CADMUS



Iowa 2018 Energy Wise Program Final Report

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Prepared for:

Iowa Utility Association

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About Cadmus

Cadmus is a strategic and technical consultancy compelled to help solve the world's most challenging problems. We assemble outstanding teams of leading experts who work seamlessly across disciplines to help our clients achieve extraordinary results. From energy, water, and transportation to safety, security, and resilience—together, we are strengthening society and the natural world. Cadmus' more than 600 consultants serve government, commercial, and nongovernmental organizations around the world.

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Introduction

This report presents the results of Cadmus' assessment of the Iowa 2018 Energy Wise Program. The program is sponsored by Alliant Energy Corporation, Black Hills Energy, and MidAmerican Energy, in coordination with the Iowa Utility Association.

Energy Wise is an adult energy education initiative, through which the sponsors provide community action agency (CAA) staff training and Energy Wise Home Savings Kits (Energy Wise Kits) containing energy-efficient measures. The CAAs who implement the program provide workshops and one-on-one training for Iowa families who are at a minimum 200% below the federal poverty level, are eligible for the Low-Income Home Energy Assistance Program, participate in the Family Development Self Sufficiency Program, or have children in the Head Start Program. Energy Wise helps participants reduce their energy use and utility costs.

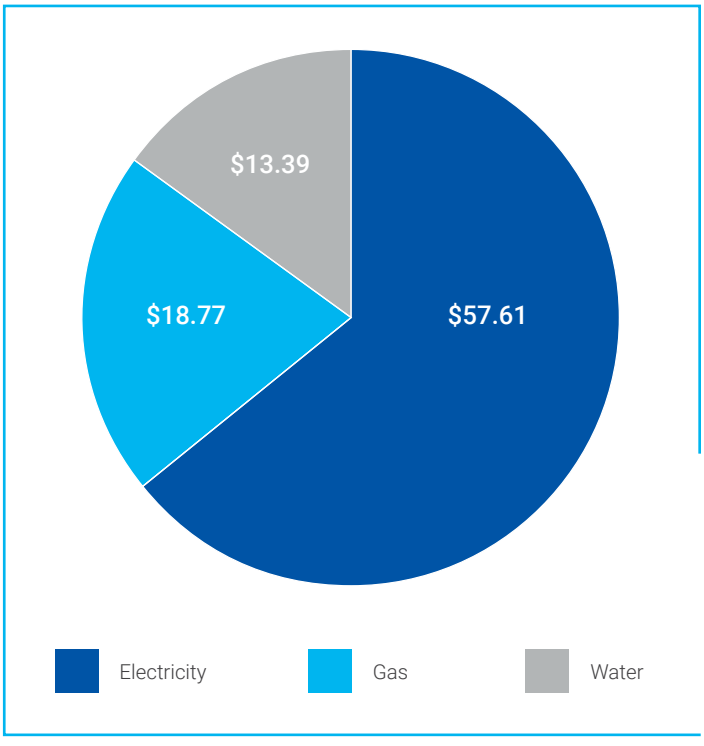
All participating households learn about saving energy from their local CAAs and receive Energy Wise Kits containing energy-efficient measures to install in their homes. Participants fill out surveys to report on their pre-installation energy usage and success at installing the measures.

Cadmus collected and analyzed participant data to determine the energy and cost savings generated by the Energy Wise participants and by the program overall. In 2018, Energy Wise generated an estimated combined participant bill savings of $399,550 from the 4,500 Energy Wise Kits provided to participants;[1] this equates to an average participating household savings of approximately $89.77 per year.[2]

Figure 1 shows the allocation of participant cost savings by resource type—electricity, natural gas, and water.

This report describes the program implementation and estimated savings generated in the 2018 program year. The next section outlines the program and CAA participation, followed by details of the program processes in 2018, and the energy and cost savings achieved by the average participant and for the program overall.

Figure 1. Average First-Year Energy Wise Program Participant Savings by Resource Type



1 Cadmus calculated savings based on the distribution of 4,451 Energy Wise Kits; program staff distributed an additional 49 Energy Wise Kits to CAA's for training purposes.

2 Cadmus calculated the average participant savings by analyzing participants' responses to survey questions. We then multiplied this savings by the number of Energy Wise Kits distributed to determine the overall program savings for installed measures.

Program Implementation

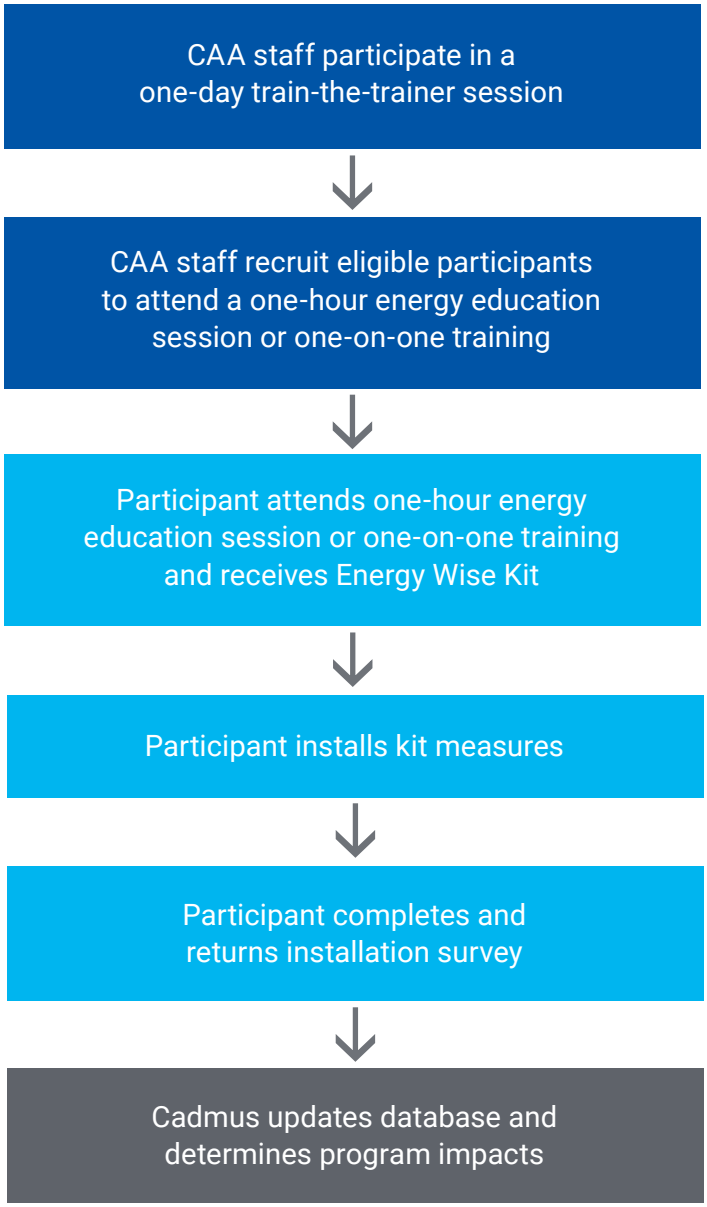
Energy Wise is an adult energy education program targeted to low-income households. Each participating household also receives an Energy Wise Kit containing easy-to-install energy-efficient measures. In 2018, the following 17 CAAs and nonprofit organizations provided program education and Energy Wise Kits to families in their service areas:

- Community Action Agency of Siouxland
- Hawkeye Area Community Action Program
- IMPACT Community Action Program
- Matura Action Corp
- Matura Action Corp Family Development and Self Sufficiency (FaDSS)
- Mid-Sioux Opportunity
- North Iowa Community Action Organization
- Northeast Iowa Community Action Corp FaDSS
- Operation Threshold
- Operation New View Community Action Agency
- South Central Iowa Community Action Program
- South Central Iowa Community Action Program FaDSS
- Southern Iowa Economic Development Association
- Tri-County Child & Family Development Council, Inc. Head Start
- Upper Des Moines Opportunity, Inc.
- West Central Community Action
- Your Own United Resources, Inc. - Head Start

