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June 28, 2019

Ms. Stephany Powell Coker
Secretary to the Commission
Public Service Commission of Wisconsin
610 North Whitney Way
P.O. Box 7854
Madison, Wisconsin 53707-7854

RE: Wisconsin Power and Light Voluntary Program Impact Analysis of Sense Whole Home Monitor Pilot (PSC REF#: 347625) **Docket No. 6680-EE-2019**

Dear Secretary Coker:

Enclosed is the Wisconsin Power and Light Final analysis of behavior and savings opportunities from first full phase of the Sense Whole Home Monitor Pilot.

If you have any questions on the proposed program, please contact Jeff Adams, Lead Customer Program Manager, 608-458-8419; JeffAdams@alliantenergy.com.

Sincerely,

/s/ Brian Penington
Brian Penington
Manager Regulatory Relations and Policy
Wisconsin Power and Light Company

CADMUS

Sense Home Energy Monitor Pilot Program

ALLIANT ENERGY

June 28, 2019

Prepared for:

Public Service Commission of Wisconsin

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Madison, Wisconsin

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CADMUS

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Executive Summary

Alliant Energy and Cadmus conducted an exploratory pilot to investigate the potential benefits of a customer-facing, broadband, device-level energy monitor. Residential customers were provided a free Sense monitor in exchange for participating in the program and sharing their monitor data. The first 100 monitors were installed in rural areas of Wisconsin during the summer of 2018. In a second phase of the pilot (currently in progress), an additional 100 monitors will be installed along with an accessory that collects circuit-level data.

The pilot had three primary objectives: derive estimates of the energy savings achievable through the replacement or servicing of inefficient equipment, identify behavioral effects produced by homeowner's awareness of energy use, and assess the impact that might be achieved with demand response initiatives.

This evaluation reports on the full first phase of the pilot, including recruitment, installation, results of participant and stakeholder surveys, and results of device-level energy data analysis.

Summary of Key Findings and Conclusions

Device-level home energy monitoring delivers opportunities and insights in several areas of interest such as behavioral and resource acquisition energy savings, customer engagement, and demand response initiatives.

Process Findings

- New energy-savings opportunities were sought out by nearly one-third of survey respondents, and 57% said their opinion of WPL had improved since participating in the pilot.
- Prior to participating, 82% of respondents said they were very or somewhat knowledgeable about energy-savings strategies for their home. After participating, 98% of respondents said they were very or somewhat knowledgeable about energy-savings strategies for their home.

Impact Findings

- "Always On" loads constitute roughly one quarter of average daily household consumption and present an opportunity to reduce overall participants' energy use by 9%. The replacement of incandescent lights and inefficient refrigerators could yield an additional 5% of savings potential.
- Preliminary pre- and post- app access analysis of total household consumption indicates that the more eager app users saved an average of 1.8 kWh per day over participants who did not actively engage with the app. The statistical significance of this finding is low ($p=0.30$); the addition of pilot Phase 2 participants will help clarify and further constrain this result.
- After air conditioners, the study found that the devices that contribute the most peak coincident load are "Refrigerators," "Always On" and "Dryers."

Conclusions

The Sense monitor and the associated application could be a substitute for aspects of an in-person energy audit by providing homeowners with a complete picture of their disaggregated electrical loads and how their energy use compares with state or regional efficiency definitions (in the Wisconsin and Indiana technical reference manuals [TRMs]). In addition, a monitor-specific return-on-investment and payback calculator should be developed to connect homeowners with other Focus on Energy programs and encourage homeowners to upgrade inefficient appliances.

As Cadmus collects more disaggregated electrical load data in the pilot expansion, the initial peak demand trends observed in this study (see Figure 19) will become increasingly accurate and Alliant Energy could build demand response initiatives using device-specific findings.

This energy-monitoring technology does not by itself offer homeowners specific energy conservation recommendations related to envelope improvements (i.e. air sealing, insulation, and glazing upgrades). A weather-normalized analysis of monitor data from air conditioner and air-source heat pump (i.e. electric-based HVAC load) activity would highlight higher-than-average HVAC loads for some households within the pilot participant pool and allow Alliant Energy to target those homes for in-person weatherization-focused energy audits.

Challenges to the widespread use of this technology include initial cost, installation and connection complications, and the accurate identification of all detected devices. In Phase 2, the pilot expansion, 100 more monitors will be deployed with an accessory that can more granularly identify and categorize end-use electrical loads. These additional data will improve Cadmus' ability to calculate reliable estimates of savings.

Introduction

In its decision of December 20, 2016 (PSC REF#: 295732 relating to Dockets 5-FE-100 and 5-FE-102), the Public Service Commission of Wisconsin (PSCW) stated that it is "particularly interested in examining the role broadband access could play in expanding access to energy efficiency programs and services, and assessing whether Focus participation could be improved through coordination with other state and federal programs designed to increase broadband access in the state."

In directing "the development of additional Focus program offerings for rural Wisconsin that would support more equitable distribution of Focus benefits throughout all areas of the state, and also be designed to seek the additional benefits through the support of increased access to broadband services by tying the use of the internet to increased energy efficiency measures, incentivizing broadband providers to market Focus along with new or upgraded service, and providing programs to promote increased energy efficiency in the build-out of rural broadband service," the PSCW created the opportunity and demand for new energy efficiency programs for the market to promote.

The Sense Home Energy Monitor Pilot was directed by Alliant Energy and Cadmus. The pilot targeted customers in rural areas to determine the feasibility of mitigating some of the inequities in cost and access that have traditionally resulted in rural customers being underserved by Focus on Energy programs.

The pilot centered its analysis on three key areas: residential energy savings, customer engagement and behavior change, and time-of-use/demand response. The goal in Phase 1 was not to deliver immediate savings but rather to demonstrate the potential of the Sense device to deliver cost-effective savings at scale. Phase 1 also targeted rural populations.

In Phase 2, the pilot is expanding to include 100 more device installations in rural, suburban, and urban areas and adding an accessory that will enable even more accurate identification and targeting of end-use device savings. The addition of these devices will result in increased statistical confidence in findings from the second phase of the study.

Methodology

This section describes Cadmus' process, impact, and market effects evaluation methodology for Phase 1 of the Sense Home Energy Monitor Pilot Program.

Process Evaluation

Cadmus conducted these process evaluation activities:

- Telephone interview with two pilot program staff members
- Telephone interview with five Sense monitor technicians
- Online survey with 63 participants

Stakeholder Interviews

To gain a thorough understanding of the pilot program design and implementation, Cadmus conducted a telephone interview with two Sense Home Energy Monitor Pilot Program staff members who gave their perspectives on program performance, successes, challenges, and plans.

Cadmus also conducted telephone interviews with Sense monitor installation technicians to gather information about scheduling and installation process, practices, and challenges.

Customer Surveys

Cadmus conducted online surveys with participants in the test and control groups to collect data about the following:

- Satisfaction with the Sense monitor, overall program, and Alliant Energy
- Challenges and benefits of participation
- Behavioral changes made after program participation

Impact Evaluation

Participant Selection and Recruitment Survey

Participants were recruited from rural and low- to middle-income zip codes, representing customers that have historically been underserved by energy efficiency programs. Sampling from these areas served to increase access to program funds and promote customer engagement in this underserved population. Attention was also given to the geographic distribution of zip codes and households with potential for energy savings that did not strongly deviate from the average annual consumption of the population. All selected participants were required to live in the Alliant Energy service territory and have access to a broadband internet connection.

Sample selection involved some tradeoffs in meeting study objectives and conducting a strictly random sample. The study required applying several criteria in selecting zip codes and households. First, Cadmus refined the initial list of rural zip codes to include only those with greater than 200 households and assumed that this threshold would achieve a 10% response rate in recruitment (i.e. a total of 100 participants across five zip codes).

Geographic diversity was achieved by randomly selecting zip codes within these constraints, mapping the chosen zip codes, assessing their dispersion, and repeating this process if necessary. Cadmus also selected households with slightly above average annual energy consumption as an attempt to ensure greater opportunities for implementing energy efficiency measures. This step also removed outliers that could bias the results of the pilot. Cadmus created histograms of annual consumption and bound selection to annual household energy consumptions between 10,000 kWh and 16,000 kWh, approximately the 3rd quartile of energy use.

A pool of homeowners in Alliant territory with annual energy consumption in this range were sent a recruitment survey that included questions about the following:

- Home age
- Square footage
- Home type
- Number of full-time occupants
- Internet latency

The recruitment survey yielded an eligible pool of 100 rural participants who were then contacted and scheduled for Sense monitor installations.

Sense Installations

Cadmus schedulers contacted eligible participants and coordinated installation visits with a Cadmus field technician and licensed electrician. While the electrician installed the Sense monitor in the participant's electric panel, the Cadmus technician worked with the participant to sign the customer agreement, deliver a gift card incentive, and connect the Sense monitor to the homeowner's Wi-Fi. Cadmus technicians also collected field data which included:

- Confirmation of square footage
- Number of stories
- Whether an air conditioner was present in the home

They also took a photo of the Sense monitor in the electric panel after it was installed. All installations were completed in the summer of 2018.

Troubleshooting Visits

In September 2018, raw disaggregated Sense end-use data indicated that of the 100 originally installed Sense devices, 19 were offline. These offline monitors were distributed across over 50% of the targeted zip codes. The connection failures were attributed to three primary causes:

- Power outages (12 devices)
- Incorrect current transducer (CT) installation (six devices)

- Poor Wi-Fi connection (one device)

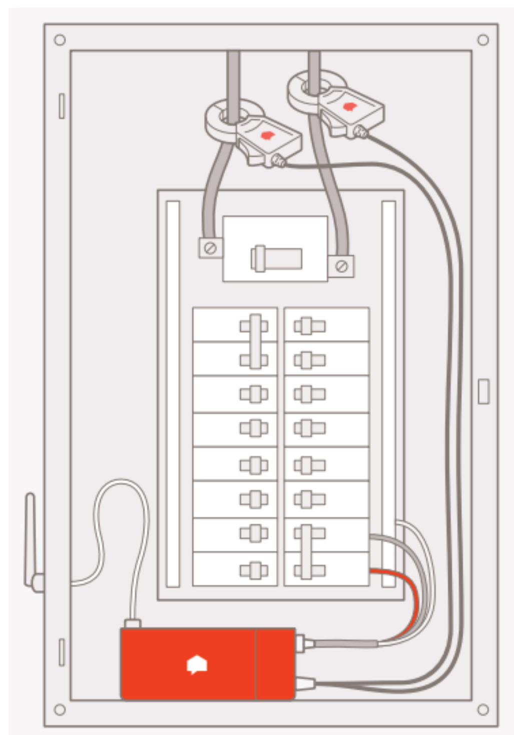
Power Outages

Twelve Sense devices had lost power and either required a reboot and/or fixing the connection between the device and the breaker providing the power. Cadmus coordinated a troubleshooting visit to these homes during which an electrician removed the electrical panel cover, verified that the power cable from the Sense device was connected to a breaker in the panel, and flipped the breaker off and on (ensuring that the startup sound was audible).

Current Transducer Installation Failure

Six devices went offline due to incorrect CT installations. The CTs in the Sense installation kit are intended for installation on the two main service lines entering the home's electrical panel as shown in **Error! Reference source not found.**. Critically, these CTs must be oriented correctly so that the logo on ach is facing the same direction. The CTs must also remain closed to accurately detect and disaggregate the various sub-loads throughout the house.

