COMMERCE DEPARTMENT
ENERGY RESOURCES

Small Commercial Characterization

4/30/2018
Contract 104450

Conservation Applied Research and Development (CARD) FINAL Report

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ACKNOWLEGEMENTS

This project was supported in whole by a grant from the Minnesota Department of Commerce, Division of Energy Resources, through the Conservation Applied Research and Development (CARD) program, which is funded by Minnesota ratepayers. The authors would also like to acknowledge the kind support of all stakeholders, including the utilities in Minnesota, the Center for Energy and Environment, CERTS, and all the building owners who generously allowed their time, and for many, access to their buildings. We also acknowledge the cooperation of Illume Advising, who shared resources and worked alongside us as they completed a related study in Minnesota.

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Executive Summary

Seventhwave conducted primary and secondary research on the small commercial sector in Minnesota. The objective of this research is to provide insights on energy use and attitudes toward energy in this sector and to inform energy efficiency program designs that address barriers to participation.

The small commercial sector is historically difficult to reach due to its dispersed nature and other market barriers. Several Minnesota utilities do not have programs specifically targeting small businesses, and those energy efficiency programs that do target the sector have long been dominated by lighting-only retrofit programs. As federal lamp standards become more stringent and market penetration of efficient products grows, lighting-only programs will have increasing difficulty achieving savings goals. New, more holistic programs that address the barriers facing small commercial customers are needed to serve this market and contribute to achieving the 1.5 percent savings goal.

To help surpass these barriers, Seventhwave characterized this hard-to-reach market, focusing especially on more comprehensive opportunities that go beyond lighting retrofit. We identified promising program strategies for reductions in heating, cooling, ventilation and process loads.

Method

For purposes of this study, we define small commercial businesses as businesses with less than 50 employees, the primary exception being food service establishments which tend to have high number of employees per business. For those businesses, we increased the employee limit to 100 employees.

Seventhwave collected data from 1,440 small businesses in Minnesota using a telephone survey. Respondents provided information on types of equipment, energy conservation behaviors, and energy decision-making authority for the business. We recruited 100 businesses from the phone survey to participate in a site visit which gathered more detailed information. These businesses were proportionally selected both in and around the Twin Cities and throughout Greater Minnesota and included offices, food service, retail and grocery establishments. Seventhwave also obtained utility consumption histories from 54 businesses.

Using this data, we developed a list of 100 measures spanning all relevant end-uses and determined savings values using the Minnesota Technical Reference Manual (TRM), other state's TRMs or engineering calculations. We then combined this information with the results of our secondary research on small business program best practices to develop recommendations for program approaches to address this sector.

Small business characteristics

According to the U.S. Census Bureau's County Business Patterns, most of the small businesses in Minnesota employ fewer than five people and only one-tenth employ 20 or more. Nearly half of small business employees in Minnesota work in retail, accommodation and food service or health care.

The small businesses in our study occupy spaces that tend to be smaller than 5,000 square feet and are in a single-story building. There were very few businesses overall that occupied spaces larger than 50,000 square feet.

We found a variety of building ownership structures within the business segments: retail, food service and office business segments are more likely to lease or rent their businesses space, while groceries are likely to own their building.

Business owner attitudes and motivations

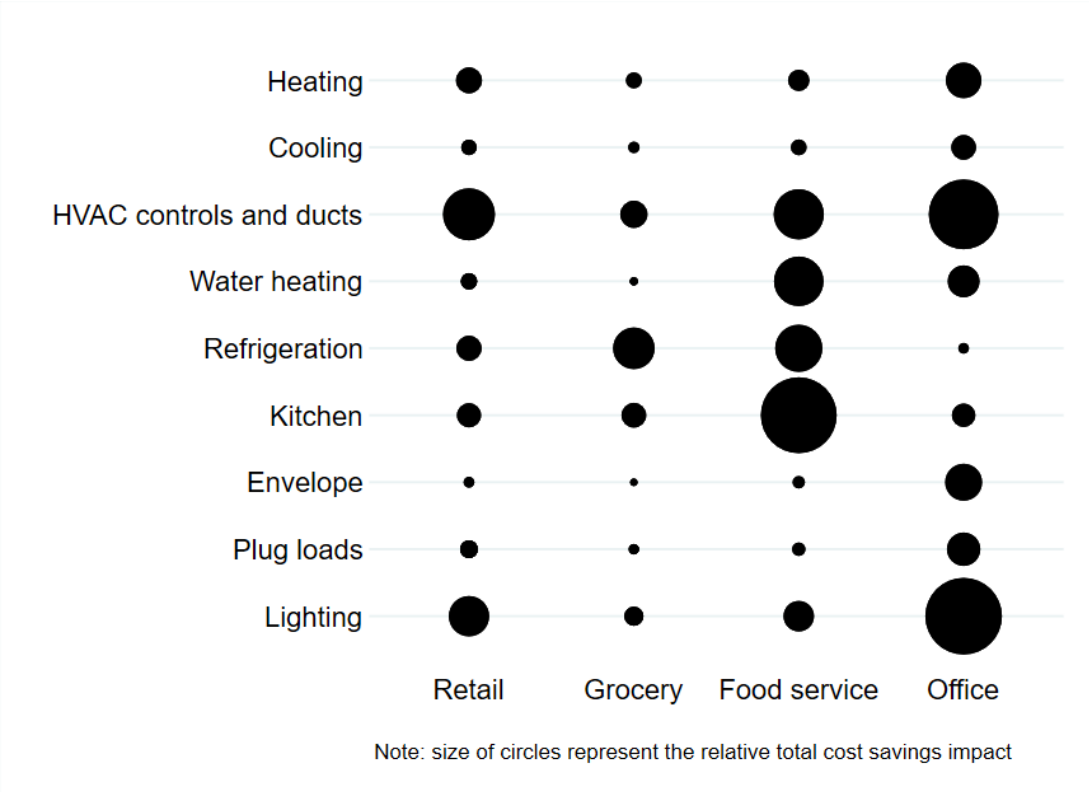
Small business owners spend little time thinking about energy usage in their business. Generally, the owners or managers that we interviewed spent on average about five percent of their time thinking about energy-related topics, including things like HVAC maintenance. This varied slightly depending on the business segment, with the highest proportion of time spent by food service owners or managers and the lowest spent by retail owners or managers.

Less than half of the businesses we interviewed participate in utility energy efficiency programs and the lowest rate is among food service and grocery establishments. Most business owners were aware of lighting rebates, but less aware of other opportunities. Interestingly, several respondents remarked that they were aware of residential rebates, but not business rebates. See *Attitudes and motivation of owners and managers* for more detail.

Characteristics and opportunities

From the hundreds of businesses that we surveyed and the 100 that we visited, we quantified a wide variety of both building characteristics and opportunities across all building end uses. The *Energy usage and energy savings opportunities* section provides tables characterizing this data for a number of different parameters and categories. A summary of the specific measures would be too detailed to cover in an executive summary, but the savings opportunities for each major end use are summarized in Figure 1. This figure shows the relative potential across entire state of Minnesota, with savings weighted according to the number of building of each type in the state.

Figure 1. Total energy savings potential in Minnesota small businesses, by end use



Program opportunities

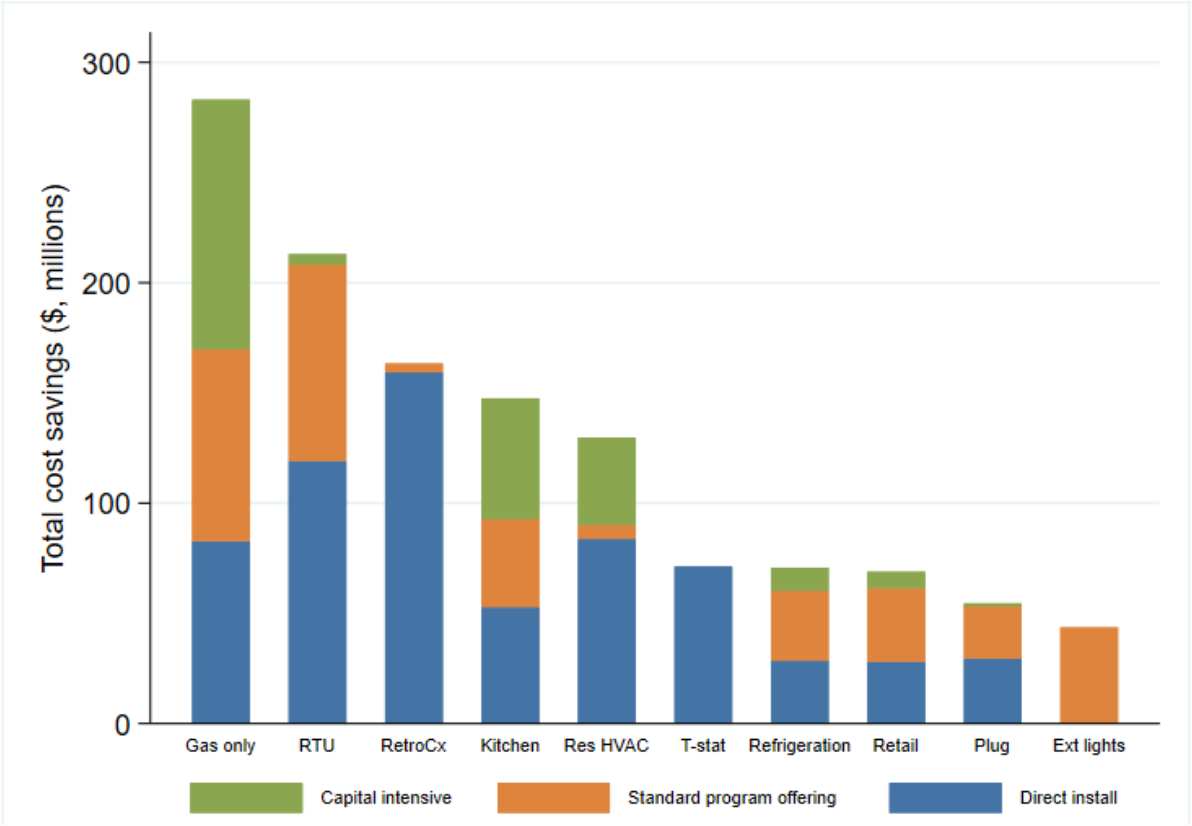
We organized the energy-saving opportunities that we identified into a series of measure bundles, each representing a potential program offering or area that a utility could use to support its small business customers. These measures are bundled to appeal to business types that use certain equipment and are tiered to provide a customer journey from low cost to higher cost opportunities. The ten program bundles are:

1. **Capture gas savings**. Many Minnesota gas utilities do not have a significant offering for small business customers. This program bundle represents a potential solution to that gap.
2. **Tackle rooftop units.** This measure bundle addresses the prevalence of RTUs in small commercial businesses.
3. **Retrocommissioning.** Considers the ability to take this typically large-building focused program to smaller businesses.
4. **Taming kitchen energy intensity.** Targets the high energy use of commercial kitchen equipment.
5. **HVAC crossover.** We found a striking amount of overlap between residential and commercial HVAC. This package provides energy efficiency opportunities for small businesses that use residential-style HVAC systems.
6. **Everyone has a thermostat.** A program bundle made up of highly cost-effective approaches to improving thermostat control in small businesses.

7. **Refrigeration.** Promotes upgrades to the refrigeration systems that use a substantial amount of energy in every small grocery and convenience store.
8. **Selling efficiency to retail**. Retail is the least energy intensive of the building types we observed, but is a common building type in Minnesota and therefore worth some type of targeted offering.
9. **If it's plugged in, it's plug load.** This offering addresses the growing energy use from plugged-in equipment that is present in most small businesses.
10. **Exterior lighting.** A logical next step for existing lighting programs focusing on interior retrofit is to move outside.

The energy savings potential for each of these program areas, by delivery method, is summarized in Figure 2.

Figure 2. Total cost savings from recommended measure bundles, broken out by program type



Introduction

According to the US Census Bureau's 2013 County Business Patterns (CBP), there are roughly 138,000 small businesses in Minnesota, accounting for 94 percent of all businesses in the state and employing over one million people.

This sector is historically difficult to reach due to its dispersed nature and their competing demands, and so often benefits from a specific, targeted approach. Several Minnesota utilities do not have programs specifically targeting small businesses, and those energy efficiency programs that do target the sector have long been dominated by lighting-only retrofit programs. This is the case in Minnesota and elsewhere in the Midwest. Though these lighting programs have had significant success, there is a need for more holistic programs in the small commercial sector. Programs will have increasing difficulty achieving savings goals through lighting in the future as federal lamp standards become more stringent and market penetration of efficient products grows.

In addition, gas utilities recognize a lack of options for cost effective program offerings in the sector. New, more holistic, programs are needed in Minnesota to serve the small commercial sector and contribute to achieving the 1.5 percent savings goal.

To address these issues, Seventhwave characterized this hard-to-reach market by identifying important sector segments using public data and identifying key energy savings opportunities in those segments using both telephone surveys and on-site data collection. Coupling the primary data collected with best-practice research from around the country, Seventhwave identifies promising program strategies to motivate small business owners to consider reductions in heating, cooling, ventilation and process loads, in addition to lighting energy reductions.

Objectives

The goal of this research is to provide the necessary foundation to pilot new ideas or adapt ideas from other sectors to address the Minnesota small commercial market. Our key objectives include:

1) understand key segments of the small commercial building sector in Minnesota and document how those buildings use energy;

2) identify barriers and opportunities for implementing energy efficiency improvements in those segments beyond basic lighting; and

3) recommend strategies for utility programs.

Part of this research was also conducted in collaboration with another CARD-supported study specifically focused on behavioral opportunities in the energy efficiency sector (Illume, 2017); the objectives were closely correlated and some efforts directly served both projects.

Report Organization

The remainder of this report provides our findings, which are presented as follows:

- We begin with a literature review of typical program approaches, both in Minnesota and nationally, to give readers perspectives about current state of programming in small business segments (pg. 15)
- We discuss the methods of this research (pg. 22) to understand the small business sector in Minnesota, including our methods for telephone surveys, site visits, measure analysis, utility bill analysis, and program analysis.
- We discuss the key characteristics of small businesses in Minnesota, including details on the four targeted businesses, building characteristics such as age, size, occupancy rates, ownership structure and renovations (pg. 28)
- The attitudes and motivation section (pg. 35) explores our qualitative conclusions on motivations, attitudes, and perspectives of energy usage and program participation based on our interviews with business owners and managers during our site visits.
- In the section on energy usage and energy savings opportunities, we report the bulk of our findings and conclusions about end-use characteristics, measure opportunities and program recommendations (beginning on pg. 41)
- We first provide an overview of building energy usage, with a summary of the utility data that we weather-normalized (pg. 41)
- The overview of measure opportunities (pg. 43) summarizes the highest savings opportunities by building type.
- For each end use, we provide a summary of characteristics and highlight the most prevalent savings opportunities associated with that end-use (beginning on pg. 49)
- Finally, we offer our program conclusions that are informed by the measure opportunities, building characteristics and secondary research conducted (pg. 77). We organize these conclusions into recommended technical bundles followed by recommendations for implementation approaches or strategies.
- The references used in this report are listed beginning on page 103.

In addition to the main body of the report, a series of appendices (starting on pg. 105) provides additional details about the study and our methods.

Background on Small Business Programs

Our background research on small business programs included a review of the research (evaluations, papers, reports, presentations) on programs and potential for energy savings from this sector, and a review of the approaches that have been used to engage this market.

Existing research

Our literature review looked at contemporary programs and evaluations or research around best practices for energy efficiency programs targeting small businesses. Traditionally, small commercial programs focus on:

- Direct install programs: implementers or vendors install energy efficiency measures at the business site with approval of the customer. These are easy-to-install measures such as LED bulbs and the delivery approach is designed to be simple: the business does not need to fill out applications, get bids for the work, or wait to get a rebate (Nowak, 2016).
- Small business as a market channel: specialized marketing of standard business programs to reach smaller customers.
- Free or reduced cost energy assessments
- Lighting replacements, along with some specialized programs for certain small business types like restaurants or convenience stores, which offer other retrofits

In recent years, there has been increasing interest in tapping this hard-to-reach market, and in transitioning to more comprehensive approaches that not only reach beyond lighting but also potentially incorporate multiple systems at once. Following is an annotated bibliography of the literature pertinent to small business energy efficiency programs.

York, Dan et al. 2013. Frontiers of Energy Efficiency: Next Generation Programs Reach for High Energy Savings.

It has become more challenging for energy efficiency programs to reach savings targets as efficiency standards for appliances and other equipment have increased and building codes have become more stringent. In this report, York et al. looks at what the next generation of programs need to focus on to achieve higher energy savings.

Overall, York et al. highlighted the following trends in the next generation of energy efficiency programs:

- Focusing on system efficiencies in commercial and residential buildings rather than the efficiency of individual technologies
- Focusing on process optimization in industry

- Tailoring programs using data analytics to reach underserved market (and increase participation)

- Designing behavior-based programs that motivate customers to reduce energy use

In the small commercial sector, energy efficiency programs have been slowly making inroads in these historically hard-to-reach businesses. However, the programs that have been successful have tended to be direct install lighting programs. Savings from these programs will decline as minimum efficiency standards and building codes raise the baseline efficiency of lighting systems. In order to continue to capture energy savings from small businesses, efficiency programs will need to broaden the end-uses they target beyond lighting to achieve deeper savings per business and increase the number of program participants. End-uses to target include refrigeration and miscellaneous plug loads.

Harvey, Constance. 2013. Best practices in small commercial HVAC programs at California utilities.

This report reviewed small commercial HVAC efficiency programs that were offered by three California utilities. All three utility programs similar delivery mechanisms and included downstream and upstream incentives, demand response, and quality installation and maintenance. Two best practices identified included:

- **HVAC distributor incentive program**. The goal is to increase the sale and stocking of high efficiency HVAC equipment for commercial installation. When done well, this strategy is successful because a small number of manufacturers and distributors can make a substantial impact on the decisions to purchase and install high efficiency equipment.

- **Contractor training**. The goal is to ensure that contractors install high efficiency HVAC equipment correctly, ensuring that it performs as intended and delivers the savings expected.

Meyers, Steven. 2011. Achieving Success in Small Business Markets When Traditional Marketing Won't Do it All. Presented at AESP Spring Conference, Atlanta, GA.

EnerPath delivers turnkey energy efficiency programs for utilities nationwide targeting residential and small business customers. Their turnkey programs for small businesses follow a tiered structure in which they offer something simple at no cost, provide the customer with a positive experience and give them a path to buy more efficiency. Of the programs we reviewed, the Focus on Energy Small Business Program follows this model most closely. Their tiered model includes:

Tier 1—Quick payback, inexpensive measures that would not require financing and would be provided for free or with a co-pay required from the customer

Tier 2—Longer payback measures that require some payment from the customer. These measures would typically have a utility incentive (e.g., rebate)

Tier 3—Measures that require significant capital investment by the customer and can be supported using outside financing. Renewable projects could also qualify.

Some of the lessons they've learned from delivering this turnkey program to small businesses are:

- This segment needs education about energy efficiency and all the available programs
- Close rates can exceed 60 percent when speaking with customers face-to-face
- Businesses open utility company mail – use this connection to market the program

York, Dan et al. 2015. Expanding the Energy Efficiency Pie: Serving More Customers, Saving More Energy Through High Program Participation. ACEEE, Washington, DC.

ACEEE identified program participation as a critical metric for increasing energy savings from utility energy efficiency programs. This report highlights small business programs that were successful at reaching this historically hard-to-reach segment by taking specific actions to expand participation. Some of these actions included:

- Extending loan terms
- Enhancing the sales skills of staff delivering the program
- Simplifying the process with standard forms to make it easier to participate
- Adding a job skills training component

Garland, Gregory. 2013. Successful Tactics for Improving Customer Satisfaction in Small and Unassigned Businesses through Energy Efficiency. Proceedings of the 2013 AESP National Conference, Orlando, FL.

Increasing energy costs and power outages were leading to customer satisfaction issues among DTE's unassigned business accounts (customers with less than 500,000 kWh annual usage). In an effort to provide these customers with a better experience from their utility, DTE launched a campaign in early 2012 to increase their awareness and participation in DTE's energy efficiency business program. The campaign was designed to educate small business owners on ways to lower their monthly bills. DTE provided the resources, training and education, from special offers and promotions to training utility auditors and installers, to convince their customers that they understood their business and were concerned with their satisfaction.

In order to effectively communicate with and provide the product offerings most appropriate to this customer class, DTE segmented them into five broad categories based on the results of a commercial segment study:

- Leave Me Alone
- Help Me Learn
- Energy Efficiency Advocates
- Budget Focused

- Tech/Thought Leaders

They then tailored their communication and product offerings to each segment except the budget focused group. DTE decided not to target this group because they believed they were least likely to participate in the program.

DTE found the following communication channels to work effectively for their small business customers:

- Canvass – show up with an offer they can't refuse; this was the most effective outreach tactic
- Direct mail – small business owners read their mail
- Bill inserts – small business owners pay attention to their bills
- Word of mouth – when one small business owner participates, they are likely to tell their friends, families and other businesses

Through this small business campaign, DTE successfully increased the participation of small businesses in its energy efficiency program. They also saw an improvement of nearly 20 percent in satisfaction among these customers.

Preservation Green Lab et al. 2013. *Realizing the Energy Efficiency Potential of Small Buildings*. National Trust for Historic Preservation, Washington, DC.

This report characterizes small commercial buildings (smaller than 50,000 square feet) and identifies the scope and scale of energy efficiency opportunities in this sector more specifically than has been done before.

Exemplary Program Approaches

We looked at small business program designs and approaches around the U.S. There are several programs both regionally and nationally that are developing better, more holistic practices for getting to energy savings beyond lighting in the small commercial sector. These programs include exploring new approaches (Nowak, 2016) such as:

Vertically integrated implementation in which the implementer of the program handles everything from administration, to outreach, to managing different contractors in different trades to get the work done.

An exemplary program employing this model is Ecology Action's SMART Scale. The Sacramento Municipal Utility District demonstrated this approach and saw as much as twice the savings from the SMART Scale program model than they were capturing from traditional direct install programs that focused on lighting.

Leverage existing business relationships (through business associations) to make small businesses aware of energy efficiency for their business and energy efficiency programs that could help them.

One example of this approach was the small business energy coaching pilot program which was a partnership with the Lake Street Council (an association serving the Minneapolis Lake Street business community), the Great Plains Institute's Metro Clean Energy Resource Team, and the Minnesota Chamber of Commerce Energy Smart program. The Lake Street Council was the face of the program, connecting its business members to the Energy Smart program. Metro CERT assisted with overall project coordination.

Neighborhood blitz targeting municipalities where small businesses are clustered in the main business district or neighborhood business districts in larger cities with high densities of small businesses. A neighborhood blitz is a variation on a direct install program. Targeted businesses in a narrow geographic area receive a mailing announcing that energy advisors will be in the area on a specific day. On blitz day, the advisors conduct free audits of the business and install low-cost measures.

Eversource (then NStar) implemented the Main Street Energy Efficiency Pilot program in 2013 and achieved nearly 100 percent participation. The program installed lighting retrofits, exit sign retrofits, LEDs, and pre-rinse spray valves among other measures.

Financing. We suspected, and confirmed in our research, that both cash flow and pure capital are barriers to any measure with substantial cost. This does not impact the majority of measures, but in any more holistic approach where measures with deeper savings need to be considered financing can help overcome those barriers. It is relatively common in small business programs, either direct through the utility or through a third-party financer.

Target energy intensive end uses in small businesses. This approach targets end uses that a small business would have, such as commercial coolers or freezers in a convenience store, and streamlines the process for participating in the program.

Arizona Public Service has an "express solutions" program designed for small and midsize commercial customers. The program provides a free energy assessment and discounts up to 90 percent on qualifying lighting and refrigeration equipment. The program focuses on these end uses because they offer the most savings potential and quick paybacks.

Pacific Gas and Electric tested customer reaction to advanced programmable thermostats in a pilot demand response program. They used HVAC contractors to deliver and install the thermostats.

A full list of research identified in our literature review can be found in Appendix A.

Existing small commercial programs in Minnesota

Minnesota utilities have a variety of energy efficiency programs serving their commercial customers. Primarily, programs for small commercial customers are direct install or prescriptive programs that offer rebates for specific energy efficiency measures. To draw small commercial customers to a direct install program, they offer a free audit and installation of low-cost measures such as programmable thermostats, LED bulbs and faucet aerators. Prescriptive rebate programs will market the rebates by

targeting specific types of businesses, such as foodservice or convenience store/gas station. However, these programs generally are not designed specifically to address the barriers that a small business might have in investing in energy efficient products.

Small business owners generally have both time and financial constraints, and limited knowledge of energy efficient products or the actions they can take to make their business more energy efficient. They likely lease their space creating disincentives to make capital improvements. Addressing these barriers specifically differentiates those programs that target small businesses from the more generic commercial energy efficiency programs.

An example of a program that is designed to address the specific barriers that small businesses face is the Center for Energy and Environment's One-Stop Efficiency Shop®.

The Center for Energy and Environment runs the One-Stop Efficiency Shop® for small commercial customers in Xcel Energy's Minnesota service territory. This program uses the assessment-plus-incentive approach (Nowak, 2016) to promote lighting and RTU upgrades. It overcomes the barriers that small business owners face by offering a full-service program that helps the business through the entire process from conducting an onsite audit, providing recommendations and estimated costs, offering substantial rebates, arranging reasonable financing and project contracting, and completing all the program paperwork. The energy assessment and recommendations are provided free of charge and substantial rebates (up to 60 percent of the energy efficiency project cost) on lighting retrofits and RTU improvements are designed to ensure participation.

Some utilities have also employed a small business energy savings blitz. This direct install approach targets municipalities where small businesses are clustered in the main business district. Energy advisors go from business to business offering onsite energy audits and installing low-cost energy efficiency measures such as LED bulbs and faucet aerators. The energy advisors provide the business with a report identifying energy saving opportunities and available incentives. Currently, Minnesota Power offers this program to interested municipalities.

Interviews with energy efficiency program stakeholders indicate that, while utility programs have tried approaches targeting small commercial customers, most utilities do not currently offer programs specifically designed for these customers. The following table provides an overview of some of the different efforts in Minnesota that have been made to engage small commercial customers in reducing their energy use.

Table 1. Overview of small commercial programs in Minnesota

Program name	Provider	Measures included	Delivery mechanism
One Stop Efficiency Shop	CEE	Lighting, RTU upgrades	Direct install for lighting. Contractor delivered for RTU.

Program name	Provider	Measures included	Delivery mechanism
Energy Coaching Pilot	Minneapolis Lake Street Council; Energy Smart and Metro CERT	Energy assessment and lighting upgrades	Partnered with local business organizations on outreach to the community.
Door-to-door pilot	SMMPA and CERTS	Mostly lighting and cooling	CERTS conducted door-to-door outreach and hand-holding assistance to get SMMPA customers to consider programs
Small Business Energy Saving Blitz	Minnesota Power	Energy assessment	Dedicated week offering onsite energy analysis to small businesses in a city or town.

Method

Identifying Small Businesses

For purposes of this study, we define small commercial businesses as businesses with less than 50 employees, with the primary exception to this definition being food service establishments which tend to have high number of employees per business. For those businesses, we increased the employee limit to 100 employees. Typically, a small commercial utility program may include businesses that have a maximum level of energy demand or usage; however, we were limited in this research because we did not have access to utility data to choose our sample population. Therefore, we used number of employees as a proxy since it is a readily available data point in the Census CBP. We exclude self-employed individuals, farms, and entities in a handful of other industry sectors.

Stakeholder interviews

We also needed to understand the landscape of small commercial programs and other small business energy efficiency activity in Minnesota to put our results in context, and aid in the creation of program recommendations. To that end, we conducted interviews early in the project with six Minnesota utilities with an interest in small commercial programs, two consultants implementing such programs, and Department of Commerce staff. We followed up with a few of these organizations throughout the project to get feedback on specific concepts. Some of the results of these interviews can be found in *Existing small commercial programs in Minnesota*. All results were taken into account in our conclusions and recommendations at the end of the report.

Survey

The team collected data from 1,440 Minnesota small businesses via a telephone survey administered from June through early October of 2016. Professional interviewers contacted each business and used screening questions to identify an employee with knowledge of the company's energy use practices and equipment. The interviewers gathered data on the types of equipment, energy conservation behaviors, and the energy decision-making authority in the businesses surveyed.

The team collaborated with the CARD Behavior Segmentation and Potential Study to develop a combined survey instrument and joint data collection activity. This collaboration allowed the teams to expand their sample size and to ensure that the research projects did not over-burden small businesses with multiple requests for survey participation.

Sampling Strategy

To ensure a representative sample of small businesses, the team stratified the sample by:

Number of employees: very small (1 to 9 employees); small (10 to 49 employees); medium (50 to 99 employees). These definitions align with publicly available data from the 2013 US Census County Business Patterns (2013 CBP).

Business segment: food service, grocery and convenience, retail, wholesale, education, office. The team identified six business types (plus an "other" category) that align with both the Commercial Buildings Energy Consumption Survey (CBECS) data and NAICS codes to serve two purposes: 1) to stratify the sample based on the most common small business types in Minnesota and 2) to enable extrapolation of potential estimates to county and utility service territories by merging results with the 2013 US Census Zip Code Business Patterns (2013 ZBP) and 2013 CBP data. The team identified the top six CBECs building types based on aggregate gas/electric bills and mapped NAICs codes to these types.

Location: Twin Cities vs rest of Minnesota. The team stratified the sample based on location to enable comparisons between the Twin Cities and the rest of the state (hereafter, Greater Minnesota) and to meet the sampling needs of the CARD Behavior Segmentation and Potential Study.

The final sample definition included 29 strata, shown in Appendix F.

Survey Instrument

The survey instrument included screening questions and questions on businesses practices, building details, decision-making, and end-uses as described in Table 2. The complete survey instrument is included in Appendix B.

Table 2. Survey question types

Data Class	Types of Data	Rationale for Inclusion
Screening criteria & firmographics	The responsibilities and decision-making authority of the respondent within the organization	To identify and screen for the individuals most likely to (a) be aware of, and (b) take action in response to their enegy use.
Screening criteria & firmographics	Self reported business type and asociated NAICs codes	To align with NAICs codes and screen for eligible business types
Screening criteria & firmographics	Size of the organization, number of employees	To screen for eligible businesses (<100 employees) and to align with census data to map back to the GIS database, for segmentation.

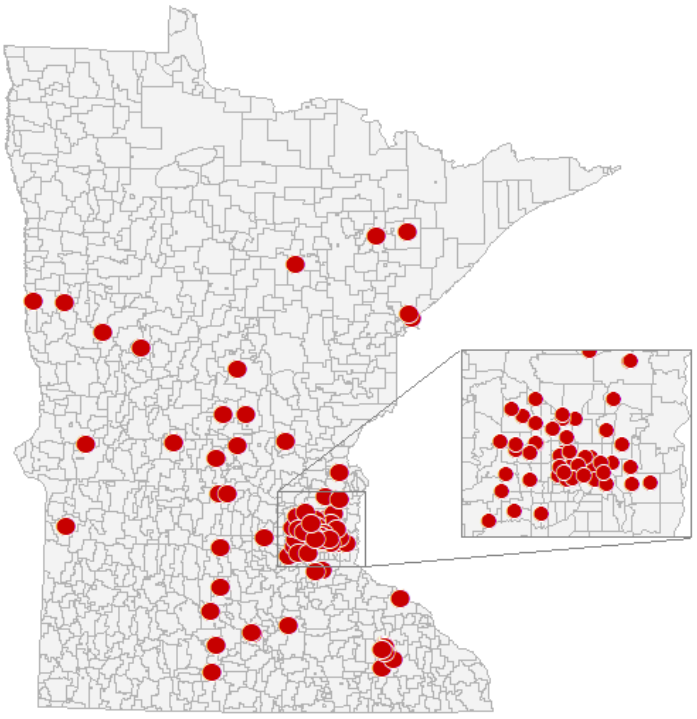
Data Class	Types of Data	Rationale for Inclusion
Screening criteria & firmographics	Sales volume	To align with census data to map back to the GIS database, for segmentation.
Building detail	Building type: Free-standing, multi-unit; exterior materials window coverage, insulation	To support engineering estimates and assumptions and to better classify businesses based on opportunties.
Building detail	Building ownership: Lease or own	To determine the types of actions businesses take to reduce their use.
Business practices	Hours of operation: Determine hours during which the premises are occupied	To determine how impactful various end use behavior or setting modifications may be on the business.
Business practices	Decision-making practices: Determine who makes decisions about equipment purchases, maintenance, and operations	To identify whether decisions are made by the business owner, property manager, landlord, or corporate office.
End use detail	End uses and settings: Identify the presence of end uses in the business, including: heating, cooling, lighting, plug load, and specialty equipment	To identify the specific end uses in place within the data to inform segmentation and the engineering estimates of the savings potential of end use behaviors.
End use detail	End use practices: Identify any practices regularly carried through within the business, such as shutting down of equipment, temperature set-backs, etc.	To inform estimates of the savings potential of altered end use behaviors.
End use detail	Control over key end use practices : Determine the extent to which the respondent has control over the management of end uses, such as HVAC, lighting, plug load, settings	To determine whether or not there are barriers to behavior modifications within the business due to competiting priorities and users.

Site visits

Survey respondents were asked if they would be interested in participating in a site visit component of the study. From this pool, we recruited and completed site visits for 100 businesses between the fall of 2016 and the summer of 2017. For purposes of the site visits, we limited our scope to four business segments: retail, grocery/convenience stores, food service, and offices; these segments were chosen based on levels of energy intensity, interest from interviewed Minnesota stakeholders, and gaps in existing knowledge in the state. The four segments comprise of nearly 50% of small commercial energy usage.

In total, we visited, 25 offices, 24 food service, 22 retail and 29 grocery establishments. These businesses were geographically diverse, proportionally selected both in and around the Twin Cities and throughout Greater Minnesota as illustrated in Figure 3.

Figure 3. Size visit locations throughout Minnesota



The objective of the site visit was to gather more detailed information about the business, its equipment and the owner's or manager's attitudes towards energy. To that end, we designed a field instrument capable of capturing over 800 unique data points for each business. The initial portion of each site visit was an approximately 15-minute interview with facility staff, during which we gathered high level information about the business and building. In addition, during this period, we gathered information surrounding the businesses' operations and attitudes towards energy. We spent the remainder of the site visit independently gathering data about: building geometry, envelope, interior and exterior

lighting, HVAC, domestic hot water, plug loads, refrigeration, kitchen equipment, and other miscellaneous loads.

Utility bill analysis

We asked telephone survey and site visit participants for permission to obtain energy usage histories from their energy providers. Ultimately, we received usable utility consumption histories for 54 businesses. To analyze the energy consumption data, we merged the consumption data with temperature data from nearby weather stations, and ran algorithms intended to disaggregate space-heating and cooling consumption from other end uses—as well as normalize each businesses usage to 30-year weather norms. See Appendix F for details.

Measure analysis

We reviewed more than 120 distinct measures that spanned all significant end-uses. Ultimately, we narrowed the list to 100 measures, spanning all relevant end-uses including HVAC, domestic hot water, refrigeration, kitchen equipment, plug loads, lighting, and other miscellaneous measures. Note that the measures were key in developing the data we intended to gather on site.

We developed an opportunity incidence rate based on the data collected onsite. This metric represents the percentage of relevant businesses for which the opportunity exists. For instance, a business would have an opportunity to upgrade its furnace if it 1) had a furnace and 2) that furnace was non-condensing. For a few measures, we used the larger telephone survey to develop incidence rates; however, the telephone survey did not capture the level of detail we needed to fully explore the majority of measures. The measure saving values in terms of normalized electricity and natural gas were developed using Minnesota Technical Reference Manual (TRM) savings assumptions and when that information was unavailable, we looked towards other states' TRMs or engineering calculations. The measure list and assumptions used in savings calculations can be found in Appendix D.

The normalized savings (i.e. kWh and therm savings per square foot) were then applied along with the opportunity incidence to each building we visited. In this manner, we calculated per premise average savings. We then weighted each building savings by its representative factor within the greater population in order to calculate the statewide savings potential of a given measure.

Program analysis

To develop the conclusions found in the *Program Opportunities* section, we first looked to the areas of energy waste identified in our primary data collection. We then looked to our secondary data collection of literature and program experiences from across the country. As a result, recommendations are made based on both new program approaches that appear to fill gaps in Minnesota, as well as best practices for more holistic programs from other states and regions that appear to be a good fit for Minnesota.

Uncertainty Estimation

There are several sources of uncertainty involved in the study. At the first level, there is sampling uncertainty associated with the survey data from which some of the characteristics and measure conclusions were derived: one would expect repeated survey samples to yield slightly different results simply due to random variation from one sample to the next.

For example, our analysis indicates that the margin of error for the statewide proportion of food service businesses that are in a standalone building structure is about ±5 percentage points.[1] In theory, in nine cases out of 10, the survey results would differ by no more than five percentage points from the results that we would get if we could survey all businesses in the state. We should note that in practice, there are factors such as survey non-response and response biases that may introduce other sources of error into the results: these are difficult to quantify, although we attempted to mitigate them through robust survey techniques. Additionally, we expected to see more electrically-heated buildings in our sample than what we actually encountered. With the small number of these buildings, we did not feel comfortable weighting them up to the total population, so there may be a bias towards non-electrically-heated buildings.

The uncertainty is greater with data gathered only on the site visits because our site data sample is significantly less than our survey sample, with only 100 buildings. For information gathered on our site visits, there is generally a margin of error of approximately ±17 percentage points, with a slightly better uncertainty for the grocery business segment (at ±15 percentage points) because of a higher number of grocery site visits proportional to the total population of grocery establishments. For ease of reading, we report the point estimates of technical savings only, but the reader should note that each estimate has a wide band of uncertainty.

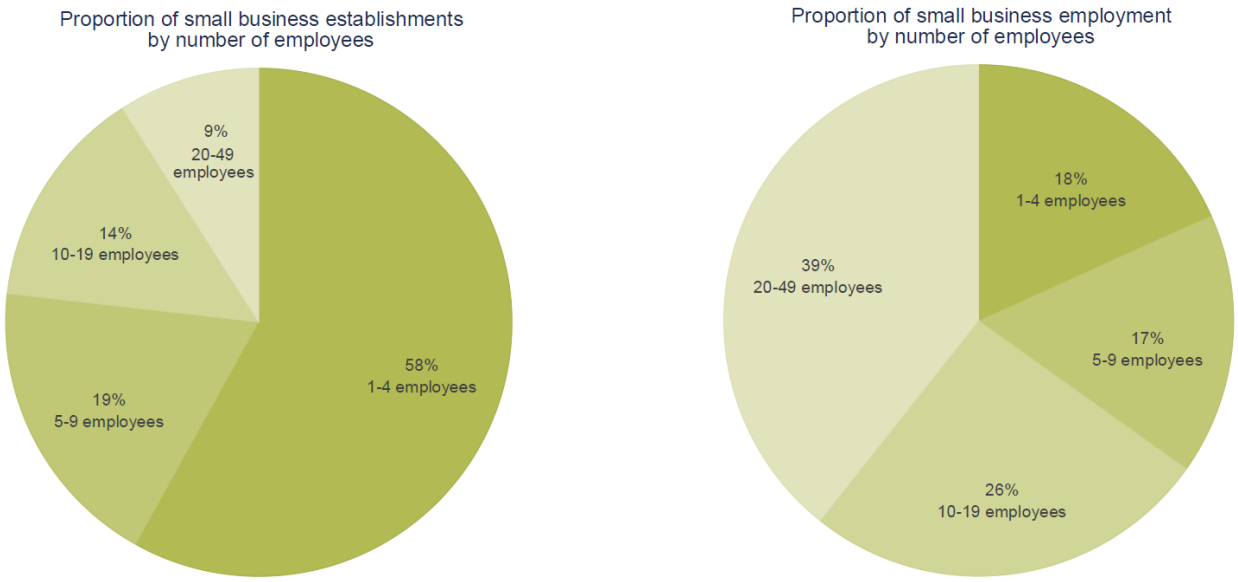
[1] At a 90 percent confidence level.

Overview of small businesses in Minnesota

Population description

According to the CBP, the majority of small businesses in Minnesota employ fewer than five people and only one-tenth employ 20 or more (see Figure 4). Conversely, the majority of people employed by a small business work at an establishment with at least 10 employees. Only one-third of small business employees in Minnesota work at the smaller sized establishments.[2]

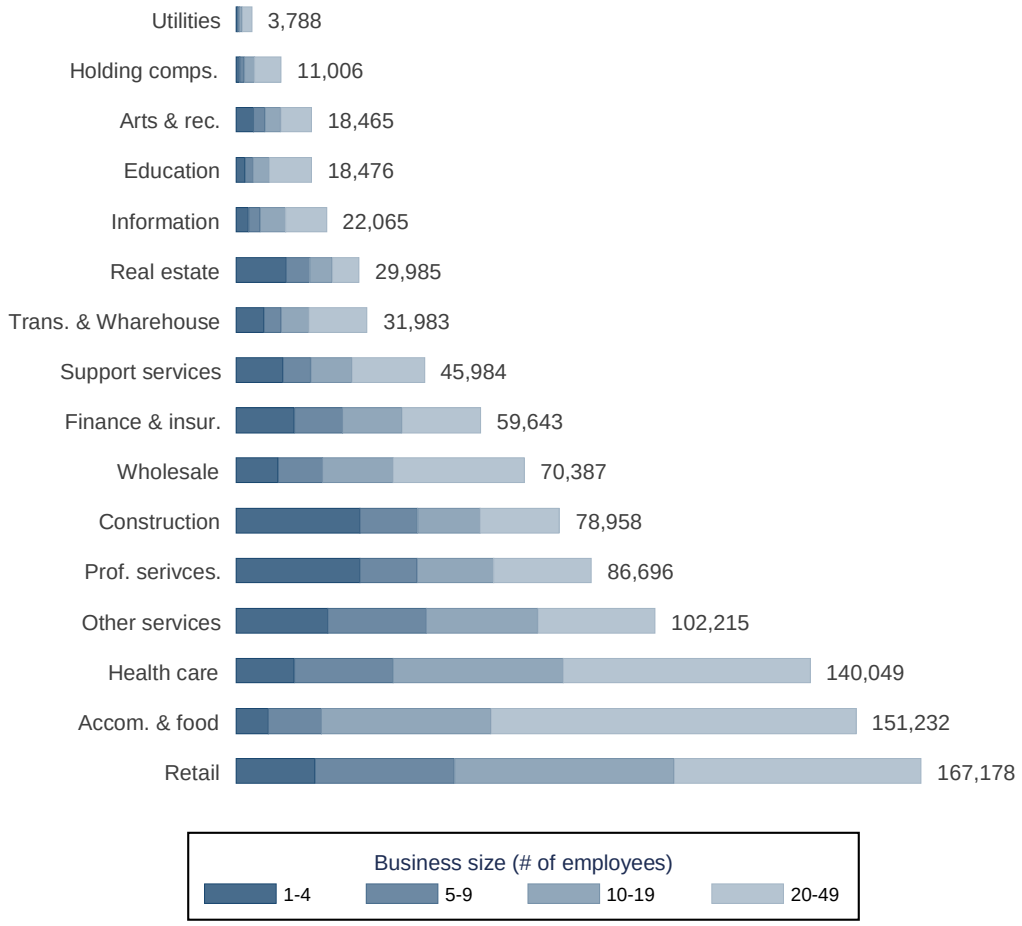
Figure 4. Small business establishments and estimated employment, by business size category



Nearly half of small business employees in Minnesota work in retail, accommodation and food service or health care (Figure 5). In 60 out of the state's 72 counties, the predominant industry is accommodation and food, measured by estimated employment. Industries with the least small business employment tend to be industries typically associated with larger entities, like utilities and education. Construction and professional services, industries that might be considered larger businesses, stand apart with a large portion of these segments' employment among businesses with 1-4 employees. The breakout of business size within each sector is shown by the graduated blue shading on each bar in Figure 5.

[2] CPB does not break out employment statistics by establishment size categories. Employment-based statistics in this analysis are based on estimates using the midpoint of the size category. For example, to estimate the number of employees at businesses with 1-4 employees, we multiplied 2.5 employees by the number of establishments in that category.

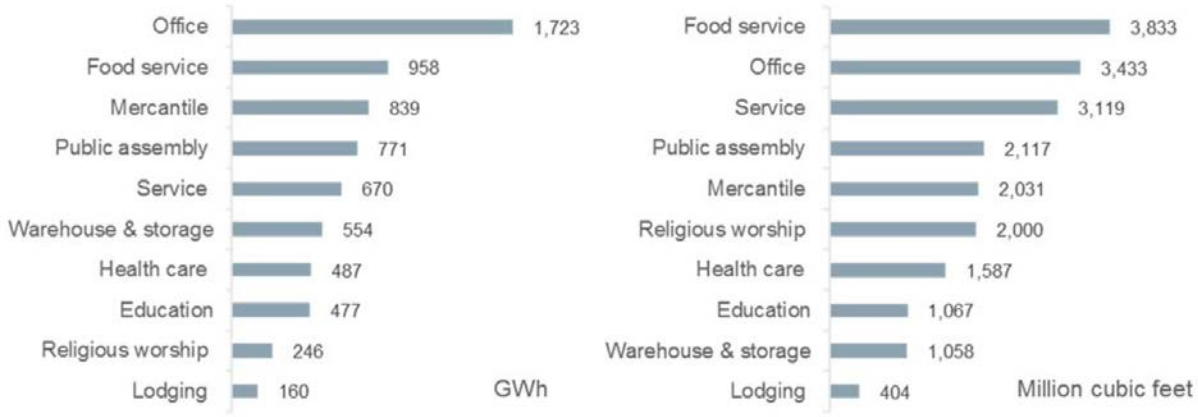
Figure 5: Estimated employment among small businesses in Minnesota, by industry sector and business size category



A common barrier to reaching small businesses is the split incentive that occurs when an entity (e.g. landlord or tenant) that could potentially make an energy improvement is different from the entity that pays the utility bills and therefore benefits from the energy saved. This is certainly an issue in Minnesota's small businesses, but only for some. Census data shows that *by square footage* 66 percent of small business space is not subject to the split incentive; the same entity both owns the infrastructure and pays the utility bills.

Moving beyond square footage, energy usage may be the most relevant metric to describe small businesses for the energy efficiency community. Figure 6 describes the energy used by each major business activity (i.e. segment) in the state. Office spaces use the most energy of any segment due to the sheer quantity of square footage devoted to the segment. Less common segments like food service and service also use a substantial amount of energy due to their much higher energy intensity. Public assembly and mercantile (i.e., retail) round out the large energy users.

Figure 6. Total electricity (GWh) and natural gas (million cubic feet) consumption among small businesses in Minnesota, by primary business activity



Examples of Small Commercial Businesses

Small businesses are comprised of a diverse set of services and building types. As part of our field research, we visited 100 small businesses within the four business types that ranged from mom-and-pop retail shops to offices in multi-tenant commercial structures. Figure 7 shows photos of the diversity in building types that we visited.

Figure 7. Examples of building types from the site visits

Key characteristics of small businesses

In this section, we provide general building and business characteristics of the four business segments that are the focus of this research. The results are summarized primarily from the telephone surveys. With the larger sample of respondents in the telephone survey, they provide a more representative view of the four business segments than the smaller sample of onsite visits.

The small businesses in our study occupied spaces that tended to be smaller than 5,000 square feet and located in a one-story building (Table 3). There were very few buildings overall that occupied spaces larger than 50,000 square feet.

Table 3: Building characteristics of small commercial businesses – business area and number of stories

	Overall	Retail	Grocery	Food Service	Office
Business total area					
Less than 5,000 square feet	73%	61%	76%	60%	78%
5-10,000 square feet	11%	10%	10%	19%	10%
10-25,000 square feet	9%	14%	7%	11%	7%
25-50,000 square feet	4%	6%	4%	8%	3%
More than 50,000 square feet	3%	9%	2%	3%	1%
Building total stories					
One story	62%	69%	76%	90%	51%
Two stories	23%	22%	12%	5%	31%
Three stories	5%	4%	3%	2%	8%
Four to nine stories	6%	4%	5%	2%	7%
More than 10 stories	3%	1%	5%	2%	3%

Table 4: Ownership structure and building type

	Overall	Retail	Grocery	Food Service	Office
Ownership structure					
Lease their business space	57%	61%	24%	60%	60%
Own and occupy the whole building	41%	38%	72%	39%	38%
Own the building but lease out space	2%	1%	4%	2%	2%
Building type					
Free-standing	46%	38%	71%	48%	44%
Multi-tenant commercial	38%	31%	14%	25%	48%
Enclosed mall or strip mall	19%	34%	18%	29%	11%
Percent of building occupied by tenant*					
Mean percentage	81%	78%	81%	68%	84%

* Site visit data

We found a variety of ownership structures within the business segments (Table 4). For retail, food service and office business segments, it was more likely that they lease or rent their businesses space. The opposite is true for the grocery segment, where nearly three quarters of the businesses own and occupy the whole building. In terms of the building structure, we are more likely to see the grocery business segment in free-standing buildings, while the other business segments were more commonly

found in multi-tenant or mall structures. Offices that are not in free-standing structures are more likely to be found in multi-tenant structures rather than malls. There were a few businesses that owned the building but leased out the space to other tenants.

For those businesses that are leasing their space, the majority of business segments have a lease longer than five years. Yet, nearly a quarter of food service and office business segments have a relatively shorter lease of two to four years, which may make longer-term investments such as energy efficient upgrades more challenging to justify.

Table 5: Length of lease

	Overall	Retail	Grocery	Food Service	Office
Length of lease *					
1-year lease	5%	14%	0%	7%	0%
2 to 4-year lease	16%	0%	11%	25%	20%
5 to 20-year lease	64%	73%	89%	56%	60%
Greater than 20-year lease	16%	14%	0%	12%	20%

* Site visit data

The number of peak occupants varies considerably among business segments (Table 6). Food service establishments are most likely to see the most occupants come through their doors, with the three other business segments ranging relatively evenly between 10 and 100 peak occupants. We found that these four business segments are likely to employ less than 10 employees, with the exception of food service establishments which generally employee a range between 1 and 49 employees.

Table 6: Number of peak occupants and number of employees

	Overall	Retail	Grocery	Food Service	Office
Number of peak occupants*					
less than 10 occupants	9%	15%	2%	5%	9%
10 to 19 occupants	27%	22%	37%	13%	31%
20 to 49 occupants	36%	43%	24%	6%	43%
50 to 100 occupants	12%	10%	25%	27%	9%
more than 100 occupants	15%	9%	12%	49%	9%
Number of employees					
less than 10 employees	62%	63%	53%	37%	72%
10 to 19 employees	18%	22%	28%	22%	14%
20 to 49 employees	15%	14%	14%	26%	11%
50 to 100 employees	5%	1%	6%	15%	2%

* Site visit data

A significant number of businesses report that their buildings were either built or majorly renovated in the last 15 years (Table 7). This skew towards newer buildings may stem from the fact that our question

emphasized both the building age and when the building was majorly renovated; it is likely that the very oldest buildings have been renovated in the more recent past. About a third of our site visit respondents said that they had a lighting renovation in the last two years, which may be indicative of the increasing competitiveness of high efficiency lighting.