Figure 2 illustrates the program implementation process, which began with train-the-trainer sessions for CAA staff. During these sessions, Cadmus presented training on how to provide energy education and Energy Wise Kits to participants. CAA staff then recruited program participants and conducted Energy Wise workshops and one-on-one trainings. Program participants completed the following three steps:

1. Attended a workshop or one-on-one training
2. Installed the Energy Wise Kit measures and adopted other energy-saving behaviors
3. Completed and returned the survey

Figure 2. Energy Wise Program Process

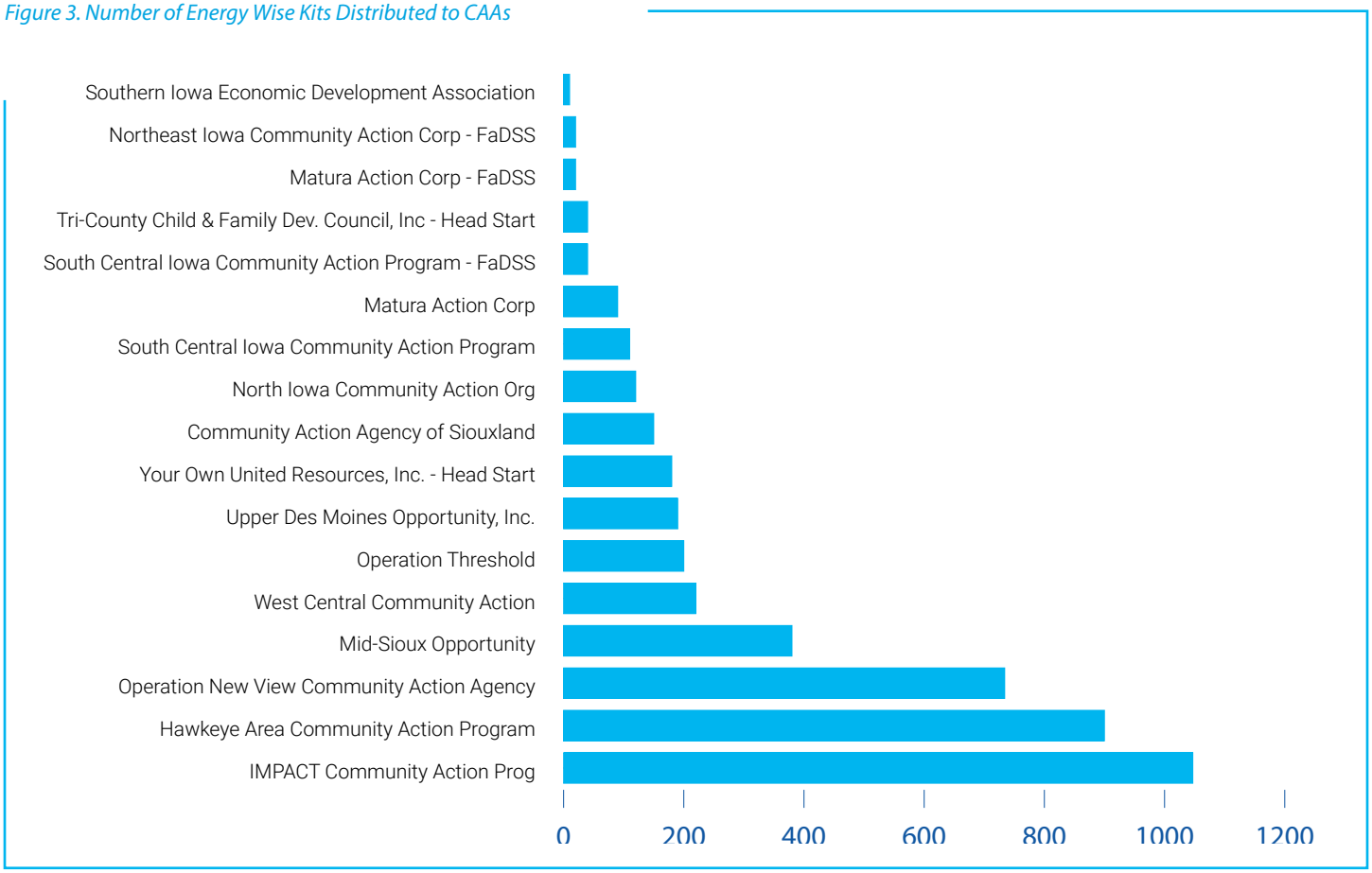


Cadmus entered participants who returned the surveys via mail into a monthly $100 drawing. We analyzed the participant surveys to determine program impacts. In April 2018 and September 2018, we conducted training sessions on home energy use and how to deliver energy education with staff from CAAs in Emmetsburg, Des Moines, Waterloo, Creston, and Dubuque, with 49 staff members from seven agencies.

In addition to training sessions, the Energy Wise website is a resource for CAA staff and program participants. CAA staff can use the website for program management or to introduce new clients to the program components. New program participants can view installation videos for Energy Wise Kit measures, access efficiency tips, and find contact information for CAAs on the website.

During the 2018 program year, the CAAs received 4,500 Energy Wise Kits. Figure 3 shows the distribution across CAAs.

Figure 3. Number of Energy Wise Kits Distributed to CAAs



Participant Process

CAA staff recruited participants for the Energy Wise workshops during their day-to-day interactions. During the training, CAAs covered the basics of energy use, ways to identify energy-savings opportunities, the process for installing the Energy Wise Kit measures, and ways to take advantage of other low- and no-cost energy-saving opportunities.

During the workshop or one-on-one training, each participant received an Energy Wise Kit with these energy-saving measures (in addition to energy education information):

- Three light emitting diode lights (LEDs): 9-watt equivalent to a 60-watt incandescent bulb
- One high-efficiency showerhead: 1.5 gallons per minute (gpm)
- Two faucet aerators: one for the kitchen (1.5 gpm) and one for the bathroom (1.0 gpm)
- One FilterTone air filter alarm for furnace or air conditioner

- One digital thermometer to test the temperature of a room, hot water, and inside the refrigerator and freezer
- One water-flow measurement bag
- Rope caulk for weather-stripping around doors, windows, and other openings
- Window insulator kit
- Instruction booklet and installation guide

Program participants who filled out a survey after attending the training session and after installing Energy Wise Kit measures were entered into a monthly $100 drawing. The survey asked about participants' experience, success with installing the Energy Wise Kit measures, and about basic household characteristics that impact energy consumption (e.g., type and quantity of appliances, cooling sources, and the number of people living in the household).

In 2018, 517[3] program participants returned a survey. Cadmus used these surveys to determine the installation rate for each measure included in the Energy Wise Kits.

Participant Response

The survey asked respondents if Energy Wise increased their knowledge about how to save energy in their homes and if the class was effective in teaching them new ways to save energy at home. Most survey respondents (89%) reported that the program increased their knowledge about how to save energy in their homes "very much" or "somewhat" (Figure 4). Similarly, most survey respondents (92%) reported that the class was "very effective" or "somewhat effective" in teaching them new ways to save energy at home (Figure 5).

