ELPC Exhibit No. _____

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio Edison Company, The Cleveland Electric Illuminating Company and The Toledo Edison Company for Approval of Their Energy Efficiency and Peak Demand Reduction Program Portfolio Plans for 2017 through 2019	)))))))	Case No. 16-0743-EL-POR

DIRECT TESTIMONY OF
JOHN PAUL JEWELL
ON BEHALF OF
ENVIRONMENTAL LAW & POLICY CENTER

September 13, 2016

OVERVIEW

Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. My name is John Paul Jewell. My business address is Environmental Law and Policy Center, 35 E. Wacker Dr., Suite 1600, Chicago, IL 60601.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING TODAY?

A. I am testifying on behalf of the Environmental Law and Policy Center (ELPC).

Q. PLEASE DESCRIBE YOUR BACKGROUND AND EXPERIENCE.

A. I am the Clean Energy Finance Specialist and Research Coordinator at ELPC. I received my Bachelor of Arts from the University of Chicago, and a Master of Environmental Management and Master of Business Administration from Yale University. I have 7 years of experience in energy issues, including energy efficiency, energy auditing, and utility efficiency program design. I have attached my résumé as Exhibit A. I represent ELPC in the Ohio utility efficiency collaborative groups for Duke, FirstEnergy, AEP Ohio, and Dayton Power and Light. I have provided expert testimony before the Michigan Public Service Commission for case U-17792 and have represented ELPC in the Illinois Energy Efficiency Stakeholder Advisory Group (IL-SAG) for the last three years. The IL-SAG handles energy efficiency issues for the two electric utilities – ComEd and Ameren – and the four gas utilities in the state – Nicor, Peoples Gas, NorthShore Gas, and Ameren. With the Illinois utilities and other stakeholders over the last 18 months, I have helped to lead a collaborative process specifically dedicated to developing a smart thermostat offering in Illinois. This offering launched on October 5, 2015, and the collaborative has continued meeting regularly to refine marketing, messaging, and rebate strategies, to develop an approach for reaching lower income customers, and to address evaluation issues that have arisen with the smart thermostat measure.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to address the reasonableness of the proposed FirstEnergy Corp's (FirstEnergy) Energy Efficiency (EE) and Peak Demand Reduction (PDR) Plans (Proposed Plans) for 2017 through 2020 that were submitted by Ohio Edison Company, The Cleveland Electric Illuminating Company, and the Toledo Edison Company on June 15, 2016. I will refer to these companies collectively as "FirstEnergy." In my testimony I describe my assessment of the proposed EE and PDR plans and make suggestions for modifications and improvements. I will also evaluate the extent to which the proposed plans reflect best practice ideas.

Q. WITH WHAT CRITERIA DO YOU EVALUATE THE PLANS?

A. I am evaluating the plans on several different criteria. Generally, a well-designed efficiency plan embraces industry best practices, encourages customers to implement energy efficiency measures that they would not do on their own in the absence of the plan, reaches different customer segments, transforms the market to be more energy efficient, and is cost effective. In Ohio, the utility efficiency plans are allowed by statute to take credit for customer actions not related to the utility efficiency programs. I believe that counting such customer actions is not a best practice, and though allowed by law, is not a prudent use of ratepayer dollars and should not count toward shared savings incentives.

Q. WHAT IS YOUR IMPRESSION OF THE PROPOSED EFFICIENCY PLAN?

A. I am pleased that FirstEnergy has proposed a new energy efficiency plan. Utility-run efficiency plans provide customer and societal benefits and help reduce energy costs for customers. Many customers will not or cannot implement cost-effective energy saving measures without assistance from their utilities. FirstEnergy should spend ratepayer funds to encourage deployment of efficiency measures that are unlikely to occur absent utility programs. The approved plan must be cost effective, which means the benefits exceed the costs. Therefore, FirstEnergy customers will benefit from reduced electricity costs, lower system demand, and many additional non-energy benefits. While FirstEnergy's plan provides customer savings, it should be improved to provide customers with greater value. Much has changed in the world of energy efficiency in the five years since FirstEnergy filed its last plan, and best practices have evolved. In my ensuing testimony, I provide recommendations that will move FirstEnergy's plans toward best practices.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.

A. In my testimony I note:

- FirstEnergy proposes to continue discounting compact fluorescent lightbulbs (CFLs) throughout its three-year portfolio, despite the advent of superior light emitting diodes (LEDs) with costs that are declining. As prices of LED lighting decrease and quality and flexibility increase, CFLs are becoming the market baseline. Lighting program funds should be dedicated exclusively to promoting LED technology rather than fluorescent lighting.

- FirstEnergy proposes a modest smart thermostat program. However, the program is very small in scale and limited in scope. FirstEnergy should increase the annual smart thermostat installation goals and budget while also committing to develop a retail rebate strategy for smart thermostats. Because smart thermostats are a newer technology, FirstEnergy should undertake customer education initiatives to inform customers about their energy savings potential. Further, based on my experience in other markets, if the utility introduces a significant effort to promote and incent smart thermostats, manufacturers may invest their own money in promoting the technology and educating customers. A small program is unlikely to merit the type of marketing investment from the smart thermostat manufacturers needed to make a program successful.
- FirstEnergy proposes to spend $22.4 million over three years on energy saving kits. The measures in kits tend to have lower in service rates than intended and are not a best practice. FirstEnergy should cut its kit spending by half, and focus the remaining kits on multifamily and low income households.
- FirstEnergy proposes to spend $4.95 million to count nearly 193 million kWh in savings from Customer Action Programs. While the law was changed in 2014 to allow customer actions to count toward utility savings goals, FirstEnergy's Customer Action Programs do not reflect best practice ideas, as they merely count actions that customers take on their own without incentives or rebates. In addition, allocating

nearly $5 million to, and counting toward shared savings, a program that does not generate any new savings strikes me a waste of ratepayer funds.

- FirstEnergy should provide a more detailed plan for how it will implement weatherization measures such as air sealing, duct sealing, and insulation.
- FirstEnergy should increase the size of its Government Tariff Lighting Program to provide more incentives for LED traffic signals and streetlights for municipalities in its territory.
- FirstEnergy should coordinate delivery of audits, weatherization, and additional measures that may have both electricity and gas savings with gas utility efficiency programs operating in FirstEnergy territory.

<u>RESIDENTIAL LIGHTING</u>

Q. DESCRIBE THE RESIDENTIAL LIGHTING PROGRAM.

A. FirstEnergy's proposed EE and PDR plan relies heavily on savings from residential programs that provide rebates and incentives for CFLs. FirstEnergy proposes to spend $1,748,346 on CFL lamp incentives in the lighting subprogram of the Energy Efficient Products Program and $7,083,279 on LED lamp incentives. While FirstEnergy's trend toward emphasizing LEDs is moving in the right direction, it does not go far enough. The $1.75 million proposed spending on CFL lamps is a significant missed opportunity to further promote LED lighting and may delay the transformation of the lighting market in FirstEnergy territory. CFL lightbulbs are inferior to LEDs in several ways, and CFL lamp and fixture rebates and incentives should not be included in the plan. FirstEnergy's proposed plan does not indicate whether the $1.75 million for CFLs is for standard general service lighting or specialty bulbs, and therefore I assume it is for standard bulbs.

Q. HOW HAVE FEDERAL LIGHTING STANDARDS IMPACTED THE LIGHTING MARKET?

A. With passage of the Energy Independence and Security Act of 2007 (EISA), Congress established minimum energy efficiency standards for general service lightbulbs. Traditional incandescent lightbulbs most commonly used by consumers at the time do not meet the new requirements and are no longer manufactured in the United States. Instead, the least-efficient standard lightbulbs that are commercially available today are incandescent halogen bulbs, which are not as efficient as CFLs or LEDs.

Q. HOW ARE CFLS AND LEDS DIFFERENT?

A. LED lamps are more efficient than CFLs, using fewer watts per lumen. LEDs have a longer life (fifteen years for LEDs vs seven years for CFLs)[1]. Both types use less electricity than incandescent halogen lightbulbs. LEDs have higher customer satisfaction due to their versatility, quality of light, lack of a “warm up” period, and lack of mercury[2]. LEDs tend to be more expensive than CFLs (though LED prices are falling), and therefore a utility incentive is more useful in increasing their attractiveness to buyers. Finally, LEDs present a greater opportunity to transform lighting for residential customers than CFL incentives do. Below are average prices and ranges I found for

[1] Cleveland Electric Illuminating Appendix C-1 Page 2 of 8.

[2] A 2015 study of the residential lighting market in Massachusetts conducted by the Cadmus Group found that 45% of respondents preferred LEDs over CFLs, while only 10% preferred CFLs over LEDs.
Lighting Market Assessment and Saturation Stagnation Overall Report, the Cadmus Group, Page 35.

CFLs, LEDs, and Halogen 60-Watt equivalent standard lightbulbs via Home Depot's website in FirstEnergy territory:

Bulb Type	Average Price per Bulb	Range Price per Bulb
CFL	$2.11	$1.91-$2.15
Incandescent Halogen	$1.99	$1.99
LED	$4.99	$2.12-$8.49

As the table shows, CFLs and incandescent halogen lightbulbs are similar in price, and in some cases, CFLs are the lowest-cost option. LEDs on average are more expensive, though there are some models that are cost-competitive.

Q. PLEASE DESCRIBE THE OPPORTUNITY FOR LED LIGHTING.

A. In the Market Potential Study, Harbourfront Group indicates that 65% of FirstEnergy customers have CFLs installed while only 45% of customers have LEDs.[3] Witnesses Fitzpatrick and Miller indicate that the average FirstEnergy customer has between eight and ten bulbs in their home that could be replaced with a bulb that's more efficient than the baseline technology, which is an incandescent halogen bulb.

Q. WHAT IS YOUR GENERAL IMPRESSION OF THE MARKET POTENTIAL STUDY'S INFORMATION ON LIGHTING?

A. I do not believe that the Market Potential Study collected the data necessary to justify FirstEnergy's significant proposed investment in CFL lighting. Without a detailed analysis of the type and quantity of lightbulb in an average customer's home, in addition

[3] Market Potential Study pages 60-62.

to an analysis of the type, quantity, and price of lighting available in major retail outlets in FirstEnergy territory, it is difficult to justify spending $1.75 million on incentives for customers to buy a technology that is the least-cost option they would likely purchase anyway. If the Market Potential Study showed that many customers were still using incandescent halogen lightbulbs and replacing them with incandescent halogen bulbs at the store, that CFLs were more expensive than incandescent halogen bulbs, and that CFLs were not readily available at low cost at most major retail outlets in FirstEnergy territory, then a CFL discount program might be justified. However, the Market Potential Study did not show this. Instead, the Market Potential Study's section on lighting estimated the proportion of FirstEnergy customers that have CFL bulbs and LEDs in their homes. Moreover, the online prices I discuss above show that the average CFL is only 12 cents more than an incandescent halogen. There is no reason to discount a CFL.

Q. IS THERE ADDITIONAL INFORMATION THAT CAN INFORM LIGHTING PROGRAM DESIGN RECOMMENDATIONS?

A. Yes. It would be useful for FirstEnergy to update its potential study with more in-depth information about customer lighting habits and trends. For instance, it is important to program design to know how many light sockets in each home or business have CFLs, LEDs, or inefficient incandescent and halogen bulbs; which of these sockets are used the most; and what technologies and prices are available to consumers when they seek to replace bulbs. With such information on how FirstEnergy customers use lighting, the utility can better design its efficiency program incentives, messaging, and delivery channels to match customer needs and to transform the market effectively. The

Commission should order FirstEnergy to conduct a comprehensive survey of residential and commercial lighting trends to better understand if any opportunity remains for efficiency in customer homes and businesses. Further, the Commission should order FirstEnergy to update its program based on the findings of such a survey.

Q. HOW DO UTILITY REBATES INFLUENCE A MARKET?

A. Discounts in energy efficiency programs are used to reduce the price of efficient technology for customers so that they are more likely to buy it. Rebates and incentives are particularly useful for driving sales of costlier or newer technology. With utility discounts and marketing, retailers will generally promote the efficient measures more vigorously and dedicate more prominent shelf space to the efficient items. For example, with the advent of energy efficient LED lighting, many big-box stores now have in-store lighting displays and signs that provide additional information on how to choose an efficient lightbulb, what type of bulb is best for specific rooms or applications, and how much a customer could save through normal use of an efficient bulb. The utility programs can help jumpstart sales and leverage manufacturer and retailer investments in customer education.

Q. ARE CFL DISCOUNTS A BEST PRACTICE IDEA?

A. No. If FirstEnergy's EE and DSM programs are to incorporate best practice ideas, then they should provide incentives for the most efficient cost-effective technology, which is LED lighting. Further, FirstEnergy EE and DSM program money should be used to encourage customers to implement an efficiency measure that they would not adopt without the program. In the lighting market, CFLs are considered an "old" technology relative to LEDs. They use more energy, they have poorer customer satisfaction, and they have been a cheap lighting option for years. CFL lighting is already in nearly two-thirds of FirstEnergy residential customer homes, and without any utility incentives, can be purchased from Home Depot in FirstEnergy territory for between $1.91 and $2.15 per bulb. For comparison, an incandescent halogen of the same lumen output costs $1.99 and LEDs range from $2.12 to $8.49 per bulb.[4] When CFLs are available for purchase for a lower cost than other comparable lighting offerings, they should not be incented by utility programs.

Several major manufacturers have stopped production of CFLs in favor of LEDs and retail trends are moving to favor LEDs as the efficient lighting choice. With EISA and the 2017 Energy Star 2.0 standards, CFLs are becoming the baseline technology, and FirstEnergy should not be spending ratepayer dollars to incentivize the baseline. The 2017 EnergyStar standards will give LEDs a significant advantage over CFLs. Under the 2017 Energy Star standards, the minimum Lamp Efficacy for Energy Star certification will be 80 lumens per watt. While most commercially available CFLs with an incandescent equivalent of 60 watts have lamp efficacies between 60 and 70 (falling short of the standard), LEDs with the same incandescent-equivalent wattage do meet the standard with efficacies ranging from 80 to 100 lumens per watt. Because of this, CFLs will become the baseline and LEDs will be the efficient technology. FirstEnergy should put program dollars toward promoting the efficient technology.

[4] Survey of HomeDepot.com 60-Watt equivalent standard lightbulb offerings for stores in Cleveland, OH area. Accessed 8/16/2016.

LEDs remain the most promising lighting technology of the future and in FirstEnergy territory in 2015, LEDs were the most popular. In FirstEnergy's 2015 Customer Action Program Measurement and Verification report, ADM estimates that in 2015, residential customers installed 1,956,397 LED bulbs, 1,716,792 CFL bulbs, and 131,137 halogen bulbs, all in a year with no utility efficient lighting incentives.[5] These circumstances show that the market is already pushing customers to move to efficient lighting without any utility intervention. LED and CFL installations dominated the market as customers installed more than 14 LEDs and 13 CFLs for every incandescent halogen bulb in FirstEnergy territory. Despite the dominance of efficient lighting in the marketplace and the emergence of LEDs as the most popular option, FirstEnergy's portfolio still dedicates significant resources to providing rebates for CFLs. At this point, if FirstEnergy provides incentives for customers to buy CFL lightbulbs, it will only serve to slow the market transformation that is already underway.

Q. WHAT DO YOU THINK RETAILERS WILL DO IF FIRSTENERGY PROVIDES CFL INCENTIVES?

A. With utility CFL incentives, retailers in FirstEnergy territory are likely to dedicate more shelf space to the technology. Absent CFL discounts, lighting retailers would be less likely to promote CFLs. Since CFLs are already among the lowest-cost lightbulbs available, further discounting their price may eat into efficient LED market share. Conversely, offering more incentives for LEDs will encourage retailers to dedicate more

[5] http://dis.puc.state.oh.us/TiffToPDf/A1001001A16E12B10005H04417_8.pdf Section 5-1.

resources to promoting that technology. I visited three Home Depot locations and a Target in FirstEnergy territory in June and observed that most of the shelf space for general service lighting was dedicated to displaying LED bulbs and very little space was provided for CFLs.[6] If FirstEnergy were to provide retail incentives for CFL lighting, it is reasonable to expect Home Depot would expand the shelf space dedicated to CFLs at the expense of efficient LED displays. FirstEnergy efficiency funds should go toward promoting LEDs, which are a better, more efficient, and more-expensive technology.

Q. WHAT ARE OTHER OHIO UTILITIES DOING?

A. Other utilities in Ohio and elsewhere are eliminating CFL rebates and incentives as they move their lighting programs to exclusively promote LEDs for general use. AEP Ohio, Dayton Power & Light, Duke Energy Ohio, Commonwealth Edison, Ameren Illinois, and others in the northeast have eliminated or have proposed eliminating CFL discounts within the next year. For these utility programs, residential lighting and most commercial lighting incentives will focus exclusively on LEDs, and FirstEnergy's should as well.

Q. WHAT ARE YOUR RECOMMENDATIONS FOR FIRSTENERGY'S RESIDENTIAL ENERGY EFFICIENT PRODUCTS PROGRAM?

A. I recommend that the Commission order FirstEnergy to change its Energy Efficient Products Lighting Subprogram to offer incentives only for LED lighting and to eliminate any incentives or rebates for CFL lighting. Further, I recommend that the Commission

[6] On June 22, 2016, I visited three Home Depot locations and a Target to observe how shelf space was allocated to different types of lighting. The three Home Depots I visited were: 877 E. 200th St, Euclid, OH; 6199 Wilson Mills Rd, Highland Heights, OH; 10800 Brookpark Rd, Cleveland, OH. The Target address is: 36195 Euclid Ave, Willoughby, OH.

order FirstEnergy to conduct a more comprehensive study of lighting habits and the remaining potential for energy efficient lighting in customer homes. The budgets, targets, and measures of the Energy Efficient Products and Energy Efficient Homes programs should be adjusted pending the results of such a study to ensure they are designed to effectively drive energy efficient lighting adoption for residential customers.

SMART THERMOSTATS

Q. WHAT IS A SMART THERMOSTAT?

A. There are varying definitions of "smart thermostats" but generally they fit the common description of being a Wi-Fi-connected thermostat, with temperature settings that can be adjusted remotely via a smartphone or computer, and have some type of occupancy sensing technology that allows the thermostat to automatically adjust heating and cooling settings to save energy. Some smart thermostats have additional features, such as weather information displays; "free cooling" wherein the smart thermostat senses that the outside air is cooler than inside and uses the air conditioner fan to pull in cool outside air without running the AC's cooling functions; demand response abilities; detailed reports on heating and cooling usage with energy saving tips and nudges; appliance maintenance alerts; and communication and control abilities for other energy-using devices, such as pool pumps, security systems, and appliances. While these devices are a relatively new product class, there have been several devices on the market for a few years, with seemingly more being introduced every few months. They mostly target residential customers, but I have encountered utility programs that deploy smart thermostats to commercial customers, multifamily buildings, and even public housing. Further, while I will mostly refer to the benefits of smart thermostats in terms of electricity savings, in gas-heated homes they generate gas savings as well. This is why any utility smart thermostat program should be coordinated between electric and gas utilities to maximize customer benefits.

Q. WHAT ADVANTAGES DO SMART THERMOSTATS OFFER OVER OTHER HEATING AND COOLING EFFICIENCY MEASURES?

A. Heating and cooling of unoccupied spaces is one of the largest contributors to wasted energy in an average home.[7] Energy waste can be categorized as technological waste, wherein savings potential exists in equipment upgrades, and behavioral waste, which results from inefficient temperature setpoints, longer than necessary run times, and from having equipment on when it is not being used.[8] While FirstEnergy has not conducted the type of study Opinion Dynamics did for ComEd, I see no reason why there would be significant differences in how an average customer uses and wastes energy in FirstEnergy territory.