Figure 1. Illustrated Sense Installation in Electrical Panel



In some cases, the CTs were not both oriented in the same direction, but in most cases of failure, the installation of the electrical panel cover (which safely hides the Sense monitor and live breaker connections) applied pressure to the CTs, forcing them open. During the troubleshooting visits, the electrician removed the electrical panel cover and reoriented the CTs and main service lines (where possible) so they both faced the right direction and were firmly embedded in the electrical panel cavity.

Poor Wi-Fi Connection

One offline device was logging very high latency rates, which prevented the consistent upload of disaggregated electrical loads in the home because the electrical panel was too far from the internet modem. A Cadmus technician visited the home and installed a Wi-Fi signal booster partway between the modem and electrical panel.

Persistent Failures

Most troubleshooting site visits were conducted between September 2018 and February 2019, but some devices (not necessarily the same ones) continued to intermittently lose their Wi-Fi connection or otherwise failed to communicate electric load signals to the Sense servers. The following status updates show that discontinuous power and internet connections have likely continued to affect the consistency of data from the Phase 1 pilot devices:

- September 1, 2018: 19 monitors offline

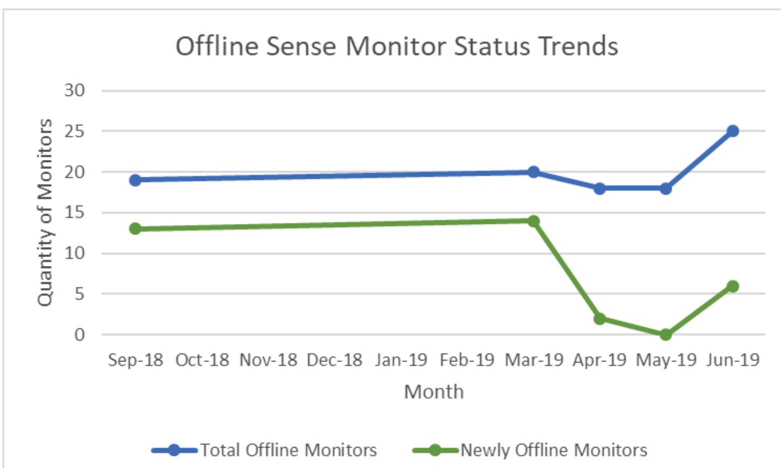
- March 20, 2019: 20 monitors offline
- April 26, 2019: 18 monitors offline
- May 3, 2019: 18 monitors offline
- June 7, 2019: 25 monitors offline

From September 2018 through June 2019, Cadmus observed that a total of 41 unique monitors exhibited offline status at some point. Thirteen of the original 19 monitors identified as offline in September 2018 were serviced and have not again appeared on the list of offline monitors. Of the remaining six, four have had persistent connection issues, one was offline throughout the spring and only recently returned to online status, and one was removed because the homeowner no longer wanted to participate in the pilot.

In March and April of 2019, 13 additional monitors acquired offline status, which has continued through the submission of this report. Three unique monitors appeared on the offline status report in March of 2019 but were restored to online status in the following month. Five new monitors appeared with offline status during the latest status check in June, and one monitor was restored.

Figure 2. shows the trend of newly offline monitors over the past nine months compared to total number of monitors observed to be offline every month. Although there are fewer previously offline monitors now than in September 2018, the total number of offline monitors has increased in the past month. It is unlikely that monitors that have recently acquired offline status are offline due to CT installation failures—more likely, failure has been caused by power outages or Wi-Fi connectivity problems.

Figure 2. Offline Sense Monitor Status Trends



After coordinating troubleshooting to fix the first 19 offline devices, Cadmus focused its efforts on securing and analyzing data from the monitors that are consistently online. Lessons learned during the first phase of the pilot have resulted in an updated recruitment survey and evaluation plan for the second phase of the pilot, both of which are designed to minimize unplanned monitor disconnections and further troubleshooting visits.

Process Evaluation Findings

Stakeholder Interviews

Alliant Energy launched the Sense Home Energy Monitor Pilot Program to investigate the potential benefits of this technology in rural areas. Currently, only one other utility is known to have implemented a similar energy monitoring Pilot program. Alliant Energy anticipates that the two phases of the pilot will help in designing and implementing future programs based on load disaggregation technology. Through the Phase 1 rollout, program staff identified three areas for improvement:

- Identifying and maintaining signal strength during installation
- Rebooting the Sense monitor in the event of a power outage
- Granting customers access to the Sense app as soon as the Sense monitor has been installed

Installer Interviews

Cadmus contracted with Mainstage Lighting and Electric to schedule and perform the Sense monitor installations at the homes of participants selected through the recruitment survey. Once selected, participants were contacted to schedule an installation visit. While at the home, the technician confirmed that the monitor was connected to Wi-Fi. The technician reported two main challenges during installation. One challenge was that a small percentage of electric panels did not have enough wiring to install the monitor. A second challenge was that the distance between the panel and the Sense monitor was too large, which caused connectivity issues during installation. Overall, the technician said the scheduling and installation process were easy.

Cadmus also interviewed technicians who subsequently visited homes to troubleshoot offline issues. They noted similar connectivity issues due to the distance between the panel and Sense monitor. Other connectivity issues stemmed from limited internet service in the participant's area. One technician noted a lack of enough information about the Sense monitor and suggested supplying informational materials before the technicians made troubleshooting inspections. These technicians also said that, overall, the scheduling and installation process were easy.

Satisfaction

A survey of Sense Home Energy Monitor Pilot participants asked respondents to rate their satisfaction with the pilot application process, the Sense monitor, the pilot, and Alliant Energy.

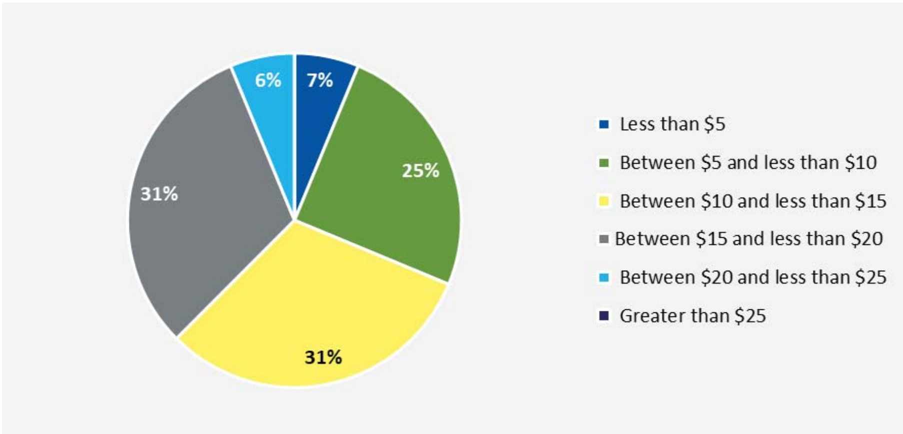
Satisfaction with the Application Process

Respondents reported a *very* (81%) or *somewhat positive* (19%) sign-up experience for the Sense Home Energy Monitor Pilot (n=62 respondents). Survey respondents also reported high satisfaction with the length of time it took for the Sense Monitor to be installed after their application was submitted (98%, n=63) and the technician who installed the Sense monitor (97%, n=63).

Satisfaction with the Sense Monitor

Of 60 respondents, 25 said they saw a decrease in their monthly energy costs since accessing the Sense monitor app. Of these 25 respondents, 31% said they noticed a decrease in monthly energy costs between $10 and $15 and 31% noticed a decrease between $15 and $20 (as shown in Figure 3.). Eighty percent of respondents were satisfied with the decrease in energy costs after accessing the Sense app, with 52% *very satisfied* and 28% *somewhat satisfied* (n=25).

Figure 3. Monthly Energy Cost Savings



Source: Cadmus Survey question B9. "By about how much did your monthly energy costs decrease?" (n=25)

Of the respondents who did not notice a decrease in their monthly energy costs, the survey asked for reasons. The top four reasons were:

- They did not make any behavior changes (9 respondents)
- Higher than usual energy consumption recently occurred (5 respondents)
- The Sense monitor has not identified all electronic devices (5 respondents)
- Connectivity issues with the Sense monitor (4 respondents)

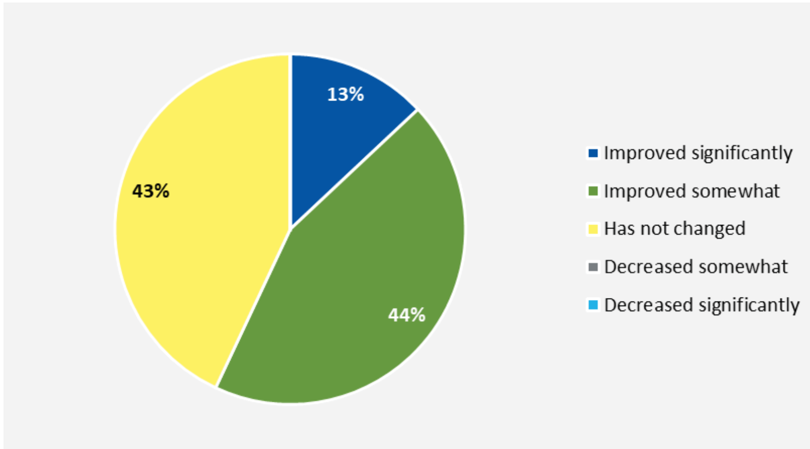
Satisfaction with the Program

Cadmus asked respondents to rate their satisfaction with the Sense Home Energy Monitor Pilot and Alliant Energy using a scale of 0 to 10, where 0 is *not at all satisfied* and 10 is *extremely satisfied*. Respondents reported a mean satisfaction rating of 8.2 for the pilot and 8.6 for Alliant Energy. When asked how the pilot could be improved, 12 respondents gave suggestions. The most frequently mentioned were these:

- Provide more instruction on how to use the Sense monitor or Sense mobile app (5 respondents)
- Provide more accurate identification of devices (5 respondents)
- Resolve connectivity issues (1 respondent)
- Grant access to the Sense app immediately after installation (1 respondent)

Cadmus asked respondents if their opinion of Alliant Energy had changed since participating in the pilot. As shown in Figure 4., 57% said their opinion of Alliant Energy had improved.

Figure 4. Opinion of Alliant Energy



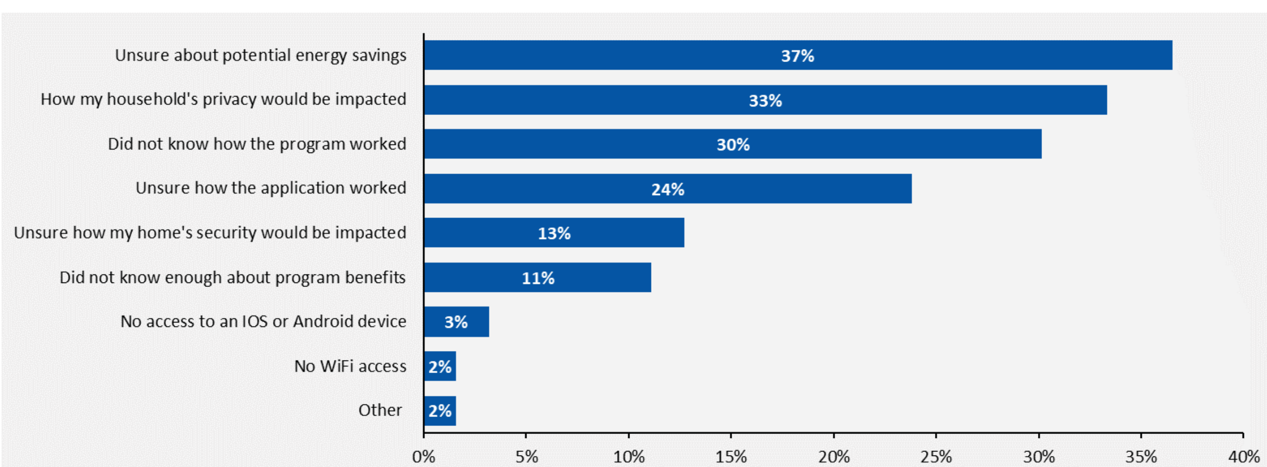
Source: Cadmus survey question B15. "Since participating in the Sense Home Energy Monitor Pilot program, has your opinion of Alliant Energy…" (n=63)

Challenges to Participation

Cadmus asked respondents if they had any reservations about participating in the pilot. Of 62 respondents, 48 said they had at least one reservation. The top three concerns related to the uncertainty of potential energy savings (37%), how their home's privacy would be impacted (33%), and not knowing how the program worked (30%). Figure 5. presents these reservations in detail.