Figure 4. Knowledge About How to Save Energy at Home Increased by Energy Wise (n=506)

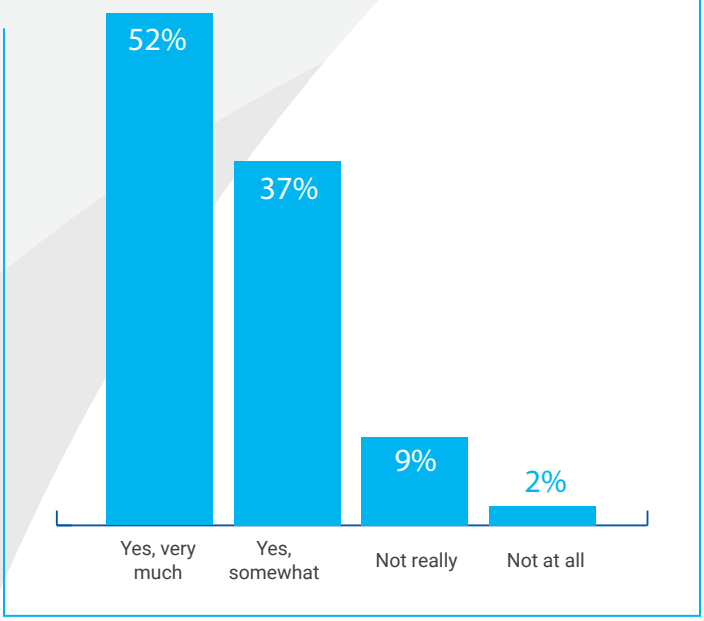
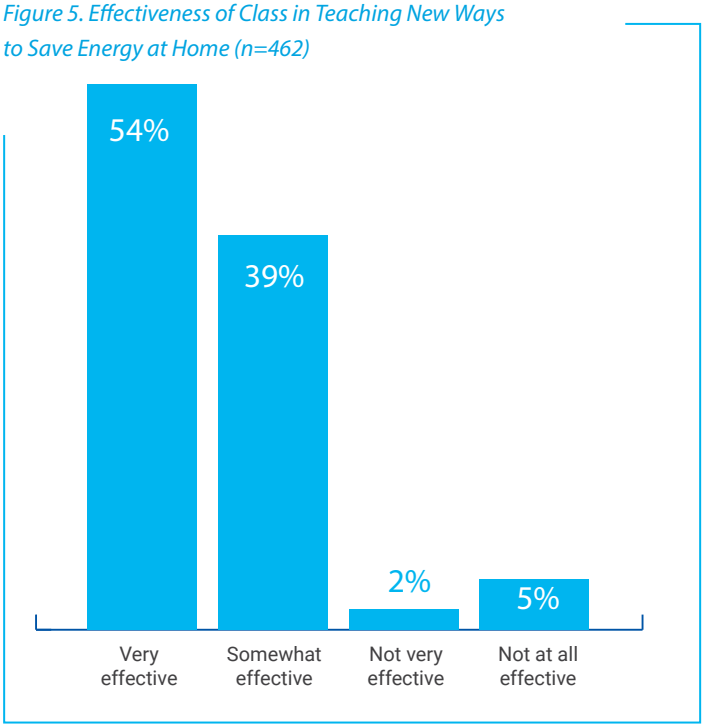


Figure 5. Effectiveness of Class in Teaching New Ways to Save Energy at Home (n=462)



3 In total, 518 survey responses were submitted but 1 survey response was excluded since it was filled out as part of the agency training.

Impact Evaluation

Participant Characteristics

Cadmus analyzed the participant surveys and calculated the energy savings that resulted from participants having installed Energy Wise Kit measure s and implementing energy-saving behaviors.

The household data collected from the surveys included the following participant characteristics and baseline energy-consumption data:

- Resident occupancy
- Type of space and water heating equipment
- Type of fuel used for space and water heating
- Appliance and cooling equipment saturation
- Home electronic equipment saturation
- Energy Wise Kit measure installation rates

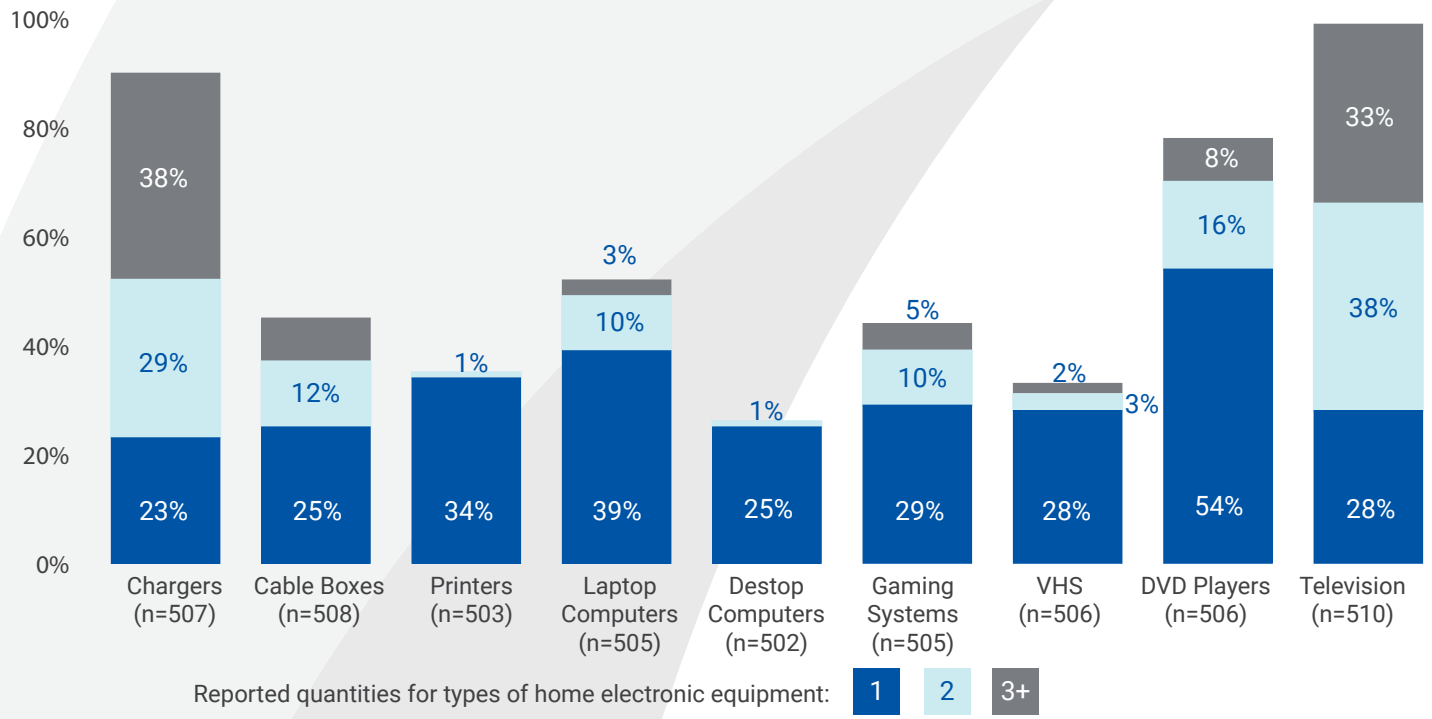
Table 1 lists the average participating household characteristics of the 517 respondents.

Table 1. Energy Wise Program Participant Household Characteristics

CHARACTERISTIC INFORMATION		AVERAGE
Occupancy	People per Household	2.6
Type of Space Heating Fuel	Electric Furnace	28.6%
	Natural Gas Furnace	63.3%
	Heat Pump	5.1%
	Other Electric	0.4%
	Oil	0.8%
	Other	1.8%
Type of Water Heating Fuel	Electric	44.8%
	Natural Gas	54.0%
	Other	1.2%
Type of Air Conditioning	Central Air Conditioning	61.0%
	Window or Room Air Conditioning	33.3%
	Room Fans	3.1%
	Other	2.5%
Appliances	Dishwasher	36.5%
	Additional Refrigerator	12.2%
	Stand-Alone Freezer	47.21%

The surveys also included questions about the type and quantity of participants home electronic equipment. Figure 6 shows the home electronics reported by participants.