There are a few ways to reduce this energy waste: (1) weatherizing a home with insulation and air sealing so that the house stays a comfortable temperature longer; (2) installing an efficient heat pump or air conditioner so that it takes less energy to heat or cool a home to the ideal temperature; or (3) installing a smart thermostat so that heating and cooling equipment run less often and only when needed to provide comfort to the

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[7] See: ComEd Wasted Energy Study, Exhibit B.
[8] See: Peoples Gas Light and Coke Company Wasted Energy Study, Exhibit C.

occupants. While each of these measures can provide significant energy savings, smart thermostats have the lowest incremental cost and can be installed the fastest. FirstEnergy can reach more customers to reduce wasted energy for a lower cost by emphasizing smart thermostats in their programs.

Q. WHAT ADVANTAGES DO SMART THERMOSTATS OFFER OVER PROGRAMMABLE OR MANUAL THERMOSTATS?

A. Thermostats generally fall into one of four categories: manual, programmable, Wi-Fi-programmable (or "connected"), and smart. Manual thermostats require a user to change a setting on the thermostat every time they want their home temperature changed. While some have temperature selection features, some simply offer "off" or "on" options. If a user leaves a room or a home for which a manual thermostat controls the temperature and they do not change the temperature settings, they will waste energy heating or cooling that space. A programmable thermostat allows a user to designate specific temperature set points for specific times and days of the week. While a correctly-programmed thermostat can in theory help a user save money, in practice the devices are rarely programmed to maximize energy savings. Further, if a user's schedule changes, or as the seasons change, they will have to re-program their thermostat's set points. Wi-Fi-programmable thermostats are slightly more advanced than programmable thermostats in that they allow a user to remotely program the thermostat through a phone or computer, rather than requiring programming directly on the device. A user must still change the temperature set points if their schedule or the seasons change.

The biggest problem with programmable thermostats is that many of them are not programmed correctly and essentially function as manual thermostats, wherein a user leaves their thermostat at a constant setpoint throughout the day and must physically change the temperature setting on the thermostat every time they want to adjust their heating and cooling use. Users may initially program energy-saving set points for their schedules, but as seasons change, or users go on vacation, or schedules change from week to week, a programmable thermostat will need to be re-programmed to reduce heating and cooling usage when users are not home, or when they are asleep. As part of my experience, Peoples Gas in 2014 found that about half of customers heat their residences at a constant temperature throughout the day and did not set back their programmable thermostats properly.[9] Opinion Dynamics conducted a study on behalf of Commonwealth Edison in 2013 and found that 31-38% of central cooling energy usage was waste resulting from customers who did not use recommended efficient cooling temperatures or who cooled their homes while empty.[10]

Smart thermostats offer a solution to reducing energy that is wasted on heating and cooling unoccupied homes. If a smart thermostat detects that a home is unoccupied, it can automatically reduce the HVAC's heating or cooling activity. Additionally, some smart thermostats allow users to click an "away" button that will automatically turn the HVAC system to an energy-saving mode. Over time, smart thermostats adapt to user habits and will adjust HVAC settings to automatically ensure comfort when a user is home and energy savings when a user is away. Programmable and manual thermostats

[9] See Exhibit C.
[10] See Exhibit B.

do not do this. Even Wi-Fi-connected programmable thermostats are inferior to smart thermostats. While Wi-Fi-connected programmable thermostats do allow users to remotely adjust temperature settings, the savings are not automatic as they are with smart thermostats, and Wi-Fi-connected programmable thermostats lack the advanced features of smart thermostats that can bring automated savings and customer comfort.

Q. ARE THERE EVALUATED SAVINGS FOR SMART THERMOSTATS?

A. Several studies have been conducted by manufacturers, utilities, and utility evaluators to investigate the savings of smart thermostats. While methodologies of these studies have varied, results point to significant heating and cooling savings when a smart thermostat replaces a manual or standard programmable thermostat.

- A 2015 evaluation by Cadmus in NIPSCO territory found smart thermostats had annual savings of 203 kWh over manual thermostats and 14 kWh over programmable thermostats plus natural gas savings in gas-heated homes.[11]
- A 2015 evaluation by Cadmus in Vectren territory found smart thermostats had annual savings of 176 kWh over manual thermostats and 10 kWh over programmable thermostats plus natural gas savings in gas-heated homes.[12]

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[11] The Cadmus Group, Inc. "Evaluation of the 2013-2014 Programmable and Smart Thermostat Program." January 22, 2015. Prepared for Northern Indiana Public Service Company. https://myweb.in.gov/IURC/eds/Modules/Ecms/Cases/Docketed_Cases/ViewDocument.aspx?DocID=0900b631801c5039

[12] The Cadmus Group, Inc. "Evaluation of the 2013-2014 Programmable and Smart Thermostat Program." January 29, 2015. Prepared for Vectren Corporation. http://www.cadmusgroup.com/wp-content/uploads/2015/06/Cadmus_Vectren_Nest_Report_Jan2015.pdf?submissionGuid=2b173018-76a3-4597-b773-0a8ed55af0c4

- A 2014 study of Nest Learning Thermostats by Apex Analytics on behalf of the Energy Trust of Oregon found smart thermostats had annual savings of 4.7% of total electric load, or 781 kWh over a mix of manual and programmable thermostats.[13]
- Ecobee, a smart thermostat manufacturer, claims that its smart thermostat saves an average 253 kWh and 220 therms per year.[14]
- Nest has published a study that shows its smart thermostat saves 221 kWh and 92 therms per year.[15]
- The Illinois TRM deems 101 kWh savings for smart thermostats installed in the state, plus between 53-84 therms of natural gas savings for gas-heated homes.[16]

As these studies indicate, electricity savings values will be higher in homes that have electric heat and central cooling. Smart thermostats can still provide savings for customers who have only electric heat or central cooling, but electric savings are greatest in all-electric homes with central cooling. Similarly, smart thermostats generate natural gas savings for users with gas heat. As the Market Potential Study indicates, 18.2% of FirstEnergy customers have electric heat, and 69.4% have central air conditioning.[17]

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[13] Apex Analytics LLC. "Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation." October 10, 2014. Prepared for Energy Trust of Oregon. http://energytrust.org/library/reports/Nest_Pilot_Study_Evaluation_wSR.pdf

[14] Ecobee, Inc. "Ecobee 2012 Energy Savings Estimates, Version 2." August 12, 2013.

[15] Nest Labs. "Energy Savings from the Nest Learning Thermostat: Energy Bill Analysis Results. February 2015. https://nest.com/downloads/press/documents/energy-savings-white-paper.pdf

[16] Illinois Energy Efficiency Stakeholder Advisory Group. "Illinois Statewide Technical Reference Manual for Energy Efficiency Version 5.0. Volume 3: Residential Measures." February 11, 2015. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_5/Final/IL-TRM_Effective_060116_v5.0_Vol_3_Res_021116_Final.pdf

[17] Market Potential Study, pp 72-74.

Q. DO YOU BELIEVE THESE SAVINGS ESTIMATES ARE ACCURATE?

A. I have reason to believe that some of the studies underestimate savings. For example, the NIPSCO and Vectren studies evaluated smart thermostats against programmable thermostats that were professionally programmed and monitored by evaluators. This does not reflect the reality mentioned earlier that programmable thermostats are frequently programmed improperly. As utilities continue to evaluate smart thermostat performance, particularly in homes that are of average efficiency and not considered "early adopters" of efficient technology, it is reasonable to expect evaluated savings values for smart thermostats will increase.

Q. CAN SMART THERMOSTATS BE USED FOR PEAK DEMAND REDUCTION OR DEMAND RESPONSE?

A. Yes. In addition to their energy efficiency capabilities, smart thermostats can provide a mechanism for utility demand response for customers even without a smart meter installed. Nest, for instance, offers programs with utilities wherein enrolled customers can opt to have their thermostat setpoint raised a few degrees during peak demand times and/or "pre-cool" their home in the hours before peak demand hits. Additionally, if a utility sends alerts to customers asking them to reduce energy usage during peak events, a smart thermostat user can change their HVAC set point remotely via their smartphone. A manual or programmable thermostat owner would not be able to participate. Finally, many smart thermostats, including market leaders Nest and ecobee, can connect to other smart devices in the home, such as pool pumps, power strips, ceiling fans, lighting controls, and other devices. The smart thermostat can tell these other smart devices to power on or off depending on whether a user is home or away. And if a utility needed to reduce electricity demand during a peak event, smart thermostat owners with other connected devices could control many of these smart devices via their smart thermostat. Smart thermostats provide for a relatively inexpensive way to take advantage of energy savings and demand response that come from a growing market of smart home devices. Thus, I encourage widespread deployment of the devices to serve as a platform for additional energy saving services that can be deployed with or without a smart meter.

Q. PLEASE DESCRIBE FIRSTENERGY'S SMART THERMOSTAT OFFERINGS.

A. FirstEnergy has included the smart thermostat measure in several programs, the most significant of which is the Smart Thermostats subprogram, part of the Energy Efficient Homes program. FirstEnergy's plan describes this subprogram as "deployment of a program-specific smart thermostat to residential customers with either of the following HVAC systems: central air conditioning, heat pumps, electric resistance furnace or geothermal heat pump." The plan indicates that 10,000 smart thermostats will be deployed per year each of the three years, with a rebate of $100 each, for a total of $3,000,000. This would reach roughly 1.6% of residential customers over 3 years. It is my understanding that FirstEnergy will use IGS to deliver these 10,000 smart thermostats to customers, though I do not have more detail on how this partnership will work.

Smart thermostats are also included as a measure in the Energy Efficient Products program HVAC subprogram. In this subprogram, FirstEnergy's plan indicates that over three years, across the three territories, it plans to deploy 1,065 programmable or smart thermostats, which would reach an additional 0.06% of residential customers.

Q. DOES THE MARKET POTENTIAL STUDY CONTAIN INFORMATION ON SMART THERMOSTATS?

A. Yes. The Market Potential Study estimates that 12.1% of residential customers have installed a smart thermostat in the last 5 years. This would mean that 224,000 FirstEnergy customers have installed a smart thermostat.

Q. DO YOU THINK THE MARKET POTENTIAL STUDY'S SMART THERMOSTAT ESTIMATES ARE REASONABLE?

A. I have several reasons to believe the MPS wildly overestimates the penetration of smart thermostat technology. First, the question asked by the surveyor does not define "smart thermostat" for the respondent. I think it is likely that respondents confuse smart thermostats with thermostats that are merely Wi-Fi connected or with programmable thermostats. Second, this is a relatively new technology that FirstEnergy has not been promoting in the last few years. At a retail cost of roughly $250 for the type of smart thermostat I describe above, it would take significant promotion from the utility to move over 50,000 per year for five years. As an example, ComEd promoted smart thermostats in Northern Illinois with a $100 rebate and significant marketing efforts starting in October 2015 in a territory of 3.6 million residential customers. In the first 10 months of this program, ComEd processed roughly 35,000 rebates. While 224,000 smart thermostats over 5 years is an achievable number in FirstEnergy territory, it requires marketing, promotion, rebates, and customer education that we have not yet seen from FirstEnergy.

Q. HOW DOES THIS POTENTIAL OVER ESTIMATION OF SMART THERMOSTAT PENETRATION AFFECT FIRSTENERGY'S PROPOSED EE AND DSM PORTFOLIO?

A. This likely-incorrect estimate of smart thermostat penetration means that FirstEnergy is underestimating the potential for savings from implementing a well-marketed smart thermostat incentive program. Additionally, if FirstEnergy or its consultants claim that roughly 55,000 customers a year are installing advanced smart thermostats without any promotion or incentive from the utility, then they will also be claiming savings that are likely not occurring.

Q. DO YOU THINK FIRSTENERGY'S SMART THERMOSTAT PROGRAM IS SUFFICIENT IN SCOPE AND SCALE?

A. No. I think that FirstEnergy's proposed Energy Efficient Homes Smart Thermostat Sub-program is too small of an effort, too limited in scope, and by using IGS, limits competition and innovation.[18] The Commission should order FirstEnergy to increase its budget and planned deployment of smart thermostats for residential customers. These efforts should be of sufficient scale to transform the residential thermostat market, and I think a good goal for FirstEnergy's territory would be 4% of residential customers per

[18] FirstEnergy includes smart thermostats as a measure in its plan in two places: the Smart Thermostat subprogram of the Energy Efficient Homes Program and as a measure in the HVAC subprogram of the Energy Efficient Products Program. The bulk of the smart thermostat measures will be delivered via the Smart Thermostat subprogram, which I understand will be delivered by IGS.

year, or 220,000 by the end of 2020. As I learned from the Northern Illinois smart thermostat rebate initiative, when a utility provides a significant commitment to moving the thermostat market toward smart thermostats, manufacturers will invest in their own marketing efforts. For example, when the utility rebate debuted in Northern Illinois, Nest deployed a large marketing campaign with ads on bus stops, train stations, a presence at various community events, and a customer education and thermostat giveaway event. Similarly, ecobee began heavily advertising the customer benefits of smart thermostats online. Even HVAC contractors began marketing smart thermostats and the rebates in the region. Smart thermostats are a relatively new technology and product class, and it will likely take significant investment in marketing and customer education from the utility and thermostat providers to reach high penetration targets. Customers at first are unlikely to fully understand how a smart thermostat can save on energy costs and maximize comfort as it learns a user's habits. A rebate and a concerted educational campaign from FirstEnergy and other Ohio utilities will help raise the profile of smart thermostats as an energy saving device and will allow many more customers to access the technology quickly. This spending will produce greater results and economies of scale if the targets are sufficiently high. For instance, a well-run smart thermostat program will require several categories of non-incentive costs such as marketing, customer and contractor outreach, administration, and rebate processing. Higher smart thermostat goals will see lower non-incentive spending per unit and per kWh saved.

Q. WHAT DO YOU RECOMMEND AS SMART THERMOSTAT REBATE AMOUNT?

A. FirstEnergy should set the rebate at $100, or in the case of a joint program with gas utilities, ensure that a customer can access a rebate of at least $100 between the electric and gas utility. $100 would cover roughly 40% of the cost of a smart thermostat, which is generally the amount necessary to incent the average utility customer to take action. When we were developing the program in Northern Illinois, all of the involved parties agreed that a $100 rebate was high enough that it would grab people's attention. FirstEnergy should aim to reach 12% of its customers with a smart thermostat in the first three years of the plan, which amounts to roughly 73,000 per year. After three years, the program should be re-assessed and changed if needed in light of new technologies, program and device performance, market conditions, and smart thermostat prices. Ultimately, FirstEnergy's goal should be to reach most customer homes with a smart thermostat.

Q. HOW SHOULD FIRSTENERGY FUND THIS INCREASED SMART THERMOSTAT EFFORT?

A. I recommend that FirstEnergy reduce its spending on EE Kits by 50% and instead allocate that money toward retail rebates and direct installations of smart thermostats. Further, FirstEnergy should limit incentives for standard programmable thermostats to only low income customers who do not have Wi-Fi and are unlikely to install Wi-Fi in the near future, and shift those funds to smart thermostats as well.

Q. HOW CAN FIRSTENERGY ENGAGE MORE OF ITS CUSTOMERS ON SMART THERMOSTATS?

A. FirstEnergy should undertake a customer education effort to reach as many of its customers as possible with information on the energy savings potential of smart thermostats. When FirstEnergy makes this commitment, thermostat providers are likely to engage in their own marketing campaigns as well.

Q. THROUGH WHAT CHANNELS SHOULD THE SMART THERMOSTATS BE DELIVERED?

A. I recommend that FirstEnergy use several channels for reaching its customers with rebated smart thermostats. A retail rebate program is the most important channel, which will allow customers to purchase a qualifying thermostat in a retail store or online, install it themselves, and then apply for the utility rebate. A direct install option is also important, which will allow customers who are not comfortable with the installation to have the thermostat professionally installed by a professional, or will allow utility contractors to install a smart thermostat during a residential energy assessment. Finally, FirstEnergy should engage with trade allies and other parties as a third installation channel for rebated smart thermostats. My understanding of the proposed portfolio is that this third channel is how IGS will be involved with the FirstEnergy smart thermostat rebates.

Q. SHOULD THE SMART THERMOSTAT SUBPROGRAM INCLUDE PARTIES BEYOND FIRSTENERGY AND IGS?

A. FirstEnergy should work with parties beyond IGS to develop a program to deliver smart thermostat rebates and direct installations to customers. While I do not know the details of the agreement between FirstEnergy and IGS, I know from my experience coordinating Northern Illinois's smart thermostat initiative that encouraging competition, openness, and innovation among interested parties can benefit the consumer. In Northern Illinois, ComEd and the gas companies developed a specification for what smart thermostats qualified for their rebate and engaged directly with trade allies to ensure they understood the devices and how they can help customers save energy. Parties such as ELPC, the Citizens Utility Board, the City of Chicago, thermostat manufacturers, and others provided input and worked collaboratively to sell the benefits of the program to customers. A year into the program, we have seen qualifying devices grow from two to eight, prices have come down on several models, and manufacturers have shared market segmentation data, focus group findings, and sales statistics with the utilities and other interested stakeholders. FirstEnergy should involve parties its smart thermostat subprogram beyond IGS.

Q. HAVE PROGRAMS LIKE THIS BEEN IMPLEMENTED ELSEWHERE?

A. Yes. Commonwealth Edison, in Northern Illinois, launched a smart thermostat rebate program in October 2015 in conjunction with the gas utilities in the region. Participants in this program can receive a mail-in rebate of $100 from ComEd and $20 from the gas companies toward the purchase of a qualifying smart thermostat (as of June 1, 2016, the gas companies increased their rebate to $50). Additionally, smart thermostats are available at a discounted price of $150 via direct install in ComEd's Home Energy Assessment program that is jointly administered with the gas utilities. Finally, customers can receive a $125 rebate from ComEd when they have an HVAC contractor professionally install a smart thermostat. In its first 10 months, the program has been a success, providing rebates and incentives for 35,000 smart thermostats.

<u>EE Kits</u>

Q. DOES FIRSTENERGY PROPOSE TO USE ENERGY EFFICIENCY KITS IN ITS PLAN?

A. Yes. FirstEnergy proposes to dedicate $22.4 million to opt-in energy efficiency kits incentives, plus operations costs. While FirstEnergy has not finalized its kit contents, the savings values proposed in the plan are based on kits that contain one 23-watt CFL, one 3-way CFL, six LEDs, two LED nightlights, a furnace whistle, and two low-flow faucet aerators. FirstEnergy proposes that customers can request a kit be mailed to them.

Q. DO YOU HAVE AN OPINION ABOUT THE EFFECTIVENESS OF THESE KITS?

A. I believe the kits are not a prudent use of efficiency budget, and they should be scaled back by at least 50% to be used only for low-income and multifamily customers. FirstEnergy should direct 50% of the proposed kit funding to comprehensive audits and direct-install measures, such as lighting, smart thermostats, and smart power strips.

Q. IS IT LIKELY THAT ALL OF THE KIT MEASURES WILL BE INSTALLED AS INTENDED?

A. No. The 2016 PA TRM, which FirstEnergy uses as a source for its savings and in service rate (ISR) assumptions, assumes the following ISRs for kit contents:

- CFL: 0.92
- 3-way CFL: 0.92
- LED: 1.0
- LED Nightlight: 0.3
- Furnace Whistle: 0.1
- Low Flow Aerator: 0.14.

In other words, the PA TRM assumes that for every kit that is mailed, 90% of the furnace whistles, 70% of the LED nightlights, and 86% of the low flow aerators are not installed, while over 90% of the lightbulbs are installed. The FirstEnergy 2015 Status Report Evaluation indicates that actual installation rates in Ohio are lower for the lighting measures than the PA-TRM estimates: 23 watt CFLs had ISRs of 0.78 versus the PA TRM value of 0.92; 3-way CFLs had ISRs of 0.76 versus the PA-TRM value of 0.92; and LED nightlight ISRs were 0.27, versus PA-TRM values of 0.30. 12.5 watt LEDs were not evaluated, but given that all other kit lighting measures had ISRs of 0.88 or lower in 2015, I do not believe that kit LEDs as proposed by FirstEnergy will have ISRs of 1.0 as assumed in the PA-TRM and FirstEnergy plan. The money proposed for kits would be better spent on audits and direct install measures where ISRs are higher.[19]

[19] Home Performance Program Evaluation, Measurement, and Verification Report, 2015. http://dis.puc.state.oh.us/TiffToPDf/A1001001A16E12B10005H04417_4.pdf, Section 5-10

Despite having evaluated savings results for kits in FirstEnergy territory, the FirstEnergy plan relies on the PA TRM. Where actual evaluated results are available for EE measures in FirstEnergy territory, those savings values should be used for planning and for prospectively crediting savings of measures to the utility program.

