		Make Up Air	Fan Quantity									
			Average Horsepower									
			Is VSD Installed?	Y	N	UNK	Y	N	UNK	Y	N	UNK
			If no VSD, Year of Fan Motor									
		ERV / HRV	Total Number of ERV/HRV									
			Average CFM of ERV/HRV									
	Number of Laboratory Vent Hoods in labs Surveyed			__	Avg. Size of Hood Opening			ft^2	DCV?		Y	N

Additional HVAC Details	**Cooling Towers**	Number of Cooling Towers		Total # CT Fan Motors		
		Avg Motor HP		Number that are VSD controlled		__
		Is VSD possible to install?		Y N		
	CW Pumps	Total Number CW Pumps in facility		Number that are VSD controlled		
		Avg Motor HP		VSD Possible to install?		Y N

General Lighting Inventory Survey Form

Record information ONLY for areas that have been surveyed (in activity area form)

Item #		___	___	___	___
(Same as Item #)		☐ ___	☐ ___	☐ ___	☐ ___
Activity Area ID#					
Indoor or Outdoor Lighting		**I O**	**I O**	**I O**	**I O**
Lighting Application Type Code					
Lamps/fixtures are accessible		Y N	Y N	Y N	Y N
Lighting System Age: Year of Installation					
Total # of Fixtures					
Control Type	Control Type **Code**				
	Bi-level / Multi-Level Switching	**Y N UNK**	**Y N UNK**	**Y N UNK**	**Y N UNK**
Fixture Details	High Bay **(HB)** or Low Bay **(LB)**	**HB LB**	**HB LB**	**HB LB**	**HB LB**
	Fixture Mounting Type **Code** ***R** = Recessed **S** = Surface **H** = Hanging*	**R S H**	**R S H**	**R S H**	**R S H**
	# of Lamps per Fixture?				
	Hardwired, **P**lug-in, **B**attery, **S**olar?	**H P B S**	**H P B S**	**H P B S**	**H P B S**
De-lamping	LF EE Delamping observed?	**Y N Inc**	**Y N Inc**	**Y N Inc**	**Y N Inc**
	LF Lamps Removed per fixture?				
Lamp Details	Lamp Type **Code**				
	LF Lamp/Tube Length, ft	2 3 4 8 ____ft	2 3 4 8 ____ft	2 3 4 8 ____ft	2 3 4 8 ____ft
	LF Lamp/Tube Diameter	T5 T8 T12 T__	T5 T8 T12 T__	T5 T8 T12 T__	T5 T8 T12 T__
	LF - If T5, High Output (HO)?	Y N	Y N	Y N	Y N
	ICL Lamp Shape/Features **Code**				
	ICL Lamp Base **Code**	**S P OT UNK**	**S P OT UNK**	**S P OT UNK**	**S P OT UNK**
	Lamp & LED Fix. Manufacturer**				
	Lamp & LED Fix. Model Number**				
	Lamp & LED Fix. Watts				
T12s	Ballast Type	**E M**	**E M**	**E M**	**E M**

*** Record make and model information ONLY if **wattage** information cannot be determined.*

Item #		___	___	___	___
Building ID					
Exit Signs	**Total Qty of Exit Signs**				
	Total Qty Exit Signs that are LED				

If the facility has T12s with magnetic ballasts	
Does the facility have T12s in storage?	**Y N**
-- If yes, approximately how many?	
When the lamp burns out, does the facility plan to: (1) Replace bulbs with T12s (2) Upgrade fixture to other linear technology? (3) Upgrade fixture to LED technology? (4) Other (explain)	
When the ballast burns out, does the facility plan on: (1) Replace ballast with like technology (currently stocked) (2) Upgrade fixture to other linear technology? (3) Upgrade fixture to LED technology? (4) Other (explain)	

Lighting Inventory Comments:

_____
_____
_____
_____
_____

Food Service Equipment ☐ N/A

DISHWASHERS *(specify high vs low temp – circle one)*						
Building ID	__		__		__	
# Dishwashers that are Under Couner	___	**High Low**	___	**High Low**	___	**High Low**
# of Dishwashers that are Single-Tank, Stationary	___	**High Low**	___	**High Low**	___	**High Low**
# of Dishwashers that are Single-Tank, Conveyor	___	**High Low**	___	**High Low**	___	**High Low**
# Dishwashers that are Pot/Pan/Utensil	___	**High Low**	___	**High Low**	___	**High Low**
# Dishwasers that are OTHER Type	___	**High Low**	___	**High Low**	___	**High Low**
Total # Dishwashers with Elec. Booster Heater						
Total # of Dishwashers that are Energy Star						

GRIDDLES			
Building ID	__	__	__
# Electric Griddles			
# Gas Griddles			
# Griddles that are Energy Star			