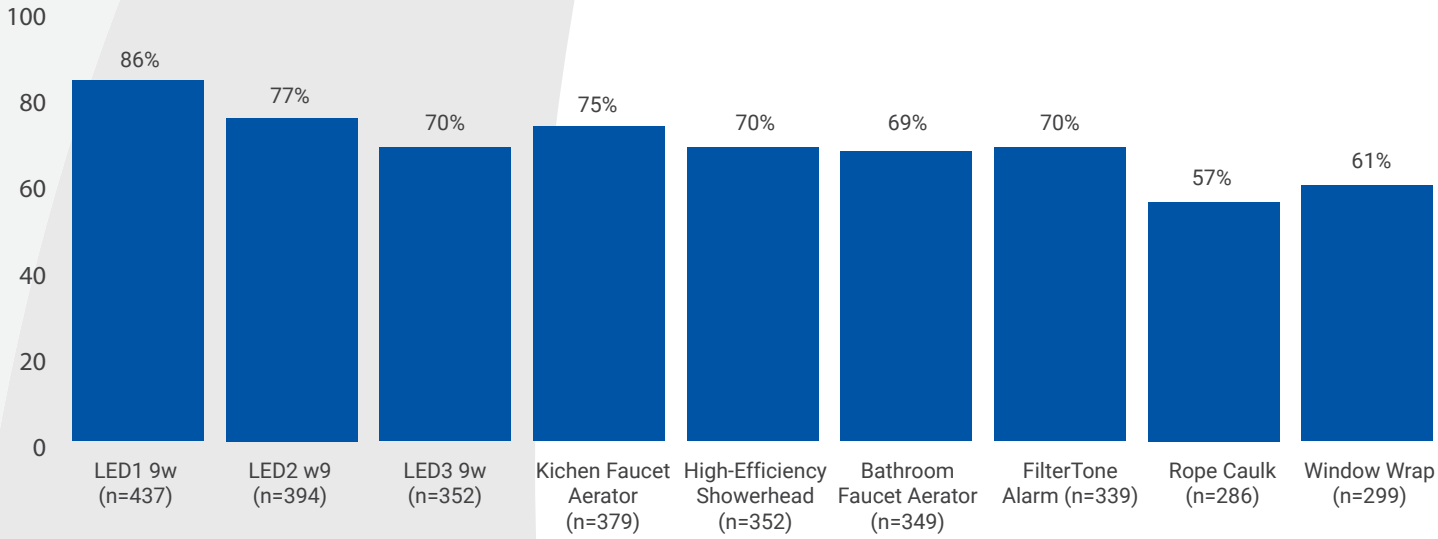
Figure 6. Energy Wise Program Participant Home Electronics



Program Statistics

The amount of energy savings realized through the program is based on the percentage of each Energy Wise Kits measure installed. Figure 7 shows the participant-reported installation rates for each Energy Wise Kits measure. Cadmus assumed that participants who did not return a survey (nonresponding participants) installed the measures at the same rate as the responding participants.[4]

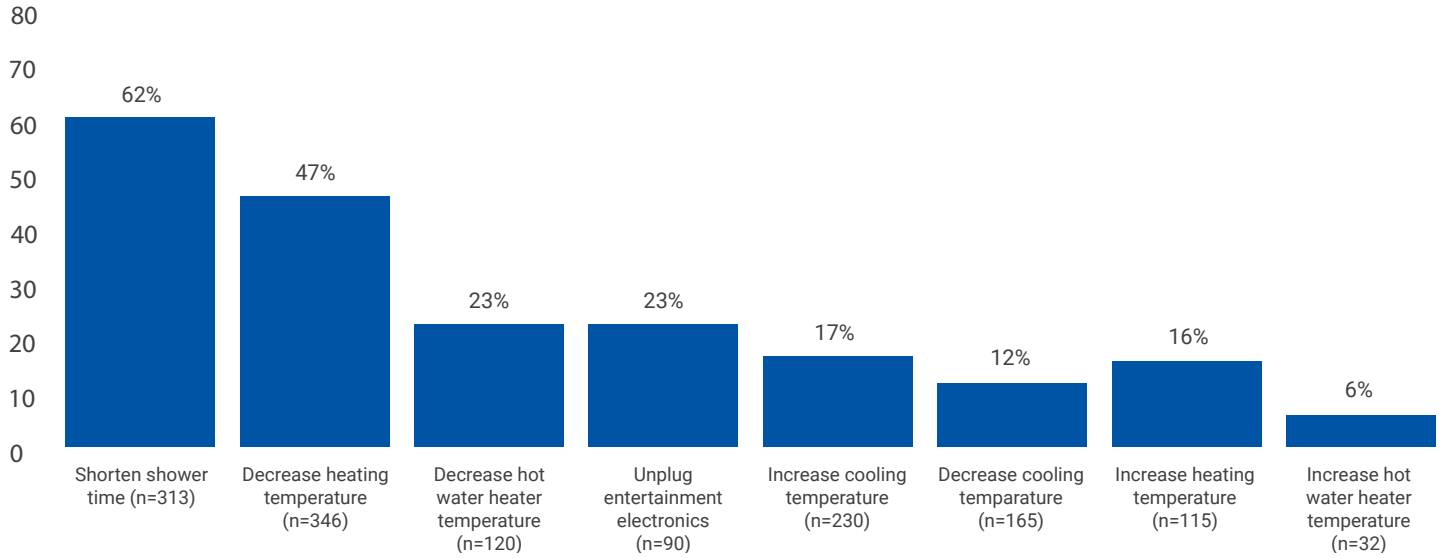
Figure 7. Energy Wise Kit Measure Installation Rates



4 We extrapolated the average savings per responding participants to the entire population of participants. This approach is supported by findings in the evaluation report: Navigant Consulting. *Elementary Energy Education Program*. Prepared for Commonwealth Edison Company and Nicor Gas Company. 2013.

The survey also included questions about participants' energy-saving behaviors as implemented in their home (Figure 8).

Figure 8. Behavior Change Implementation Rates



Some households decreased their heating setting and increased their cooling setting. Participants also reported shortening shower times and unplugging electronics when not in use. The surveys also revealed that some participants increased their heating temperatures and decreased their cooling temperature, which negatively impacted their savings. Cadmus factored positive and negative energy impacts into the total program savings.

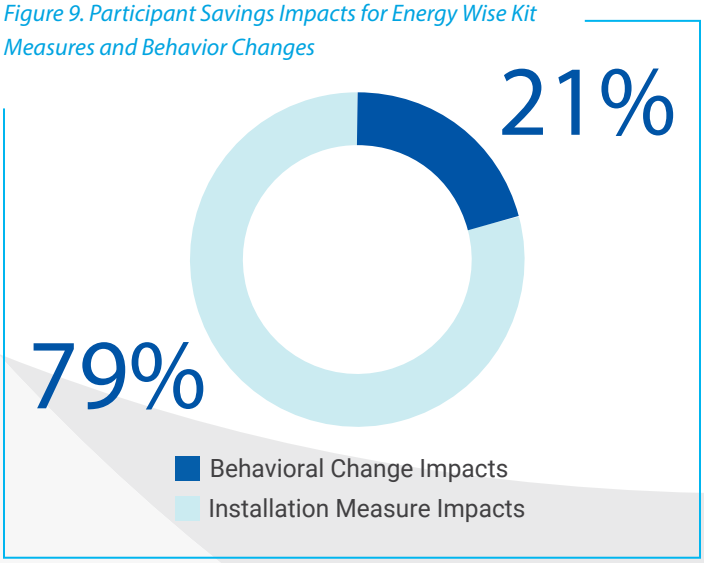
Savings Calculations

Cadmus based the energy and cost savings calculations for the Energy Wise Program on the average participating household characteristics, Energy Wise Kit measure installation rates, participants' reported behavior changes, and the Iowa Energy Efficiency Statewide Technical Reference Manual Version 3.0 (Iowa TRM) . For each measure, we estimated water, electricity, and natural gas savings. This section provides descriptions of the calculations we used, including installation rates and impacts generated by average participants. Appendix A provides further detail on the inputs and sources used in the savings calculations.

The average participating household saved approximately $89.77 per year on its combined utility bills. These savings will continue for several years over the life of the Energy Wise Kit measures.

The survey results show that 79% of the total dollar savings in 2018 was attributable to installing the Energy Wise Kit measures and 21% derived from adopting energy-saving behaviors (Figure 9). We assumed shorter lifetimes when estimating the behavior-change savings from the educational component of the program; however, these effects can last indefinitely if reinforced through ongoing educational efforts.

Figure 9. Participant Savings Impacts for Energy Wise Kit Measures and Behavior Changes



5 Iowa Energy Efficiency Statewide Technical Reference Manual Version 3.0 Volume 2: Residential Measures. September 14, 2018. Effective January 1, 2019.