When asked what Alliant Energy could do to help address these reservations, 15 respondents gave suggestions. The most frequently mentioned were to provide more information about the pilot or Sense monitor (11 respondents), provide training on how to use the Sense app (3 respondents), provide more information on the program's benefits (2 respondents), provide data comparisons of home energy use (2 respondents), and to provide an FAQ sheet (2 respondents).

Figure 5. Reservations about the Sense Home Energy Monitor Pilot

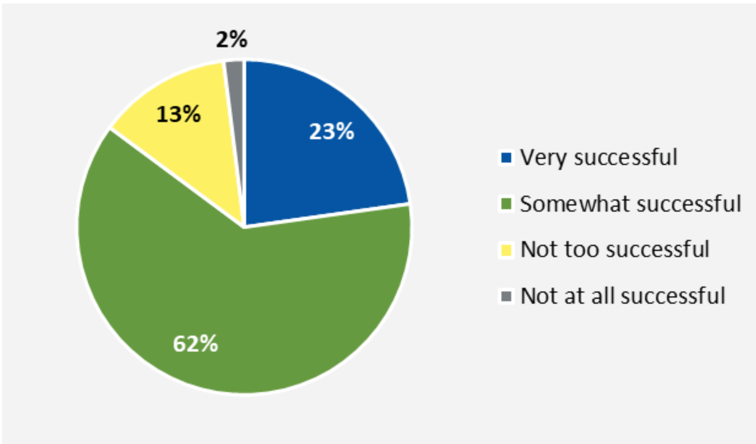


Source: Cadmus survey question C1. "Did you have any reservations about participating in the Sense Home Energy Monitor Pilot Program?" Multiple responses allowed (n=63).

Device Identification

As shown in Figure 6., 86% of respondents said their Sense monitor was successful at accurately identifying different sources of energy within their home.

Figure 6. Success with Energy Source Identification



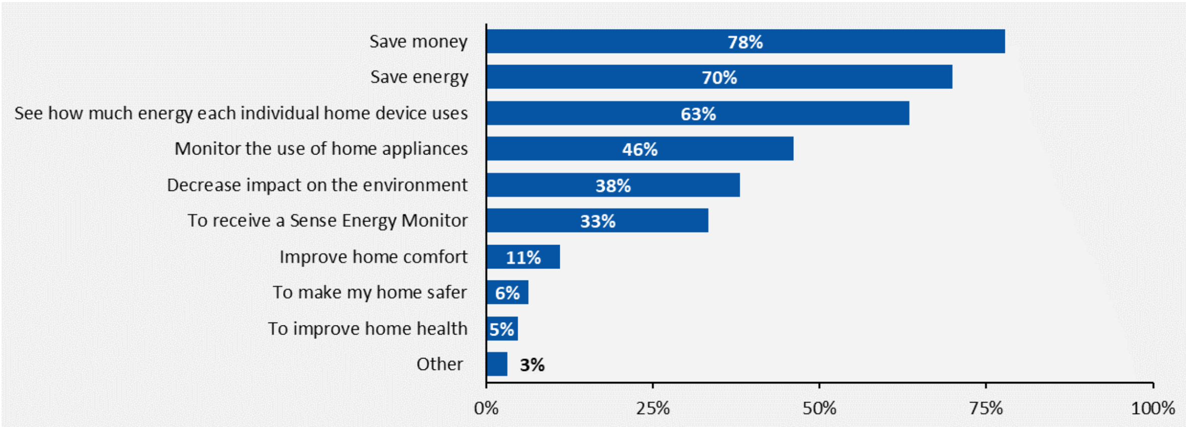
Source: Cadmus survey question C4. "How successful was the device at accurately identifying different sources of energy use in your home?" (n=62)

When asked about the amount of effort required to confirm or identify devices through the Sense app, 65% of respondents said it required a *reasonable amount*, 23% said it required *too much* effort, and 13% said it required *very little* effort (n=62).

Benefits of Participation

Cadmus asked respondents what motivated them to participate in the Sense Home Energy Monitor Pilot Program. As show in Figure 7., some of the top reasons were to save money (78%), save energy (70%), and identify how much energy each electronic device uses in their home (63%). Almost all (98%, n=63) said that they plan to keep the Sense monitor installed after the pilot program has completed.

Figure 7. Motivations to Participate

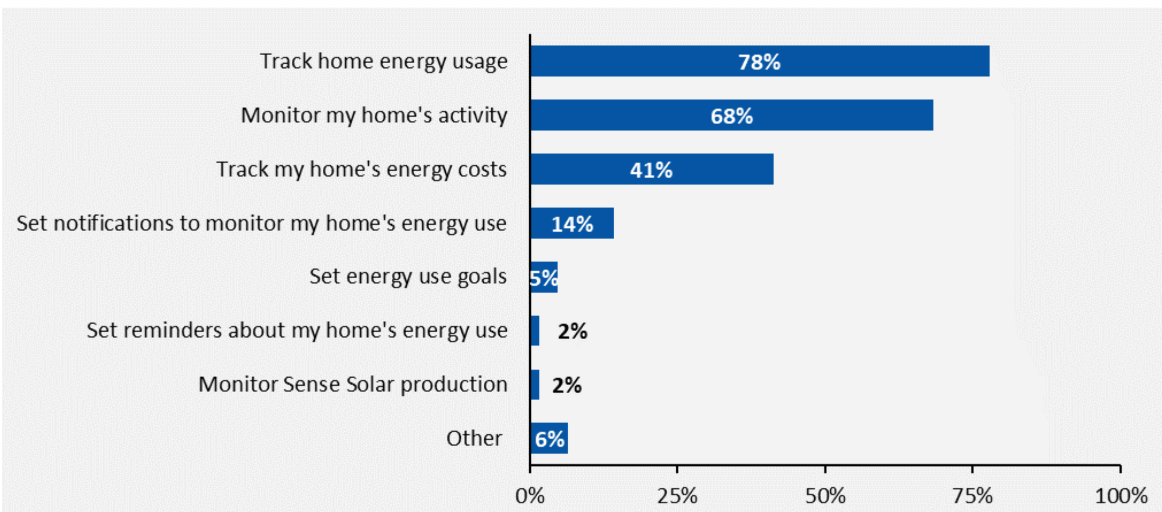


Source: Cadmus survey question D1. "What motivated you to participate in the Sense Home Energy Monitor Pilot Program?" Multiple responses allowed (n=63).

Sense Home Energy Monitor App

Most respondents have accessed the Sense app (95%, n=63), primarily to track their home's energy usage (78%) and to monitor their home's activity (68%), as shown Figure 8..

Figure 8. Sense Home Energy Monitor App



Source: Cadmus survey question E4. "How have you used the Sense Monitor App?" Multiple responses allowed (n=63).

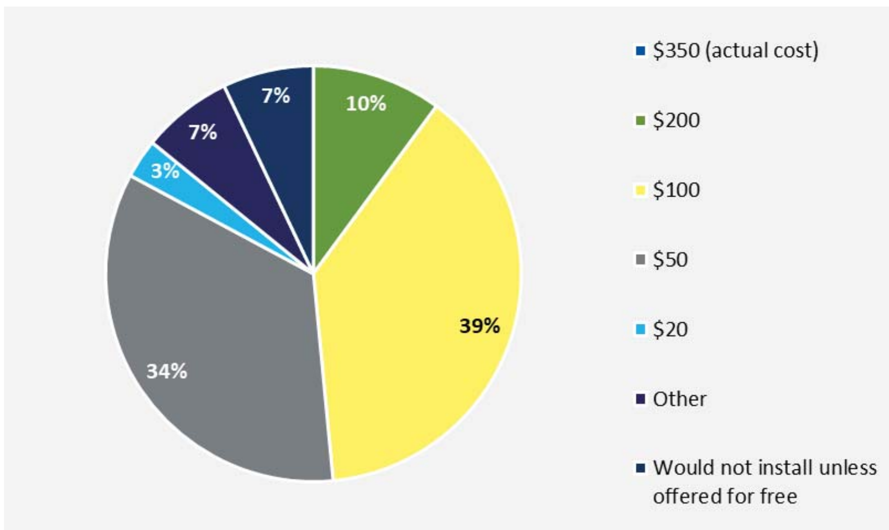
Overall, 80% of respondents were satisfied with the Sense app interface, with 27% *very satisfied* and 53% *somewhat satisfied* (n=60). Some of the suggestions to improve the Sense app included these:

- "No recommendations for the [Sense] app per se, but rather I would like the browser-based interface to be as fully functional and its use encouraged as much as the smartphone app."
- "Better support in renaming devices and helpful suggestions on identifying undetermined devices."

- "Continued improvement of device identification and more accurate billing estimate (the app usually estimates about 30% lower than my actual bill)"
- "Ability to name a new device immediately, even if it is only a name for my viewing would help."

Cadmus asked respondents if, based on their experience with the pilot, they would be willing to install a Sense monitor in their home had one not been offered. Over half (52%, n=63) said they would have been willing to install a Sense monitor without the program. Figure 9. shows how much respondents would have been willing to contribute toward the cost of a Sense monitor had one not been offered through the program. Thirty-nine percent would have been willing to pay $100, and 34% would have been willing to pay $50.

Figure 9. Sense Home Energy Monitor App



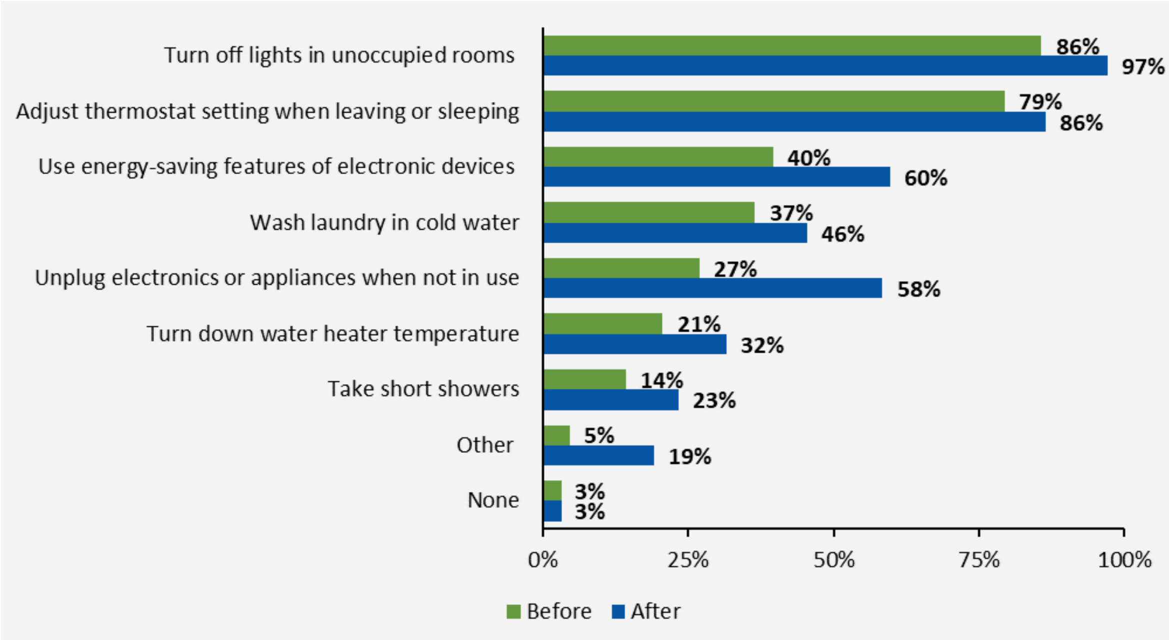
Source: Cadmus survey question E9. "How much would you have been willing to contribute toward the cost of a Sense Monitor (including installation)?" (n=63).