COMBINATION OVENS			
Building ID	__	__	__
# Electric Combination Ovens			
# Gas Combination Ovens			

CONVECTION OVENS			
Building ID	__	__	__
# Electric Convection Ovens			
# Gas Convection Ovens			

OTHER KITCHEN EQUIPMENT			
Building ID	__	__	__
# of Electric Steam Cookers			
# of Electric Commercial Fryers			
# of Electric Food Holding Cabinets			

KITCHEN VENT HOODS			
Building ID	__	__	__
# of Kitchen Vent Hoods			
Avg Size of Hood Opening	**ft^2**	**ft^2**	**ft^2**
Demand Controlled Ventilation	**Y N**	**Y N**	**Y N**

Office Equipment ☐ N/A

Record information ONLY for areas that have been surveyed (in activity area form)

Activity Area ID#		__	__	__	__	__
Total Number (#) of Desktop Computers						
% of Desktop Computers that are Energy Star		%	%	%	%	%
% of Desktop Computers with Flat Screen Monitors		%	%	%	%	%
% of Desktop Computers with Multiple Monitors		%	%	%	%	%
Total Number (#) of Laptop Computers						
% of Laptop Computer that are Energy Star		%	%	%	%	%
% of Laptops with 1 or more monitors		%	%	%	%	%
Advanced Power Strips (APS)	Total Number of APS					
	-- # Laptops connected to APS					
	-- # Desktops connected to APS					
	-- Other equipment plugged into APS *(describe multiple)*	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**
		Desc: **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**
		Desc: **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**	**Desc:** **Qty: ___**
# of Inkjet Printers						
# of Laser Printers						
# of FAX Machines						
# of Photocopiers / All-in-ones						
# of Smart Boards						
# of TVs or Video Displays						
# of Point-Of-Sale Machines						

Data Centers Survey Form ☐ No Access ☐ N/A

Area ID# *(from Activity Area Table)*	___		**Co-location Data Center**	**Y**	**N**
Size/Description:	**SC** = Server Closet **SR =** Server Room **L** = Localized < 1,000 ft² **MD** = Mid-Tier Data Center <5,000 ft² **E** = Enterprise > 5,000 ft²		**SC SR L MD E**		
Power Usage Effectiveness (PUE) *(Self Report)*	___		**Floor Area of Data Center**		**ft²**
# of Racks		**kW/Rack**		**Number of Servers per Rack**	
Air Management	**H/C, Open** = Hot Aisle/Cold Aisle, Open **H/C, Ducted** = Hot Aisle/Cold Aisle, Ducted **H/C, Enc. =** Hot Aisle/Cold Aisle, Fully Enclosed **In-Row** = In Row Cooling		**H/C, Open H/C, Ducted H/C, Enc In-Row None**		
Cooling	**IT Equipment Has Dedicated Cooling?**	**Y N**			
	Number of CRAC/CRAH systems		**Avg. Capacity of CRAC/CRAH Units**		**kBtuh**
	Total Dedicated Chiller Load	**Tons**	**Chiller Efficiency**		**kW/ton**
UPS	**Total UPS Output**	**kW**	**Is UPS Energy Star Rated?**	**Y**	**N**

Walk-Ins and Preparation Areas ☐ N/A

Walk-in/Display Case Type [A]:	**SCP =** Self-contained package **RR =** Remote/Rack System **RCU =** Dedicated system w/remote cond.-comp. unit
Temp. Range [B]:	**F**=Freezer (LowTemp) **C**=Cooler (MedTemp) **P**=Prep Area (HighTemp)
Evaporator Fan Motor Codes [C]:	**SE** = Standard Efficiency **ECM** = Electronically-commutated motor **Q =** Q-sync **OT =** Other **UNK =** Unknown
Ref Ltg Type [D]:	**T12, T8, T5** = Lin. Fluorescent **INC** = Incandescent **CFL** = CFL **LED** = LED strip, etc. **N** = None **OT** = Other

Walk-In Item #		W____	W____	W____	W____	W____
Walk-In Type [A]:		SCP RR RCU	SCP RR RCU	SCP RR RCU	SCP RR RCU	SCP RR RCU
-- If **SCP** or **RCU**, total Compressor HP						
Temp. Range [B]		F C P	F C P	F C P	F C P	F C P
Floor Area (ft^2)						
Ceiling Height (ft)						
Door gasket damaged or missing?		Y N	Y N	Y N	Y N	Y N
Auto-closer on door?		Y N	Y N	Y N	Y N	Y N
Strip Curtains present?		Y N	Y N	Y N	Y N	Y N
Economizer Present		Y N UNK	Y N UNK	Y N UNK	Y N UNK	Y N UNK
Evap. Fan	Evaporator Fan Motor Type[C]	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK
	# of Evaporator Fans					
	Avg. Motor Rating [Watts]					
Walk-In Ltg	Ref Ltg Type[D]					
	Total # of lamps					
	Watts per Lamp (average if multiple)					
Display Case Item # *(if applicable)*		D__	D__	D__	D__	D__