Energy Wise Kit Measure Installation Savings

This section describes the savings derived from each measure in the Energy Wise Kit.

LEDs

Cadmus determined LED savings based on the wattage of the replaced bulb, as prescribed by Energy Independence and Security Act (EISA) lighting standards and the Iowa TRM.[6] Using these parameters, the following formulas provided average savings per participant:

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * (WHFeHeat + (WHFeCool - 1))$$

$$\Delta Therms = - \frac{\frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * Hours * HF * 0.03412}{\eta Heat} * \%GasHeat$$

Where:

$Watts_{Base}$	=	Baseline bulb wattage
$Watts_{EE}$	=	Efficient bulb wattage
ISR	=	In-service rate
WHFeHeat	=	Waste heat factor electric heating
WHFeCool	=	Waste heat factor electric cooling
HF	=	Heating factor
ηHeat	=	Efficiency of heating system

Table 2 shows the average wattage of the replaced bulbs and amount of savings generated from the replacement bulbs. For 9-watt LEDs, Cadmus calculated the wattage of the replaced bulbs by applying the EISA-derived ratio of efficient wattage to baseline wattage.

Table 2. LED Lighting Characteristics and Savings

Energy Wise Kit Measure	Average Wattage of Bulb Replaced	Installation Rate	Average Participant Savings (kWh/year)	Average Participant Savings (therm/year)
9-watt LED1	**29.5**	**86%**	**19.8**	**-0.3**
9-watt LED2	**29.5**	**77%**	**17.9**	**-0.3**
9-watt LED3	**29.5**	**70%**	**16.1**	**-0.3**

High-Efficiency Showerhead

By installing the high-efficiency showerhead, program participants received water and electric and natural gas savings. Cadmus calculated showerhead savings based on survey results and the Iowa TRM using the following formulas:

6 Ibid

$$\Delta kWh = \%ElectricDHW * (GPM_base - GPM_low) * L * Household * SPCD * \frac{365.25}{SPH} * EPG_electric * ISR$$

$$\Delta Therms = \%FossilDHW * \left((GPM_base - GPM_low) * L * Household * SPCD * \frac{365.25}{SPH} \right) * EPG_gas * ISR$$

$$\Delta Gallons = (GPM_base - GPM_low) * L * Household * SPCD * \frac{365.25}{SPH} * ISR$$

Where:

%ElectricDHW	=	Proportion of homes with electric water heat
GPM_base	=	Gallons per minute for baseline fixture
GPM_low	=	Gallons per minute for low-flow fixture
L	=	Length of shower time per person per day (minutes)
Household	=	People per household
SPCD	=	Number of showers per person per day
EPG_electric	=	Energy per gallon of hot water supplied by electricity
ISR	=	In-service rate
%FossilDHW	=	Proportion of homes with natural gas water heater
SPH	=	Number of showerheads per home
EPG_gas	=	Energy per gallon of hot water supplied by natural gas

Table 3 lists the electric and natural gas savings for installing efficient showerheads. On average, program participants also saved 1,777 gallons of water per year.

Table 3. Showerhead Characteristics

Fuel Type	Pre-Installation Flow Rate	Post-Installation Flow Rate	Usage Minutes per Day	Saturation	Installation Rate	Average Participant Savings (unit/year)
Electric	**2.35 gpm**	**1.5 gpm**	**7.8**	**45%**	**70%**	**88.2 kWh**
Natural Gas				**54%**		**4.6 therms**

Kitchen and Bathroom Faucet Aerators

Cadmus calculated water, electric, and natural gas savings from installing high-efficiency faucet aerators using a method similar to that used for showerheads, using the two equations from the Iowa TRM provided below. Although surveys asked program participants to provide flow rates (gallons per minute) of their existing aerators and high-efficiency aerators, Cadmus used the default pre- and post-gallons-per-minute assumptions from the Iowa TRM.

$$\Delta kWh = \%ElectricDHW * ((GPM_base - GPM_low) * L * Household * SPCD * 365.25 * \frac{DF}{FPH}) * EPG_electric * ISR$$

$$\Delta Therms = \%FossilDHW * ((GPM_base - GPM_low) * L * Household * SPCD * 365.25 * \frac{DF}{FPH}) * EPG_gas * ISR$$

$$\Delta Gallons = ((GPM_base - GPM_low) * L * Household * 365.25 * \frac{DF}{FPH}) * ISR$$

Where:

%ElectricDHW	=	Proportion of homes with electric water heater
GPM_base	=	Gallons per minute for baseline fixture
GPM_low	=	Gallons per minute for low-flow fixture
L	=	Length of faucet use per person per day (minutes)
Household	=	People per household
DF	=	Drain factor
FPH	=	Number of faucets per household
EPG_electric	=	Energy use per gallon of hot water supplied by electricity
ISR	=	In-service rate
%FossilDHW	=	Proportion of homes with natural gas water heater
EPG_gas	=	Energy per gallon of hot water supplied by natural gas

Table 4 shows the key information we used to determine the kitchen aerator energy savings for electric and natural gas water heaters. On average, participants saved approximately 968 gallons of water per year from installing the kitchen faucet aerator.

Table 4. Kitchen Faucet Aerator Characteristics and Savings

Fuel Type	Pre-Installation Flow Rate	Post-Installation Flow Rate	Usage Minutes per Day	Saturation	Installation Rate	Average Participant Savings (unit/year)
Electric	**1.8 gpm**	**1.4 gpm**	**4.5**	**45%**	**75%**	**39.4 kWh**
Natural Gas				**54%**		**2.0 therms**

Table 5 shows the key information we used to determine the average savings for installing the bathroom faucet aerator. On average, participants saved approximately 384 gallons of water per year from installing the bathroom faucet aerator.

Table 5. Bathroom Faucet Aerator Characteristics and Savings

Fuel Type	Pre-Installation Flow Rate	Post-Installation Flow Rate	Usage Minutes per Day	Saturation	Installation Rate	Average Participant Savings (unit/year)
Electric Savings	**1.8 gpm**	**1.0 gpm**	**2**	**45%**	**69%**	**12.6 kWh**
Natural Gas				**54%**		**0.7 therms**

FilterTone Alarm

The FilterTone alarm helps save energy by alerting residents when it is time to change their furnace filter. Over time, the build-up of significant solids on the filter, such as dirt and dust, creates pressure that activates the alarm. Cadmus estimated that the amount of savings resulting from more regular filter changes is 1% of the base energy consumption for heating and cooling. We calculated energy savings from regular filter changes as follows: [7,8]

$$Heating\ Energy\ Savings\left(\frac{kWh/therm}{Year}\right) = Installation\ Rate \times Fuel\ Saturation \times 1\%\ Heating\ Baseline$$

$$Cooling\ Energy\ Savings\left(\frac{kWh}{Year}\right) = Installation\ Rate \times Fuel\ Saturation \times 1\%\ Cooling\ Baseline$$

Table 6 shows the electric and natural gas savings from installing the FilterTone alarm.

Table 6. Regular Filter Change Savings

Fuel Type	Installation Rate	Average Participant Savings (unit/year)	
		Heating	Cooling
Electric	**70%**	**24 kWh**	**31.4 kWh**
Natural Gas		**2.5 therms**	**-**

Rope Caulk

The Energy Wise Kits included rope caulk so participants can seal gaps in their window frames, around pipes, and any place with air infiltration. Cadmus estimated that installing rope caulk saved 1% of the base energy consumption for heating.[9] We applied the same methods used for the FilterTone alarm heating and cooling energy savings to calculate savings for this measure:

$$Heating\ Energy\ Savings\left(\frac{kWh/therm}{Year}\right) = Installation\ Rate \times Fuel\ Saturation \times 1\%\ Heating\ Baseline$$

$$Cooling\ Energy\ Savings\left(\frac{kWh}{Year}\right) = Installation\ Rate \times Fuel\ Saturation \times 1\%\ Cooling\ Baseline$$

Table 7 shows the electric and natural gas savings from participants' installing rope caulk in their home.