Behavioral Changes

Cadmus asked respondents about their energy-saving habits before and after participating in the pilot. Of 63 respondents, all but 3% said they used energy-saving habits to reduce their energy consumption before participating. After participating, 56% of respondents said they had made additional changes to their daily behavior to reduce energy use. Figure 10. presents energy-saving behaviors before and after participation in the program.

Prior to participating, 82% of respondents said they were *very* or *somewhat knowledgeable* about energy-saving strategies for their home (14% and 68% respectively, n=63). After participating, 98% said they were *very* or *somewhat knowledgeable* about energy-saving strategies for their home (19% and 79% respectively, n=53).

Figure 10. Energy-Saving Behaviors



Source: Cadmus survey question F1 and F2A. "Before participating in the Sense Home Energy Monitor Pilot program, did you or any members in your household have any habits that were meant to reduce your energy consumption? (select all that apply)" and "Since participating in the Sense Home Energy Monitor Pilot Program, have you or members in your household changed any of your daily habits that would affect your energy consumption (e.g., changing the indoor temperature when you're not home, changing when lights are turned on/off, etc.)?" Multiple responses allowed (n=63).

Cadmus also asked respondents if they had investigated other energy-saving opportunities. Of 63 respondents, 32% said they had sought out additional energy-saving opportunities. Additionally, 40% (n=83) of respondents said they had purchased new energy-saving products, and 16% (n=63) purchased other Wi-Fi enabled devices due to their participation in the pilot program.

Impact Evaluation Findings

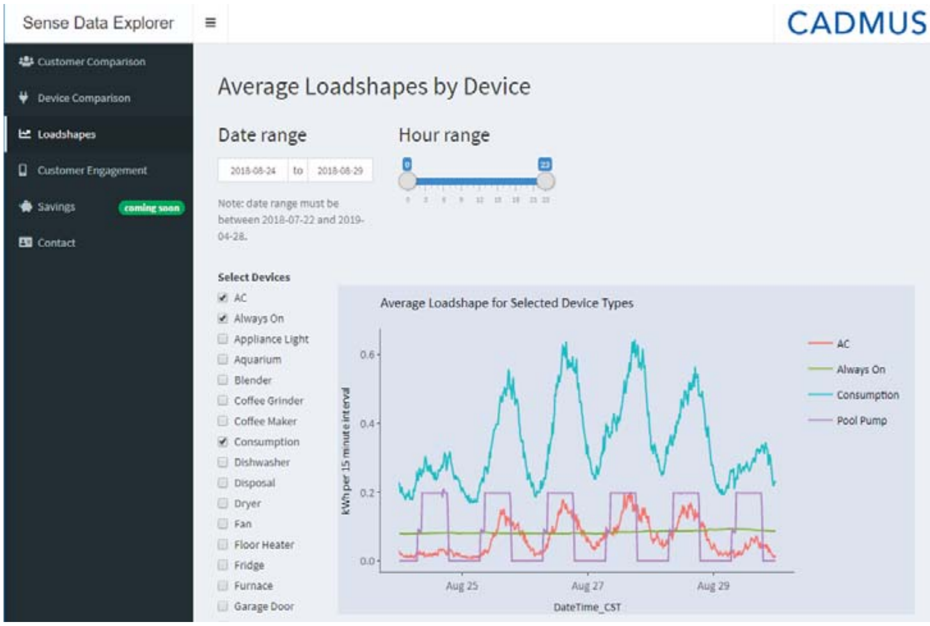
The Sense Home Energy Monitor Pilot was designed to assess the feasibility of using the emerging Sense monitor technology as a tool to inform and develop new energy-saving programs for Wisconsin homes. This technology uses machine-learning algorithms to disaggregate electric sub-loads throughout the home in which the device is installed. Sense identifies the unique electric load signature of lights, appliances, and other end-use devices and labels them for viewing within the app. In this study, Sense also delivered energy-use data to Cadmus for analysis.

This section presents Cadmus' analysis of the disaggregated Sense load data for three categories of interest, as defined in Docket 6680-GF-133: residential energy savings, customer engagement and behavior, and collection of time-of-use/demand response data.[1]

Cadmus created an online dashboard to share data insights and allow key stakeholders to explore potential opportunities for savings. The dashboard allows viewers to investigate each participant's device-level consumption, identify devices with higher than normal consumption over a selected time period, and view average consumption patterns among all participants. Figure 11 illustrates the interactive functionality of the load shape exploration tab. The dashboard has been shared with key partners at Alliant Energy, WI PSC and the WI Focus on Energy Administrator APTIM and is regularly updated as new data are received from Sense.

[1]Public Service Commission of Wisconsin. October 16, 2015. *Wisconsin Power and Light Company Voluntary Utility Programs.* Order PSC Docket 6680-GF-133, REF#:276417. https://apps.psc.wi.gov/vs2015/erf_view/viewdoc.aspx?docid=%20276417

Figure 11. Sample Dashboard Image



Residential Energy Savings

Cadmus identified the annual energy use thresholds that define baseline and efficient technologies according to the Wisconsin and Indiana TRMs. In the absence of specific definitions of efficient and inefficient products, such as in the case of "Always On" loads, Cadmus defined a median wattage based on the data collected from all Sense monitors in households participating in the Pilot and used this wattage to distinguish between efficient and inefficient usage levels. For incandescent lighting loads, Cadmus calculated savings potential based on a wattage reduction of 5/6 based on typical LED, CFL, and incandescent bulb wattages. Energy-savings potential for these electric end-use categories—always on, incandescent, appliances, electric dryers, refrigerators, water heaters, and dishwashers—was determined based on the conversion of inefficient end-users to the efficient or median population threshold and is further described below.

Always On

Sense Labs' research estimates that 23% of a typical home's energy consumption falls in the category of "Always On"[2]: devices that are plugged in and draw current and power despite not being actively used 24 hours a day such as televisions or hot water kettles. "Always On" load generally include a base level of consumption from otherwise uniquely-identified appliances. For example, a refrigerator with an 8-

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2 Walton, Robert. May 8, 2019. "Loads as traditional energy saving measures diminish." *Utility Dive*. https://www.utilitydive.com/news/sense-targets-41b-of-always-on-loads-as-traditional-energy-saving-measur/554284/

watt baseline consumption will have 8 W of its demand and energy use attributed to the "Always On" category. This could lead to underestimates in annual energy use projections in the Appliances section.

An analysis of the data from all households reporting electric loads in the pilot study found a median total demand of 1,067.2 watts and a median "Always On" demand of 260 watts (roughly 24.5%), which is consistent with Sense Labs' reported national average. Figure 12. shows the potential for savings as "Always On" loads are reduced from above the median to the median in all pilot households.

Figure 12. Always On Savings Opportunity

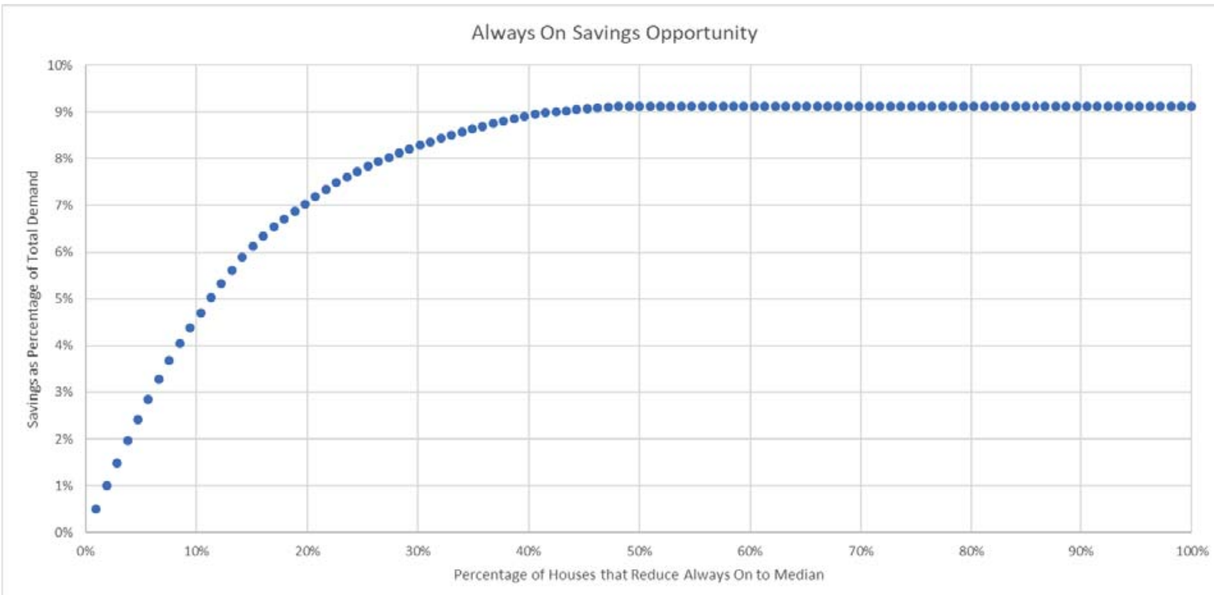


Figure 12 shows how energy savings increase as "Always On" loads are reduced to the median level; these savings are calculated by converting the largest "Always On" loads first. In practice, customers would reduce their "Always On" loads in a random order, therefore the most useful way to interpret this figure is to focus on the overall percentage of savings that could be achieved if *all* homes with high "Always On" loads reduced them to the median value.

In this pilot, approximately 40% of all households had higher-than-median "Always On" loads and a regression of all homes to the 260-watt median would reduce overall energy use by over 9% across the pilot or roughly 10,300 kW of base demand.

"Always On" load sources differ from household to household, but many can be controlled by using a power strip. Several Focus on Energy programs offer free or discounted advanced power strips (APS) to single family households such as those that participated in this study. Advanced power strips detect when devices plugged into them are not in use and eliminate the power supplied to those devices. This method of load reduction requires little customer education, whereas the next best strategy for reducing "Always On" loads—actively unplugging appliances and other electricity-using devices—requires significant and consistent behavioral changes.