Display Cases ☐ N/A

Display Case Item #		**D__**	**D__**	**D__**	**D__**	**D__**
Approx. Year of Installation						
Display Case Length Lin. ft.						
Door Gasket Length (per door) Lin. ft.						
Number of Doors						
Display Case Type [A]:		SCP RR RCU	SCP RR RCU	SCP RR RCU	SCP RR RCU	SCP RR RCU
-- If **SCP** or **RCU**, total Compressor HP						
Temp. Range [B]		F C	F C	F C	F C	F C
Anti-Sweat Heater Control: A=Always On **C**=Cycling w/Humidistat **U**=Unknown **N**=None		A C U N	A C U N	A C U N	A C U N	A C U N
Evap. Fan	Evaporator Fan Motor Type[C]	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK	SE ECM Q OT UNK
	# of Evaporator Fans					
	Fan Controller Present?	Y N	Y N	Y N	Y N	Y N
	Motor Rating [Watts]					
Display Lighting	Ref Ltg Type[D]					
	Total # of lamps					
	Watts per Lamp *(average if multiple)*					

Remote Rack Systems ☐ N/A

Remote Refrigeration Rack Systems								
Compressor Details	Rack Item Number	__				__			
	Number of Compressors in Rack								
	Avg Compressor HP								
	Variable Speed Drive	Y N				Y N			
Condenser Details	# of Condenser Fans (Air-Cooled | Evap Cooled)	(air)		(evap)		(air)		(evap)	
	Fan Motor HP (Air-Cooled | Evap Cooled)	(air)		(evap)		(air)		(evap)	
	Variable Speed Drive (Air-Cooled | Evap Cooled)	Y N	(air)	Y N	(evap)	Y N	(air)	Y N	(evap)

Commercial Self-Contained/Unitary Ref. Cases ☐ N/A

Qty of Residential type refrigerators/freezers	___	Energy Star Observed?	Y N
Total Number of Ice Machines	___	Energy Star Observed?	Y N
Total Number of Refrigerated Vending Machines	___	Energy Star Observed?	Y N

Case Style Type Codes: **RI**= Reach-In **RO**=Roll-in **WT**=Worktop table **PA**=Pass-through **UC**=Undercounter **OT**=Other

Refg Ltg. Type: **T12, T8, T5** = Lin. Fluorescent **INC**=Incandescent **CFL**=CFL **LED**=LED strip, etc. **N**=None **OT**=Other

Temp Service Type: **R**= Refrigerator **F**=Freezer

Item #	Equip Code	Temp. Service Type	Case Style Type	Length (ft)	# of Doors	Vol ft^3	Total Qty	Year Manf.	Refg Ltg Type	Total lamp Qty*	Per-Lamp Watts
		R F									
		R F									
		R F									
		R F									
		R F									
		R F									

* Total Lamp Qty is across all of the refrigerated cases listed by each Item #. It is not on a per-case basis.

Equip Code	Equipment Description
SD	Solid door upright or worktop table refrigerator/freezer case, one to three doors
GD	Glass door upright refrig/freezer cases from one to three doors
BV	Glass door **beverage** merchandiser (e.g. vendor supplied) from 1 to 4 doors
OD	Open upright display case (**pizza, juice, etc**.) usually 4, 5, 6 ft lengths
OI	Open Island case (**cheese, sometimes produce or juice**) from 8 to 16 ft long
CF	Coffin type glass top freezer cases (**usually ice cream**) typically 6 or 8 ft
SC	Service case (**bakery, sometimes deli**) from 4 to 8 ft long
IM	**Ice** merchandisers (storage boxes)
OT	Other self-contained refrigerated cases not listed above (describe in comments)

Water Heating and Water Fixtures Survey Form

☐ **Not Accessible** ☐ **No Water Heating**

Water Heating Equipment Type [(A)]: (S) – Storage **(I) -** Instantaneous **(HP)** – Heat Pump **(B) -** Boiler **(C)** – Central Plant (shared) **(O)** – Other *(describe)*
Fuel Type [(B)]: (E) – Electric **(G)** – Natural Gas **(P)** – Propane **(FO)** – Fuel Oil **(S)** – Solar w/ backup