7 Reichmuth, Howard. *Engineering Estimates of Savings from Use of FilterTone Alarm.* November 1999.

8 The average annual space heating usage of 12,048 kWh and 576 therms and average annual space cooling usage of 1,697 kWh is based on the 2012 Cadmus potential study for Iowa and the equipment saturations and housing stock reported by participants.

9 California Measurement Advisory Council. California *Low-Income Energy Efficiency Program 2005 Costs and Bill Savings Report.* April 2006.

Table 7. Rope Caulk Savings

Fuel Type	Installation Rate	Average Participant Savings (unit/year)	
		Heating	Cooling
Electric	**57%**	**23.5 kWh**	**7.4 kWh**
Natural Gas		**2.1 therms**	**-**

Window Wrap

The Energy Wise Kits included window wrap that participants could apply to inefficient windows to reduce air infiltration. Cadmus estimated energy saving from window wrap by applying the following Iowa TRM formula's with survey results. We estimated that each window covered is approximate 8 square feet and used 2018 survey results to determine the number of windows covered.

Table 8 shows the electric and natural gas savings from participants' installing window wrap in their home.

$$\Delta kWh = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Old} + R_{New}}\right) * A_{window} * HDD * 24 * ADJ_{window}}{(\eta_{heat} * 3412)}$$

$$\Delta Therms = \frac{\left(\frac{1}{R_{Old}} - \frac{1}{R_{Old} + R_{New}}\right) * A_{window} * HDD * 24 * ADJ_{window}}{(\eta_{heat} * 100{,}000)}$$

Where:

ROld	=	R-value value of existing window assembly
RNew	=	R-value of added air layer
Awindow	=	Net area of insulated window (ft2)
HDD	=	Heating Degree Days
ηHeat	=	Efficiency of heating system
3412	=	Conversion from Btu to kWh
100,000	=	Conversion from Btu to therm

Cadmus also estimated electric savings for gas furnaces as result of reductions in fan operating times using the following formula from the Iowa TRM.

$$\Delta kWh heating = If\ gas\ furnace\ heat,\ kWh\ savings\ for\ reduction\ in\ fan\ run\ time$$

$$= \Delta Therms * Fe * 29.3$$

Where:

F_e	=	Furnace Fan energy consumption as a percentage of annual fuel consumption = 3.14%
29.3	=	kWh per therm

Table 8. Window Wrap Savings

Fuel Type	Installation Rate	Average Participant Savings (unit/year)
Electric	**61%**	**67.7 kWh**
Natural Gas		**2.4 therms**

Behavior Changes

The Energy Wise Kits included a digital thermometer so participants could adjust the temperature of their appliances or energy-using equipment such as water heaters, refrigerators and freezers, and heating and cooling units. The CAAs also encouraged participants to change the way they use energy in their home, such as by taking shorter showers and unplugging electronics when not in use.

The survey included questions about whether participants had engaged in the following energy-saving behaviors after completing the program:

- Changed the temperature settings for their water heating (increased or decreased)
- Changed the temperature settings for the space heating or cooling (increased or decreased)
- Shortened the length of their showers
- Unplugged home electronics

Cadmus used the participants' responses to calculate the effects of these energy-saving behaviors (the results are shown in Table 9 through Table 12). On average, participating households saved approximately 97.3 kWh and 5.1 therms per year by taking energy-efficient actions in their homes.

Water Temperature Adjustment

Cadmus based the savings associated with adjusting the water heater temperature on the Iowa TRM. We assumed that the average hot water heater temperature was reduced by 15 degrees and the average tank capacity was 50 gallons.[10,11]

$$\Delta kWh = \frac{(U * A * (Tpre - Tpost) * Hours)}{3{,}412 * RE_electric}$$

$$\Delta Therms = \frac{U * A * (Tpre - Tpost) * Hours}{100{,}000 * RE_gas}$$

Where:

U	=	Overall heat transfer coefficient of water heater tank
A	=	Surface area of water heater tank
Tpre	=	Hot water setpoint prior to adjustment
Tpost	=	New hot water setpoint

10 Iowa Energy Efficiency Statewide Technical Reference Manual Version 3.0 Volume 2: Residential Measures. September 14, 2018; Effective January 1, 2019.

11 Ibid

Hours	=	Number of hours in a year
RE_electric	=	Recovery efficiency of electric hot water heater
RE_gas	=	Recovery efficiency of natural gas hot water heater

Twenty-three percent of surveyed participants reduced their hot water heater temperatures. On average, participants saved 8.5 kWh and 0.4 therms per year from reducing the hot water heater temperature (Table 9).

Table 9. Water Temperature Change Characteristics and Savings

Action and Fuel Type	Implementation Rate	Change in Temp (°F)	Savings/ °F	Saturation	Average Respondent Savings (unit/year)
Decreasing Water Temperature					
Electric	**23.4%**	**-15**	**0.4%**	**45%**	**8.5 kWh**
Natural Gas				**54%**	**0.4 therms**
Increasing Water Temperature					
Electric	**6.2%**	**5**	**0.4%**	**45%**	**-0.8 kWh**
Natural Gas				**54%**	**-0.04 therms**

Space Temperature Adjustment

Cadmus estimated that heating and cooling temperature adjustments save 1% of the base energy consumption, per degree adjusted.[12] We used the following calculation, similar to the water heater adjustment, to estimate space temperature savings:

$$\text{Space Temperature Energy Savings} \left(\frac{\text{kWh/therm}}{\text{Year}} \right) = \text{Installation Rate}$$
$$\text{x } (\text{Avg°F}_{Pre} - \text{Avg°F}_{Post}) * \text{Fuel Saturation} * 1\% \text{ Heating/Cooling Baseline}$$

Forty-seven percent of surveyed participants decreased their heating temperatures and reported average reductions of 4 degrees, and 17% of participants increased their cooling temperatures and reported an average increase of 3.8 degrees. On average, participants saved 47 kWh or 4 therms by adjusting their space heating temperature, and they saved 4 kWh by adjusting their space cooling temperature (Table 10).

12 U.S. Department of Energy. *Energy Efficiency and Renewable Energy.* June 24, 2012. Available online: https://energy.gov/energysaver/thermostats

Table 10. Air Temperature Change Characteristics and Savings

Action and Fuel Type	Installation Rate	Change in Temp (°F)	Savings/ °F	Saturation	Average Respondent Savings (unit/year)
Decreasing Heating Temperature					
Electric	**47%**	**-3.7**	**1%**	**34%**	**71.4 kWh**
Natural Gas				**63%**	**6.3 therms**
Increasing Heating Temperature					
Electric	**16%**	**3.7**	**1%**	**34%**	**-24 kWh**
Natural Gas				**63%**	**-2.1 therms**
Decreasing Cooling Temperature					
Electric	**12%**	**-3.4**	**1%**	**98%**	**-6.8 kWh**
Increasing Cooling Temperature					
Electric	**17%**	**3.8**	**1%**	**98%**	**10.7 kWh**

Shortened Shower Length

Cadmus used the following calculation to estimate energy savings for this behavior change:[13]

$$Water\ Heating\ Energy\ Savings\left(\frac{kWh}{\frac{therm}{Year}}\right) = Installation\ Rate \times \left(\frac{Min}{Day}_{Pre} - \frac{Min}{Day}_{Post}\right) \times Fuel\ Saturation \times \frac{Savings}{min} \times 365$$

On average, participants saved 14.1 kWh or 0.5 therms by reducing the length of their showers (Table 11). Program participants also saved an average of 284 gallons of water per year by reducing their shower time.

13 Cadmus used the average shower length reduction from the following source: U.S. Environmental Protection Agency. *Water and Energy Savings from High Efficiency Fixtures and Appliances in Single Family Homes*. 2005.