Table 7. Building age or last major renovation

	Overall	Retail	Grocery	Food Service	Office
Building age or last major renovation					
Contemporary building (last 15 years)	50%	51%	46%	64%	45%
Post-energy crisis	35%	33%	40%	24%	39%
Post-WWII	8%	10%	9%	4%	9%
Pre-WWII	7%	6%	5%	8%	7%
Last major lighting renovation *					
Within last 2 years	37%	37%	45%	31%	38%
3 to 10 years ago	12%	15%	8%	9%	12%
More than 10 years ago	3%	10%	4%	8%	0%
Never had lighting renovation	47%	38%	43%	52%	49%

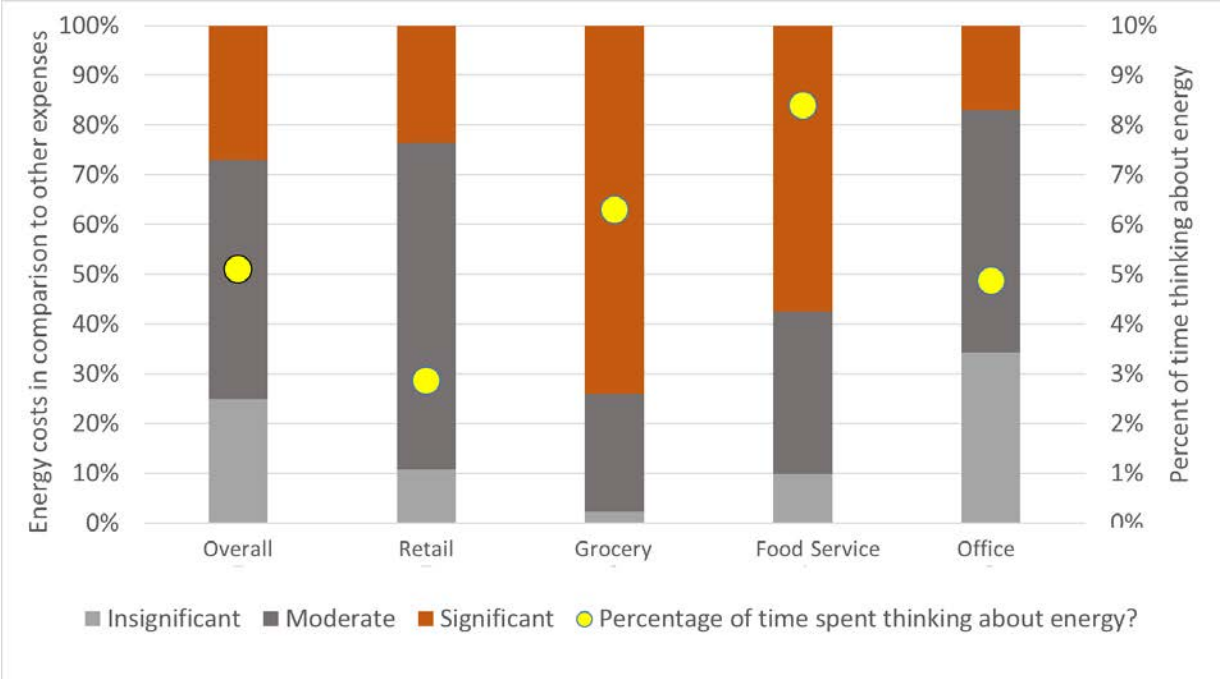
* Site visit data

Attitudes and motivation of owners and managers

In addition to the building and equipment characteristics of small businesses, we wanted to identify challenges that small business owners and managers face, to understand underlying trends that may affect all small businesses. At the start of each site visit our researchers asked the owner or manager a series of questions to explore perception of energy use, plans for investing in energy upgrades, and motivations behind those plans.

We found that while some owners and managers found their energy costs to be significant relative to other expenses, little time is spent devoted to thinking about energy usage in the business (Figure 8). Generally, the owners or managers that we interviewed spent on average about five percent of their time thinking about energy-related topics, including things like HVAC maintenance. This varied slightly depending on the business segment, with the highest proportion of time spent by food service owners or managers and the lowest spent by retail owners or managers. Similarly, food service and grocery business segments reported significantly higher energy costs, which is not surprising considering the energy consumption of refrigeration and food-service related equipment. Yet, it was less likely that those owners or managers in food service establishments benchmarked their energy data against previous years or other similar buildings (Table 8).

Figure 8: Energy costs in comparison to expenses and percent of time thinking about energy



Overall, a strong majority of businesses did not benchmark or did not know if they benchmarked their energy consumption data. Some used an auto-pay approach and didn't even see their utility bills. This highlights an opportunity for small business owners and managers to take a closer look at their energy

consumption on a regular basis to understand how their business stacks up against other similar businesses—or for the utility to do it for them.

Table 8: Incidence of benchmarking

	Overall	Retail	Grocery	Food Service	Office
Do you benchmark?					
Yes	35%	32%	39%	22%	39%
No	62%	59%	61%	70%	61%
Don't know	3%	9%	0%	9%	0%

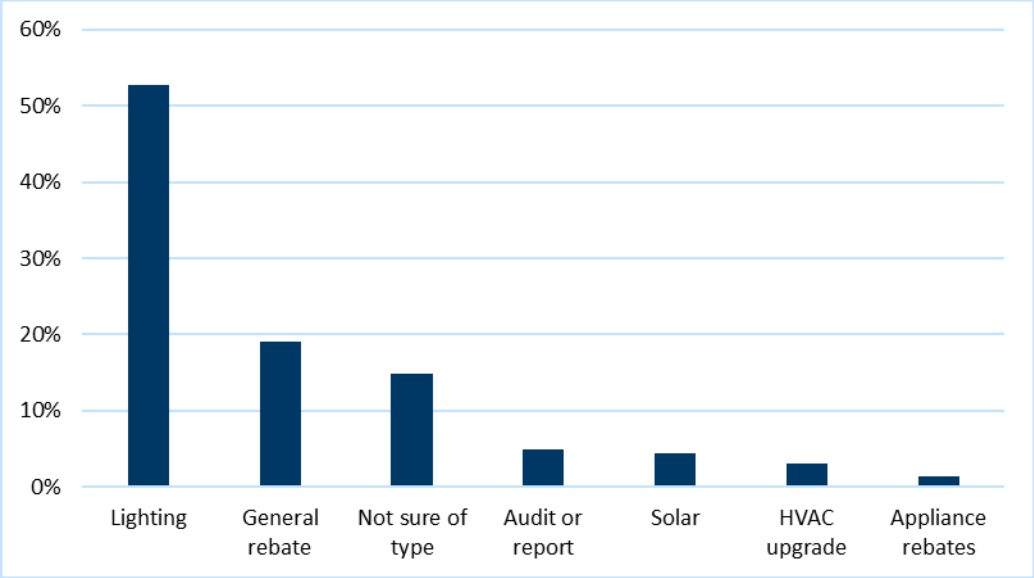
A majority of business owners and managers were aware of utility rebates or technical assistance; however, there were still a significant number that expressed that their utility did not offer rebates even when nearly every business was eligible for them (Table 9). Additionally, when we asked an open-ended question on which types of rebates utilities offer, most businesses were aware of lighting rebates, with a smaller percentage that said either a "general rebate" or weren't sure of type (Figure 9). The remaining responses ranged from HVAC upgrades, audits and appliance rebates. This suggests opportunity for utilities to get beyond lighting in this sector simply by making customers more aware of different opportunities. Though it wasn't a quantified response, a number of respondents also remarked that they were not aware of business rebates, but were aware of the residential rebates they were offered in their utility bills at home.

Less than half the businesses said they participated in programs, with the lowest rates of participation (around 30 percent) in food service and grocery establishments. Some who were aware of programs but hadn't participated in them reported a lack of knowledge on how to participate in the programs.

Table 9. Knowledge of utility rebates

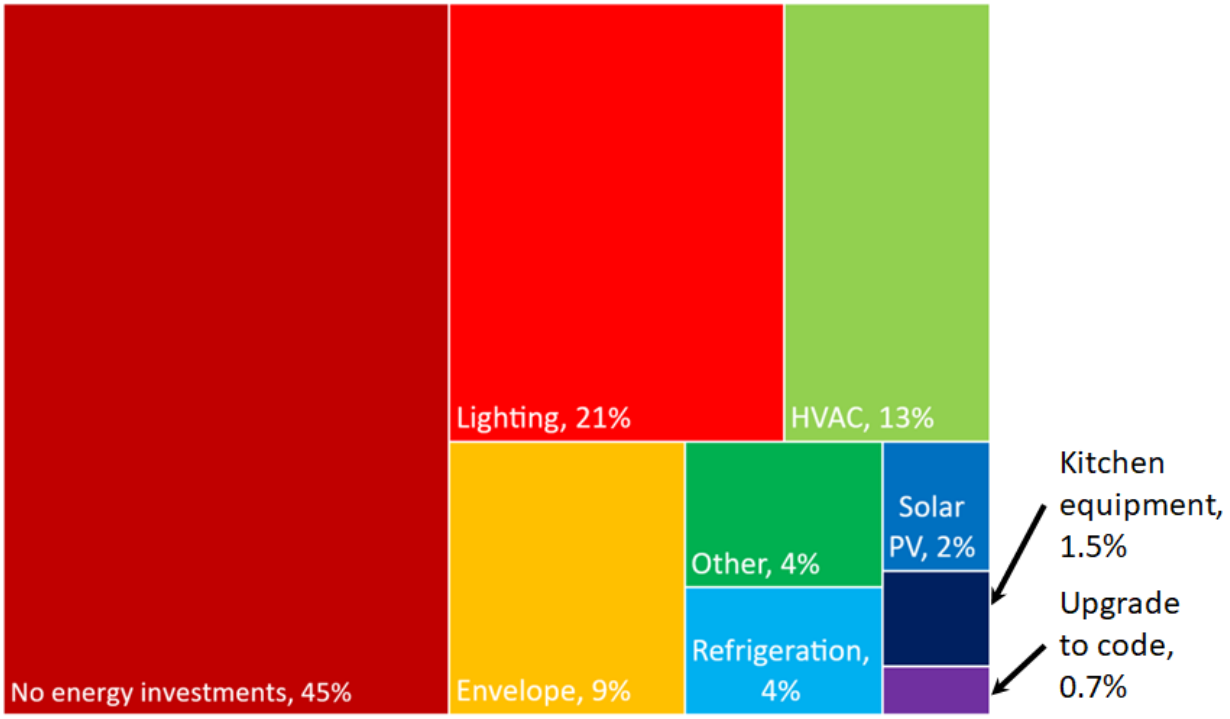
	Overall	Retail	Grocery	Food Service	Office
Does your utility offer technical assistance or rebates?					
Yes	65%	82%	64%	48%	65%
No	23%	5%	21%	35%	26%
Don't know	12%	14%	14%	17%	10%
Have you participated?					
Yes	46%	43%	33%	30%	52%
No	53%	57%	63%	65%	48%
Don't know	1%	0%	4%	5%	0%

Figure 9: Responses to what types of programs their utilities offer



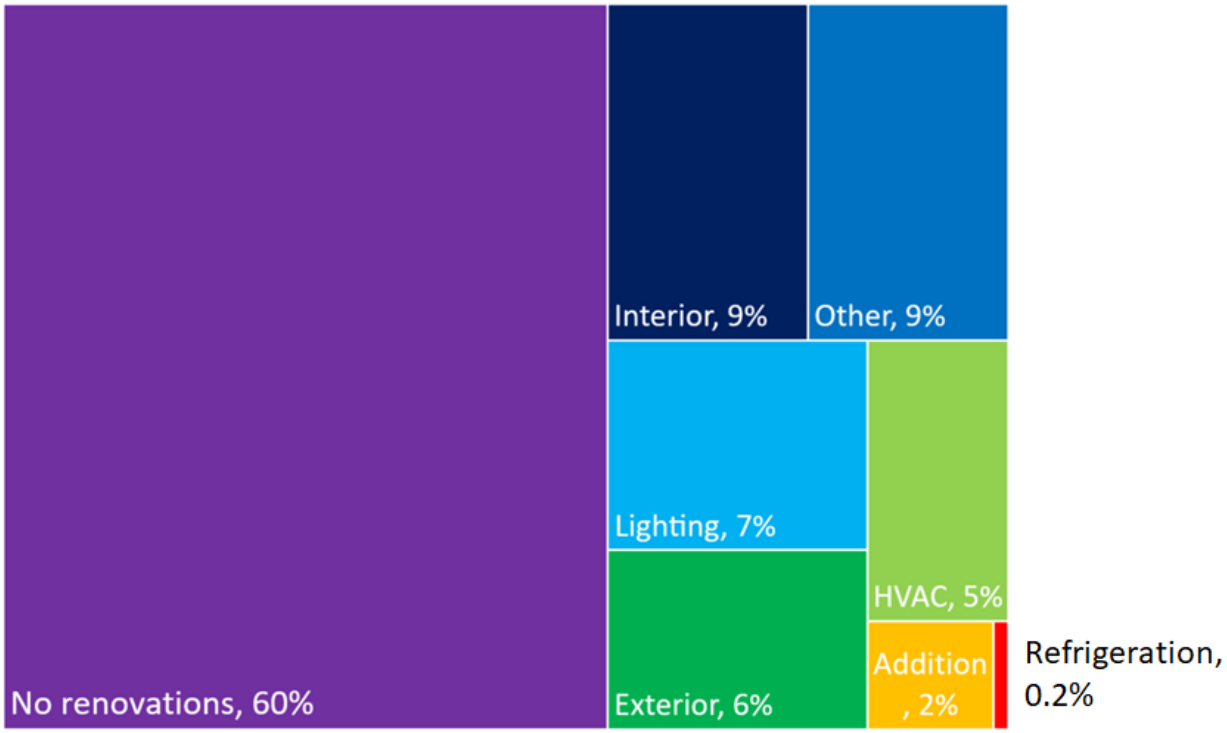
While business owners and managers may say they spend only a small portion of their time thinking of energy in their jobs, a significant number reported that they have made some energy upgrades in the past five years, ranging from lighting (the most frequently reported at 21 percent overall), HVAC and envelope. Some grocery establishments also reported having upgraded refrigeration in the past five years.

Figure 10: Energy investments in past five years



When asked about future plans for renovation (energy-related and otherwise), most businesses said that they are not planning for renovations in the next five years (Figure 11). Those that did point out a renovation were more likely to say that they were planning for an interior renovation, a lighting upgrade or a non-categorizable "other" which may include new driveway, new patio or selling the business. The retail respondents showed a higher prevalence of plans for lighting upgrades (22 percent compared to the average 7 percent).

Figure 11: Future planned renovations in the next five years



We explored motivations and barriers related to investing in energy efficiency equipment or processes. For those that made recent energy efficiency investments, we probed on the primary reasons for making those investments (Table 10). The two most prominent reasons were to save money or because they had to make an end-of-life equipment replacement. This underscores the importance of clearly conveying the options for small businesses to not only save money but be able to time projects for when they need it most at the end of a piece of equipment's life. Comfort-related motivations also were prevalent especially in the office segment—some owners recorded issues with both winter and summertime discomfort. In retail, another main reason was that the investment was part of another remodeling effort or move. For grocery stores, the appearance of the system they were replacing played a role in making the investment. The business case most often cited in our interviewers was the desire to be more "green." The other category includes: security reasons, financing available, corporate policy, and contractor recommendations

Table 10. Reasons for making energy efficiency investments

	Overall	Retail	Grocery	Food Service	Office
Reason for making investments					
Save money	30%	32%	39%	23%	31%
End of life replacement	25%	35%	32%	42%	18%
Comfort reasons	12%	0%	2%	3%	18%
Part of remodel or move	8%	15%	2%	9%	6%
Aesthetic preference or convenience	7%	3%	17%	0%	9%
Business case	6%	0%	2%	0%	9%
Durability/functionality	5%	6%	5%	3%	4%
Other	8%	9%	0%	20%	6%

Table 11 shows the barriers that were expressed by the owners and managers on our site visits. Respondents had the opportunity to list all perceived barriers, although we did not ask respondents to rank them. Many respondents listed the lack of capital as being a barrier, and to a lesser extent, the question of payback was cited as a reason not to make investments. Owners remarked that they might take action if they only knew what their top cost-effective measures would be, and have some proof that they were cost effective.

Food service owners and managers had slightly higher responses for the barrier of lack of expertise to make a decision; this suggests that the investments they are considering are more complex than other business segments. Lack of time to think about investments was most prevalent in food service compared to other business segments. And while we initially hypothesized that the owner and renter split incentive would be a strong disincentive to make investment, we found that relatively few of our respondents cited it as one. The other category includes: savings not high enough, waiting for improved business cycle, project too complex, negative impact on product / process/customers, they wouldn't receive the benefit, they are a franchise, bad previous experience.

Table 11: Barriers to energy efficiency investments

	Overall	Retail	Grocery	Food Service	Office
Barrier to efficiency investments					
Lack of capital	30%	57%	37%	17%	27%
Need better/specific payback	12%	10%	13%	17%	11%
Other priorities	9%	0%	6%	13%	11%
Lack of expertise	9%	4%	9%	19%	7%
Waiting for equipment to fail	8%	5%	4%	6%	11%
Lack of time	5%	0%	14%	7%	4%
Owner/lease disincentive	4%	9%	4%	2%	4%
*Other**	22%	16%	11%	19%	27%

About half of the small commercial businesses in our study report belonging to a business organization (Table 12). When asked about what kind of business organization, they often specified a chamber of

commerce or similar general local business support entity. They also reported belonging to business-specific organizations, such as a restaurant organization or a grocery association. These business associations may offer a unique avenue of communication for program outreach and education. This will be discussed further in the program recommendations section.

Table 12: Business association membership

	Overall	Retail	Grocery	Food Service	Office
Belong to business associations?					
No	47%	45%	48%	50%	47%
Yes	53%	55%	52%	50%	53%

The scope of this research project did not cover solar or renewable energy opportunities, so we did not quantify attitudes or potential for this resource. But it's worth noting that in our open-ended questions, a significant number of small business owners expressed a desire to add solar panels to their businesses. We use the generic term "solar panels" here on purpose—owners did not generally have a specific type of solar or any specific plan in mind, but simply desired to use solar to both save energy and presumably promote their business. This is certainly an area for consideration for small commercial programs, when and where regulation allows for them to support renewable energy.

Energy usage and energy savings opportunities

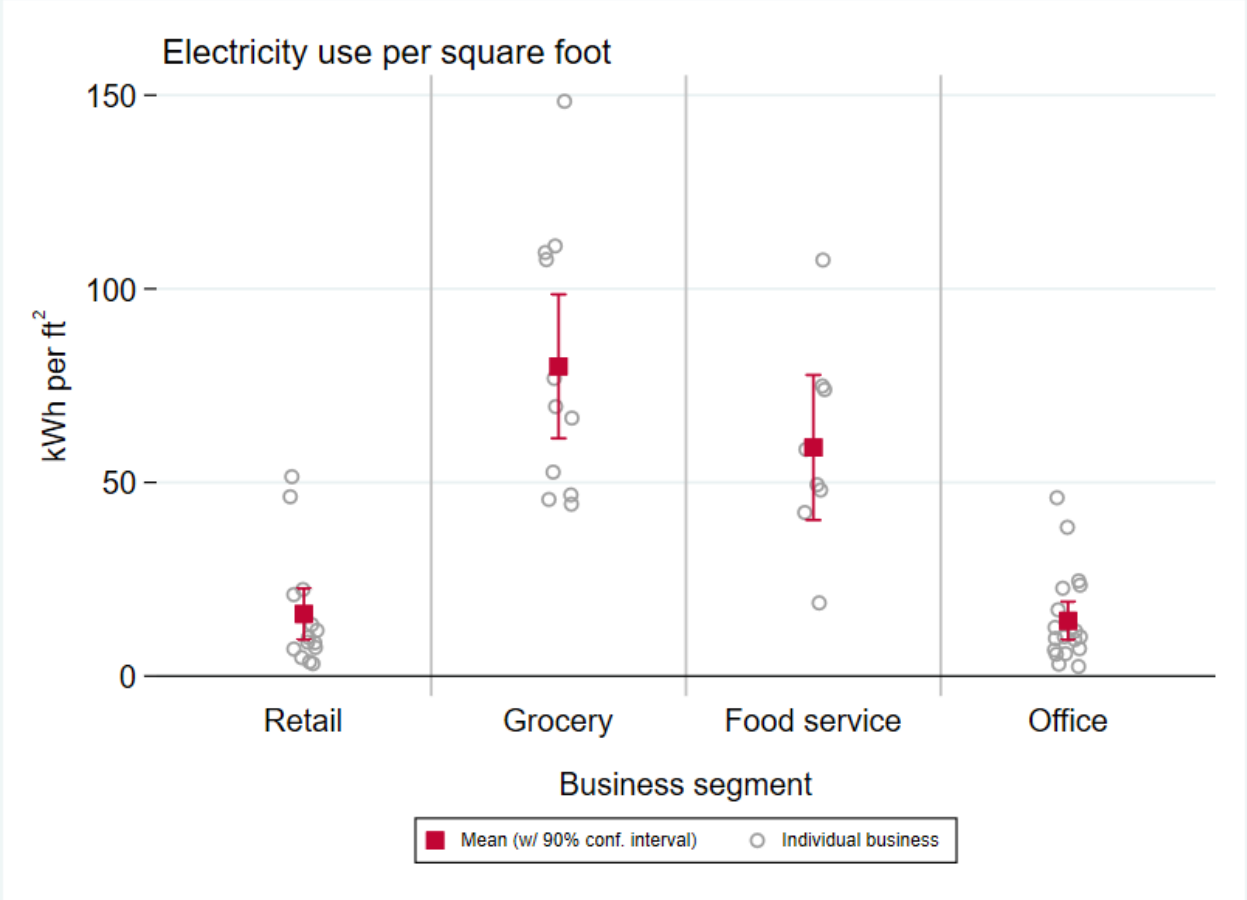
The following sections quantify the characteristics and energy reduction opportunities in the buildings we studied. We first discuss *energy usage* for the four building types, then discuss opportunities *by building type*, and finally lay out characteristics and opportunities *by energy end use*.

Building energy usage

During the site visits, we asked participants to fill out utility release forms to gather two years of utility data, where available. Just over half of the buildings (54) provided us with utility release forms. We weather-normalized the data, which allowed us to identify heating and cooling signatures.

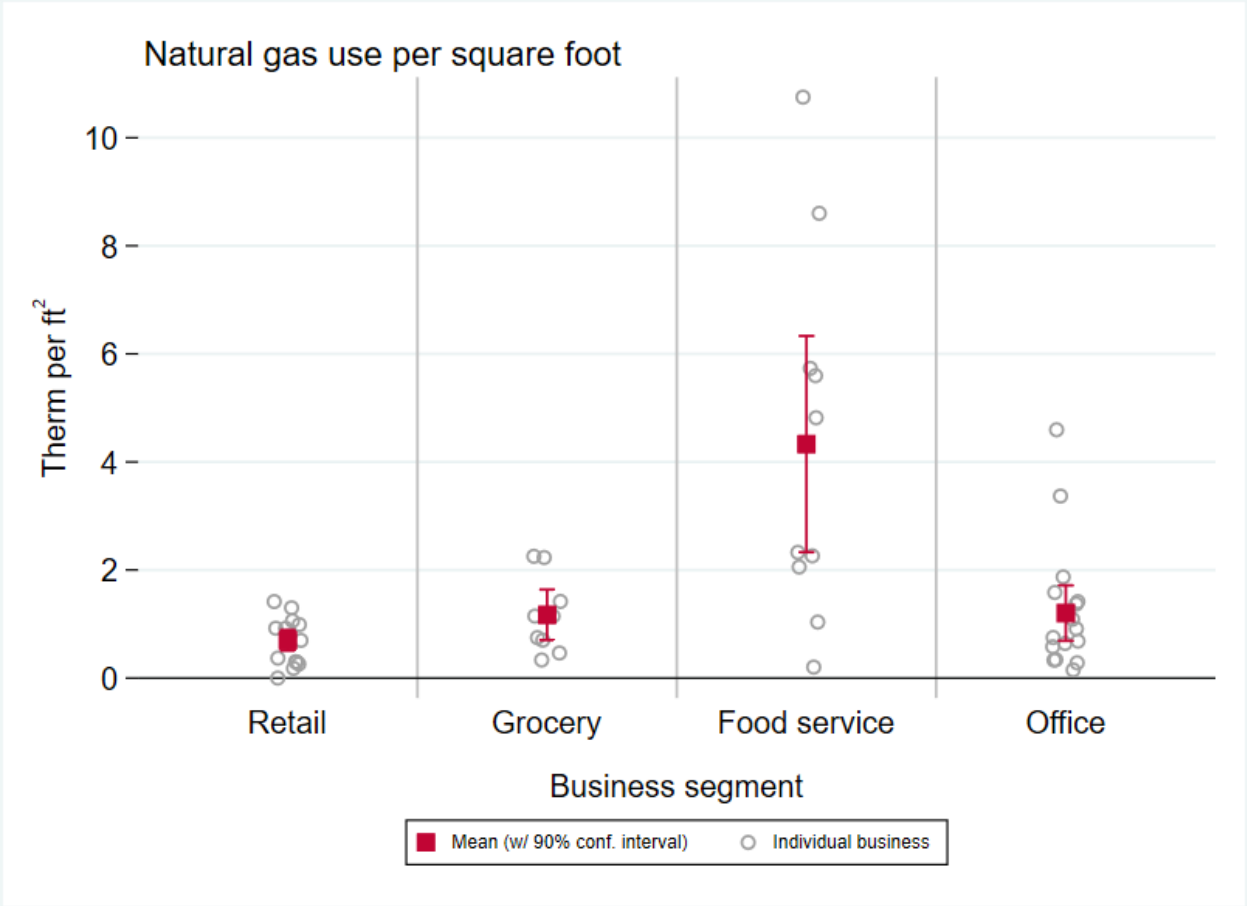
Appendix F: Weather normalization goes into greater detail about the weather normalization process. When breaking out the utility data by business type, it is important to keep in mind that with the low number of businesses in each segment group, we see substantial variability in the data.

Figure 12: Utility data - electricity use per square foot



For electric usage, we do see a trend of higher consumption in grocery and food service, likely due to loads from refrigeration and cooking (Figure 12). The wider error bands in both grocery and food service suggest a greater variability in electricity usage within that building segment. The error bands in retail and office businesses are narrower, suggesting a more homogeneous use of energy. We see similar trends for natural gas usage, with wide error bands in food service, and relatively small error bands for the other three business segment (Figure 13). This likely stems from the variety of food service establishments and the ways that they operate both the heating of the building space and kitchen operations.

Figure 13: Utility data – natural gas use per square foot



For those interested in the energy usage of other building types, previous research funded by the state of Minnesota has published energy usage information for other small commercial building types. Together, these sources give a comprehensive picture of the energy usage of the small commercial sector in Minnesota. Commerce has published this data for convenience stores (Ambach, 2013) and medium-sized lodging (Dvorak, 2015), both studied by Michaels Energy in the past few years. An even more specific small business type, rural grocery stores, was studied by the University of Minnesota Extension (Draeger, 2017). Finally, data for building types such as public assembly and public order and safety are covered in part by all the public buildings in Minnesota that are required to benchmark and disclose their energy usage (Minnesota B3, 2017).

Overview of measure opportunities by building type

We initially reviewed more than 120 distinct measures that spanned all significant end uses. Ultimately, we narrowed the list to 100 measures, spanning all relevant end-uses including HVAC, domestic hot water, refrigeration, kitchen equipment, plug loads, lighting, and other miscellaneous measures.

We developed an opportunity incidence rate based on the data collected onsite. For a few measures, we used the larger telephone survey to develop incidence rates; however, the telephone survey did not capture the level of detail we needed to fully explore the majority of measures. The measure saving values were developed using Minnesota Technical Reference Manual (TRM) savings assumptions and when that information was unavailable, we looked towards other states' TRMs or engineering calculations. The measure list and assumptions used in savings calculations can be found in Appendix D. More details specific to building characteristics from which these opportunities were identified can be found in the subsequent sections.

In the following sections, we provide a summary of key opportunities by business segment. The summary lists show technical potential rather than achievable or economic potential and does not address interactivity or mutual exclusivity of measures. We only show the top twenty measures for purposes of this discussion; the full tables can be found in Appendix E: Measure savings results by business segment. These measures are ranked by statewide total cost savings. During our program opportunity analysis below, we explore the interactions of measures by specifying measure bundles that can be used in program design.

Retail opportunities

Retail establishments have highly variable occupancy and relatively high HVAC and lighting loads. This is borne out in the most impactful measures which tend to be HVAC and lighting controls that take advantage of this variability. In terms of statewide total cost savings, the two highest saving measures are advanced RTU control packages and RTU tune-up and airflow. These measures both have high average savings combined with a high incidence of RTUs in this sector. The next two highest savings measures are both lighting control measures; interior lighting time clocks and high bay occupancy sensors (in the back-of-house or storage areas).

In terms of average electric savings per premise, the three most impactful measures are high bay occupancy sensors, RTU tune-up and airflow, and Energy Star dishwashers. Energy Star dishwashers unfortunately have a very low incidence, pulling down their overall impact in terms of statewide potential.

In terms of average natural gas savings per premise, the three most impactful measures are exhaust heat recovery, kitchen demand ventilation controls, and demand control ventilation using carbon dioxide sensors. The incidence for kitchen demand control ventilation controls and exhaust heat recovery are also very small, reducing their overall impact statewide.

Table 13. Savings for top ranking retail measures

#	Top-ranking Retail Measures	Average premise electric savings (kWh)	Average premise natural gas savings (therms)	Statewide total cost savings ($)	Percent opportunity incidence	% of total utility costs
1	Adv RTU control package	15,135	1390	$14,895,770	53%	7%
2	RTU tune-up and airflow	18,505	0	$11,083,700	53%	5%
3	Interior lighting time clocks	10,345	0	$8,579,620	73%	4%
4	High bay occupancy sensors (back of house)	23,480	0	$6,761,760	26%	3%
5	DCV, CO2	2,880	1535	$6,280,480	41%	3%
6	Smart thermostat	4,250	485	$3,780,350	44%	2%
7	EMS / BAS	1,455	265	$3,542,070	95%	2%
8	Variable speed fans	5,590	0	$3,475,890	55%	2%
9	Program thermostat	3,480	485	$3,397,530	44%	2%
10	Interior delamping	6,980	0	$3,377,330	43%	2%
11	RTU replacement (condensing)	0	670	$3,195,710	60%	2%
12	DCV, Occ sensors	1,345	770	$3,096,010	41%	1%
13	Anti-sweat heater control	9,480	0	$2,948,660	28%	1%
14	Exterior lighting retrofit	2,810	0	$2,849,550	90%	1%
15	ENERGY STAR Dishwasher	18,000	750	$2,678,400	10%	1%
16	Server: transfer air to cool, then exhaust	5,400	0	$2,488,320	41%	1%
17	Exterior motion sensors	2,550	0	$2,438,560	85%	1%
18	Kitchen demand ventilation controls	14,230	3650	$2,290,640	5%	1%
19	Exhaust heat recovery	0	5070	$2,044,220	5%	1%
20	Furnace tune-up and airflow	0	590	$2,004,510	43%	1%

Grocery opportunities

Grocery establishment are unique in their high refrigeration energy consumption. This key characteristic means that the most impactful measures for this sector affect refrigeration and are primarily electric savings measures. The top measures should drive utility programs to examine refrigeration opportunities that target grocery and convenience stores. This idea will be explored further in the program opportunity section below.

In terms of statewide total cost savings, the most impactful measures are refrigeration maintenance, applying doors to open refrigerated display cases, implementing anti-sweat heater controls, and

retrofitting refrigeration fan motors with electronically commutated motors. In terms of average electric savings per premise, these are also the highest savings measures.

In terms of average natural gas savings per premise, the three most impactful measures are kitchen demand ventilation controls, advanced control retrofit packages for existing RTUs and furnace tune-ups. The incidence for kitchen demand control ventilation controls is relatively small, reducing its overall impact statewide. There are no associated electric savings for the furnace tune-up measure, reducing its overall statewide impact.

Table 14. Savings for top ranking grocery measures

#	Top-ranking Grocery Measures	Average premise electric savings (kWh)	Average premise natural gas savings (therms)	Statewide total cost savings ($)	Percent opportunity incidence	% of total utility costs
1	Refrigeration maintenance	50,130	**0**	$9,158,500	51%	9%
2	Door retrofit	33,015	0	$6,388,680	54%	6%
3	Anti-sweat heater control	32,200	0	$5,882,760	51%	6%
4	EC motors	29,045	0	$5,864,120	56%	6%
5	Adv RTU control package	10,435	2,020	$3,546,090	40%	3%
6	Display case lighting	12,775	0	$2,962,000	65%	3%
7	Floating head pressure control	25,105	0	$2,847,040	32%	3%
8	Kitchen demand ventilation controls	15,755	4,040	$2,826,510	18%	2%
9	VFD on condenser fans	22,315	0	$2,530,700	32%	2%
10	RTU tune-up and airflow	16,395	0	$2,366,050	40%	2%
11	Night covers	9,180	0	$1,570,160	48%	4%
12	Exterior lighting retrofit	5,445	0	$1,553,370	80%	1%
13	Exterior motion sensors	4,430	0	$1,382,470	87%	1%
14	Smart thermostat	2,365	460	$1,291,780	65%	3%
15	EMS / BAS	810	440	$1,259,660	90%	1%
16	Exterior photocells/timer	10,545	0	$1,249,640	33%	1%
17	Program thermostat	1,985	380	$1,079,430	65%	1%
18	DCV, CO2	2,125	610	$1,043,150	46%	1%
19	Variable speed fans	6,035	0	$986,600	46%	1%
20	Furnace tune-up and airflow	0	825	$985,250	48%	1%

Food service opportunities

Food service establishments are a unique business type. They combine occupant variability with high HVAC loads and unique cooking and refrigeration end uses. In terms of statewide total cost savings, the most impactful measure was demand control ventilation specific to kitchen exhaust. In addition to the electric savings from turning down exhaust fan operations during periods of no cooking, there is heating savings for a cold-climate like Minnesota when warm air is exhausted and make-up air needs to be heated.

Additional savings include HVAC measures such as tuning up RTUs and applying advanced RTU controls, domestic hot water (DHW) savings through efficient water heater replacement, and refrigeration maintenance. There are certain end-use opportunities such as the dishwasher and DHW heater upgrade that are unique to food service establishments because of their high hot water and cleaning loads. Controls such as building automation systems (BAS) or energy management systems (EMS), smart thermostats, and programmable thermostats (which are mutually exclusive measures, but are shown here as standalone measures) show substantial savings due to operational changes in heating and cooling settings.

These measures all tended to have the highest average electric and natural gas savings per premise as well as a high incidence. BAS/EMS controls opportunity incidence was particularly high, being applicable in almost every establishment we visited. Surprisingly, food preparation equipment measures are not found in this list in large quantities. Only ENERGY STAR dishwashers and griddles made the top 20.

Table 15. Savings for top ranking food service measures

#	Top-ranking Food Service Measures	Average premise electric savings (kWh)	Average premise natural gas savings (therms)	Statewide total cost savings ($)	Percent opportunity incidence	% of total utility costs
1	Kitchen demand ventilation controls	19,645	5,035	$33,221,860	67%	7%
2	RTU tune-up and airflow	23,455	0	$13,793,170	66%	6%
3	DHW heater replacement (high eff)	0	2,795	$13,366,070	76%	18%
4	Adv RTU control package	15,430	860	$12,622,330	66%	7%
5	Refrigeration maintenance	23,625	0	$12,044,130	57%	4%
6	EMS / BAS	1,190	1,655	$11,125,660	97%	2%
7	Smart thermostat	7,745	1,560	$9,428,060	56%	5%
8	ENERGY STAR Dishwasher	12,640	525	$8,501,440	62%	2%
9	Program thermostat	6,450	1,290	$7,825,020	56%	2%

#	Top-ranking Food Service Measures	Average premise electric savings (kWh)	Average premise natural gas savings (therms)	Statewide total cost savings ($)	Percent opportunity incidence	% of total utility costs
10	Interior delamping	8,660	0	$4,602,850	59%	4%
11	Exhaust heat recovery	0	1,015	$4,152,280	65%	1%
12	Variable speed fans	4,450	0	$3,450,340	86%	1%
13	Evaporator fan control	4,740	0	$3,283,400	77%	1%
14	DCV, CO2	1,520	715	$3,094,870	53%	1%
15	Interior lighting time clocks	5,085	0	$2,679,990	59%	1%
16	Exterior lighting retrofit	2,985	0	$2,457,350	92%	1%
17	Exterior photocells/timer	6,010	0	$2,225,720	41%	1%
18	Exterior motion sensors	2,650	0	$2,183,410	92%	1%
19	RTU replacement (condensing)	0	370	$1,995,750	86%	6%
20	ENERGY STAR griddle	6,440	380	$1,820,150	43%	1%

Office opportunities

Office buildings are characterized by regular occupancy and few unique loads. HVAC and lighting therefore rise to the top as primary energy opportunity types.

In terms of statewide total cost savings, the most impactful lighting measures are turning off interior lights with time clocks, tune-up and airflow adjustment of RTUs, advanced RTU control packages, smart thermostats, reducing light in over-lit spaces through delamping, and reducing electric light levels in daylit spaces. The most impactful HVAC measures are tune-up and airflow adjustment of RTUs, advanced RTU control packages, and smart thermostats.

In terms of average electric savings per premise, RTU tune-up and airflow as well as advanced control packages are also high on the list. Controlling exterior lightings with a photocell or timer has high per premise savings, but low overall incidence.

In terms of average electric savings per premise, advanced RTU control packages are again high on the list. Window replacement and scheduling of outdoor air have high per premise savings, but low overall incidence.

Retrofitting exterior lighting with higher efficiency fixtures, controlling exterior lights with motion sensors and upgrading to EMS or BAS controls all have high opportunity incidence.

Additionally, we identified a server measure that addresses the additional cooling loads that stem from server operations.

Table 16. Savings from top ranking office measures

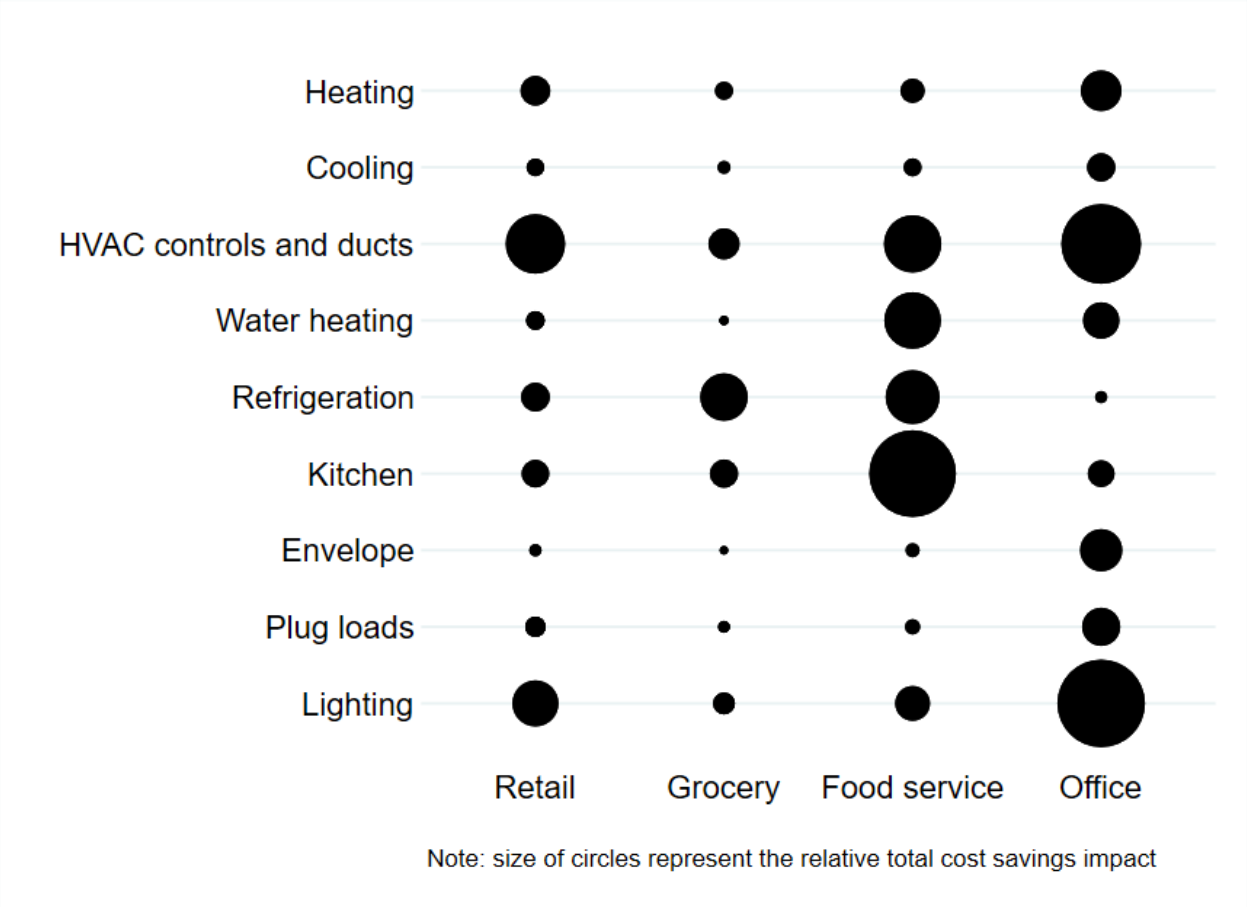
#	Top-ranking Office Measures	Average premise electric savings (kWh)	Average premise natural gas savings (therms)	Statewide total cost savings ($)	Percent opportunity incidence	% of total utility costs
1	Interior lighting time clocks	11,450	**0**	$33,908,920	75%	18%
2	RTU tune-up and airflow	27,145	0	$27,834,260	26%	14%
3	Adv RTU control package	15,180	790	$21,252,080	26%	11%
4	Smart thermostat	4,395	600	$20,105,660	62%	10%
5	Interior delamping	9,480	0	$19,878,930	53%	10%
6	Interior occupancy/vacancy sensors	5,595	0	$18,044,270	82%	9%
7	Program thermostat	3,725	500	$16,904,510	62%	9%
8	Interior daylighting controls	5,515	0	$16,018,960	74%	8%
9	Server: transfer air to cool, then exhaust	6,530	0	$15,794,500	62%	8%
10	Variable speed fans	12,890	0	$15,296,040	30%	8%
11	Exterior lighting retrofit	3,305	0	$11,387,410	88%	6%
12	Exterior photocells/timer	15,180	0	$9,794,140	16%	5%
13	Exterior motion sensors	2,585	0	$9,328,150	92%	5%
14	EMS / BAS	820	205	$8,147,140	92%	4%
15	Window replacement	3,025	1,650	$7,047,200	12%	4%
16	OA scheduling	820	735	$6,752,910	29%	4%
17	DCV, CO2	500	500	$6,649,190	43%	3%
18	DCV, Occ sensors	500	500	$6,649,190	43%	3%
19	RTU replacement (condensing)	0	685	$6,476,160	34%	3%
20	High bay occupancy sensors (back-of-house)	9,180	0	$5,922,770	16%	3%

Building characteristics and opportunities by end use

Figure 14 shows the total cost-savings potential across business types and energy end uses. The size of each circle is proportional to the aggregate statewide savings potential, which is a combination of the opportunity incidence of individual measures and the savings potential from these opportunities. The savings are weighted by business segment.

The largest opportunities shown in this figure relate to HVAC controls and ducts, refrigeration, water heating, commercial kitchen and lighting.

Figure 14: Total cost-savings potential across business types and energy end use



The following sections discuss each end use shown in Figure 15 (plus a few other miscellaneous ones) with detail on both 1) the characteristics of those end uses and 2) the top energy opportunities for each.

HVAC controls and ducts

HVAC systems are predominately single zone RTUs or furnaces with an even split between the two. Food service is the exception where we found predominantly RTUs. Most of the sites we visited do not have

economizers. And for those that do, the age of the RTU may be the more important metric in determining whether it had an economizer.

Most buildings don't have secondary heating systems but if they do, the systems are typically a unit heater or radiant heater.

The HVAC systems we encountered are characterized in Table 17 and below in Table 18.

Table 17. Primary HVAC system by business type

	Overall	Retail	Grocery	Food Service	Office
Primary HVAC airside type					
Furnace	43%	33%	34%	16%	53%
RTU, single zone	41%	55%	60%	81%	26%
RTU, multi-zone (VAV)	5%	0%	0%	0%	8%
Unit heater	4%	5%	2%	0%	4%
Heat pumps	3%	5%	0%	0%	4%
Radiant	3%	0%	0%	3%	4%
None	0%	0%	2%	0%	0%
Fan coil	0%	2%	0%	0%	0%
Other multi-zone	0%	0%	2%	0%	0%

Table 18. Number of RTUs by building type

	Overall	Retail	Grocery	Food Service	Office
Number of RTUs					
1 RTU	27%	41%	44%	46%	0%
2 to 4 RTUs	49%	41%	53%	37%	63%
greater than 5 RTUs	24%	19%	3%	17%	37%

Food Service buildings have more exhaust fans than the other building types. Most run continuously and could benefit from controls that would turn them off occasionally (Table 19).

Table 19. Exhaust fans and controls by business type

	Overall	Retail	Grocery	Food Service	Office
Number of dedicated exhaust fans					
No dedicated exhaust fans	65%	87%	68%	17%	70%
1 dedicated exhaust fans	11%	5%	21%	42%	21%
2-3 dedicated exhaust fans	5%	8%	8%	20%	9%
4 or more dedicated exhaust fans	2%	0%	3%	21%	0%
Exhaust fan controls					
Continuous operation	59%	16%	8%	67%	10%
Operates with HVAC	0%	8%	8%	17%	5%
Operates manually or by occupancy sensor	12%	60%	85%	17%	35%
Never or almost never operates	29%	16%	0%	0%	50%

We did not find any demand controlled ventilation (DCV) in the establishments we visited, though it can often be difficult to identify the presence of DCV. In our site visits, we identified areas of the building where DCV may be applied based on the size of the space and density of people, and whether it lent itself to DCV via an occupancy sensor or CO_2 sensor. The highest opportunities for DCV is in food service and sales floors of grocery and other retail (Table 20). The number of people in office buildings does not vary as significantly as the other business types, so energy savings opportunities are limited.

Table 20. Percent of area suitable for DCV by building type

	Overall	Retail	Grocery	Food Service	Office
Percent of building area suitable for DCV					
0%	14%	7%	15%	30%	12%
1-24%	1%	5%	0%	3%	0%
25-49%	12%	0%	2%	9%	16%
50-74%	14%	5%	20%	30%	12%

Only about half of the buildings bring in outside ventilation air through the HVAC system (Table 21). RTUs typically provide outside air, but residential style furnaces do not. A few buildings, primarily offices, have operable windows for ventilation. Other buildings depend on air entering through open doors for ventilation air.

Table 21. Ventilation method by building type

	Overall	Retail	Grocery	Food Service	Office
Ventilation mode of delivery					
None (beside infiltration)	25	39%	37%	5%	25%
Mechanical only	56	51%	63%	83%	51%
Operable windows only	11	0%	0%	3%	16%
Mix of mechanical and operable windows	3	0%	0%	6%	4%
Other	5	0%	0%	3%	4%

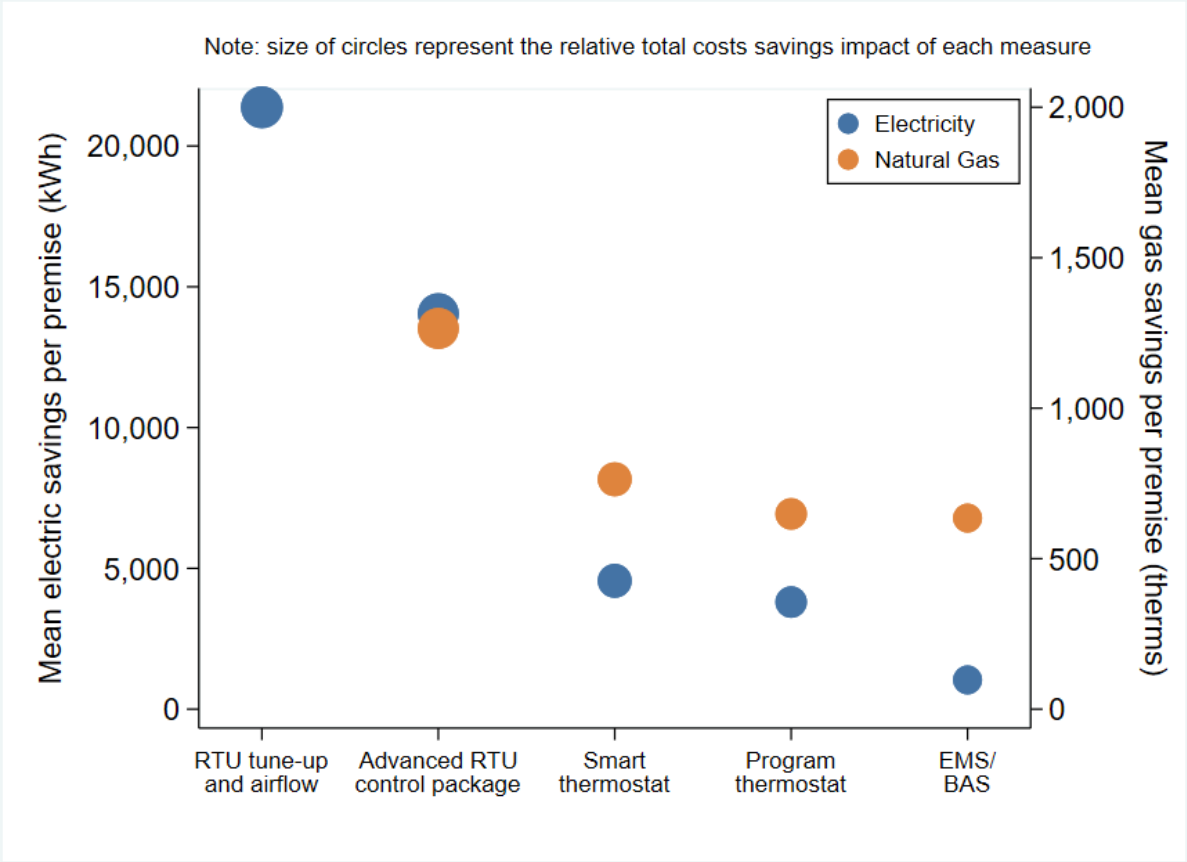
We found a high saturation of programmable thermostats but setbacks are not being used across the board (Table 22). Setbacks appear to skew toward four degrees, possibly the default setting from the manufacturer.