Another issue with EE kits is that the recipient may install the measures in a less-than-ideal way or not at all. For example, a customer may use a kit-provided LED to replace a still-functioning CFL, rather than replacing their incandescent or halogen bulbs. Alternatively, a kit recipient may install an LED in a low-usage application, such as a closet light socket while leaving an incandescent in a high-usage socket. Finally, a resident may request a kit and simply not install all eight energy-efficient lightbulbs if they have no use for a 3-way CFL, 100-watt equivalent CFL, or LED nightlights. These problems tend to decrease when lighting and the other kit measures are installed by an energy auditor during an energy audit, where the lighting measures can be matched to the lighting needs.

Q. IN WHAT SITUATIONS DO YOU RECOMMEND ENERGY EFFICIENCY KITS BE USED?

A. Kits do have merit in certain circumstances, such as for low- and moderate-income customers, and for customers who live in multifamily buildings. These two groups tend to be harder to reach with energy efficiency measures. Lower income individuals may not have the funds to purchase energy efficient lighting or may not have access to information about energy savings technology. Multifamily building residents may not want to invest in a higher-cost LED when they are not responsible for their apartment's electricity bill, or if they might not plan to live in their apartment for long enough to recoup the investment. In these cases, kits can provide access to energy-saving LED lighting that otherwise may not be installed by a resident.

Q. ARE THERE ANY OTHER BEST PRACTICE IDEAS THAT FIRSTENERGY SHOULD CONSIDER?

A. Yes. FirstEnergy should be following examples of other utility efficiency program best practice ideas.

First, FirstEnergy should coordinate with gas companies on jointly-delivered programs that have both gas and electric savings. These may include audits and direct install efforts, residential and small business retrofits and weatherization, smart thermostat rebates, and other programs. Delivery of an energy audit that assesses electricity and gas savings and provides incentives for measures that reduce kilowatt hours and therms can help reduce the cost of the savings and allow for deeper savings measures. Columbia Gas, for instance, offers energy efficiency programs for its customers, some of which are in FirstEnergy territory. While the measures offered obviously target gas savings, many happen to have electricity savings as well. Jointly delivering energy audits, direct install measures, weatherization, and smart thermostat rebates with Columbia Gas would be one way for FirstEnergy to make its energy efficiency budgets reach more customers with deeper savings.

Second, FirstEnergy should emphasize "smart" measures that can help automate savings and provide a platform for additional efficiency services and savings. Beyond smart thermostats, which I covered extensively earlier in my testimony, these include advanced or smart power strips, smart pumps, and lighting controls, which all have energy savings, but may also be utilized to provide demand response opportunities for FirstEnergy customers. As I mentioned earlier, demand response reduces peak load, which is generally more expensive to procure, and in turn can reduce energy costs for the utility. Some smart devices, such as smart thermostats and advanced power strips can provide real-time energy usage data, which may be of assistance in evaluating programs or in tailoring program delivery strategies to optimize performance.

Third, FirstEnergy should move some of its rebates and incentives upstream. An upstream rebate means that FirstEnergy would pay incentives to distributors, dealers, or even manufacturers of energy efficiency measures before a measure is installed, rather than directly to the customer after they have installed a measure. Those parties, in turn, pass on the savings to customers so customers do not have to take any extra steps to receive a rebate. This helps reduce transaction costs and the time customers must invest to take advantage of FirstEnergy's incentives. It also can help drive program participation and product promotion from retailers and contractors who would offer a superior, energy-saving measure at a discounted price. Measures that could potentially use upstream rebates include lighting, appliances, smart pumps, heat pumps, and smart thermostats. I am aware of several utility programs that have successfully used midstream or upstream rebates to improve uptake and/or reduce transaction costs. When

Energize Connecticut moved its HVAC rebates from a downstream, mail-in-rebate to an upstream rebate provided to distributors, participation grew from 270 in 2014 to 1502 in 2015.[20] Efficiency Vermont piloted midstream smart pump rebates in 2013 and saw growth from an average of 62 rebates per year when the rebates were provided downstream to 2,870 when they were provided to wholesale distributors.[21]

Fourth, FirstEnergy should detail a specific plan for offering rebates and incentives for weatherization measures, such as insulation, air sealing, and duct sealing. FirstEnergy's proposed plan makes brief mention of weatherization in Appendix C-3 when it describes its Comprehensive Audit and Multifamily audit measures: "Comprehensive measures that are eligible for incentives, as a result of diagnostics and testing include, but are not limited to: Windows, Duct Sealing, and Wall & Attic Insulation, etc.". However, the plan provides little other detail on how these measures will be delivered or promoted, or how many of each weatherization measure FirstEnergy estimates it will perform. Weatherization is an important component of any best practice portfolio, as it generates significant, durable energy savings and non-energy benefits that last for 20 years. However, because weatherization takes more planning and is more costly, most customers will not weatherize their home or business without utility incentives. Unlike appliances, where standards and improving technology mean that customers tend to replace old devices with more efficient new ones, there is no similar "natural" improvement in efficiency of customer building shells without utility incentives and

[20] http://aceee.org/sites/default/files/pdf/conferences/eer/2015/Jennifer_Parsons_Session4A_EER15_9.22.15.pdf

[21] http://ilsagfiles.org/SAG_files/Meeting_Materials/2015/November_2015_Meetings/SAG_Presentation_November_2015_Grundfos.pdf page 23.

promotion of insulation, air sealing, and duct sealing. The Commission should order FirstEnergy to develop a detailed plan for delivery of weatherization measures to customer homes and businesses, complete with goals, delivery strategy, and marketing plans. Further, FirstEnergy should specifically target weatherization measures to the participants in its Energy Efficient New Homes subprogram to ensure new homes are weatherized from the start.

<u>LED Streetlighting</u>

Q. DOES FIRSTENERGY PROPOSE TO OFFER LED STREET LIGHTING INCENTIVES IN ITS PLAN?

A. Yes. Under the Government Tariff Lighting Program, FirstEnergy proposes to offer financial incentives for efficient street lighting or traffic lighting on customer owned lights. FirstEnergy estimates that over the three year proposed plan, it will provide incentives for 1,320 LED traffic signals and 3,100 customer-owned street and area lights.

Q. DO YOU THINK THE PROPOSED GOVERNMENT TARIFF LIGHTING PROGRAM IS ADEQUATE?

A. I am glad to see LED traffic signals and street and area lights as eligible measures in the proposed plan. However, I believe that FirstEnergy should increase the number of units for which it plans to provide incentives. Traffic, street, and area lights, when converted to efficient LEDs, generate significant operational savings through lower energy use and reduced maintenance needs. Most streetlights run for eight hours every single night, which means savings of efficient LED streetlights are fairly predictable and low risk.

Additionally, the quality of light and durability of LED fixtures can provide public safety benefits. Despite these benefits, the upfront capital cost of converting a fleet of streetlights poses a challenge many cities with competing budget priorities. Thus, utility incentive programs, like the proposed Government Tariff Lighting Program, should be encouraged and expanded. While the plan and Market Potential Study do not include a breakdown of the total number of traffic signals, street lights, and area lights in FirstEnergy territory, it does note that FirstEnergy has 3,650 streetlighting customers. I have reason to believe that there is potential in FirstEnergy territory for many more LED streetlight conversions than the utility has budgeted for in this Portfolio. Because of economies of scale, it often makes economical and logistical sense for municipalities to convert their streetlights *en masse*, which will usually means a few thousand at a time. FirstEnergy's plan allocates only enough resources for 1,320 traffic signals and 3,100 street and area lights – which could easily be consumed by one small city's streetlight fleet. FirstEnergy should at least triple its proposed budget and goals for the Government Tariff Lighting Program and aim to provide incentives for at least three municipalities in FirstEnergy territory to fully convert its outdoor lighting stock to LEDs.

Customer Action Program

Q. PLEASE EXPLAIN FIRSTENERGY'S PROPOSED CUSTOMER ACTION PROGRAM.

A. FirstEnergy has proposed counting savings from the Customer Action Program (CAP) in three areas: Residential, Small Enterprise, and Large Enterprise. The CAP plans to quantify and claim credit for savings and peak demand reductions achieved by customers outside of utility-administered programs. Over the three-year plan, FirstEnergy proposes spending $4.9 million on the Customer Action Plan and claiming 192,997,956 kWh in savings. This spending will not be on any incentives, marketing, or program administration – it will strictly be used on evaluating the savings from measures customers will take on their own.

Q. DO YOU THINK THE SIZE OF FIRSTENERGY'S PROPOSED SPENDING AND CLAIMED SAVINGS ON THE CAP ARE REASONABLE?

A. No. The nearly $5 million that FirstEnergy allocates to the Customer Action Program is not a prudent use of ratepayer funds. The purpose of a utility energy efficiency portfolio is to implement programs that achieve energy savings. The Customer Action Program does not represent implementation of a program, nor does it cause any energy savings. Unlike other utility energy efficiency measures, it is not eligible to be bid into PJM's capacity markets. The Customer Action Program is simply an expensive counting exercise that will allow FirstEnergy to claim an additional 192,997,956 million kWh that customers will undertake without any incentive, rebate, or assistance from the utility. While the law does allow utilities to claim customer actions toward their efficiency goals, the Customer Action Program is far from a best practice idea, and FirstEnergy should not receive shared savings for the actions its customers take outside of utility programs.

The funds allocated toward the Customer Action Program should be reduced as low as possible, because they do not produce real results, and those funds should be directed other programs that actually produce savings.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes. I summarized my main points at the beginning of my testimony. I believe that the recommendations I make above will improve FirstEnergy's programs and provide customers with additional benefits.

CERTIFICATE OF SERVICE

I hereby certify that a true copy of the foregoing *Direct Testimony of John Paul Jewell* submitted on behalf of the Environmental Law & Policy Center was served by electronic mail upon the following Parties of Record on September 13, 2016.

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rdove@attomeydove.com
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DIRECT TESTIMONY OF JOHN PAUL JEWELL
ON BEHALF OF
ENVIRONMENTAL LAW & POLICY CENTER

September 13, 2016

<u>Exhibit A</u>

JOHN PAUL JEWELL

35E. Wacker Dr. Ste 1600 Chicago, IL 60601
jpjewell@elpc.org

EXPERIENCE

2013 – Present | **Environmental Law & Policy Center –** *Clean Energy Finance Specialist* | *Chicago, IL*

- Direct company research initiatives and manage project teams to write and publish reports on the clean energy and transportation manufacturing supply chains in Midwestern states.
- Quantify economic, environmental, and technical benefits of clean energy and transportation and advocate for better policies in regulatory proceedings and legislative processes.
- Lead efforts to introduce smart thermostats as an energy saving measure for utility customers in Northern Illinois. Coordinate customer education and marketing campaign design efforts with utilities, consumer advocates, and smart thermostat manufacturers.

2011 – 2013 | **Vestas Wind Systems –** *Graduate Program, Sales and Planning*

Rotation 1: Vestas Americas, Regional Sales Portfolio, *Portland, OR*

- Served as lead project manager for implementation of new forecasting process to reduce inventories and production costs in regional sales units.

Rotation 2: Global Supply Chain Management, *Aarhus, DK*

- Updated 3-year sales forecast and allocated $7B yearly production capacity to sales territories.
- Analyzed KPIs to assess sales and supply risks and presented weekly to management.

Rotation 3: Sales Eastern Europe and Austria, *Hamburg, DE*

- Supported sales teams to generate and follow leads, structure deals, and engage with customers.
- Implemented training program to improve sales process in emerging European markets.

2009 – 2011 | **Dairy Farmers of America, Inc. –** *Industry and Public Affairs Coordinator* | *Kansas City, MO*

- Developed strategy, forged partnerships, and implemented projects to measure and reduce environmental impacts and improve sustainability of farms, factories, and transportation.
- Conducted energy efficiency audits on member dairy farms.
- Managed operations and marketing for Dairy Energy Services. Won two awards at National Milk Producers Federation Communications Competition for communications efforts.
- Reached 18,000 farmers with renewable energy information via mailings and workshops.

2008 | **Environmental Defense Fund –** *Summer Associate* | *Boston, MA*

- Structured proposal for strategic efficiency partnership with finance and real estate firms.
- Modeled energy and financial impacts of efficiency upgrades to commercial buildings.

2007 | **Center for Development Finance** – *Summer Associate* | *Chennai, India*

- Developed methodology to rate firms on environmental, social, and governance metrics.

EDUCATION

2006 – 2009 | **Yale School of Management** | *New Haven, CT*
Yale School of Forestry and Environmental Studies

Master of Business Administration, Master of Environmental Management

- GMAT: 770 (99^{th} percentile).
- Recipient of Grantham Award in Business and the Environment.
- Economics teaching fellow for 3 semesters.

2002 – 2006 | **University of Chicago** | *Chicago, IL*

Bachelor of Arts with High Honors: Environmental Studies, Anthropology

- GPA: 3.6, Maroon Key Society.

ADDITIONAL INFORMATION

- Microsoft Office, ArcGIS, Adobe Illustrator and Photoshop, SAP BI.
- Native English, Intermediate French, Beginner Spanish, Beginner German.
- Participant in 2015 inaugural Crain's Chicago Leadership Academy.

DIRECT TESTIMONY OF JOHN PAUL JEWELL
ON BEHALF OF
ENVIRONMENTAL LAW & POLICY CENTER

September 13, 2016

Exhibit B

Opinion Dynamics

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

March 20, 2013

VERMONT ENERGY INVESTMENT CORPORATION

MAD DASH FIELD SERVICES

Research Objectives

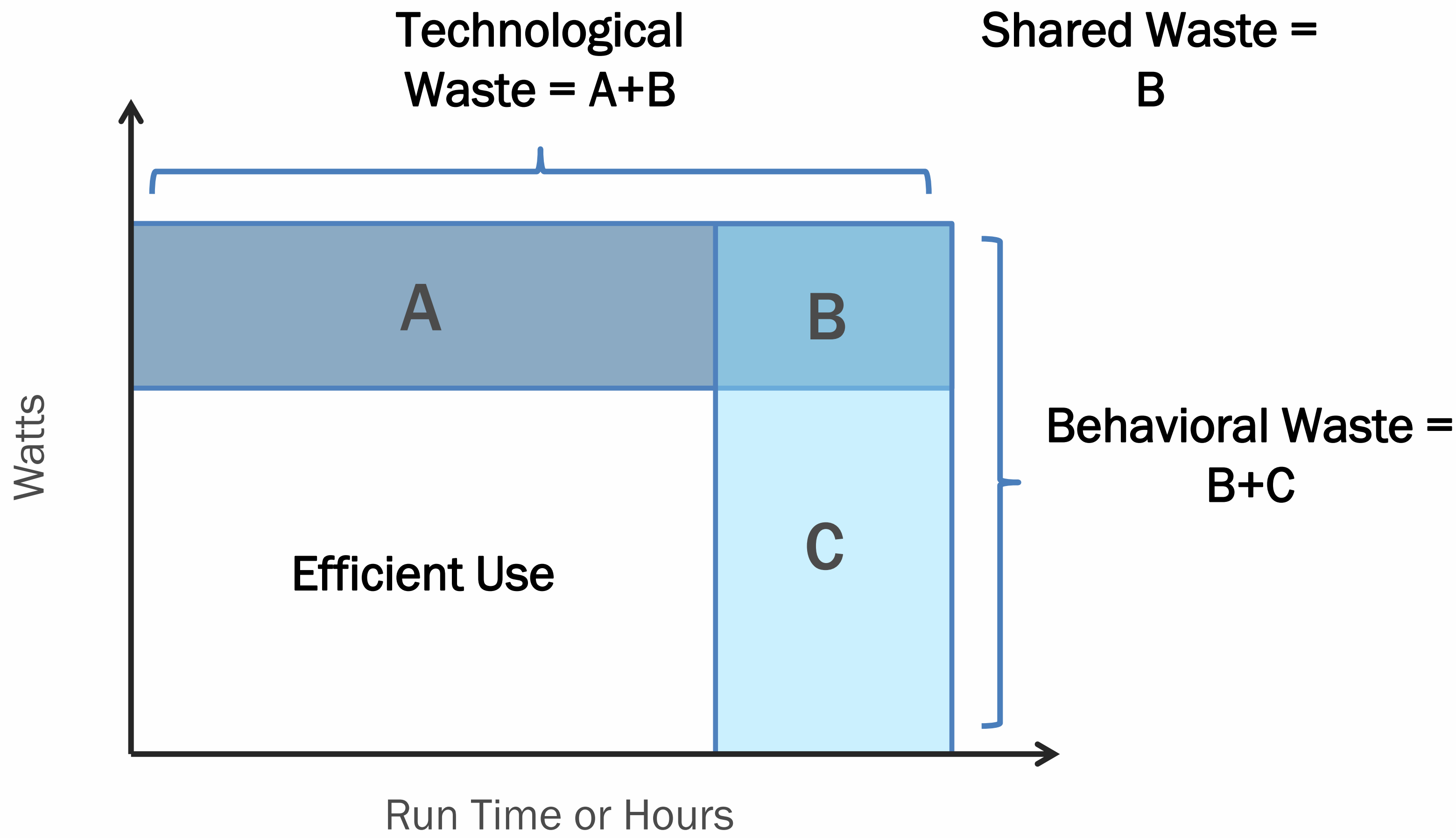
- Support ComEd's program planning and gap identification efforts
- Provide a comprehensive assessment of usage and waste at the end-use level
- Develop energy use profiles by end-use and segment that quantify:
  - Current usage
  - Energy waste due to inefficient technologies
  - Energy waste due to inefficient customer behaviors
  - "Efficient" energy usage

Opinion **Dynamics**

Methodology

- End-uses included in usage and waste analysis:
  - Residential
    - Lighting
    - Cooling
    - Electric Space Heating
    - Electric Water Heating
    - Major Appliances
    - Electronics & Computing
  - Commercial & Industrial
    - Lighting
    - Cooling
    - Ventilation
    - Refrigeration
    - Motors
    - Office Equipment
- Extensive primary data collection and metering
- Determination of efficient technologies and behaviors for each end-use
- Enhanced engineering analysis to assess energy usage and waste

Conceptualizing Usage and Waste

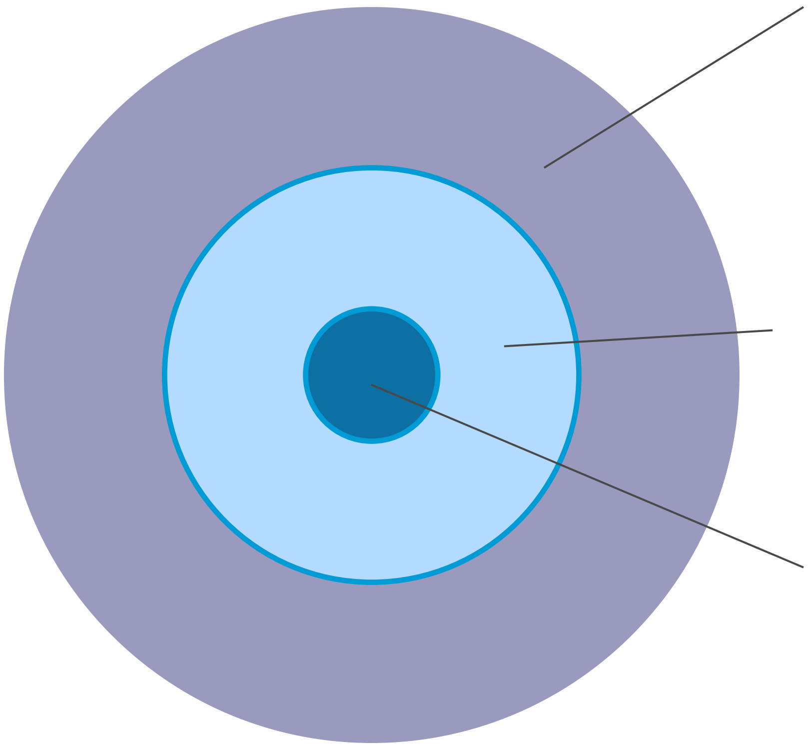


Opinion **Dynamics**

Residential Study

Residential Primary Data Collection

June - October 2012



Mail Survey: 4,414 completes
- Penetration/saturation
- Behavioral/operational practices