Table 11. Shortened Shower Characteristics and Savings

Fuel Type	Installation Rate	Change in Minutes/Day	Saturation	Average Respondent Savings (unit/year)
Electric	**62%**	**-0.84**	**45%**	**14.1 kWh**
Natural Gas			**54%**	**0.5 therms**

Unplug Electronics

To estimate savings from this measure, Cadmus used survey responses to determine the percentage of participants who unplugged electronics, with a fixed average savings value of 0.042 kW[14] per home. We used these inputs in the following equation to calculate average savings per participant:[15]

$$Electric\ Energy\ Savings\left(\frac{kWh/therm}{Year}\right) = Installation\ Rate*2{,}452\ hrs*0.042\ kW$$

On average, participants saved 24 kWh by unplugging electronics in their homes (Table 12).

Table 12. Unplugged Electronics Characteristics and Savings

Fuel Type	Installation Rate	Change in Watts	Saturation	Average Participant Savings (unit/year)
Electric	**23%**	**42**	**100%**	**24 kWh**

Program Savings Summary

On average, each Energy Wise participant in Iowa saved approximately $89.77 in the first year of participation. Table 13 details participant savings by each Energy Wise Kit measure installed and each energy-saving behavior adopted.

14 Cadmus used plug load information from the following source: Lawrence Berkley National Laboratory. *Standby Power Summary Table*. Available online: http://standby.lbl.gov/summary-table.html.

15 The 2,452 value equals annual hours unplugged and assumes electronics being unplugged for more hours on school days and fewer hours on weekends, holidays, and summer.

Table 13. Average Annual Participant Household Savings[a]

Energy-Efficient Kit Measure or Behavior Change	Electric (kWh)	Natural Gas (therms)	**Water (gallons)**
9-Watt LED1	**19.8**	**-0.3**	**0**
9-Watt LED2	**17.9**	**-0.3**	**0**
9-Watt LED3	**16.1**	**-0.3**	**0**
High-Efficiency Showerhead	**88.2**	**4.6**	**1,777.3**
Faucet Aerator - Kitchen	**39.4**	**2.0**	**968.4**
Faucet Aerator - Bathroom	**12.6**	**0.7**	**384.1**
FilterTone Alarm	**24.0**	**2.5**	**0.0**
Rope Caulk	**30.8**	**2.1**	**0.0**
Window Wrap	**68.7**	**2.4**	**0.0**
Decrease Hot Water Temperature	**8.5**	**0.4**	**0.0**
Increase Hot Water Temperature	**-0.8**	**-0.04**	**0.0**
Decrease Heating Temperature	**71.4**	**6.3**	**0.0**
Increase Heating Temperature	**-24.0**	**-2.1**	**0.0**
Decrease Air Conditioning Temperature	**-6.7**	**0**	**0.0**
Increase Air Conditioning Temperature	**10.7**	**0**	**0.0**
Shorten Shower Time	**14.1**	**0.5**	**283.8**
Unplug Home Electronics	**24.1**	**0**	**0.0**
Total	**446.3**	**18.5**	**3,414**
Cost Savings	**$57.6**	**$18.7**	**$13.39**
Total Savings Per Participant			**$89.77**

[a] The total savings values may not sum due to rounding. Cadmus calculated the cost savings using the electric (12.91¢ per kWh) and natural gas ($1.01 per them) rates reported by the Energy Information Administration and water rate of $2.93 per centum cubic feet based on a comparison of water utilities.

Table 14 lists the overall annual participant bill savings for the program, which are projected to total $399,550 in cost savings for the first year following program participation.

Table 14. Year One Overall Energy Wise Resource and Cost Savings[a]

Energy-Efficient Kit Measure or Behavior Change	Electric (kWh)	Natural Gas (therms)	**Water (gallons)**
9-Watt LED1	88,011	-1,359	-
9-Watt LED2	79,507	-1,199	-
9-Watt LED3	71,736	-1,041	-
High-Efficiency Showerhead	392,656	25,735	7,910,881
Faucet Aerator - Kitchen	175,473	9,690	4,310,132
Faucet Aerator - Bathroom	56,254	3,018	1,709,651
FilterTone Alarm	246,665	12,327	-
Rope Caulk	137,203	9,302	-
Window Wrap	305,866	8,220	-
Decrease Hot Water Temperature	38,023	2,572	-
Increase Hot Water Temperature	-3,380	-188	-
Decrease Heating Temperature	317,707	32,438	-
Increase Heating Temperature	-106,842	-8,634	-
Decrease Air Conditioning Temperature	-30,447	-	-
Increase Air Conditioning Temperature	47,786	-	-
Shorten Shower Time	62,697	2,362	1,263,159
Unplug Home Electronics	107,358	-	-
Total	**1,986,273**	**82,406**	**15,193,822**
Cost Savings	**$256,428**	**$83,545**	
Total Savings Per Participant			**$399,550**

[a] The total savings value may not sum due to rounding.

Peak Impacts

Based on the average annual participant household savings per measure reported in Table 13, Cadmus determined the kilowatt and on-peak therm savings impacts per Energy Wise Kit. We based the peak inputs on the Iowa TRM, with the exception of the FilterTone alarm, window wrap, and rope caulk. These were based on end-use load shapes using system peak definitions from the 2013 planning studies (Table 15).

Table 15. 2018 Energy and Peak Therms Impact per Energy Wise Kit

Measure	kW Savings	On-Peak Therm Savings
9-Watt LED1	**0.003**	**-0.001**
9-Watt LED2	**0.002**	**-0.001**
9-Watt LED3	**0.002**	**-0.001**
High-Efficiency Showerhead	**0.005**	**0.013**
Faucet Aerator - Kitchen	**0.006**	**0.006**
Faucet Aerator - Bathroom	**0.01**	**0.002**
FilterTone Alarm		**0.027**
Water Heater Setback	**0.001**	**0.003**
Rope Caulk		**0.020**
Window Wrap		**0.103**
Total	**0.029**	**0.166**

Potential Savings

The sections above described the calculated average savings resulting from the participants' first year in the program. The actual savings for individual participants vary by the characteristics of their pre-installation energy use, which measures they installed, their household demographics, and what energy-saving behavior(s) they adopted in their home.

Households that installed all of the Energy Wise Kit measures and implemented energy-saving actions in their home could save a significant amount of money and energy, as much as $266 (for homes with electric space and water heating) or $124 (for homes with natural gas space and water heating) on their annual utility bills, depending on their heating fuel type (Table 16).

Table 16. Potential Annual Household Savings for Participants

Energy-Efficient Measure or Behavior Change	Electric Space and Water Heat	Natural Gas Space and Water Heat
9-Watt LED1	$2.98	$2.39
9-Watt LED2	$2.98	$2.39
9-Watt LED3	$2.98	$2.39
High-Efficiency Showerhead	$36.20	$12.19
Faucet Aerator - Kitchen	$15.18	$5.11
Faucet Aerator - Bathroom	$5.26	$1.77
FilterTone Alarm	$25.10	$15.39
Rope Caulk	$18.28	$8.57
Window Wrap	$42.33	$6.33
Decrease Hot Water Temperature	$10.53	$3.54
Decrease Heating Temperature	$57.07	$21.44
Increase Air Conditioning Temperature	$8.32	$8.32
Shorten Shower Time	$6.55	$1.47
Unplug Home Electronics	$13.28	$13.28
Bill Savings	**$247.04**	**$104.59**
Water Savings	**$18.96**	**$18.96**
Total Per Participant Savings	**$266.00**	**$123.55**

Lifetime Savings

Based on the lifetime of each installed Energy Wise Kit measure, coupled with the expectation that households will continue the energy-saving behaviors they reported, Cadmus calculated the long-term value of Energy Wise. Table 17 shows the lifetime of each measure according to manufacturer information. We conservatively estimated a two-year lifetime for behavioral changes, although these changes could continue indefinitely if reinforced with educational messages.