Table 22. Thermostat type and setback use by business type

	Overall	Retail	Grocery	Food Service	Office
Thermostat type					
Manual	27%	26%	30%	36%	25%
Programmable	67%	72%	61%	64%	67%
Smart	3%	0%	5%	0%	4%
BAS / EMS	3%	2%	4%	0%	4%
Are setbacks being used?					
No	43%	28%	60%	27%	49%
Yes	57%	72%	40%	73%	51%
Thermostat setback by type					
Advanced thermostat - setback	47%	61%	40%	49%	43%
Advanced thermostat - not setback	27%	17%	25%	14%	33%
Manual thermostat - setback	11%	11%	0%	24%	8%
Manual thermostat - not setback	16%	11%	34%	13%	16%

In addition to characterizing the HVAC controls systems, we also identified opportunities for energy savings in all areas. The scale of the top energy saving opportunities are given in Figure 15, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 15: Energy savings from top HVAC control measures by premise and by total aggregate cost savings



Heating

Primary heating

Nearly half (43 percent) of small businesses use residential-style heating as described in Table 17 above. The predominant systems are furnaces. Table 23 shows the average number of furnaces by business type for those buildings whose primary HVAC type is a furnace.

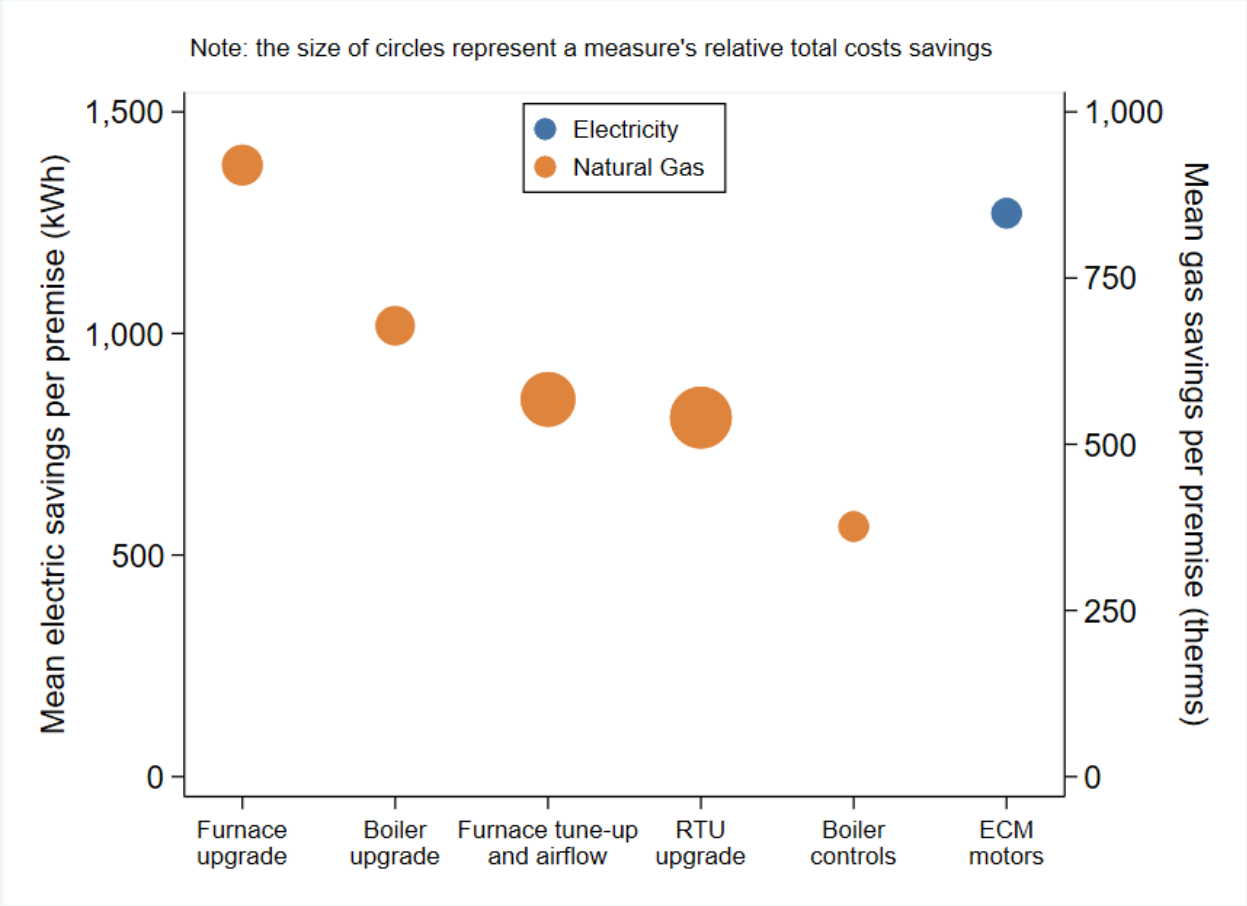
Table 23. Average number of furnaces by business type

	Overall	Retail	Grocery	Food Service	Office
Average number of furnaces	2.6	2.7	1.6	2.0	2.8

Boilers or steam heat are less common than furnaces. Boilers are present in some retail buildings but very few small commercial buildings have steam. Some office buildings have purchased steam. The boilers present in retail buildings tended to be more than 20 years old, inefficient and in poor shape, presenting opportunities for replacing, improving controls or converting to hot water.

In addition to characterizing the heating systems, we also identified opportunities for energy savings in all areas. The scale of the top energy saving opportunities are given in Figure 16, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 16: Energy savings from top heating measures by premise and by total aggregate cost savings



The main class of opportunity for natural gas savings is from replacing heating equipment with newer, more efficient units. The highest opportunity is from replacing residential-style furnaces. However, significant savings may also be found through boiler and RTU replacement. Due to the high penetration of furnaces, furnace tune-ups are also a significant heating end-use opportunity. Boiler controls include installing a cut-out and reset controls. A significant electricity saving potential related to heating measures include replace existing permanent split capacitor (PSC) fan motor with high-efficiency electronically commutated motors (ECMs) in furnaces.

Supplemental heating

Most small businesses do not have supplemental heating. This is especially true for retail, grocery and food service businesses. It is more likely to find supplemental heating in office spaces, with electric baseboard heating and unit heaters being the primary mode (Table 24).

Table 24. Supplemental heating by type and fuel

	Overall	Retail	Grocery	Food Service	Office
Supplemental heat type					
None	57%	77%	62%	88%	44%
Baseboard	20%	5%	0%	0%	30%
Unit Heater	11%	9%	10%	8%	13%
Radiant heater	7%	5%	3%	4%	9%
Portable space heater	4%	5%	14%	0%	4%
Heat reclaim	0.5%	0%	7%	0%	0%
Supplemental heating fuel					
Electric	60%	40%	55%	67%	62%
Natural Gas or Propane	19%	60%	18%	0%	15%
Hot water	14%	0%	9%	33%	15%
Steam	6%	0%	0%	0%	8%
Heat reclaim	1%	0%	18%	0%	0%

In those businesses that have supplemental heating, it is likely to serve just one or two small areas of the building space (Table 25). It is primarily controlled through a manual thermostat. There is potential for simultaneous heating and cooling if the supplemental heater thermostat is not the same thermostat that controls the cooling system.

Table 25. Areas served by supplemental heating and control types

	Overall	Retail	Grocery	Food Service	Office
What does supplement heat serve?					
The entire skin (i.e. baseboard)	14%	20%	0%	0%	15%
A major portion of the building	35%	20%	10%	33%	38%
One or two small areas	51%	60%	90%	67%	47%
Supplemental heat control					
Manual knob	47%	20%	73%	67%	47%
Thermostat, indoor	47%	80%	18%	33%	46%
BAS	6%	0%	0%	0%	8%
Primarily just left off	1%	0%	9%	0%	0%

Cooling

Cooling is provided mainly with split air conditioner systems or RTUs. They tend to be small capacity systems that are quite old—generally older than what is thought to be their useful life. Older units are especially prevalent in restaurants while groceries are more likely to have newer units (Table 26).

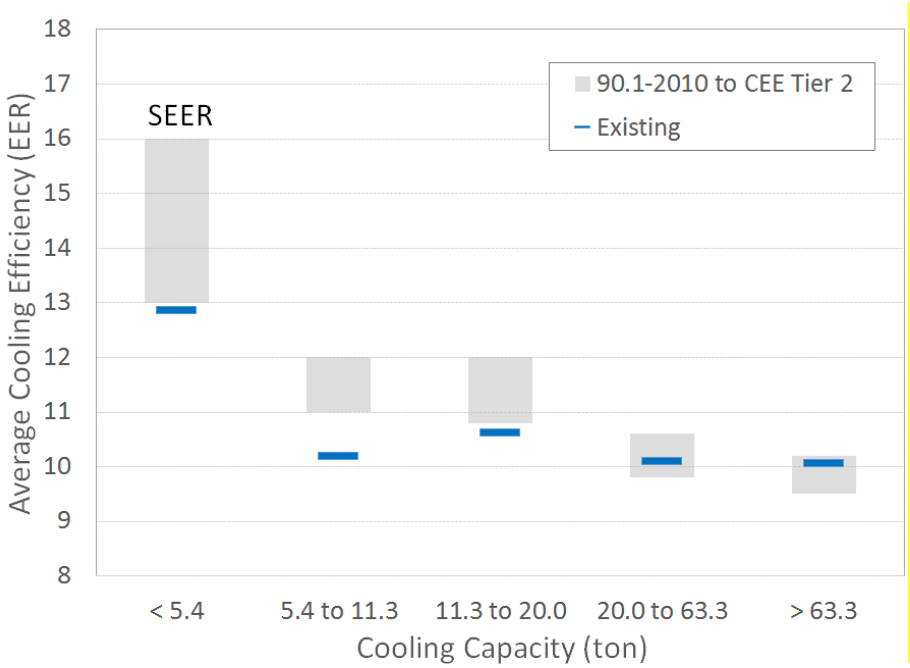
Table 26. Key characteristics of cooling systems

	Overall	Retail	Grocery	Food Service	Office
Type of primary cooling system					
Rooftop unit	46%	55%	59%	81%	34%
Split A/C	43%	35%	37%	11%	53%
Window or wall A/C	6%	5%	0%	3%	8%
Air source heat pump	3%	0%	0%	5%	4%
Water source heat pump	1%	5%	0%	0%	0%
None	0%	0%	4%	0%	0%
Cooling capacity					
1 to 2.9 tons	25%	9%	22%	9%	34%
3 to 4.9 tons	42%	44%	34%	38%	43%
5 to 9.9 tons	20%	26%	30%	39%	13%
10 to 29 tons	9%	20%	12%	11%	4%
Over 30 tons	4%	2%	2%	3%	6%
Cooling age of primary equipment					
less than 5 years old	20%	0%	7%	20%	27%
5 to 9 years old	13%	12%	44%	6%	13%
10 to 14 years old	20%	30%	20%	18%	18%
15 to 19 years old	19%	11%	13%	37%	18%
Over 20 years old	27%	48%	16%	20%	24%
Cooling efficiency					
8 to 9.9 EER	27%	38%	17%	32%	25%
10 to 11.9 EER	34%	31%	40%	50%	31%
12 to 14.9 EER	24%	31%	30%	10%	25%
over 15 EER	15%	0%	13%	9%	19%

The full load cooling efficiency is currently the major driver of how much electricity a split air conditioner or RTU consumes. A recent Minnesota CARD study characterized the RTUs in Minnesota, finding that the average full load cooling efficiency was 10.6 EER (Schuetter 2017). Considerable room for improvement exists across most cooling capacity ranges. Using data from the Minnesota CARD RTU characterization, Figure 17 illustrates the average cooling efficiency for Minnesota RTUs as compared to potential

replacement options ranging from the current Minnesota energy code[3] to CEE's Tier 2.[4] In RTUs with smaller cooling capacities most associated with small business, the average existing efficiency is below the code-minimum and well-below the CEE Tier 2 recommendation, suggesting considerable opportunity for improved efficiency.

Figure 17: Average cooling efficiency by cooling capacity

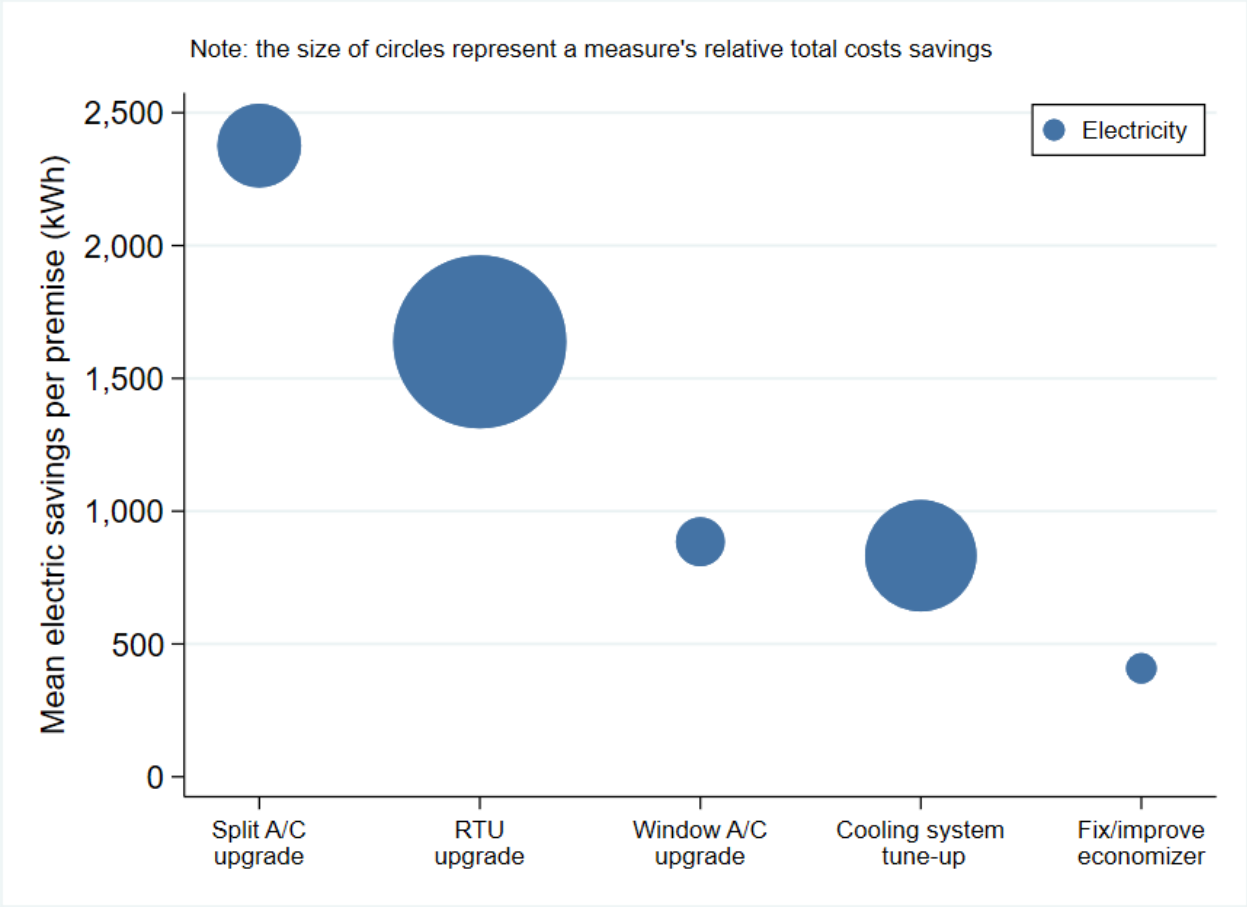


In addition to characterizing the cooling systems, we also identified opportunities for energy savings in all areas. The scale of the top energy saving opportunities are given in Figure 18 with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

[3] ASHRAE 90.1-2010, Table 6.8.1A

[4] CEE 2016. High Efficiency Commercial Air-conditioning and Heat Pumps Initiative. Consortium for Energy Efficiency. 2016.

Figure 18: Energy savings from top cooling measures by premise and by total aggregate cost savings



For the cooling end use across all building types, the main class of opportunity for electricity savings is from replacing cooling equipment with newer, more efficient units. The highest savings per premise can be found through replacing residential-style split air conditioners. Replacing RTUs with a high-efficiency, condesing unit can save the most in total cost savings. Window air conditioning units save a significant amount per premise when replaced, but as the size of the bubble suggests, this measure does not offer as much relative total costs savings as other measures. Simple maintenance such as tuning and cleaning cooling equipment also saves a considerable amount of total costs savings. Finally, fixing broken economizers may offer a minimal amount of savings both on a per-premise basis and in comparative total costs savings. Note that the top measures within the cooling end use did not have natural gas savings.

Domestic hot water

Domestic hot water (DHW) heating is dominated by storage water heaters, roughly half of which are electric (Table 27). The electric water heaters tend to be smaller capacity than the natural gas water heaters. High energy factor electric storage water heaters are more prevalent in offices while lower efficiency natural gas storage water heaters dominate food service (Table 28).

Table 27. Water heater size by fuel type

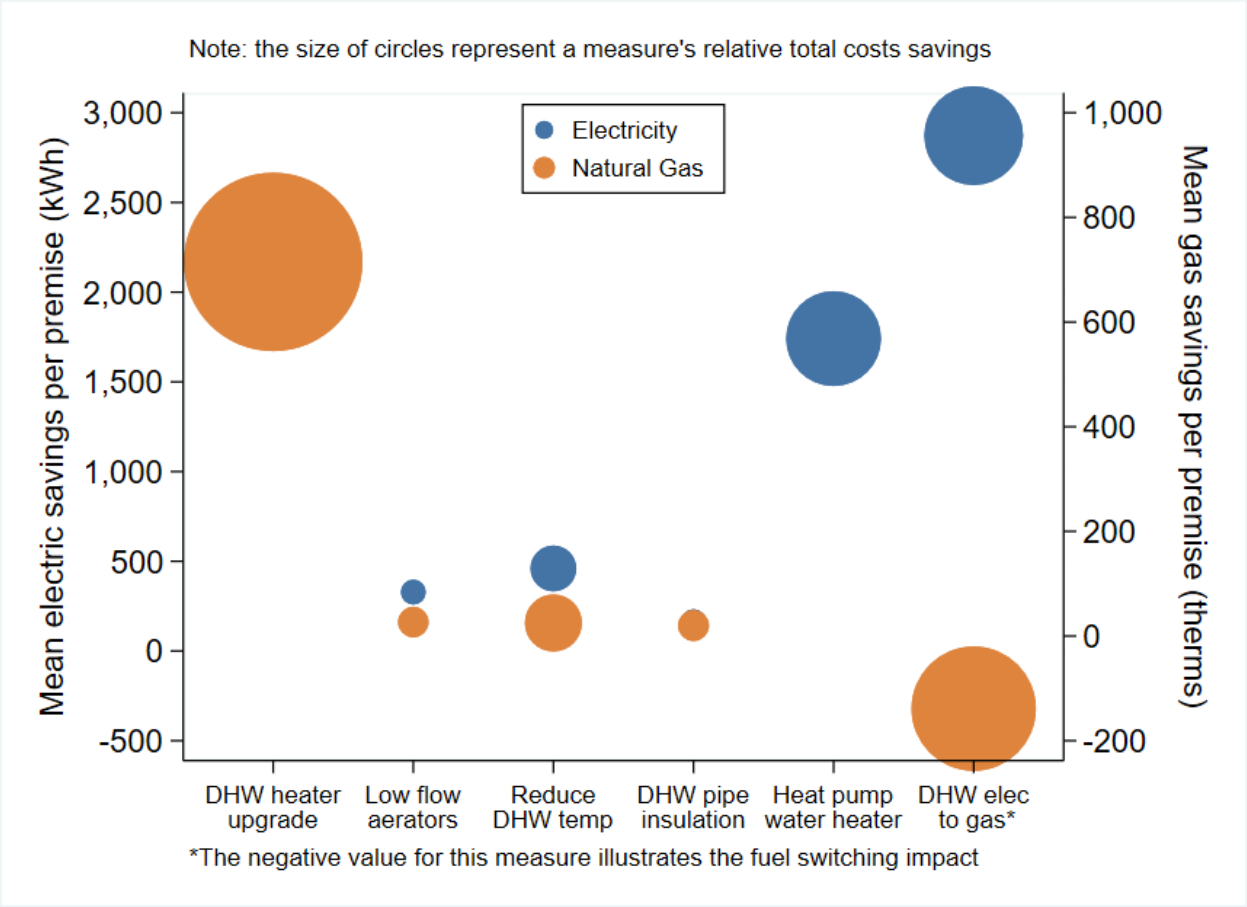
Size of water heater	Natural Gas	Electric
0 to 19 gallons	0%	26%
20 to 49 gallons	52%	39%
50 to 99 gallons	38%	34%
100 to 120 gallons	9%	1%

Table 28. Water heater fuel and efficiency by building type

Description	Overall	Retail	Grocery	Food Service	Office
DHW					
Natural gas	45%	53%	54%	82%	33%
Electric resistance	52%	37%	35%	12%	67%
Propane	1%	0%	0%	6%	0%
DHW efficiency					
Less than 0.67 EF	37%	33%	23%	44%	21%
0.67 to 0.82 EF	12%	24%	34%	35%	12%
0.83 to 0.90 EF	3%	25%	35%	15%	22%
0.91 to 0.98 EF	47%	18%	8%	6%	45%

In addition to characterizing the cooling systems, we also identified opportunities for energy savings in all areas. The scale of the top energy saving opportunities are given in Figure 19 with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 19: Energy savings from top DHW measures by premise and by total aggregate cost savings



For the water heating end use across all building types, the main opportunity for energy savings both on a per-premise basis and in aggregate statewide costs savings is from replacing natural-gas fired water heaters with newer more efficient modelsInstalling heat pump water heaters saves a considerable amount of electricity. Similarly, switching an electrically-powered water heater with a natural gas fuel water heater saves a significant amount of electrical energy but at a penatly of increased natural gas use. DHW pipe insulation, turning down the DHW temperature setpoint, and low-flow aerators and sprayers all reduce the load on the water heater, saving electricity for heat pump water heaters and natural gas for natural gas-fired water heaters.

Refrigeration

Not surprisingly, refrigeration equipment is prevalent primarily in grocery/convenience and food service. Food service locations tend to specifically have walk-in coolers and freezers (often one of each). Some retail establishments also have refrigeration – floral shops are a prime example. And a number of types of retails stores have a cold beverage display case.

We characterized the types, quantities, and components of refrigeration equipment in each building type. We begin in Table 29 by showing the quantities of each major display case type, by building type.

Table 29. Display case quantities by building type

	Overall	Retail	Grocery	Food Service
Reach-in freezer – number of doors*				
Less than 3	50%	29%	14%	100%
3 to 5	12%	71%	8%	0%
5 to 10	22%	0%	46%	0%
11 to 25	1%	0%	2%	0%
Greater than 25	14%	0%	29%	0%
**Note: retail only has 2 instances*				
Reach-in cooler – number of doors				
10 or less	57%	42%	14%	100%
11 to16	12%	19%	18%	0%
17 to 26	13%	14%	32%	0%
27+	18%	25%	36%	0%
Open freezer – length				
Less than 20 linear feet	-	-	79%	-
20 or greater linear feet	-	-	21%	-
Open cooler – length				
Less than 20 linear feet	-	-	34%	-
20 to 49 linear feet	-	-	18%	-
50 to 99 linear feet	-	-	41%	-
100 or greater linear feet	-	-	8%	-
Service cooler – length*				
Less than 10 linear feet	-	-	46%	86%
10 to 19 linear feet	-	-	17%	14%
20 to 49 linear feet	-	-	38%	0%
50 or greater linear feet	-	-	0%	0%
**Note: retail had 1 instance of 50+ foot cooler, which is not reported here*				
Percentage of refrigerated cases that are self-contained				
0 to 24%	54%	79%	55%	48%
25 to 49%	6%	0%	21%	5%
50 to 74%	12%	0%	11%	22%
75 to 100%	28%	21%	13%	25%

Even small grocery and convenience stores contain a substantial amount of refrigerated display cases, especially coolers of all kinds. Small grocery and convenience stores also generally have walk-in coolers and freezers. These are also much more common in food service than display cases; food service establishments generally have too much refrigerated food to store only in self-contained refrigerators and freezers and use walk-ins as a result. Walk-in equipment counts are listed in Table 30, along with the quantities of fans in each.

Table 30. Walk-in refrigeration quantities by building type

	Overall	Retail	Grocery	Food Service
Number of walk-in freezers				
1	-	-	70%	95%
2	-	-	30%	5%
Number of walk-in freezer evaporator fans				
1 to 2 fans	-	-	26%	77%
3 to 4 fans	-	-	30%	19%
5 to 10 fans	-	-	28%	4%
11 to 30 fans	-	-	16%	0%
Number of walk-in coolers				
1	60%	37%	61%	64%
2	29%	50%	17%	28%
3	6%	13%	7%	4%
4	5%	0%	15%	4%
Number of walk-in cooler evaporator fans				
1-to 2 fans	22%	0%	7%	49%
3 to 4 fans	42%	39%	29%	36%
5 to 10 fans	29%	50%	50%	11%
11 to 30 fans	8%	11%	15%	4%

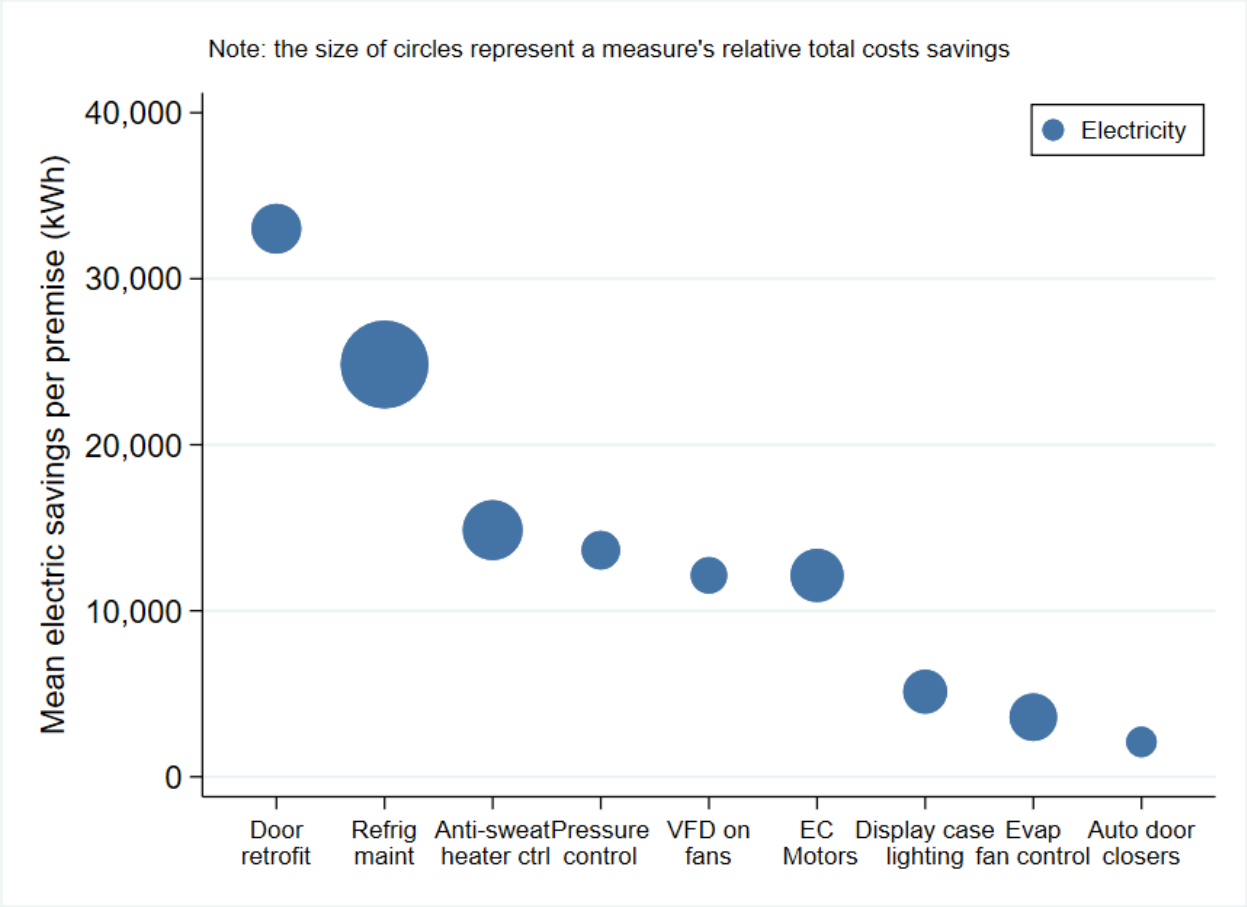
A large majority of those display and walk-in refrigeration units are cooled by compressor and condenser equipment that is separate from the units where food is stored. We characterized the scale of all the refrigeration equipment in typical stores by summing the horsepower of all of these compressors. The results are given in Table 31.

Table 31. Total refrigeration system size, by horsepower

	Overall	Retail	Grocery	Food Service
Total compressor power (HP)				
1 to 9 HP	62%	42%	32%	79%
10 to 49 HP	28%	58%	21%	21%
50 to 99 HP	8%	0%	38%	0%
Over 100 HP	2%	0%	9%	0%

In addition to characterizing the refrigeration systems, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 20, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 20: Energy savings from top refrigeration measures by premise and by total aggregate cost savings



For the refrigeration end use across all building types, the biggest opportunities for electricity savings are from adding doors to refrigerated display cases or tuning up the refrigeration equipment. Rrefrigeration tune-up and maintenance, including clearing space around condensers, offer a significant low-cost/no cost measure. Additional measures that offer considerable per-premise savings include adding anti-sweat heater control, and head and suction pressure control on compressors. Replace existing standard-efficiency shaded-pole evaporator fan motor with high-efficiency EC motors in refrigerated display cases or fan coil in walk-ins can also provide significant per-premise savings. Display-case LEDs, evaporator fan controls and automatic door closer for walk-in refrigerators and freezers can provide energy savings, but in comparison to other measures, they offer less savings on both a per-premise and statewide potential. The most capital-intensive measure would be application of variable frequency drives to condenser fans, which we found to provide good per-premise savings.

Plug loads

Plug loads in this context refer to all miscellaneous electric loads that are not for refrigeration, cooking, or servers. Plug loads were common in all building types, though they were most prominent in office and retail buildings, as well as certain types of food service.

Almost every small commercial building (all but three of them) that we visited had at least one computer. Computers use energy in a variety of ways including the PC operating both actively and in standby or sleep mode, the monitor's operation, as well as any other peripherals using energy. Table 32 quantifies the number of computers we found in each building, as well as how many were laptops and how many had an extra monitor.

Table 32. Computer plug load by building type

	Overall	Retail	Grocery	Food Service	Office
Number of computers					
No computers	3%	0%	13%	15%	0%
1 to 4 computers	33%	49%	81%	80%	14%
5 to 9 computers	18%	26%	4%	6%	21%
10 to 49 computers	41%	26%	2%	0%	57%
50 or more computers	5%	0%	0%	0%	8%
Percentage of computers that are laptops	16%	8%	17%	23%	16%
Percentage of computers with an extra monitor	27%	4%	7%	6%	39%

Televisions are increasingly common in commercial buildings. They are used not just as televisions but as computer monitors, conference room displays, or for streaming announcements or advertisements in building lobbies and circulation spaces. Where they are left on all day to provide information, they use a substantial amount of energy. Table 33 quantifies the number of televisions that we found.

Table 33. Number of televisions by building type

	Overall	Retail	Grocery	Food Service	Office
Number of televisions					
No TVs	36.8%	41%	46%	39%	34%
1 or 2 TVs	42.8%	38%	41%	25%	49%
3 to 9 TVs	18.2%	16%	13%	28%	17%
10 to 49 TVs	2.2%	5%	0%	9%	0%

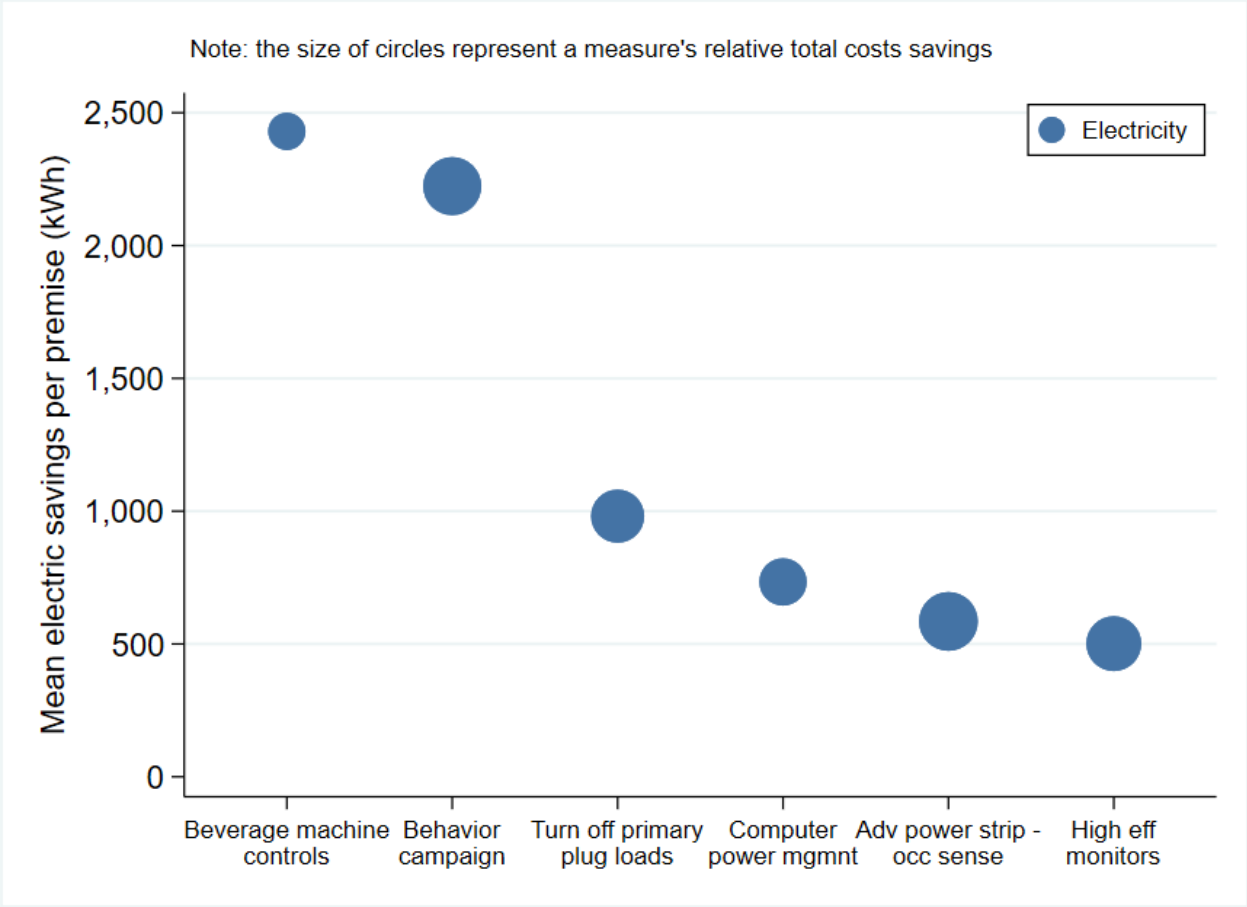
Point-of-sale terminals, which functionally similar to computers, are found in any building where customers pay for goods or services. Most retail, grocery, and food service establishments had one to three point-of-sale terminals. They use nearly as much energy as computers, and have similar potential for savings through measures. Table 34 summarizes the number of point-of-sale terminals we found.

Table 34. Number of point-of-sale (POS) terminals by building type

	Overall	Retail	Grocery	Food Service	Office
Number of point-of-sale terminals					
No dedicated POS terminals	55.3%	26%	0%	5%	81%
1 or 2 POS terminals	26.2%	48%	44%	59%	10%
3 to 9 POS terminals	18.4%	27%	54%	35%	9%
10 to 49 POS terminals	0.1%	0%	2%	0%	0%

A previous CARD-funded study published in 2016 (Hackel, 2016) strictly focused on plug loads in Minnesota offices. This study looked at offices of all sizes, but data was normalized by workstation. (The buildings in that study average 255 ft^2 per workstation.) The average workstation had 0.65 desktop PCs, 0.43 laptops, 1.3 monitors, 0.8 task lights, and 1.4 other plug loads. These inventories of workstation plug loads compare very closely to the computer, laptop, and monitor statistics from the current study.

Figure 21: Energy savings from top plug load measures by premise and by total aggregate cost savings



In addition to characterizing the plug loads, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 21, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of

the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

For the plug load end use across all building types, the highest per-premise savings is from implementing controls to turn off lights on beverage machines during unoccupied periods; however, the incidicent of opportunity is low, which make this measure less impactful from a total cost savings perspective. A behavior change program offers an interesting option that can yield a high per-premise saving. Such a program encourages occupants to reduce their usage such as by turning off monitors and powering down computers at night. Additional impactful plug load measures include turning off primary plug loads at night, implementing a computer power management program, upgrading to advanced power strips with occupancy sensors, and replace computer monitors with high efficiency monitors.

Servers

Slightly less than half of small commercial buildings have servers (Table 35). Of these, more than half of offices and about one-third of retail establishments have servers. Servers are much less likely to be present in groceries or food service establishments. Of the businesses that have servers, nearly all have fewer than five. More than two-thirds (67 percent) of server rooms are cooled using the building's primary HVAC system. About another one-fifth (18 percent) use an exhaust fan to pull air out of the room—essentially using the building's HVAC system to cool the room. A very small percentage (5 percent) of server rooms are cooled using either a computer room air conditioning unit (CRAC) or a split system. The average server room temperature at the sites visited was 72.5ºF, falling in the middle of ASHRAE's recommended server room air temperature range of 64.4 ºF to 80.6ºF. Simply increasing this towards the high end of the ASHRAE recommended range would result in cooling energy savings. Note that this recommended temperature is different than the thermostat setpoint, which is often several degrees lower.

Table 35. Number of servers and UPS capacity by building type

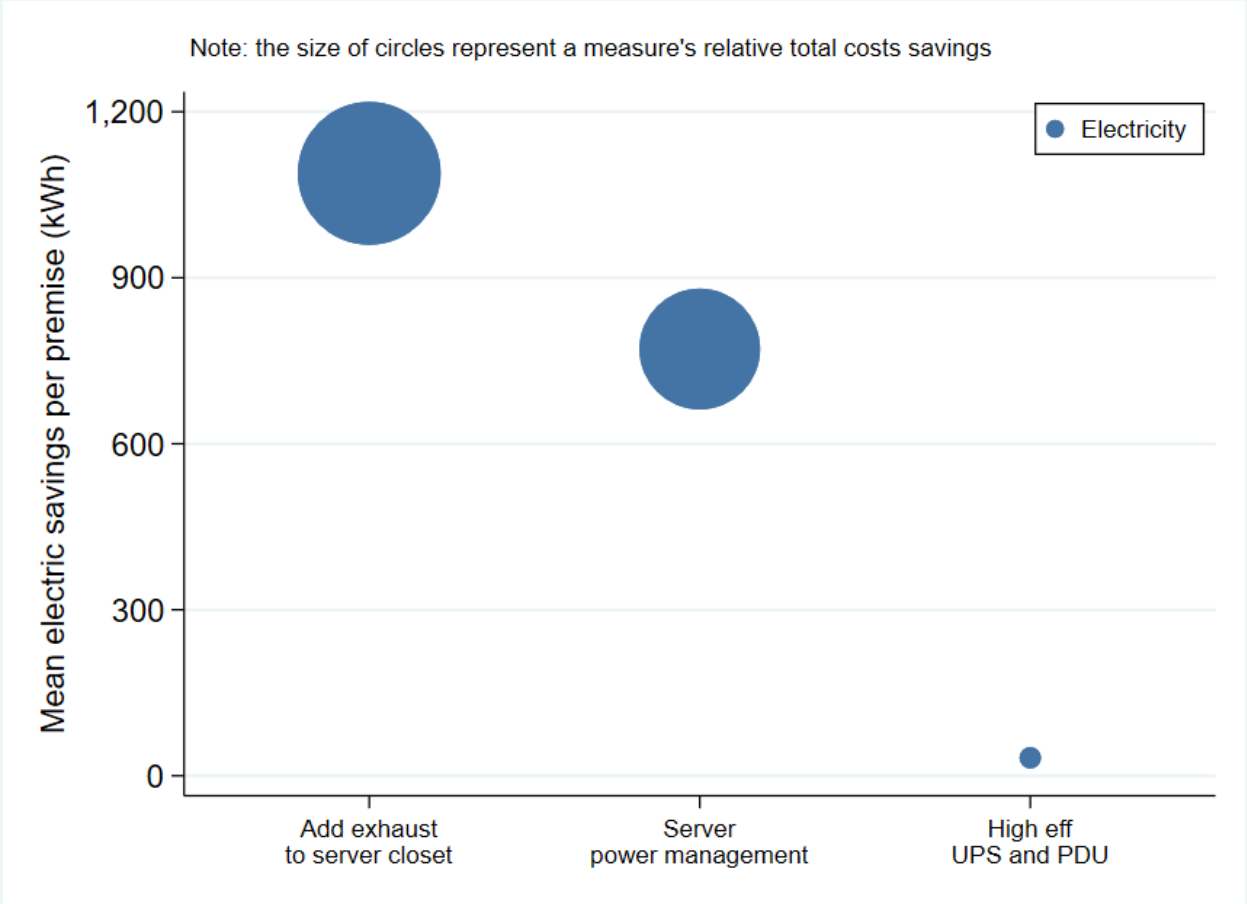
	Overall	Retail	Grocery	Food Service	Office
Total number of servers					
No servers	52.7%	59%	90%	92%	38%
Less than 5 servers	43.9%	36%	10%	8%	57%
5 to 10 servers	3.5%	5%	0%	0%	4%
Total Uninterruptible Power Supply (UPS) capacity (VA)					
Less than 1000 VA	13.4%	25%	100%	100%	8%
1000 to 4999 VA	72.3%	75%	0%	0%	75%
5000 to 12000 VA	14.4%	0%	0%	0%	17%

Total uninterruptible power supply (UPS) capacity is predominantly between 1000 and 4999 VA (72 percent). The rest is split fairly evenly between less than 1000 VA (13 percent) and 5000 to 12000 VA (14 percent). As UPS capacity increases, the amount of energy saved from increasing UPS efficiency also

increases. This typically means that the economics of this upgrade is more favorable in the higher capacity range.

In addition to characterizing the server loads, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 22, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential

Figure 22: Energy savings from top server measures by premise and by total aggregate cost savings



Two server measures were most important (Figure 22). The first, adding exhaust to server closet, pulls warm air out of the building when cooling is required; cooler air 'transfers' in from rest of the building to serve the data center's cooling demand. The second, implementing server power management, sets a server to low power mode during periods of low usage. In parallel to this project, another relevant CARD project was also underway.[5] This project identified a number of data center measures worth considering for small businesses in Minnesota.

[5] Shen et al., "Small Embedded Data Center Program Pilot", COMM-CARD01-20140512-86772, June 2017.

Envelope

Slightly more than half of the buildings we collected data on have concrete or concrete block walls. About one quarter are wood frame. More than half of these buildings have roof insulation entirely above deck. The roofs are generally in good shape, with only some signs of wear.

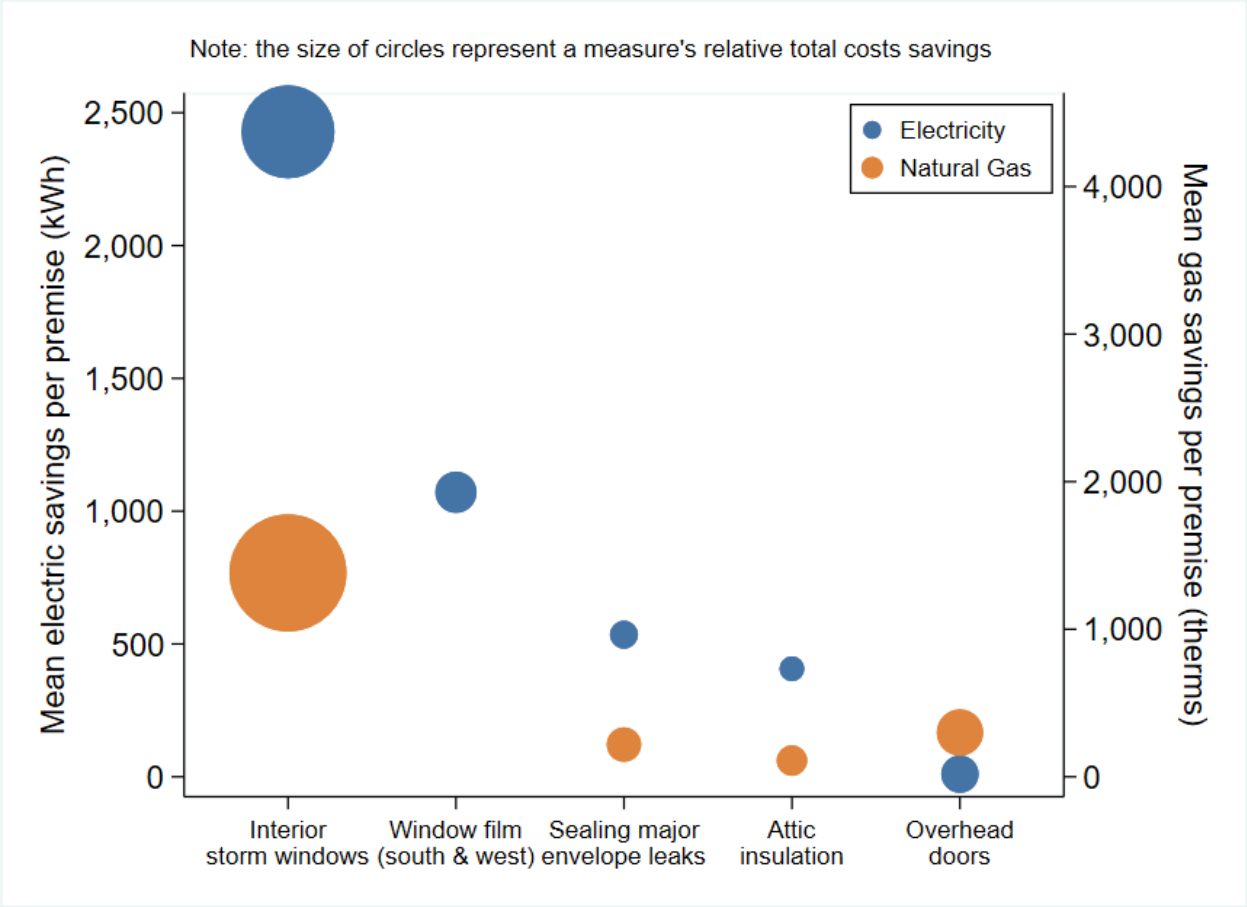
The primary glazing type on these buildings is double-pane) and is in good shape, generally. Food service and groceries were somewhat less likely to have double-pane glazing. Nearly two-thirds of the buildings we studied have a low window-to-wall ratio (65 percent have a WWR less than 20 percent). The rest have WWRs between 20 and 50 percent. Buildings with a lower WWR lose less conditioned air to outside than those with higher WWR. We did not encounter buildings that had higher WWR than 50%. Table 36 summarizes envelope characteristics.

Table 36: Envelope characteristics by building type

	Overall	Retail	Grocery	Food Service	Office
Primary wall type					
Concrete or concrete block	54%	70%	66%	72%	44%
Structural brick	5%	0%	15%	8%	4%
Metal building	4%	5%	2%	6%	4%
Metal framed	11%	26%	6%	0%	9%
Wood framed	26%	0%	11%	14%	39%
Primary glazing type					
Single pane	8%	9%	28%	16%	4%
Single pane with storm windows	4%	0%	2%	9%	4%
Double pane	88%	91%	70%	75%	92%
Roof type					
Insulation entirely above deck	51%	48%	37%	68%	49%
Metal buildings	1%	5%	0%	0%	0%
Attic and other	11%	2%	5%	3%	16%

In addition to characterizing the building envelopes, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 23, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 23: Energy savings from top envelope measures by premise and by total aggregate cost savings



For the envelope end use across all building types, the main opportunity for energy savings is from sealing off unheated areas. This measure reduces infiltration from this unconditioned space, thereby reducing both the heating and cooling demand on the primary HVAC system. The second most impactful envelope measure is adding interior storm windows. This measure effectively increases the U-value of the windows during the winter months, reducing the heating and cooling loads and the fan energy needed to meet them. Increasing overhead door insulation and sealing major envelope leaks have additional, non-negligible energy savings opportunities.

Commercial Kitchens

Of the small commercial buildings in Minnesota, 18 percent have a commercial kitchen (Table 37). Unsurprisingly, the majority of commercial kitchens are found in food service establishments. Grocery establishments also have a smaller proportion of commercial kitchens.

Table 37: Commercial kitchens by building type

	Overall	Retail	Grocery	Food Service	Office
Type of commercial kitchen					
None	81.7%	94%	62%	3%	96%
Fast food	4.5%	0%	6%	32%	0%
Cafeteria	4.1%	0%	13%	6%	4%
Large commercial kitchen	8.9%	6%	5%	59%	0%
Snack bar	0.8%	0%	14%	0%	0%
Average hours per day the kitchen actively being used for cooking	10.4	7.0	10.7	12.0	5.0

Over half of food service establishments have large commercial kitchens and nearly one-third have fast food kitchens. These commercial kitchens are being actively used for cooking on average 12 hours per day. The long hours of operation, combined with the energy intensiveness of these types of kitchens, makes commercial kitchens a significant energy end use for food service establishments.

Snack bars are present in 14 percent of grocery establishments and 13 percent have a cafeteria. These commercial kitchens are being actively used for cooking on average 10.7 hours per day. Although these hours of operation are relatively long, the lower energy intensiveness of their kitchen type makes commercial kitchens a less significant energy end use in grocery establishments.

The following information is presented as overall values across all small commercial buildings with commercial kitchens, as opposed to broken out by building type.

Table 38: Commercial kitchen ventilation characteristics

Question	Overall
Is kitchen hood exhaust supplied by make-up air unit?	
No	25%
Yes	75%
What type of kitchen hood exhaust controls are present?	
None/Manual	90%
Temperature probe only	6%
Temperature and optic sensor	3%
Fuel of commercial griddles	
Natural Gas	52%
Electric	48%

Three quarters of kitchen hood exhaust is handled by a make-up air unit (Table 38). The remainder are likely not explicitly handled, but rather use the buildings primary HVAC system instead. In these situations, there is likely significant under-pressurization of the building, leading to suboptimal HVAC

performance and comfort issues. In systems with make-up air units, significant opportunities for energy savings exist such as through advanced controls and increased heating or cooling efficiency.

One such opportunity is using temperature and/or optical sensors to ramp down the exhaust fan during periods of low or no cooking. Less than 10 percent of kitchen exhaust systems currently use either type of this control.