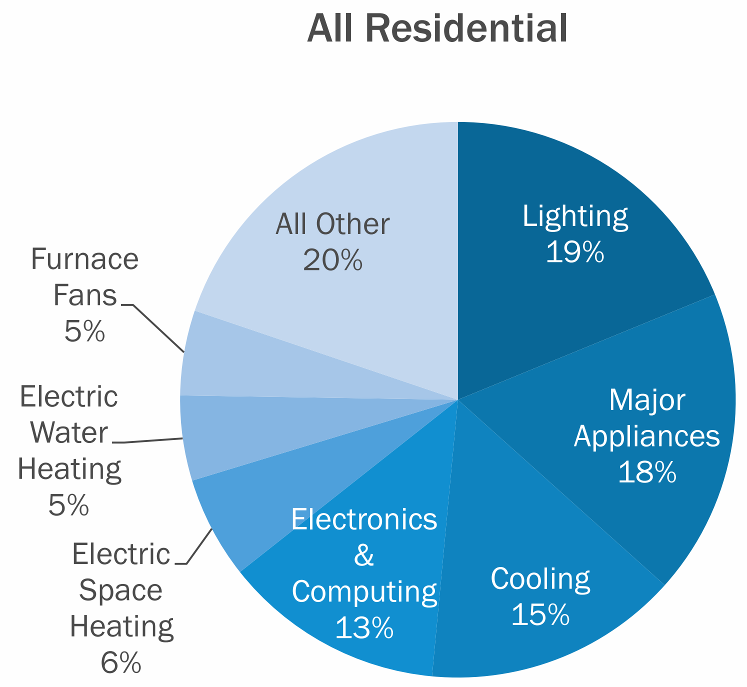
In-Home Audits: 297 completes
- Penetration/saturation
- Equipment technical specifications

Monitoring: 140 completes
- Current logging on all circuits
- Lighting /occupancy
- Temperature and humidity

Opinion Dynamics

Residential End-Use Profile: Current Usage

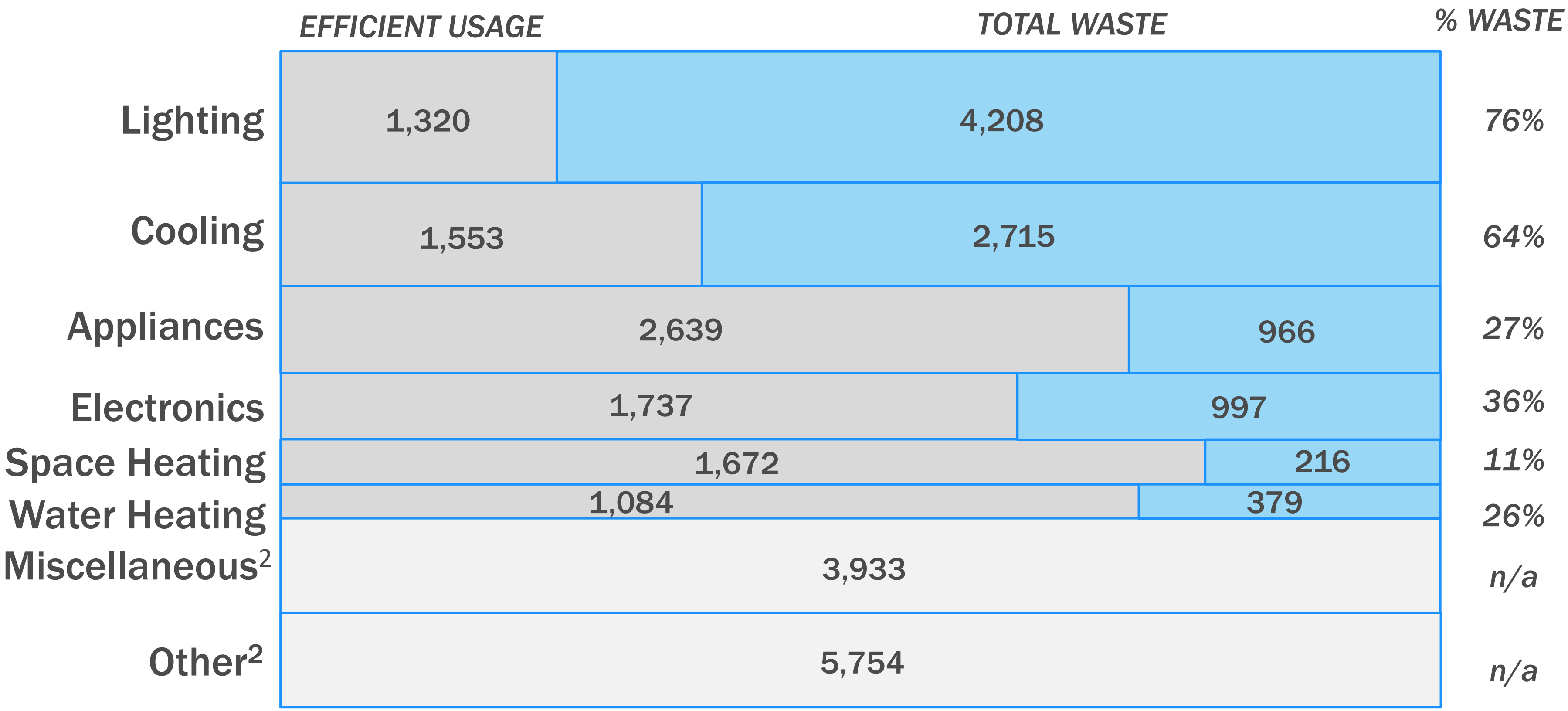
	All Res.	Single Family	Multi-family
Lighting	19%	21%	13%
Major Appliances	18%	17%	20%
Cooling	15%	15%	12%
Electronics & Computing	13%	12%	17%
Electronic Space Heating	6%	4%	14%
Electric Water Heating	5%	3%	12%
Furnace Fans	5%	5%	3%
All Other	20%	23%	7%
TOTAL	100%	100%	100%



Opinion **Dynamics**

Residential Usage and Waste Summary

Annual GWh for ComEd Residential Customers[1]



Opinion **Dynamics**

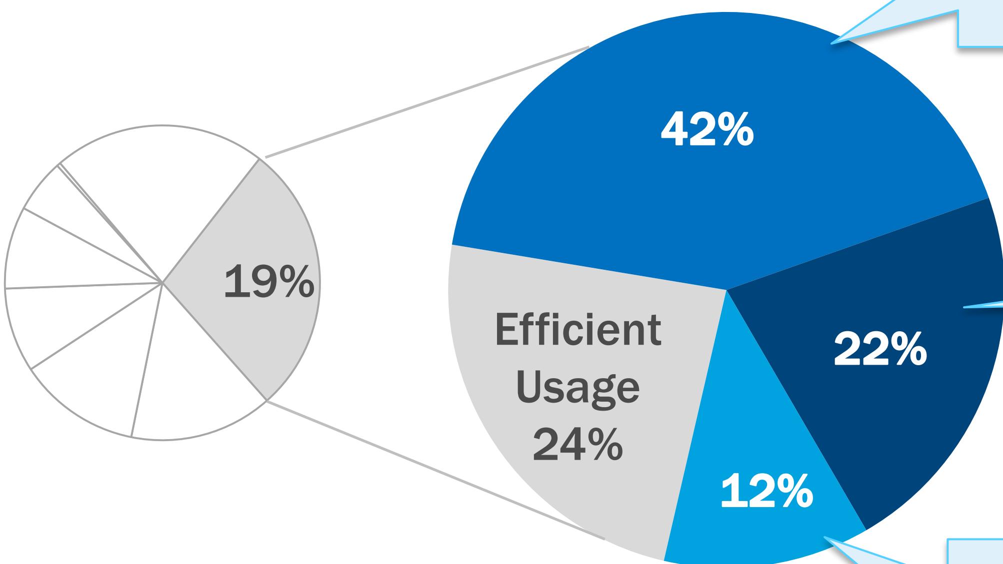
[1] Values sum to total 2011 GWh for in-scope residential customers
[2] Total current usage, waste not estimated

Residential Lighting Usage and Waste Results

Penetration: 100%

Current Usage: 5,528 GWh

Current Waste: 4,208 GWh



Technology Waste: 42-64%

- Upgrade incandescent and halogen bulbs to CFLs

Shared Waste*

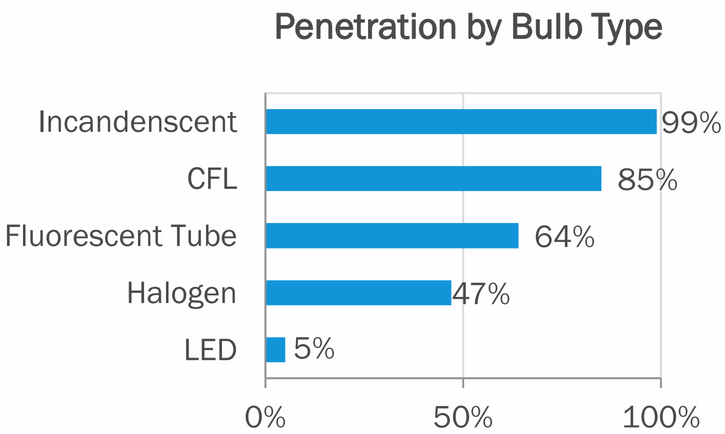
Behavioral Waste: 12-34%

- Turn off lights when room not in use (15-minute time-out)

Opinion **Dynamics**

* Either technology or behavioral waste, depending on which is addressed first

Residential Lighting Highlights



Single Family	Multi-Family
100%	98%
90%	75%
72%	49%
50%	40%
7%	3%

- Lighting technology waste is high due to high socket saturation of incandescents
- Socket saturation of CFLs still relatively low
- Very few homes have LEDs

- Single family homes have higher CFL penetration but lower socket saturation compared to multi-family homes

	All Res.	Single Family	Multi-family
Mean number of light bulbs	57	73	29
% incandescent bulbs	63%	65%	56%
% CFLs	23%	20%	27%
% fluorescent tubes	7%	8%	6%
% halogen	6%	4%	8%

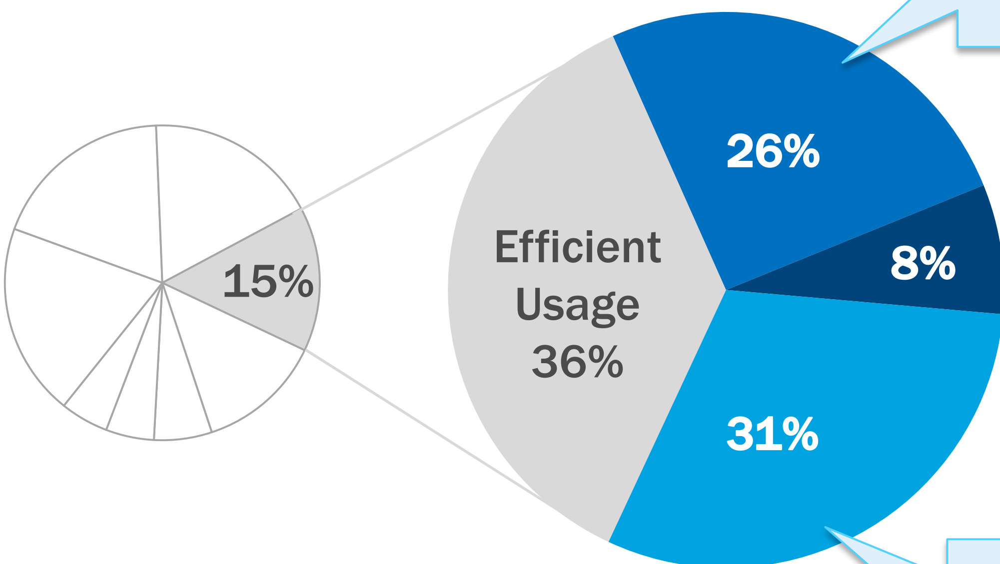
Opinion **Dynamics**

Residential Cooling Usage and Waste Results

Penetration: 97%

Current Usage: 4,268 GWh

Current Waste: 2,715 GWh



Technology Waste: 26-33%

- Upgrade to new Energy Star units
- Add insulation and duct sealing

Shared Waste*

Behavioral Waste: 31-38%

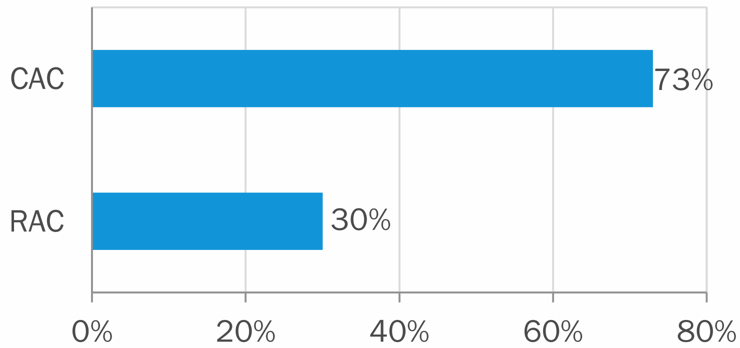
- Increase temperature setpoints
- Perform annual system maintenance

Opinion **Dynamics**

* Either technology or behavioral waste, depending on which is addressed first

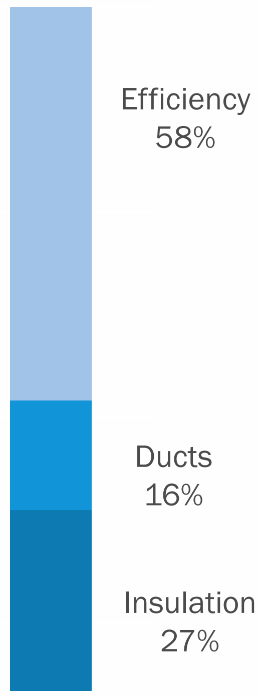
Residential Cooling Highlights: Technology Waste

Penetration By Type of Cooling Equipment



	Single Family	Multi-Family
CAC	87%	46%
RAC	18%	52%

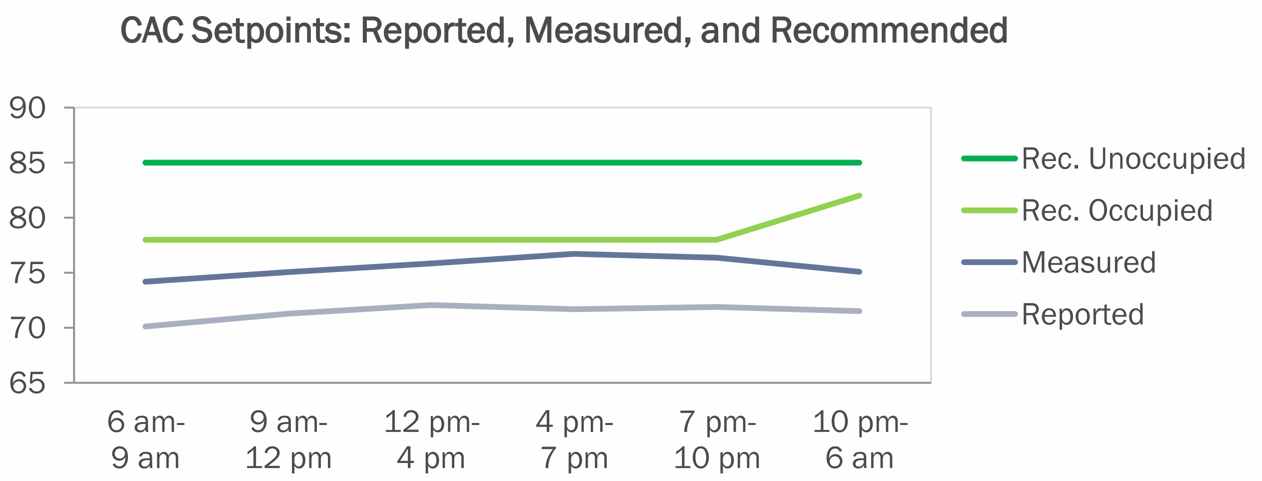
CAC Technology Waste

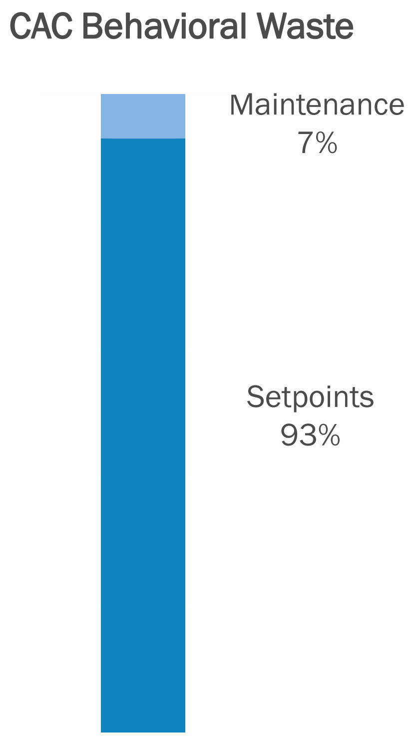


- 73% of households have CAC
- CAC represents 94% of cooling usage
- Upgrading to efficient units presents largest opportunity for technology savings
- Estimated categories of waste are interactive

Opinion **Dynamics**

Residential Cooling Highlights: Behavioral Waste





- Significant opportunities for savings from increasing setpoints
- But recommended setpoints are high
- Measured setpoints are higher than self-reported
- Estimated categories of waste are interactive

Opinion **Dynamics**

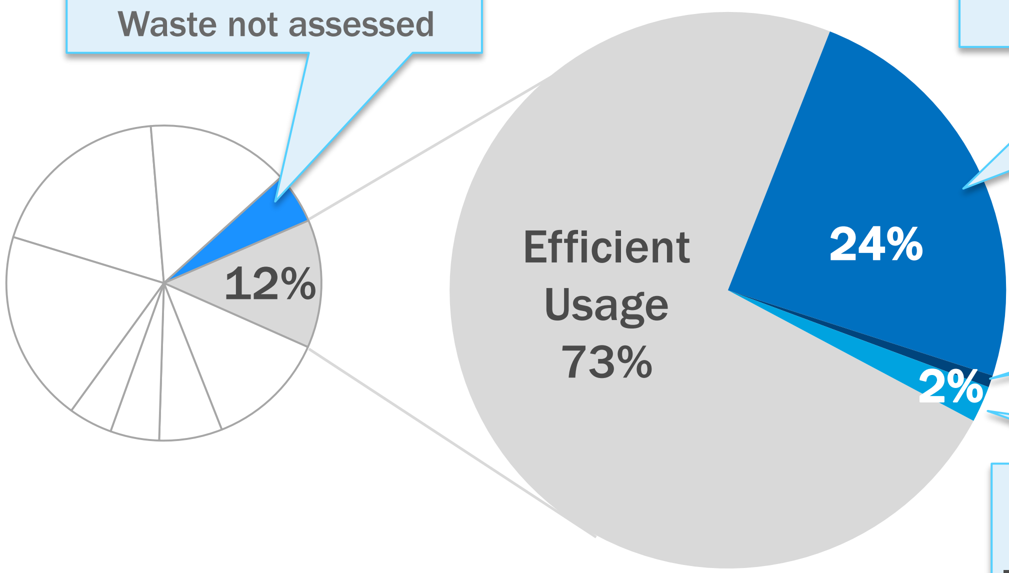
Residential Appliance Usage and Waste Results