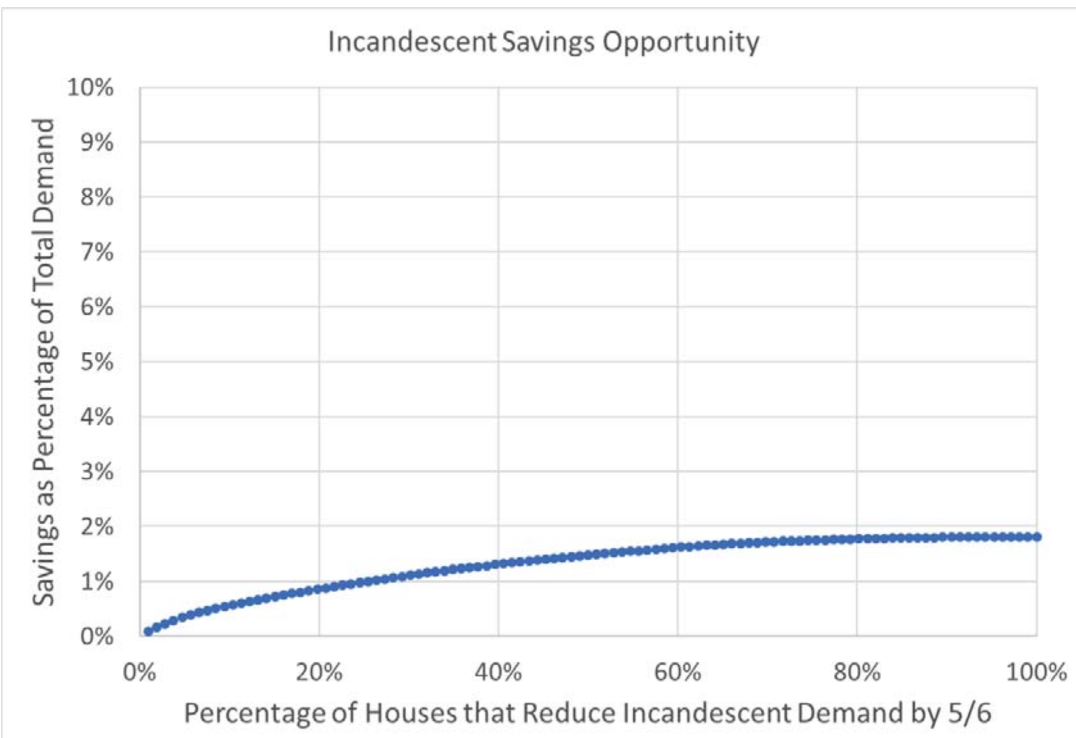
The Simple Energy Efficiency Kit program offers free advanced power strips to homeowners and renters while the Retail Lighting and Appliance, Retail Lighting Pop-Up Store, and upcoming Online Marketplace programs offer them at a discount. Various advanced power strips that eliminate "Always On" loads use different controls, such as remote control, motion sensing, or master-device selection. Even with an advanced power strip, some education is necessary to help homeowners target rooms and plug-in loads where the "Always On" demand is highest.

Alliant or Focus on Energy could provide targeted training to homeowners separately from or in collaboration with Sense through their mobile application. For example, expanding the Simple Energy Efficiency Kit program to include a digital power meter could help homeowners that do not have a Sense monitor identify their highest "Always On" load devices and either actively unplug them or use them with an advanced power strip.

Incandescent

Sense's disaggregated load data suggests that, of the median total consumption of 1,067 watts for each participant household, the median incandescent bulb demand is approximately 19.4 watts. Figure 13 shows that by reducing all above-median household incandescent bulb demand to the median, the total demand of all participant homes could be reduced by 1.8% or roughly 2,050 kW.

Figure 13. Incandescent Savings Opportunity



To target the conversion of incandescent to higher efficiency bulbs, the same Focus on Energy programs that offer advanced power strips also supply high-efficiency bulbs to homeowners at discounted or no cost. The Simple Energy Efficiency Kit program supplies free LEDs whereas the Retail Lighting and

Appliance, Retail Lighting Pop-Up Store, and forthcoming Online Marketplace programs offer discounted LED bulbs.

Homeowners who already have LEDs, CFLs and incandescent bulbs installed may find it difficult to identify the least efficient bulbs for replacement, especially because some LEDs look very similar to incandescent bulbs. Demand can also be reduced by converting CFLs to LEDs, but these should be targeted after all incandescent bulbs have been replaced. Alliant Energy or Focus on Energy could offer homeowners awareness education training separate from or directly through the Sense mobile application.

Appliances

This section presents findings regarding the potential for device upgrade savings from electric dryers, refrigerators, water heaters, and dishwashers. Cadmus analyzed appliance energy use for 93 pilot participants who had at least three months of complete data available (on average, these customers had 247.5 days of data). For each customer and device type, Cadmus estimated expected annual consumption using the average daily consumption over the observed days and classified these estimates according to relevant Wisconsin and Indiana TRM values for baseline, inefficient, and efficient devices. Specifically, efficiency levels for refrigerators and dishwashers are not provided in the WI TRM so, with the agreement of representatives from Alliant Energy and the Wisconsin PSC, Indiana's TRM was referenced as a supplementary reference manual[3]. Potential savings are reported for two upgrade scenarios:

- Replacement of all inefficient devices to achieve the baseline consumption level for all participating customers
- Replacement of all inefficient and baseline devices to achieve the efficient consumption level for all participating customers.

For electric dryers, water heaters, and dishwashers, the analysis assumed that each home would not use more than one of these appliance types. However, the Sense disaggregation algorithm identified a greater number of these device types than one would reasonably expect (e.g., 1.6 electric dryers per home). Discussions with Sense have suggested that some appliances can have several unique duty cycle signatures (e.g., a clothes dryer may have a timed dry, air dry, or permanent press setting). The associated unique signatures may then be classified by unique device IDs under the same device type category. Cadmus' chronological analysis of device activity generally indicated that unique device IDs of one type did not register loads at the same time. Therefore, when a customer had multiple device IDs within one of these device types, Cadmus combined their consumption to produce an estimate of the customer's total consumption for each device type.

[3] As noted in future footnotes, the IN TRM sections on refrigerators and dishwashers reference national ENERGY STAR standards (i.e. not unique to Indiana).

Disaggregated refrigerator data was treated differently to account for homes having multiple refrigerators. Each refrigerator identified by Sense was treated as a unique device. Cadmus restricted the analysis to identified refrigerators with non-zero consumption on at least 95% of the days in the analysis.

Electric Dryers

Sense identified electric dryer consumption for 87 pilot participants. The Wisconsin TRM defines the maximum baseline and efficient annual electric dryer consumption as 768.9 kW and 608.5 kWh, respectively.[4] Figure 14 depicts the distribution of annual electric dryer consumption broken into TRM-related categories. The electric dryer energy consumption of 33% of participants above baseline levels. Another 7% of participants exceeded the efficient consumption level. Three customers had unusually high projected electric dryer consumption (greater than 2,000 kWh per year), which could be due to atypical usage patterns or device misidentification.

Figure 14. Electric Dryer Energy Consumption

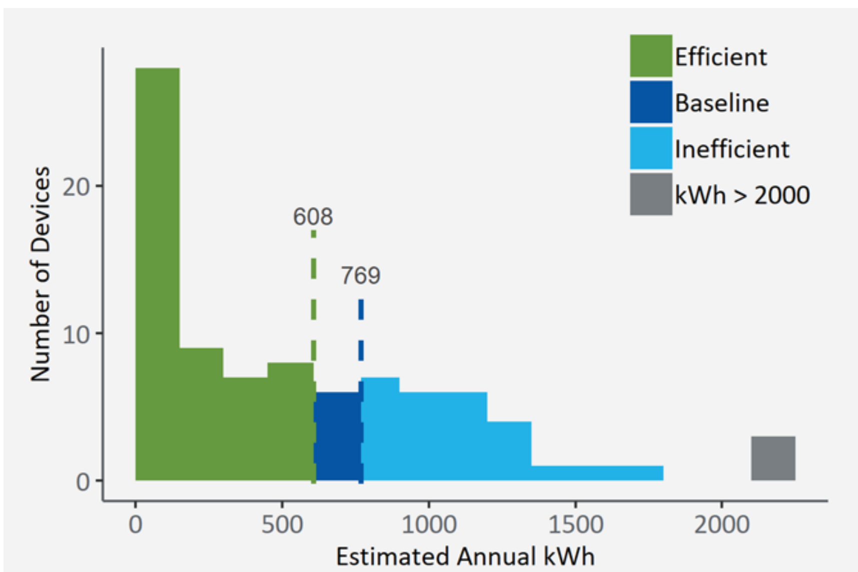


Table 1 contains estimates of the potential savings from device upgrades for two scenarios. For customers in the inefficient category, a dryer upgrade to the baseline or efficient level would save an average of 319 kWh or 480 kWh per year, respectively. These savings correspond to a 2.8% or 4.2% average reduction relative to average pilot participant total annual consumption.[5]

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[4] See "Electric Clothes Dryer, ENERGY STAR," pg. 851, in Wisconsin Focus on Energy. *2018 Technical Reference Manual*. Prepared by Cadmus.

[5] The estimated annual average per-household consumption, based on pilot-to-date disaggregated loads, is 11,393 kWh.

Table 1. Electric Dryer Upgrade Savings Potential

Current Efficiency Classification	Target Efficiency Classification	Target Consumption Level	Number of Replacements	Average Savings (kWh per Device)	Total Annual Savings (kWh)
Scenario 1: Replacement of Inefficient Devices to the Baseline Level					
Inefficient	Baseline	768.9	26	319	8,312
kWh > 1500	Baseline	768.9	3	2,603	7,809
Scenario Total	**Baseline**	**768.9**	**29**	**556**	**16,121**
Scenario 2: Replacement of Baseline and Inefficient Devices to the Efficient Level					
Baseline	Efficient	608.5	6	60	362
Inefficient	Efficient	608.5	26	480	12,484
kWh > 1500	Efficient	608.5	3	2,763	8,290
Scenario Total	**Efficient**	**608.5**	**35**	**603**	**21,136**

Although rebates have been offered for high efficiency electric dryer replacements in the past, they were discontinued because of low savings potential and high existing market penetration. Currently, Focus on Energy has no programs that would phase out inefficient dryers and encourage the purchase of new efficient electric dryers. Cadmus' findings in the pilot sample indicated, however, that there is significant potential for savings associated with upgrading electric dryers.

Refrigerators

Cadmus conducted savings analysis with refrigerator consumption data for 168 devices identified by Sense that registered non-zero consumption on at least 95% of analysis days (i.e., days for which disaggregated loads were available). The Indiana TRM indicates baseline and efficient annual refrigerator consumption of 595.9 kWh and 478 kWh, respectively.[6]

Figure 15. illustrates the distribution of refrigerator consumption relative to TRM-defined levels. Ten percent of refrigerators exceeded the baseline consumption level. Another 15% of refrigerators exceeded the efficient consumption level. Four refrigerators were identified as having unusually large energy consumption (greater than 1,000 kWh per year).

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[6] Averaged baseline and ENERGY STAR® annual energy use across bottom freezer, top freezer, and side-by-side models for both baseline and efficient consumption levels. "Efficient Refrigerator – ENERGY STAR and CEE Tier 2 (Time of Sale)," pg. 9, in *Indiana Technical Reference Manual Version 2.2*. July 28, 2015. Prepared by Cadmus.