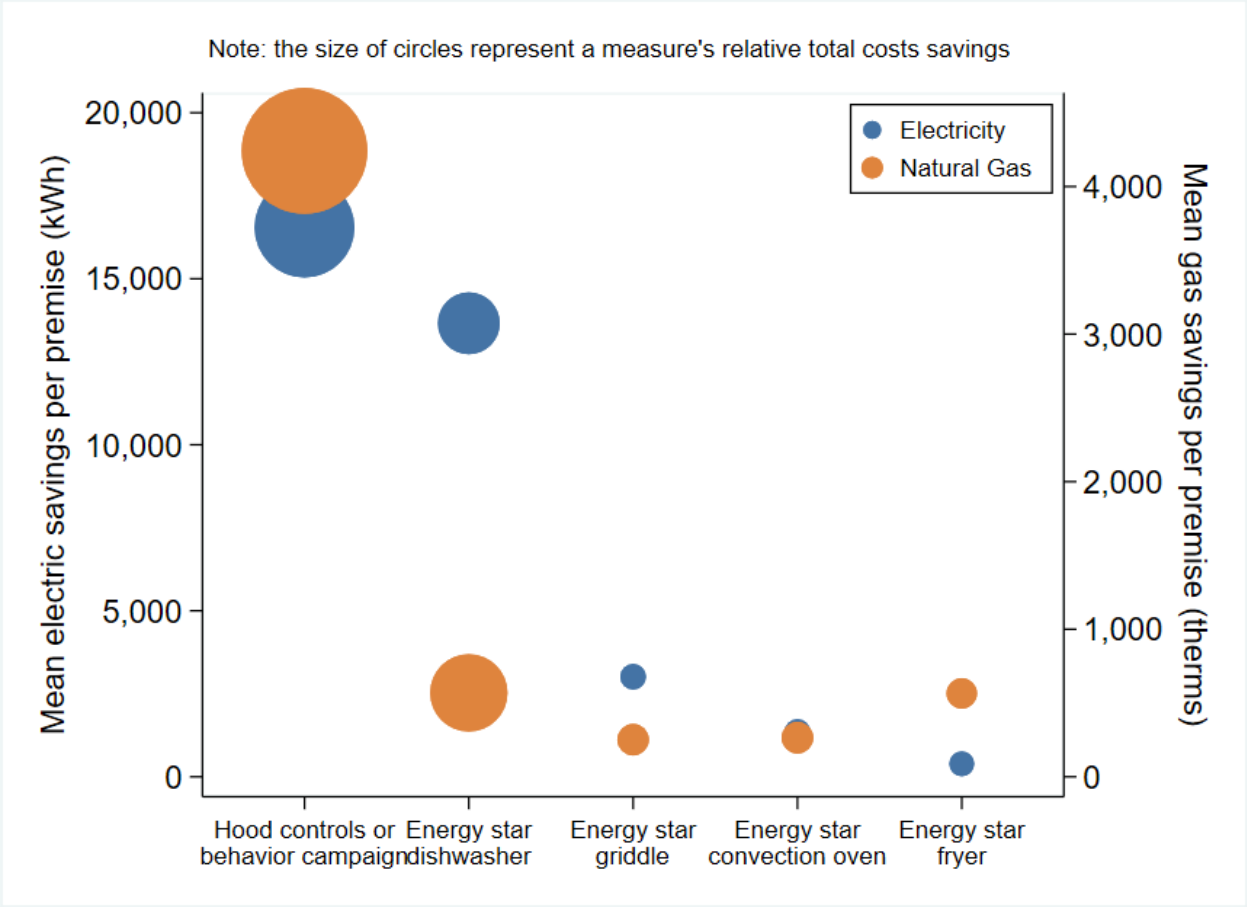
Table 39 illustrates the average number of each piece of commercial kitchen equipment in small commercial buildings with commercial kitchens. It also shows the percent of each that were efficient, as well as the efficient upgrade type. Note that there are a large number of different commercial kitchen equipment types and the data shown below is not weighted to the total population. For most every commercial kitchen equipment type, there was low penetration of efficient options, leading to high opportunity for increased energy efficiency. We did not find any efficient versions of broilers and charbroilers, fryers, griddles, steam cookers, ranges or rotisserie ovens.

Table 39: Commercial kitchen equipment

	Average count	Percent of Efficient Equipment	Number of businesses with this type of equipment	Efficient Description
Commercial refrigerators	2.9	12%	27	Energy Star
Commercial freezer	1.8	24%	19	Energy Star
Commercial ice maker	1.3	9%	25	Energy Star
Commercial dishwasher	1.1	12%	24	Energy Star
Combination oven	1.8	6%	10	Energy Star
Convection oven	1.9	10%	21	Energy Star
Broilers and Charbroilers	1.0	0%	6	Energy Star
Fryer	2.0	0%	21	Energy Star
Griddle	2.3	0%	16	Energy Star
Holding cabinet	1.4	n/a	1	n/a
Steam cooker	1.3	0%	3	Energy Star
Range	1.4	0%	23	Induction
Rotisserie oven	1.0	0%	2	Induction
Salamander broiler	1.0	100%	1	Infrared

In addition to characterizing commercial kitchens, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 24, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 24: Energy savings from top commercial kitchen measures by premise and by total aggregate cost savings



For the kitchen end use across all building types, the main opportunity for energy savings is from reducing kitchen hood exhaust either through automated controls or a behavior change program. This upgrade reduces the amount of heating and cooling energy needed to temper the make-up air, as well as the fan energy needed to move it. The second largest opportunity is from replacing existing dishwashers with new, more efficient ENERGY STAR models. Replacing commercial steam cookers and combinations ovens with newer, more efficient models also have saving, but to a lesser extent than other commercial kitchen measures.

Lighting

Interior lights

More than half of the buildings we collected data on have T8 or T5 fluorescent fixtures to meet their primary interior lighting needs. However, nearly one-fifth still use T12 fluorescent fixtures. LED lighting is growing and is the primary lighting type in 22 percent of retail establishments and 31 percent of groceries. LEDs are much less common in food service and offices. Compact fluorescent bulbs were the

largest secondary interior lighting type. For the approximately 20% of establishments that use task lighting, the majority use fluorescent lighting rather than LEDs. Occupancy or vacancy are used in less than 10% of the buildings we visited. Only two buildings we visited had photocontrols.

In addition to characterizing the interior lighting loads, we also identified opportunities for energy savings in all areas. The scale of these energy saving opportunities are given in Figure 25, with the y-axis representing the average electric savings per store, and the size of the data point representing the total magnitude of the electricity savings across the state of Minnesota; small points represent opportunities that offer a relatively small total cost savings potential.

Figure 25: Energy savings from top interior lighting measures by premise and by total aggregate cost savings.

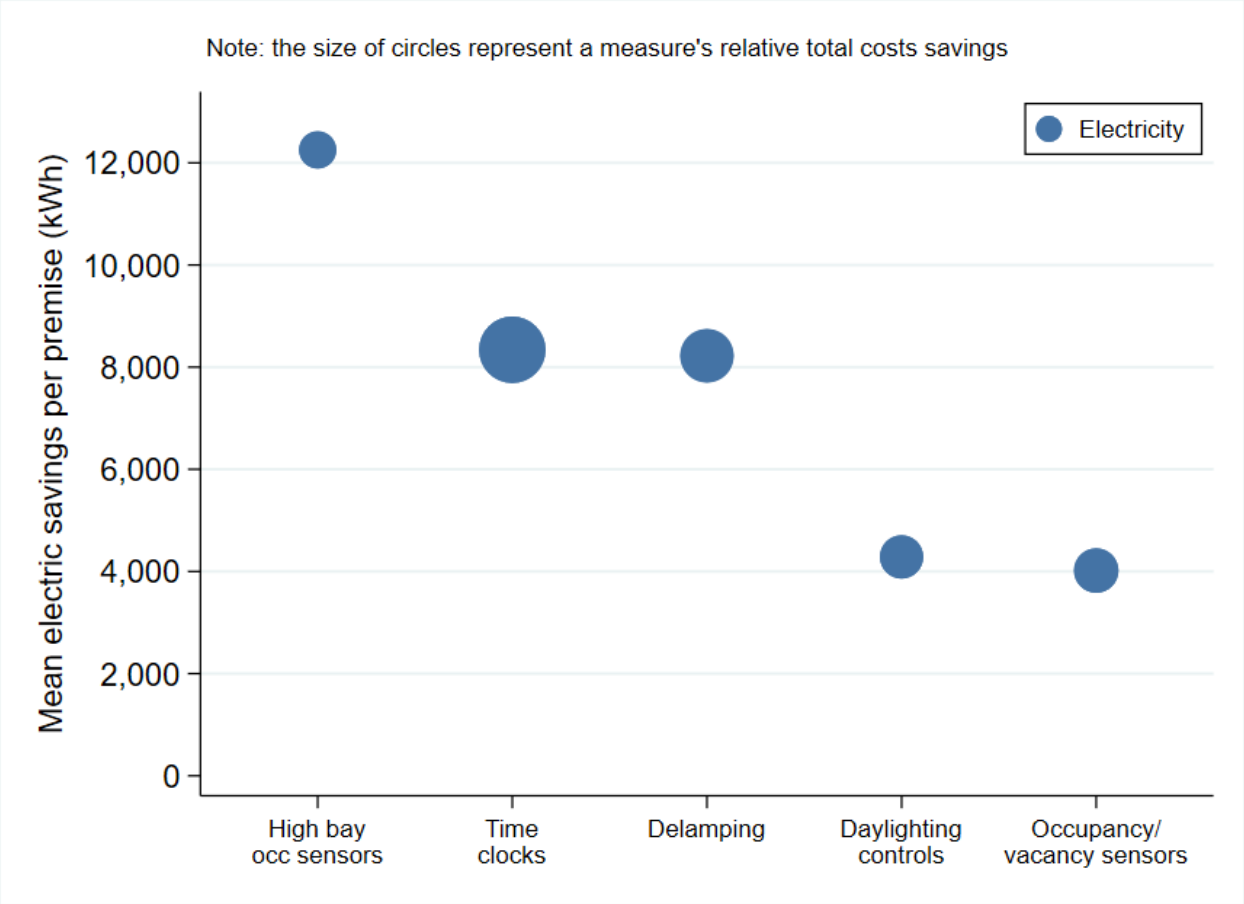


Figure 25 illustrates the top energy savings opportunities for the lighting end use other than lamp and fixture retrofit. The vast majority of buildings we visited had opportunities for lamp and fixture retrofits, but these measures are not listed here because we want to focus on lighting opportunities outside of typical retrofit opportunities. For the lighting end use across all building types, the main opportunity for energy savings is from implementing occupancy controls to turn off lights in high bay areas during unoccupied periods. The next two measures have similar savings: turning off interior lights via a timeclock delamping overlit interior spaces. Implementing photosensor controls to reduce light levels in

daylit spaces as well as installing occupancy sensors to turn off lights also saves significant electrical energy.

Exterior lights

LED lighting is the primary parking lot lighting type for only 10 percent of the buildings we visited, while more than a third have some form of HID lighting (Table 40). However, nearly half have no parking lot lighting.

Table 40. Exterior lighting characteristics by building type

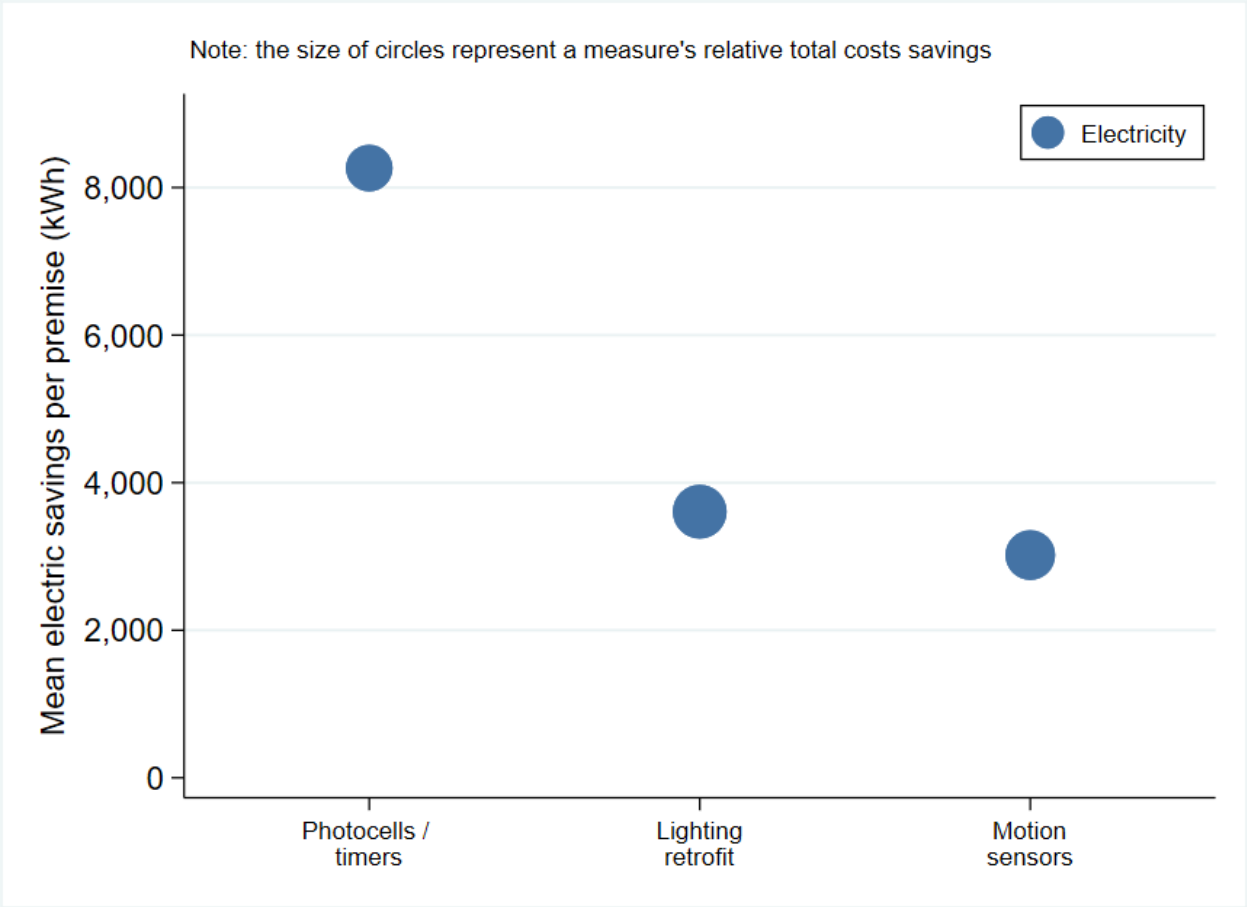
	Overall	Retail	Grocery	Food Service	Office
Parking lots and drives: primary lighting type					
Incandescent/halogen	0.4%	0%	0%	3%	0%
Fluorescent (CFL or other)	5.1%	5%	11%	6%	4%
LED	10.2%	2%	14%	8%	13%
*HID**	35.5%	45%	65%	30%	31%
None	48.7%	48%	10%	53%	51%

*HID includes low pressure sodium, high pressure sodium, metal halide, or mercury vapor lighting

Only about five percent of exterior lighting was controlled with motion sensors. Another one-fifth was manually controlled, relying on people to turn it off when not needed.

The scale of energy saving opportunities in the area of lighting are given in Figure 26.

Figure 26: Energy savings from top exterior lighting measures by premise and by total aggregate cost savings



Other End Uses

Laundry

Only a small percentage of buildings have commercial laundry systems (Table 41).

Table 41. Presence of commercial laundry systems by building type.

	Overall	Retail	Grocery	Food Service	Office
Laundry?					
No	98%	95%	97%	96%	100%
Yes	2%	5%	3%	4%	0%

Compressed air

In the business segments we visited, compressed air was not common. It is slightly more likely to encounter compressed air systems in retail and grocery stores. However, there are other small business segments outside of the scope of this study, that likely have a high prevalence of compressed air, such as mechanic shops, car washes, etc.

Program Opportunities

This section provides our recommendations for programs based on both our research into program best practices nationwide as well as our building characterization and measure opportunity identification.

We first provide an overview of recommended implementation and outreach approaches that focus on how to work specifically with customers in the small commercial sector. We then provide an overview of specific measure bundles that would make sense as focused program offerings.

Customer-focused program approaches

Utility programs that understand the challenges and constraints of their small commercial customers can develop outreach and implementation approaches that overcome these barriers. We identified a number of such approaches through secondary research of nationwide best practices, and conversations with business owners in Minnesota.

The implementation approaches in Table 42 include proven approaches that are implementable today. They are described in further detail below. There are other approaches that may become viable in the future, such as remote energy audits and detailed energy disaggregation, or deep retrofit programs. These have not yet been proven to be cost-effective however.

Table 42: Recommended implementation strategies and the challenges they address

Implementation approach	Benefits
Vertically integrated program	Addresses varied and holistic nature of the measures
Needs-based marketing and outreach	Engages customers because the program targets issues that matter most. Follow-up allows for multiple points of entry into the program to address the ebbs and flows of the business cycle.
Ally with trusted information channels (e.g. business associations)	Provides marketing through trusted networks
Easy financing options	Provide alternatives to high capital expenditures
Selling non-energy benefits (e.g. productivity, comfort)	More motivation beyond simply saving money.
Customer journey to deeper savings	Allows for the flexibility that is needed for small businesses
Using residential marketing channels	Improved outreach connection to busy small business owners.

Vertically integrated program implementation. CIPs can enlist a vertically integrated program implementer that handles all aspects of program implementation from administration, to outreach and sales, and project execution. Such an entity generally works with all trade ally types. We found that vertically integrate programs may work best for a diverse set of businesses in the small commercial sector. A vertically integrated program allows the program administrator to be nimble and flexible in finding the appropriate trade allies from a variety of trades, and it can streamline the process for a business from identifying energy efficiency opportunities to moving through a program. Xcel's One-Stop Efficiency Shop is the best current example of this in Minnesota, though it essentially only focuses on lighting and so does not take advantage of the multiple trade-ally approach.

Needs-based marketing and outreach. Customers can be heavily segmented, with customer needs identified by not only segment (e.g. occupant comfort for restaurants, profit margin for grocery) but also by specific end uses (e.g. those customers with high plug loads). Marketing and outreach activities can then be focused on customer needs. Understanding that small commercial businesses are a varied market with unique needs and business goals among business types, an effective program implementer will use marketing that targets a specific subgroup. The marketing should address the areas of energy conservation that would be most effective for saving energy, comfort, or processes. For example, a grocery store may become more engaged when refrigeration efficiency measures are highlighted and put in terms that are meaningful to the business owner or manager. For example, "By upgrading your refrigeration units now, you can save valuable labor time, and save on energy costs." Or, "Your margins on food sales are low, but margins on energy saved are 100 percent."

Alliance with trusted information channels. A successful program engages with customers on many levels, including trusted information channels such as business organizations. Additionally, having touches at various points of the year (possibly from various angles) can attract customers. One message to the customer may not be effective because of the ebbs and flows of a particular entity's business cycle. Having multiple follow-up messages across varied channels allows for multiple points of entry into the program.

Marketing the program through trusted sources such as business organizations or local chambers of commerce may add weight to the offering. Many small businesses belong to either local organizations or regional business-related organizations—they may be more likely to listen to messages coming from those organizations, since they are perceived to be trusted and knowledge sources.

Programs need to be nimble enough to help customers that may speak a different language or have different values and approaches to business. Local business associations can also aid efficiency programs in understanding this need and in working more closely with different groups of owners.

Perhaps the most common business association types are local chambers of commerce. Many chambers of commerce are unfortunately not yet set up to assist energy efficiency programs. But many are beginning to try, and all have connections in place to potentially be of assistance. An organization called Chambers for Innovation and Clean Energy (CICE) is a national network of local chambers dedicated to energy efficiency. CICE helps both chambers and member companies navigate energy efficiency and renewable energy, and can provide guidance and examples for chambers that are interested in being

more involved in this space. And the Institute for Market Transformation has launched the Small Business Energy Initiative specifically focused on chambers and small business chamber members.

Easy financing options. Even when a small business is doing well, cash flow is still often a concern for most small businesses. Incorporating financing options that are easy to access is important. But potentially more importantly, recruitment efforts may fail if they only focus on money and financing options; programs that emphasize comfort, convenience and improved operations may be a stronger sell than a simple payback. Many utilities already offer some type of financing to customers either on their own or with a financial partner; these programs can simply be specialized to target smaller customers and loans. The Retail Industry Leaders Association has published a guide to energy efficiency financing that may be helpful (IMT, 2017).

Selling non-energy benefits. Translate energy program benefits in multiple ways beyond just simple payback. Communicate benefits of comfort, convenience and improvements in business process. Our conversations with owners suggest that many types of owners can be just as motivated (or even more) by non-energy benefits than by the energy savings from an upgrade. More specifically, non-energy benefits include improvements to any of the following:

- Thermal comfort. Especially important to any small business with customers that visit.
- Visual and acoustic comfort. Especially important to retail owners.
- Indoor air quality. Included both ventilation and combustion safety issues that we observed.
- Maintenance. Small business owners generally do not have staff or time to provide proper maintenance to equipment.
- Productivity. Labor costs are higher than energy costs, so any benefit to productivity is an even bigger selling point.

Customer journey to deeper savings. Provide an easy progression from low-cost measure to more capital-intensive projects. Have a planned process for a customer to move from low-cost direct-install measures to more capital-intensive project. It is important to not only streamline the process, but also to engage customers along that journey. Implementers should recognize that they are continually balancing a number of different priorities and will forget about energy at times, but can be brought back to it. If potential participants understand that there is a process in place to make larger investments when they are ready for them, then they may keep that process in mind as they evaluate their priorities. This is also where multiple points of follow-up are helpful to keep future options and goals in mind. The measure bundles in the next section are all set up based on this customer journey.

Consider using residential marketing channels. Many of the building owners that we talked with had very little knowledge of their utility's business efficiency offerings. They barely had time to look at their business' utility bills. However, many were aware of their utility's home efficiency offerings. Presumably they have more time to look at information their utility sends them regarding their home, and to consider some basic home energy improvements. If a utility has data or a method to target small

business owners where they live instead of where they work, perhaps piggybacking on their existing residential programs, they may have more marketing impact.

Bundling measures for program offerings

As outlined in our recommended implementation strategies, customers have limited bandwidth and therefore respond better to more focused, targeted messages. Customers may respond better when provided with a discrete number of choices. This is why many programs bundle measures into categories, and approach businesses based on the category (or a few categories) that make the most sense for that business. Entire programs may focus on just one of these bundle categories (or two related categories). Or a larger, more integrated program could be successful selling a few of these bundles; this may be the place for a vertically integrated approach where one implementer can work with multiple types of subcontractors.

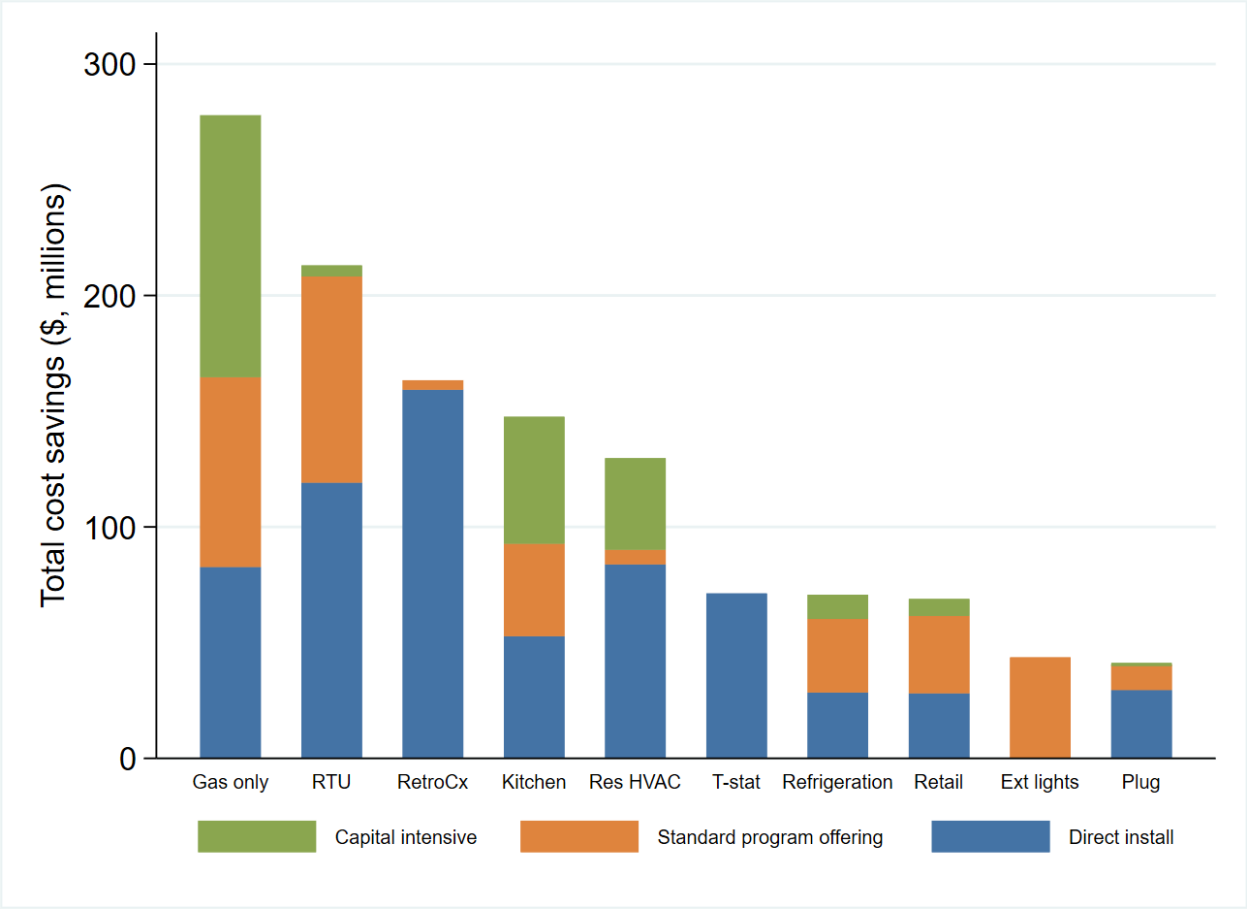
With that in mind, we categorized the 100 measures described earlier in the report into 10 bundles based on a variety of different criteria including end-use, but also other things such as fuel type or business function. The 10 bundles are listed here and described in further detail below:

1. Capture gas savings
2. Tackle rooftop units
3. Retrocommissioning
4. Taming kitchen energy intensity
5. HVAC crossover: from residential to commercial
6. Everyone has a thermostat
7. Refrigeration
8. Selling energy efficiency to retail
9. If it's plugged in, it's plug load
10. Exterior lighting

We also recognized the need to plan for a customer's journey through an efficiency program over time. Customers will often not be inclined to begin with a major capital project to save energy. We recommend offering a progression of products from low-cost or direct-install type measures, to more capital-intensive measures. For each bundle, we categorized measures the predominant program delivery type: *direct-install* refers to smaller measures that may fit in a traditional direct install or other low-cost/no-cost program approach. *Standard program* offerings are measures that are typically offered in a standard rebate-based program but could be targeted at small businesses as well. Finally, *capital-intensive* measures are just that—larger, higher cost measures that may need more than just a rebate to be sold: hand-holding, financing, or economic analysis.

The results in Figure 27 compare total statewide costs savings potential of each measure bundle, according to the program delivery types that we've discussed.

Figure 27: Total cost savings from recommended measure bundles, broken out by program type



Gas-only measures stand out with the highest cost savings and an evenly distributed breakout among program-delivery mechanisms. This result suggests that there is considerable technical opportunity for natural gas utilities in small commercial energy programming.

Other system-level bundles, such as RTU-specific measures or residential-type HVAC measures incorporate both electric and natural gas measures. The retrocommissioning bundle, which includes measures addressing both heating and cooling systems as well as refrigeration, domestic hot water and plug load, shows significant savings and is largely offered in a direct-install type of program delivery. Kitchen measures offer technical savings evenly across program delivery types.

Capture gas savings

Program approach description

Due to a reliance on savings from lighting (and in some cases refrigeration), most small business programs are either implemented by electric utilities, or jointly implemented by electric and gas utilities. But there are significant gas savings opportunities that could warrant an HVAC-focused, but still holistic, gas utility small business offering. One delivery approach would be to partner with an electric small business program that is, perhaps, focused on lighting.

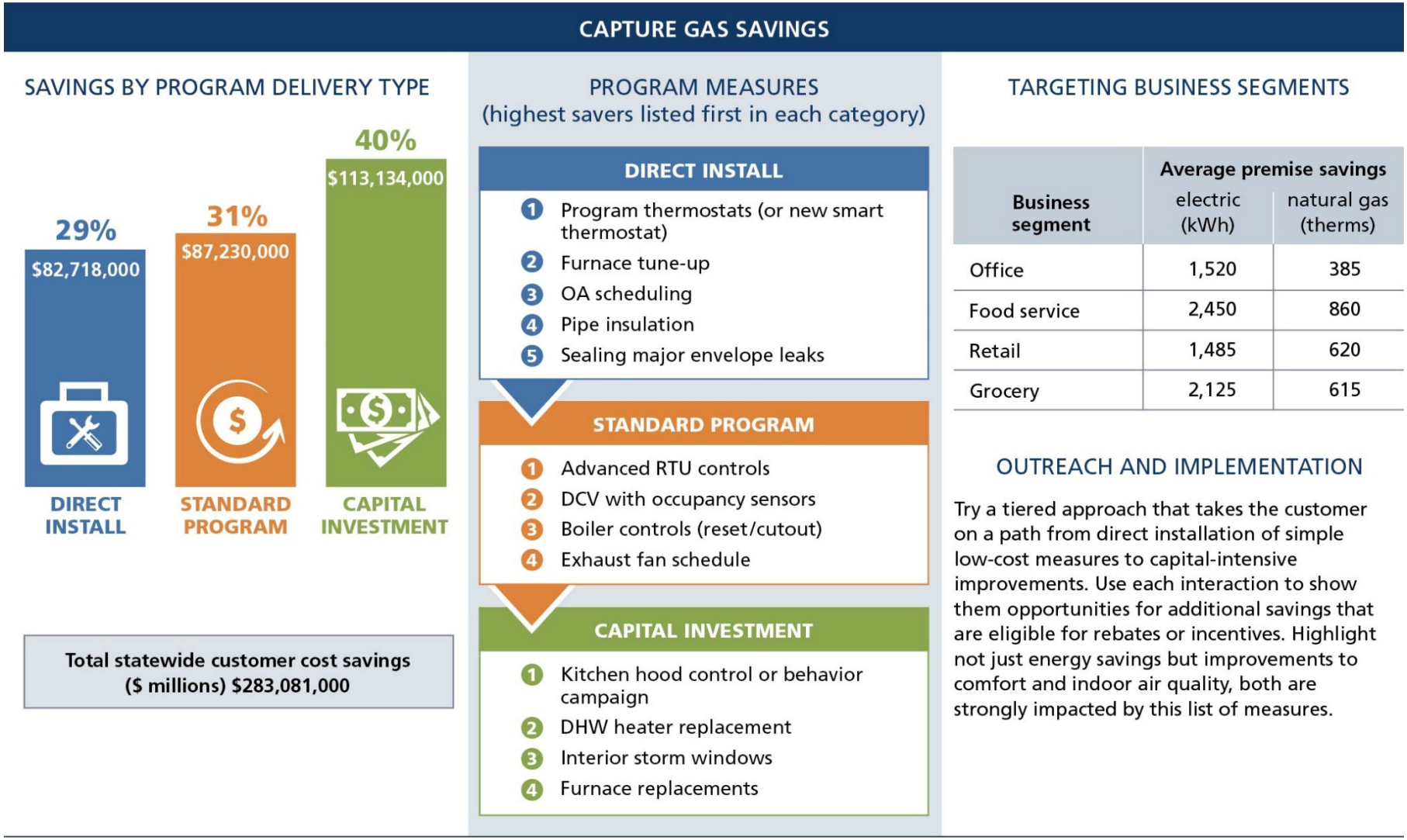
Gas utilities interested in this type of program have a range of measures to plan the customer journey, from simple direct install measures like OA scheduling, to retrofit measures like advanced RTU controls, and eventually larger capital measures like interior storm windows. Incentives for anything more than the direct install measures could be standard prescriptive incentives.

Audiences and applications

The best applications for a gas utility program offering would be food service, followed by retail. These two building types have the most potential for gas energy savings in typical buildings. Office spaces should also be targeted because of the high number of offices in the state; many building types also contain offices, from manufacturing facilities to service facilities. If a partner electric utility exists, one strong audience would be any business that has conducted some amount of lighting retrofit in the recent past.

Figure 28 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 28. Program bundle for gas utilities



Tackle rooftop units

Program approach description

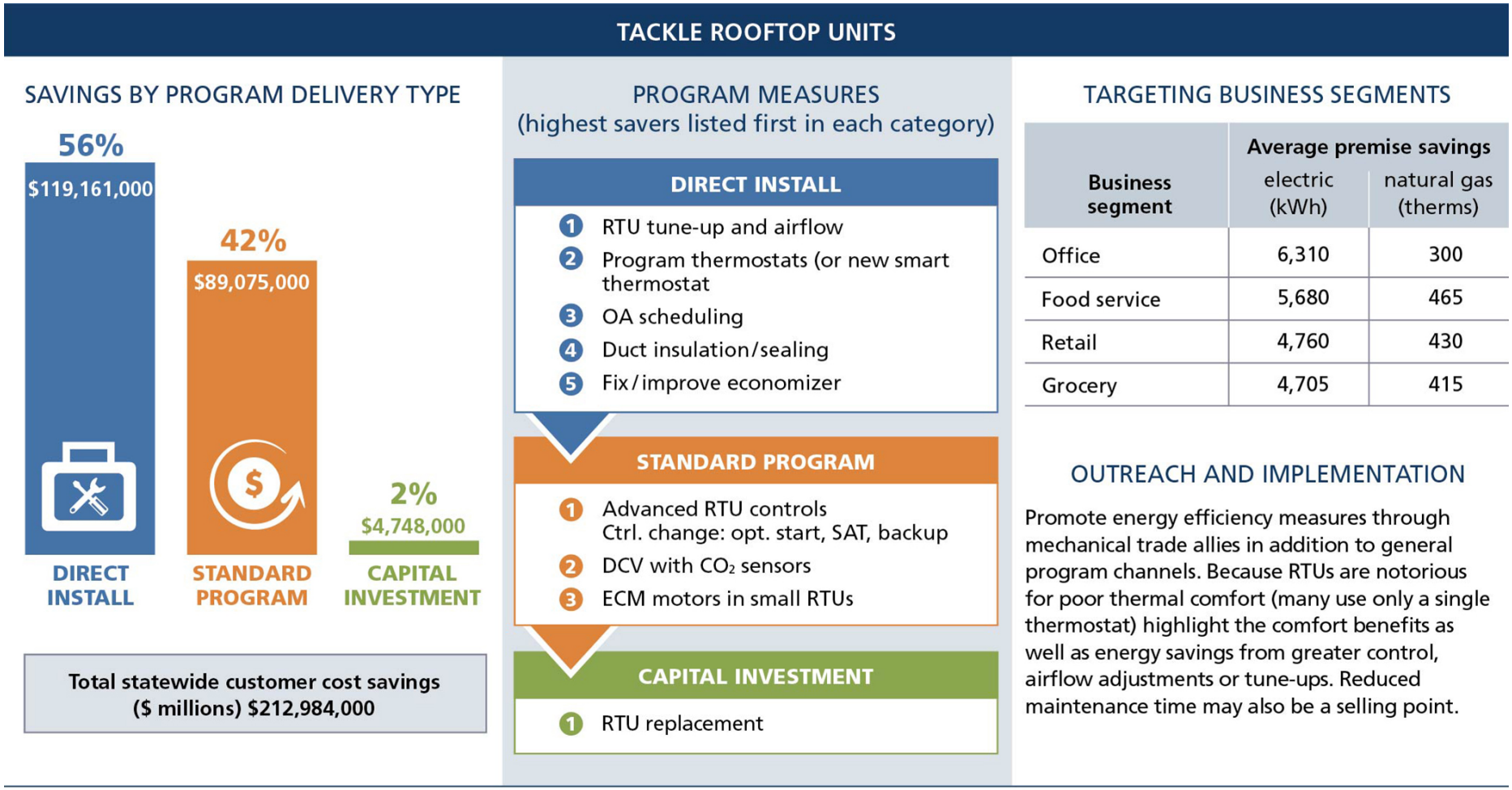
The most common HVAC system type for small commercial buildings in Minnesota is rooftop units (RTUs). Many locations have multiple units, and they are generally poorly maintained and often kept past their useful life. There is significant energy to be saved in tuning, retrofitting, adding controls to, and upgrading them. Significant incentives may be needed for the more capital-intensive measures like advanced rooftop unit controls, and replacement.

Audiences and applications

Rooftop units are found in most types of commercial buildings. They are present in nearly every food service and most retail establishments, making those excellent applications. Small grocery is also a primary application. And nearly every such building has some opportunity for savings.

Figure 29 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 29. Program bundle for rooftop units



Retrocommissioning: not just for the big guys

Program approach description

In larger buildings, it's often called retrocommissioning; in smaller buildings it's often called a building tune-up. Either one results in small low-cost/no-cost improvements to a building's mechanical (and sometimes electrical) system. This program approach is akin to direct-install but involves deeper technical modifications and highly skilled trade allies. Other utilities (such as ComEd's Retrocommissioning program in Illinois) have found ways to make this program type serve medium-sized businesses; the approach can continue to be tuned to try to make it cost effective for even smaller businesses.

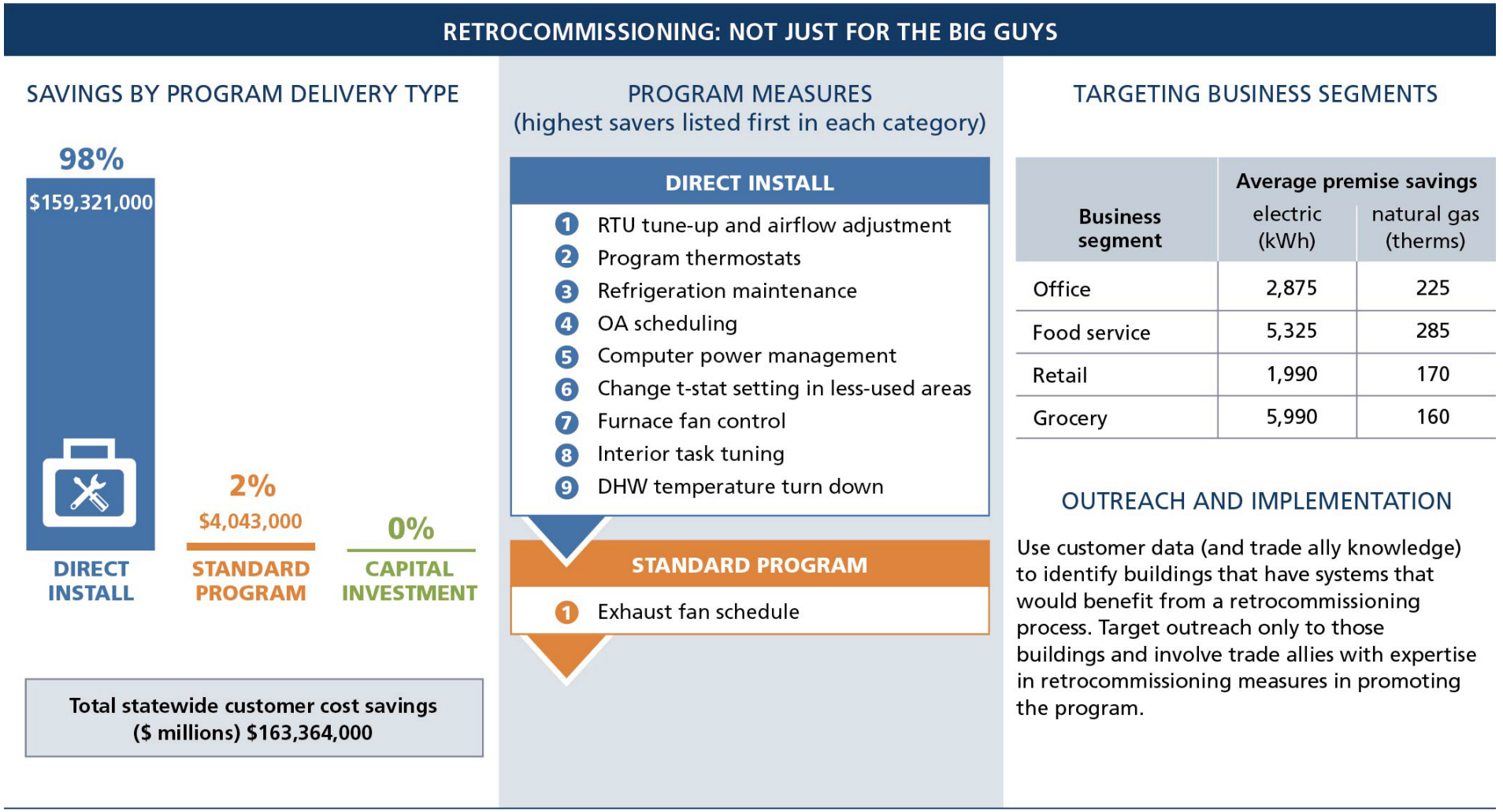
The traditional retrocommissioning approach of offering incentives for individual measures and making decisions based on economic calculations for each is likely not effective. Incentive frameworks in this sector should be simplified. One solution would be a blanket incentive rate based on system type and size. A more complex approach could be based on a checklist of measures identified in an initial site survey.

Audiences and applications

Retrocommissioning can work in all types of applications, though generally the larger and more complex building systems make the best candidates, especially those with existing HVAC controls beyond a simple thermostat. This may seem a contradiction to the nature of small business programs, but there is a niche for these types of premises in the small business sector. For example, 18 percent of the businesses in our sample had medium sized systems of 10 tons or greater (and many of those had multiple such systems).

Figure 30 presents the most cost-effective measures in the center of the graph, from lower cost at the top to costlier at the bottom. Savings by sector are shown on the right.

Figure 30. Program bundle for retrocommissioning



Business segment	Average premise savings electric (kWh)	natural gas (therms)
Office	2,875	225
Food service	5,325	285
Retail	1,990	170
Grocery	5,990	160

Taming kitchen energy intensity

Program approach description

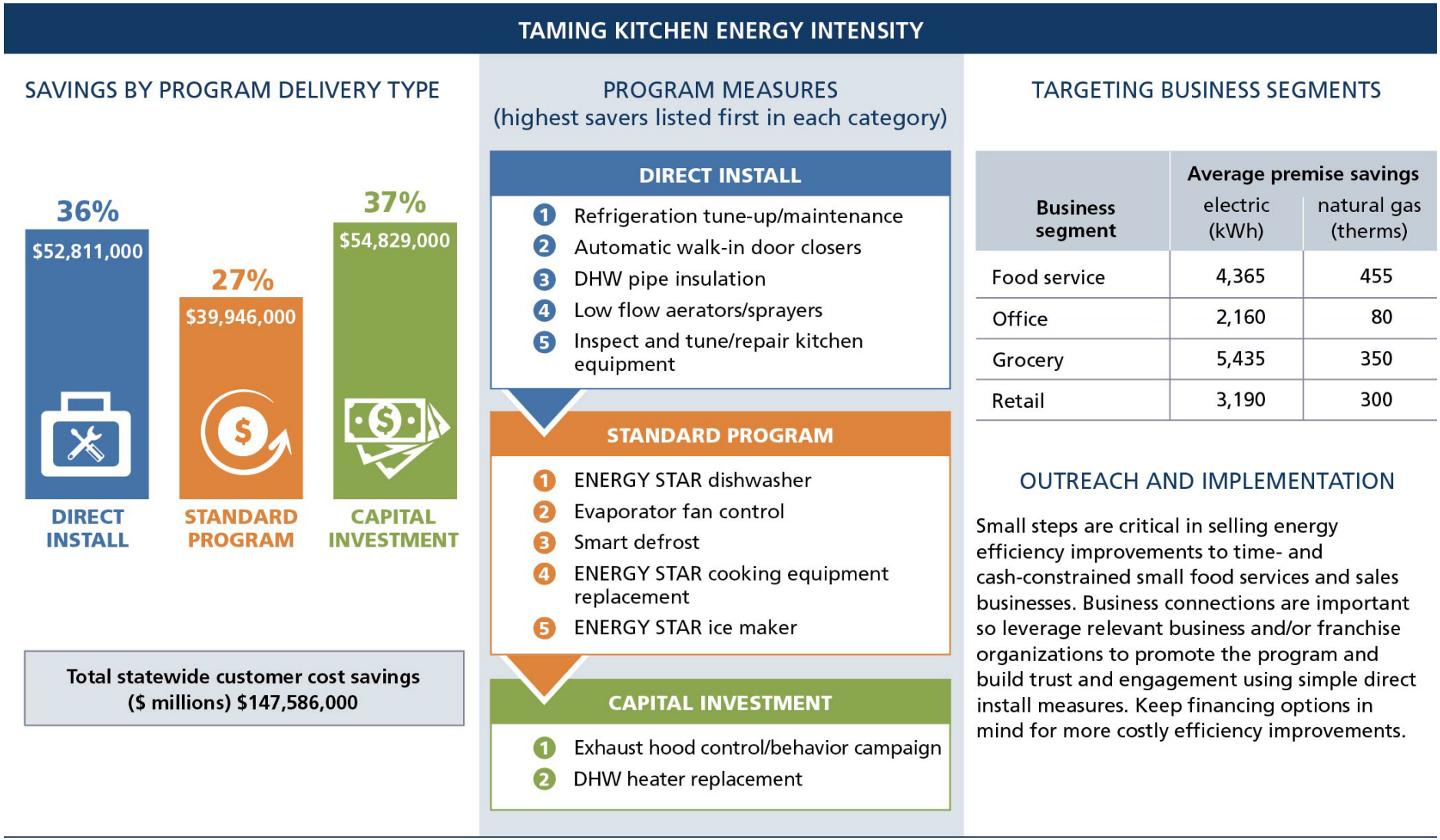
On a per area basis, kitchens are the highest energy intensity space type in the small commercial sector. Due to this energy intensity, a small commercial program offering that just targets the types of buildings that have these space types is warranted for most utilities, especially where it can be done jointly between gas and electric utilities.

Audiences and applications

Kitchens exist in, of course, restaurants. But this program offering is also present in many grocery stores, small lodging, and some public buildings. Many of these building owners in this segment own multiple establishments too, so they should be approached with a number of establishments in mind, making them more effectively like a larger business.

Figure 31 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 31. Program bundle for commercial kitchens



HVAC crossover: from residential to commercial

Program approach description

Most utilities in Minnesota have a trade ally network that is focused on mechanical systems in residential buildings. Not all utilities have such a network for small businesses. But 43 percent of the small businesses that we encountered had residential-style HVAC systems. Utilities would benefit if they can eliminate barriers between commercial and residential HVAC programs, and co-implement measures across the two sectors. Incentive frameworks can also be similar to residential programs, though sizes are often a bit larger and so could warrant a larger per-device incentive, or a shift to a per-ton incentive.

Audiences and applications

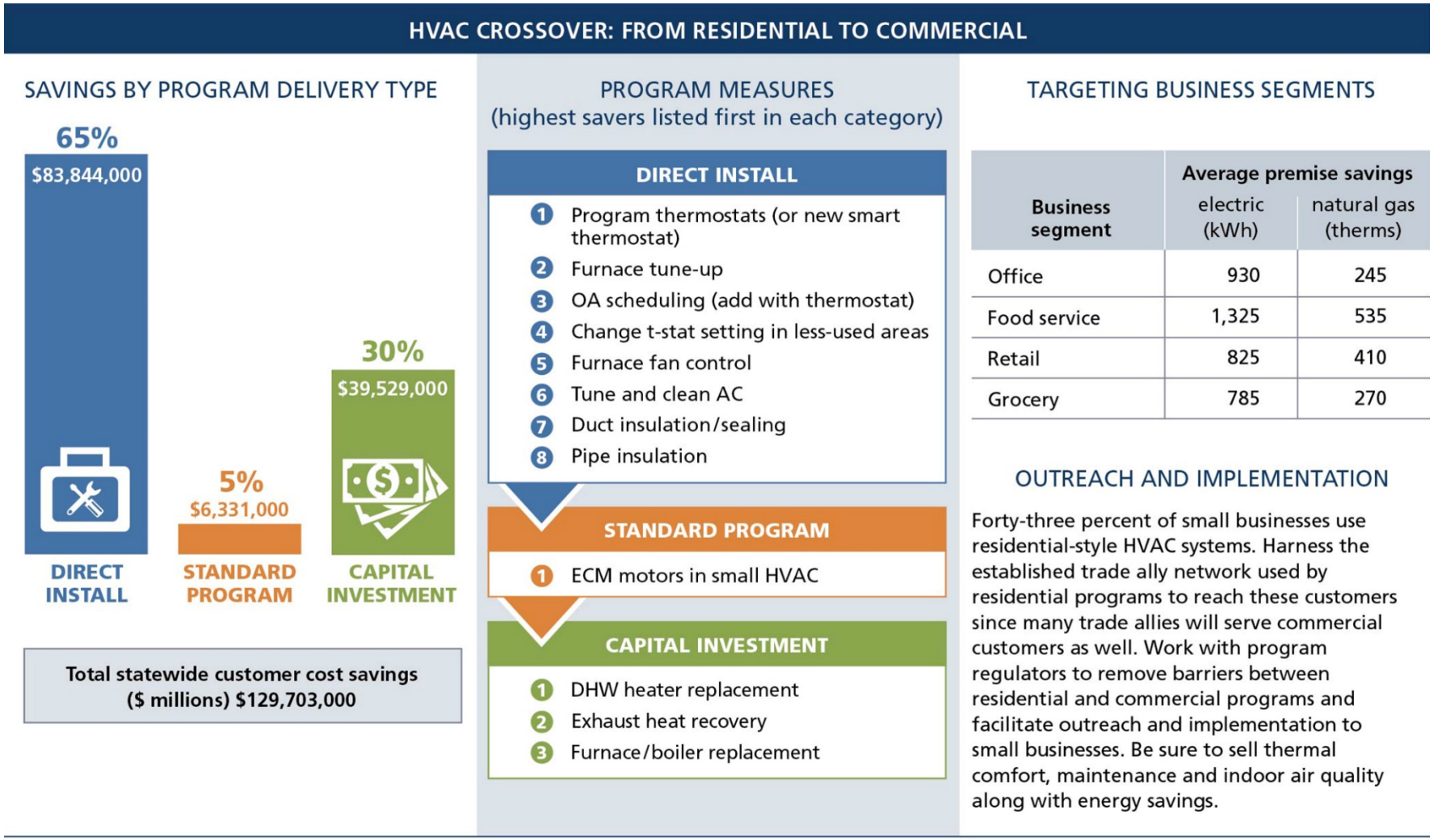
Any building with a residential-style HVAC system—furnaces and/or split-system air conditioners—would be applicable; these were widely found in all the small business types that we researched.

Incidentally, most small business owners also pay utility bills at home, and interact with their utility via residential programs.

Many of the business owners and facility managers we spoke with were more familiar with the residential programs serving them at home than they were with the commercial programs serving their business. So it is possible that we could reach those audiences in their homes in addition to at their places of business.