Penetration: 100%

Current Usage: 3,475 GWh

Current Waste: 966 GWh

5% - Cooking Appliances Waste not assessed



Technology Waste: 24-25%

- Upgrade appliances to new Energy Star units

Shared Waste*

Behavioral Waste: 2-3%

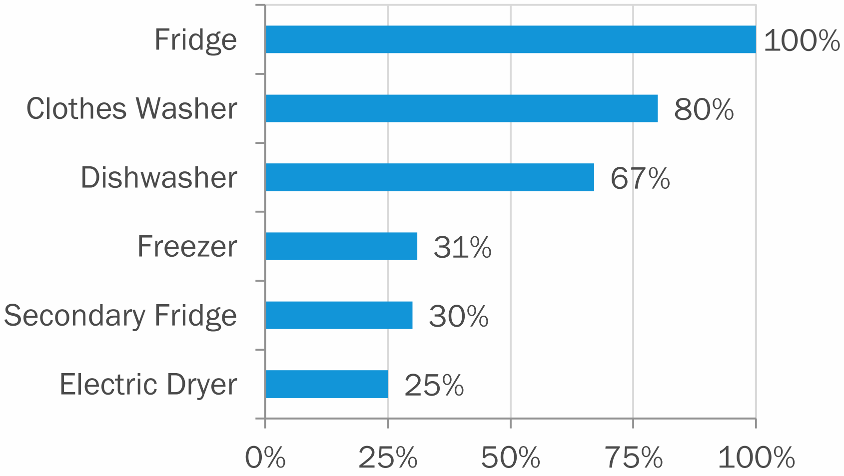
- Unplug unused fridges and freezers
- Use “no heat dry” feature on dishwashers
- Eliminate partial dishwasher loads
- Eliminate excessive hot water laundry usage

Opinion **Dynamics**

* Either technology or behavioral waste, depending on which is addressed first

Residential Appliance Highlights

Penetration by Appliance Type

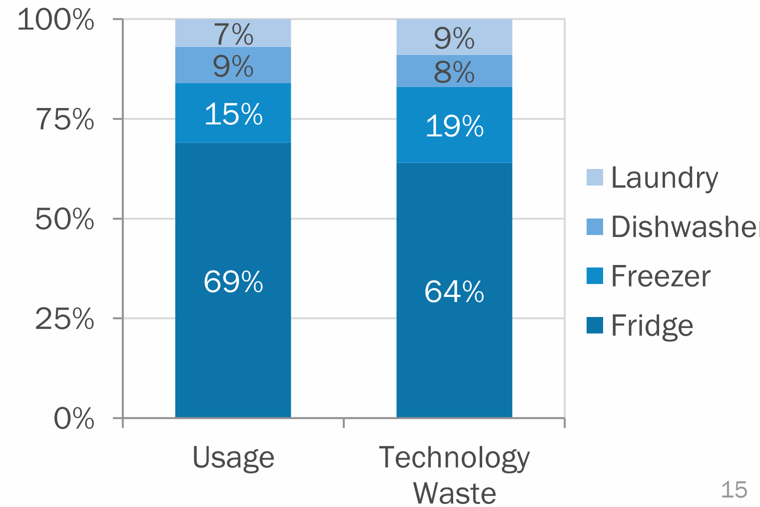


	Single Family	Multi-Family
Fridge	100%	100%
Clothes Washer	98%	47%
Dishwasher	75%	54%
Freezer	40%	13%
Secondary Fridge	42%	7%
Electric Dryer	26%	23%

- Relatively low incidence of electric dryers
- 42% of single family homes have secondary fridge

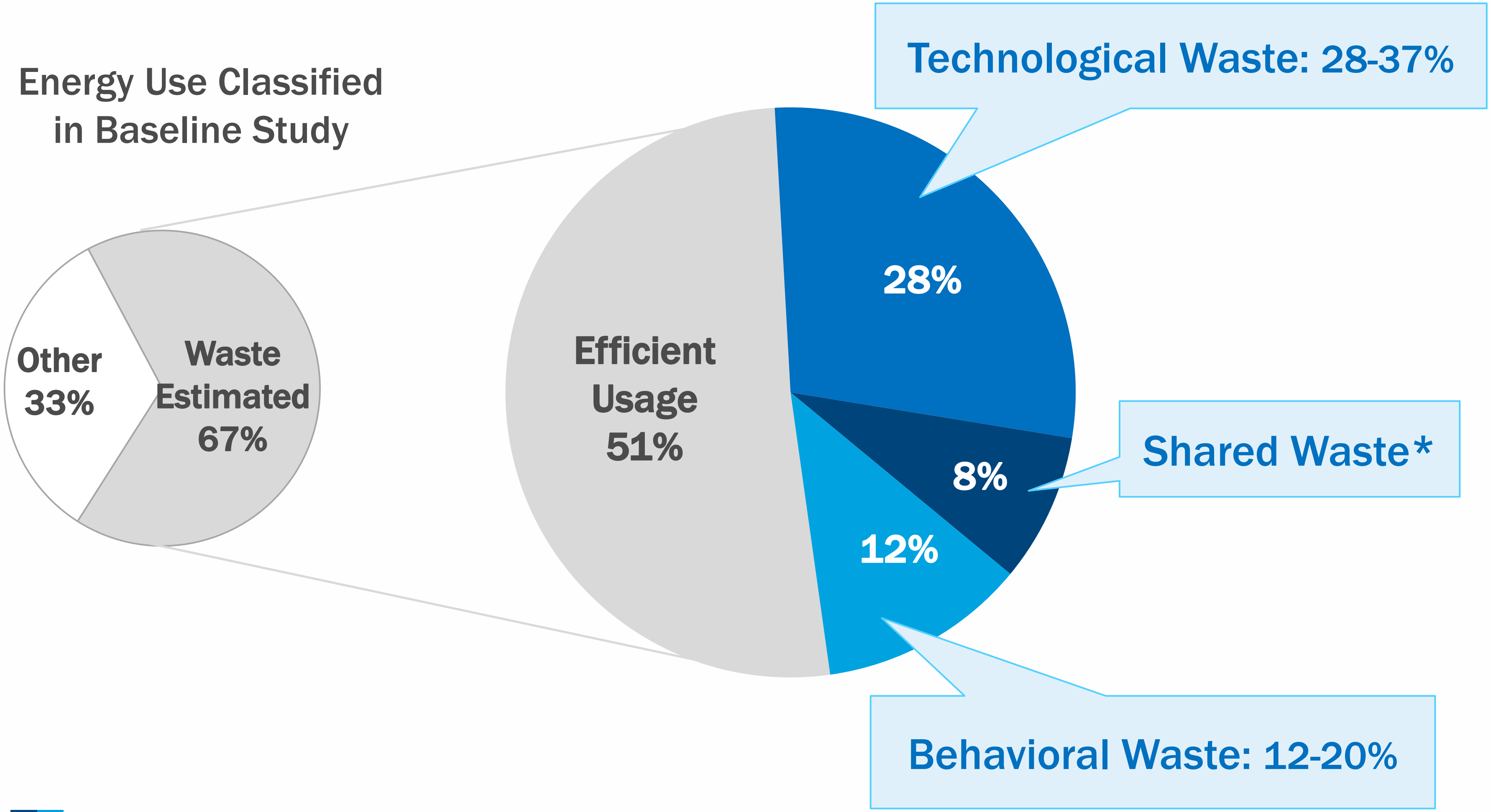
- Few units meet current Energy Star standards
- Freezers tend to be older and less efficient than fridges

Contribution to Appliance Usage and Waste



Opinion **Dynamics**

Residential Usage and Waste Summary



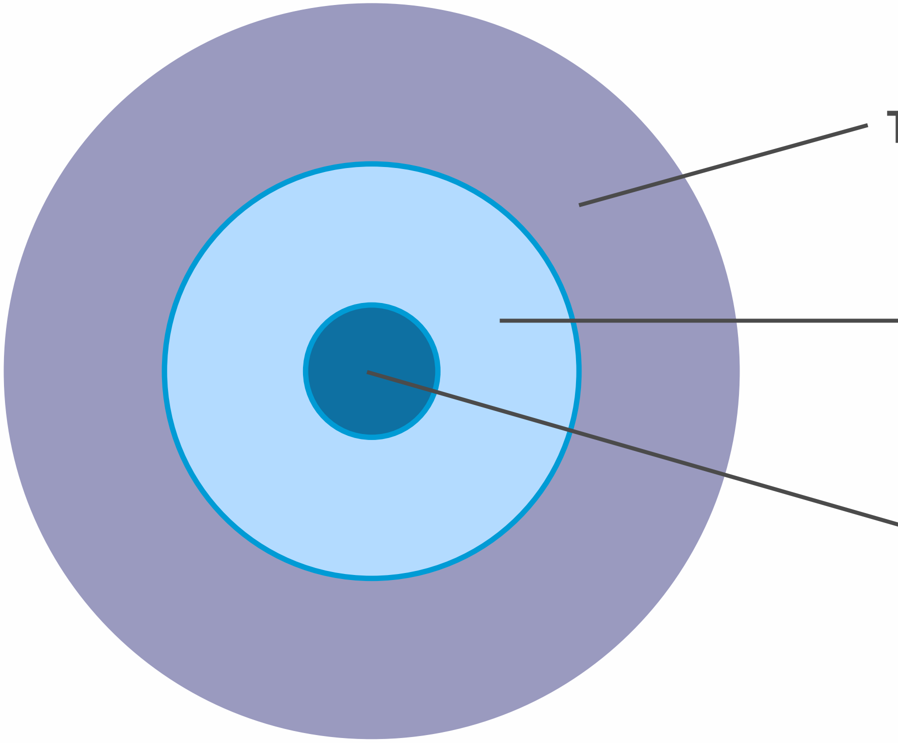
Opinion **Dynamics**

* Either technology or behavioral waste, depending on which is addressed first

Commercial & Industrial Study

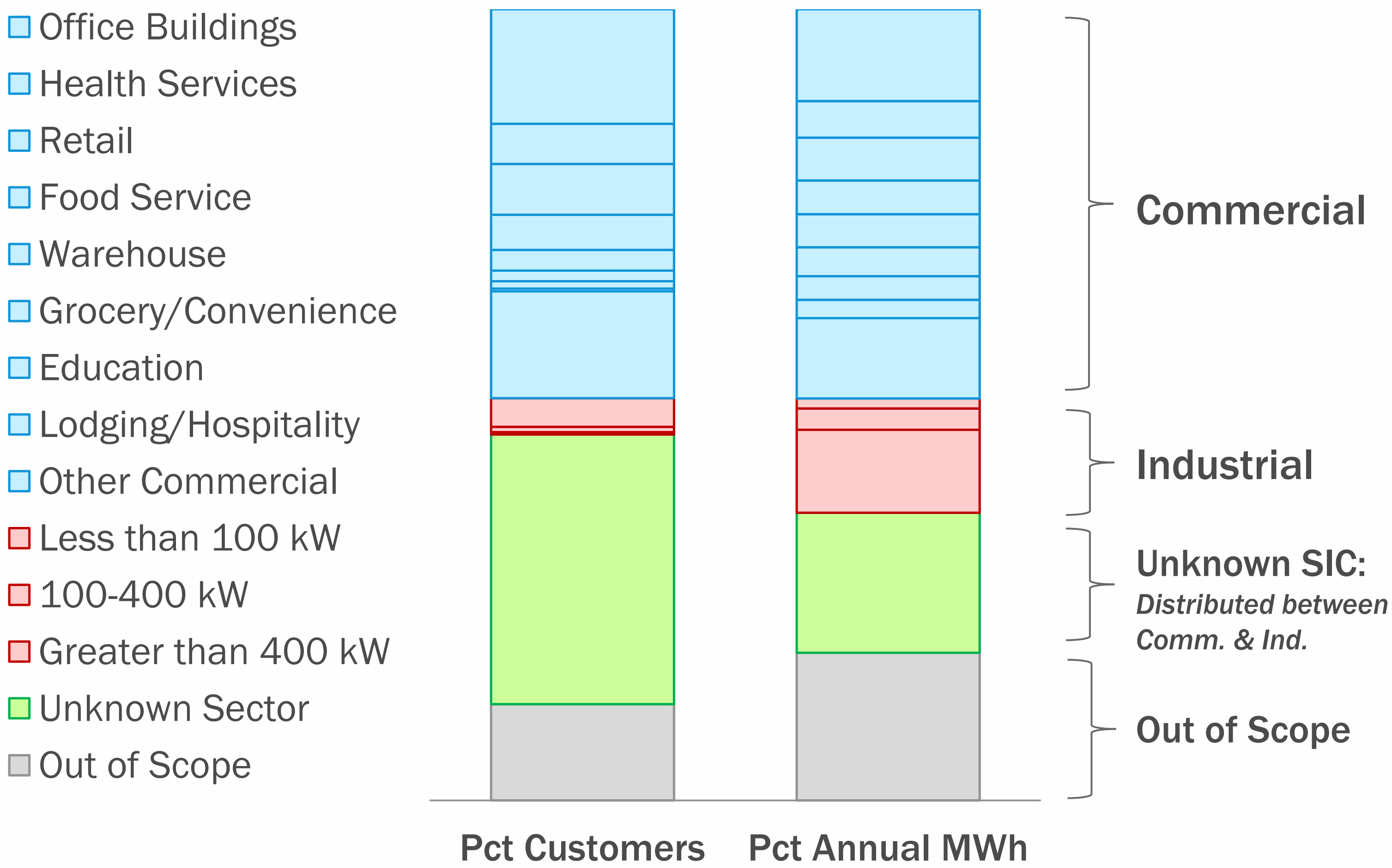
C&I Primary Data Collection

July – November 2012



Opinion Dynamics

ComEd Commercial & Industrial Customers

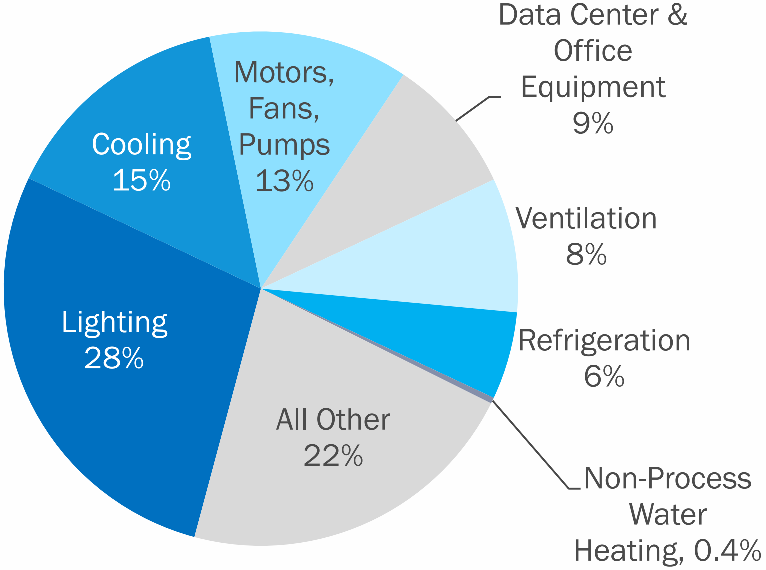


Opinion **Dynamics**

C&I End-Use Profile: Current Usage

	All C&I	Comm. Total	Industrial Total
Lighting	28%	31%	17%
Cooling	15%	15%	11%
Ventilation	8%	9%	7%
Motors, Pumps	13%	6%	36%
Refrigeration	6%	6%	1%
Data Center & Office Eqpt	9%	10%	3%
Non-Process Water Heating	0.4%	0.4%	0.2%
All Other	22%	22%	25%
TOTAL	*100%*	*100%*	*100%*

All Commercial & Industrial



Opinion **Dynamics**

C&I Usage and Waste Summary

Annual GWh for ComEd Commercial & Industrial Customers[1]

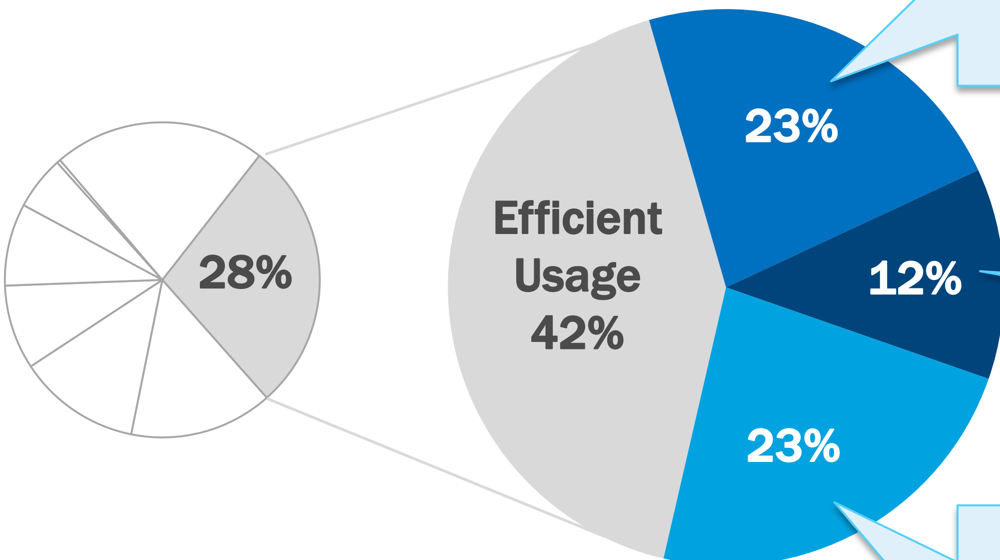
	EFFICIENT USAGE	TOTAL WASTE	% WASTE
Lighting	4,581	6,346	58%
Cooling	3,605	2,159	37%
Ventilation	2,940	368	11%
Motors[2]	4,739	185	4%
Office Eqpt[3]	1,415	1,981	58%
Refrig.	1,264	892	41%
All Other	8,689		n/a

Opinion Dynamics

[1] Values sum to total 2011 GWh for in-scope C&I customers
[2] Includes motors, fans and pumps
[3] Includes computers, imaging equipment, servers, TVs, cash registers

C&I Lighting Usage & Waste Results

Penetration: 100%
10,926 GWh Current Usage
6,356 GWh Current Waste



Technology Waste: 23-35%

- Upgrade to high-efficiency lamps, including LEDs
- Assume current lighting design

Shared Waste*

Behavioral Waste: 23-35%

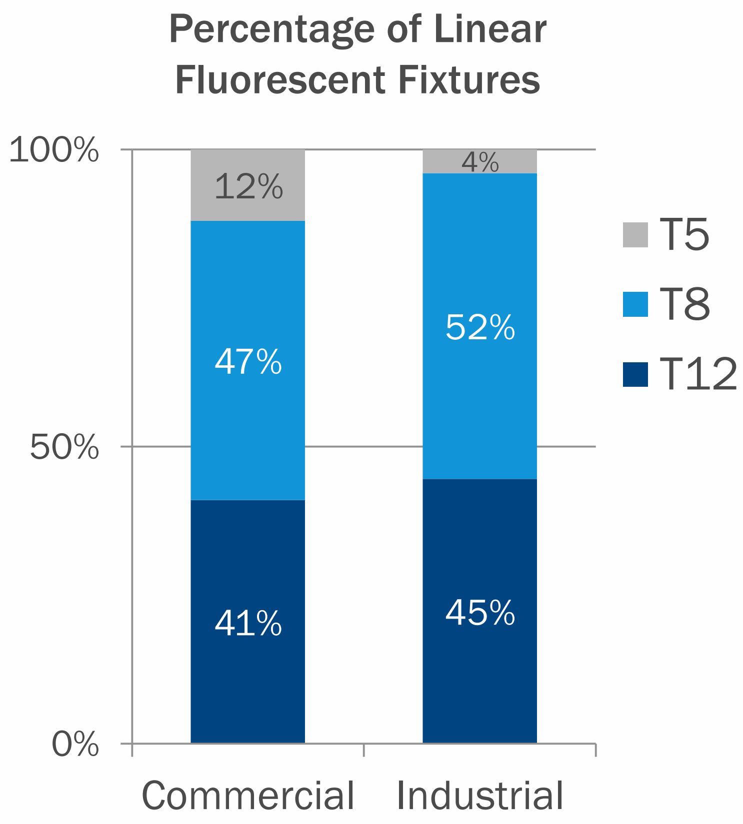
- Turn off lights when not in use for given task
- Implement multiple methods of lighting controls