Figure 15. Refrigerator Energy Consumption

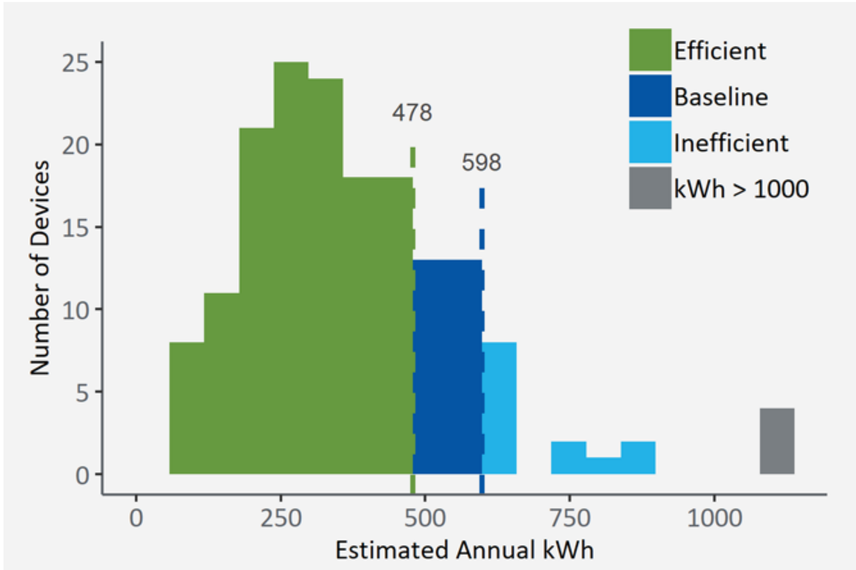

Table 2 contains estimates of potential savings from refrigerator upgrades for two scenarios. In the inefficient category, a refrigerator upgraded to either the baseline or efficient level would save an average of 103 kWh or 223 kWh per year, respectively. These savings correspond to a 0.9% or 2.0% average reduction relative to average pilot participant total annual consumption.

Table 2. Refrigerator Upgrade Savings Potential

Current Efficiency Classification	Target Efficiency Classification	Target Consumption Level	Number of Replacements	Average Savings (kWh per Device)	Total Savings (kWh)
Scenario 1: Replacement of Inefficient Devices to the Baseline Level					
Inefficient	Baseline	598	13	103	1,336
kWh > 1000	Baseline	598	4	657	2,629
Scenario Total	**Baseline**	**598**	**17**	**233**	**3,964**
Scenario 2: Replacement of Baseline and Inefficient Devices to the Efficient Level					
Baseline	Efficient	478	26	55	1,425
Inefficient	Efficient	478	13	223	2,896
kWh > 1500	Efficient	478	4	777	3,109
Scenario Total	**Efficient**	**478**	**43**	**173**	**7,430**

The savings potential for refrigerators is lower than that for electric dryers in both scenarios. Focus on Energy's Appliance Recycling Program pays homeowners $25 for each recycled refrigerator. A return-on-investment calculator could be sent via the Sense app to help homeowners determine how quickly a new refrigerator would recover its cost in lower monthly electrical bills.

Water Heaters

Sense identified electric water heater consumption for 37 pilot participants. The Wisconsin TRM indicates baseline and efficient annual heat pump water heater consumption of 3,160 kWh and

1,499 kWh, respectively.[7] Figure 16 shows the distribution of customer electric water heater consumption relative to TRM-defined levels. The annual projected water heater consumption for 19% of participants exceeded the baseline consumption level. Another 24% of customers had annual water heater consumption levels exceeding the efficient consumption level.

Figure 16. Water Heater Energy Consumption

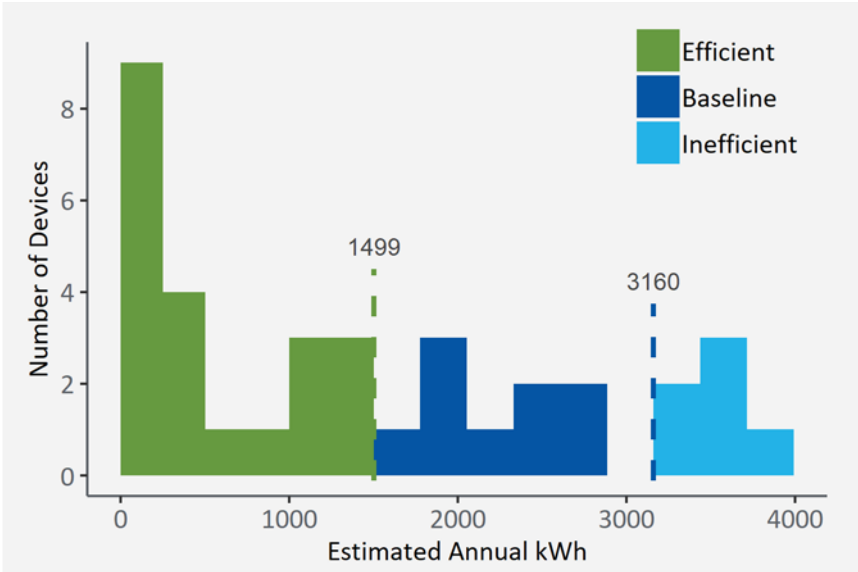

Table 3 contains estimates of the potential savings from water heater upgrades for two scenarios. For devices in the inefficient category, a water heater upgrade to either the baseline or efficient consumption level would save an average of 588 kWh or 768 kWh per year, respectively. These savings correspond to a 5.2% or 6.7% average reduction relative to average pilot participant total annual consumption.

Table 3. Water Heater Upgrade Savings Potential

Current Efficiency Classification	Target Efficiency Classification	Target Consumption Level	Number of Replacements	Average Savings (kWh per Device)	Total Savings (kWh)
Scenario 1: Replacement of Inefficient Devices to the Baseline Level					
Inefficient	Baseline	3,159	7	588	4,116
Scenario 2: Replacement of Baseline Efficient and Inefficient Devices to the Efficient Level					
Baseline	Efficient	1,499	9	768	6,908
Inefficient	Efficient	1,499	7	2,248	15,739
Scenario Total	**Efficient**	**1,499**	**16**	**1,415**	**22,647**

7 The baseline heat pump water heater has an energy factor of 0.945. The efficient heat pump water heater is ENERGY STAR certified. Heat Pump Water Heater," pg. 782, in Wisconsin Focus on Energy. *2018 Technical Reference Manual*." Prepared by Cadmus.

There are currently no Focus on Energy programs that would encourage homeowners to purchase new efficient heat pump water heaters and phase out their inefficient water heaters. The savings potentials shown in Table 3 suggest that upgrades under Scenario 2 would save more energy annually by upgrading fewer devices (22,647 kWh saved by upgrading 16 devices) than Electric Dryer Scenario 2 upgrades (21,136 kWh saved by upgrading 35 devices). A return-on-investment calculator (sent via the Sense app) could demonstrate the potential payback time for converting to a more efficient appliance based on monthly electricity bill savings.

Dishwashers

Sense identified dishwasher consumption for 59 pilot participants. The Indiana TRM indicates baseline and efficient annual dishwasher consumption levels of 420 kWh and 270 kWh, respectively.[8] Figure 17 depicts the distribution of customer dishwasher consumption relative to TRM-defined levels. Consumption for 3% of identified dishwashers exceeded the efficient consumption level, representing a relatively small savings opportunity.

Figure 17. Dishwasher Energy Consumption

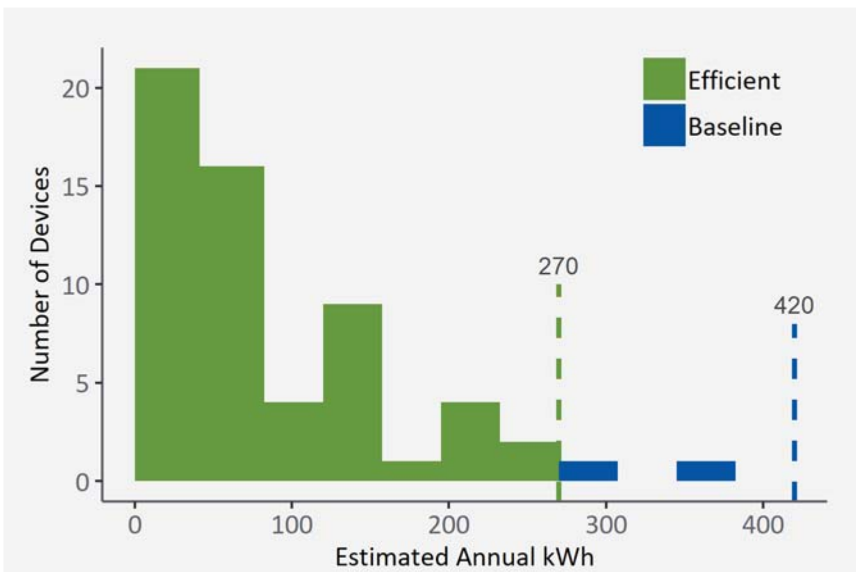

Table 4Table 3 contains estimates of the potential savings from dishwasher upgrades for two scenarios. All dishwashers met the baseline consumption level, so no savings were associated with Scenario 1. Under Scenario 2, the two devices that exceeded the efficient consumption level could be replaced for

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[8] The efficient consumption level is defined by the ENERGY STAR standards for dishwashers and the baseline consumption level amounts to the ENERGY STAR consumption level plus the kWh claimed savings for such an upgrade in this section of the TRM. See “ENERGY STAR Dishwasher,” pg. 20 in *Indiana Technical Reference Manual Version 2.2*. July 28, 2015. Prepared by Cadmus.

an average per-device savings of 44 kWh per year. These savings correspond to a 0.4% average reduction relative to average pilot participant total annual consumption.

Table 4. Dishwasher Upgrade Savings Potential

Current Efficiency Classification	Target Efficiency Classification	Target Consumption Level	Number of Replacements	Average Savings (kWh per Device)	Total Savings (kWh)
Scenario 1: Replacement of Inefficient Devices to the Baseline Level					
Inefficient	Baseline	420	0	0	0
Scenario 2: Replacement of Baseline and Inefficient Devices to the Efficient Level					
Baseline	Efficient	270	2	44	88

Currently, Focus on Energy has no programs that would encourage homeowners to purchase new efficient dishwashers and phase out their existing inefficient dishwashers. Based on Cadmus' findings for pilot participants, shown in Table 4, it would not be advantageous to promote dishwasher replacement in future Focus on Energy programs.

Engagement and Behavior Change Savings

Sense monitor users can access a Sense mobile app that provides information on real time and historical energy consumption in their homes. Participants in this pilot were not given access to the app for several months after the monitor was installed so Cadmus could observe participant consumption prior to any behavioral impacts related to app access. On December 10, 2018, participants received encouragement to download and use the Sense app.

An analysis of consumption (before and after each participant's first app access date) found that an estimated savings of 1.8 kWh, or 6% of average daily consumption, could be attributed to app use. However, this result is not statistically significant ($p = 0.30$).[9] The robustness of this estimate is limited because the sample size is relatively small and there is potential for bias due to the participants self-selection into the app access treatment group. That is, observed savings might reflect the consumption patterns of eager users, the participants who were most responsive to the encouragement to use the app.[10]

9 Cadmus estimated the effect of app access on average daily consumption using a differences-in-differences model, which allowed for variation in the date of app access. The model used customer and date fixed effects. Customer fixed effects control for variation in individual customer average consumption. Date fixed effects control for variation over time (e.g., average weather impacts). Cadmus adjusted the resulting standard errors to account for clustering at the individual participant level according to industry best practices for panel regression models.

10 Construction of a randomized control trial (RCT) involving randomization of participants into app access and no app access groups would likely require a larger sample size to produce reliable estimates. An RCT analysis of behavioral savings is outside the objectives of the pilot.