Figure 32 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 32. Program bundle for residential-style HVAC



Everyone has a thermostat

Program approach description

Every small business has at least one thermostat. Most have more than one, and many of those are either manual (27 percent) or in some way is not set back at any time (43 percent). This results in one of the most cost-effective bundles that we've identified, with both significant and broad savings applicability. All measures are lower cost, quicker installations that fit in or near the direct install category. Incentives are not necessary.

Audiences and applications

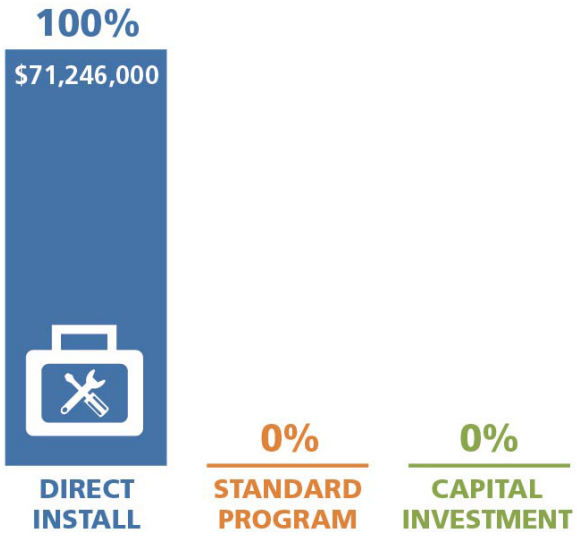
All segments have thermostats that are potentially applicable, though grocery stores often have limited capability to modify or modulate thermostat setpoints due to a desire for more consistency in temperatures. Office and retail segments have the highest share of thermostats in need of help—manual thermostats and unprogrammed thermostats.

Figure 33 presents the most cost-effective measures in the center of the graph, from lower cost at the top to costlier at the bottom. Savings by sector are shown on the right.

Figure 33. Program bundle for thermostats

EVERYONE HAS A THERMOSTAT

SAVINGS BY PROGRAM DELIVERY TYPE



Total statewide customer cost savings ($ millions) $71,246,000

PROGRAM MEASURES
(highest savers listed first in each category)

DIRECT INSTALL

1. New smart thermostat
2. Program thermostats
3. OA scheduling
4. Change t-stat setting in less-used areas
5. Furnace fan control

OUTREACH AND IMPLEMENTATION

Every small business has at least one thermostat. Thermostat measures are inexpensive and simple to install, making them an excellent measure for moving beyond lighting efficiency. They're easily added to bundles of measures targeting a range of small businesses and end uses or they can stand on their own. Sell thermal comfort as well as energy savings when offering these thermostat upgrades.

TARGETING BUSINESS SEGMENTS

Business segment	Average premise savings	
	electric (kWh)	natural gas (therms)
Office	2,190	465
Food service	2,975	690
Retail	1,535	350
Grocery	1,240	225

Refrigeration: where to start

Program approach description

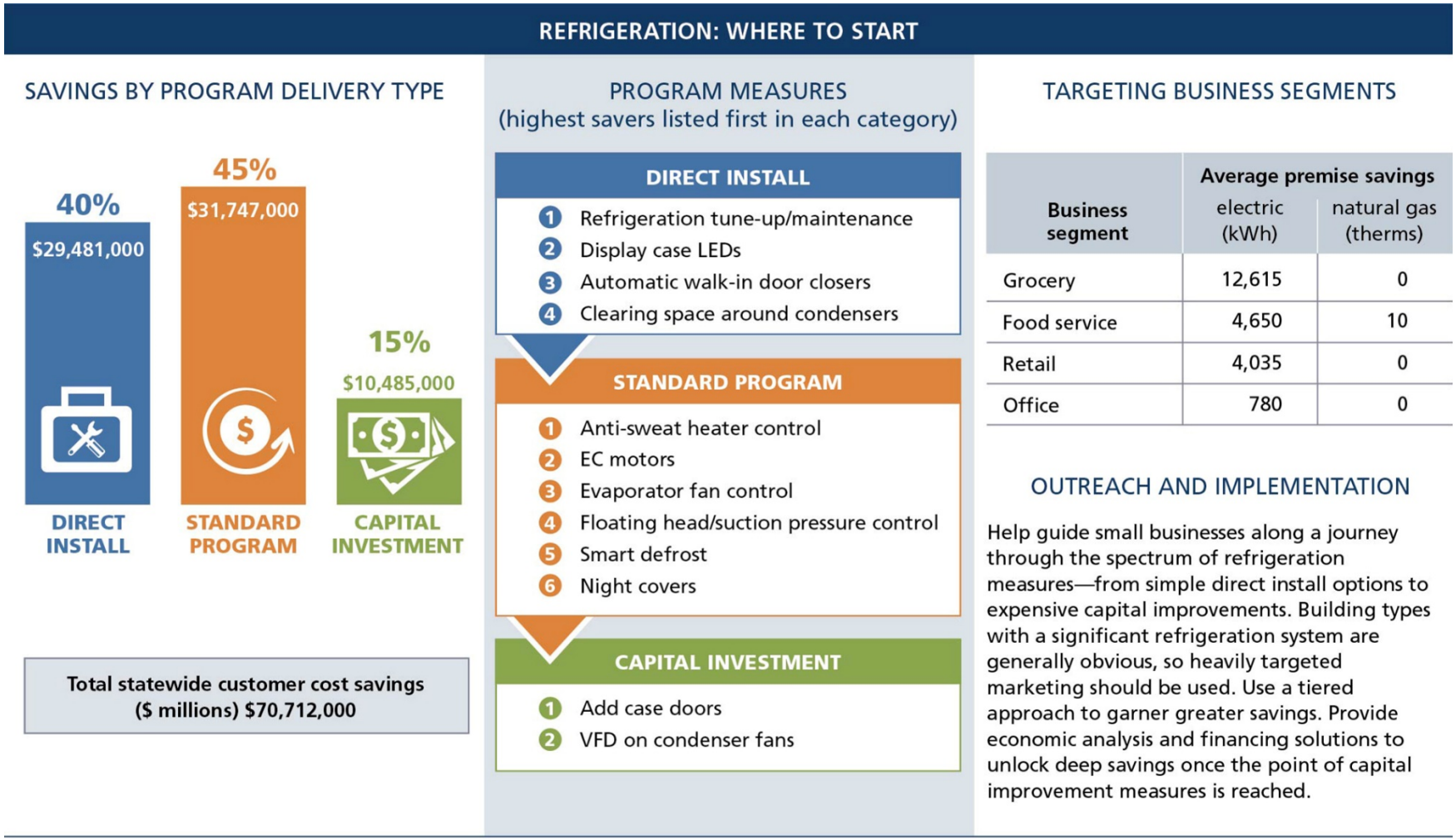
Refrigeration measures have the highest per premise savings of any bundle, making them an excellent first choice for an electric utility looking for an approach beyond lighting in the small commercial sector (there are no savings here for gas utilities). Many of the measures included in this bundle require a relatively standard incentive framework, though higher per kWh (or kW) incentives specifically for smaller businesses would lead to more equitable cost effectiveness for this sector. Regardless, additional outreach and assistance is needed to promote and incentivize these measures in smaller commercial, because these businesses do not have the facility management staff that standard grocery stores have (though some are still chain stores which may have those resources). Therefore, these programs may rely on trade allies even more than the standard grocery program offerings do.

Audiences and applications

This program bundle is aimed squarely at the grocery segment, which includes both small grocery and convenience stores, and both single owner and chain store audiences. Though there is some applicability for some of these measures to food service (those with a lot of walk-in space) and retail sectors (that happen to have refrigerated display cases). Once a program is reaching the grocery segment conveniently, some promotion across segments is warranted.

Figure 34 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 34. Program bundle for refrigeration measures



Selling energy efficiency to retail

Program approach description

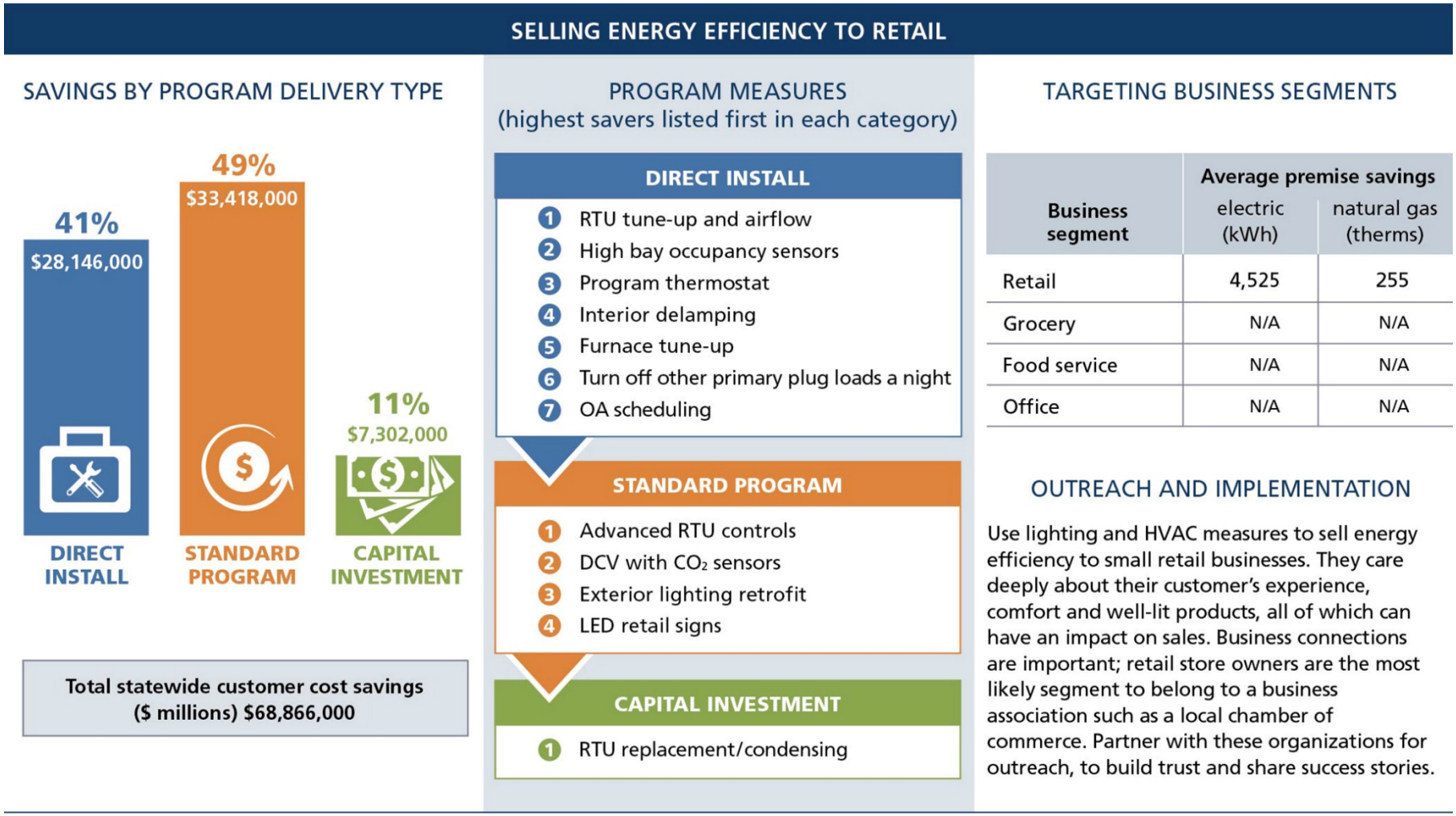
Retail establishments (non-food) have the lowest per-premise average savings of the four building types that we investigated, but there are so many small retail establishments – and they are easily targeted by building type – such that it is worth considering a targeted retail offering for the unique loads and opportunities that they do have. With the limited capital that most small stores have available, measures are mostly found in the low cost direct install category and standard program offering category. Basic HVAC measures are a key element, so this could be an HVAC trade ally driven program. Some specialty measures such as high-bay occupancy sensors (for all back-of-house space) and plug load control do exist that need to be handled specifically for retail customers. Plug load control in a retail environment is dependent on the products being sold. Any store that sells products that plug in and use energy will often operate these products (lighting, audio, video, comfort products, etc.) during open hours. Additionally, signs and displays often light up in these stores as well. Ensuring that all these elements are turned off at night whether manually or automatically is a key energy saving measure.

Standard incentive offerings could be used for most of these measures, though a behavior campaign targeting things like plug loads and lighting would follow a behavior program framework instead.

Audiences and applications

The audience for this offering is simply any retail store that would not be a good fit for the more energy intensive refrigeration and cooking offerings. Figure 35 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 35. Program bundle for retail establishments



If it's plugged in, it's plug load

Program approach description

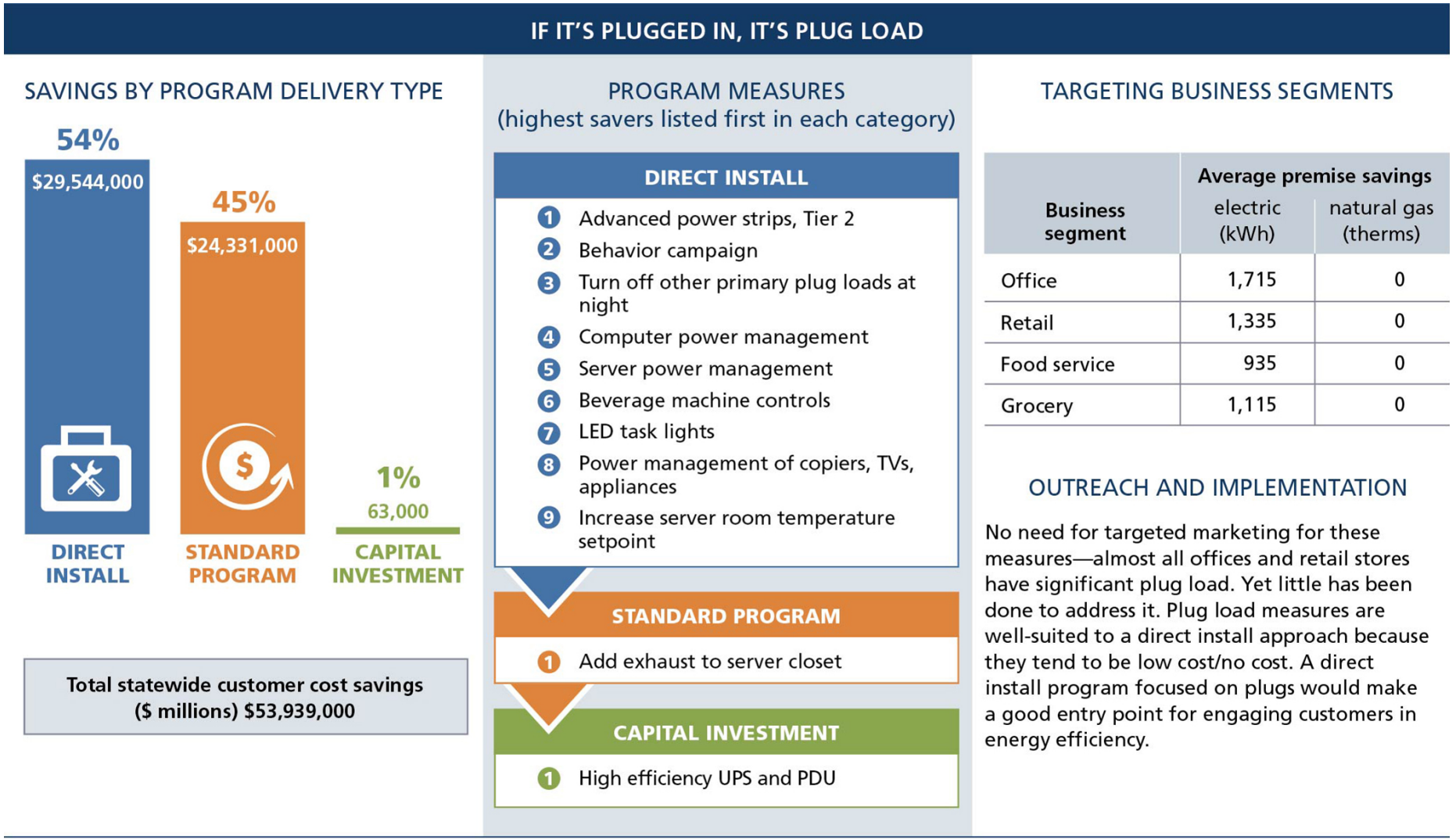
Plug loads are another program area that is solely for electric utilities. Most plug load measures are characterized by being low cost, and many are actually no-cost apart from the hand-holding that is always needed to get an owner on board with a plug load savings approach. In fact, though these measures are simple they may require some interaction with IT staff or contractors at the business in order to implement, which strengthens the need for some technical hand-holding to be available from the program to move a business owner from interested to implementing. Utilities could begin including more IT expertise on staff or amongst their implementation contractors' staff to work with the growth in energy usage that is affected or even fully controlled by IT personnel.

Audiences and applications

While many of these bundles have the largest impact in grocery and restaurants, the plug load bundle has the largest impact in the office and retail segments. This is simply where the most devices are plugged in, and many of them are left on overnight. But all of these segments have plug loads, so some elements of the plug load bundle could be used in any holistic small business program.

Figure 36 presents the most cost-effective measures in the center of the graph, from lower cost at the top to more capital intensive at the bottom. Savings by sector are shown on the right.

Figure 36. Program bundle for plug loads



Exterior lighting

Program approach description

A nice transition for a small business program focused on interior lighting would be to add a significant exterior lighting component. This program approach could cover retrofit of all exterior lighting (parking, drive, entryway, and façade or sign) to LEDs. It would also cover the basic methods of controls. Penetration of both of these areas of energy efficiency was still very low in the sites we visited.

Audiences and applications

Most buildings have exterior lighting, though grocery and food service tended to have more (per building size) than most. Due to low existing measure penetration, any small commercial entity that has previously participated in an interior lighting program should be considered for a targeted offering aimed at their exterior lighting.

Figure 37 presents the most cost-effective measures in the center of the graph, from lower cost at the top to costlier at the bottom. Savings by sector are shown on the right.

Figure 37. Program bundle for exterior lighting

EXTERIOR LIGHTING

SAVINGS BY PROGRAM DELIVERY TYPE

Total statewide customer cost savings ($ millions) $43,641,000

PROGRAM MEASURES
(highest savers listed first in each category)

STANDARD PROGRAM

1. Exterior lighting retrofit
2. Exterior motion sensors
3. Exterior photocells/timer

OUTREACH AND IMPLEMENTATION

Addressing exterior lighting efficiency is an excellent next step once a direct install or standard program has made basic interior lighting improvements. Improving the lighting quality outside the building and reducing maintenance are concerns for small business owners on par with saving energy. Target likely candidates using available property tax or other data describing the size of the business' property in relation to the building.

TARGETING BUSINESS SEGMENTS

Business segment	Average premise savings	
	electric (kWh)	natural gas (therms)
Office	7,085	0
Food service	3,880	0
Retail	2,080	0
Grocery	6,805	0

Future Work

This project's focus was primarily a quantitative assessment of the characteristics and opportunities in small commercial buildings in Minnesota. There are a few key areas that it did not cover that require future work in order for all Minnesota utilities to be successfully deploying these programs.

- Though we provided program offering 'bundles' in the report, these bundles were not paired with a deployable program design or any pilot testing. Both will be needed by the utilities that first attempt to move beyond lighting in this sector, and we encourage those utilities to document their successes and lessons learned for others. There are some offerings in Xcel Energy territory that are beginning to test these approaches, for example.

- Similarly, additional feedback could be sought from owners on the nature of the program offerings that we put together in this project. Though we talked with a number of owners about the different measures and approaches, this project did not include a follow-up survey to test the viability of all of our program offerings against the opinions of individual business owners. Though we do have the benefit of having put them together with substantial data on owner attitudes and measure opportunities.

- We did not map opportunities by utility type or territory. It would be helpful to know how the opportunities map to IOUs vs. consumer owned utilities. It would also be beneficial to add a locational component to this analysis. The sample size for our on-site data is not large enough to do either of these analyses. The survey data that we did collect could be analyzed in this way however. Some amount of this was completed in the related statewide commercial behavior segmentation and potential study (Illume, 2017), but more could be conducted using our data or other data.

- The scope of this research project did not cover solar or renewable energy opportunities, so we did not quantify attitudes or potential for this resource. But it's worth noting that in our open-ended questions, a significant number of small business owners expressed a desire to add solar panels to their businesses. The energy savings potential, economics, and program feasibility for solar should also be studied and compared with the energy efficiency measures quantified here.

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Appendix A: Literature Review

Seventhwave reviewed a report on next generation efficiency programs published in 2013 by the American Council for an Energy Efficient Economy for background information on small business programs. The report was very useful for characterizing current small business energy efficiency programs and for identifying best practices for these programs in the future.

Next Generation Efficiency Programs (ACEEE)

ACEEE. 2013. Frontiers of Energy Efficiency: Next Generation Programs Reach for High Energy Savings.

As the baseline for energy efficiency changes (as a result of more stringent building codes and efficiency standards for appliances and other equipment), energy efficiency programs face greater challenges in achieving energy savings. ACEEE describes what the next generation of energy efficiency programs might look like in order to achieve high savings per customer and greater customer participation. For small business programs, they note that the bulk of savings from the current generation of programs have come from lighting and those savings will be harder to come by as lighting efficiency standards are changing rapidly. In the future, savings will not come primarily from new technologies, but from enhanced marketing, financing and generous incentives that increase the number of program participants.

Suggestions for the next generation of small business programs:

- Use customer relationship management software and data analytics to target communications and outreach.
- Integrate energy efficiency with demand response programs
- Offer incentives for multiple measures including refrigeration, HVAC and insulation in addition to lighting

Three well-established programs have evolved to incorporate next generation program strategies for small businesses.

Connecticut Small Business Energy Advantage

This program is designed and managed to encourage small business owners to do comprehensive energy efficiency projects. It includes:

- Bonus incentives (beyond what they would get for a lighting-only project) for implementing projects with multiple energy saving measures.
- Incentives are available for controls, refrigeration, compressors and HVAC roof top units.
- Marketing efforts that target underserved areas in larger cities, including Empowerment Zones, minority business organizations, veteran's organizations, etc.

- Minimizes customer effort with direct services (onsite assessment and direct installation) and reduces financial barriers through incentives and on-bill financing for qualifying customers.

Connecticut Small Business Energy Advantage website (http://www.energizect.com/your-business/solutions-list/Small-Business-Energy-Advantage)

National Grid Small Business Program

This program provides turn-key services at very low cost to business owners. It includes:

- Generous financial incentives (70 percent of project cost, 0 percent interest on-bill financing for the remaining 30 percent of project cost for a term up to 24 months).
- Additional measures beyond lighting such as refrigeration, energy-efficient time clocks, photo cells for outdoor lighting, occupancy sensors, programmable thermostats and energy-efficiency measures for walk-in coolers.
- Local vendors provide services for the program which builds support and acceptance.

Southern California Edison Direct Install Program (Ecology Action)

SCE has elected to go broader rather than deeper to obtain energy savings through their small business program. This approach includes:

- Outreach to small businesses using less than 100 kW (mailers, media events, door-to-door in targeted areas, presentations to ethnic groups and community-based organizations).
- Jobs component through partnerships with community organizations that result in skilled jobs in installation, energy auditing and clerical work.

Other Programs

Following are descriptions of several other programs that incorporate components of ACEEE's next generation strategies.

These programs offer a variation on the model of:

- Conducting a free on-site energy assessment
- Providing a report on energy saving opportunities
- Installing a basic set of energy efficiency measures
- Offering rebates or financing for additional efficiency measures

Minnesota One-Stop Efficiency Shop

This program is an example of a full-service model targeting lighting efficiency in businesses that have a peak demand of 400 kW or less. It is designed to overcome barriers by offering substantial incentives and bringing service to the customer rather than relying on them to seek out contractors.

Administrator: Center for Energy and Environment (third party) for Xcel Energy's customers
Assessment: free lighting audit with cost savings recommendations.

Lighting efficiency measures: rebates worth up to 60 percent of installed costs; serve as liaison with contractor and complete and submit rebate paperwork.

Minnesota One-Stop Efficiency Shop website (http://mncee.org/What-We-Do/Program-Design-and-Delivery/One-Stop-Efficiency-Shop/)

PG&E – Business Energy Reports

This program is designed to deliver customized information to individual businesses and motivate these businesses to take energy savings actions by comparing their usage to similar businesses and offering them customized solutions for managing their energy use.

Participants get a personalized assessment of their energy use with customized recommendations for saving energy. PGE uses energy analytics and performance monitoring to create one report that compares the business' energy use to a similar business and then six reports to help the business track energy use.

PG&E Business Energy Reports website
(http://www.pge.com/en/mybusiness/save/ber/index.page?WT.mc_id=Vanity_ber)

ComEd Comprehensive Energy Efficiency Solutions for Small Businesses

This program is designed to diversify savings and increase the adoption of non-lighting energy efficiency measures. The marketing campaign offers a comprehensive approach (the works), focus on compressed air (the big blast) or a focus on refrigeration (the big chill). It also encourages the adoption of smart thermostats and Building Energy Management Systems in anticipation of the utility providing better energy analytics to its customers.

ComEd Comprehensive Energy Efficiency Solutions for Small Businesses website
(https://www.comed.com/business-savings/small-business/Pages/default.aspx)

Focus on Energy Small Business Program

This program has targeted lighting and refrigeration as having the greatest potential for savings for small businesses. It provides a free lighting and/or refrigeration assessment and then offers a menu of savings opportunities at increasing costs. The business owner can choose the cost level that fits their budget. Substantial incentives are offered for LED lighting with a maximum incentive of $7500 for energy saving products and installation services.

Focus on Energy Small Business website (https://focusonenergy.com/business/efficient-facilities/small-business)

Consumers Energy – Michigan Small Business Solutions Program

Energy efficiency measures: incentives paid directly to contractor on project completion reducing cost to business owner. Facility assessments provided.

MidAmerican – Iowa Energy Assessments

Energy assessment: review of facility's operating equipment and systems; catered to building size and business needs.

Energy efficiency measures: direct install measures for small businesses; assessment report connects customer to prescriptive and custom rebates.

NSTAR – Main Street Program

Urban business district blitz direct install program targeting businesses using less than 20kW. Auditors and installers move through the neighborhood identifying and installing gas and electric measures for free.

ComEd – RetroCx Tune-up

Retrocommissioning for small buildings (less than 150,000 sq. ft. and less than 3 GWh annual energy use). Incentives include an engineering study valued up to $10,000 and fully funded implementation of selected operational improvements.

Best Practices in Energy Efficiency Programs for Small Businesses

Drake, Trevor. 2014. Blog: A New Approach to Small Business Energy Efficiency. Great Plains Institute. (http://www.betterenergy.org/blog/new-approach-small-business-energy-efficiency)

Garland, Gregory. 2013. Successful Tactics for Improving Customer Satisfaction in Small and Unassigned Businesses through Energy Efficiency. Proceedings of the 2013 AESP National Conference, Orlando, FL.

Harvey, Constance. 2013. *Best practices in small commercial HVAC programs at California utilities*.

> This report reviewed small commercial HVAC efficiency programs that were offered by three California utilities. All three programs had similar delivery mechanisms and included downstream and upstream incentives, demand response, and quality installation and maintenance. Best practices identified included:
>
> **HVAC distributor incentive program**. The goal is to increase the sale and stocking of high efficiency HVAC equipment for commercial installation. When done well, this strategy is successful because a small number of manufacturers and distributors can make a substantial impact on the decisions to purchase and install high efficiency equipment.
>
> **Contractor training**. The goal is to ensure that contractors install high efficiency HVAC equipment correctly, ensuring that it performs as intended and delivers the savings expected.

Herter, Karen et al. 2009. *A Successful Case Study of Small Business Energy Efficiency and Demand Response with Communicating Thermostats.* Proceedings of the International Energy Program Evaluation Conference, Portland, OR.

Itron. 2008. *Energy Efficiency Best Practices: What's New?* California Best Practices Project Advisory Committee.

Meyers, Steven. 2011. Achieving Success in Small Business Markets When Traditional Marketing Won't Do it All. Presented at AESP Spring Conference, Atlanta, GA.

> EnerPath delivers turnkey energy efficiency programs for utilities nationwide targeting residential and small business customers. Their turnkey programs for small businesses follow a tiered structure in which they offer something simple at no cost, provide the

customer with a positive experience and give them a path to buy more efficiency. Of the programs we reviewed, the Focus on Energy Small Business Program follows this model most closely. Their tiered model includes:

> Tier 1—Quick payback, inexpensive measures that would not require financing and would be provided for free or with a co-pay required from the customer
> Tier 2—Longer payback measures that require some payment from the customer. These measures would typically have a utility incentive (e.g., rebate)
> Tier 3—Measures that require significant capital investment by the customer and can be supported using outside financing. Renewable projects could also qualify.

Some of the lessons they've learned from delivering this turnkey program to small businesses are:

- This segment needs education about energy efficiency and all the available programs
- Close rates can exceed 60 percent when speaking with customers face-to-face
- Businesses open utility company mail – use this connection to market the program

NIBS. 2014. *Financing Small Commercial Building Energy Performance Upgrades: Challenges and Opportunities*. National Institute of Building Sciences, Council on Finance, Insurance and Real Estate.

NMR Group, Inc. 2015. Baseline Characterization Market Effects Study of Investor-Owned Utility Residential and Small Commercial HVAC Quality Installation and Quality Improvement Programs in California. California Public Utilities Commission, Energy Division.

Nowak, Seth. 2016. Big Opportunities for Small Business: Successful Practices of Utility Small Commercial Energy Efficiency Programs. ACEEE, Report Number U1607.

Sabo, Carol et al. 2011. *Comparing Energy Efficiency Program Rebates and Incentive Levels.* Proceedings of the International Energy Program Evaluation Conference. Boston, MA.

Sabo, Carol et al. 2010. Best Practices and the Benefits of Delivering Plug-Load Energy Efficiency in Businesses?

York, Dan et al. 2015. Expanding the Energy Efficiency Pie: Serving More Customers, Saving More Energy Through High Program Participation. ACEEE.

Appendix B: Survey instrument

ILLUME

INTRODUCTION & SCREENER

Hello, my name is [INTERVIEWER NAME] and I am calling on behalf of the Seventhwave, a non-profit research organization. We are conducting a fact-finding survey to help Minnesota utilities understand how electricity and natural gas is used in small businesses.

Could I please speak with someone who is responsible for making decisions about energy use at [facility_address]? This could be the person who decides when lights are turned on and off, manages the thermostat set-points, or turns equipment on and off.

[IF RESPONDENT CAN ANSWER THE QUESTIONS, CONTINUE WITH:]

This is a fact-finding survey to help Minnesota utilities understand how energy is used in small businesses. We are not selling anything, and responses will not be connected with your firm or organization in any way. This survey will take about 10 to 15 minutes to complete.

1. [CONTINUE TO WITH SURVEY]
2. [SET UP CALLBACK TIME, GET CONTACT NAME AND PHONE NUMBER]
3. REFUSED [THANK AND TERMINATE]

[CLARIFICATION IF NEEDED: This research is funded by the Minnesota Division of Energy Resources. The survey responses we collect will help us understand how small businesses use energy and identify strategies that might be of interest to small business to help them reduce their energy use and utility bills. All responses will be kept confidential.]

[CLARIFICATION IF NEEDED: I am calling from Leede Research Group. We are working with the non-profit research organization, Seventhwave to gather input from small businesses.]

[CLARIFICATIONS, IF NEEDED: We have questions specific to how your business uses heating systems, hot water systems and other electricity and natural gas using equipment. We are looking for a person knowledgeable about how these systems are used, such as the person who decides when the lights or equipment are on or off or manages thermostat set-points. If you have more than one location, we are only interested in learning about the space and equipment at [facility_address].]

[IF PERSON ASKS WHY WE ARE CALLING THEM OR WHERE WE GOT THE TELEPHONE NUMBER: We randomly selected small businesses that appeared in the ZipUSA database of businesses. We called either the telephone number on file for this business or, if there wasn't a telephone number listed there, we looked it up.]

[IF TRANSFERRED TO SOMEONE ELSE – REINTRODUCE WITH:]

Hello, my name is [INTERVIEWER NAME] we are calling on behalf of Seventhwave, a non-profit research organization. I was referred to you as someone who is responsible for making decisions about energy usage for the facility at [facility_address]. We are conducting a fact-finding survey to help Minnesota utilities understand how electricity and natural gas is used in small businesses in its service area. We are not selling anything, and responses will not be connected with your firm or organization in any way. This survey will take about 10 to 15 minutes to complete; and all responses will be kept confidential.

1. [CONTINUE TO WITH SURVEY]
2. [SET UP CALLBACK TIME, GET CONTACT NAME AND PHONE NUMBER]
3. REFUSED [THANK AND TERMINATE]

[IF REFERRED TO SOMEONE ELSE, BUT NOT TRANSFERRED TO THAT PERSON, GET CONTACT NAME OF TARGET PERSON AND PHONE NUMBER, AND NAME OF REFERRING INDIVIDUAL. PUT SAMPLE POINT BACK IN THE QUEUE.]

SCREENER

First, I have a few questions about your business and your role.

S1. About how many full and part-time employees work at this facility? [IF NEEDED: An estimate is fine]

[RECORD NUMBER OF EMPLOYEES 1-100]
996. More than 100 [THANK AND TERMINATE]
998. (Don't Know) [THANK AND TERMINATE]
999. (Refused) [THANK AND TERMINATE

[If # of employees <= 3] ask:

S1a. Is this a home-based business? [IF NEEDED: Defined as a business operated primarily out of a residential property or dwelling unit rather than a commercial property]

1. Yes [THANK AND TERMINATE]
2. No
3. (Don't Know) [THANK AND TERMINATE]
4. (Refused) [THANK AND TERMINATE]

S2. What is your job title? **[DO NOT READ; SELECT ONE]**

1. (President/Owner/CEO)
2. (Accounting/finances)
3. (Director/Administration/Company Management)
4. (Facility Manager/Operations/Maintenance/Engineering)
5. (Energy Manager)
6. (Manager)
7. (Other (Specify))
8. (Don't know)
9. (REFUSED)
10. (Employee)

S4. Are you responsible for any of the following? **[ROTATE; READ; SELECT ALL]**

1. Purchasing or replacing equipment like lighting, heating, air conditioning, or refrigeration [go to S4a]
2. Deciding when lights or equipment are turned on or off [skip to S5]
3. Setting the thermostat temperature or schedule [skip to S5]
4. (None of these) [go to S4a]
5. (Don't know) [go to S4a]
6. (REFUSED) [go to S4a]

IF S4<>2 & S4<>3, ask S4a. If S4=2 only or S4=3 only or S4 = 2 and 3 then go to S5 (continue with survey).
S4a. Is there another person at this facility who is more involved with making decisions about energy usage that I can talk to?

1. No
2. (Don't Know)
3. (Refused)
4. Yes [Re-start with intro and screener]

IF S4a<4 AND S4=1: Continue with this person (they make purchasing decisions, and no one better is available)
If S4a<4 and S4>3: Thank and Terminate (they do not make any kind of the decisions we are interested in)

S5. What is the space at [facility_address] primarily used for? **[DO NOT READ. CONFIRM IF NEEDED.] [IF NEEDED: What use takes up the most space?]**

[**INTERVIEWER NOTE: DO NOT READ, BUT CODE RESPONSES BASED ON DESCRIPTIONS BELOW**.]

1.	RETAIL	This includes retail establishments and dealers. DOES NOT INCLUDE GROCERY OR CONVENIENCE STORES. Can include clothing, electronics, appliances, sporting goods, building and garden equipment, motor vehicles and parts, home furnishings, health and personal care products, general and miscellaneous merchandise
2.	GROCERY OR CONVENIENCE STORES	Includes grocery stores, convenience stores, gas stations, bodegas, mini-marts, liquor stores, beer and wine stores, specialty food stores. DOES NOT INCLUDE RESTAURANTS
3.	FOOD SERVICE	Preparation and sale of food and drink for consumption. Includes: restaurants, cafeterias, bars, pubs, fast food, catering service, reception hall, coffee shop, donut shop, ice cream shop, and others.
4.	EDUCATION	Includes elementary and secondary schools, colleges, universities, professional schools, business schools, computer and management training, technical and trade schools, and other schools, day care.
5.	OFFICE	Buildings used for general office space. Includes telecommunications, data processing, banking, credit, financial, real estate, professional services, administrative and support services, non-profit or social services, city hall, retail that does not have a storefront, insurance, government office, real estate or property management, religious office.
6.	OUTPATIENT HEALTHCARE	Offices of dentists, physicians, other health practitioners. Outpatient care centers, medical and diagnostic labs, veterinarian
7.	INPATIENT HEALTHCARE	Hospitals, [THANK AND TERMINATE]
8.	WHOLESALE/ WAREHOUSE	Warehousing and storage or wholesalers of any kind of product including, but not limited to: furniture, construction materials, appliances, hardware, machinery, paper products, grocery, apparel, alcohol, miscellaneous
9.	PUBLIC ORDER AND SAFETY	Police station; fire station, jail, courthouse, probation office, penitentiary
10.	SERVICES	Includes salons, barbershops, dry cleaning and laundry services photo processing shop, tanning salon, copy center or printing shop, kennel
11.	WORKSHOPS AND AUTOMOTIVE AND REPAIR	Includes vehicle repair shops, car wash, workshop/repair shop
12.	LODGING	Hotels, motels, rooming and boarding houses, nursing care facilities, assisted living facilities, other residential care facilities
13.	RELIGIOUS WORSHIP	Buildings in which people gather for religious activities. Can include: chapels, churches, mosques, synagogues, temples.

14.	PUBLIC ASSEMBLY	Buildings where people gather for social and recreational activities such as community center, convention center, senior center, gymnasium, health club, bowling alley, ice rink, field house, theater, museum, sports area, movie theater, library, night club, funeral home, student activities center, transportation terminal, dance studio, radio station
15.	MANUFACTURING /MINING/INDUSTRIAL	Includes mining, oil and gas extraction, any kind of manufacturing (food, beverage, textile mills, apparel, wood, paper, chemical, plastics, metal, machinery, electronics, furniture, transportation, other manufacturing) [THANK AND TERMINATE]
16.	AGRICULTURAL	Includes crop production, animal production, fishing, hunting, trapping [THANK AND TERMINATE]
17.	POSTAL SERVICE	[THANK AND TERMINATE]
18.	RESIDENTIAL	Private household – home-based business OR not a business [THANK AND TERMINATE]
19.	OTHER	SPECIFY
20.	DON'T KNOW	[THANK AND TERMINATE]
21.	REFUSED	[THANK AND TERMINATE]

BUILDING DETAIL

Now, I'd like to ask a few questions about your facility.

BD1. What is the approximate square footage of the space your business occupies at this facility? [IF NEEDED: An approximate number is ok. **DO NOT READ prompt if necessary**]

1. up to 5,000 square feet
2. More than 5,000, but less than or equal to 10,000 square feet
3. More than 10,000, but less than or equal to 25,000 square feet
4. More than 25,000, but less than or equal to 50,000 square feet
5. More than 50,000 square feet
6. (Don't Know)
7. (Refused)

(F4 note with exact square feet if given)

BD2. Is your business at this location a franchise or chain? **[DO NOT READ]**

1. Yes
2. No
3. (Don't Know)
4. (Refused)

BD2A. Is your business at this location run by local, state or federal government? **[DO NOT READ]**

1. Yes
2. No
3. (Don't Know)
4. (Refused)

BD3. Which of the following best describes the building your business is in?
1. Free standing building with one tenant [skip to BD5]
2. Enclosed mall or strip mall (IF NEEDED: Shopping malls made of multiple connected establishments)
3. Multi-tenant commercial building (IF NEEDED: For example, an office building with multiple offices, or a mixed-use building with office, retail and possibly residential)
4. Other (Specify) [skip to BD5]
5. (Don't Know) [skip to BD5]
6. (Refused) [skip to BD5]

[ASK IF BD3=2,3]

BD4. What percentage of the building does your business occupy?
[Numeric open end 1-100; 998=Don't know, 999=Refused]

BD5. Which of the following best describes the ownership at your facility?
1. My company owns and occupies the facility
2. My company owns the facility but it is rented to someone else
3. My company rents or leases the facility
4. (Other: Specify)
5. (Don't know)
6. (Refused)

BD6. How many stories does the building have? **[DO NOT READ]**
1. One
2. Two
3. Three
4. Four to nine
5. More than 10
6. (Don't know)
7. (Refused)

BD7A. About how long ago was the building either built, or majorly renovated? [IF NEEDED: A major renovation includes changes to more than 50% of the space] [DO NOT READ]
1. 6 or fewer years [2010 to 2016]
2. 7 to 16 years [2000 to 2009]
3. 17 to 26 years [1990 to 1999]
4. 27 to 36 years [1980 to 1989]
5. 37 to 46 years [1970 to 1979]
6. 47 to 56 years [1960 to 1969]
7. 57 to 66 years [1950 to 1959]
8. 67 to 76 years [1940 to 1949]
9. 77 to 86 years [1930 to 1939]
10. More than 86 years [before 1930]
11. (Don't know)
12. (Refused)

(F4 note with exact year if given)

BUSINESS PRACTICES

Now I'd like to ask a few questions about your business operations.

BP1. What are your hours of operation on most days of the week? [RECORD OPENING AND CLOSING TIME IN MILITARY TIME] [Clarification: by hours of operation, we mean when the lighting, heating or cooling are on, and there are any number of occupants present. These may be different from your official business hours]
1. START TIME: _____ END TIME: _____
2. Open 24 hours
3. 3. (Don't know)
4. (Refused)

BP2. Is your business closed any days of the week? [**DO NOT READ**. SELECT ALL]
1. (Monday)
2. (Tuesday)
3. (Wednesday)
4. (Thursday)
5. (Friday)
6. (Saturday)
7. (Sunday)
8. (No, open every day)
9. (Don't know)
10. (Refused)

BP3. Are there months in the year in which your business does not operate at all?
1. Yes
2. No [skip to BP5]
3. (Don't know) [skip to BP5]
4. (Refused) [skip to BP5]

[ASK IF BP3=1]

BP4. During what months does your business NOT operate? [**DO NOT READ RESPONSES**; MULTIPLE RESPONSE, UP TO 11]
1. (January)
2. (February)
3. (March)
4. (April)
5. (May)
6. (June)
7. (July)
8. (August)
9. (September)
10. (October)
11. (November)
12. (December)
13. (Don't know)
14. (Refused)

BP5. Does your business pay electric or natural gas utility bills for this facility?
1. (Electric)
2. (Natural Gas)
3 (Electric and natural gas)
4. (Do not pay for electric or gas bills)
5. (Don't Know)
6. (Refused)

BP6. Does your company have any formal energy reduction goals?
1. Yes
2. No
3. (Don't know)
4. (Refused)

BP7. Do you have procedures for cleaning crew or housekeeping staff to turn off lights or reset temperatures after they clean?
1. Yes
2. No
3. (Don't know)
4. (Refused)
5. (Do not have a cleaning crew)

Now I'm going to ask a few questions about your utility.

BP8. Does your utility provide energy audits or rebates for energy efficiency?
1. Yes
2. No [skip to OS1]
3. (Don't know) [skip to OS1]
4. (Refused [skip to OS1]

[ASK IF BP8=1]
BP9. In the last two years, did you receive any rebates, upgrade any equipment or receive an energy audit with help from your utility? [SELECT ALL THAT APPLY. DO NOT READ.]
1. Had an Energy Audit
2. Lighting upgrade
3. Thermostat or controls upgrade
4. Insulation or windows upgrade
5. Heating equipment upgrade
6. Cooling equipment upgrade
7. Kitchen or refrigeration equipment upgrade
8. Other _____
9. (None of these – we did not receive a rebate or audit from utility in the past two years)
10. (Don't know)
11. (Refused) On-SITE VISIT RECRUITMENT

OS1. Before we get into more questions, I'd like to offer you a chance to participate in the on-site portion of this study. We're offering a limited number of businesses $75 for allowing a trained researcher to visit your facility, catalog energy-using equipment, and look for energy saving opportunities. We can work around your schedule to ensure our visit doesn't interfere with your business. We'll provide free energy-saving recommendations for your facility, plus the $75 incentive.

OS2. May I pass your information on to my colleagues so that they can call you about an on-site survey if your building qualifies?

1. Yes
2. No [skip to OS3]
3. (Don't know) [skip to OS3]
4. (Refused) [skip to OS3]

(IF NEEDED: The length of the visit will depend on your facility and equipment. You will get an estimate of how long it will take within 10 minutes of arrival; a typical facility may take about 2 to up to 3 hours. **But during that that time, it's not necessary for you to accompany the researcher throughout the visit, unless you want or need to**. After the visit there will be no further action required by your business. Individual results from your business will be kept confidential.

[IF needed **because they hesitate** because a landlord or property management needs to be involved: We can still work with your landlord or property management company. We'll take your name and get you more details]. (Please clarify which name you are typing in either their name or the landlord's)

[IF OS2=2,3,4, SKIP TO OS3]

Great! Someone from Seventhwave will be contacting you. Right now, we are scheduling visits anytime from a month to six months from now. Can you please confirm your name?

QNAME First and last name -Renter
QPHONE Phone number -Renter
QNAME First and last name -Landlord
QPHONE Phone number -Landlord

OS2a: What's the best time of day to reach you? [Record verbatim.]

[INTERVIEWER NOTE: If they want a phone number from Seventhwave-Jeanette LeZaks, provide it: 608-210-7100]

Thank you very much for your interest. I now have some questions about your company's building and its energy using equipment. (Continue)

[READ IF DECLINED SITE VISIT]

OS3. Thank you anyway. Let's continue with questions about your company's building and energy using equipment.

1. (Continue)

END USE DETAIL

EU1. Which of the following uses of energy does your business have? [ROTATE, READ ALL. MULTIPLE SELECT]

1. Laundry room or commercial laundry equipment
2. Commercial kitchen [Note to interviewer: we are not interested in small kitchens like the ones found in break-rooms.]
3. Servers or data centers
4. Retail cash registers [ASK IF S5= 1, 2, 3, 6, 10, 11]
5. Multiple televisions or electronic retail displays
6. Refrigerated display cases [ASK IF S5=1, 2, 3, 10, 14]
7. Major process equipment, like air compressors, motors, or large power tools, etc] [ASK IF S5=1,8,10,11]
8. None of the above
9. (Don't know)
10. (Refused)

LIGHTING

[ASK All]

Indoor Lighting Equipment

My next questions are about indoor lights in your facility.

L1. What types of overhead lighting is installed in your space? Do you have… [1=Yes, 2=No, 3=Don't know, 4=Refused]

1. LED lights
2. Linear fluorescent lights
3. Compact fluorescent lights / CFLs [IF NEEDED: Sometimes are twisted, but CFLs come in traditional shapes also]
4. Incandescent bulbs [IF NEEDED: Traditional light bulbs]
5. High intensity discharge lights [IF NEEDED: Bright individual bulbs used in wide or tall area overhead lighting in spaces such as retail stores, factories, warehouses, and parking lots]

L2. Thinking about the overhead lights in your space, are they controlled by … [MULTIPLE SELECT]

1. Manual switches
2. Dimmers or dual level switches
3. Timeclock or Building Automation System [if needed: central system that turns lights on/off at specified times of the day]
4. Occupancy sensors
5. Daylight sensors (IF NEEDED: near windows)
6. Something else (specify)
7. (Don't know)
8. (Refused)

[ASK IF L2=3]

L3. What percentage of lights are controlled by the timeclock or building automation system? [if needed: central system that turns lights on/off at specified times of the day]
[NUMERIC OPEN END, 0 to 100; 998=Don't know, 999=Refused]

[SKIP L4 if BP1=2 (business is open 24/7)]

L4. Outside of operating hours, approximately what percentage of indoor lights are kept on? [NUMERIC OPEN END, 0 to 100; 998=Don't know, 999=Refused]

L5. Given the amount of daylight that your business gets during a typical day, do you think there is an opportunity to turn any overhead lights off, and still get enough light?
1. Yes
2. No
3. (Don't know)
4. (Refused)

L6. Who is primarily responsible for purchasing or replacing your overhead lighting?
1. Business owner
2. A facility manager or employee of this business
3. Property manager or landlord
4. External contractor (IF NEEDED: For example, a person or company that your company hires to make equipment or maintenance decisions)
5. Someone else (specify)
6. (Don't know)
7. (Refused)
8. (Corporate office)

COOLING

[ASK ALL]
Now I have some questions about your cooling in your business' location.

C1. What types of cooling equipment are installed in your building? Do you have… [SELECT ALL] **[Note to interviewer: if respondent immediately says that they have no cooling, confirm Response #6, but do not read the rest of responses]**
1. Rooftop unit or packaged A/C unit
2. Split A/C unit or residential-type air conditioner [IF NEEDED: split units are sometimes called mini-split or ductless units]
3. Chiller [IF NEEDED: Unit uses water or other liquid to cool air or equipment]
4. Heat pump (IF NEEDED: Geothermal, air source or water source heat pump
5. Window or wall A/C units
6. ***(The building does not have cooling equipment) [SKIP TO NEXT SECTION: SPACE HEATING]***
7. (Other, specify)
8. (Don't know)
9. (Refused)

C2. What percentage of your facility's space is cooled / air conditioned? **[DO NOT READ RESPONSES]**
1. All
2. More than 75%
3. 50% to 75%
4. 25% to 50%
5. Less than 25%
6. (Don't know)
7. (Refused)

Rooftop or Packaged Units

[ASK IF C1=1, ELSE SKIP TO WINDOW/WALL UNITS]

C3. What is the average age of the rooftop or packaged units [**DO NOT READ RESPONSES**. IF NEEDED: give your best estimate]?
1. 6 or fewer years [purchased in 2010-2016]
2. 7-14 years [purchased in 2002-2009]
3. 15-20 years [purchased in 1996-2001]
4. More than 20 years [older than 1996]
5. (Don't know)
6. (Refused)

Window/Wall Units

[ASK IF C1=5, ELSE SKIP TO NEXT SECTION]

C4. How many window or wall A/C units are installed in your business' space [IF NEEDED: give your best estimate]?
[NUMERIC OPEN END, 1 TO 75; 98=Don't know, 99=Refused]

[ASK ALL]

SPACE HEATING

I would now like to ask about your business' space heating.

SH1. What types of heating systems does your business use? [SELECT ALL] **[Note to interviewer: if respondent immediately says that they have no heating, confirm Response #9, but do not read the rest of responses]**
1. Electric resistance [IF NEEDED: baseboard, ceiling, floor or wall]
2. Natural gas boiler
3. Natural gas forced air furnace
4. Propane system
5. Infrared heaters
6. Heat pump [IF NEEDED: heats and cools]
7. Portable space heaters
8. [DO NOT READ. IF OFFERED:] Wood stove or fireplace
9. ***[DO NOT READ]: (No space heating)***
10. Other (Specify)
11. (Don't know)
12. (Refused)

Furnaces

[ASK IF SH1=3]

SH3. What is the average age of the furnace(s) (DO NOT READ RESPONSES. IF NEEDED: Give your best estimate)?