Opinion **Dynamics**

* Either technology or behavioral waste, depending on which is addressed first

Lighting Technological Waste Highlights

- T12s are common
  - Penetration of T12s is higher than T8s
  - Saturation of T8s slightly higher than T12s
- Technological waste highest in industrial and lodging segments
  - Industrial: Driven by metal halides and T12s
  - Lodging: Driven by incandescents and T12s

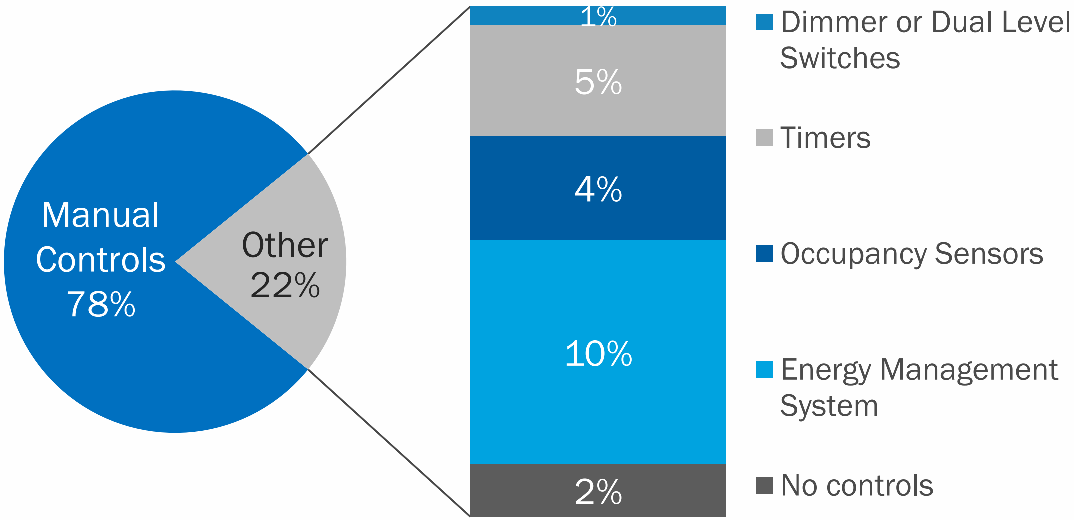


Opinion Dynamics

Lighting Behavioral Waste Highlights

- 30% waste from leaving lights on when space is not occupied (allowing for 15-minute time-out)
- Behavioral waste also highest for industrial and lodging segments
- High penetration of manual controls

Percentage of Light Fixtures with Control Types



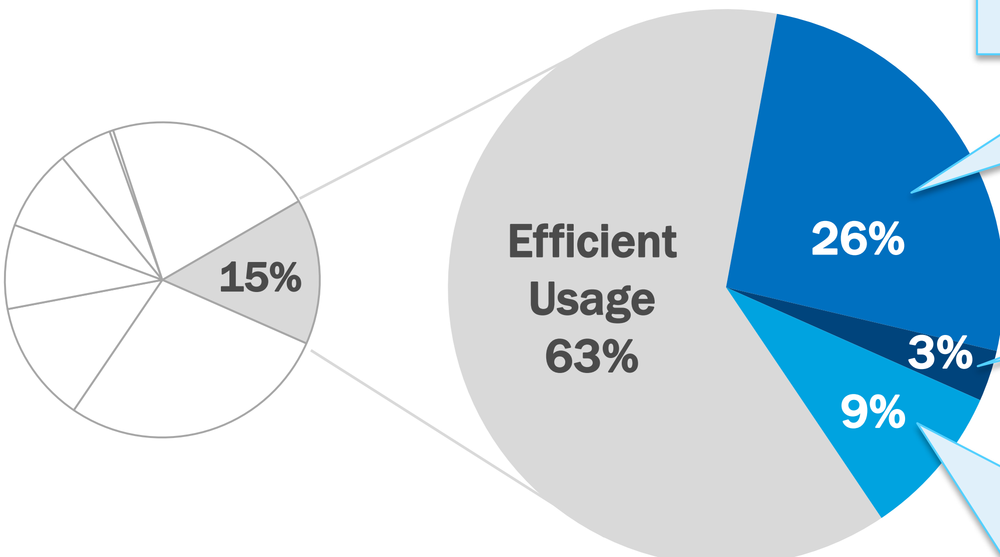
Opinion **Dynamics**

C&I Cooling Usage & Waste Results

Penetration: 64%

5,764 GWh Current Usage

2,159 GWh Current Waste



Technology Waste: 26-29%

- Upgrade to new, efficient system according to ComEd incentive qualification standards[1]

Shared Waste[2]

Behavioral Waste: 9-12%

- Regular maintenance
- Increase occupied temp. setpoint (77° F commercial; 82° F industrial)
- Increase unoccupied temp. setpoint (82° F)

Opinion **Dynamics**

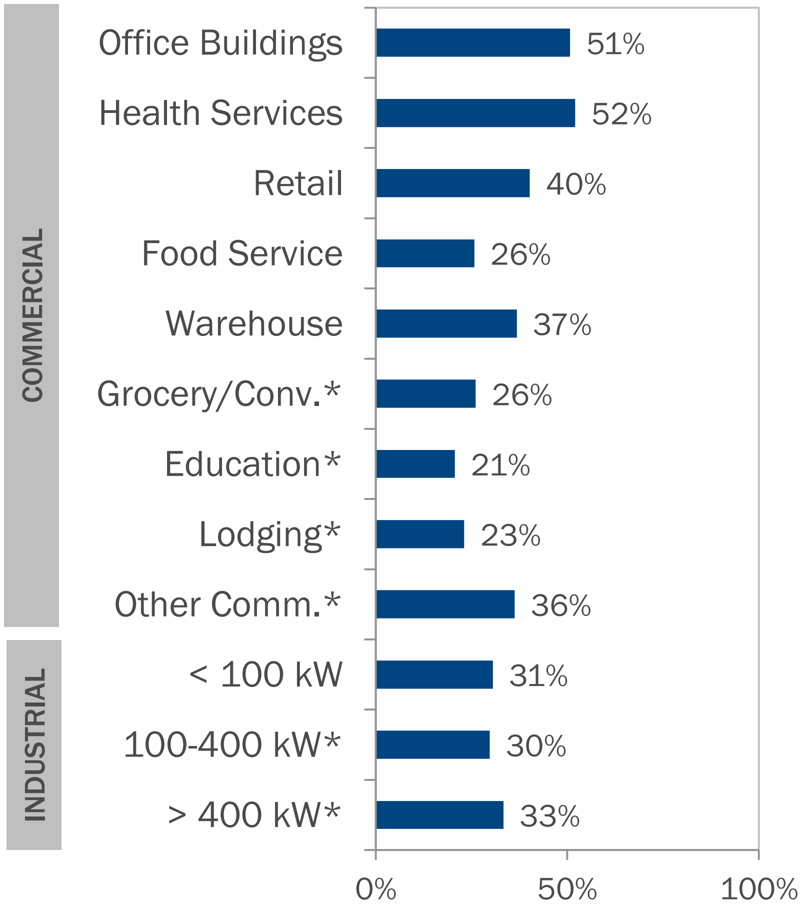
[1] Chiller and Room AC high-efficiency based on ComEd incentive standards. Split and packaged guidelines: 15 SEER for systems below 5.4 tons, 12.2 EER for system 5.4-20 tons, 10.6 EER for systems above 20 tons

[2] Either technology or behavioral waste, depending on which is addressed first

Cooling Technological Waste Highlights

- Average age of Packaged and Split AC systems is 12 years (14 among Industrial)
- Technological waste higher for Warehouse, Industrial <100 kW, Food Service, and Grocery/Convenience

% Customers with packaged/split systems with average age of 15 years or more



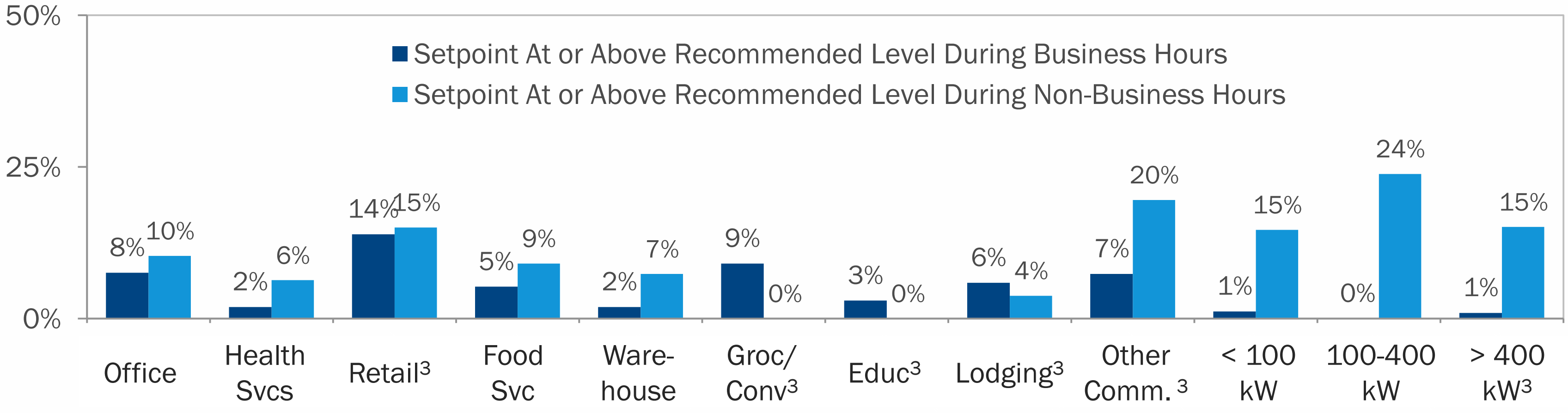
Opinion Dynamics

* Sample size < 30

Cooling Behavioral Waste Highlights

- Majority of customers are not using recommended setpoints
- Majority of central air systems are in use while business is closed (though may be set back)
- Regular maintenance is common (80% of C&I customers)

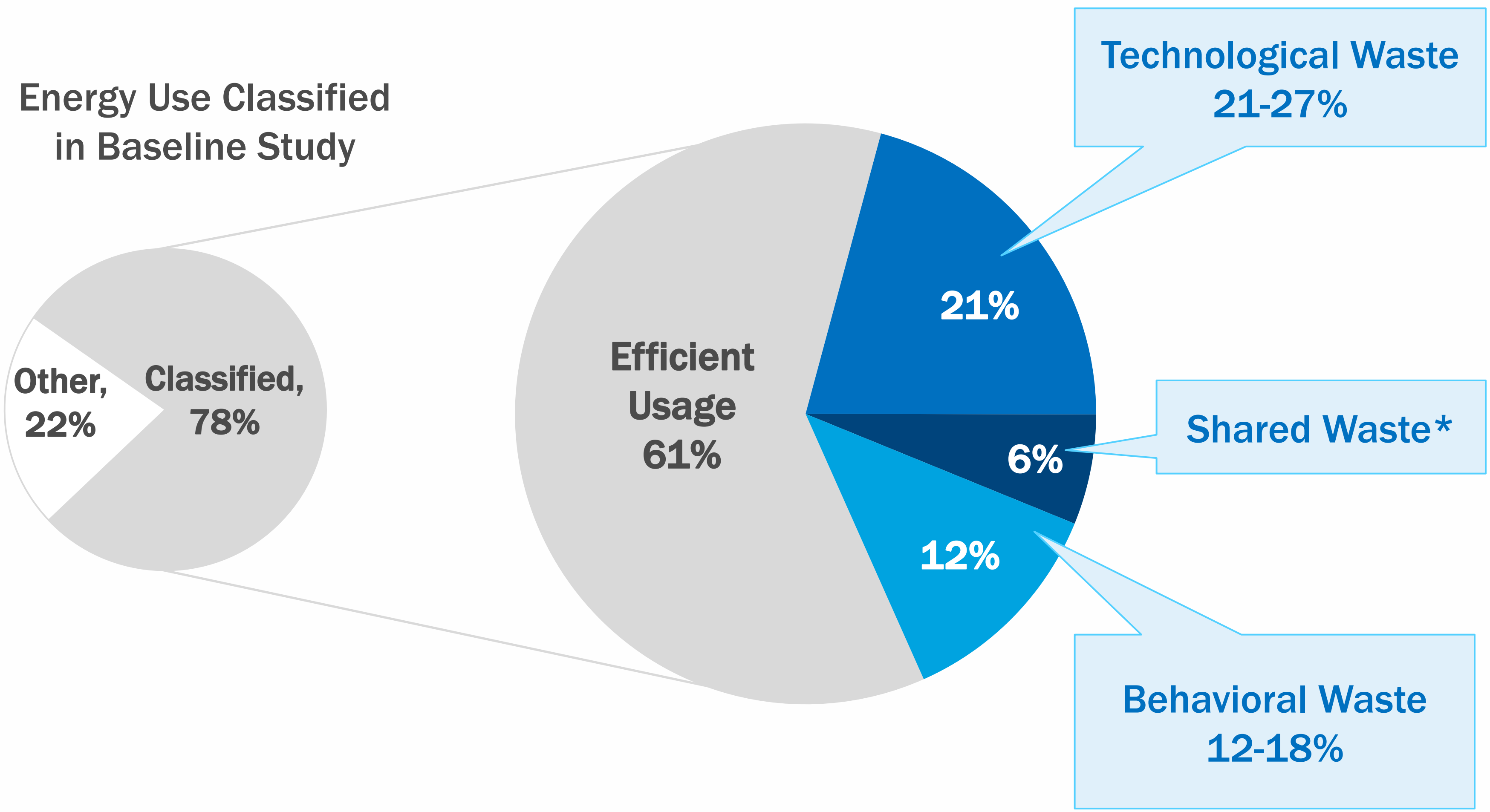
Percentage of Customers with Cooling Setpoint At or Above Recommended Levels[1,2]



Opinion Dynamics

[1] Based on ASHRAE 55-2004 comfort range.
[2] Figure refers to central cooling only (chillers, split and packaged units)
[3] Sample size less than 30 for average setpoint during non-business hours (Sample size is at least 30 for setpoints during business hours)

C&I Usage and Waste Summary



Opinion Dynamics

* Either technology or behavioral waste, depending on which is addressed first

Upcoming Potential Study

- Leverage primary data collection from baseline study
- Additional primary data collection activities:
  - Payback acceptance surveys
  - Trade ally interviews
- Schedule: Residential
  - Draft achievable potential results completed
  - Report available around 4/15
- Schedule: C&I
  - Draft achievable potential results completed by 3/31
  - Report available around 4/30

Opinion **Dynamics**

DIRECT TESTIMONY OF JOHN PAUL JEWELL
ON BEHALF OF
ENVIRONMENTAL LAW & POLICY CENTER

September 13, 2016

Exhibit C

ENERGY CENTER OF WISCONSIN

PREPARED BY
Energy Center of Wisconsin

Peoples Gas Light and Coke Company Wasted Energy Study

November 2014

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Peoples Gas Light and Coke Company Wasted Energy Study

November 2014

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EXECUTIVE SUMMARY

In its order in Docket 13-0550 the Illinois Commerce Commission ordered the Peoples Gas Light and Coke Company to study the potential to reduce wasted energy use.[1] In response, Peoples Gas retained the Energy Center of Wisconsin to study this issue.

We address energy savings that can be garnered by changing consumer behavior. Examples include setting back thermostats when space is unoccupied and washing clothes in cold water instead of hot or warm. We analyze the potential to reduce energy waste from two perspectives: (1) before any other energy efficiency actions are taken; and (2) after all technically feasible energy efficiency opportunities are captured. The savings available in the former case are greater than those available in the latter case because installing the other energy efficiency measures first reduces base energy use to which energy savings rates are applied. Table 1 reports the annual savings for the waste-reducing behavioral actions we investigated.

Table 1
Upper-Bound Estimates of Annual
Energy Waste Reduction Opportunities

Waste-Reducing Energy-Saving Behavior	Savings Before Technology Measures Installed (million therms)	Savings After Technology Measures Installed (million therms)
Residential Sector		
Set back thermostat[2]	16.1	9.9
Wash clothes in cold water	6.5	4.8
Reduce water heater temperature	1.4	1.0
Maintain heating system	0.9	0.5
Subtotal	**24.9**	**16.2**
Commercial Sector		
Set back thermostat	6.4	3.3
Maintain heating system	0.8	0.4
Subtotal	**7.2**	**3.7**
Grand total	**31.1**	**19.9**

These estimates represent upper bounds for two reasons. First, they are the possible savings from particular behavioral actions that could be achieved if all persons not currently practicing those behaviors were to adopt them. It is almost certain that some customers would not change behavior in this way. Second, these estimates also do not reflect economic considerations. For example, heating system maintenance may require hiring a professional, which may further limit the likelihood that the reported savings will be achieved. Achievable savings levels would be noticeably lower than those reported here.

[1] Order, Docket 13-0550: Petition Pursuant to Section 8-104 of the Public Utilities Act to Submit an Energy Efficiency Plan, Illinois Commerce Commission, May 20, 2014, p. 8.
[2] Assumes that customers setting back install smart thermostats. If they instead install standard programmable thermostats, or use a manual approach, the savings would be 40 percent less than those shown in the table.

CHAPTER 1: BACKGROUND

PEOPLES GAS 2013 ENERGY EFFICIENCY POTENTIAL STUDY

In developing estimates of the potential to eliminate energy waste, we rely heavily on the work we conducted in preparing the energy efficiency potential study for Peoples Gas. The primary data we collected reflects the characteristics of the utility under review, and is therefore likely to be more accurate than information gleaned from other studies. In the potential study we completed 2,096 residential and 796 commercial phone surveys in the Peoples Gas and North Shore service areas. We also completed 114 residential and 60 commercial site visits in the utilities' service areas. We combined the information from the surveys and site visits with billing information from Peoples Gas's billing system to fully characterize energy consumption by end use. In this study we supplemented that analysis with field research that we conducted in other Midwest states. We filled remaining gaps with information from the technical literature.

UPPER-BOUND VERSUS ACHIEVABLE ESTIMATES

We examined the potential to reduce energy waste on the part of individually-metered customers, which includes all single-family customers and a portion of multi-family customers. To put the energy waste reduction estimates we report here in perspective, the achievable energy efficiency potential for the entire Peoples Gas system in the 2013 study was 6 million therms per year. This current study shows that if we could reduce wasted energy to the full extent, the savings would greatly exceed the 2013 achievable potential estimate, suggesting that it is unlikely that our wasted energy opportunities estimates can be achieved in full. Nevertheless, that is not our intent. Rather, our goal is to develop an upper bound estimate of that savings potential. Practical considerations mean that Peoples Gas could achieve but a fraction of those savings. That is not to say that there are no opportunities to reduce energy waste.

INTERACTIONS BETWEEN TECHNOLOGICAL AND BEHAVIORAL ENERGY EFFICIENCY OPPORTUNITIES

Energy efficiency measures and waste-reducing behavior change actions have interactive effects. Each measure or action taken reduces the base amount of energy savings available for the next measure or action. For example, installing five energy efficiency measures that each reduce space heating energy use by 10 percent would not reduce total heating use by 50 percent, but rather by 41 percent.[3] The following tables show the difference in savings estimate from behavior change activity that results from changing the order in which the actions are taken.

[3] The mathematical formula is: base usage after all measures are installed = $(1\text{-savings rate})^{\text{years}} = (1-0.10)^5 = 0.59$, or 59 percent of the original use, which is a 41 percent reduction.