Figure 18. Average Daily Consumption Before and After App Access

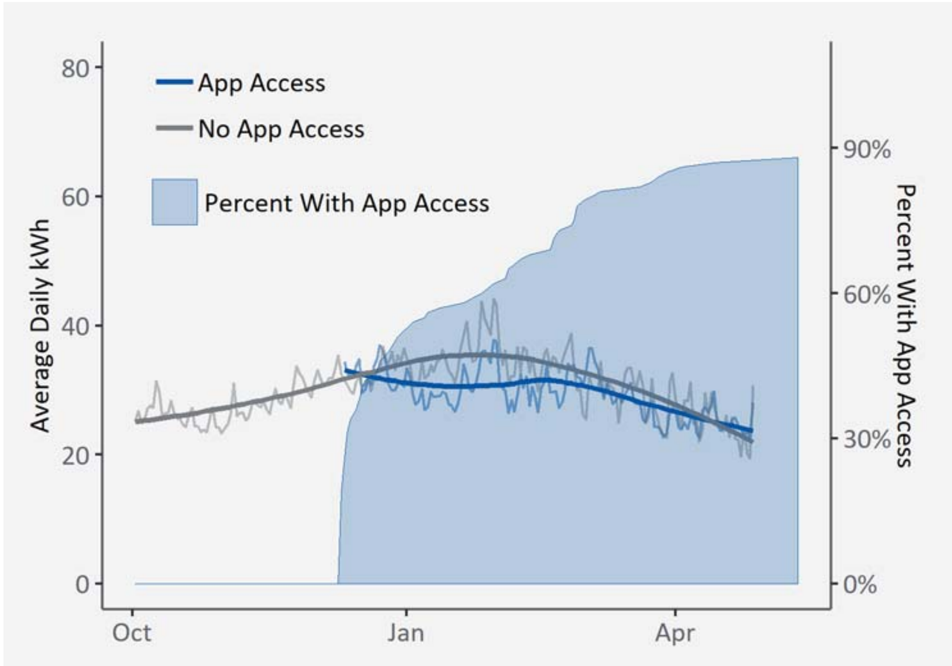


Figure 18. compares average daily consumption for participants with and without app access. Actual daily averages vary somewhat and are presented with the jagged grey and blue lines. The smoothed lines (calculated as a moving average of the actuals) present a clearer comparison of consumption differences between app users and non-app users. Participants were first encouraged to access the app on December 10, 2018. As additional encouragement was offered over subsequent months, more participants began using the app.

Figure 19. Average Hourly Consumption Pre and Post App Access

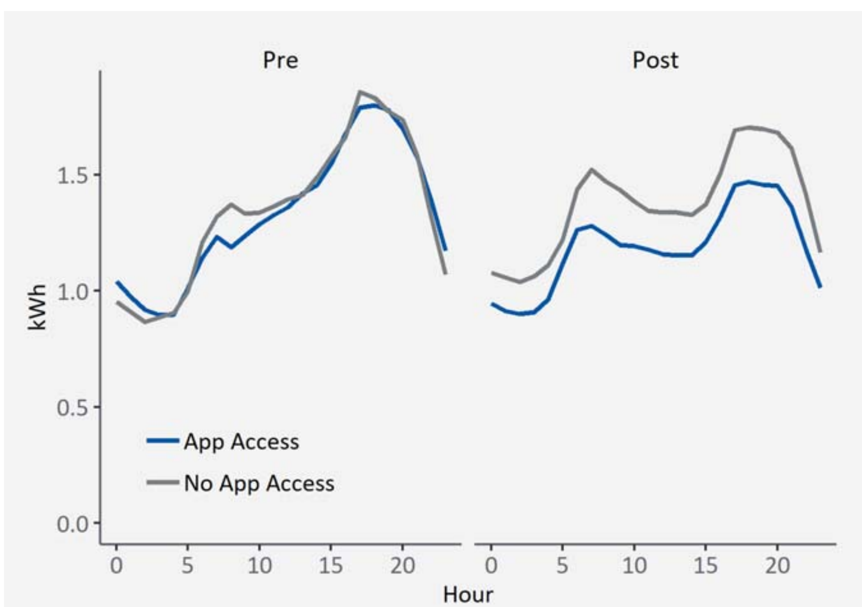


Figure 19. compares hourly consumption for app and non-app users during the pre- and post- access periods. These groups were not randomly determined; participants self-selected into the app user group by responding to the encouragement. The analysis tested whether customers who responded to app access encouragement were representative of the whole pilot participant population. The left panel (Pre) shows alignment in hourly load shapes during the period prior to app access, indicating that those who responded to app use encouragement were representative of the whole pilot population. The right panel (Post) shows a reduction in consumption for participants with app access relative to those participants who did not access the app.

Time of Use Rates and Demand Response

Cadmus assessed the device-specific potential for demand response savings by isolating device-level consumption during peak demand events.

Figure 20. depicts the distribution of each device type as a percentage of aggregate program load during the eight on-peak weekday hours (11 a.m. to 7 p.m.) of the 2018 Midcontinent Independent System Operator (MISO) peak day (August 27). The device types that provided the greatest opportunity for demand savings were, in descending order of savings, air conditioners, dryers, water heaters, and pool pumps. This list excludes unidentified loads and devices with static loads (i.e., refrigerators and "Always On").

Figure 20. Percentage, by Device, of Aggregate Pilot Program Load during MISO August Peak Hours

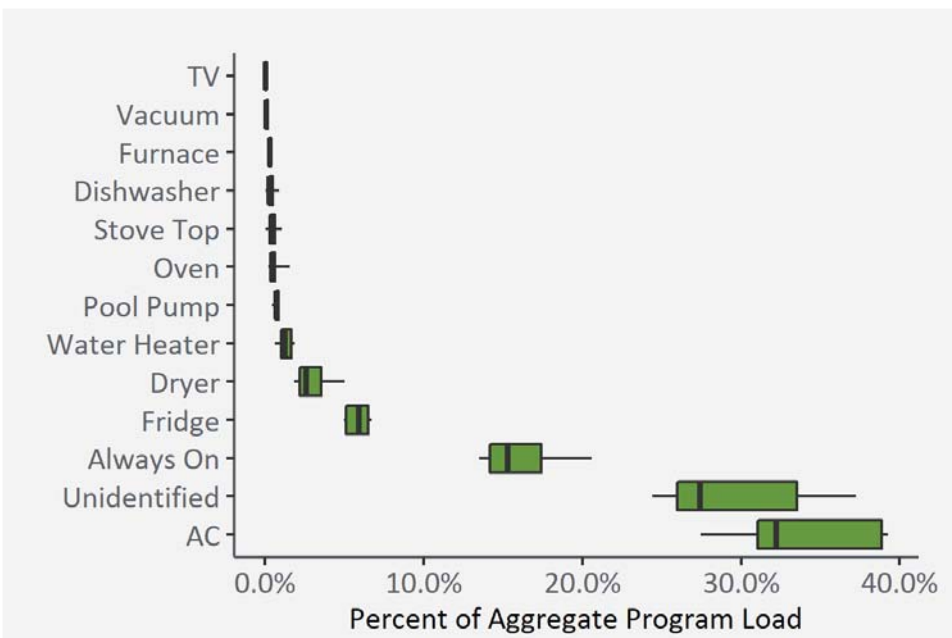
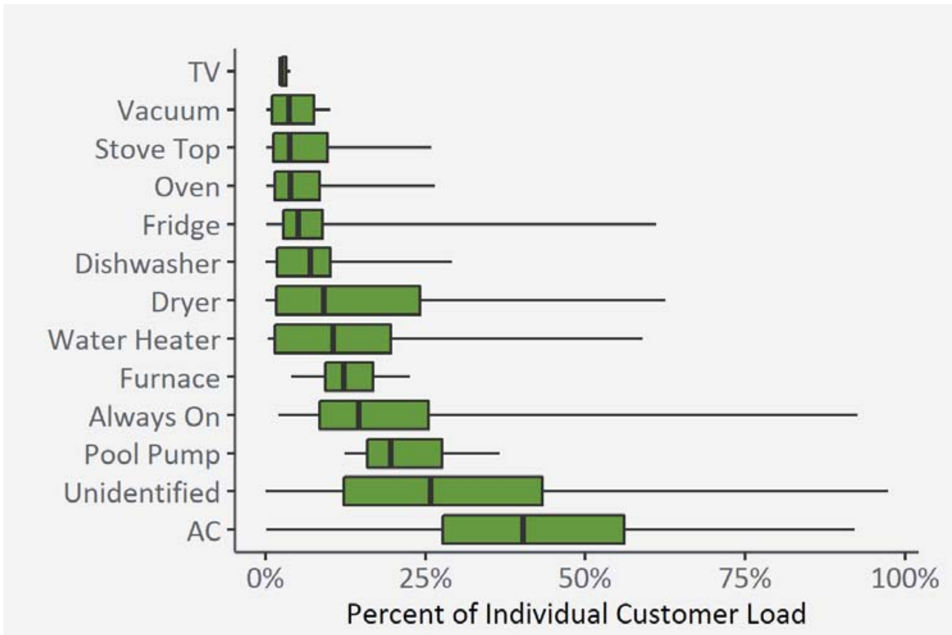


Figure 21. depicts the distribution of each device type as a percent of individual customer load during the same eight on-peak weekday hours (11 a.m. to 7 p.m.) of the 2018 MISO peak day (August 27). This figure highlights the potential for demand savings from devices that are used in a minority of homes but

contribute a large percentage of total demand. Pool pumps contribute less than 3% of aggregate program peak load but contribute an average of 20% of individual participant load, for those that have them. Thus, pool pumps may present the second-best opportunity for per-device demand savings after air conditioners.

Figure 21. Device Percentage of Individual Customer Load during MISO August Peak Hours



Device Demand Analysis

The currently defined time-of-use hours for Alliant Energy residential service are as defined in Figure 22..

Figure 22. Alliant Energy Residential Service Time-Of-Use Rates

RESIDENTIAL SERVICE TIME-OF-USE ELECTRIC

9. Energy Pricing Period

The Energy Pricing Period Schedule available to all customers is as follows:

Energy Pricing Period	Weekday Time Period
High Rate (Summer)	11 a.m. to 7 p.m.
High Rate (Winter)	5 p.m. to 9 p.m.
Low Rate	11 p.m. to 6 a.m.
Regular Rate	All Other Hours

All hours during Saturday, Sunday, and Holidays are designated as Low Rate Pricing Periods. Holidays are New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day.

Summer is designated as the calendar months of June, July and August. Winter is designated as the calendar months of December, January and February.

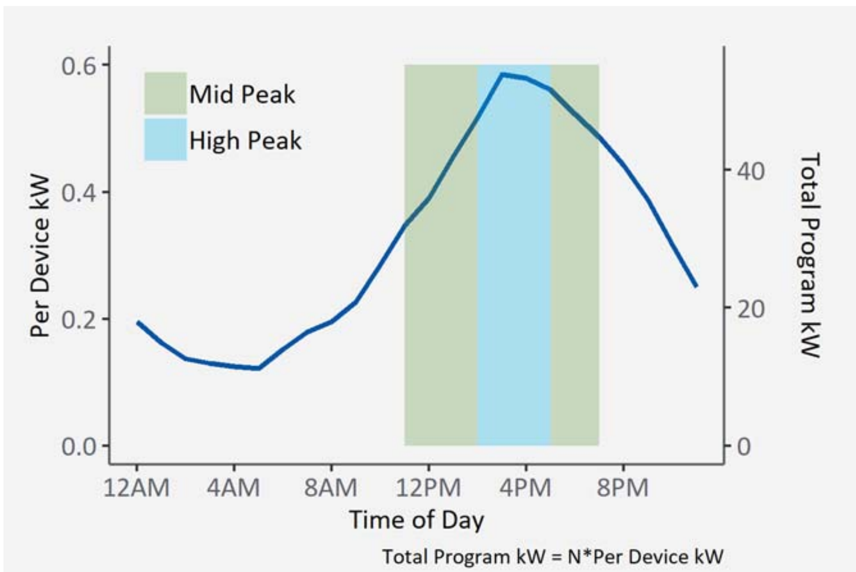
Source: Alliant Energy

Cadmus has structured its demand reduction analysis based on the high rate (summer) weekday times. The following sections describe the analysis for each device.