Table 17. Lifetime of Energy Wise Kit Measures and Behavior Changes

Energy-Efficient Measure or Behavior Change	Lifetime (Years)
9-Watt LED1	**10**
9-Watt LED2	**10**
9-Watt LED3	**10**
High-Efficiency Showerhead	**10**
Faucet Aerator - Kitchen	**9**
Faucet Aerator - Bathroom	**9**
FilterTone Alarm	**3**
Rope Caulk	**3**
Window Wrap	**1**
Behavioral Changes	**2**

Applying these lifetime estimates and the average participant savings, we calculated the present value of the savings for each Energy Wise Kit measure and the present value of each type of behavioral change (Table 18).[16]

16 Cadmus calculated the present value using reported measure lives and a 3.01% discount rate derived from the 10-year value U.S. Treasury Note from January 2, 2018 to December 31, 2018. U.S. Department of the Treasury website: https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=longtermrateYear&year=2018

Table 18. Present Value of Energy Wise for Participants

Energy-Efficient Kit Measure or Behavior Change	Electricity Bill	Natural Gas Bill	Water Bill
9-Watt LED1	**$81,541**	**-$1,317**	**$0**
9-Watt LED2	**$73,662**	**-$1,172**	**$0**
9-Watt LED3	**$66,463**	**-$1,057**	**$0**
High-Efficiency Showerhead	**$432,010**	**$175,547**	**$264,360**
Faucet Aerator - Kitchen	**$176,234**	**$71,612**	**$131,479**
Faucet Aerator - Bathroom	**$56,498**	**$22,958**	**$52,152**
Filter Tone Alarm	**$90,044**	**$32,428**	**$0**
Rope Caulk	**$50,085**	**$26,594**	**$0**
Window Wrap	**$38,330**	**$10,483**	**$0**
Behavioral Changes	**$106,911**	**$43,993**	**$9,475**
Utility Bill Reduction	**$1,171,779**	**$380,069**	**$457,467**
Program Total			**$2,009,315**

Over the lifetime of the installed Energy Wise Kit measures, the program has the potential to yield approximately $5.52 in participant savings for every $1 invested.

Savings Allocation to Utility

Energy Wise is sponsored by Alliant Energy Corporation, Black Hills Energy, and MidAmerican Energy, in coordination with the Iowa Utility Association. Table 19 shows the annual electricity and natural gas savings allocated to each utility based on their portion of funding the Energy Wise Program. The program does not track kits by utility due to overlapping service territories; however, we have estimated the approximate number of kits delivered to each utility's customers based on same allocation as the savings.

Table 19. Savings Allocation to Utility

Impacts by Utility	Electric (kWh)	Natural Gas (therm)	Electric (kW)	On-peak therm savings	Approximate Number of Kits
Alliant Energy	**1,086,508**	**27,826**	**72**	**245**	**2,207**
Black Hills Energy	**-**	**31,536**	**-**	**277**	**417**
MidAmerican Energy	**899,765**	**23,044**	**60**	**203**	**1,827**
Total Savings	**1,986,273**	**82,406**	**132**	**725**	**4,451**

Appendix A. Savings Inputs and Sources

Cadmus estimated energy savings for the Energy Wise Kit measures. Table 20 provides details on the input values and sources used for these estimates.

Table 20. Iowa Energy Wise Program Savings Inputs and Sources

Assumption	Cadmus Value	Cadmus Source
LED		
Watts baseline	29.5	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Watts efficient	9	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Hours	1,157	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Waste heat factor cooling	1.12	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018 and survey data
Waste heat factor heating	0.87	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018 and survey data
In-service rate (1st, 2nd, 3rd)	86%, 77%, 70%	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Heating factor	0.53	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Efficiency of heating system	78%	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Percentage of homes with natural gas heat	70.8%	Survey data
Participants	4,451	Cadmus program tracking
Effective useful life (years)	10	Iowa TRM 2017
High-Efficiency Showehead		
Average household size	2.62	Weighted average based on survey data
Showers per home	1.5	Survey data weighted average
Percentage water heated by natural gas	54%	Survey data
Percentage water heated by electricity	45%	Survey data
In-service rate	70%	Survey data

Assumption	Cadmus Value	Cadmus Source
Average showerhead flow rate (gpm)	2.35	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Average retrofit flow rate (gpm)	1.5	Cadmus program tracking
Participants	4,451	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Showers per capita per day	0.6	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Shower duration (minutes)	7.8	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Shower temperature (°F)	101	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Ground water temperature (°F)	56.5	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Natural gas water heater efficiency	2.51	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Ground water temperature (°F)	56.5	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Kitchen Faucet Aerator		
Average household size	2.62	Weighted average based on survey data
Percentage of water heated by natural gas	54%	Survey data
Percentage of water heated by electricity	45%	Survey data
In-service rate	75%	Survey data
Average kitchen aerator flow rate (gpm) * throttling factor	1.83	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Average retrofit flow rate (gpm) *throttling factor	1.43	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Participants	4,451	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Length of use (minutes per person per day)	4.5	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Fixtures per household	1.0	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Electric water heater efficiency	0.98	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Natural gas water heater efficiency	0.78	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Drain factor	75%	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Effective useful life (years)	9	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Electric water heater efficiency	0.98	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Faucet temperature (°F)	93	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018

Assumption	Cadmus Value	Cadmus Source
Ground water temperature (°F)	56.5	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Bathroom Faucet Aerator		
Average household size	2.62	Weighted average based on survey data
Percentage of water heated by natural gas	54%	Survey data
Percentage of water heated by electricity	45%	Survey data
In-service rate	69%	Survey data
Average kitchen aerator flow rate (gpm) * throttling factor	1.83	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Average retrofit flow rate (gpm) *throttling factor	0.95	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Participants	4,451	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Length of use (minutes per person per day)	1.65	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Fixtures per household	2.25	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Electric water heater efficiency	0.98	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Natural gas water heater efficiency	0.78	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Effective useful life (years)	9	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018
Filter Tone Alarm		
Annual energy (kWh) use for space heating or furnace	12,048	Cadmus Potential Study for Iowa 2012 adjusted by survey reported housing stock and equipment saturation
Annual energy (therms) use by central space heating or furnace	576	Cadmus Potential Study for Iowa 2012 adjusted by survey reported housing stock and equipment saturation
Projected increase in efficiency (natural gas)	1%	Reichmuth, Howard. Engineering Estimates of Savings from Use of Filter Tone Alarm. November 1999.
In-service rate	69.6%	Survey data
Percentage of space heated by electricity	34.12%	Survey data
Percentage of space heated by natural gas	63.33%	Survey data
Participants	4,451	Program data
Effective useful life (years)	3	Cadmus

Assumption	Cadmus Value	Cadmus Source
Rope Caulk		
Annual energy (kWh) use for space heating or furnace	12,048	Cadmus Potential Study for Iowa 2012 adjusted by survey reported housing stock and equipment saturation
Annual energy (therms) use by central space heating or furnace	576	Cadmus Potential Study for Iowa 2012 adjusted by survey reported housing stock and equipment saturation
Projected increase in efficiency (natural gas)	1%	California Measurement Advisory Council. California Low-Income Energy Efficiency Program 2005 Costs and Bill Savings Report. April 2006.
In-service rate	51.7%	Survey data
Percentage of space heated by electricity	34.12%	Survey data
Percentage of space heated by natual gas	63.33%	Survey data
Participants	4,451	Program Data
Effective useful life (years)	3	Cadmus
Window Wrap		
^{R}old	R-2	Iowa Technical Reference Manual 2017
^{R}new	R-2.85	Iowa Technical Reference Manual 2017
^{A}window (square feet)	8	Iowa Technical Reference Manual 2017
ADJwindow	63%	Iowa Technical Reference Manual 2017
HDD	5052	Iowa Technical Reference Manual 2017
Efficiency of heating system (gas)	0.74	Iowa Technical Reference Manual 2017 and and weighted survey results by equipment saturation
Efficiency of heating system (electric)	1.0	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018 and weighted survey results by equipment saturation.
Windows covered	2.44	Survey data
In-service rate	61%	Survey data
Percentage of space heated by electricity	34.12%	Survey data
Participants	4,451	Cadmus program tracking
Effective useful life (years)	1	Iowa TRM Version 3.0, Volume 2: Residential Measures, September 14, 2018

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