Table 2
Interactive Effects of
Energy Savings Actions or Measures
Behavior Change First

Energy Saving Action or Measure	Savings Rate	Base Use (therms)	Energy Savings (therms)	Adjusted Base Use (therms)
Behavior Change	10%	1,000	100	900
Technology A	10%	900	90	810
Technology B	10%	810	81	729
Technology C	10%	729	73	656
Technology D	10%	656	66	590

Table 3
Interactive Effects of
Energy Savings Actions or Measures
Behavior Change Last

Energy Saving Action or Measure	Savings Rate	Base Use (therms)	Energy Savings (therms)	Adjusted Base Use (therms)
Technology A	10%	1,000	100	900
Technology B	10%	900	90	810
Technology C	10%	810	81	729
Technology D	10%	729	73	656
Behavior Change	10%	656	66	590

To address this sequencing issue we estimate energy savings from two perspectives. First we estimate the savings from waste-reducing behavior changes assuming that no technological energy saving measures were implemented. Then we estimate the savings from the behavior changes assuming that all the available energy saving technologies, regardless of cost-effectiveness, have been implemented. The difference in estimates is significant, with the after-technologies estimate generally being about 40 to 60 percent lower than the before-technologies estimate.

CHAPTER 2: OPPORTUNITIES TO REDUCE ENERGY WASTE IN THE RESIDENTIAL SECTOR

NATURAL GAS END USE IN THE RESIDENTIAL SECTOR

In the Peoples Gas service area, space heating accounts for 75 percent of total natural gas consumption in the residential sector. Water heating accounts for 20 percent of total consumption. The two end uses therefore account for nearly all the gas consumption in that sector. We focus on actions that could reduce energy waste for these two end uses.

RESIDENTIAL SPACE HEATING

Thermostat Setback

If customers heat living space to levels that meet their comfort needs or health requirements, they are not wasting energy, even if the temperature setting may seem high to others. On the other hand, if customers would be just as comfortable, if not more comfortable, at lower temperature settings, they are wasting energy by heating space to higher temperatures. If they never change the thermostat setting and heat space to same temperature regardless of whether there is anyone in the space, again they are wasting energy during the periods when the space is unoccupied. Furthermore, sleep experts suggest that a cooler room (one lower in temperature than that used during waking hours) improves the quality of sleep.[4] Therefore, customers not setting back temperature during sleeping hours are likely wasting energy, as well.

The U.S. Department of Energy recommends a base temperature of 68 degrees when consumers are using space and a 10-15 degree setback when space is unoccupied or when sleeping.[5] We view the DOE recommended setback temperatures as outer bounds and would expect to observe less extreme behavior in practice.

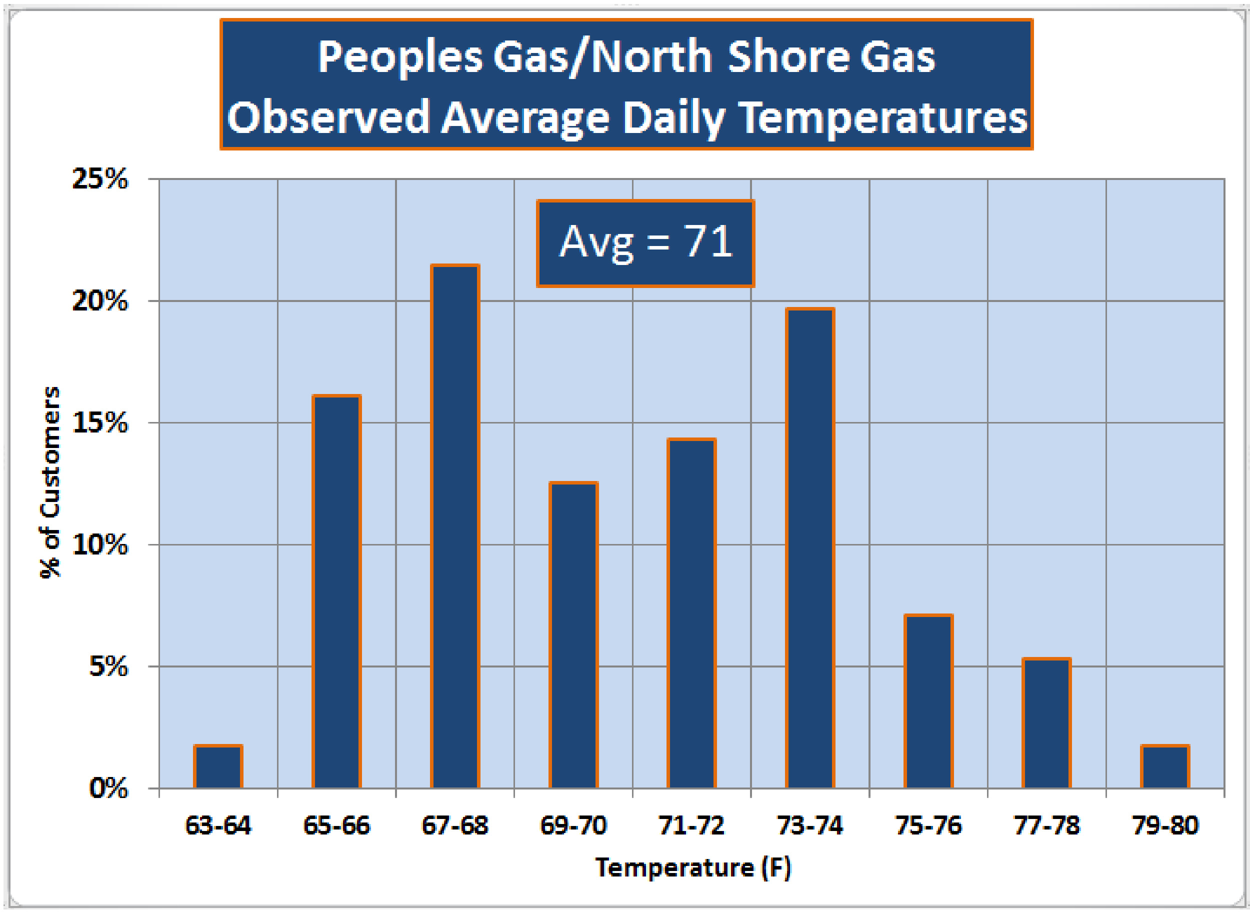
The most accurate means of measuring the extent that Peoples Gas customers not now setting back their thermostats would be willing to do so would be a carefully designed before-after experiment with treatment and control groups. Conducting such primary data collection is beyond the scope of this analysis.

Absent such a controlled experiment, we relied on the data we collected in the residential site visits conducted for the potential study. We recorded hourly indoor temperatures (ambient temperatures, not thermostat settings) for 56 residential customers in the Peoples Gas/North Shore Gas service areas. The average daily temperature varies considerably over the sample residences, ranging from about 63 degrees at the low end and about 80 degrees at the high end. See Fig. 1. The average daily temperature across all residences in the sample is 71 degrees.

[4] National Sleep Foundation, http://sleepfoundation.org/bedroom/touch.php

[5] The DOE analysis states that consumers save one percent per degree set back for every eight hours of setback. Reducing average daily temperature by one degree is equivalent to a one-degree setback for 24 hours, or a 3 percent energy savings. See http://energy.gov/energysaver/articles/thermostats

Figure 1

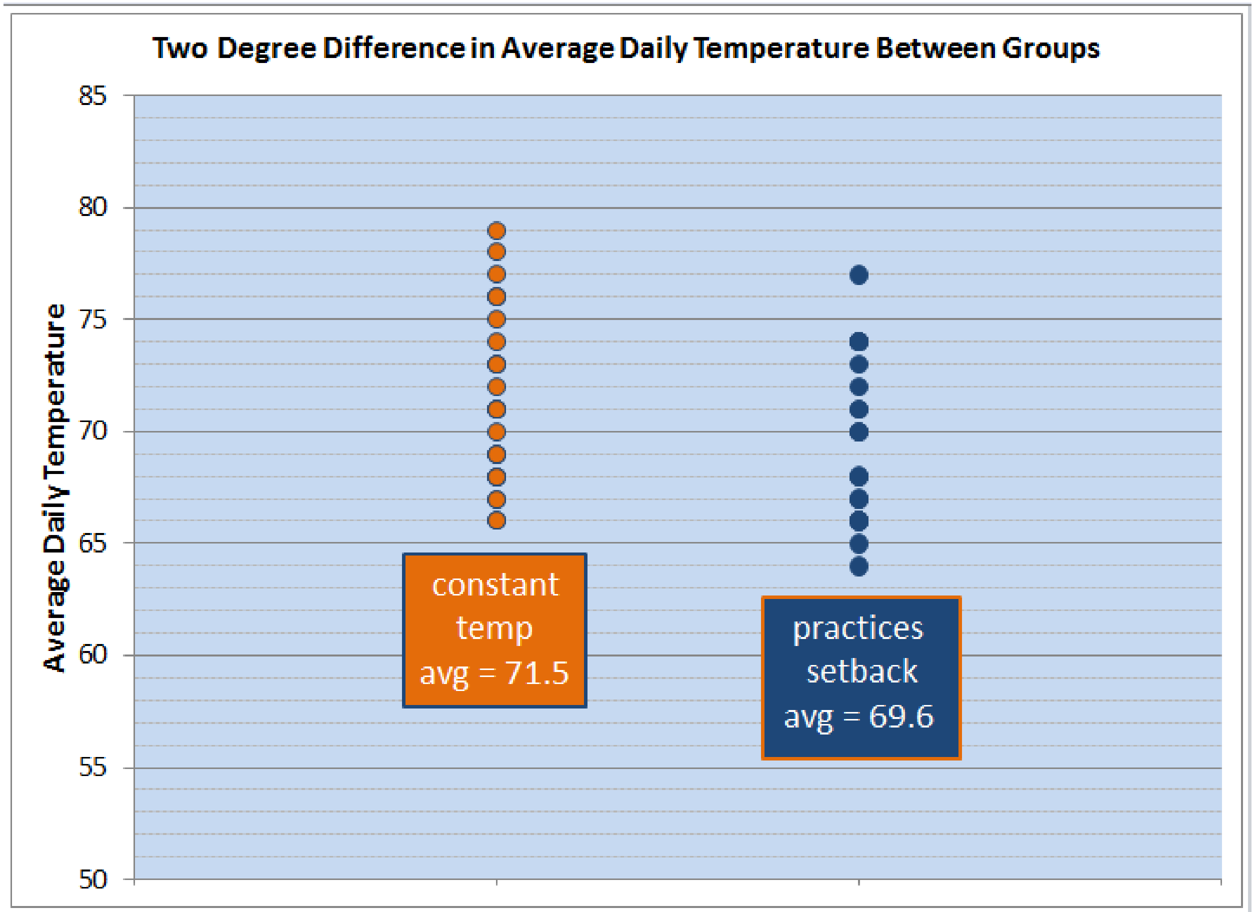


A closer look at the hourly temperature data observed for each residence reveals that about half of the customers heat their residences to a constant temperature throughout the day. The remaining customers manifest a variety of setback behaviors as revealed by the deviations in hourly temperatures recorded by the loggers.

In the next stage of the analysis we separated customer data into two groups, those who set back the thermostat (temperatures varied over the day) and those who do not (constant temperatures). While the average daily temperature for the first group is slightly lower than the average for the second, there is wide dispersion within each group. See Fig. 2. Put another, the fact that a customer sets back the thermostat does not mean that the average daily temperature is higher than average. Conversely, a residence for which there was not thermostat set back could manifest a lower-than-average daily temperature.

On average, however, those setting back thermostats have average daily temperatures that are about two degrees lower than those who do not. Statistical analysis of these data reveals that the presence of setback behavior is a statistically significant predictor of the average daily temperature, but it nevertheless explains only six percent of the variation in that figure. This suggests that there are a lot of other factors that determine the average daily temperature.

Figure 2



As a first cut, we assume that those other factors are approximately constant between groups. If that is true, then the two-degree difference in average temperatures observed for the setting-back and not-setting-back groups is a reasonable estimate of the magnitude of setback we would obtain if those not setting back did adopt setback behavior.

To fully understand this issue, is important to distinguish between the reduction in average daily temperature (measured in degrees) and the extent of the setback (also measured in degrees). Reducing the constant base temperature setting for a home is one way to lower average daily temperature; using varying temperature settings throughout the day is another. The following table shows that consumers can achieve the same reduction in average daily temperature in a variety of ways.

Table 4
Different Means of Achieving a Two-Degree Reduction
in Average Daily Temperature

Hour of the Day	Current Setting		Adjust Base Temp Setting	Set Back Night Temp	Set Back at Night and When Away
1	71		69	65	68
2	71		69	65	68
3	71		69	65	68
4	71		69	65	68
5	71		69	65	68
6	71		69	71	71
7	71		69	71	71
8	71		69	71	71
9	71		69	71	68
10	71		69	71	68
11	71		69	71	68
12	71		69	71	68
13	71		69	71	68
14	71		69	71	68
15	71		69	71	68
16	71		69	71	68
17	71		69	71	68
18	71		69	71	71
19	71		69	71	71
20	71		69	71	71
21	71		69	71	71
22	71		69	65	71
23	71		69	65	68
24	71		69	65	68
Avg	71		69	69	69

Knowing the change in average daily temperature from introducing setback behavior allows us to estimate the energy savings. The DOE estimates that residential customers who reduce average daily temperature by one degree will on average reduce energy consumption by three percent.[6] The two-degree reduction in average temperature we observed in the data would therefore produce energy savings of six percent.

[6] The DOE analysis states that consumers save one percent per degree set back for every eight hours of setback. Reducing average daily temperature by one degree is equivalent to a one-degree setback for 24 hours, or a 3 percent energy savings. See http://energy.gov/energysaver/articles/thermostats

Recall, though, that the two-degree temperature reduction estimate was a first-cut estimate based on the site visit data. We test our result against the information in the Illinois Technical Reference Manual and find that it is consistent with that resource. The TRM suggests that customers installing a programmable thermostat will experience a six percent reduction in energy use, which is equivalent to a two-degree reduction in average daily temperature, precisely matching our estimate.[7]

We also examined the savings that could be garnered if customers installed state-of-the-art smart thermostats, which research suggests can save more energy than either standard programmable thermostats or manual setback behavior. Smart thermostats typically allow customers remote access through the Internet, and some automatically adjust settings based on historical patterns or occupancy. This increased flexibility and capability generally allows customers greater control—and produces greater energy saving—than that associated with either manual or standard programmable thermostat control.

In a field experiment in Massachusetts customers who were given a smart thermostat reduced energy consumption by about 10 percent,[8] which is equivalent to a 3.3 degree reduction in average daily temperature.[9] We prepared a separate analysis assuming that customers currently not setting back installed a smart thermostat and used it to control indoor temperatures. For that scenario we assumed a 10 percent energy savings.[10]

The Peoples Gas potential study reveals that single-family homes consume about 261 million therms per year to heat living space, while individually-metered customers in multi-family residences consume 109 million therms per year for that purpose. The residential survey results reveal that 65 percent of single-family residences and 37 percent of multi-family residences are already practicing thermostat setback behavior, which we assume eliminates them as candidates for further setback behavior. Removing that space heating load from the total leaves 92 million and 69 million therms of space heating load in the single-family and multi-family segments, respectively, that could save energy by implementing setback practices. Applying the six percent savings rate discussed above produces total therm savings of about 10 million therms per year.

Table 5
Savings From Thermostat Setback
Programmable Thermostat or Manual Setback
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	92	6%	5.5
Multi-family	69	6%	4.1
Total	**161**		**9.6**

If we assume that the customers use a smart thermostat, which we assume will save 10 percent, the savings estimate increases to about 16 million therms per year.

[7] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.
[8] The Cadmus Group, Inc., 2012. *Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation: Part of the Massachusetts 2011 Residential Retrofit and Low Income Program Area Evaluation*.
[9] 3.3° average daily temperature reduction x 3% energy savings/degree temperature reduction = 10% energy savings.
[10] That savings estimate is likely an outer bound. During the field study the thermostat was installed by a professional and the customers were provided with instructions as to how to use it. This increases the likelihood that customers will use the device in an optimal manner to meet their space heating needs.

Table 6
Savings From Thermostat Setback
Smart Thermostat
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	92	10%	9.2
Multi-family	69	10%	6.9
Total	**161**		**16.1**

The preceding analysis assumes that no other energy efficiency actions are taken prior to implementing the setback behavior. The potential study estimates that if all technically feasible energy efficiency measures were implemented prior to implementing the setback behavior, the available space heating loads would decline to 54 million and 45 million terms, respectively, for the single-family and multi-family segments. The following tables show that this reduces the savings from thermostat setback to about 6 to 10 million therms per year, depending on the means employed to achieve the temperature setbacks.

Table 7
Savings From Thermostat Setback
Programmable Thermostat or Manual Setback
After Technology Measures Installed
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	54	6%	3.2
Multi-family	45	6%	2.7
Total	**99**		**5.9**

Table 8
Savings From Thermostat Setback
Smart Thermostat
After Technology Measures Installed
(millions)

Segment	Available Space Heating Load	Savings Factor	Annual Savings
Single-Family	54	10%	5.4
Multi-family	45	10%	4.5
Total	**99**		**9.9**

Heating System Maintenance

Gas furnaces

In the Peoples Gas service area there are 183 thousand single-family households and 174 thousand multi-family households with furnaces, which consume a total of 183 million and 92 million therms per year in each segment, respectively. Research suggests that energy savings will occur from increased frequency of filter changes only if the filter is currently being changed less often than annually. A field study we conducted in Minnesota revealed that 95 percent of customers change their filters at least annually. This allows us to estimate the furnace space heating load that would be subject to savings from more frequent filter changes.

Table 9
Portion of Furnace Load Subject to Savings From
Increased Frequency of Filter Changes
(therms-millions)

Segment	Furnace Consumption	Percent of Customers Not Setting Back	Adjusted Consumption
Single-family	183	5%	9.1
Multi-family	92	5%	4.6
Total	**275**		**13.7**

Energy Center analysis suggests that the annual energy savings from an increased frequency of filter change for those who currently do not change filters at least once per year is 2 percent. We use this savings rate to estimate aggregate savings.

Table 10
Savings From Increased Frequency of
Furnace Filter Changes
(therms-millions)

Segment	Furnace Consumption	Savings Factor	Adjusted Consumption
Single-family	9.1	2%	0.18
Multi-family	4.6	2%	0.09
Total	**13.7**		**0.27**

If energy-saving technologies are installed prior to the change in furnace filter replacement frequency, the single-family figure declines to 0.11 million therms, and the multi-family figure declines to 0.06 million therms, producing a total therm savings of 0.17 million therms.

Boiler maintenance

In the Peoples Gas service area there are 58 thousand single-family households and 26 thousand individually-metered multi-family residences with boilers.[11] These boilers consume a total of 90 million therms per year.

Table 11
Annual Therm Usage by Boiler Type
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	53	24	77
Multi-family	7	6	13
Total	**60**	**30**	**90**

Results from the Energy Center's survey of Minnesota homeowners reveals that about 70 percent are performing regular maintenance on their heating systems, leaving 30 percent of customers who could

[11] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.

adopt new maintenance practices.[12] This reduces the total therms available for boiler maintenance activity to 27 million therms.

Table 12
Annual Therm Usage by Boiler Type
For Customers Not Maintaining Boilers
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	16	7	23
Multi-family	2	2	4
Total	**18**	**9**	**27**

Using the TRM's calculation of 2 percent savings achieved from a boiler tune-up,[13] we estimate that 30 percent of residential customers are not performing regular maintenance and could achieve an annual total savings of 0.53 million therms, as shown in the following table.

Table 13
Annual Therm Savings by Boiler Type
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	0.32	0.14	0.46
Multi-family	0.04	0.03	0.07
Total	**0.36**	**0.17**	**0.53**

If customers install available technology measures before they implement a more-frequent furnace filter change, the savings decline as follows:

Table 14
Annual Therm Savings by Boiler Type
After Technology Measures Installed
(therms-millions)

Segment	Steam Boilers	Hydronic Boilers	Total
Single-family	0.19	0.08	0.27
Multi-family	0.03	0.02	0.05
Total	**0.22**	**0.10**	**0.32**

Heating System Maintenance: Combined Savings

Combining the furnace filter and boiler maintenance estimates produces the following savings estimates for heating system maintenance.