Air Conditioners

Figure 23 depicts the average summer air conditioner demand profile on non-holiday weekdays. Air conditioner consumption was identified in 92 (n=92) unique Sense monitors during the summer of 2018. During high peak (2 p.m. to 5 p.m.) and mid-peak hours (11 a.m. to 2 p.m. and 5 p.m. to 7 p.m.), air conditioners present an average potential peak demand savings opportunity of 0.56 kW and 0.47 kW per device, respectively.

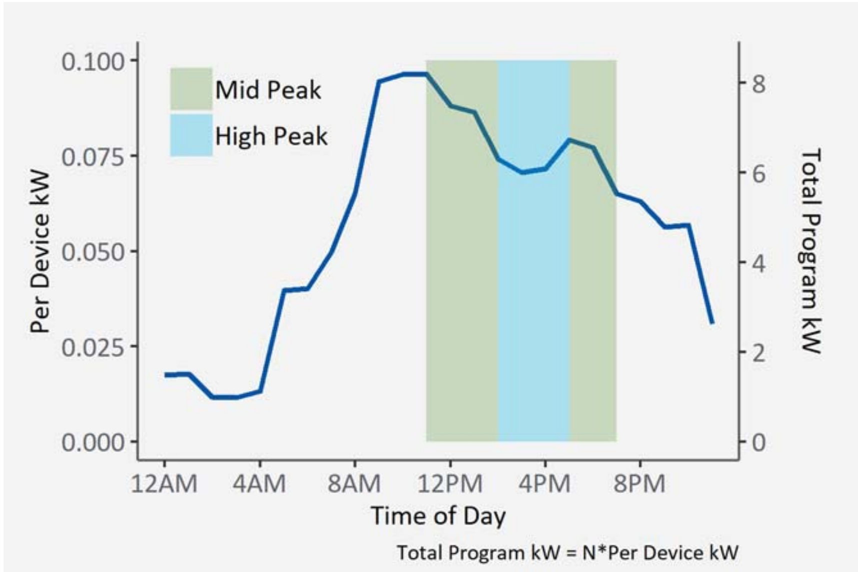
Figure 23. AC Average Summer Demand Profile



Electric Dryers

Figure 24 depicts the average summer dryer demand profile on non-holiday weekdays. Electric dryer consumption was identified by 85 (n=85) unique Sense devices in the summer of 2018. During high peak (2 p.m. to 5 p.m.) and mid peak hours (11 a.m. to 2 p.m. and 5 p.m. to 7 p.m.), dryers present an average potential savings opportunity of 0.07 kW and 0.08 kW per device, respectively. It is notable that peak electric dryer demand is typically highest in the mornings and did not typically coincide with the defined peak hours.

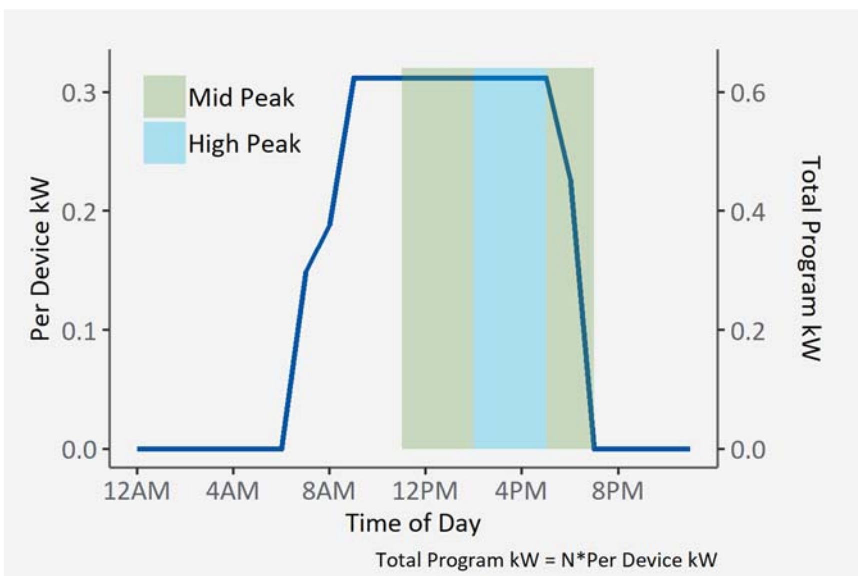
Figure 24. Dryer Average Summer Demand Profile



Pool Pumps

Figure 25. depicts the average summer pool pump demand profile on non-holiday weekdays. Pool pump consumption was identified by two (n=2) unique Sense monitors during the summer of 2018. During high peak (2 p.m. to 5 p.m.) and mid peak hours (11 a.m. to 2 p.m. and 5 p.m. to 7 p.m.), pool pumps represent an average potential savings opportunity of 0.31 kW and 0.25 kW per device, respectively.

Figure 25. Pool Pump Average Summer Demand Profile



Conclusions and Recommendations

Based on the detailed evaluation findings, Cadmus came to the following conclusions and recommendations.

Process

Conclusion: Over half of the homeowners changed their energy-saving behavior after participating in the Sense Home Energy Monitor Pilot.

After participating in the pilot, 56% of respondents said they made additional changes to their daily behavior to reduce energy use (n=63). Most notably, 31% of respondents began unplugging electronics or alliances when not in use and 20% began using energy-saving features of electronic devices (n=63).

Conclusion: Despite uncertainty about potential energy savings, privacy impacts, and how the program worked overall, homeowners still decided to participant in the Pilot.

Over half of the respondents said they had at least one reservation about participating in the pilot. The opportunity to save money and energy and to track energy usage by device, however, overrode these reservations when deciding to participate.

- **Recommendation: Provide a frequently asked questions (FAQ) sheet during the installation appointment to present additional information about the pilot and the Sense monitor.** The FAQ sheet should include information on how a participant's privacy may be impacted, how to identify electronic devices through the Sense monitor, and troubleshooting solutions in case the monitor goes offline.
- **Recommendation: Provide utility bill cost comparisons pre and post Sense monitoring.** Respondents were most interested in saving money and energy. A short cost comparison report may reduce uncertainty about potential energy-saving benefits and encourage greater participation for future programs.

Conclusion: Variability in electric panel access and cavity space, along with panel location relative to the wireless internet modem, disrupted the availability of consistent disaggregated electrical loads from all installed Sense monitors.

Of the 106 monitors installed in the summer of 2018, only 86 were consistently reporting at the time this report was prepared. The three primary issues are described in the *Troubleshooting Visits* subsection in the *Methodology* section.

- **Recommendation: Determine Wi-Fi signal strength at the electrical panel during the Sense monitor installation.** In the pilot expansion (Phase 2), a Cadmus technician will be testing Wi-Fi signal strength at the panel during installation to ensure the monitor will continuously upload disaggregated load data to the server.
- **Recommendation: Request photo of open panel from participants before the home visit so that the Cadmus technician and installing technician can determine the feasibility of**

installation. During scheduling calls for the pilot expansion, Cadmus is requesting photos of electrical panels with covers removed to determine the feasibility of installation.

Impact

Conclusion: A significant percentage of aggregate demand and individual customer demand during the MISO peak day (25% to 30%) was attributed to unidentified loads. These loads had a signature that could not be attributed to a predefined load shape or appliance type in the Sense machine-learning algorithm.

- **Recommendation: During the pilot expansion, install an accessory that will disaggregate loads and categorize their location in the home based on breaker labels.** During the second round of Sense monitor installations (beginning June 2019), an additional module will be installed with each Sense monitor that will include CT connections to each individual breaker. Along with a more robust data collection protocol during each site visit (appliance type and location, HVAC type, and lighting descriptions will be recorded), the percentage of unidentified loads for the pilot expansion should be lower.

Conclusion: While "Always On" loads account for roughly one quarter of a home's annual energy consumption, it is unclear whether there is a correlation between "Always On" load percentage and square footage, number of occupants, or other home and behavior patterns.

- **Recommendation: Expand the pool of eligible homeowners for the Sense Pilot to correlate "Always On" and other residential energy savings trends to parameters such as total household energy use, number of occupants, and square footage.** Cadmus' initial hypothesis is that the number of occupants in a home would correlate strongly to "Always On" consumption and square footage would correlate to a lesser extent. With more detailed data collection during the Pilot Expansion, Cadmus can visualize these relationships and draw broader conclusions with more certainty on the energy usage patterns of Alliant customers.

Conclusion: Sense monitors and the associated mobile app can serve as a superior substitute for some aspects of an in-person energy audit.

An in-person energy audit can provide building envelope improvement recommendations to a homeowner that cannot be offered by the Sense monitor. However, our findings (see *Residential Energy Savings* and

Figure 19. compares hourly consumption for app and non-app users during the pre- and post- access periods. These groups were not randomly determined; participants self-selected into the app user group by responding to the encouragement. The analysis tested whether customers who responded to app access encouragement were representative of the whole pilot participant population. The left panel (Pre) shows alignment in hourly load shapes during the period prior to app access, indicating that those who responded to app use encouragement were representative of the whole pilot population. The right panel (Post) shows a reduction in consumption for participants with app access relative to those participants who did not access the app.

Time of Use Rates and Demand Response sections) indicate that homeowners could save substantially on their monthly bills, particularly for appliances with high electrical demand during peak hours.

- **Recommendation: Develop a return on investment (ROI) calculator for various appliances that shows payback period for appliance upgrades.** This would take projected annual kWh usage data from the Sense app and, based on annual kWh saved from an upgrade and the typical cost of an upgraded appliance, provide a payback year range.
    - **Challenge: An ROI calculator would need to draw data from Sense to be used as an input in a calculator that is developed separately.** Cadmus has developed an online dashboard that compiles all regular disaggregated load data from active Sense monitors, which could calculate projected or average annual energy consumption. Homeowners would need to be notified (either via a link within the app or an email) that they could calculate potential appliance replacement savings. Such a calculator should also reference any rebate opportunities, such as through Focus on Energy's Appliance Recycling Program, and how those rebate opportunities would improve the payback period.
- **Recommendation: To support the ROI calculator, Focus on Energy should expand the Appliance Recycling Program to offer incentives for electric water heater and dryer recycling.** In addition to expanding the recycling program, and based on demand respond findings, targeted rebates should be offered for electric water heater, electric dryer, and air conditioner upgrades in existing or new Focus on Energy programs.
- **Recommendation: Based on Cadmus' Sense dashboard, Alliant Energy could develop and notify customers of demand response initiatives for end uses that make up a high percentage of home demand during peak hours.**
    - **Challenge: The Sense pilot has (so far) gathered a small sample of demand trends for specific end uses.** As this pilot doubles or triples in size, more statistically reliable load shapes for high-demand end uses can be derived. Theoretically, Alliant Energy could contact all its customers with the same demand response initiatives even if they did not participate in the pilot program.