1. 6 or fewer years [purchased in 2010-2016]
2. 7-14 years [purchased in 2002-2009]
3. 15-20 years [purchased in 1996-2001]
4. More than 20 years [older than 1996]
5. (Don't know)
6. (Refused)

[IF C1=6 and SH1=9 do not ask heating and cooling section. Skip to Water Heating]

HEATING AND COOLING OPERATIONS AND MAINTENANCE

IF (C1=1-5, 7, 8, or 9) and (SH1= 1-8, 10, 11, or 12) then [TEXT1] = heating and cooling
ELSE IF (C1=1-5, 7, 8, or 9) and SH1=9 then [TEXT1] = cooling
ELSE IF (SH1= 1-8, 10, 11, or 12) and C1=6 then [TEXT1] = heating

HC1. Who is primarily responsible for purchasing or replacing your **[text1]** equipment?

1. Business owner
2. A facility manager or employee of this business
3. Property manager or landlord
4. External contractor (IF NEEDED: For example, a person or company that your company hires to make equipment or maintenance decisions)
5. Someone else (specify)
6. (Don't know)
7. (Refused)
8. (Corporate office)

HC2. Who is primarily responsible for conducting maintenance on your **[text1]** equipment?

1. Business owner
2. A facility manager or employee of this business
3. Property manager or landlord
4. External contractor (IF NEEDED: For example, a person or company that your company hires to make equipment or maintenance decisions)
5. Someone else (specify)
6. (Don't know)
7. (Refused)
8. (Corporate office)

HC3. What best describes the frequency of maintenance of your **[text1]** equipment?
1. Maintenance happens only as issues arise
2. Maintenance occurs during seasonal start-up of equipment
3. Maintenance happens on a regular schedule, multiple times per year.
4. (Other (specify))
5. (Don't know)
6. (Refused)

HC4. How is your facility's primary **[text1]** equipment controlled?
1. Manual thermostat
2. Programmable thermostat
3. Energy Management or Building Automatic System (EMS or BAS)
4. Time clock
5. (Other, specify)
6. (Don't know)
7. (Refused)

[ASK IF HC4=2]
HC5. Is the programmable function of the thermostat currently being used?
1. Yes
2. No
3. (Don't know)
4. (Refused)

[ASK IF C1 = 1,3,4]
HC6. Think about the number of cooling units on the roof or outside your facility. Now, think about the number of thermostats. Is the number of thermostats in your facility greater than the number of cooling units?
1. Yes
2. No
3. (Don't know)
4. (Refused)

HC7A. What is the typical temperature setting of your business during operating hours in the summer?
And what temperature in the winter? (IF NEEDED: Your best estimate is okay. Operating hours are hours when the equipment is running and there are people in the building) [NUMERIC OPEN RESPONSE IN DEGREES FARENHEIGHT; range 30-90, 98=Don't Know 99=Refused]

SUMMER TEMPERATURE_____ (hc7a)

WINTER TEMPERATURE_____ (hc7)

[SKIP IF BP1=2]
HC8A. What is the typical temperature setting outside of operating hours in the summer? And in the winter? [IF NEEDED: Your best estimate is okay] [NUMERIC OPEN RESPONSE IN DEGREES FARENHEIGHT; range 30-90, 98=Don't Know 99=Refused]

SUMMER TEMPERATURE_____ (hc8a)
WINTER TEMPERATURE_____ (hc8)

HC9. Who is primarily responsible for setting the temperatures of your **[text1]** equipment? **[DO NOT READ RESPONSES]** INTERVIEWER NOTE: If customers (like hotel guests) set the temperature, use #6 to record verbatim who controls the temperature].

1. Building owner
2. External maintenance company or property manager
3. Business owner or employees of this business
4. Settings are determined by health or safety regulations
5. Settings are determined by a corporate or central office
6. Someone else (specify)
7. (Don't know)
8. (Refused)

[SKIP IF HC9=4]

HC10. Do you think that any changes could be made to your temperature settings to use less energy, but still be comfortable?

1. Yes
2. No
3. (Don't know)
4. (Refused)

WATER HEATING

[ASK ALL]

WH1. What do you use your hot water for? **[DO NOT READ; SELECT ALL]**

1. (Sinks in bathrooms, employee lunch room/break room or kitchenette) [INTERVIEWER: clarify that it's not a commercial kitchen)
2. (Showers)
3. (Laundry / Washing clothes)
4. (Washing dishes in a commercial kitchen) [INTERVIEWER: Clarify that it's a commercial kitchen]
5. (Regular deep-cleaning of whole facility)
6. (Don't have hot water) **[SKIP TO NEXT SECTION]**
7. (Other, specify)
8. (Don't Know)
9. (Refused)

[CONTINUE IF WH1=2,3,4,5,7 ELSE SKIP TO NEXT SECTION]

WH2. What fuel does your business use for hot water? (If needed: This includes heating water for washing, cooking, and similar applications, but not heating or industrial processes.) **[DO NOT READ; SELECT ALL]**

1. (Gas)
2. (Electric)
3. (Oil)
4. (Solar)
5. (Propane)
6. (Don't know)
7. (Refused)

WH3. Are your water heater temperature settings regulated by health or safety regulations? **[DO NOT READ]**

1. Yes
2. No
3. (Don't know)
4. (Refused)

OFFICE EQUIPMENT/COMPUTERS/DATA CENTER

[ASK ALL]

I would now like to ask you about your business' office equipment and computers.

OE1. How many computers are in regular use at your facility? [NUMERIC OPEN END, 1 TO 997; 998=Don't know, 999=Refused]

[ASK OE2 to OE6 IF OE1>0]

OE2. What percentage of those computers are laptops?
[NUMERIC OPEN END, 0 TO 100; 998=Don't know, 999=Refused]

OE3. Who is primarily responsible for purchasing or replacing your computer equipment?

1. Business owner or office manager
2. An employee (IF NEEDED: IT manager)
3. IT sub-contractor or consultant
4. (Other – Specify)
5. (Don't know)
6. (Refused)
7. (Corporate office)

OE4. Who is primarily responsible for maintaining your computer equipment? That is, who handles maintenance, trouble-shooting problems, computer settings?

1. Business owner or office manager
2. An IT employee (IF NEEDED: IT manager)
3. IT sub-contractor or consultant
4. [DO NOT READ] (Every employee is responsible for their own computer; no central management)
5. Someone else (specify)
6. (Don't know)
7. (Refused)
8. (Corporate Office)

OE5. Which of the following best describes what happens to your computers at the end of the working day?
1. Computers are left on until the next working day
2. Computer power settings are implemented to put computers to sleep when occupants leave
3. Individual computer users are in charge of turning their computers off
4. (Other) Please specify)
5. (Don't know)
6. (Refused)

OE6. When you purchase office equipment, do you have a policy in place to purchase Energy Star rated equipment? **[DO NOT READ]**
1. Yes
2. No
3. (Don't know)
4. (Refused)

OE7. How many printers or multifunction imaging devices does your facility have? [IF NEEDED: A multifunction device is usually a large copier/printer/scanner]
[NUMERIC OPEN END, 1 TO 499]
500. 500 or more
998 (Don't know)
999 (Refused)

[ASK IF EU1=3]
OE8. How many server racks does your company have? [IF NEEDED: A server rack contains multiple servers stacked one above the other]
[NUMERIC OPEN END, 1 TO 9997; 9998=Don't know, 9999=Refused]

REGISTERS
[ASK IF EU1=4]

Now I have question about your cash registers.

RG1. Outside of business hours, are your cash registers turned off, put in standby/idle mode or left on?
1. Turned off
2. Put in standby/idle mode
3. Left on
4. (Don't know)
5. (Refused)

DISPLAYS
[ASK IF EU1=5]

RD1. How many televisions or electronic displays are in regular use at your business?
[NUMERIC OPEN RESPONSE; 998=Don't know; 999=Refused]

RD2. Outside of business hours, are your retail/television displays turned off, put in standby/idle mode or left on?
1. Turned off
2. Put in standby/idle mode
3. Left on
4. (Don't know)
5. (Refused)

FOOD SERVICE EQUIPMENT
[ASK IF EU1=2]

Now I would like to ask some questions about your business' food service equipment.

FS1. Which of the following types of kitchen equipment does your business have and regularly use? [MULTIPLE RESPONSE; Interviewer note: we don't need counts of equipment, only that the respondent has them]
1. Fryers
2. Griddles
3. Infrared broilers
4. Kitchen exhaust hoods
5. (Don't know)
6. (Refused)

[ASK IF FS1=4]

FS2. Which of the following best describes your exhaust hoods?
1. Manual hoods that are always on
2. Manual hoods that are switched off only when facility is closed
3. Manual hoods that are switched off during periods of no cooking
4. Automatic hoods that are variable speed, modulating during periods of no cooking
5. (Other: Specify)
6. (Don't know)
7. (Refused)

REFRIGERATION
[ASK if EU1=6]

My next few questions are about your company's use of refrigeration.

RF1. Which of the following types of refrigeration equipment do you have in your facility? (IF NEEDED: By cases, we mean "display cases")
[SELECT ALL]
1. Open refrigerated display cases
2. Open freezer display cases
3. Refrigerated display cases with doors
4. Freezer display cases with doors
5. Walk-in coolers / cooler rooms
6. Walk-in freezers / freezer rooms

7. Ice machines
8. (Don't know)
9. (Refused)

[ASK RF2 if HC1 did not get asked or if HC1 equals 6 or 7]

RF2. Who is primarily responsible for purchasing or replacing your refrigeration equipment?
1. Business owner
2. A facility manager or employee of this business
3. Property manager or landlord
4. External contractor (IF NEEDED: For example, a person or company that your company hires to make equipment or maintenance decisions)
5. Someone else (specify)
6. (Don't know)
7. (Refused)

RF3. Who is primarily responsible for conducting maintenance on your refrigeration equipment?
1. Business owner
2. A facility manager or employee of this business
3. Property manager or landlord
4. External contractor (IF NEEDED: For example, a person or company that your company hires to make equipment or maintenance decisions)
5. Someone else (specify)
6. (Don't know)
7. (Refused)

RF4. What best describes the frequency of maintenance of your refrigeration equipment?
1. Maintenance happens only as issues arise
2. Maintenance happens on a regular schedule, once per year.
3. Maintenance happens on a regular schedule, multiple times per year.
4. (Other (specify))
5. (Don't know)
6. (Refused)

[CREATE TEXT2:
IF RF1=1 or 3 then TEXT2=refrigerated
IF RF1=2 or 4 then TEXT2=freezer
IF RF1= (1 or 3) AND (2 or 4) then TEXT2=refrigerated and freezer]

[ASK IF RF1=1-4]

RF5. Do you have a separate compressor rack that serves all of the **[TEXT2]** cases, or does each case have fully self-contained refrigeration?
1. (Separate compressor rack)
2. (Fully self-contained refrigerator)
3. (Mix – some are served by compressor rack and some are fully self-contained)
4. (Don't know)
5. (Refused)

[ASK IF RF1=1-4]

RF6a. How many aisles of **[TEXT2]** display cases are in your facility? (An aisle with cases on both sides counts as two aisles – if you have a wall with cases, it would be one aisle)
[NUMERIC OPEN END, 1 TO 99; 998=Don't know, 999=Refused]

[ASK IF RF1=1 or 2]

RF7. In your open **[TEXT2]** cases, do you pull down a curtain on a nightly basis? **[DO NOT READ]**
1. Yes
2. No
3. (Don't know)
4. (Refused)

[ASK IF RF1=5 or 6;
IF RF1=5 then TEXT3=coolers
IF RF1=6 then TEXT3=freezers
IF RF1=5 or 6 then TEXT3=coolers and freezers]

RF8. Do the doors of your walk-in **[TEXT3]** have strip curtains or self-closing doors?
1. Strip curtains
2. Self-closing doors
3. Both
4. None
5. (Don't know)
6. (Refused)

BUILDING ENVELOPE

[ASK ALL]

Thank you. I just have a few more questions about your building.

BE1. What is the type of wall construction in your building?
1. Wood or steel stud framing
2. Block wall
3. Concrete
4. Prefab metal building
5. (Other: specify)
6. (Don't know)
7. (Refused)

BE2. To your knowledge, does the building have wall insulation? **[DO NOT READ]**
1. (Yes)
2. (No)
3. (Don't know)
4. (Refused)

BE4. Approximately how much of the outer wall area of the building is covered by windows? **[DO NOT READ]**

1. (No windows)
2. (Just a few windows) (0 to 25%)
3. (Several windows but less than half of the wall area) (26 to 49%)
4. (More than half/Most of the wall area are windows/mostly glass exterior) (50% or more)
5. Don't know
6. Refused

[SKIP IF BE4=1]

BE5. What type of windows do you have? [IF RESPONDENT SAYS MORE THAN ONE TYPE PROMPT: The most common type of window?]

1. Single pane
2. Single pane with storm windows
3. Double pane
4. Triple pane
5. (Other, specify)
6. (Don't know)
7. (Refused)

PROCESS EQUIPMENT

[ASK IF EU1=7]

PE. What kinds of major process equipment do you have at your facility, not including kitchen or office equipment? [RECORD VERBATIM] [INTERVIEWER NOTE: We do not need counts of these pieces of equipment, just a brief list]

DIRECT INSTALL INTEREST

I have one more question.

DI1. If your utility began offering a program in which they would stop by for a brief visit to install some free equipment that saves energy, like light bulbs, how likely is it that someone in your facility would be able to make time for that visit?

1. Very likely
2. Somewhat likely
3. Somewhat unlikely
4. Very unlikely
5. (Don't know)
6. (Refused)

THANK YOU AND CLOSING

Those are all the questions I have for you today. Thank you so much for your time.

Appendix C: Site visit protocols

Small_Commercial_Site_Visit_Instrument

Field	Question	Answer
Pre Visit		
pre-visit_intro	Fill out this section in the car prior to going into the business.	
bldgid	Enter the building ID number *This will auto-populate survey data*	
researcher	Who are you?	alisa Alisa Petersen john John Viner schuetter Scott Schuetter hackel Scott Hackel
date_visit	Enter the date of the site visit	
change_name	Be sure to change the name at the end of the form when you Save Form and Exit.	
ID check		
check_id_note	If the Building ID number was typed correctly, you should see the business name and address here: [company_surv] at [address_surv] *If you don't see it, go back and double check the Business ID #. Be sure there aren't extra spaces at the end.*	
General Information		
bldg_pic	Take a picture of the building	
dwelling_intro	Upon entering the business, introduce yourself and remind owner of the site visit process. Describe what you will be doing, how long it will take and ask if they have any questions. You'll be conducting a walk-through audit, which includes cataloguing all energy using equipment and lighting in the building. You'll be taking pictures and using a tablet to collect information. You'd like to get into HVAC rooms and rooftop, if possible. Ask them if they have any questions. If they are OK with it, we'd also like to ask them for a utility release form so we can better understand their energy consumption patterns. Mention that all information collected will be used anonymously. And that they'll get $75 at the end of this. This project is funded by the Department of Commerce, Division of	

Field	Question	Answer
	Energy Resources. It's goal is to characterize the energy consumption from equipment in commercial buildings. It is not a comprehensive audit, but a list of potential improvements will be provided after the visit.	
bldg_age	1. What year was the building built? *Survey said the building is "[bldg_age_surv]" years old.*	
occ_year	2. What year did you begin occupying this building?	
yr_major_renov	3. What year was the last major renovation? *leave blank if no major renovation*	
yr_intlight_retrofit	4. What year was the last major interior lighting retrofit? *leave blank if no interior lighting retrofit*	
num_occ	5. Number of occupants at peak	
inter-general-notes	Optional: Add any additional notes pertaining to "General Information" section here	
Tenant Information		
owner_type	6. Is the tenant space leased or owned by its occupant business(es)? *Survey said "[owner_type_surv]"*	1 Owned 2 Leased by one business 3 Leased by multiple businesses 4 Owned by one of the occupant business, leased by other(s)
Tenant Information > Owner Meter		
bldg_elecmeter	Building-level electric meter? *Answer 'No' if building is part of a multi-building campus with no building-by-building metering*	1 Yes 0 No
bldg_gasmeter	Building-level gas meter? *Answer 'No' if building is part of a multi-building campus with no building-by-building metering, or is all electric*	1 Yes 0 No
Tenant Information > Tenant Information (cont)		
elec_meter	a. Does the tenant space have its own electric meter?	1 Yes 0 No
natgas_meter	b. Does the tenant space have its own gas meter?	1 Yes 0 No
hwsteam_meter	c. Are tenants charged for the heating hot water or steam they are provided? *leave blank if hot water or steam is not provided*	1 Yes 0 No 8 Other
hwsteam_meter_other	Describe "other" tenant billing options here:	

Field	Question	Answer
	if applicable	
dhw_meter	d. Is the primary source of domestic hot water provided free to tenants, or do tenants pay for hot water in their utility bills? *leave blank if no domestic hot water*	1 Tenants pay 2 Landlord pays
bldg_perc_occ	e. Portion of building area that is occupied by the subject tenant? (%) *Hint 1: Plus or minus 10%* *Hint 2: Survey said "[bldg_perc_occ_surv]"%*	
interview-tenant-notes	Optional: Add any additional notes pertaining to "Tenant Information" section here	
utility_release_note	Ask the interviewee if they are willing to sign a utility release form. The data is used strictly for research purposes, to better understand the energy consumption of small commercial buildings. It will be kept completely anonymous.	
Operations		
hr_arrive	7. What hour in the morning do people typically begin arriving? *use military time (5:00 am = 0500, 5:00 pm = 1700)*	
hr_hvac_on	8. What hour in the morning does the HVAC turn on - meaning ventilation turns on, or thermostat sets up? *use military time (5:00 am = 0500, 5:00 pm = 1700)*	
hr_leave	9. What hour in the evening does the last person typically leave? *use military time (5:00 am = 0500, 5:00 pm = 1700)*	
hr_hvac_off	10. What hour in the evening does the HVAC shut off- meaning ventilation turns off, or thermostat sets back? *use military time (5:00 am = 0500, 5:00 pm = 1700)*	
day_occ	11. How many days per week is the building occupied? *Survey said "[days_occ_surv]"*	
interview-operations-notes	Optional: Add any additional notes pertaining to "Operations" section here	
Attitudinal		
note_attitudinal	Read through questions. Some may not be applicable based on previous questions. Don't feel the need to read the response categories.	
int_future_reno	12. Are you planning any renovations in the next 5 years?	1 Addition or annex 2 Significant interior renovation

Field	Question	Answer
		3 HVAC equipment upgrade 4 New exterior or window 5 No major renovations planned 8 Other, describe below:
int_future_reno_other	Describe "other" renovation options here: *if applicable*	
int_perc_manage_energy	13. Thinking about your job responsibilities, what percentage of time do you spend managing your facility's energy consuming equipment?	
int_energycost_expense	14. Thinking about your business' energy costs in comparison to your other operating expenses, are they a significant/moderate or average/insignificant portion?	1 Insignificant 2 Moderate/average 3 Significant
int_energycost	15. Do you think your energy costs are low, high or just about average for a building of this type?	1 Low 2 Medium 3 High
int_benchmark	16. Do you benchmark your energy/utility usage? *Compare it to your previous or other similar building energy usage*	1 Yes 2 No 9 Don't know
int_benchmarktool	a. If you benchmark, do you use a tool or software? *Leave blank if they don't benchmark*	1 Utility website 2 Portfolio manager 3 Spreadsheet 8 Other, describe below:
int_benchmarktool_other	Describe "other" benchmark tool or software here: *if applicable*	
int_utilityknowledge	17. Does your utility offer technical assistance or rebates for making energy efficiency upgrades?	1 Yes 2 No 9 Don't know
int_utilityprog	a. If yes, what do they offer? *Leave blank if no utility assistance*	
int_utilityprog_part	b. Have you participated in those programs?	1 Yes 2 No 9 Don't know
int_utilityprog_part_desc	Describe how you participated *Leave blank if no participation*	
int_energystudy	18. Have you had any energy studies, such as an energy audit, done on this property?	1 Yes 2 No 9 Don't know
int_energystudy_yr	a. How long ago did you have them done? *Type in number of years ago*	
int_energystudy_util	b. Was the energy study part of utility assistance?	1 Yes 2 No 9 Don't know

Field	Question	Answer
int_energystudy_reason	c. Why did you have the energy study done?	
int_energyinvest	19. What energy saving investments/upgrades have you done in the past 5 years?	1 Code 2 HVAC equipment upgrade 3 Envelope 4 Lighting 8 Other, describe below:
int_energyinvest_other	Describe other energy investments	
int_energyinvest_reason	19a. What prompted you to make those investments/upgrades? *Probe for whether it was because of utility assistance, or part of an energy study? Other reasons?*	
int_energyinvest_did_not_make	20. Were there any energy saving investments/upgrades you wanted to make, but couldn't (and why)? *Ask this question regardless of whether they have made other investments*	
int_energyinvest_barriers	21. Is there anything preventing you from making investments/upgrades to save energy? *This should be asked based on responses from previous questions. Do not read responses, but prompt if necessary*	1 Lack of time 2 Lack of expertise 3 Lack of capital 4 Other priorities are higher 5 Savings not high enough 6 Waiting for equipment to fail 7 Waiting for improved business cycle/economy 8 Too complex 9 Impact on product/process/customers 10 Need better/specific payback 88 Other, describe below:
int_energyinvest_barriers_desc	Provide more detail here	
int_who_maint_HVAC	22. Who is primarily reponsible for conducting maintenance of the primary HVAC units?	1 Business owner 2 A facility manager or employee of this business 3 Property manager or landlord 4 External contractor 5 Someone else 9 Cannot determine
int_freq_maint_HVAC	23. What best describes the frequency of maintenance of your HVAC equipment?	1 Only as issues arise 2 During seasonal start-up of equipment (twice per year) 3 Regular schedule (multiple times per year)
int_equip_upgrade	24. Do you ever upgrade equipment before it fails?	1 Yes 2 No 9 Don't know

Field	Question	Answer
int_equip_upgrade_desc	Provide more detail here	
int_actions_energy	25. Have you or the building occupants made any operational changes, or modified any behaviors, to help reduce energy use in the building? *this is meant to be apart from equipment retrofits done to the building; prompt with examples if needed*	1 Yes 2 No 9 Don't know
int_actions_energy_desc	If yes, what have you done?	
int_comfort	26. Do occupants of your space complain of comfort issues?	1 No complaints 2 Space is too hot 3 Space is too cold 4 Lighting is not good 5 Odor complaints
int_bus_assoc	27. Do you belong to any business associations? *List the associations here (separated by comma).*	
int_bus_assoc_interaction	a: What's your level of interaction with those associations?	1 Don't do anything, but pay my dues 2 Get information / resources from them about my business 3 Networking opportunities 4 Other:
int_bus_assoc_desc	Describe your level of interaction in more detail here, if you'd like.	
int_things_to_watch_for	28. Before I head out to complete my walkthrough, is there anything else I should know about related to the energy use in the building?	
int_segmentation	29. DO NOT READ: Researcher, based on this interview, please select the following option that best describes which of the attitudes applies to the leader(s) of this business	1 Leave me alone, I'm not interested in energy efficiency. 2 Help me learn about energy. 3 I'm an advocate for energy efficiency, help me do the most/best I can. 4 My priorities (including energy) are entirely focused on budget. 5 It's important that I be a technology or thought leader.
Building Information		
bldg_length	Length of building (ft)	
bldg_width	Width of building (ft)	
bldg_numfloor	Number of floors	
bldg_clgheight	Floor to ceiling height (ft)	
bldg_totarea	Estimated total floor area (sq ft)	

Field	Question	Answer
	Hint 1: Survey said "[bldg_totarea_surv]" *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
bldg_perc_heat	Portion of building area that is heated? (%) *Hint 1: Plus or minus 10%* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
bldg_perc_cool	Portion of building area that is cooled? (%) *Hint 1: Plus or minus 10%* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 3: Survey said "[bldg_perc_cool_surv]"*	
bldg_typ_prim	Primary building activity type *Survey said "[bldg_typ_prim_surv]"*	1 None 2 Retail, enclosed or strip mall 3 Retail, standalone 4 Grocery or convenience store 5 Food service 6 Education 7 Office 8 Outpatient Healthcare 9 Inpatient healthcare 10 Warehouse or wholesale 11 Public order and safety 12 Service, personal services 13 Service, workshop/repair/automotive 14 Workshop, automotive, repair 15 Lodging 16 Religious worship 17 Public Assembly 18 Manufacturing, mining, industrial 19 Agricultural 20 Postal service 21 Residential
bldg_type_prim_perc	Portion of building area that is primary building activity type *Plus or minus 10%*	
bldg_type_prim_desc	Describe the primary building activity in just a few words *such as 'auto body shop' as opposed to 'Service' above*	
bldg_type_sec	Secondary building activity type	1 None

Field	Question	Answer
		2 Retail, enclosed or strip mall 3 Retail, standalone 4 Grocery or convenience store 5 Food service 6 Education 7 Office 8 Outpatient Healthcare 9 Inpatient healthcare 10 Warehouse or wholesale 11 Public order and safety 12 Service, personal services 13 Service, workshop/repair/automotive 14 Workshop, automotive, repair 15 Lodging 16 Religious worship 17 Public Assembly 18 Manufacturing, mining, industrial 19 Agricultural 20 Postal service 21 Residential
bldg_type_tert	Tertiary building activity type	1 None 2 Retail, enclosed or strip mall 3 Retail, standalone 4 Grocery or convenience store 5 Food service 6 Education 7 Office 8 Outpatient Healthcare 9 Inpatient healthcare 10 Warehouse or wholesale 11 Public order and safety 12 Service, personal services 13 Service, workshop/repair/automotive 14 Workshop, automotive, repair 15 Lodging 16 Religious worship 17 Public Assembly 18 Manufacturing, mining, industrial 19 Agricultural 20 Postal service

Field	Question	Answer
		21 Residential
bldg_numlivunit	Number of residential living units above or attached to the building? *Hint 1: Answer 0 if none* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
bldg_other_fueltype	Any other sources of energy supplied to the building other than natural gas or electricity? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Propane 3 Fuel oil 4 Steam 5 Hot water 6 Chilled water 7 Coal 8 Other, describe below:
bldg_other_fueltype_other	Describe "other" fuel types here: *if applicable*	
tenant_v_bldg	What portion of the building does the subsequent interior data include? *answer "All" if you can get access to over 80% of building and it's energy equipment*	1 All the tenant spaces 2 Only the interviewed tenant space
walkthru-bldginfo-notes	Optional: Add any additional notes pertaining to "Building Information" section here	
walkthru-bldginfo-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Building Information" section	
Envelope (Exterior)		
Envelope (Exterior) > Pictures of Facades		
north_facade_pic	Take a picture of the north façade	
east_facade_pic	Take a picture of the east façade	
south_facade_pic	Take a picture of the south façade	
west_facade_pic	Take a picture of the west façade	
Envelope (Exterior) > Walls		
wall_type_prim	Primary wall type *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Concrete or concrete block 3 Structural brick 4 Metal building 5 Metal framed 6 Wood framed 8 Other, describe below:
wall_type_prim_other	Describe "other" primary wall type here: *if applicable*	
Envelope (Exterior) > Walls > Primary Wall		
prim_wall_perc	Percent of total above-grade wall area covered by primary wall type (%)	

Field	Question	Answer
	Plus or minus 10%	
prim_wall_cond	Condition of primary wall type	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
wall_type_sec	Secondary wall type *Hint 1: Select 'None' if comprises less than 20% of total wall area* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Concrete or concrete block 3 Structural brick 4 Metal building 5 Metal framed 6 Wood framed 8 Other, describe below:
wall_type_sec_other	Describe "other" secondary wall type here: *if applicable*	
Envelope (Exterior) > Walls > Secondary Wall		
sec_wall_perc	Percent of total above-grade wall area covered by secondary wall type (%) *Plus or minus 10%*	
sec_wall_cond	Condition of secondary wall type	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
Envelope (Exterior) > Glazing		
glazing_type_prim	Primary glazing type	1 None 2 Single pane 3 Single pane with storm windows 4 Double pane 5 Combination of single and double pane 8 Other, describe below:
glazing_type_prim_other	Describe "other" primary glazing type here: *if applicable*	
Envelope (Exterior) > Glazing > Primary Glazing		
prim_glazing_perc	Percent of total glazing area covered by primary glazing type (%) *Plus or minus 10%*	
prim_glazing_cond	Condition of primary glazing type	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon

Field	Question	Answer
ext_shading_orient_prim	For primary glazing type, which facades have exterior shading?	1 North 2 Northeast 3 East 4 Southeast 5 South 6 Southwest 7 West 8 Northwest
glazing_type_sec	Secondary glazing type *Select 'None' if comprises less than 20% of total glazing area*	1 None 2 Single pane 3 Single pane with storm windows 4 Double pane 5 Combination of single and double pane 8 Other, describe below:
glazing_type_sec_other	Describe "other" secondary glazing type here: *if applicable*	
Envelope (Exterior) > Glazing > Secondary Glazing		
sec_glazing_cond	Condition of secondary glazing type	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
ext_shading_orient_sec	For secondary glazing type, which facades have exterior shading?	1 North 2 Northeast 3 East 4 Southeast 5 South 6 Southwest 7 West 8 Northwest
wwr	Approximate total window-to-wall ratio (%) *Include all glazing types*	
glazing_operable	Are more than 20% of the windows operable?	1 Yes 0 No
glazing_operable_freq	If operable, what frequency are they used? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Never 2 Rarely 3 Occasionally 4 Frequently
Envelope (Exterior) > Doors		
door_type_prim	Primary door type	1 None 2 Opaque Man 3 Glass Man 4 Opaque Overhead 5 Glass Overhead

Field	Question	Answer
prim_door_num	Number of primary door type	8 Other, describe below:
door_type_sec	Secondary door type *Select 'None' if comprises less than 20% of total door area*	1 None 2 Opaque Man 3 Glass Man 4 Opaque Overhead 5 Glass Overhead 8 Other, describe below:
sec_door_num	Number of secondary door type	
door_type_other	Describe "other" primary or secondary door types here: *if applicable*	
walkthru-env-ext-notes	Optional: Add any additional notes pertaining to "Envelope (Exterior)" section here	
walkthru-env-ext-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Envelope (Exterior)" section	
Lighting (Exterior)		
extlight_park_type	Parking lots and drives: primary lighting type *if unsure, consider asking where replacement bulbs are kept*	1 Incandescent/halogen 2 Fluorescent (CFL or other) 3 LED 4 HID (low pressure sodium, high pressure sodium, metal halide, or mercury vapor) 5 Induction 6 None 8 Other, describe below:
extlight_park_other	Describe "other" parking lot and drives exterior lighting types here: *if applicable*	
Lighting (Exterior) > Exterior lighting - Parking lots and drives		
extlight_park_num	Parking lots and drives: number of primary lighting type	
extlight_park_percon	Parking lots and drives: percent on during your (daytime) visit (%)	
extlight_door_type	Doors: primary lighting type *Hint 1: big wallpacks typically mean HID, small wallpacks typically mean fluorescent* *Hint 2: if unsure, consider asking where replacement bulbs are kept*	1 Incandescent/halogen 2 Fluorescent (CFL or other) 3 LED 4 HID (low pressure sodium, high pressure sodium, metal halide, or mercury vapor) 5 Induction 6 None 8 Other, describe below:
extlight_door_other	Describe "other" door exterior lighting types here: *if applicable*	
Lighting (Exterior) > Exterior lighting - Doors		

Field	Question	Answer
extlight_door_num	Doors: number of primary lighting type	
extlight_door_percon	Doors: percent on during your (daytime) visit (%)	
extlight_ctrl_type	Exterior lighting control type *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Manual 2 Timer 3 Motion Sensor 4 Photosensor
extlight_retail_num	Number of retail signs with integrated lighting	
extlight_retail_percled	Percent of retail signs with integrated lighting that are LED (%)	
walkthru-lighting-ext-notes	Optional: Add any additional notes pertaining to "Lighting (Exterior)" section here	
walkthru-lighting-ext-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Lighting (Exterior)" section	
Plug Loads		
walkthru_recommend	Now that you are inside the building, consider walking thru it once first to get a sense for the things you'll see and where they are.	
num_computers	Number of computers *Survey said "[num_computers_surv]"*	
per_advstrips	Percentage of workstations that have advanced power strips *Hint 1: Plus or minus 10%* *Hint 2: typically have means of differentiating between controlled and uncontrolled plugs, i.e. color*	
num_op_senstrips	Number of opportunities for load sensing power strips *such as teleconference, AV equip controlled off TV, or other situations with peripheral devices*	
per_laptops	Percentage of computers that are laptops *Hint 1: Plus or minus 10%* *Hint 2: Count laptop docks without laptops in them*	
per_extra_monitors	Percentage of computers with an extra monitor *Hint 1: Plus or minus 10%* *Hint 2: Desktops with more than 1 monitor* *Hint 3: Laptops with any connected monitor*	
computer_power_management_type	Typical computer power management type *Hint 1: To test, wiggle mice on a few PCs not in use. Consider asking occupant permission first.* *Hint 2: Survey said "[computer_pwr_mgmt_type_surv]"*	1 PC and monitor on 2 PC on, monitor screensaver 3 PC on, monitor off 4 PC in sleep (power light on, no signal to monitor)

Field	Question	Answer
		5 PC off
night_devices	Describe any large equipment that is on at night *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
num_copiers	Number of copiers and multi-functional devices *don't count devices that only print*	
num_tvs	Number of TVs *Survey said "[num_tvs_surv]"*	
num_clng_fans	Number of ceiling fans	
num_elevators	Number of elevators *enter value for tenant spaces as well as whole buildings*	
elevator_type	Elevator type *Hint 1: leave blank if no elevators* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 3: Hydraulic typically has elevator room at bottom, 5 stories or less* *Hint 4: Traction typically has elevator room at top, older buildings*	1 Hydraulic 2 Traction 8 Other, describe below:
elevator_type_other	Describe "other" elevator types here: *if applicable*	
num_res_refrig	Number of residential refrigerators	
num_res_washmachine	Number of residential clothes washing machines	
num_coffee	Number of coffee machines	
num_personal_comfort	Number of personal comfort devices *such as fans and personal heaters*	
num_water_coolers	Number of refrigerated water coolers *includes water fountains that use electricity to cool water*	
num_bev_machines	Number of beverage machines *don't include other types of vending machines*	
num_pos_terminals	Number of point of sale terminals *Survey said "Had point of sale terminals? = [has_pos_surv]"*	
walkthru-plug-loads-notes	Optional: Add any additional notes pertaining to "Plug Loads" section here	
walkthru-plug-loads_unknown-pic	Optional: Take a picture of any unknown item you encounted within "Plug Loads" section	
Server		
num_servers	Total number of servers *Survey said "Had servers? = [has_server_surv]"*	
num_network_equip	Total pieces of networking equipment	
Server > Server Info		

Field	Question	Answer
temp_server_note	Reminder: Place the temperature and relative humidity sensor somewhere in the server room. It will need a minute or so to equilibrate for the upcoming reading.	
server_power_management	Is server power management implemented? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Yes 0 No
server_virtualization	Is server virtualization implemented? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Yes 0 No
ups_capacity	Total Uninterruptible Power Supply (UPS) capacity (VA) *Hint 1: If rackmounted, UPS will typically be on bottom.* *Hint 2: VA is typically found on nameplate, as digits in model number.* *Hint 3: If not readily available, you may substitute PDU capacity if it is readily available.* *Hint 4: If unknown, leave blank. If none, enter 0.*	
ups_ENERGYSTAR	Is Uninterruptible Power Supply (UPS) ENERGY STAR rated? *often on nameplate/sticker*	1 Yes 0 No 2 Not Applicable
server_cooling_type	How is the main server room cooled?	1 Primary building HVAC 2 CRAC 3 Split system 8 Other, describe below:
server_cooling_type_other	Describe "other" server cooling types here: *if applicable*	
server_cooling_cap	Total cooling capacity of cooling system(s) for the server room(s)? (MBH) *If readily available*	
server_temp	What is the temperature inside the server room? (F) *leave handheld in place for at least 1 minute before reading*	
server_rh	What is the relative humidity inside the server room? (%) *leave handheld in place for at least 1 minute before reading*	
server_group_notes	Optional: Add any additional notes pertaining to "Server" section here	
server_group_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Server Info" section	
HVAC (Airside)		
airside_type_prim	Primary HVAC system type	1 None

Field	Question	Answer
		2 RTU, single zone 3 RTU, multi-zone (VAV) 4 Other multi-zone (AHU with CHW and/or HW) 5 Furnace 6 Heat pumps 7 Fan coil (with CHW and HW) 8 Other single zone 9 Unit ventilator (not a unit heater) 10 Other DX terminal units: PTAC, window unit, etc. 11 Radiant (floor, radiator, panels, etc.) 12 Unit heater 88 Other, describe below:
airside_type_prim_other	Describe "other" primary airside system types here: *if applicable*	
HVAC (Airside) > Primary Airside System		
airside_perc_prim	Percent of building area served by primary HVAC system type (%) *Hint 1: Plus or minus 10%* *Hint 2: do not include unconditioned or semiheated below grade areas when calculating percent*	
airside_fan_type_prim	Primary HVAC system fan type *Look for VFD*	1 Multi or Variable Speed 2 Constant 3 Cannot determine 4 Not Applicable
airside_reheat_type_prim	Primary VAV box reheat type *only applicable for VAV systems*	1 No reheat 2 Electric coil 3 Hot water coil
airside_type_sec	Secondary HVAC system type *Select 'None' if comprises less than 20% of total floor area*	1 None 2 RTU, single zone 3 RTU, multi-zone (VAV) 4 Other multi-zone (AHU with CHW and/or HW) 5 Furnace 6 Heat pumps 7 Fan coil (with CHW and HW) 8 Other single zone 9 Unit ventilator (not a unit heater) 10 Other DX terminal units: PTAC, window unit, etc. 11 Radiant (floor, radiator, panels, etc.) 12 Unit heater 88 Other, describe below:

Field	Question	Answer
airside_type_sec_other	Describe "other" secondary system types here: *if applicable*	
HVAC (Airside) > Secondary Airside System		
airside_perc_sec	Percent of building area served by secondary HVAC system type (%) *Hint 1: Plus or minus 10%* *Hint 2: do not include unconditioned or semiheated below grade areas when calculating percent*	
airside_fan_type_sec	Secondary HVAC system fan type *Look for VFD*	1 Multi or Variable Speed 2 Constant 3 Cannot determine 4 Not Applicable
airside_reheat_type_sec	Secondary VAV box reheat type *only applicable for VAV systems*	1 No reheat 2 Electric coil 3 Hot water coil
num_furnace	Number of furnaces	
num_furnace_noncond	Number of furnaces that are non-condensing	
length_unins_duct	Length of uninsulated ducts in under-conditioned or un-conditioned spaces (linear feet)	
length_unseal_duct	Length of unsealed ducts in under-conditioned or un-conditioned spaces (linear feet)	
economizer_working	What is the economizer condition? (i.e. damper, linkage, and actuator)	1 No economizer 2 Looks great, no visible signs of wear 3 Generally in good shape, some signs of wear 4 In bad shape, in need of repair or replacement soon
num_wo_ecmotors	Number of small units without electronically commuted motors (e.g. PSC motors) *look at furnaces, fan coils, heat pumps and other single zone units*	
walkthru-hvac-airside-notes	Optional: Add any additional notes pertaining to "HVAC (Airside)" section here	
walkthru-hvac-airside-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Airside)" section	
HVAC (Ventilation)		
vent_type	How is ventilation delivered? *Hint 1: could include primary and/or secondary HVAC systems* *Hint 2: look for outdoor air intakes* *Hint 3: don't include individual bath fans*	1 None 2 Mechanical only 3 Operable windows only 4 Mix of mechanical and operable windows 8 Other, describe below:

Field	Question	Answer
vent_type_other	Describe "other" ventilation types here: *if applicable*	
vent_only	Are there any ventilation-specific air handlers serving even a portion of the ventilation (MAU, DOAS, any >75% OA)? *Hint 1: if the primary or secondary air side systems are >75% OA, answer yes* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 3: typically when one rooftop unit looks different than others, MAU for kitchen or other exhaust, in association with heat pumps or VRF*	1 Yes 0 No
HVAC (Ventilation) > Dedicated Ventilation System		
ded_vent_perc	Percent of building area served by dedicated ventilation system (%) *Hint 1: Plus or minus 10%* *Hint 2: do not include unconditioned or semiheated below grade areas when calculating percent*	
vent_fan_power	Total fan size of dedicated ventilation system (hp) *only if easily found*	
mau_heat_eff	If dedicated ventilation system is a MAU, what is its nameplate full load heating efficiency? (%) *calculate by dividing (output / input)*	
HVAC (Ventilation) > Ventilation ECMs		
vent_erv	Is there energy recovery ventilation serving the majority of the ventilation? *Hint 1: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 2: May be found as small box near furnace, add on to RTU, labeled on larger AHU, and on dedicated ventialtion systems*	1 Yes 0 No
dcv_co2_area	DCV CO2: Percentage of total area served (%) *Hint 1: Look for small box with air vents, in addition to thermostat* *Hint 2: do not count unconditioned or semiheated below grade areas when calculating percent*	
dcv_add_area	DCV: Percentage of total area that could additionally be served (%) *Hint 1: Look for conference, training and other rooms with high and variable occupancy* *Hint 2: do not count unconditioned or semiheated below grade areas when calculating percent*	
vent_parking	Is there an enclosed parking garage?	1 Yes

Field	Question	Answer
vent_parking_sys	Is there a ventilation system for the enclosed parking garage? *Apart from the main ventilation system*	0 No 1 Yes 0 No
HVAC (Ventilation) > Parking Garage Ventilation System		
vent_parking_sys_ctrl	Parking garage ventilation system control type?	1 None (on 24/7) 2 Timer 3 CO/NOX sensor
vent_parking_sys_onoff	Is the parking garage ventilation system ever off during the site visit?	1 Yes 0 No
walkthru-hvac-ventilation-notes	Optional: Add any additional notes pertaining to "HVAC (Ventilation)" section here	
walkthru-hvac-ventilation-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Ventilation)" section	
HVAC (Thermostats)		
tstat_type	Primary thermostat type *Hint 1: Survey said "[tstat_type_surv]"* *Hint 2: If wifi enabled, select "Smart"*	1 None 2 Manual 3 Programmable 4 Smart 5 BAS / EMS
HVAC (Thermostats) > Smart & Programmable Thermostats		
tstat_setbacks	Are temperature setbacks being used? *Survey said "[tstat_proguse_surv]"*	1 Yes 0 No 2 Not Applicable
tstat_fan_setting	What is the thermostat fan setting?	1 Fan-On 2 Fan-Auto 8 Other, describe below:
tstat_fan_setting_other	Describe "other" thermostat fan settings here: *if applicable*	
HVAC (Thermostats) > Thermostat Setpoints		
note_tstat	The following questions ask about temperature settings. Data is pulled in from the survey with responses in Fahrenheit with the following exceptions: 98=don't know, 99=refused	
tstat_winter_occ	WINTER: Thermostat setpoint during OCCUPIED hours? (F) *Hint 1: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 2: Survey said "[tstat_winter_occ_surv] F"*	
tstat_winter_unocc	WINTER: Thermostat setpoint during UNOCCUPIED hours? (F) *Hint 1: If left blank, this question will appear again at the end of the*	

Field	Question	Answer
	form for you to ask the owner/manager *Hint 2: Survey said "[tstat_winter_unocc_surv] F"*	
tstat_summer_occ	SUMMER: Thermostat setpoint during OCCUPIED hours? (F) *Hint 1: Leave blank if no cooling* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 3: Survey said "[tstat_summer_occ_surv] F"*	
tstat_summer_unocc	SUMMER: Thermostat setpoint during UNOCCUPIED hours? (F) *Hint 1: Leave blank if no cooling* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 3: Survey said "[tstat_summer_unocc_surv] F"*	
tstat_setpoint_relax	Estimate of total ancillary area where temperature setpoints could be relaxed (ft^2) *Take temperature reading in separated, transient spaces such as external hallways, stairwells, storage and mechanical rooms.*	
walkthru-hvac-thermostats-notes	Optional: Add any additional notes pertaining to "HVAC (Thermostats)" section here	
walkthru-hvac-thermostats-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Thermostats)" section	
HVAC (Other)		
pressurization	When you open doors, is there any noticeable over or underpressurization in main building areas?	1 Not noticeable 2 Overpressurization (pushing toward exterior) 3 Underpressurization (pulling into interior)
destrat_area	Destratification Fans: Estimate of total area served (ft^2)	
destrat_add_area	Destratification Fans: Estimate of total area that could additionally be served (ft^2) *Look for high bay areas with ceiling heights greater than 25 feet*	
walkthru-hvac-other-notes	Optional: Add any additional notes pertaining to "HVAC (Other)" section here	
walkthru-hvac-other-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Other)" section	
HVAC (Pumping)		
num_pumps	Number of hydronic HVAC pumps *Hint 1: don't count pumps that are process related* *Hint 2: when pumps are in groups of 2*	

Field	Question	Answer
	or 3 identical pumps, subtract one from each group before adding to this total (because that one is probably a redundant backup).	
HVAC (Pumping) > HVAC (Pumping) Repeat (1)		(Repeated group)
pump_type	Which equipment does this pump serve?	1 Chiller or chilled water 2 Heat rejection (cooling tower, etc.) 3 Boiler or hot water 4 Steam/condensate system 5 DHW 8 Other, describe below:
pump_type_other	Describe "other" pump types here: *if applicable*	
pump_power	Pump power (hp)	
pump_vfd	Is a VFD controlling this pump?	1 Yes 0 No
pump_vfd_freq	Frequency of VFD reading? (Hz)	
walkthru-hvac-pumping-notes	Optional: Add any additional notes pertaining to "HVAC (Pumping)" section here	
walkthru-hvac-pumping-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Pumping)" section	
HVAC (Cooling)		
cooling_type_prim	Primary cooling equipment type *Survey said "[coolingtype_surv]"*	1 None 2 Split A/C 3 RTU 4 Window (or thru wall) A/C 5 Air-Cooled Chiller 6 Water-Cooled Chiller 7 ASHP 8 WSHP 9 GSHP 10 Evaporative RTU 88 Other, describe below:
HVAC (Cooling) > Primary Cooling Equipment		
cooling_perc_prim	Percent of full cooling load provided by primary cooling type (%) *do not include unconditioned or semiheated below grades areas when calculating percentage*	
num_cooling_prim	Number of typical primary cooling units	
cooling_cap_prim	Typical primary cooling unit cooling capacity (MBH)	
cooling_fan_power_prim	Typical primary cooling unit fan size (hp) *Hint 1: if not RTUs or heat pumps, leave blank* *Hint 2: only enter if easily read*	

Field	Question	Answer
cooling_age_prim	Typical primary cooling unit age representing the majority of primary cooling capacity (yr) *Hint 1: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 2: If rooftop or packaged units, survey said "[cooling_age_rtu_surv]"*	
cooling_eff_prim	Typical primary cooling unit nameplate full load efficiency value	
cooling_effunit_prim	Typical primary cooling unit nameplate full load efficiency type	1 SEER 2 EER 3 COP 4 kW/ton
cooling_far_prim_pic	Take a picture of a typical primary cooling unit from a distance	
cooling_close_prim_pic	Take a picture of a typical primary cooling unit nameplate	
cooling_type_prim_other	Describe "other" primary cooling equipment here: *if applicable*	
cooling_prim_group_note	Optional: Add any additional notes pertaining to "Primary Cooling Equipment" section here	
cooling_prim_group-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Primary Cooling Equipment" section	
cooling_type_sec	Secondary cooling equipment type *Select 'None' if comprises less than 20% of total cooling load*	1 None 2 Split A/C 3 RTU 4 Window (or thru wall) A/C 5 Air-Cooled Chiller 6 Water-Cooled Chiller 7 ASHP 8 WSHP 9 GSHP 10 Evaporative RTU 88 Other, describe below:
HVAC (Cooling) > Secondary Cooling Equipment		
cooling_perc_sec	Percent of full cooling load provided by secondary cooling type (%) *do not include unconditioned or semiheated below grades areas when calculating percentage*	
num_cooling_sec	Number of typical secondary cooling units	
cooling_cap_sec	Typical secondary cooling unit cooling capacity (MBH)	
cooling_fan_power_sec	Typical secondary cooling unit fan size (hp)	

Field	Question	Answer
	Hint 1: if not RTUs or heat pumps, leave blank *Hint 2: only enter if easily read*	
cooling_age_sec	Typical secondary cooling unit age representing the majority of secondary cooling capacity (yr) *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
cooling_eff_sec	Typical secondary cooling unit nameplate full load efficiency value	
cooling_effunit_sec	Typical secondary cooling unit nameplate full load efficiency type	1 SEER 2 EER 3 COP 4 kW/ton
cooling_type_sec_other	Describe "other" secondary cooling equipment here: *if applicable*	
cooling_sec_group_note	Optional: Add any additional notes pertaining to "Secondary Cooling Equipment" section here	
cooling_sec_group-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Secondary Cooling Equipment" section	
HVAC (Cooling) > Heat Rejection		
heat_reject	Heat rejection type associated with chiller?	1 Air-cooled chiller 2 Fluid cooler 3 Closed-circuit cooling tower 4 Open cooling tower 8 Other, describe below:
heat_reject_other	Describe "other" heat rejection type here: *if applicable*	
chw_temp	Chilled water temperature (F)	
perc_unins_chw_pipe	Percent of visible uninsulated chilled water pipe (%)	
heat_reject_far_pic	Take a picture of a heat rejection unit from a distance	
heat_reject_group_note	Optional: Add any additional notes pertaining to "Heat Rejection" section here	
heat_reject_group-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Heat Rejection" section	
HVAC (Supplemental)		
supp_heat_type	Main supplemental heating system type *If baseboard is only source of heat, it should be primary HVAC system*	1 None 2 Baseboard 3 Portable space heater 4 Radiant panels 5 Unit Heater

Field	Question	Answer
		8 Other, describe below:
supp_heat_type_other	Describe "other" supplemental heating system here: *if applicable*	
num_unit_heaters	Number of unit heaters that are non-condensing	
HVAC (Supplemental) > Supplemental Heat Information		
supp_heat_fuel	Main supplemental heating system fuel	1 Natural Gas or Propane 2 Hot water 3 Steam 4 Electric 8 Other, describe below:
supp_heat_fuel_other	Describe "other" supplemental heating fuel types here: *if applicable*	
supp_heat_ctrl	How is main supplemental heat controlled? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Manual knob 2 Thermostat, outdoor 3 Thermostat, indoor 4 BAS 5 Rarely turned on
supp_heat_serv	What does the main supplemental heating system serve?	1 The entire skin (i.e. baseboard) 2 A major portion of the building 3 One or two small areas 8 Other, describe below:
supp_heat_serv_other	Describe "other" options for what the main supplemental heating systems serves here: *if applicable*	
walkthru-hvac-supplemental-note	Optional: Add any additional notes pertaining to "HVAC (Supplemental)" section here	
walkthru-hvac-supplemental-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Supplemental)" section	
HVAC (Hot Water, Steam)		
hwsteam	Is there steam or hot water used for heating in the building? *Survey said "[hwsteam_surv]"*	1 Yes 0 No
HVAC (Hot Water, Steam) > Boiler Information		
hwsteam_type	What is the source of steam or hot water? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Hot water boiler 2 Steam boiler 3 Purchased hot water 4 Purchased steam
hwsteam_fuel	What fuel is used to provide the steam / hot water?	1 Natural Gas 2 Electric 3 Propane 4 Fuel Oil 8 Other, describe below:

Field	Question	Answer
		9 Cannot determine
hwsteam_fuel_other	Describe "other" steam / hot water fuel types here: *if applicable*	
num_boiler	Number of boilers	
cap_boiler	Typical boiler heating capacity (MBH)	
age_boiler	Typical boiler age representing the majority of the heating capacity *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
cond_boiler	Typical boiler condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
eff_boiler	Typical boiler nameplate full load efficiency (%) *divide output by input*	
ctrlbox_boiler	Do the boilers have a control box?	1 Yes 0 No
hw_temp	Hot water temperature (F)	
boiler_far_pic	Take a picture of a typical boiler from a distance	
boiler_close_pic	Take a picture of a typical boiler nameplate	
HVAC (Hot Water, Steam) > Steam Information		
perc_unins_hwsteam	Percent of visible uninsulated HW or steam pipe (%)	
num_traps	Approximate number of steam traps *generally one per radiator, two per riser, and any large ones visible on the lowest level (this is a conservative estimate)*	
freq_trap_maint	How often are steam traps repaired or replaced? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Never 2 Rarely 3 Occasionally 4 Frequently
trap_survey	Has there ever been a thorough steam trap survey? *Hint 1: investigating leakage, etc.* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Yes 0 No
yr_trap_survey	What year was the steam trap survey completed? *Hint 1: leave blank if no steam trap survey completed* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	

Field	Question	Answer
walkthru-hvac-hwsteam-note	Optional: Add any additional notes pertaining to "HVAC (Hot Water, Steam)" section here	
walkthru-hvac-hwstream-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Hot Water, Steam)" section	
Domestic Hot Water		
dhw_enduses	Which end uses does domestic hot water serve in this building? *Survey said "[dhw_sinks_surv], [dhw_showers_surv], [dhw_laundry_surv], [dhw_dishes_surv], [dhw_deepclean_surv]"*	1 None 2 Faucets 3 Showers 4 Commercial Kitchen 5 Laundry 6 Commercial Laundry 7 Process Load 8 Other, describe below:
dhw_enduses_other	Describe "other" end uses that DHW serves here: *if applicable*	
Domestic Hot Water > Faucet Flowrate Calculator (1)		(Repeated group)
faucet_vol	Faucet flowrate input: volume (mL) *do not measure standard bathroom faucets*	
faucet_time	Faucet flowrate input: time (s) *do not measure standard bathroom faucets*	
faucet_flowrate_note	Your calculated faucet flowrate was [faucet_flowrate] gpm	
num_faucet_lowflow	Number of similar faucets	
Domestic Hot Water > Shower Flowrate Calculator (1)		(Repeated group)
shower_vol	Shower flowrate input: volume (mL) *most commonly used*	
shower_time	Shower flowrate input: time (s) *most commonly used*	
shower_flowrate_note	Your calculated shower flowrate was [shower_flowrate] gpm *low flow defined as having a flowrate less than 2.5 gpm*	
num_shower_lowflow	Number of similar showers	
freq_shower_lowflow	Frequency of use of showers *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Never 2 Rarely 3 Occasionally 4 Frequently
Domestic Hot Water > Pre-rinse Sprayer Flowrate Calculator (1)		(Repeated group)
prerinse_vol	Pre-rinse sprayer flowrate input: volume (mL)	
prerinse_time	Pre-rinse sprayer flowrate input: time (s)	
prerinse_flowrate_note	Your calculated pre-rinse sprayer flowrate was [prerinse_flowrate] gpm	

Field	Question	Answer
	low flow defined as having a flowrate less than 1.6 gpm	
num_prerinse	Number of similar pre-rinse sprayers	
num_dhw_heater	Number of DHW heaters	
Domestic Hot Water > DHW Heaters		
dhw_heater_type	Typical DHW heater type	1 Storage 2 Tankless 3 Indirect or combi
dhw_heater_fuel_type	Typical DHW heater fuel	1 Natural Gas 2 Electric Resistance 3 Heat Pump 4 Propane 5 Fuel Oil 6 Solar 8 Other, describe below:
dhw_heater_fuel_type_other	Describe "other" DHW heater fuel types here: *if applicable*	
cap_dhw_heater	Typical DHW heater capacity (MBH)	
vol_dhw_heater	Typical DHW volume (gal)	
eff_dhw_heater	Typical DHW heater nameplate full load efficiency value *Hint 1: can divide output by input to calculate* *Hint 2: if gas-fired; atmospheric = 80%, condensing = 90%*	
eff_dhw_heater_unit	Typical DHW heater nameplate full load efficiency type	1 Thermal Efficiency 2 Energy Factor 3 COP
dhw_heater_far_pic	Take a picture of a typical DHW heater from a distance	
dhw_temp	Domestic hot water temperature (F) *take temperature at tap after running hot water only, watch for temperature to equilibrate*	
perc_unins_dhw	Percentage of visible domestic hot water pipe that is uninsulated (%)	
walkthru-dhw-note	Optional: Add any additional notes pertaining to "Domestic Hot Water" section here	
walkthru-dhw-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Domestic Hot Water" section	
Refrigeration		
refrig_type	What types of commercial refrigeration equipment are in this building? *Survey said "[has_open_fridge_surv], [has_open_freezer_surv], [has_fridge_doors_surv], [has_freezer_doors_surv], [has_walkin_cooler_surv],*	1 None 2 Reach-In Freezer 3 Reach-In Cooler 4 Open Freezer 5 Open Cooler 6 Walk-In Freezer 7 Walk-In Cooler

Field	Question	Answer
	[has_walkin_freezer_surv], [has_icemachine_surv]"	8 Service Freezer 9 Service Cooler 88 Other, describe below:
refrig_type_other	Describe "other" commercial refrigeration types here: *if applicable*	
space_rh	What is the relative humidity inside the store near the refrigeration equipment (preferably near the reach-in freezer)? (%) *leave handheld in place for at least 1 minute before reading*	
Refrigeration > Reach-In Freezers		
num_reachin_freezer	Number of doors on reach-in freezer cases	
light_type_reachin_freezer	What kind of lighting is primarily used for reach-in freezers?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5 5 LED 8 Other, describe below:
light_type_reachin_freezer_other	Describe "other" lighting types for reach-in freezers here: *if applicable*	
per_occ_reachin_freezer	Percent (by number of doors) of reach-in freezer cases controlled by occ sensors (%) *Hint 1: leave blank if no lighting* *Hint 2: sensor is usually centered above cases*	
evapfan_cur_reachin_freezer	Typical reach-in freezer case evaporator fan current (Amps) *If readily available*	
antisweat_ctrl_reachin_freezer	Anti-sweat heater control type for reach in freezer cases *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Humidity 3 Dew Point 9 Cannot determine
antisweat_cur_reachin_freezer	Typical reach-in freezer case anti-sweat heater current (Amps) *Hint 1: if readily available* *Hint 2: leave blank if no anti-sweat heater*	
gasket_cond_reachin_freezer	Reach-in freezer door gasket condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
note_reachin_freezer	Optional: Add any additional notes pertaining to "Reach-In Freezers" section here	

Field	Question	Answer
reachin_freezer_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Reach-In Freezers" section	
Refrigeration > Reach-In Coolers		
num_reachin_cooler	Number of doors on reach-in cooler cases	
light_type_reachin_cooler	What kind of lighting is primarily used for reach-in coolers?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5 5 LED 8 Other, describe below:
light_type_reachin_cooler_other	Describe "other" lighting types for reach-in coolers here: *if applicable*	
per_occ_reachin_cooler	Percent (by number of doors) of reach-in cooler cases controlled by occ sensors (%) *Hint 1: leave blank if no lighting* *Hint 2: sensor is usually centered above cases*	
evapfan_cur_reachin_cooler	Typical reach-in cooler case evaporator fan current (Amps) *If readily available*	
antisweat_ctrl_reachin_cooler	Anti-sweat heater control type for reach in cooler cases *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Humidity 3 Dew Point 9 Cannot determine
antisweat_cur_reachin_cooler	Typical reach-in cooler case anti-sweat heater current (Amps) *Hint 1: if readily available* *Hint 2: leave blank if no anti-sweat heater*	
gasket_cond_reachin_cooler	Reach-in cooler door gasket condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
note_reachin_cooler	Optional: Add any additional notes pertaining to "Reach-In Coolers" section here	
reachin_cooler_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Reach-In Coolers" section	
Refrigeration > Open Freezers		
len_open_freezer	Length of open freezer cases (linear feet)	
light_type_open_freezer	What kind of lighting is primarily used for open freezer cases?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5

Field	Question	Answer
		5 LED 8 Other, describe below:
light_type_open_freezer_other	Describe "other" lighting types for open freezers here: *if applicable*	
num_light_open_freezer	Typical number of rows of lights for open freezer cases *leave blank if no lighting*	
per_occ_open_freezer	Percent (by linear feet) of open freezer cases controlled by occupancy sensor (%) *leave blank if no lighting*	
per_curt_open_freezer	Percent (by linear feet) of open freezer cases with night curtains (%)	
evapfan_cur_open_freezer	Typical open freezer case evaporator fan current (Amps) *If readily available*	
note_open_freezer	Optional: Add any additional notes pertaining to "Open Freezers" section here	
open_freezer_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Open Freezers" section	
Refrigeration > Open Coolers		
len_open_cooler	Length of open cooler cases (linear feet)	
light_type_open_cooler	What kind of lighting is primarily used for open cooler cases?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5 5 LED 8 Other, describe below:
light_type_open_cooler_other	Describe "other" lighting types for open coolers here: *if applicable*	
num_light_open_cooler	Typical number of rows of lights for open cooler cases *leave blank if no lighting*	
per_occ_open_cooler	Percent (by linear feet) of open cooler cases controlled by occupancy sensor (%) *leave blank if no lighting*	
per_curt_open_cooler	Percent (by linear feet) of open cooler cases with night curtains (%)	
evapfan_cur_open_cooler	Typical open cooler case evaporator fan current (Amps) *If readily available*	
note_open_cooler	Optional: Add any additional notes pertaining to "Open Coolers" section here	

Field	Question	Answer
open_cooler_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Open Coolers" section	
Refrigeration > Walk-In Freezers		
num_walkin_freezer	Number of walk-in freezers	
num_evapfan_walkin_freezer	Number of walk-in freezer evaporator fans *total fans, not per freezer*	
evapfan_cur_walkin_freezer	Typical walk-in freezer evaporator fan current (Amps) *If readily available*	
evapfan_onoff_walkin_freezer	Were walk-in freezer evaporator fans ever off during the site visit *aka: do they cycle?*	1 Yes 0 No
per_tempsens_walkin_freezer	Percent of walk-in freezer with a temperature probe by evaporator fan *This is to determine if temperature termination defrost is present*	
defrost_type_walkin_freezer	What type of defrost is used for walk-in freezers? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Electric 2 Hot Gas 3 Air 9 Cannot determine
per_stripcurtain_walkin_freezer	Percent of walk-in freezer doors with strip curtains (%)	
per_autodoor_walkin_freezer	Percent of walk-in freezer doors with self-closing doors (%)	
light_type_walkin_freezer	What kind of lighting is primarily used for walk-in freezers?	1 Flourescent - T12 2 Flourescent - T8 3 Flourescent - T5 4 Incandescent 5 CFL 6 LED 8 Other, describe below:
light_type_walkin_freezer_other	Describe "other" lighting types for walk-in freezers here: *if applicable*	
per_occ_walkin_freezer	Percent of walk in freezers with occupancy sensors (%)	
frost_walkin_freezer	Presence of significant frost in walk-in freezers?	1 Yes 0 No
gasket_cond_walkin_freezer	Walk-in freezer door gasket condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
temp_walkin_freezer	Walk-in freezer drybulb temperature (F) *leave handheld in place for at least 1 minute before reading*	

Field	Question	Answer
note_walkin_freezer	Optional: Add any additional notes pertaining to "Walk-In Freezers" section here	
walkin_freezer_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Walk-In Freezers" section	
Refrigeration > Walk-In Coolers		
num_walkin_cooler	Number of walk-in coolers	
num_evapfan_walkin_cooler	Number of walk-in cooler evaporator fans *total fans, not per cooler*	
evapfan_cur_walkin_cooler	Typical walk-in cooler evaporator fan current (Amps) *If readily available*	
evapfan_onoff_walkin_cooler	Were walk-in cooler evaporator fans ever off during the site visit *aka: do they cycle?*	1 Yes 0 No
per_tempsens_walkin_cooler	Percent of walk-in cooler with a temperature probe by evaporator fan *This is to determine if temperature termination defrost is present*	
defrost_type_walkin_cooler	What type of defrost is used for walk-in coolers? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Electric 2 Hot Gas 3 Air 9 Cannot determine
per_stripcurtain_walkin_cooler	Percent of walk-in cooler doors with strip curtains (%)	
per_autodoor_walkin_cooler	Percent of walk-in cooler doors with self-closing doors (%)	
light_type_walkin_cooler	What kind of lighting is primarily used for walk-in coolers?	1 Flourescent - T12 2 Flourescent - T8 3 Flourescent - T5 4 Incandescent 5 CFL 6 LED 8 Other, describe below:
light_type_walkin_cooler_other	Describe "other" lighting types for walk-in coolers here: *if applicable*	
per_occ_walkin_cooler	Percent of walk-in coolers with occupancy sensors (%)	
gasket_cond_walkin_cooler	Walk-in cooler door gasket condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
temp_walkin_cooler	Walk-in cooler drybulb temperature (F) *leave handheld in place for at least 1 minute before reading*	

Field	Question	Answer
note_walkin_cooler	Optional: Add any additional notes pertaining to "Walk-In Coolers" section here	
walkin_cooler_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Walk-In Coolers" section	
Refrigeration > Service Freezers		
len_serv_freezer	Length of service freezer cases (linear feet)	
light_type_serv_freezer	What kind of lighting is primarily used for service freezer cases?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5 5 LED 8 Other, describe below:
light_type_serv_freezer_other	Describe "other" lighting types for service freezers here: *if applicable*	
num_light_serv_freezer	Typical number of rows of lights for service freezer cases *leave blank if no lighting*	
per_open_serv_freezer	Percent (by linear feet) of service freezer cases that are open on front or back (%)	
note_serv_freezer	Optional: Add any additional notes pertaining to "Service Freezer" section here	
serv_freezer_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Service Freezer" section	
Refrigeration > Service Coolers		
len_serv_cooler	Length of service cooler cases (linear feet)	
light_type_serv_cooler	What kind of lighting is primarily used for service cooler cases?	1 None 2 Flourescent - T12 3 Flourescent - T8 4 Flourescent - T5 5 LED 8 Other, describe below:
light_type_serv_cooler_other	Describe "other" lighting types for service coolers here: *if applicable*	
num_light_serv_cooler	Typical number of rows of lights for service cooler cases *leave blank if no lighting*	
per_open_serv_cooler	Percent (by linear feet) of service cooler cases that are open on front or back (%)	
note_serv_cooler	Optional: Add any additional notes pertaining to "Service Cooler" section here	

Field	Question	Answer
serv_cooler_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Service Cooler" section	
per_selfcont_cases	Percentage of refrigerated cases that are self-contained *self-contained means the condenser, evaporator and compressor are integrated in the case*	
Refrigeration > Central Refrigeration		
ref_compr_power	Total compressor power (HP)	
ref_condfan_power	Total condenser fan power (HP)	
ref_cond_block	Is anything blocking the condenser's intakes or exhausts?	1 Yes 0 No
ref_dhw_hr	DHW heat recovery using waste heat from refrigeration? *Hint 1: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 2: This is rare. Look for some connection between refrigerant and DHW*	1 Yes 0 No
cent_ref_nameplate_pic	Take a picture of the central refrigeration equipment's nameplate	
note_cent_ref	Optional: Add any additional notes pertaining to "Central Refrigeration" section here	
cent_ref_unknown_pic	Optional: Take a picture of any unknown item you encounted within "Central Refrigeration" section	
Commercial Kitchen		
kitch_type	What type of commercial kitchen is associated with this building?	1 None 2 Fast food 3 Cafeteria 4 Large commercial kitchen 5 Snack bar 8 Other, describe below:
kitch_type_other	Describe "other" commercial kitchen types here: *if applicable*	
Commercial Kitchen > General Kitchen Information		
kitch_hr	Hours per day the kitchen actively being used for cooking (hr) *Hint 1: cooking equipment is on* *Hint 2: If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
kitch_meals	Meals served per day *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 None 2 Food served continuously 3 1 4 2 5 3 6 4

Field	Question	Answer
kitch_equip_type	What types of commercial kitchen equipment are in this building? *Survey said "[has_hood_surv], [has_fryer_surv], [has_griddle_surv], [has_broiler_surv]"*	1 Exhaust Hood 2 Commercial Refrigerator 3 Commercial Freezer 4 Ice Machine 5 Dishwasher 6 Combination Oven 7 Convection Oven 8 Broiler/Charbroiler 9 Fryer 10 Griddle 11 Hot Food Holding Cabinet 12 Steam Cooker 13 Range 14 Rotisserie Oven 15 Upright/Salamander Broiler
Commercial Kitchen > Kitchen Hoods		
length_kitch_hoods	Length of kitchen hoods (linear feet) *don't count hoods associated with dishwashers*	
kitch_exh_mau	Is kitchen hood exhaust supplied by make-up air unit?	1 Yes 0 No
kitch_exh_ctrls	What type of kitchen hood exhaust controls are present? *Hint 1: If left blank, this question will appear again at the end of the form for you to ask the owner/manager* *Hint 2: Survey said "[kitch_exh_ctrls_surv]"*	1 None/Manual 2 Temperature probe only 3 Optic sensor only 4 Temperature and optic sensor 5 Timer 6 Tied to HVAC controls 9 Cannot determine
kitch_exh_ctrls_pic	Take a picture of the kitchen hood controls	
Commercial Kitchen > Commercial Refrigerators		
num_comm_refrig	Total count	
num_comm_refrig_eff	ENERGYSTAR count	
cond_comm_refrig	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
Commercial Kitchen > Commercial Freezers		
num_comm_freez	Total count	
num_comm_freez_eff	ENERGYSTAR count	
cond_comm_freez	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear

Field	Question	Answer
		3 In bad shape, in need of repair or replacement soon
Commercial Kitchen > Ice Machines		
num_comm_icemach	Total count	
num_comm_icemach_eff	ENERGYSTAR count	
cond_comm_icemach	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
Commercial Kitchen > Dishwashers		
num_comm_dishwash	Total count	
num_comm_dishwash_eff	ENERGYSTAR count	
cond_comm_dishwash	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_dishwash	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Combination Ovens		
num_comm_comboven	Total count	
num_comm_comboven_eff	ENERGYSTAR count	
num_comm_comboven_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_comboven_knob	Number that have missing control knobs	
cond_comm_comboven	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_comboven	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Convection Ovens		
num_comm_convoven	Total count	
num_comm_convoven_eff	ENERGYSTAR count	
num_comm_convoven_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_convoven_knob	Number that have missing control knobs	
cond_comm_convoven	Condition	1 Looks great, no visible signs of wear

Field	Question	Answer
		2 Generally in good shape, some signs of wear
		3 In bad shape, in need of repair or replacement soon
fuel_comm_convoven	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Broilers and Charbroilers		
num_comm_broilers	Total count	
num_comm_broilers_eff	ENERGYSTAR or INFRARED count	
num_comm_broilers_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_broilers_knob	Number that have missing control knobs	
cond_comm_broilers	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_broilers	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Fryers		
num_comm_fryers	Total count	
num_comm_fryers_eff	ENERGYSTAR count	
num_comm_fryers_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_fryers_knob	Number that have missing control knobs	
cond_comm_fryers	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_fryers	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Griddles		
num_comm_griddles	Total count	
num_comm_griddles_eff	ENERGYSTAR count	
num_comm_griddles_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_griddles_knob	Number that have missing control knobs	
cond_comm_griddles	Condition	1 Looks great, no visible signs of wear

Field	Question	Answer
		2 Generally in good shape, some signs of wear
		3 In bad shape, in need of repair or replacement soon
fuel_comm_griddles	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Hot Food Holding Cabinets		
num_comm_holdcab	Total count	
num_comm_holdcab_eff	ENERGYSTAR count	
num_comm_holdcab_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_holdcab_knob	Number that have missing control knobs	
cond_comm_holdcab	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_holdcab	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Steam Cookers		
num_comm_steamcook	Total count	
num_comm_steamcook_eff	ENERGYSTAR count	
num_comm_steamcook_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_steamcook_knob	Number that have missing control knobs	
cond_comm_steamcook	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_steamcook	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Ranges		
num_comm_range	Total count	
num_comm_range_eff	INDUCTION count	
num_comm_range_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_range_knob	Number that have missing control knobs	
cond_comm_range	Condition	1 Looks great, no visible signs of wear

Field	Question	Answer
		2 Generally in good shape, some signs of wear
		3 In bad shape, in need of repair or replacement soon
fuel_comm_range	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Rotisserie Ovens		
num_comm_rotoven	Total count	
num_comm_rotoven_eff	INFRARED count	
num_comm_rotoven_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_rotoven_knob	Number that have missing control knobs	
cond_comm_rotoven	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_rotoven	Fuel Type	1 Natural Gas 2 Electric
Commercial Kitchen > Upright/Salamander Broilers		
num_comm_upsalbroil	Total count	
num_comm_upsalbroil_eff	INFRARED count	
num_comm_upsalbroil_on	Number that are on without food *Check once towards beginning and once towards the end of visit*	
num_comm_upsalbroil_knob	Number that have missing control knobs	
cond_comm_upsalbroil	Condition	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
fuel_comm_upsalbroil	Fuel Type	1 Natural Gas 2 Electric
walkthru-kitchen-note	Optional: Add any additional notes pertaining to "Commercial Kitchen" section here	
walkthru-kitchen-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Commercial Kitchen" section	
Commercial Laundry		
laundry	Is there commercial-grade laundry associated with this building?	1 Yes 0 No
Commercial Laundry > General Laundry Information		

Field	Question	Answer
num_frontwash	Number of commercial-grade, front-load washing machines	
num_topwash	Number of commerical-grade, top-load washing machines	
cond_wash	What is the general condition of the clothes washers?	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
num_elecdry	Number of commercial-grade, electric dryers	
num_gasdry	Number of commercial-grade, gas dryers	
deter_type	What type of detergent is used? *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	1 Low Temperature 2 Ozone 3 Both Low Temperature and Ozone 4 Neither Low Temperature or Ozone 9 Cannot determine
walkthru-laundry-note	Optional: Add any additional notes pertaining to "Commercial Laundry" section here	
walkthru-laundry-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Commercial Laundry" section	
Envelope (Interior)		
underneath_type	What is underneath the conditioned space?	1 Ground 2 Heated Parking 3 Unconditioned Parking 4 Conditioned Basement 5 Unconditioned Basement/Crawlspace
floor_uncond	Are there any floors between fully conditioned and semi or unconditioned zones? *Such as floor structure or partitions*	1 Yes 0 No
area_floor_uncond	Approximate area of floor between conditioned and unconditioned zones (ft^2) *leave blank if no floors between conditioned and unconditioned zones*	
thick_floor_uncond_ins	Estimated thickness of insulation of floor between conditioned and unconditioned zones (inches) *Hint 1: leave blank if no floors between conditioned and unconditioned zones* *Hint 2: enter 0 if no insulation*	
crack_loc	Are there visible cracks around any of the following?	1 None 2 Cantilevers

Field	Question	Answer
		3 Chases 4 Chimneys 5 Floor Systems Open to Unconditioned Space 6 Entry Door (weatherstripping) 7 Overhead Doors
sillbox_ins	Are the sill boxes insulated?	1 Yes 0 No 2 Not Applicable
walkthru-envelope-int-notes	Optional: Add any additional notes pertaining to "Envelope (Interior)" section here	
walkthru-envelope-int-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Envelope (Interior)" section	
Lighting (Interior)		
intlight_type_prim	Primary ambient lighting type	1 LED 2 Linear fluorescent 3 Compact fluorescent 4 Incandescent 5 High intensity discharge 6 None 8 Other, describe below:
intlight_type_prim_other	Describe "other" primary lighting types here: *if applicable*	
intlight_type_prim_perc	Percentage of total floor area covered by primary ambient lighting type (%) *leave blank if no primary ambient lighting*	
intlight_type_sec	Secondary ambient lighting type *Select "None" if comprises less than 20% of total floor area*	1 LED 2 Linear fluorescent 3 Compact fluorescent 4 Incandescent 5 High intensity discharge 6 None 8 Other, describe below:
intlight_type_sec_other	Describe "other" secondary lighting types here: *if applicable*	
intlight_type_sec_perc	Percentage of total floor area covered by secondary ambient lighting type (%) *leave blank if no secondary ambient lighting*	
task_light	Is task lighting present in association with primary and/or secondary ambient lighting?	1 Yes 0 No 2 Not Applicable
task_light_type	Primary task lighting type	1 LED

Field	Question	Answer
	leave blank if no task lighting	2 Fluorescent 3 Incandescent 8 Other, describe below:
task_light_type_other	Describe "other" task lighting types here: *if applicable*	
exit_sign_num	Number of exit signs	
ext_sign_percled	Percentage of exit signs that are LED (%) *leave blank if no exit signs*	
walkthru-lighting-int-notes	Optional: Add any additional notes pertaining to "Lighting (Interior)" section here	
walkthru-lighting-int-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Lighting (Interior)" section	
Lighting Controls		
intlight_occvac_area	Non Highbay Occ/Vac Sensors: Percentage of total area served (%)	
intlight_occvac_addarea	Non Highbay Occ/Vac Sensors: Percentage of total area that could additionally be served (%) *Look for storage, conference, printer, server, and mechanical/electrical spaces*	
intlight_highocc_area	Highbay Occ Sensors: Percentage of total area served (%) *Highbay areas typically have ceiling heights over 20'*	
intlight_highocc_addarea	Highbay Occ Sensors: Percentage of total area that could additionally be served (%) *Hint 1: Highbay areas typically have ceiling heights over 20'* *Hint 2: Look for high bay spaces with minimal occupancy*	
intlight_timer_area	Timeclock/Timers: Percentage of total area served (%) *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
intlight_timer_addarea	Timeclock/Timers: Percentage of total area that could additionally be served (%) *If left blank, this question will appear again at the end of the form for you to ask the owner/manager*	
intlight_photo_area	Photocontrol: Percentage of total area served (%) *Survey said "Has photocontrol? = [has_photocontrol_surv]"*	
intlight_photo_addarea	Photocontrol: Percentage of total area that could additionally be served (%)	

Field	Question	Answer
	Look for spaces adjacent to windows and skylights, don't include retail sales aras	
intlight_bilevel	Manual Bilevel: Of the spaces that would ideally have bi-level control, do the majority have it? *Shouldn't include corridors, electrical/mechanical rooms, lobbies, restrooms, stairways, and storage rooms.* *Shouldn't include spaces with only one fixture.*	1 Yes 0 No
intlight_dimming_area	Dimming: Percentage of total area served (%)	
intlight_delamping_area	Delamping: Percentage of total area served by 3+ lamp fixtures (%)	
lighting_ctrl_group_notes	Optional: Add any additional notes pertaining to "Lighting Controls" section here	
lighting_ctrl_group_unknown-pic	Optional: Take a picture of any unknown item you encounted within "Lighting Controls" section	
Other (Interior)		
note_other_equip	Survey said there were the following other equipment types: "[desc_other_equip_surv]"	
bath_fan	Are there any small individual bath fans?	1 Yes 0 No
Other (Interior) > Individual Bathroom Fans		
num_bath_fan	Total number of small individual bath fans	
bath_fan_ctrl	Small individual bath fan control type	1 On 24/7 2 Manual Switch (separate from lights) 3 Manual Switch (with lights) 4 Occupancy sensor
dehumid	Are there any dehumidifiers? *Not associated with the HVAC system*	1 Yes 0 No
Other (Interior) > Dehumidifiers		
num_dehumid	Total number of dehumidifiers	
num_dehumid_ineff	Number of dehumidifiers that are either not EnergyStar or very old	
comp_air	Is there a compressed air system?	1 Yes 0 No
Other (Interior) > Compressed Air		
comp_air_power	Total power of air compressors (hp)	
leak_survey	Has there ever been a thorough leakage survey on the compressed air system?	1 Yes 0 No
yr_leak_survey	What year was the compressed air leakage survey completed?	

Field	Question	Answer
	Hint 1: leave blank if no leakage survey completed *Hint 2: If left blank (and applicable), this question will appear again at the end of the form for you to ask the owner/manager*	
desc_other_equip	List all other major process equipment present. *Hint 1: Include: kilns and manufacturing equipment.* *Hint 2: Don't include: scanners, A/V equipment, electronics, etc.*	
walkthru-other-int-note	Optional: Add any additional notes pertaining to "Other (Interior)" section here	
walkthru-other-int-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Other (Interior)" section	
Envelope (Roof)		
note_env_roof	Be careful on the roof. Do not walk around on the roof while looking at this tablet.	
roof_access	Were you able to access the roof? *Perhaps not due to inclement weather or safety concerns*	1 Yes 0 No
roof_snow_access	Do you believe you would have been able to access the roof if there was significant snow? *This question is for future site visit planning purposes*	1 Yes 0 No
roof_type	Roof type	1 Insulation entirely above deck 2 Metal buildings 3 Attic and other
cond_roof	What is the condition of the roof?	1 Looks great, no visible signs of wear 2 Generally in good shape, some signs of wear 3 In bad shape, in need of repair or replacement soon
roof_pic	Take a picture of the roof	
skylight	Are there any skylights?	1 Yes 0 No
Envelope (Roof) > Skylights		
skylight_type	Skylight type?	1 Skylights 2 Tubular Daylight Devices 3 Monitors/Clerestory 8 Other, describe below:
skylight_type_other	Describe "other" skylight types here: *if applicable*	
sfr	Approximate skylight-to-roof ratio (%)	

Field	Question	Answer
Envelope (Roof) > Attic		
thick_attic_ins	Estimated thickness of attic insulation (inches)	
walkthru-env-roof-note	Optional: Add any additional notes pertaining to "Envelope (Roof)" section here	
walkthru-env-roof-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Envelope (Roof)" section	
HVAC (Roof)		
num_exh_fan	Number of dedicated exhaust fans *Hint 1: don't count bathroom exhaust fans with fractional horsepower motors* *Hint 2: also look for exhaust that is thru walls, not just roof*	
HVAC (Roof) > Dedicated Exhaust Fan Repeat (1)		(Repeated group)
exh_fan_power	Dedicated exhaust fan power (hp)	
exh_fan_sch	When does it operate? *There is a reminder in the follow-up section for you to ask the owner/manager*	1 Continuously 2 Only while primary HVAC system operates 3 On a manual or occupancy control 4 Never or almost never (e.g. smoke exhaust)
walkthru-hvac-roof-note	Optional: Add any additional notes pertaining to "HVAC (Roof)" section here	
walkthru-hvac-roof-unknown-pic	Optional: Take a picture of any unknown item you encounted within "HVAC (Roof)" section	
Pools and Spas		
pool_type	What type of pools/spas are associated with this building?	1 None 2 Indoor Pool 3 Outdoor Pool 4 Indoor Spa 5 Outdoor Spa
area_pool_in	Total area of indoor pools/spas (ft^2)	
area_pool_out	Total area of outdoor pools/spas (ft^2)	
pool_pump_power	Total pump power serving the pools/spas (hp)	
walkthru-pool-note	Optional: Add any additional notes pertaining to "Pools and Spaces" section here	
walkthru-pool-unknown-pic	Optional: Take a picture of any unknown item you encounted within "Pools and Spas" section	
Follow-up Items		
bldg_totarea_followup	Estimated total floor area (sq ft) *Survey said "[bldg_totarea_surv]"*	

Field	Question	Answer
bldg_perc_heat_followup	Portion of building area that is heated? (%) *Plus or minus 10%*	
bldg_perc_cool_followup	Portion of building area that is cooled? (%) *Hint 1: Plus or minus 10%* *Hint 2: Survey said "[bldg_perc_cool_surv]"*	
bldg_numlivunit_followup	Number of residential living units above or attached to the building? *Answer 0 if none*	
bldg_other_fueltype_followup	Any other sources of energy supplied to the building other than natural gas or electricity?	1 None 2 Propane 3 Fuel oil 4 Steam 5 Hot water 6 Chilled water 7 Coal 8 Other, describe below:
wall_type_prim_followup	Primary wall type	1 None 2 Concrete or concrete block 3 Structural brick 4 Metal building 5 Metal framed 6 Wood framed 8 Other, describe below:
wall_type_sec_followup	Secondary wall type *Select 'None' if comprises less than 20% of total wall area*	1 None 2 Concrete or concrete block 3 Structural brick 4 Metal building 5 Metal framed 6 Wood framed 8 Other, describe below:
glazing_operable_freq_followup	If operable, what frequency are they used?	1 Never 2 Rarely 3 Occasionally 4 Frequently
extlight_ctrl_type_followup	Exterior lighting control type	1 Manual 2 Timer 3 Motion Sensor 4 Photosensor
intlight_timer_area_followup	Timeclock/Timers: Percentage of total area served (%)	
intlight_timer_addarea_followup	Timeclock/Timers: Percentage of total area that could additionally be served (%)	
night_devices_followup	Describe any large equipment that is on at night	
elevator_type_followup	Elevator type *Hint 1: leave blank if no elevators* *Hint 2: Hydraulic typically has*	1 Hydraulic 2 Traction 8 Other, describe below:

Field	Question	Answer
	elevator room at bottom, 5 stories or less *Hint 3: Traction typically has elevator room at top, older buildings*	
server_power_management_followup	Is server power management implemented?	1 Yes 0 No
server_virtualization_followup	Is server virtualization implemented?	1 Yes 0 No
vent_only_followup	Are there any ventilation-specific air handlers serving even a portion of the ventilation (MAU, DOAS, any >75% OA)? *if yes, return to Dedicated Ventilation section*	1 Yes 0 No
vent_erv_followup	Is there energy recovery ventilation serving the majority of the ventilation?	1 Yes 0 No
tstat_winter_occ_followup	WINTER: Thermostat setpoint during OCCUPIED hours? (F) *Survey said "[tstat_winter_occ_surv] F"*	
tstat_winter_unocc_followup	WINTER: Thermostat setpoint during UNOCCUPIED hours? (F) *Survey said "[tstat_winter_unocc_surv] F"*	
tstat_summer_occ_followup	SUMMER: Thermostat setpoint during OCCUPIED hours? (F) *Hint 1: Leave blank if no cooling* *Hint 2: Survey said "[tstat_summer_occ_surv] F"*	
tstat_summer_unocc_followup	SUMMER: Thermostat setpoint during UNOCCUPIED hours? (F) *Hint 1: Leave blank if no cooling* *Hint 2: Survey said "[tstat_summer_unocc_surv] F"*	
cooling_age_prim_followup	Typical primary cooling unit age representing the majority of primary cooling capacity (yr) *If rooftop or packaged units, survey said "[cooling_age_rtu_surv]"*	
cooling_age_sec_followup	Typical secondary cooling unit age representing the majority of secondary cooling capacity (yr)	
supp_heat_ctrl_followup	How is main supplemental heat controlled?	1 Manual knob 2 Thermostat, outdoor 3 Thermostat, indoor 4 BAS 5 Rarely turned on
hwsteam_type_followup	What is the source of steam or hot water?	1 Hot water boiler 2 Steam boiler 3 Purchased hot water 4 Purchased steam
age_boiler_followup	Typical boiler age representing the majority of the heating capacity	

Field	Question	Answer
freq_trap_maint_followup	How often are steam traps repaired or replaced?	1 Never 2 Rarely 3 Occasionally 4 Frequently
trap_survey_followup	Has there ever been a thorough steam trap survey? *investigating leakage, etc.*	1 Yes 0 No
yr_trap_survey_followup	What year was the steam trap survey completed? *leave blank if no steam trap survey completed*	
freq_shower_lowflow_followup	Frequency of use of showers	1 Never 2 Rarely 3 Occasionally 4 Frequently
antisweat_ctrl_reachin_freezer_followup	Anti-sweat heater control type for reach in freezer cases	1 None 2 Humidity 3 Dew Point 9 Cannot determine
antisweat_ctrl_reachin_cooler_followup	Anti-sweat heater control type for reach in cooler cases	1 None 2 Humidity 3 Dew Point 9 Cannot determine
defrost_type_walkin_cooler_followup	What type of defrost is used for walk-in coolers?	1 Electric 2 Hot Gas 3 Air 9 Cannot determine
defrost_type_walkin_freezer_followup	What type of defrost is used for walk-in freezers?	1 Electric 2 Hot Gas 3 Air 9 Cannot determine
ref_dhw_hr_followup	DHW heat recovery using waste heat from refrigeration? *This is rare. Look for some connection between refrigerant and DHW*	1 Yes 0 No
kitch_hr_followup	Hours per day the kitchen actively being used for cooking (hr) *cooking equipment is on*	
kitch_meals_followup	Meals served per day	1 None 2 Food served continuously 3 1 4 2 5 3 6 4
kitch_exh_ctrls_followup	What type of kitchen hood exhaust controls are present? *Survey said "[kitch_exh_ctrls_surv]"*	1 None/Manual 2 Temperature probe only 3 Optic sensor only 4 Temperature and optic sensor 5 Timer

Field	Question	Answer
		6 Tied to HVAC controls 9 Cannot determine
deter_type_followup	What type of detergent is used?	1 Low Temperature 2 Ozone 3 Both Low Temperature and Ozone 4 Neither Low Temperature or Ozone 9 Cannot determine
yr_leak_survey_followup	What year was the compressed air leakage survey completed?	
exh_fan_sch_reminder	Do you need to ask about when exhaust fans operate? If so, you'll have to go back to that section to input information directly. Sorry.	
Ad_hoc group		
ad_hoc_intro	Fill out this section if you find things that you'd like to note but does not fit into a previously defined category (i.e. something that uses lots of energy). *Swipe forward to get a new repeating section. Each ad hoc item should have it's own section.*	
Ad_hoc group > Ad hoc repeat (1)		(Repeated group)
ad_hoc_type	Category of adhoc	1 Potentially an EE opportunity 2 Additional detail to add to another section of the form. 3 Generally interesting to note 4 Something else, describe in detail below.
ad_hoc_desc	Describe what the ad hoc item is	
ad_hoc1_pic	Take a picture of the ad hoc item	
ad_hoc2_pic	Take another picture, if you'd like	
Goodbye		
note_goodbye	You made it to the end of the site visit. Good work! Thank the participant for their time and a few questions before you go….	
report	Did they want an email describing energy savings opportunities? *If they ask for timeline, it'll take a month or two.*	1 Yes 0 No
giftcard	Did you give them the gift card and have them sign the receipt and photo release? *The photo release is an optional signature.*	1 Yes 0 No

Field	Question	Answer
pic_goodbye	Take a picture of gift card signature and photo release page	
photo_consent	Did they give you consent to use the photos taken today?	1 Yes 0 No
equip_reminder	Did you remember to take everything that you brought with you? *Don't forget and leave something behind*	1 Yes 0 No
checkin_reminder	Did you remember to email someone to let them know everything went smoothly? *Jeannette: jlezaks@seventhwave.org, 773-402-9595* *Peggy: pheisch@seventhwave.org, 608-345-2577*	1 Yes 0 No
Post-Visit		
desc_post	Provide summary assessment of energy opportunities and general overview of your site visit. To be filled out after the site visit (but don't wait too long or else details may be lost!)	
post1_pic	Picture of paper notes #1	
post2_pic	Picture of paper notes #2	
post3_pic	Picture of paper notes #3	
post4_pic	Picture of paper notes #4	
post5_pic	Picture of paper notes #5	
post6_pic	Picture of paper notes #6	

Appendix D: Savings assumptions

Measure Name	End Use	Measure Description	Savings Assumption	Source
Attic insulation	Envelope	Add insulation to attic spaces.	Increased attic insulation from R-30 to R-50	Whole building simulation
Insulate between conditioned and unconditioned areas	Envelope	Add insulation between conditioned and unconditioned areas.	Add 2" of insulation	Whole building simulation
Sealing major envelope leaks	Envelope	Seal significant leaks through building envelope.	11% savings on cooling energy consumption for Offices and 7% for all other building types; 9% savings on heating energy consumption for Offices and 5% for all other building types	Emmerich and Persily, Analysis of U.S. Commercial Building Envelope Air Leakage Database to Support Sustainable Building Design, 2013
Overhead doors	Envelope	Install new overhead doors to improve R-value and reduce infiltration.	300 therms per door	Engineering calculation
Interior storm windows	Envelope	Install interior storm windows during winter months.	Improve window assembly U-Value from 1.0 to 0.5	Engineering calculation
Window film	Envelope	Apply film to windows to reduce solar heat gain.	2% savings on electricity in Office, 0.3% in Food Service, 0.2% in Grocery, and 0.6% in Retail	Engineering judgment
Interior occupancy/vacancy sensors	Lighting	Implement occupancy-based lighting controls that reduce lighting power when no one is present.	30% savings on controlled lighting energy consumption	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
High bay occupancy sensors	Lighting	Implement occupancy-based lighting controls in high bay areas that reduce lighting power when no one is present.	30% savings on controlled lighting energy consumption	Minnesota Technical Reference Manual, Version 2.0
Interior lighting time clock	Lighting	Implement interior lighting timeclock controls to turn off lights during unoccupied periods.	Lights off 8 hours per weekday and 8 hours per weekend day (24 hours on weekend days for Offices)	Engineering calculation
Interior daylighting controls	Lighting	Implement daylight harvesting controls in perimeter areas to reduce electric lighting power during periods of sufficient daylight.	35% savings on controlled lighting energy consumption	Minnesota Technical Reference Manual, Version 2.0
Interior task tuning	Lighting	Reduce lighting power in overlit spaces by implementing high end trim.	22% savings on controlled lighting energy consumption	Schuetter, et al, Adjusting Light Levels in Commercial Buildings, MN CARD August 2015
Interior delamping	Lighting	Permanently removal fluorescent lamps from multi-lamp fixtures in overlit spaces.	0.40 W per square foot of delamped area reduction in lighting power	Wisconsin Focus on Energy Technical Reference Manual, 2015
LED exit signs	Lighting	Upgrade to LED exit signs.	240 kWh each	Minnesota Technical Reference Manual, Version 2.0
LED retail signs	Lighting	Upgrade to LED retail signs.	400 kWh per sign	Engineering calculation
Exterior lighting retrofit	Lighting	Upgrade to high efficiency exterior lighting to reduce the installed lighting power.	524 kWh per pole mounted light, 195 kWh per door mounted light	Wisconsin Focus on Energy Technical Reference Manual, 2015

Measure Name	End Use	Measure Description	Savings Assumption	Source
Exterior photocells/timer	Lighting	Implement photosenor or timer-based lighting controls that reduce exterior lighting power at night.	1100 kWh per pole mounted light, 440 kWh per door mounted light	Engineering calculation
Exterior motion sensors	Lighting	Implement motion-based lighting controls that reduce exterior lighting power when no one is present.	440 kWh per pole mounted light, 175 kWh per door mounted light	Wisconsin Focus on Energy Technical Reference Manual, 2015
Add EMS	HVAC	Add simple energy management system capable of X.	A4ssumed same savings as Programmable Thermostat measure	Whole building simulation
RTU tune-up and airflow	HVAC	Implement quality maintenance practices performed by a qualified HVAC professional on RTUs.	7,023 kWh per RTU	Rooftop Unit Tune-Ups: The AirCare Plus Program from ComEd and CLEAResult (http://www.advancedrtu.org/uploads/7/4/8/7/7487823/advanced_rtu_campaign_webinar_with_aircare_plus_8-17-16_final.pdf)
Furnace Tune-Up	HVAC	Implement quality maintenance practices performed by a qualified HVAC professional on gas forced-air furnace.	22% savings on furnace heating energy consumption	Engineering calculation

Measure Name	End Use	Measure Description	Savings Assumption	Source
Program thermostat	HVAC	Install programmable thermostat to replace manual thermostat. Alternately, actually program programmable thermostat that was never programmed properly.	Reduce heating setpoint by 7.5 F and increase cooling setpoint by 6.5 F during unoccupied periods.	Whole building simulation
Smart thermostat	HVAC	Install smart thermostat.	20% more savings than Programmable Thermostat	Engineering judgment
Advanced RTU controls	HVAC	Install controlls to existing rooftop units to optimize performance by providing variable speed fans, demand-controlled ventilation, and economizer fault detection among other features.	36% savings on building's heating, cooling and fan energy consumption	Advanced Rooftop Unit Controls (ARC) Retrofit (http://e3tnw.org/ItemDetail.aspx?id=338)
Duct insulation / sealing	HVAC	Seal and insulate ducts in unconditioned spaces.	Sealing: 8% savings on cooling energy and 11% savings on heating; Insulation: 4% savings on cooling energy and 5% savings on heating	Aldrich, R. and Puttagunta, S., "Measure Guideline: Sealing and Insulating Ducts in Existing Homes", December 2011.
Variable speed fans	HVAC	Install variable speed drive on HVAC fans and implement controls to reduce fan energy.	1700 kWh per fan motor hp	Minnesota Technical Reference Manual, Version 2.0
ECM motors in furnaces	HVAC	Replace existing PSC fan motor with high-efficiency EC motors in furnaces.	460 kWh per furnace	Wisconsin Focus on Energy Technical Reference Manual, 2015

Measure Name	End Use	Measure Description	Savings Assumption	Source
Exhaust heat recovery	HVAC	Install an energy recovery ventilator to recover heat from exhaust air streams.	65% total energy effectiveness	Minnesota Technical Reference Manual, Version 2.0
DCV with CO2 sensors	HVAC	Implement demand ventilation controls based on carbon dioxide sensors to reduce ventilation during unoccupied periods.	Cooling: 10% savings for Office, 30% savings for other building types; Heating: 18% savings for Office, 40% savings for other building types	Minnesota Technical Reference Manual, Version 2.0
DCV with occ sensors	HVAC	Implement demand ventilation controls based on occupancy sensors to reduce ventilation during unoccupied periods.	Reduced savings from DCV with CO2 sensors measure by 50%. No adjustment to Office	Minnesota Technical Reference Manual, Version 2.0
OA Scheduling	HVAC	Schedule mechanical ventilation to coincide only with primary hours of operation.	Reduce outdoor air flow rate to 10% of design flow rate during unoccupied periods.	Whole building simulation
Furnace fan control	HVAC	Set fan setting on thermostat to "Auto", allowing the fan to turn off for portion of unoccupied hours.	40% reduction of unoccupied fan energy consumption	Engineering calculation
Exhaust fan schedule	HVAC	Add control to turn off exhaust fans during unoccupied hours.	Office: 2800 kWh per fan hp, Other Building Types: 1800 kWh per fan hp	Engineering calculation
Fix/improve economizer	HVAC	Fix malfunctioning economizers.	7 kWh per MBH of cooling capacity	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
Furnace replacement	HVAC	Upgrade to high efficiency, condensing furnace.	Improve energy efficiency from 80% to 94%	Minnesota Technical Reference Manual, Version 2.0
Change t-stat setting in less-used areas	HVAC	Decrease heating setpoint in sparsely occupied areas such as stairwells.	Decreased heating setpoint from 70 to 60 F	Whole building simulation
Boiler controls (reset/cutout)	HVAC	Install boiler cut-out and reset controls.	5.5% savings on boiler natural gas consumption	Minnesota Technical Reference Manual, Version 2.0
Tune and clean boiler system	HVAC	Tune and clean boiler system.	0.290 therms/MBH for Grocery, 0.287 therms/MBH for Food Service, 0.302 therms/MBH for Office, 0.261 therms/MBH for Retail	Minnesota Technical Reference Manual, Version 2.0
Heating pipe insulation	HVAC	Install insulation on bare hot water or steam piping.	Decrease pipe heat loss from 114 to 24 Btu/hr/ft	Illinois Technical Reference Manual, Version 5.0
Steam to hot water conversion	HVAC	Convert steam to hot water heating system.	25% savings on building heating energy consumption	Lobenstein et al, "Converting steam heated buildings to hot water heat", July 1986.
Boiler replacement	HVAC	Upgrade to condensing gas-fired boilers.	Improve thermal efficiency from 80% to 87%	Wisconsin Focus on Energy Technical Reference Manual, 2015
Steam trap repair	HVAC	Replace leaking steam traps that are part of a HVAC steam distribution system.	9.2 lb/hr of steam loss with 50% loss factor	Minnesota Technical Reference Manual, Version 2.0
Oxygen trim control	HVAC	Install boiler oxygen trim controls.	0.263 therms/MBH for Grocery, 0.261 therms/MBH for Food Service, 0.274 therms/MBH for Office, 0.237 therms/MBH for Retail	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
RTU replacement (condensing)	HVAC	Upgrade to high heating efficiency rooftop unit equipment.	Upgrade from 80% to 90% thermal efficiency. Approximately 11% savings on RTU heating energy consumption	Minnesota Technical Reference Manual, Version 2.0
Destratification fans	HVAC	Install high volume low speed ceiling fans for destratification in high bay areas.	10 F reduction in conduction temperature thru roof during heating periods; additional 0.02 W per square foot due to fans	Minnesota Technical Reference Manual, Version 2.0
Split A/C replacement	HVAC	Upgrade to high cooling efficiency split A/C equipment.	Upgrade from 10 to 14 SEER. Approximately 28% savings on split A/C cooling energy consumption	Minnesota Technical Reference Manual, Version 2.0
RTU replacement	HVAC	Upgrade to high cooling efficiency rooftop unit equipment.	Upgrade from 10 to 11.2 IEER. Approximately 11% savings on RTU cooling energy consumption	Minnesota Technical Reference Manual, Version 2.0
Window A/C replacement or conversion	HVAC	Upgrade to high cooling efficiency window A/C equipment.	Upgrade from 9 to 9.7 SEER. Approximately 7% savings on window A/C cooling energy consumption	Minnesota Technical Reference Manual, Version 2.0
Tune and clean cooling system (not RTU)	HVAC	Tune and cooling system (not RTU).	6.2 kWh/MBH for Grocery, 4.7 kWh/MBH for Food Service, Office and Retail	Wisconsin Focus on Energy Technical Reference Manual, 2015
Variable speed pumps	HVAC	Install variable speed drives on HVAC pumps and implement controls to reduce pumping energy.	881 kWh per pump motor hp	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
DHW: convert electric to gas	DHW	Replace existing electric water heater with gas-fired water heater.	0.33 kWh per square foot, increase 0.016 therms per square foot	Engineering calculation
DHW pipe insulation	DHW	Add insulation to uninsulated DHW pipes.	Increase pipe insulation from R-0 to R-2	Illinois Technical Reference Manual, Version 5.0
DHW temp. turn down	DHW	Reduce domestic hot water setpoint temperature	Reduce domestic hot water setpoint temperature from 140 to 120 F. Assumed no savings in Food Service sector due to health code restrictions.	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
Low flow aerators, shower heads, pre-rinse sprayers	DHW	Install low-flow faucet aeratos, shower heads and pre-rinse sprayers.	Electric water heater: 43 kWh/faucet and 1031 kWh/sprayer for Grocery, 43 kWh/faucet and 1031 kWh/sprayer for Food Service, 29 kWh/faucet and 706 kWh/sprayer for Office, 43 kWh/faucet and 1031 kWh/sprayer for Retail; 405 kWh per shower; Natural Gas water heater: 0.192 therm/faucet and 46 therm/sprayer for Grocery, 0.192 therm/faucet and 46 therm/sprayer for Food Service, 0.131 therm/faucet and 31 therm/sprayer for Office, 0.192 therm/faucet and 46 therm/sprayer for Retail; 18 therm/showerhead	Minnesota Technical Reference Manual, Version 2.0
DHW heater replacement	DHW	Upgrade to condensing gas-fired domestic hot water heaters.	Improve energy factor from 0.56 to 0.67	Minnesota Technical Reference Manual, Version 2.0
Heat pump water heater	DHW	Replace existing electric water heater with heat pump water heater.	Improve energy factor of 0.95 to COP of 2.56	Minnesota Technical Reference Manual, Version 2.0
Computer power management	Plug loads	Enable computer power management settings.	29% savings on computer equipment electricity consumption	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016