Equipment Item #		___	___	___	___
Water Heating Equipment Type [(A)]		S I HP B C O	S I HP B C O	S I HP B C O	S I HP B C O
Fuel Type [(B)]		E G P FO S	E G P FO S	E G P FO S	E G P FO S
System Details	**Equipment Age** *(years)*				
	Manufacturer **				
	Model Number**				
	Quantity				
	Service Type	DHW DHW/Heat	DHW DHW/Heat	DHW DHW/Heat	DHW DHW/Heat
	Tank Capacity *(gallons)*				
	System Efficiency & Units	EF TE	EF TE	EF TE	EF TE
	Rated Input Capacity & Units	kW Btu	kW Btu	kW Btu	kW Btu
	Reciculation Pump EC Motor	Y N	Y N	Y N	Y N

WATER FIXTURES AND MEASURES

Are Pipes Insulated?	Y N UNK	**Insulated Storage Tank**	Y N N/A
Total Quantity of Restroom Faucets ***(in restrooms surveyed)***		**Qty Bathroom Faucets ≤1.5 GPM** *(low flow)*	
Total Quantity of Kitchen Faucets ***(in areas surveyed)***		**Quantity of Kitchen Faucets ≤2.2 GPM** *(low flow)*	
Total Quantity of Pre-Rinse Spray Valves ***(in areas surveyed)***		**Quantity of of Pre-Rinse Spray Valves ≤1.28 GPM** *(low flow)*	
Total Quantity of Showerheads ***(in areas surveyed)***		**Quantity of Showerheads ≤1.75 GPM** *(low flow)*	

LAUNDRY

Number of Residential-Style Clothes Washers		**Number of Electric Residential Clothes Dryers**	
-- # Res. Clothes Washers that are Energy Star		**Number of Gas Residential Clothes Dryers**	
Number of Commercial-Style Clothes Washers		**Number of Electric Commercial Clothes Dryers**	
-- # Com. Clothes Washers that are Energy Star		**Number of Gas Commercial Clothes Dryers**	

Ozone Washers	**Qty of Com.-Style that are Ozone Washers**	

*** Record make and model information only if Size, Capacity, and Efficiency cannot be determined onsite*

Water Heater and Fixture Comments:

_____
_____
_____
_____
_____
_____

Compressed Air Systems Survey Form ☐ N/A

Dryer Type [A]: R = Refrigerated **D** = Desiccant **C** = Centrifugal **OT** = Other **N** = None

	Compressor System Item #	___	___	___	___
	System Weekly Run Hours				
Comp. Air System	**Size of Air Storage Tank** *(gallons)*				
	System Controller Type: LL = Lead/Lag **S** = Sequencer **M** = Master Controller **N** = None	**LL S M N**	**LL S M N**	**LL S M N**	**LL S M N**
	Dryer Type [A]	**R D C OT N**	**R D C OT N**	**R D C OT N**	**R D C OT N**
	Total Dryer System Capacity *(CFM)*				
	Zero Loss Condensate Drains	**Y N DK**	**Y N DK**	**Y N DK**	**Y N DK**
	Leak Repair Frequency *(months)*				
	Blow Nozzles — **Number of Air Nozzles per System**				
	Blow Nozzles — **% of Air Nozzles that are Adjustable**				
	Blow Nozzles — **% of Nozzles that are Engrd. Blow / Entrainment Nozzles?**				
	Comment / Notes				

Compressor Survey Form ☐ N/A

Compressor Type Code [B]: (R) – Reciprocating **(RS)** – Rotary Screw **(RV)** – Rotary Vane **(C)** – Centrifual
Control Type Code [C]: (S/S) – Start/Stop **(L/NL) –** Load/No Load **(M) –** Modulating **(D/AD)** - Dual Control/Auto Dual **(VD) –** Variable Displacement **(VSD) –** Variable Speed Drive

Compressor Item #	___	___	___	___	___
Compressor System #	___	___	___	___	___
Compressor Type Code [B]	**R RS RV C**	**R RS RV C**	**R RS RV C**	**R RS RV C**	**R RS RV C**
Control Type [C]	**S/S L/NL M D/AD VD VSD**	**S/S L/NL M D/AD VD VSD**	**S/S L/NL M D/AD VD VSD**	**S/S L/NL M D/AD VD VSD**	**S/S L/NL M D/AD VD VSD**
Age of Compressor *(years)*					
Qty of Similar Comp.					
Full Load Efficiency *(kW/ton)*					
Compressor Rated Power *(kW)*					
Compressor Size *(Horsepower)*					
Low Pressure Drop Filters	**Y N DK**	**Y N DK**	**Y N DK**	**Y N DK**	**Y N DK**
Comment / Notes					

Compressed Air Comments:

_____
_____
_____
_____
_____
_____

General Comments

Item #	Form Name	Comments