[12] Energy Center of Wisconsin, 2014. *Initial Results from a Study of Quality Installation / Quality Maintenance in Minnesota Homes.*

[13] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Table 15
Annual Therm Savings From Heating System Maintenance
(therms-millions)

Segment	Furnace Filters	Boiler Maintenance	Total annual savings (therms)
Single-family	0.18	0.46	0.64
Multi-family	0.09	0.07	0.16
Total	**0.27**	**0.53**	**0.90**

If all technological efficiency-saving measures are installed first, the total savings estimate declines from 0.90 million therms per year to 0.54 million therms per year.

Table 16
Annual Therm Savings From Heating System Maintenance
After Technology Measures Installed
(therms-millions)

Segment	Furnace Filters	Boiler Maintenance	Total annual savings (therms)
Single-family	0.11	0.29	0.40
Multi-family	0.06	0.05	0.11
Total	**0.17**	**0.34**	**0.54**

RESIDENTIAL WATER HEATING

Clothes Washer Temperature Setting

In most cases, washing in cold water cleans clothes just as well as washing them in hot or warm water.[14] Cold water washing also tends to be less damaging to clothing, which extends its useful life.[15] Therefore, customers who wash clothes in hot or warm water because they believe it generally provides benefits relative to washing in cold water would be wasting energy.

EPA data suggest that the typical household washes 400 loads per year, or 7.6 loads per week.[16] In 2000 the Energy Center prepared a characterization study for Wisconsin that reports that the typical household washes 7.2 loads per week.[17] A 2010 study conducted by the Cadmus Group found that households wash 5.0 loads of laundry per week.[18] The ComEd baseline end-use saturation and penetration study reports that its customers wash on average 5.8 loads per week.[19] Leaning more heavily on the local data, we use an estimate of 6.0 loads washed per week, or 312 loads per household per year.

[14] Center for Energy & Environment, *MN Energy Challenge*, www.mnenergychallenge.org/Actions/Wash--em-Cold.aspx
[15] Martin and Rosenthal, "Cold-Water Detergents Get a Cold Shoulder," September 16, 2011, *The New York Times*, www.nytimes.com/2011/09/17/business/cold-water-detergents-get-a-chilly-reception.html?pagewanted=all
[16] U.S. Environmental Protection Agency, Green Building: Laundry Room & Basement, www.epa.gov/greenhomes/Basement.htm
[17] Energy Center of Wisconsin, 2000. *Energy and Housing in Wisconsin: A Study of Single-Family Owner-Occupied Homes*.
[18] David Korn and Scott Dimetrosky, 2010. "Do the Savings Come Out in the Wash? A Large Scale Study of In-Situ Residential Laundry Systems," *Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings*.
[19] Opinion Dynamics Corporation, 2013. *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study*.

Washing in cold water is gaining momentum, but most consumers still wash primarily with either hot or warm water.[20] The Energy Center characterization study reports that about 30 percent of loads were washed using cold water.[21] For the remaining loads, 58 percent washed in warm and 12 percent washed in hot. Data from Grand Valley State University reveals that on a national basis 37 percent of loads use cold water, with warm and hot water washing accounting for 49 percent and 14 percent of loads, respectively.[22] The ComEd baseline end-use saturation and penetration study reports that 41 percent of loads are washed in cold, 40 percent in warm and 19 percent in hot.[23] In this study we rely on the local data from ComEd, assuming that 40 percent of laundry loads in the Peoples Gas territory are washed in cold water, 40 percent in warm water and 20 percent in hot water.

The Peoples Gas potential study analysis reveals that there are 229 thousand single-family households, and 180 thousand individually-metered multi-family residences with gas water heaters. The survey data supporting the study suggests that 5 percent of single-family residences and 25 percent of multi-family residences do not have a clothes washer. This reduces the effective number of households potentially subject to laundry water temperature change behavior to 217 thousand single-family homes and 135 thousand multi-family residences.

Applying the 312 loads per household per year estimate to these effective household figures produces estimates of 68 million loads of laundry per year in the single-family segment and 42 million loads per year in the multi-family segment. We allocate these loads among the cold-warm-hot categories using the percentages identified earlier, producing the results found in the following table:

Table 17
Laundry Loads Per Year by Washing Temperature
(millions)

Segment	**Cold (40%)**	**Warm (40%)**	**Hot (20%)**
Single-Family	27	27	14
Multi-family	17	17	8
Total	**44**	**44**	**22**

Per the Peoples Gas natural gas appliance calculator, washing clothes in hot water consumes 0.147 therms per load; washing in warm consumes 0.074 therms per load.[24] Switching to from hot to cold or warm to cold washer temperature settings would therefore save those amounts, respectively, for each load switched. There are no savings for loads currently washed in cold water as there would be no change in behavior in that situation. The system-wide annual therms savings associated with switching all loads washed in either hot or warm to washing in cold is about 6 to 7 million therms per year, as shown in the following table.

[20] "Campaign Makes Progress Toward P&G's Commitment to Convert 70% of Wash Loads to Cold by 2020," Procter & Gamble News Release, April 2, 2012.
[21] Energy Center of Wisconsin, 2000. *Energy and Housing in Wisconsin: A Study of Single-Family Owner-Occupied Homes*.
[22] Grand Valley State University. *Green Laundry Statistics*, www.gvsu.edu/housing/students/green-laundry-statistics-59.htm
[23] Opinion Dynamics, 2013. *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study*.
[24] Natural Gas Appliance Calculator, www.peoplesgasdelivery.com/home/gas_calculator.aspx

Table 18
Annual Therm Savings From Switching to Cold Water Washing
(millions)

Segment	Currently Washed in Cold (40%)	Currently Washed in Warm (40%)	Currently Washed in Hot (20%)	Total
Single-Family	0.0	2.0	2.0	4.0
Multi-family	0.0	1.2	1.2	2.5
Total	**0.0**	**3.2**	**3.2**	**6.5**

These estimates reflect the energy savings that could be available if no other efficiency actions are taken. If instead we assume that all possible technological efficiency measures were implemented prior to the change in laundry water temperature setting, the base savings would be 21 percent lower for the single-family segment and 34 percent lower for the multi-family segment. Under this scenario the estimated system-wide annual therm savings from changing laundry water temperature would be about 5 million therms per year in total, as shown in the following table.

Table 19
Annual Therm Savings From Switching to Cold Water Washing
After Technology Measures Installed
(millions)

Segment	Currently Washed in Cold (40%)	Currently Washed in Warm (40%)	Currently Washed in Hot (20%)	Total
Single-Family	0.0	1.6	1.6	3.2
Multi-family	0.0	0.8	0.8	1.6
Total	**0.0**	**2.4**	**2.4**	**4.8**

Water Heater Temperature Setpoint Reduction

According to the U.S. Department of Energy, water heating is the second largest home energy expense, typically accounting for about 18 percent of a utility bill after heating and cooling.[25] To save energy and ensure both comfort and safety, it is recommended to set the water heater temperature to 120 degrees Fahrenheit. This temperature setting also helps to slow mineral buildup and corrosion in the water heater and pipes and reduce standby losses (heat from the water heater escaping into the surrounding area).[26]

As stated earlier, there are 229 thousand single-family households and 180 thousand individually-metered multi-family residences with gas water heaters.[27] An analysis of site visit data in the People's Gas potential study reveals that 36 percent of customers are setting their water heater temperature to the ideal temperature of 120 degrees, and 64 percent are setting their water heaters to a temperature within a 13 degree range of that ideal setting. Using the TRM's calculation of 6.4 therms per 15 degrees (or 0.43 therms per degree)[28] coupled with our analysis of actual water heater settings, we estimate 5.6 therms per 13 degree setback for an annual total savings of 1.5 million therms.

[25] U.S. Department of Energy, *Tips: Water Heating*, http://energy.gov/energysaver/articles/tips-water-heating
[26] U.S. Department of Energy, *Savings Project: Lower Water Heating Temperature*, http://energy.gov/energysaver/projects/savings-project-lower-water-heating-temperature
[27] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.
[28] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Table 20
Annual Therm Savings From Setting Water Heater to 120° F

Segment	Number of homes setting above 120° F	Annual savings per home (therms)	Total annual savings (million therms)
Single-family	146,279	5.6	0.8
Multi-family	115,418	5.6	0.6
Total	**261,697**		**1.4**

These estimates reflect the energy savings that could be available if no other efficiency actions are taken. Assuming that all possible technological efficiency measures were implemented prior to setting the water heater temperature to 120 degrees, the base savings would be 21 percent lower for the single-family segment and 34 percent lower for the multi-family segment. Under this scenario the estimated system-wide total annual savings from setting back the water heater temperature would be about 1.0 million therms, as shown in the following table.

Table 21
Annual Therm Savings From Setting Water Heater to 120° F
After Technology Measures Installed

Segment	Number of homes setting above 120° F	Annual savings per home (therms)	Total annual savings (million therms)
Single-family	146,279	4.4	0.6
Multi-family	115,418	3.7	0.4
Total	**261,697**		**1.0**

CHAPTER 3: OPPORTUNITIES TO REDUCE ENERGY WASTE IN THE COMMERCIAL SECTOR

NATURAL GAS END USE IN THE COMMERCIAL SECTOR

In the commercial sector, space heating accounts for about half of total natural gas consumption. While this is still a substantial amount of load, note that it is proportionately less than observed in the residential sector.

COMMERCIAL SPACE HEATING

Thermostat Setback

The analysis of potential savings from residential thermostat setback practice is a fairly straightforward task. The largely homogeneous nature of that class justifies the consistent use of well-documented assumptions regarding typical energy use and savings potential. The same cannot be said of the potential for thermostat-related savings in the commercial sector.

The commercial sector manifests considerable heterogeneity, including entities ranging in size from those smaller than a typical residence (e.g., a barber shop) to those that use many millions of therms each year (e.g., a major hospital). Furthermore, practices regarding thermostat settings vary considerably, even within the same commercial subsector.

One more complicating factor is that we do not have data logger measurements for indoor temperatures for commercial customers, as we did in the residential sector. We do, however, have reported temperature settings for morning, afternoon, evening and night for 44 commercial establishments for which we conducted site visits. The data is illuminating, although practices vary widely.

Table 22 shows the hours of operation and reported temperature settings for a fast-food restaurant. We see that even though the restaurant is not open at night during the week or on the weekend, the business does not set back its thermostat during those times. A fast-food restaurant could set back its thermostat during those periods without loss of comfort because there would typically be no one on site.

Table 22
Hours of Operation and Thermostat Settings
for a Fast-Food Restaurant

	Open for Business?	**Thermostat Setting**
	Weekdays	
Morning	Yes	72°
Afternoon	Yes	72°
Evening	Yes	72°
Night	No	72°
	Weekend	
Morning	Yes	72°
Afternoon	Yes	72°
Evening	Yes	72°
Night	No	72°

In contrast, Table 23 provides the same information for a commercial laundry facility. Note that it is open fewer hours than the fast-food restaurant and it practices setback behavior, dialing back during all periods that the business is not open. There is no setback potential for this customer.

Table 23
Hours of Operation and Thermostat Settings
for a Commercial Laundry

	Open for Business?	Thermostat Setting
	Weekdays	
Morning	Yes	70°
Afternoon	Yes	70°
Evening	No	55°
Night	No	55°
	Weekend	
Morning	No	55°
Afternoon	No	55°
Evening	No	55°
Night	No	55°

We begin this analysis by examining space heating use by subsector. To estimate the savings potential from thermostat setback in the commercial sector we consulted with Energy Center building engineers to assess the likelihood that commercial customers within each subsector are setting back their thermostat. Based on those discussions we eliminated hospitals from the analysis because they are always open, and would therefore have no opportunity to set back thermostats. We also eliminated warehouses because they typically set temperatures at low levels at all times. We did not consider industrial customers in this analysis.

Table 24 shows space heating use by sub-sector for the Peoples Gas service area.

Table 24
Commercial Sector
Space Heating Load
by Subsector
(therms-millions)

Subsector	Space Heating Load
Small office	14.0
Large office	9.0
Food service	11.0
Private education	14.4
Religious	2.7
Other health care	31.2
Service	2.8
Lodging	13.4
Retail	21.6
Food sales	22.1
Total	**142.2**

Per discussions with our building energy engineers, many commercial firms, especially those with energy management systems, already practice thermostat setback. Table 25 shows the remaining load that could be subject to setback.

Table 25
Load Not Yet Subject to Setback
Space Heating Load by Subsector
(therms-millions)

Subsector	Space Heating Load
Small office	4.2
Large office	2.7
Food service	3.3
Private education	4.3
Religious	0.8
Other health care	9.4
Service	1.4
Lodging	10.7
Retail	17.3
Food sales	19.9
Total	**74.0**

To ascertain the likely savings from thermostat setback in the commercial sector, we used our energy modeling software[29] to examine the potential savings for a variety of building types over a range of temperature setbacks. The average savings from thermostat setback for all scenarios analyzed is 8.7 percent per year, which lies within the 6-10 percent savings range we used in the residential sector. Applying this savings rate to the available therms yields annual savings of 6.4 million therms for commercial setback. If technology measures were implemented first, these savings would drop to 3.3 million therms per year.

Heating System Maintenance

We focus on boiler maintenance in this analysis. The Peoples Gas potential study survey data reveals that 53 percent of businesses surveyed are not performing regular boiler tune-ups.[30] We adjust boiler space heating use by segment to identify the portion of the load that could be subject to boiler maintenance practice.

[29] This model is used to help design buildings as part of ComEd's commercial new construction program.
[30] Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6*.

Table 26
Annual Therms Subject to Boiler Tune Up
(therms-millions)

Segment	Therms Used In Boilers	Percentage Not Practicing Maintenance	Adjusted Therms
Small office	3.5	53%	1.8
Large office	30.5	53%	16.2
Food service	1.5	53%	0.8
Private education	6.5	53%	3.5
Religious	8.0	53%	4.2
Other health care	1.0	53%	0.5
Service	2.9	53%	1.5
Lodging	21.0	53%	11.1
Retail	0.0	NA	0.0
Food sales	0.0	NA	0.0
Total	**74.8**		**39.6**

Using the TRM's estimate of 2 percent savings achieved from a boiler tune-up,[31] we determine that the customers who are not performing regular boiler tune-ups could achieve an annual total savings of 0.79 million therms, as shown in the following table.

Table 27
Annual Savings From Boiler Maintenance
(therms-millions)

Segment	Available Therms	Savings Factor	Savings
Small office	1.8	2%	0.04
Large office	16.2	2%	0.32
Food service	0.8	2%	0.02
Private education	3.5	2%	0.07
Religious	4.2	2%	0.08
Other health care	0.5	2%	0.01
Service	1.5	2%	0.03
Lodging	11.1	2%	0.22
Retail	0.0	2%	0.00
Food sales	0.0	2%	0.00
Total	**39.6**		**0.79**

[31] Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0*.

Adjusting for the technological measures reduces the savings estimate to 0.40 million therms per year.

Table 28
Annual Savings From Boiler Maintenance
After Technology Measures Installed
(therms-millions)

Segment	Savings	Savings From Technologies	Adjusted Savings
Small office	0.04	63.7%	0.01
Large office	0.32	65.9%	0.11
Food service	0.02	57.8%	0.01
Private education	0.07	39.9%	0.04
Religious	0.08	35.2%	0.05
Other health care	0.01	57.1%	0.00
Service	0.03	46.9%	0.02
Lodging	0.22	31.8%	0.15
Retail	0.00	33.9%	0.00
Food sales	0.00	58.6%	0.00
Total	**0.79**		**0.40**

CHAPTER 4: CONCLUSION

There clearly are opportunities to reduce energy waste in the Peoples Gas service area. The most promising areas are increased use of thermostat setback practices in both the residential and commercial sectors. Encouraging customers to wash laundry in cold water is another area where substantial savings could be garnered.

The following table provides the energy-savings potential in rank order based on the magnitude of savings.

Table 29
Annual Therm Savings
(millions)

Waste-Reducing Behavior	Before Technology Measures Installed	After Technology Measures Installed
Residential: set back thermostat	16.1	9.9
Residential: wash in cold water	6.5	4.8
Commercial: set back thermostat	6.4	3.3
Residential: reduce water heater temperature	1.4	1.0
Residential: maintain heating system	0.9	0.5
Commercial: maintain heating system	0.8	0.4
Total	**31.1**	**19.9**

These numbers are large relative to savings estimates from other studies, and care must be taken not to assume that these represent achievable levels. Rather they represent upper-bound estimates, savings that could be achieved if all customers not practicing the stated behaviors would adopt them. In reality, only a fraction of the customers would be willing to do so, which means that the achievable levels are noticeably lower than those shown here.

SELECTED REFERENCES

The Cadmus Group, Inc., 2012. *Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation: Part of the Massachusetts 2011 Residential Retrofit and Low Income Program Area Evaluation*.

Energy Center of Wisconsin, 2000. *Energy and Housing in Wisconsin: A Study of Single-Family Owner-Occupied Homes*.

Energy Center of Wisconsin, 2013. *Peoples Gas Light and Coke Company Energy Efficiency Potential Study: Program Years 4, 5 and 6.*

Illinois Energy Efficiency Stakeholder Advisory Group, 2014. *Illinois Statewide Technical Reference Manual for Energy Efficiency: Version 3.0.*

Opinion Dynamics Corporation, 2013. *ComEd Residential Saturation/End-Use, Market Penetration & Behavioral Study.*

Walker, Iain S., Darryl J. Dickerhoff, David Faulkner and William J.N. Turner, 2013. *System Effects of High Efficiency Filters in Homes*, Lawrence Berkeley National Laboratory.

APPENDIX

RESPONSES TO QUESTIONS AND COMMENTS RECEIVED AT THE OCTOBER 28, 2014 MEETING OF THE ILLINOIS STAKEHOLDER ADVISORY GROUP

- *In the Massachusetts smart thermostat study, how many degrees on average did people set back when they received the Ecobee device?*
  The study estimated the space heating energy savings implicitly using billing analysis, not explicitly based on observed temperature setbacks.

- *For the fast food restaurant discussed in the presentation, the open/close data on the graph appeared to refer to temperature settings, which is confusing.*
  We replaced the chart with a table to eliminate the confusion.

- *Why did the Energy Center assume that the typical family washes only 4 loads of laundry per week?*
  That was our original estimate based on discussions with energy efficiency experts. Further review of the data suggests that this figure is too low. In the final report, we used 6 loads per week. See report body for further discussion.

- *The ComEd baseline study provides local data on the proportion of customers who wash laundry in hot, warm and cold water.*
  We reviewed the study and considered that information in our analysis.

- *Did the Energy Center look at overall industrial heating system maintenance, such as leak detection in hot water heating lines?*
  We did not. We focused on areas where there is potential for an educational campaign to save energy. The sort of maintenance this question refers to is more closely related to industrial process management.

- *The assumed two-degree setback in the residential sector seems too low.*
  We did not assume a two-degree temperature setback, but rather a two-degree reduction in average daily temperature. A person setting back 8 degrees at night would cause the average daily temperature to decline by only 2.7 degrees. See body of the report for further discussion.

- *What was the setback behavior (degrees set back) observed in the commercial site visits?*
  We do not estimate degrees set back, but rather reduction in average daily temperature. The average daily temperature for commercial customers that show no setback behavior is 70.4 degrees; for those that do setback, the average daily temperature is 65.6 degrees. The temperature difference in the commercial sector is therefore about 5 degrees in contrast to the 2 degree difference in the residential sector. There could be some upward bias in the commercial data, however, since it is reported rather than measured.

- *In the commercial energy model, does the temperature setback occur independently of ventilation reduction, or are the two linked?*
  The thermostat setback occurs whenever we assumed that the building was unoccupied. The ventilation was also reduced at those times. More advanced modeling could be performed to allow for independent operation of those functions. We did not conduct such an analysis.

- *The achievable potential for Peoples Gas is about 6 million therms per year. What percentage is that of total sales?*
  The potential study shows that the target efficiency savings level for Plan Year 4 was 0.8%, or 11.2 million therms. This suggests that the total therm sales are 11.2 million / 0.008 = 1.4 billion therms. Therefore the achievable potential is 6.0 million / 1.4 billion = 0.4% of total sales.