Measure Name	End Use	Measure Description	Savings Assumption	Source
Add exhaust to server closet	Plug loads	Use exhaust fan in place of dedicated cooling equipment for server closet cooling requirements.	Improve Mechanical Load Component of data center from 1.9 to 1.1	Shen, et al, Small Embedded Data Center Program Pilot, MN CARD June 2017
Server power management	Plug loads	Enable server power management settings.	468 kWh per server	Shen, et al, Small Embedded Data Center Program Pilot, MN CARD June 2017
Turn off other primary plug loads at night	Plug loads	Turn off televisions, retail registers and retail displays during unoccupied periods.	0.1 kWh per square foot	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
Beverage machine controls	Plug loads	Install motion sensor control on refrigerated vending machines to turn off lights and compressor when not in use.	1600 kWh per beverage machine	Minnesota Technical Reference Manual, Version 2.0
Advanced power strips, Tier 2	Plug loads	Install Tier 2 advanced power strips capable of setting computer to low power mode and turning off associated peripheral devices during unoccupied periods.	180 kWh per computer	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016

Measure Name	End Use	Measure Description	Savings Assumption	Source
High efficiency UPS and PDU	Plug loads	Upgrade to ENERGY STAR UPS and PDUs.	0.025 kWh per VA for each UPS or PDU	Purchasing More Energy –Efficient Servers, UPSs, and PDUs (https://www.energystar.gov/products/low_carbon_it_campaign/12_ways_save_energy_data_center/purchasing_more_energy_efficient_servers_upss_and_pdus)
Consolidate multi-function devices	Plug loads	Consolidate multiple copiers, printers, and fax machine to one device that serves everyone.	0.075 kWh per square foot	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
High efficiency computer monitors	Plug loads	Upgrade to high efficiency computer monitors.	50 kWh per monitor	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
Advanced power strips, occ sensing	Plug loads	Install advanced power strips capable of turning off associated peripheral devices during unoccupied periods.	85 kWh per computer	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
Behavior campaign	Plug loads	Implement a behavior campaign to increase energy savings from turning off computers.	0.2 kWh per square foot	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
LED task lights	Plug loads	Upgrade to LED task lights.	40 kWh per lamp	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
Water cooler approach	Plug loads	Remove dedicated refrigerated water cooler from office: choose filtered water or water from refrigerator instead.	400 kWh per water cooler	Hackel, et al, Impacts of Office Plug Load Reduction Strategies, MN CARD October 2016
Display case LEDs	Refrigeration	Replace fluorescent lights in cooler and freezer display cases with LEDs.	Reduce display case lighting energy by 50%, increase savings by 40% to account for reduced cooling load.	Minnesota Technical Reference Manual, Version 2.0
EC Motors in refrigeration	Refrigeration	Replace existing standard-efficiency shaded-pole evaporator fan motor with high-efficiency EC motors in refrigerated display cases or fan coil in walk-ins.	Food Service: 700 kWh per walk-in cooler, 1240 kWh per walk-in freezer; Grocery: 1400 kWh per walk-in cooler, 2100 kWh per walk-in freezer; Doored cases: 350 kWh per cooler door, 530 kWh per freezer door; Open cases: 180 kWh per cooler foot, 260 kWh per freezer foot	Illinois Technical Reference Manual, Version 5.0
Refrigeration tune-up/maintenance	Refrigeration	Implement quality maintenance practices performed by a qualified professional on refrigeration equipment.	22% savings on refrigeration energy consumption.	Knowles and Baglee, "The Role of Maintenance in Energy Saving in Commercial Refrigeration", Journal of Quality in Maintenance Engineering, Vol. 18 No. 3, 2012.
Anti-sweat heater control	Refrigeration	Implement anti-sweat heater controls on refrigerated cases to turn off anti-sweat heaters when not needed.	1300 kWh per door	Minnesota Technical Reference Manual, Version 2.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
Add case doors	Refrigeration	Retrofit doors onto existing open refrigerated display cases.	615 kWh per foot of case length	Wisconsin Focus on Energy Technical Reference Manual, 2015
Evaporator fan control	Refrigeration	Install evaporator fan motor control capable of regulating its speed only when needed.	2000 kWh per door, 1000 kWh per foot of open cases	Wisconsin Focus on Energy Technical Reference Manual, 2015
ENERGY STAR commercial refrigerators	Refrigeration	Upgrade to ENERGY STAR commercial refrigerators.	500 kWh per refrigerator	Savings Calculator for ENERGY STAR Qualified Commercial Kitchen Equipment
ENERGY STAR commercial freezers	Refrigeration	Upgrade to ENERGY STAR commercial freezers.	1500 kWh per freezer	Savings Calculator for ENERGY STAR Qualified Commercial Kitchen Equipment
DHW heat recovery	Refrigeration	Recover waste heat from refrigeration equipment to preheat domestic hot water.	10% savings on domestic hot water natural gas consumption for Grocery and Food Service	Durkin, T.H. et al., "Dedicated Heat Recovery", ASHRAE Journal, October 2003
ENERGY STAR ice makers	Refrigeration	Upgrade to ENERGY STAR ice makers.	850 kWh each	Wisconsin Focus on Energy Technical Reference Manual, 2015
Automatic walk-in door closers	Refrigeration	Install an automatic closer on doors of a walk-in cooler or freezer to ensure they are firmly closed.	Cooler: 943 kWh each; Freezer: 2307 kWh each	Illinois Technical Reference Manual, Version 5.0
Night Covers	Refrigeration	Install covers on existing open refrigerated and freezer display cases during unoccupied hours.	180 kWh per foot	Illinois Technical Reference Manual, Version 5.0

Measure Name	End Use	Measure Description	Savings Assumption	Source
Clearing space around condensers	Refrigeration	Remove objects blocking airflow to condensers serving refrigeration equipment.	8.7% savings on refrigeration electricity consumption	Knowles and Baglee, "The Role of Maintenance in Energy Saving in Commercial Refrigeration", Journal of Quality in Maintenance Engineering, Vol. 18 No. 3, 2012.
Motion sensor control for case lighting	Refrigeration	Install occupancy sensors to control refrigerated case lighting.	15% savings on controlled lighting	Engineering calculation
Motion sensor control for walk ins	Refrigeration	Install occupancy sensors to control refrigerated walk-in lighting.	30% savings on controlled lighting	Minnesota Technical Reference Manual, Version 2.0
LED walk-in lights	Refrigeration	Replace fluorescent lights in walk-in coolers and freezers with LEDs.	100 kWh per walk-in	Minnesota Technical Reference Manual, Version 2.0
Floating head/suction pressure control	Refrigeration	Implement floating head pressure control on the condenser for low ambient conditions.	450 kWh per compressor hp	Engineering calculation
VFD on condenser fans	Refrigeration	Install variable speed drive on refrigeration condenser fans.	400 kWh per fan motor hp	Wisconsin Focus on Energy Technical Reference Manual, 2015
Smart defrost	Refrigeration	Implement controls to reduce the time spent in defrost cycle.	150 kWh per compressor motor hp	Engineering calculation

Measure Name	End Use	Measure Description	Savings Assumption	Source
Kitchen hood control or behavior campaign	Cooking	Install controls to modulate the kitchen hood exhaust based on heat and smoke sensors. Alternately, educate kitchen staff to manually turn off exhaust when not needed.	1186 kWh per foot of hood	Minnesota Technical Reference Manual, Version 2.1
ENERGY STAR combi ovens	Cooking	Upgrade to ENERGY STAR combination ovens.	Electric combi ovens: 4,006 kWh each; Natural Gas combi ovens: 252 therms each	Minnesota Technical Reference Manual, Version 2.0
ENERGY STAR convection oven	Cooking	Upgrade to ENERGY STAR convection ovens.	Electric: 1,350 kWh each; Natural Gas: 240 therms each	Minnesota Technical Reference Manual, Version 2.0
High efficiency broilers	Cooking	Upgrade to high efficiency broilers.	587 therms each	Minnesota Technical Reference Manual, Version 2.0
ENERGY STAR fryers	Cooking	Upgrade to ENERGY STAR fryers.	Electric hot food holding cabinets: 362 kWh each; Natural Gas hot food holding cabinets: 271 therms each	Minnesota Technical Reference Manual, Version 2.0
Clean and repair fryers	Cooking	Reduce idle time, use frypot cover during idle periods, turn off back up fryers when possible	Electric water heaters: 10 kWh each; Natural Gas water heaters: 1 therm each	Engineering calculation
ENERGY STAR griddles	Cooking	Upgrade to ENERGY STAR griddles.	Electric griddles: 2,600 kWh each; Natural Gas griddles: 150 therms each	Savings Calculator for ENERGY STAR Qualified Commercial Kitchen Equipment

Measure Name	End Use	Measure Description	Savings Assumption	Source
ENERGY STAR hot food holding cabinets	Cooking	Upgrade to ENERGY STAR hot food holding cabinets.	1700 kWh each	Minnesota Technical Reference Manual, Version 2.0
Commercial steam cooker	Cooking	Upgrade to ENERGY STAR steam cookers.	2,036 kWh each for electric cookers and 2,463 therms each for natural gas cookers	Minnesota Technical Reference Manual, Version 2.0
Infrared charbroiler	Cooking	Upgrade to infrared charbroilers.	Electric charbroilers: 1440 kWh each; Natural Gas charbroilers: 500 therm each	Minnesota Technical Reference Manual, Version 2.0
Infrared rotisserie oven	Cooking	Upgrade to infrared rotisserie ovens.	Electric rotisserie oven: 720 kWh each; Natural Gas rotisserie: 266 therm each	Minnesota Technical Reference Manual, Version 2.0
Infrared upright/Salamander broiler	Cooking	Upgrade to infrared upright/salamander broilers.	Electric upright/salamander broiler: 1344 kWh each; Natural Gas upright/salamander broiler: 425 therm each	Minnesota Technical Reference Manual, Version 2.0
ENERGY STAR dishwashers	Cooking	Upgrade to ENERGY STAR dishwashers.	Electric water heater: 12,875 kWh each; Natural Gas water heater: 2,546 kWh and 267 therms each	Minnesota Technical Reference Manual, Version 2.0

Appendix E: Measure savings results by business segment

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Add EMS	Food service	10,376,260	14,411,470	1,190	1,655	97%
Add EMS	Grocery	2,614,380	1,426,030	810	440	90%
Add EMS	Office	29,273,670	7,318,420	850	210	91%
Add EMS	Retail	16,069,510	2,921,730	1,305	235	96%
Add case doors	Food service	-	-			0%
Add case doors	Grocery	63,886,820	-	33,015	-	54%
Add case doors	Office	-	-			0%
Add case doors	Retail	-	-			0%
Add exhaust to server closet	Food service	488,850	-	660	-	8%
Add exhaust to server closet	Grocery	325,900	-	955	-	10%
Add exhaust to server closet	Office	36,327,340	-	1,500	-	64%
Add exhaust to server closet	Retail	5,723,140	-	1,240	-	36%
Advanced RTU controls	Food service	90,751,800	5,067,360	15,430	860	66%
Advanced RTU controls	Grocery	15,058,750	2,914,600	10,435	2,020	40%
Advanced RTU controls	Office	155,668,080	8,121,810	15,180	790	27%
Advanced RTU controls	Retail	90,669,870	8,326,830	15,135	1,390	46%
Advanced power strips, Tier 2	Food service	265,680	-	360	-	8%
Advanced power strips, Tier 2	Grocery	69,120	-	360	-	5%
Advanced power strips, Tier 2	Office	8,710,200	-	2,700	-	9%
Advanced power strips, Tier 2	Retail	3,193,200	-	1,065	-	23%
Advanced power strips, occ sensing	Food service	1,091,400	-	140	-	85%
Advanced power strips, occ sensing	Grocery	663,510	-	215	-	87%
Advanced power strips, occ sensing	Office	56,262,010	-	1,495	-	100%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Advanced power strips, occ sensing	Retail	6,305,640	-	490	-	100%
Anti-sweat heater control	Food service	7,085,000	-	2,900	-	27%
Anti-sweat heater control	Grocery	58,827,600	-	32,200	-	51%
Anti-sweat heater control	Office	-	-			0%
Anti-sweat heater control	Retail	29,486,600	-	9,480	-	24%
Attic insulation	Food service	-	-			0%
Attic insulation	Grocery	124,800	28,800	650	150	5%
Attic insulation	Office	1,871,480	267,350	385	55	13%
Attic insulation	Retail	42,310	28,210	185	125	2%
Automatic walk-in door closers	Food service	7,181,620	-	2,660	-	30%
Automatic walk-in door closers	Grocery	7,791,750	-	2,765	-	79%
Automatic walk-in door closers	Office	1,521,060	-	945	-	4%
Automatic walk-in door closers	Retail	4,886,630	-	2,020	-	19%
Behavior campaign	Food service	2,725,880	-	1,455	-	21%
Behavior campaign	Grocery	1,289,760	-	2,120	-	17%
Behavior campaign	Office	45,771,250	-	2,125	-	57%
Behavior campaign	Retail	12,879,360	-	3,195	-	31%
Beverage machine controls	Food service	2,923,200	-	2,800	-	12%
Beverage machine controls	Grocery	2,947,200	-	3,400	-	24%
Beverage machine controls	Office	15,484,800	-	1,920	-	21%
Beverage machine controls	Retail	2,211,200	-	1,600	-	11%
Boiler controls (reset/cutout)	Food service	-	276,730	-	335	9%
Boiler controls (reset/cutout)	Grocery	-	69,500	-	360	5%
Boiler controls (reset/cutout)	Office	-	2,931,210	-	455	17%
Boiler controls (reset/cutout)	Retail	-	411,620	-	355	9%
Boiler replacement	Food service	-	521,890	-	630	9%
Boiler replacement	Grocery	-	-			0%
Boiler replacement	Office	-	4,690,850	-	970	13%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Boiler replacement	Retail	-	1,300,190	-	435	23%
Change t-stat setting in less-used areas	Food service	12,920	32,890	25	65	6%
Change t-stat setting in less-used areas	Grocery	22,800	58,030	25	60	28%
Change t-stat setting in less-used areas	Office	1,100,070	2,800,170	170	435	17%
Change t-stat setting in less-used areas	Retail	44,830	114,120	15	35	25%
Clean and repair fryers	Food service	-	3,390	-	5	20%
Clean and repair fryers	Grocery	750	380	10	-	8%
Clean and repair fryers	Office	-	-			0%
Clean and repair fryers	Retail	-	1,730	-	5	4%
Clearing space around condensers	Food service	17,741,810	-	17,760	-	11%
Clearing space around condensers	Grocery	1,425,000	-	9,500	-	4%
Clearing space around condensers	Office	-	-			0%
Clearing space around condensers	Retail	-	-			0%
Commercial steam cooker	Food service	2,473,740	-	3,350	-	8%
Commercial steam cooker	Grocery	-	184,730	-	2,465	2%
Commercial steam cooker	Office	-	-			0%
Commercial steam cooker	Retail	-	-			0%
Computer power management	Food service	3,778,900	-	895	-	47%
Computer power management	Grocery	441,480	-	260	-	48%
Computer power management	Office	31,781,810	-	1,370	-	61%
Computer power management	Retail	4,092,630	-	410	-	78%
Consolidate multi-function devices	Food service	-	-			0%
Consolidate multi-function devices	Grocery	286,750	-	690	-	12%
Consolidate multi-function devices	Office	17,244,990	-	1,070	-	43%
Consolidate multi-function devices	Retail	2,310,640	-	690	-	26%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
DCV with CO2 sensors	Food service	7,207,230	3,391,640	1,520	715	53%
DCV with CO2 sensors	Grocery	3,477,170	993,480	2,125	610	46%
DCV with CO2 sensors	Office	8,311,490	8,311,490	500	500	44%
DCV with CO2 sensors	Retail	13,268,620	7,076,600	2,880	1,535	36%
DCV with occ sensors	Food service	3,815,590	1,695,820	805	355	53%
DCV with occ sensors	Grocery	1,738,580	496,740	1,065	305	46%
DCV with occ sensors	Office	8,311,490	8,311,490	500	500	44%
DCV with occ sensors	Retail	6,192,020	3,538,300	1,345	770	36%
DHW heat recovery	Food service	-	858,020	-	130	73%
DHW heat recovery	Grocery	-	17,310	-	5	73%
DHW heat recovery	Office	-	-			0%
DHW heat recovery	Retail	-	-			0%
DHW heater replacement	Food service	-	19,094,390	-	2,795	76%
DHW heater replacement	Grocery	-	24,520	-	20	35%
DHW heater replacement	Office	-	141,740	-	15	30%
DHW heater replacement	Retail	-	150,200	-	30	42%
DHW pipe insulation	Food service	120,320	147,050	460	25	71%
DHW pipe insulation	Grocery	457,770	29,400	460	25	61%
DHW pipe insulation	Office	6,957,870	201,630	460	25	61%
DHW pipe insulation	Retail	1,380,230	132,480	460	25	69%
DHW temp. turn down	Food service	-	-			0%
DHW temp. turn down	Grocery	96,770	11,360	505	20	23%
DHW temp. turn down	Office	1,654,940	67,020	340	15	26%
DHW temp. turn down	Retail	113,720	101,840	140	45	24%
DHW: convert electric to gas	Food service	3,199,280	(155,120)	2,935	(140)	12%
DHW: convert electric to gas	Grocery	2,275,890	(110,350)	1,805	(90)	35%
DHW: convert electric to gas	Office	76,454,070	(3,706,860)	2,900	(140)	70%
DHW: convert electric to gas	Retail	15,968,240	(774,220)	3,850	(185)	32%
Destratification fans	Food service	(505,300)	189,490	(1,935)	725	3%
Destratification fans	Grocery	(62,590)	24,080	(835)	320	2%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Destratification fans	Office	(346,790)	138,720	(215)	85	4%
Destratification fans	Retail	(5,791,730)	2,316,690	(1,095)	435	41%
Display case LEDs	Food service	2,206,700	-	1,010	-	24%
Display case LEDs	Grocery	29,620,050	-	12,775	-	65%
Display case LEDs	Office	559,710	-	345	-	4%
Display case LEDs	Retail	16,149,650	-	6,375	-	20%
Duct insulation / sealing	Food service	353,710	75,790	680	145	6%
Duct insulation / sealing	Grocery	103,680	103,680	270	270	11%
Duct insulation / sealing	Office	293,570	146,780	180	90	4%
Duct insulation / sealing	Retail	155,520	51,840	270	90	4%
EC Motors	Food service	6,654,010	-	2,775	-	27%
EC Motors	Grocery	58,641,240	-	29,045	-	56%
EC Motors	Office	-	-			4%
EC Motors	Retail	8,419,600	-	4,570	-	14%
ECM motors in small HVAC	Food service	819,720	-	1,110	-	8%
ECM motors in small HVAC	Grocery	1,312,380	-	985	-	37%
ECM motors in small HVAC	Office	20,775,440	-	1,610	-	34%
ECM motors in small HVAC	Retail	3,974,400	-	1,380	-	22%
ENERGY STAR combi ovens	Food service	6,457,670	406,220	5,925	490	21%
ENERGY STAR combi ovens	Grocery	3,845,760	37,800	6,675	505	18%
ENERGY STAR combi ovens	Office	-	-			0%
ENERGY STAR combi ovens	Retail	-	-			0%
ENERGY STAR commercial refrigerators	Food service	10,297,500	-	1,565	-	73%
ENERGY STAR commercial refrigerators	Grocery	454,500	-	925	-	14%
ENERGY STAR commercial refrigerators	Office	806,500	-	500	-	4%
ENERGY STAR commercial refrigerators	Retail	-	-			0%
ENERGY STAR convection oven	Food service	3,067,200	1,523,040	1,800	460	56%
ENERGY STAR convection oven	Grocery	765,450	36,000	2,240	240	14%
ENERGY STAR convection oven	Office	2,177,550	-	1,350	-	4%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
ENERGY STAR convection oven	Retail	-	414,720	-	360	9%
ENERGY STAR fryer	Food service	961,470	1,885,620	710	520	55%
ENERGY STAR fryer	Grocery	123,800	81,300	465	360	14%
ENERGY STAR fryer	Office	-	-			0%
ENERGY STAR fryer	Retail	-	468,290	-	815	4%
ENERGY STAR griddles	Food service	13,457,600	677,700	6,440	380	43%
ENERGY STAR griddles	Grocery	499,200	33,750	2,600	225	10%
ENERGY STAR griddles	Office	-	-			0%
ENERGY STAR griddles	Retail	-	86,400	-	150	4%
ENERGY STAR hot food holding cabinets	Food service	6,137,000	-	2,350	-	29%
ENERGY STAR hot food holding cabinets	Grocery	1,632,000	-	2,125	-	21%
ENERGY STAR hot food holding cabinets	Office	-	-			0%
ENERGY STAR hot food holding cabinets	Retail	1,958,400	-	3,400	-	4%
ENERGY STAR ice maker	Food service	11,290,500	-	1,965	-	64%
ENERGY STAR ice maker	Grocery	1,264,500	-	1,500	-	24%
ENERGY STAR ice maker	Office	-	-			0%
ENERGY STAR ice maker	Retail	1,728,000	-	3,000	-	4%
Energy Star Dishwasher	Food service	66,576,380	2,634,000	12,640	525	62%
Energy Star Dishwasher	Grocery	1,800,000	75,000	12,000	500	4%
Energy Star Dishwasher	Office	19,356,000	806,500	12,000	500	4%
Energy Star Dishwasher	Retail	20,736,000	864,000	18,000	750	9%
Energy Star commercial freezers	Food service	9,009,000	-	2,465	-	41%
Energy Star commercial freezers	Grocery	738,000	-	2,160	-	10%
Energy Star commercial freezers	Office	2,419,500	-	1,500	-	4%
Energy Star commercial freezers	Retail	2,592,000	-	4,500	-	4%
Evaporator Fan control	Food service	32,834,000	-	4,740	-	77%
Evaporator Fan control	Grocery	9,624,000	-	3,770	-	71%
Evaporator Fan control	Office	3,226,000	-	2,000	-	4%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Evaporator Fan control	Retail	11,980,000	-	3,850	-	24%
Exhaust fan schedule	Food service	1,840,680	-	3,525	-	6%
Exhaust fan schedule	Grocery	270,000	-	1,800	-	4%
Exhaust fan schedule	Office	13,775,020	-	2,135	-	17%
Exhaust fan schedule	Retail	1,347,840	-	1,170	-	9%
Exhaust heat recovery	Food service	-	5,931,830	-	1,015	65%
Exhaust heat recovery	Grocery	-	556,080	-	1,855	8%
Exhaust heat recovery	Office	-	-			0%
Exhaust heat recovery	Retail	-	2,920,320	-	5,070	4%
Exterior lighting retrofit	Food service	24,573,530	-	2,985	-	92%
Exterior lighting retrofit	Grocery	15,533,740	-	5,445	-	80%
Exterior lighting retrofit	Office	111,986,860	-	3,410	-	87%
Exterior lighting retrofit	Retail	30,382,740	-	2,585	-	91%
Exterior motion sensors	Food service	21,834,080	-	2,650	-	92%
Exterior motion sensors	Grocery	13,824,680	-	4,430	-	87%
Exterior motion sensors	Office	91,587,810	-	2,660	-	91%
Exterior motion sensors	Retail	26,079,240	-	2,335	-	87%
Exterior photocells/timer	Food service	22,257,180	-	6,010	-	41%
Exterior photocells/timer	Grocery	12,496,440	-	10,545	-	33%
Exterior photocells/timer	Office	97,941,360	-	15,180	-	17%
Exterior photocells/timer	Retail	760,320	-	1,320	-	4%
Fix/improve economizer	Food service	329,490	-	395	-	9%
Fix/improve economizer	Grocery	-	-			0%
Fix/improve economizer	Office	688,750	-	425	-	4%
Fix/improve economizer	Retail	233,860	-	405	-	4%
Floating head/suction pressure control	Food service	6,047,870	-	8,195	-	8%
Floating head/suction pressure control	Grocery	28,470,420	-	25,105	-	32%
Floating head/suction pressure control	Office	-	-			0%
Floating head/suction pressure control	Retail	1,759,500	-	7,650	-	2%
Furnace fan control	Food service	976,830	-	660	-	16%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Furnace fan control	Grocery	717,650	-	575	-	35%
Furnace fan control	Office	13,815,350	-	1,430	-	26%
Furnace fan control	Retail	2,341,350	-	925	-	24%
Furnace replacement	Food service	-	448,450	-	1,720	3%
Furnace replacement	Grocery	-	393,200	-	800	14%
Furnace replacement	Office	-	4,851,100	-	750	17%
Furnace replacement	Retail	-	1,373,000	-	410	26%
Furnace tune-up and airflow	Food service	-	1,317,690	-	595	25%
Furnace tune-up and airflow	Grocery	-	1,407,490	-	825	48%
Furnace tune-up and airflow	Office	-	7,654,460	-	365	56%
Furnace tune-up and airflow	Retail	-	3,127,800	-	485	50%
Heat pump water heater	Food service	1,938,960	-	1,780	-	12%
Heat pump water heater	Grocery	1,379,330	-	1,095	-	35%
Heat pump water heater	Office	46,335,800	-	1,755	-	70%
Heat pump water heater	Retail	9,677,720	-	2,335	-	32%
Heating pipe insulation	Food service	-	-			0%
Heating pipe insulation	Grocery	-	-			0%
Heating pipe insulation	Office	-	45,160	-	30	4%
Heating pipe insulation	Retail	-	44,930	-	80	4%
High bay occupancy sensors	Food service	-	-			0%
High bay occupancy sensors	Grocery	2,669,290	-	4,100	-	18%
High bay occupancy sensors	Office	59,227,750	-	9,180	-	17%
High bay occupancy sensors	Retail	67,617,640	-	23,480	-	22%
High efficiency UPS and PDU	Food service	7,750	-	10	-	8%
High efficiency UPS and PDU	Grocery	9,580	-	30	-	10%
High efficiency UPS and PDU	Office	566,400	-	50	-	34%
High efficiency UPS and PDU	Retail	92,380	-	40	-	18%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
High efficiency broilers	Food service	-	612,830	-	585	12%
High efficiency broilers	Grocery	-	156,730	-	585	7%
High efficiency broilers	Office	-	-			0%
High efficiency broilers	Retail	-	-			0%
High efficiency computer monitors	Food service	450,100	-	135	-	37%
High efficiency computer monitors	Grocery	354,450	-	175	-	59%
High efficiency computer monitors	Office	50,728,850	-	1,365	-	98%
High efficiency computer monitors	Retail	3,882,000	-	330	-	91%
Infrared charbroiler	Food service	-	522,000	-	500	12%
Infrared charbroiler	Grocery	276,480	37,500	1,440	500	7%
Infrared charbroiler	Office	-	-			0%
Infrared charbroiler	Retail	-	-			0%
Infrared rotisserie oven	Food service	-	151,090	-	265	6%
Infrared rotisserie oven	Grocery	54,000	-	720	-	2%
Infrared rotisserie oven	Office	-	-			0%
Infrared rotisserie oven	Retail	-	-			0%
Infrared upright/Salamander broiler	Food service	-	-			0%
Infrared upright/Salamander broiler	Grocery	-	-			0%
Infrared upright/Salamander broiler	Office	-	-			0%
Infrared upright/Salamander broiler	Retail	-	-			0%
Insulate between conditioned and unconditioned areas	Food service	(246,600)	-	(130)	-	21%
Insulate between conditioned and unconditioned areas	Grocery	(117,260)	16,890	(780)	115	4%
Insulate between conditioned and unconditioned areas	Office	(2,006,120)	-	(620)	-	9%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Insulate between conditioned and unconditioned areas	Retail	-	-			0%
Interior daylighting controls	Food service	2,815,900	-	875	-	36%
Interior daylighting controls	Grocery	541,870	-	1,300	-	12%
Interior daylighting controls	Office	160,189,640	-	5,515	-	77%
Interior daylighting controls	Retail	18,506,120	-	9,450	-	15%
Interior delamping	Food service	46,028,520	-	8,660	-	59%
Interior delamping	Grocery	9,207,400	-	7,770	-	33%
Interior delamping	Office	198,789,320	-	9,480	-	56%
Interior delamping	Retail	33,773,310	-	6,980	-	38%
Interior lighting time clock	Food service	26,799,860	-	5,085	-	59%
Interior lighting time clock	Grocery	8,107,640	-	6,480	-	35%
Interior lighting time clock	Office	339,089,250	-	11,450	-	79%
Interior lighting time clock	Retail	85,796,150	-	10,345	-	64%
Interior occupancy/vacancy sensors	Food service	12,609,220	-	2,160	-	65%
Interior occupancy/vacancy sensors	Grocery	-	-			0%
Interior occupancy/vacancy sensors	Office	180,112,420	-	5,875	-	81%
Interior occupancy/vacancy sensors	Retail	-	-			0%
Interior storm windows	Food service	1,090,980	545,490	4,180	2,090	3%
Interior storm windows	Grocery	-	-			0%
Interior storm windows	Office	14,637,980	7,976,290	3,025	1,650	13%
Interior storm windows	Retail	93,310	466,560	80	405	9%
Interior task tuning	Food service	807,350	-	620	-	15%
Interior task tuning	Grocery	-	-			0%
Interior task tuning	Office	1,624,280	-	505	-	9%
Interior task tuning	Retail	3,139,020	-	2,725	-	9%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Kitchen hood control or behavior campaign	Food service	118,892,940	30,475,090	19,645	5,035	67%
Kitchen hood control or behavior campaign	Grocery	10,115,390	2,592,820	15,755	4,040	18%
Kitchen hood control or behavior campaign	Office	-	-			0%
Kitchen hood control or behavior campaign	Retail	8,197,630	2,101,250	14,230	3,650	4%
LED exit signs	Food service	2,484,960	-	780	-	35%
LED exit signs	Grocery	833,040	-	520	-	45%
LED exit signs	Office	19,245,360	-	1,150	-	44%
LED exit signs	Retail	5,418,240	-	645	-	65%
LED retail signs	Food service	4,250,800	-	670	-	71%
LED retail signs	Grocery	1,986,000	-	840	-	66%
LED retail signs	Office	-	-			0%
LED retail signs	Retail	5,621,200	-	650	-	67%
LED task lights	Food service	-	-			0%
LED task lights	Grocery	-	-			0%
LED task lights	Office	13,807,280	-	950	-	39%
LED task lights	Retail	-	-			0%
LED walk-in lights	Food service	1,502,000	-	245	-	68%
LED walk-in lights	Grocery	592,200	-	235	-	70%
LED walk-in lights	Office	161,300	-	100	-	4%
LED walk-in lights	Retail	610,400	-	170	-	28%
Low flow aerators, shower heads, pre-rinse sprayers	Food service	80,540	74,660	75	10	85%
Low flow aerators, shower heads, pre-rinse sprayers	Grocery	196,780	18,010	290	10	67%
Low flow aerators, shower heads, pre-rinse sprayers	Office	1,540,420	50,000	240	30	21%
Low flow aerators, shower heads, pre-rinse sprayers	Retail	34,660	53,880	45	30	20%
Motion sensor control for case lighting	Food service	537,990	-	220	-	27%
Motion sensor control for case lighting	Grocery	5,235,840	-	1,525	-	96%
Motion sensor control for case lighting	Office	132,270	-	80	-	4%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Motion sensor control for case lighting	Retail	4,471,730	-	1,255	-	28%
Motion sensor control for walk ins	Food service	807,800	-	125	-	71%
Motion sensor control for walk ins	Grocery	271,800	-	190	-	40%
Motion sensor control for walk ins	Office	-	-			0%
Motion sensor control for walk ins	Retail	-	-			0%
Night Covers	Food service	-	-			0%
Night Covers	Grocery	15,701,580	-	9,180	-	48%
Night Covers	Office	-	-			0%
Night Covers	Retail	-	-			0%
OA Scheduling	Food service	-	709,180	-	545	15%
OA Scheduling	Grocery	-	-			0%
OA Scheduling	Office	9,250,560	8,325,500	820	735	30%
OA Scheduling	Retail	499,800	1,249,500	360	905	11%
Overhead doors	Food service	-	-			0%
Overhead doors	Grocery	1,500	45,000	10	300	4%
Overhead doors	Office	48,390	1,451,700	10	300	13%
Overhead doors	Retail	2,300	69,000	10	300	2%
Oxygen trim control	Food service	-	25,890	-	100	3%
Oxygen trim control	Grocery	-	-			0%
Oxygen trim control	Office	-	715,980	-	150	13%
Oxygen trim control	Retail	-	135,410	-	170	6%
Program thermostat	Food service	32,604,230	6,520,850	6,450	1,290	56%
Program thermostat	Grocery	4,600,870	884,780	1,985	380	65%
Program thermostat	Office	88,400,800	11,055,100	3,915	525	60%
Program thermostat	Retail	18,812,190	2,612,800	2,865	400	51%
RTU replacement	Food service	9,443,880	-	1,220	-	86%
RTU replacement	Grocery	3,891,940	-	1,735	-	63%
RTU replacement	Office	28,519,410	-	2,115	-	36%
RTU replacement	Retail	9,194,350	-	1,480	-	53%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
RTU replacement (condensing)	Food service	-	2,851,070	-	370	86%
RTU replacement (condensing)	Grocery	-	974,800	-	435	63%
RTU replacement (condensing)	Office	-	9,251,650	-	685	36%
RTU replacement (condensing)	Retail	-	4,565,300	-	670	53%
RTU tune-up and airflow	Food service	137,931,720	-	23,455	-	66%
RTU tune-up and airflow	Grocery	23,660,490	-	16,395	-	40%
RTU tune-up and airflow	Office	278,342,560	-	27,145	-	27%
RTU tune-up and airflow	Retail	110,836,990	-	18,505	-	46%
Refrigeration tune-up/maintenance	Food service	120,441,270	-	23,625	-	57%
Refrigeration tune-up/maintenance	Grocery	91,584,990	-	50,130	-	51%
Refrigeration tune-up/maintenance	Office	-	-			0%
Refrigeration tune-up/maintenance	Retail	2,265,980	-	755	-	23%
Sealing major envelope leaks	Food service	774,670	193,670	710	180	12%
Sealing major envelope leaks	Grocery	110,760	147,690	170	225	18%
Sealing major envelope leaks	Office	-	-			0%
Sealing major envelope leaks	Retail	1,004,290	200,280	725	250	11%
Server power management	Food service	345,380	-	470	-	8%
Server power management	Grocery	230,260	-	675	-	10%
Server power management	Office	25,666,060	-	1,060	-	64%
Server power management	Retail	4,043,520	-	880	-	36%
Smart defrost	Food service	7,136,280	-	1,475	-	54%
Smart defrost	Grocery	7,636,420	-	3,340	-	64%
Smart defrost	Office	-	-			0%
Smart defrost	Retail	6,157,500	-	2,055	-	23%
Smart thermostat	Food service	39,125,080	7,879,360	7,745	1,560	56%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
Smart thermostat	Grocery	5,485,650	1,061,740	2,365	460	65%
Smart thermostat	Office	104,318,680	13,266,120	4,620	635	60%
Smart thermostat	Retail	22,992,680	2,612,800	3,500	400	51%
Split A/C replacement	Food service	2,273,670	-	2,275	-	11%
Split A/C replacement	Grocery	1,526,430	-	4,465	-	10%
Split A/C replacement	Office	6,774,600	-	1,050	-	17%
Split A/C replacement	Retail	789,360	-	1,715	-	4%
Steam to hot water conversion	Food service	-	-			0%
Steam to hot water conversion	Grocery	-	-			0%
Steam to hot water conversion	Office	-	-			0%
Steam to hot water conversion	Retail	-	292,030	-	505	4%
Steam trap repair	Food service	-	-			0%
Steam trap repair	Grocery	-	-			0%
Steam trap repair	Office	-	-			0%
Steam trap repair	Retail	-	391,220	-	680	4%
Tune and clean cooling system	Food service	3,075,900	-	1,200	-	29%
Tune and clean cooling system	Grocery	743,930	-	695	-	30%
Tune and clean cooling system	Office	10,282,160	-	490	-	56%
Tune and clean cooling system	Retail	6,537,270	-	945	-	54%
Tune and clean system	Food service	-	109,970	-	135	9%
Tune and clean system	Grocery	-	27,840	-	145	5%
Tune and clean system	Office	-	1,475,020	-	185	21%
Tune and clean system	Retail	-	273,670	-	90	23%
Turn off other primary plug loads at night	Food service	6,178,060	-	725	-	95%
Turn off other primary plug loads at night	Grocery	2,606,370	-	730	-	100%
Turn off other primary plug loads at night	Office	30,138,160	-	1,140	-	70%
Turn off other primary plug loads at night	Retail	12,725,880	-	1,330	-	74%

Measure description	Business type	Total electric savings (kWh)	Total gas savings (therms)	Average electric savings per premise (kWh)	Average gas savings per premise (therms)	Percent opportunity within business segment
VFD on condenser fans	Food service	5,375,880	-	7,285	-	8%
VFD on condenser fans	Grocery	25,307,040	-	22,315	-	32%
VFD on condenser fans	Office	-	-			0%
VFD on condenser fans	Retail	1,564,000	-	6,800	-	2%
Variable speed fans	Food service	34,503,390	-	4,450	-	86%
Variable speed fans	Grocery	9,865,950	-	6,035	-	46%
Variable speed fans	Office	152,960,360	-	12,890	-	31%
Variable speed fans	Retail	34,758,880	-	5,590	-	48%
Variable speed pumps	Food service	-	-			0%
Variable speed pumps	Grocery	-	-			0%
Variable speed pumps	Office	6,110,530	-	1,895	-	9%
Variable speed pumps	Retail	963,460	-	1,195	-	6%
Water cooler approach	Food service	190,800	-	400	-	5%
Water cooler approach	Grocery	243,600	-	585	-	12%
Water cooler approach	Office	14,194,400	-	520	-	73%
Water cooler approach	Retail	4,422,800	-	610	-	56%
Window A/C replacement or conversion	Food service	1,904,600	-	2,295	-	9%
Window A/C replacement or conversion	Grocery	7,920	-	105	-	2%
Window A/C replacement or conversion	Office	417,660	-	50	-	21%
Window A/C replacement or conversion	Retail	1,257,980	-	1,090	-	9%
Window film	Food service	697,010	-	280	-	28%
Window film	Grocery	128,860	-	485	-	7%
Window film	Office	11,661,990	-	2,410	-	13%
Window film	Retail	1,278,720	-	1,110	-	9%

Appendix F: Weather normalization

For businesses in the study where we were able to obtain actual energy-consumption histories, we analyzed these data in relation to weather data to perform two important functions: (1) disaggregate weather-sensitive space heating and air conditioning use from other uses; and, (2) adjust heating and cooling consumption to long-term average weather conditions. This appendix provides details about the weather-normalization procedures that we used.

Given a history of monthly electricity or gas consumption for a given business and a database of daily outdoor temperatures for a nearby weather station, we fit one of four models to the data:

1. Model 1 (heating-only): Use per day = $\alpha + \beta_h h_{\tau h} + \varepsilon$
1. Model 2 (cooling-only): Use per day = $\alpha + \beta_c h_{\tau c} + \varepsilon$
2. Model 3 (heating-and-cooling): Use per day = $\alpha + \beta_h h_{\tau h} + \beta_c h_{\tau c} + \varepsilon$
3. Model 4 (no-heating-or-cooling): Use per day = $\alpha + \varepsilon$

where,

$\alpha \equiv$ non-weather sensitive (or base) use per day

$\beta_{h,c} \equiv$ use per heating or cooling degree day

$h_{h,c} \equiv$ average heating or cooling degree days per day from base temperature $\tau_{h,c}$, which in turn is calculated from daily average outdoor temperatures (T_{avg}) as:

$H_h \equiv \max(\tau_h - T_{avg}, 0)$

$H_c \equiv \max(T_{avg} - \tau_c, 0)$

and then averaged over the consumption period

$\tau_{h,c} \equiv$ base temperature for calculating heating or cooling degree days

$\varepsilon \equiv$ random error component

Model 1 (heating only) is appropriate for analyzing gas usage for businesses with gas space heat or electrically-heated homes with no air conditioning. Model 2 (cooling only) is appropriate for analyzing electricity usage for businesses with air conditioning but no electric space heat. Model 3 is appropriate for analyzing businesses with electric space heat and air conditioning. Model 4 is appropriate for gas or electricity consumption where no space-heating or space-cooling equipment is present.

For each of the first three models, the α, β, and τ coefficients are fit individually to each business using a modified least-squares approach that searches across a range of τ values, and chooses the value(s) of τ with the best fit (r^2). An additional Bayesian component effectively restricts τ to be in a range that is typical of most homes, unless the improvement in fit is large.[6] The fourth model (no heating or cooling) is simply fit as the average consumption per day of the period analyzed.

[6] Specifically, we employed a Gaussian loss function centered at 60F with a standard deviation of 8F for $\tau_{h,c}$.

We started by fitting all models to each business, and used goodness-of-fit criteria to select the most appropriate one. We then compared the selected models to the reported end-uses for the business, and selected a more appropriate model as needed. For example, if the algorithms selected a cooling model for electricity, but the business reported no air conditioning equipment, we over-rode the default model selection.

Once the appropriate model is fit to the data, weather-normalized annual use for each component can be calculated using long-term average heating and/or cooling degree days at the fitted value(s) of τ. The long-term averages that we used were based on the period 1981-2010.

Appendix G: Detailed Survey Methodology

Survey Sampling Plan

Business Size Definitions

For purposes of sampling, the team defined business size by the number of employees in the business. To align study definitions with publicly available data from the 2013 US Census County Business Patterns (2013 CBP), the sample is stratified on three business sizes: 1 to 9 employees (very small), 10 to 49 employees (small), and 50 to 99 employees (medium).

The definition of small and medium businesses varies amongst program implementers, researchers, utilities, and government, with some using number of employees and others using building square footage or energy usage as an indicator of size. Definitions of small businesses include businesses with less than 100 employees, less than 50,000 square feet, and/or less than 100 kW. The US Small Business Administration defines small businesses based on revenue or number of employees depending on the North American Industry Classification System (NAICS) code. The 2013 County Business Patterns data provides counts of business establishments7 by number of employees and business type (NAICS code) for each Minnesota ZIP code and county. We chose to align our definition with the CBP definition to allow for using CBP data for additional extrapolation.

Table 43 shows the distributions of businesses in Minnesota by number of employees. Among businesses with fewer than 100 employees in Minnesota, about 23 percent of employees work in medium businesses and 77 percent work in small or very small businesses.

7 Census defines an establishment as a single physical location; a company may have multiple establishments.

Table 43. Business Size Definitions

Size Category	Number of Employees	Total Establishments	Total Employees	Percent of Total Small-Medium Business Employees
VERY SMALL	1-4	75,727	189,318	27%
	5-9	24,447	171,129	
SMALL	10-19	18,494	268,163	50%
	20-49	11,796	406,962	
MEDIUM	50-99	4,056	302,172	23%
Sub-Total	**1-99**	**134,520**	**1,337,744**	**100%**
LARGE (Out of Scope)	100-249	2,268	395,766	
	250-499	581	217,585	
	500-999	207	155,147	
	1000+	135	202,500	
TOTAL	1-1000+	137,711	2,308,742	

Source: US Census 2013 County Business Patterns data for Minnesota
(Excludes manufacturing-related establishments)
Source: US Census 2013 County Business Patterns data for Minnesota
(Excludes manufacturing-related establishments)

The sample of medium businesses consisted of a statewide random sample while the small business sample was further stratified by business type and geography.

Business Type Definitions

The team identified six business types (plus an "other" category) that align with both the Commercial Buildings Energy Consumption Survey (CBECS) data and NAICS codes to serve three purposes: 1) To stratify the sample based on the most common SMB types in Minnesota; 2) To enable extrapolation of potential estimates to county and utility service territories by merging results with the 2013 US Census Zip Code Business Patterns (2013 ZBP) and 2013 CBP data; and 3) align with CBECS building types for developing baseline building models. The team identified the top six CBECs building types based on aggregate gas/electric bills and mapped NAICs codes to these types. The sample allocations based on business type are shown below.

Table 44. Business Type Sampling

Business Type	Sample Size	Sample %	CBECs %	Notes
Retail	220	18%	25%	
Office	200	17%	13%	
Warehouse/wholesale	150	13%	10%	
Food service	150	13%	11%	
Education	150	13%	6%	
Grocery and convenience	110	9%	8%	
Other	220	18%	27%	Undersample in order to oversample other segments
Total	220	18%	25%	

Geography

To enable comparisons between the Twin Cities and the rest of the state (hereafter, Greater Minnesota) and to meet the sampling needs of the CARD Market Characterization study, the sample was also stratified on geography. The seven-county Twin Cities Metro Area contains about 60% of SMBs and SMB employees. Consequently, the sample was stratified to reflect that split. Furthermore, to keep the Characterization-Study field costs manageable, the Greater Minnesota portion of the small (<50 employees) business sample was restricted to a sample of counties as shown in Figure X. Counties were selected with probability proportional to total small business employees in the county. Medium businesses (50-99 employees) were randomly sampled from anywhere in the state.

Based on a CBP analysis of number of employees, the sample by business type was split 60/40 between Twin Cities and Greater Minnesota, except for grocery and convenience where the actual split based on CBP data is 40% in the Twin Cities and 60% in Greater Minnesota. Furthermore, the sample was split between very small businesses (1-9 employees) and small businesses (10-49 employees) with 40% of the sample going to very small business and 60% going to small businesses (see Table 45)

Figure 38. Twin Cities/Greater Minnesota Strata Definitions

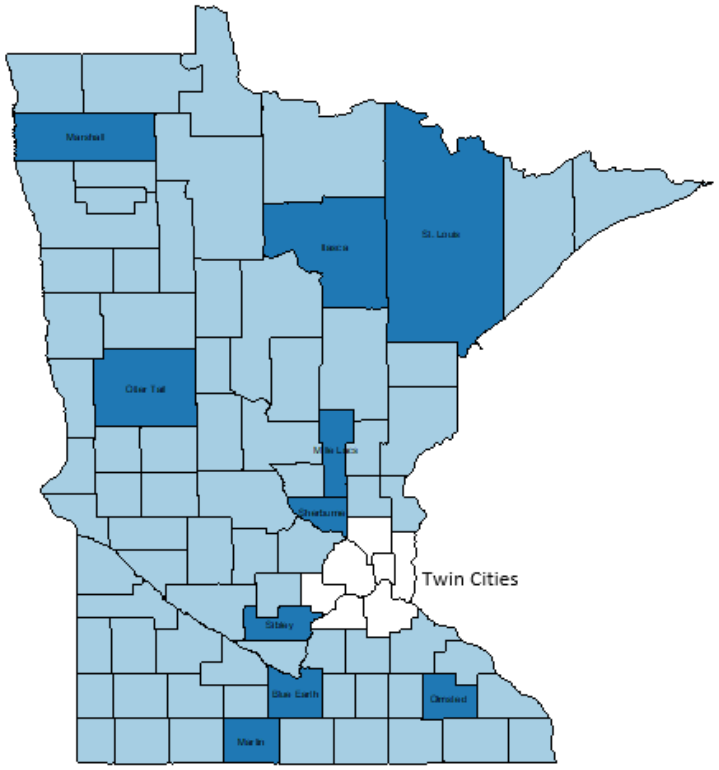

Table 45. Sample Stratification by Business Type and Location

Business Type	Twin Cities			Greater Minnesota			Total
	Very Small	Small	Total	Very Small	Small	Total	
Retail	40	90	130	25	65	90	220
Office	40	80	120	30	50	80	200
Warehouse/wholesale	30	60	90	20	40	60	150
Food service	30	60	90	20	40	60	150
Education	30	60	90	20	40	60	150
Grocery and convenience	20	30	50	20	40	60	110
Other	45	85	130	35	55	90	220
Total	235	465	700	170	330	500	1200

Investor-Owned and Community-Owned Utilities

The team analyzed the distribution of investor-owned utilities (IOUs) and Community-Owned Utilities (COUs) serving Minnesota SMBs (see Table 46). The distributions indicated that the survey sample will naturally be close to these proportions, so stratification on utility type was not necessary.

Table 46. Distribution of Utility Types Serving SMBs

	Twin Cities Metro	Greater Minnesota	Statewide
IOU	80%	20%	60%
COU	20%	80%	40%

Final Sample Quota Definitions

The final sample definition includes 29 strata as shown in Table 47.

Table 47. Final Sample Strata Definitions

Stratum	Business Type	Geography	Number of employees	Survey quota
1	Retail	all TC counties	1-9	40
2	Office	all TC counties	1-9	40
3	Warehouse/wholesale	all TC counties	1-9	30
4	Food service	all TC counties	1-9	30
5	Education	all TC counties	1-9	30
6	Grocery and convenience	all TC counties	1-9	20
7	Other	all TC counties	1-9	45
8	Retail	all TC counties	10-49	90
9	Office	all TC counties	10-49	80
10	Warehouse/wholesale	all TC counties	10-49	60
11	Food service	all TC counties	10-49	60
12	Education	all TC counties	10-49	60
13	Grocery and convenience	all TC counties	10-49	30
14	Other	all TC counties	10-49	85
15	Retail	sampled GM counties	1-9	25
16	Office	sampled GM counties	1-9	30
17	Warehouse/wholesale	sampled GM counties	1-9	20
18	Food service	sampled GM counties	1-9	20
19	Education	sampled GM counties	1-9	20
20	Grocery and convenience	sampled GM counties	1-9	20
21	Other	sampled GM counties	1-9	35
22	Retail	all GM counties	10-49	65
23	Office	all GM counties	10-49	50
24	Warehouse/wholesale	all GM counties	10-49	40
25	Food service	all GM counties	10-49	40
26	Education	all GM counties	10-49	40
27	Grocery and convenience	all GM counties	10-49	40
28	Other	all GM counties	10-49	55
29	ANY (except 'EXCLUDE')	all counties	50-99	250
				1,450